Groundwater Monitoring in Texas

ACWI SOGW Meeting
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Texas Commission on Environmental Quality
Groundwater in Texas

- Groundwater supplied 57 percent of the 16.2 million acre-feet of water used in the State in 2003
- 80 percent of the groundwater used in 2000 was for irrigation
- Remainder used for municipal supplies, rural and municipal domestic consumption, rural livestock, electric utility, and industry
- Approximately 33 percent of municipal water is obtained from groundwater sources
- Groundwater provides a significant amount of the base flow for the state’s rivers and streams, and is important to the maintenance of the state’s environment and economy
Mapped Aquifers

- **Nine Major Aquifers**
  Defined as producing large quantities of water in a comparatively large area of the state

- **Twenty-one Minor Aquifers**
  Defined as producing significant quantities of water within smaller geographic areas or small quantities in large geographic areas

- The major and minor aquifers are composed of many rock types, including limestones, dolomites, sandstones, gypsum, alluvial gravels, and in some parts of the state, igneous rocks

- The major and minor aquifers underlie approximately 76 percent of the state's surface area
Major aquifers

- Ogallala
- Seymour
- Trinity
- Carrizo-Wilcox
- Hueco-Mesilla Bolsons
- Edwards-Trinity (Plateau)
- Edwards (Balcones Fault Zone)
- Gulf Coast
The TGPC

- Created 1989 by Legislation
- Implements State’s Groundwater Protection Strategy
- Publishes Joint Groundwater Monitoring and Contamination Report
- Facilitates the Coordination of Member Agencies
Data Management Subcommittee

- Data Management Coordination
- Joint Groundwater Monitoring and Contamination Report
- Groundwater portion of the 305(b)
- Statewide Groundwater Monitoring Design
Data Dictionary - 1996

- Standardized framework for collecting and storing information on ground water
- 135 data elements
- Core set specified to meet the requirements of the Minimum Set of Data Elements for Ground Water Quality (MSDE)
- Reviewed 2006

Joint Groundwater Monitoring and Contamination Report—2006

- Annual report
- Describes the current status of groundwater monitoring programs for all Agencies
- Describes 5,576 groundwater contamination cases documented or under enforcement during the 2006 calendar year
Groundwater Monitoring Programs

- Regulatory agencies require or conduct monitoring to assure compliance with guidelines and regulations for the protection of groundwater from discharges of contaminants
- Agencies or entities conducting monitoring to assess ambient or existing groundwater quality conditions and to track changes in water quality over time
- Agencies or entities conducting research activities related to groundwater resources and groundwater conservation
Texas Water Development Board
Water Quality Sampling Program

- Monitor changes in the quality of groundwater over time and to establish natural baseline quality of groundwater in the state's aquifers
- Collected on a rotating schedule every 4 years
- Samples collected in accordance with procedures established in the TWDB's Field Manual for Ground-Water Sampling
- Results from analyses and results sampled by other entities are also entered in the TWDB’s groundwater database
Wells and springs in database

~130,000 wells and spring
Groundwater quality sampling sites and sampling agency

- Texas Water Development Board
- U.S. Geological Survey
- Cooperators
- Major aquifers
- Minor aquifers (only shown where there is no major aquifer)

Water quality measurements 2000-2005
Use data from the TWDB’s Ambient Groundwater Monitoring program, augmented by data from the TCEQ’s database of Public Water Supply analyses, to provide an idea of the extent of undesirable groundwater constituents for certain aquifers.

Constituents include nitrate, arsenic, fluoride, chloride, sulfate, iron, manganese, perchlorate, and total dissolved solids in aquifers where they pose a particular risk or problem with respect to the use of groundwater.
Distribution of perchlorate concentrations in the High Plains region of Texas

Perchlorate Concentration
- Greater than 51 ug/l
- Greater than 24.5 ug/l, but less than 51 ug/l
- Greater than 17 ug/l, but less than 24.5 ug/l
- Greater than 6 ug/l, but less than 17 ug/l
- Greater than 4 ug/l, but less than 6 ug/l
- Greater than 1 ug/l, but less than 4 ug/l
- Less than 1 ug/l
Distribution of Nitrate in the Ogallala Aquifer

Nitrate Concentration
- ▲ Less than 10 mg/l
- ★ 10 mg/l or greater, but less than 100 mg/l
- ★★ 100 mg/l or greater

Outcrop of the Ogallala Aquifer
Draft Texas Groundwater Monitoring Strategy

- Establish a baseline set of data regarding number of wells, well distribution, constituents of concern, land-use (hydro-geographical)
- Evaluate trends in water quality
- Analyze land-use effects on water quality
- Evaluate recharge and recharge variability in all aquifers
- Determine constituents of concern and methods for early detection
- Determine aquifer water levels according to regional priority
- Evaluate cycles (seasonal changes) in water quality according to regional priority
Three Draft Network Types

- Basic – Aquifer-wide – ambient conditions
- Reference – Selected – undisturbed/least disturbed settings (as aquifer changes, point of reference for comparison)
- Targeted – Local – water quality issues (water use, land use)
Draft Well Selection Guidelines

- Wells should provide a statewide overview of ground water quality
- Wells should be selected to include all major and minor aquifers
- Well network should be integrated with existing water resources data networks
- Network should provide data on water quality for studies of regional significance
- Wells should represent both horizontal and vertical distributions
- Wells should represent both domestic and public supplies
Draft Well Selection Guidelines

For Basic and Reference wells:

- Wells should be systematically distributed with respect to regional flow
- Wells should be selected so that analytical data will refine the definition of baseline quality
- Wells should be part of a present water resource data base
- Wells should be frequently used, to assure samples are representative
Draft Well Selection Guidelines

For Targeted wells:

- Wells should be selected within cones of depression in major metropolitan area pumping centers
- Wells should be selected from areas where many wells of a single type, such as irrigation wells, are concentrated
- Wells should be selected from hydrogeologically sensitive areas
Draft Well Selection Guidelines

For all wells:

❖ Adequate information must be available to enable field personnel to positively identify the well
❖ A geologic log of the well borehole must be available to identify the sequence of geologic materials penetrated by the well
❖ Well construction information must be provided, including depth drilled, depth of casing, casing material and diameter, length of open hole or type and length of screen
Constituents are Monitored according to Network Type and Aquifer Priority Levels

- Basic and Reference wells will be monitored for all compounds of interest based upon aquifer priority
- Targeted wells will be monitored for specific compounds of interest, based on the constituent(s)
Draft Priority for Major Aquifers
### Draft Constituent Groups Proposed For Monitoring

<table>
<thead>
<tr>
<th>Group</th>
<th>Constituents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field parameters</td>
<td>Water level, pH, dissolved oxygen, specific conductance, temperature, alkalinity (bicarbonate, carbonate)</td>
</tr>
<tr>
<td>Inorganics (Major ions)</td>
<td>Dissolved solids, calcium, magnesium, potassium, sodium, chloride, sulfate, bromide, fluoride, silica, sulfide, and others</td>
</tr>
<tr>
<td>Trace elements</td>
<td>Aluminum, arsenic, chromium, copper, iron, lead, manganese, nickel</td>
</tr>
<tr>
<td>Trace elements (Targeted)</td>
<td>Antimony, barium, beryllium, boron, cadmium, cobalt, iodide, lithium, mercury, molybdenum, selenium, silver, strontium, vanadium, zinc</td>
</tr>
<tr>
<td>Nutrients</td>
<td>Nitrate, nitrite, ammonia, organic nitrogen, phosphate, phosphorus</td>
</tr>
<tr>
<td>Organics (Organic compounds)</td>
<td>Organic carbon, volatile organic compounds, semivolatile organic compounds, polycyclic aromatic hydrocarbons, polychlorinated biphenyls, phenols, and others</td>
</tr>
<tr>
<td>Pesticides (Pesticide compounds)</td>
<td>Herbicides, insecticides, fungicides, rodenticides (organochlorines, organophosphates, carbamates, triazines, amides, pyrethroids, breakdown products, and others)</td>
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<tr>
<td>Microbiology</td>
<td>Coliform, streptococci, protozoans, and others</td>
</tr>
<tr>
<td>Radionuclides (Radioactivity)</td>
<td>Gross alpha and gross beta radiation, radium, uranium, radon</td>
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<tr>
<td>Gases</td>
<td>Argon, carbon dioxide, nitrogen, methane, and others</td>
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<tr>
<td>Emerging Contaminants (Wastewater analytes; pharmaceuticals, personal care products)</td>
<td>Human and veterinary pharmaceuticals, wastewater analytes (for example: caffeine, surfactants), coliphage, viruses, perchlorate and others</td>
</tr>
</tbody>
</table>
Axes contain the different network types, aquifer priority levels and constituent/parameter groups.

The field of the matrix is populated by sampling regimes; note that frequency of sampling is denoted in the matrix for frequency in years.

Targeted wells, the constituent(s) for which the well was targeted would be the only constituent(s) sampled at the suggested frequency rate.
## Draft Monitoring Matrix

<table>
<thead>
<tr>
<th>Network</th>
<th>Aquifer Level</th>
<th>Field Parameters</th>
<th>Inorganics</th>
<th>Trace Elements</th>
<th>Trace Elements (Targeted)</th>
<th>Nutrients</th>
<th>Organics</th>
<th>Pesticides</th>
<th>Microbiology</th>
<th>Radio-nuclides</th>
<th>Emerging Contaminants</th>
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<td>Priority I</td>
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<td>Basic &amp; Reference</td>
<td>Priority II</td>
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</tr>
</tbody>
</table>
Texas Water Development Board
Groundwater Level Measuring Program

- Measures groundwater levels annually in 2500 - 2900 wells completed in the 30 major and minor aquifers and located throughout the state
- Measure depths to water in accordance with procedures outlined in the TWDB Water-Level Measuring Manual
- Cooperators from groundwater conservation districts, a few cities, and the USGS provide an additional 6,000 measurements annually
- Information entered in the TWDB groundwater database
Water Level Measurements 2006

Water level measurement site and measuring agency:
- Texas Water Development Board
- U.S. Geological Survey
- Cooperators
- Major aquifers
- Minor aquifers (only shown where there is no major aquifer)
Water level recorder sites 2006

Water level recorder measurement sites and measuring agency

- Texas Water Development Board
- U.S. Geological Survey
- Edwards Aquifer Authority
- Blanco-Pedernales Groundwater Conservation District
- Cow Creek Groundwater Conservation District
- Hays-Trinity Groundwater Conservation District
- Panhandle Groundwater Conservation District
- Austin Community College
- Texas State University and Sul Ross State University
- Major aquifers
- Minor aquifers (only shown where there is no major aquifer)
Uses of Groundwater Level Measurement Data

- Identification of areas that are currently or expected to experience critical groundwater shortages within the next 25 years
- Background information for the State Water Planning Activities
- Data for the Groundwater Availability Modeling efforts
Priority Groundwater Management Area Studies
The demand for water is expected to increase by 27 percent, from almost 17 million acre-feet of water in 2000 to 21.6 million acre-feet in 2060.

Groundwater availability - the amount of water from an aquifer that is available for use - is projected to decrease 22 percent, from 12.7 million acre-feet per year in 2010 to 9.9 million acre-feet per year by 2060.
TWDB Groundwater Availability Modeling

- Provide reliable, timely data on groundwater availability to the citizens of Texas to ensure adequacy of supplies or recognition of inadequacy of supplies throughout the 50 year planning horizon.
- GAM will result in publicly available numerical groundwater flow models for the major and minor aquifers of Texas.
Groundwater availability models:
Major aquifers

Note:
The Edwards-Trinity (Plateau) and Pecos Valley aquifers are included in the same model.
These boundaries are approximate and do not show overlaps between models.
Groundwater availability models: Minor aquifers

Expected completion: 2011

Completed
Model development in progress
Structure development in progress for future model
Pending future model development
Online Resources - TWDB

- Groundwater resources
  <www.twdb.state.tx.us/groundwater>
- Water well database (levels & quality)
  <wiid.twdb.state.tx.us/>
- Daily water levels
  <www.twdb.state.tx.us/data/waterwells/>
- GIS coverages
  <www.twdb.state.tx.us/mapping/gisdata.asp>
- State Water Plan /Regional Water Plans
  <www.twdb.state.tx.us/publications/pub.asp>
Other Online Resources

Texas Groundwater Protection Committee
<www.tgpc.state.tx.us>
Texas Groundwater Protection Strategy
Joint Groundwater Monitoring and Contamination Report
Texas Groundwater Data Dictionary
GW part of 305(b) report

TWDB's Field Manual for Ground-Water Sampling

TWDB Water Level Measuring Manual
<www.twdb.state.tx.us/publications/manuals/UM-52/Um-52.pdf>