COVER PAGE

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SPONSORING ORGANIZATION: Texas Water Development Board

PROJECT TITLE: Texas Water Development Board Support of Persistent Data Services and Metadata Gap-Filling for Wells in the National Ground-Water Monitoring Network

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Summary of Texas Water Development Board's participation in the National Ground-water Monitoring Network

The Texas Water Development Board (TWDB) has participated in the National Ground-Water Monitoring Network (NGWMN, or Network) since its acceptance as a pilot project in 2009. The TWDB, mandated and allowed by the Texas Water Code to collect groundwater data, is the only agency in Texas that maintains statewide water-level and water-quality monitoring programs that include suitable sites available for inclusion in the NGWMN. TWDB has now selected just over 1,350 representative wells and springs with water-level and water-quality data in the state's nine major aquifers (Figure 1) for the NGWMN between 2009 and 2018 and provided web services for data retrieval in the NGWMN portal. Seven of eight principal or national aquifers underlying Texas (Table 1) primarily correspond to the nine major Texas aquifers, although configurations of the aquifers differ slightly (Figure 2). The eighth principal aquifer, or the Blaine, is considered a minor aquifer in Texas.

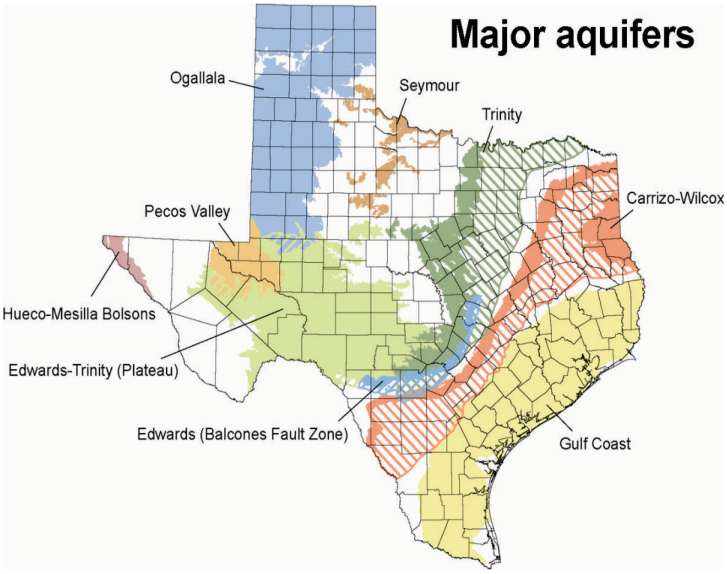


Figure 1. Major aquifers in Texas

Table 1. Principal aquifers and corresponding major Texas aquifers.

Principal Aquifer	(Major) Texas Aquifer
Coastal lowlands aquifer system	Gulf Coast Aquifer
Texas coastal uplands aquifer system	Carrizo-Wilcox Aquifer
Edwards-Trinity aquifer system	Trinity Aquifer
Edwards-Trinity aquifer system	Edwards (Balcones Fault Zone) (BFZ) Aquifer
Edwards-Trinity aquifer system	Edwards-Trinity (Plateau) Aquifer
Seymour aquifer	Seymour Aquifer
Pecos River Basin alluvial aquifer	Pecos Valley Aquifer
Rio Grande aquifer system	Hueco-Mesilla Bolson Aquifer
High Plains aquifer system	Ogallala Aquifer

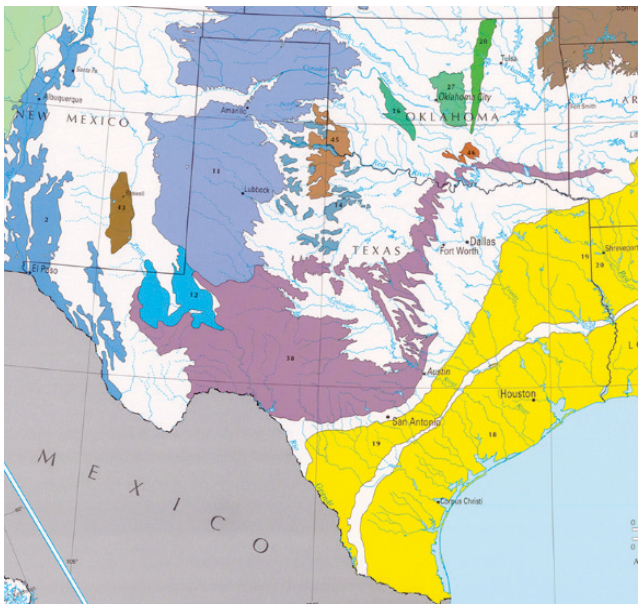


Figure 2. Principal or national aquifers in Texas

2017 - 2018 TWDB National Ground Water Monitoring Network activities

The TWDB, as an existing provider, received an award under Cooperative Agreement Number G17AC00181, from August 2017 through July 2018, to maintain Network wells and fill lithology metadata gaps. Web services providing water-quality and TWDB related data elements, last updated in 2016, will be further modified in the current award under Cooperative Agreement Number G18AC00088. This report describes the maintenance of existing Network wells and metadata (lithology) gap filling in Network wells where data were available during 2017 and 2018.

Maintenance of existing Network wells

TWDB reviewed the approximately 1,350 existing sites in the Network existing in the Network at the end of 2017 and after completion of the 2017-2018 water level season and 2018 water-quality sampling season to determine the status of data collection at these sites. The Well Registry was edited to change the status of dropped wells to Non-Display and replacement sites were added where feasible. Additional sites were not added during this period but are planned on being added in the next two years in the Rio Grande alluvial aquifer system and the Blaine aquifer.

In 2017 and 2018, TWDB and cooperators collected tape-down or electric line measurements at 6,862 surveillance and recorder wells, of which 738 are Network wells. Of the total designated 795 Network wells, 58 surveillance wells were not able to be measured, and 52 of these will be re-visited in the late 2018-early 2019 season and later re-evaluated to determine whether they need to be dropped from the Network. Six of the 58 wells were deleted from the Network and coded as non-display, and six wells were added as replacements (Table 2).

Table 2. TWDB water-level subnetwork replacement wells added in 2018

TWDB Water-level Subnetwork Replacement Wells			
Non-display NGWMN site #	**NGWMN site #**	**Principal Aquifer**	**Well Depth (ft)**
2142320	2142201	Seymour	55
5510611	5507101	Edwards-Trinity	300
6663504	6662805	Coastal lowlands aquifer system	398
6753401	6754811	Coastal lowlands aquifer system	220
7932602	7923303	Coastal lowlands aquifer system	194
8005502	8006101	Coastal lowlands aquifer system	550

All 117 trend (recorder) wells remain in operation, remain in the Network, and continue to post near real-time, provisional hourly water-level measurements on TWDB's "Water Data for Texas" web page - https://waterdatafortexas.org/groundwater. The hyperlink provided for these wells via the NGWMN portal, however, provides connection to the TWDB's groundwater database that includes six measurements a month

from the recorder wells rather than the provisional hourly measurements available on the "Water Data for Texas" web page.

In 2017, as part of TWDB's four-year sampling cycle that includes targeting the seven principal aquifers in the state (nine major Texas aquifers), the agency sampled 183 wells in the Coastal lowlands aquifer system in Texas. Of the total 552 wells in the NGWMN subnetwork, 105 sites in this aquifer have been designated as Network wells; 104 of these wells were re-sampled in 2017 and 2018; and one well was deleted from the Network. In 2018, TWDB sampled 161 wells in the Texas coastal uplands aquifer system. Of the total subnetwork wells, 100 sites in this aquifer are designated Network wells; 86 of these wells were re-sampled in 2018; and the remaining 14 wells will be re-evaluated for inclusion in the Network after the 2019 sampling season. Of the six Network wells TWDB attempted to sample in 2018 in the Rio Grande alluvial aquifer system, five were re-sampled, and the sixth will be re-evaluated for Network inclusion or replaced after the 2019 sampling season. Of the 17 Network wells in the Pecos River alluvial aquifer system wells, the TWDB sampled 10; two were deleted from the Network; and four, sampled most recently in 2016, will be scheduled for re-sampling within the recommended five-year period, or before 2022.

These 15 wells that the TWDB will evaluate for inclusion in the Network after the 2019 sampling season and the 3 wells that were deleted from the Network have been made "non-display" in the NGWMN registry, currently reducing the number of water-quality subnetwork wells (and springs) to 534 sites. While in general the TWDB's sampling schedule—in which return visits are made to NGWMN and the agency's own network wells once every four years—is appropriate to ensure that minimum frequency requirements are met, periodically challenges arise. The cost of sample analysis by TWDB's current contracted lab increased nearly 50 percent at the beginning of the agency's 2017 fiscal year. The Monitoring Section also lost staff during the 2018 fiscal year and preceding sampling season, and both factors resulted in fewer sampling visits completed than planned.

TWDB metadata gap filling in 2018

During TWDB's re-structuring of its groundwater database in 2014, a lithology table was added to allow manual addition of data from scanned images of driller's logs, if available. Lithology data exist in the driller's report database, as this information has been required to be entered by drillers since online submission of the reports, statutorily required in Texas, became possible in the early 2000s. Almost all these newer wells, however--currently over 400,000 and not including monitor and soil borings—are not in TWDB's groundwater database. The NGWMN award allowed TWDB staff to populate the lithology tables for the NGWMN wells first before continuation of this gap filling for the rest of its non-NGWMN wells.

Nearly two-thirds of the Network wells now have lithology data that will be accessible through web services (Tables 3 and 4). In general, more wells in the western part of the state lack lithology, possibly due to the relatively shallower depth (for example, in Seymour wells) and/or the more homogenous, predominantly sand- and gravel-rich alluvial formations with simpler, more clear-cut delineations between aquifer material and bedrock that drillers are familiar with and may have had less compunction to document (Figures 3 – 10).

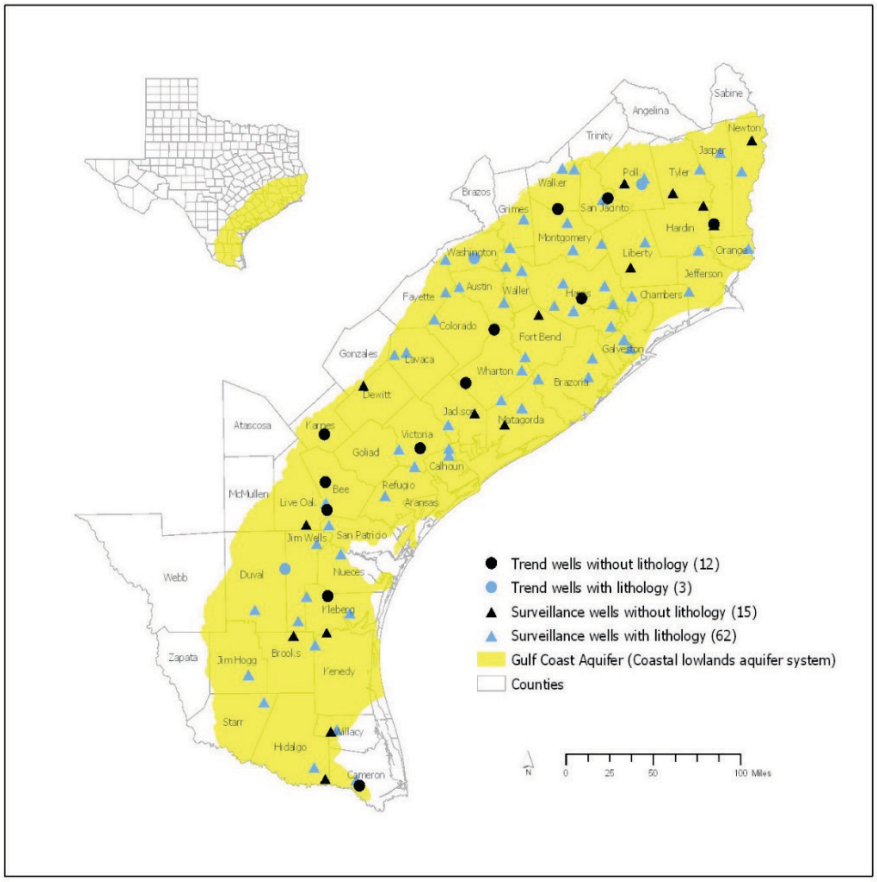
TWDB also reviewed all existing sites to replace local aquifer codes with complete local aquifer names.

Table 3. Meta-data gap filling in TWDB water-level NGWM subnetwork wells

Principal Aquifer	Sites Researched	Sites where Lithology Data Added	Percent of total
Coastal lowlands	92	65	71%
Texas coastal uplands	97	76	78%
Edwards-Trinity	190	110	58%
Seymour	39	15	38%
High Plains	361	254	70%
Pecos River alluvial	31	9	29%
Rio Grande alluvial	16	4	25%
Total (includes non-display wells)	826	533	**65%**

Table 4. Meta-data gap filling in TWDB water-quality NGWM subnetwork wells

Principal Aquifer	Sites Researched	Sites where Lithology Data Added	Percent of total
Coastal lowlands	105	76	72%
Texas coastal uplands	107	100	93%
Edwards-Trinity	201	116	58%
Seymour	26	10	38%
High Plains	125	58	46%
Pecos River alluvial	17	10	59%
Rio Grande alluvial	8	6	75%
Total (includes non-display wells)	589	376	**64%**



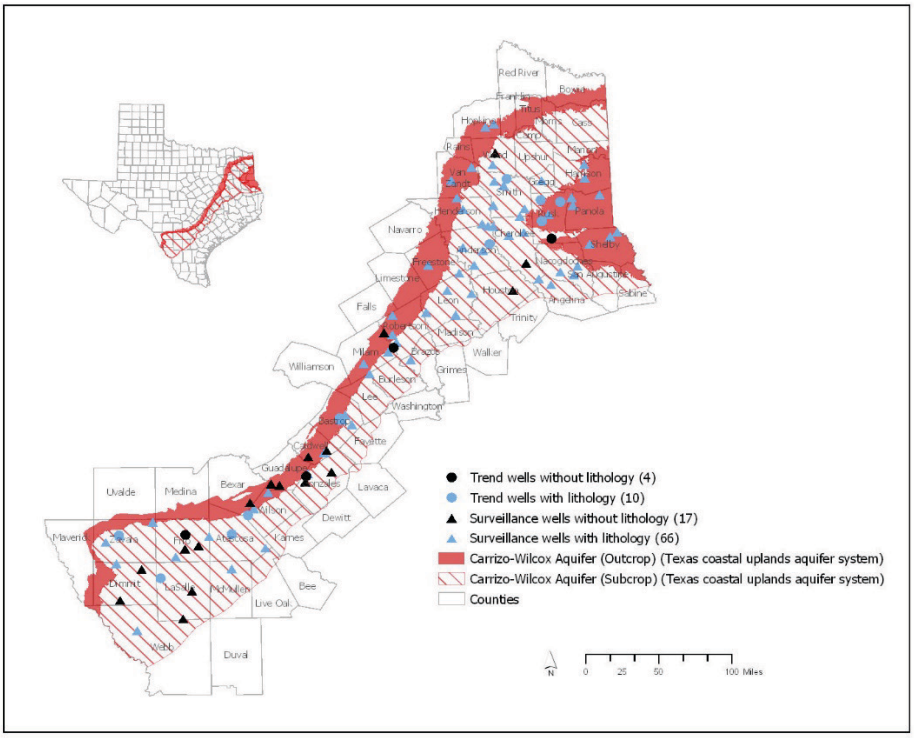


Figure 3. Trend and surveillance water-level subnetwork wells in the Coastal lowlands and Texas coastal uplands aquifer systems with lithology now accessible through the portal.

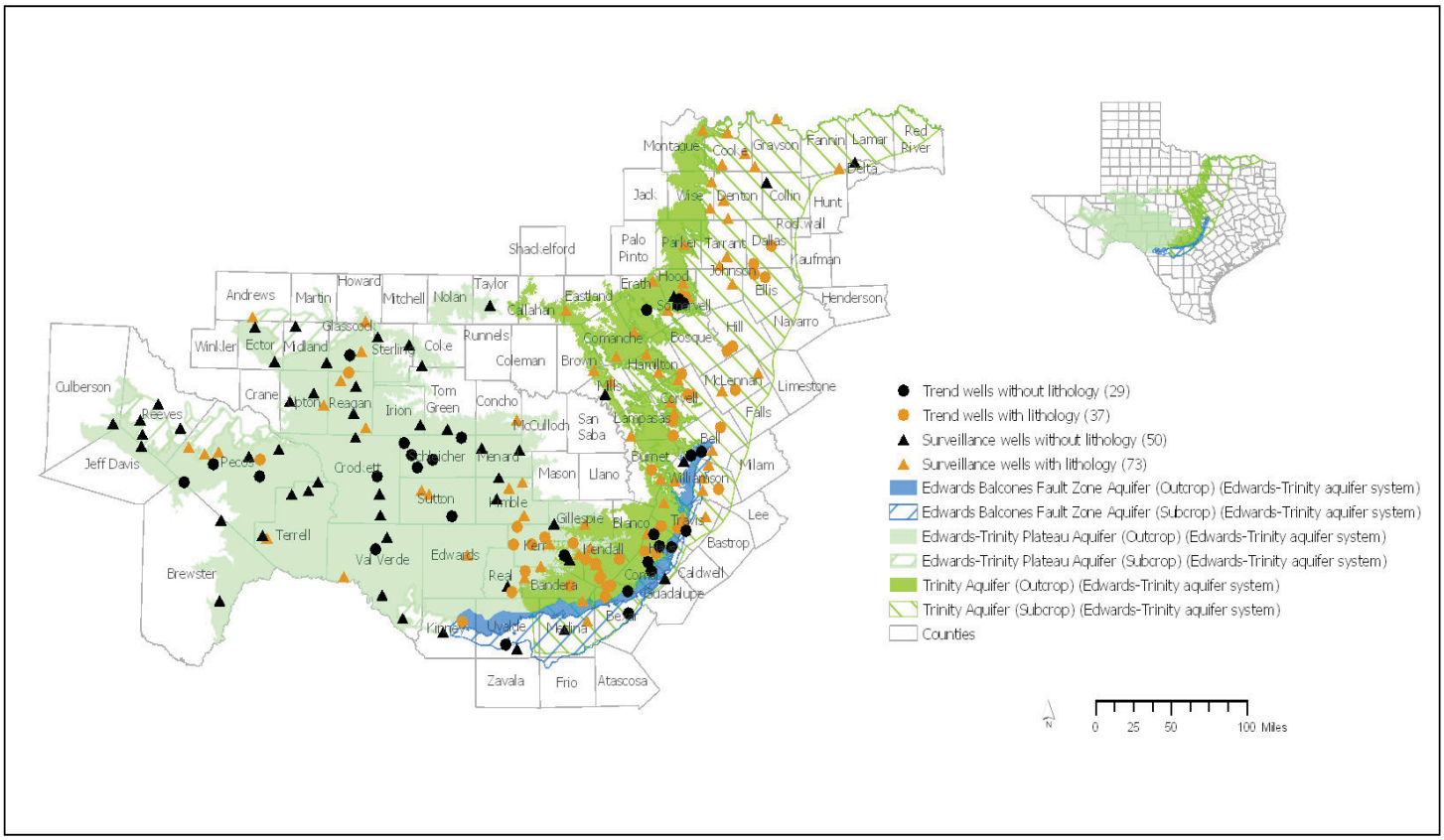


Figure 4. Trend and surveillance water-level subnetwork wells in the Edwards-Trinity aquifer systems with lithology now accessible through the portal.

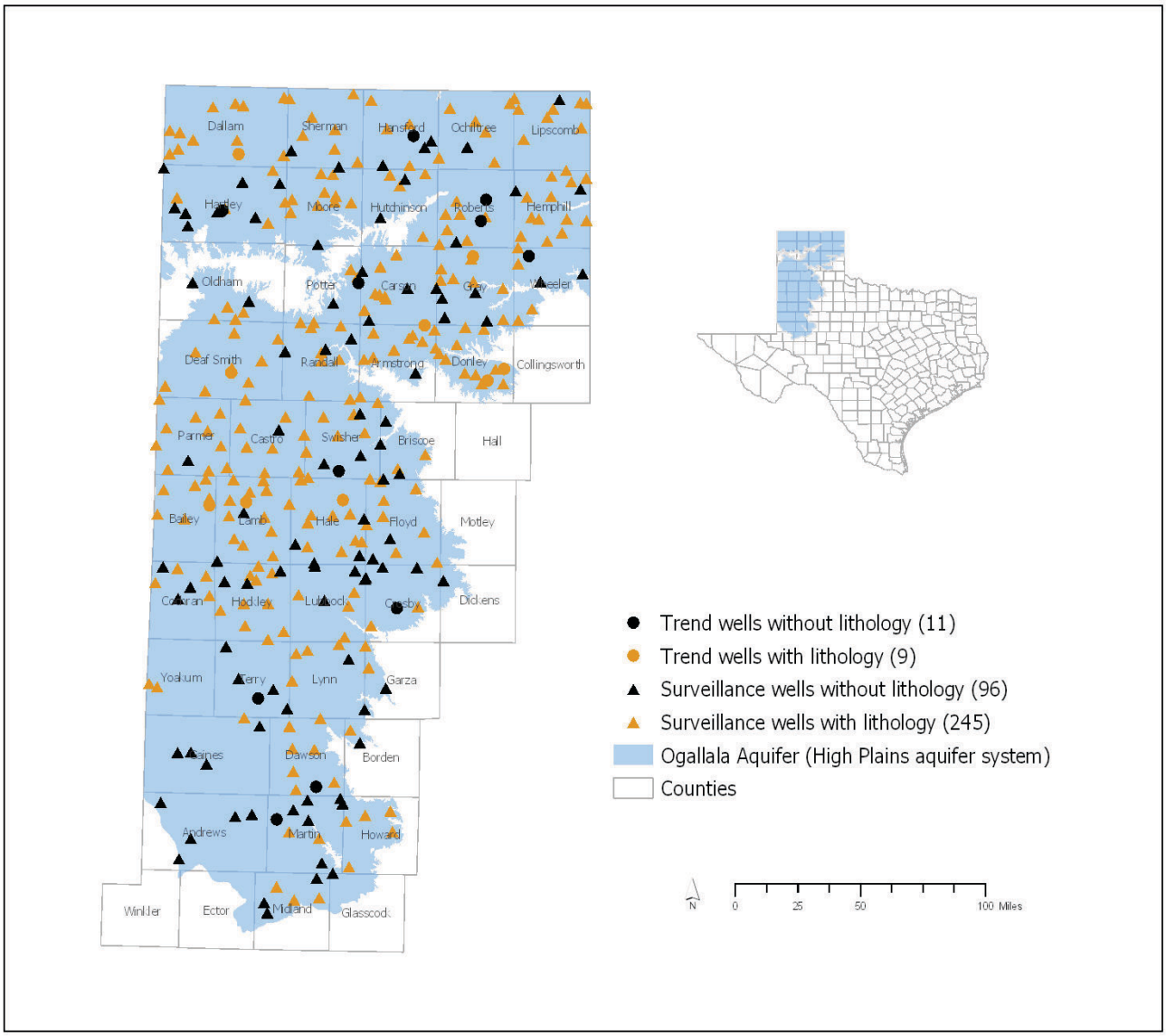


Figure 5. Trend and surveillance water-level subnetwork wells in the High Plains aquifer system with lithology now accessible through the portal.

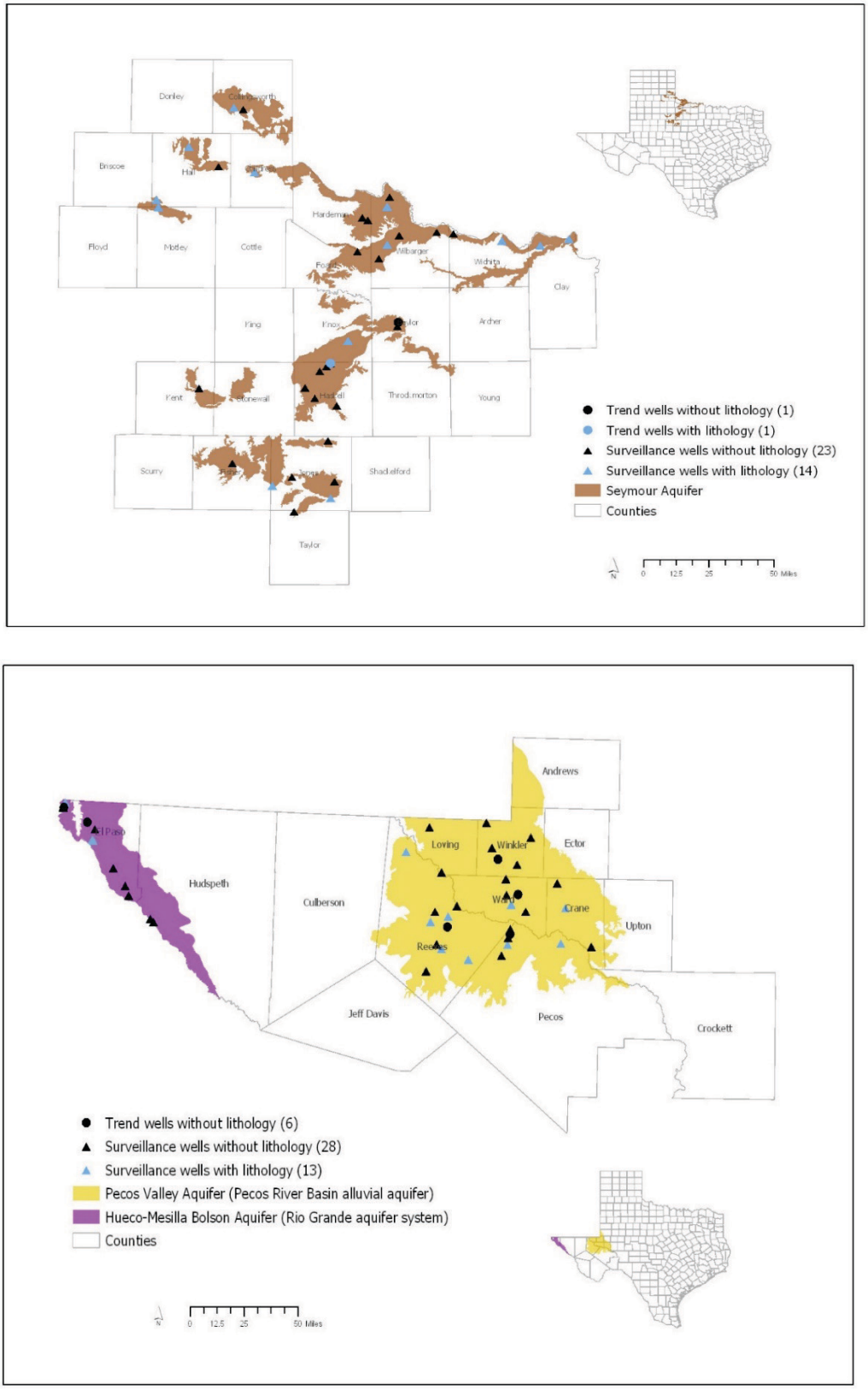
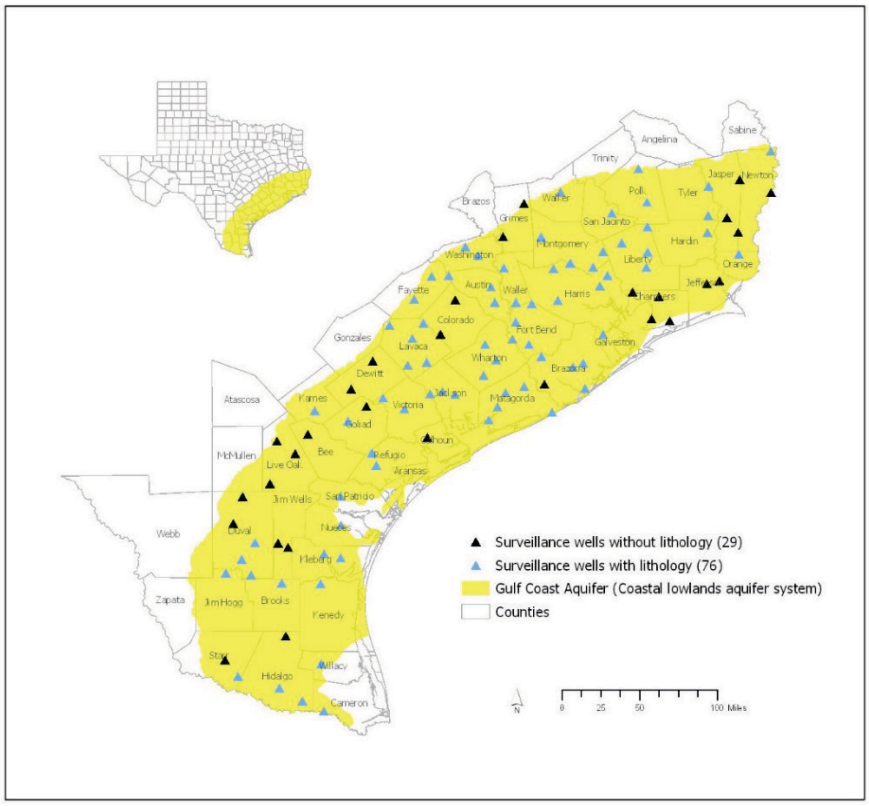


Figure 6. Trend and surveillance water-level subnetwork wells in the Seymour, Pecos River Basin, and Rio Grande aquifer systems with lithology now accessible through the portal.



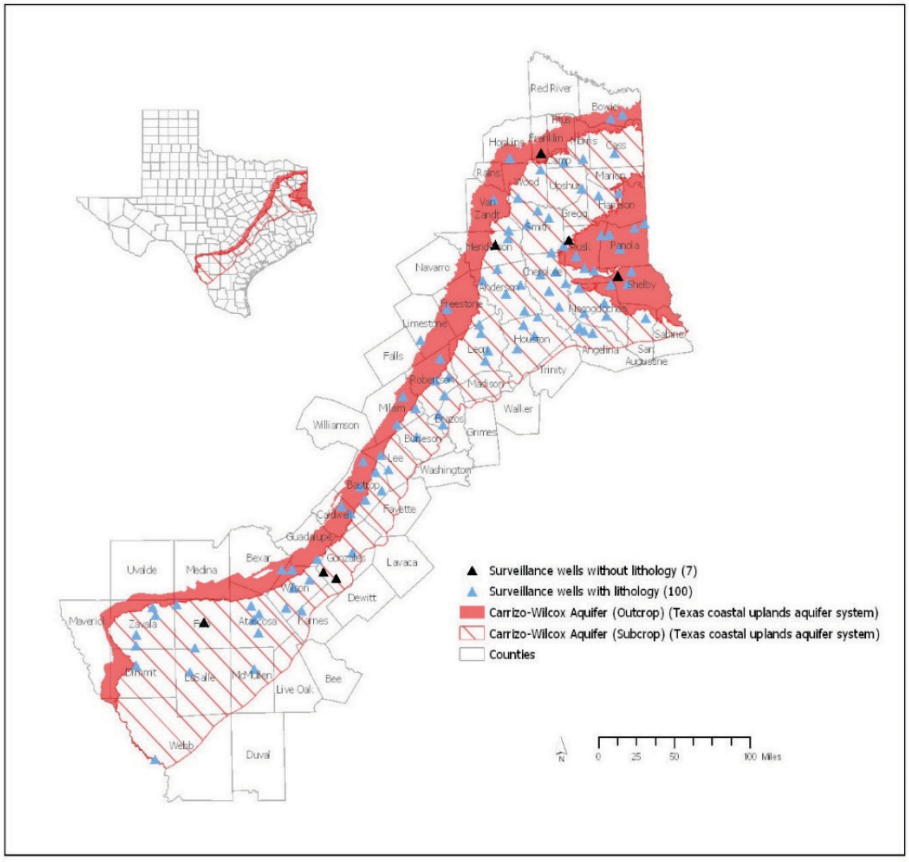


Figure 7. Surveillance water-quality subnetwork wells in the Coastal lowlands and Texas coastal uplands aquifer systems with lithology now accessible through the portal.

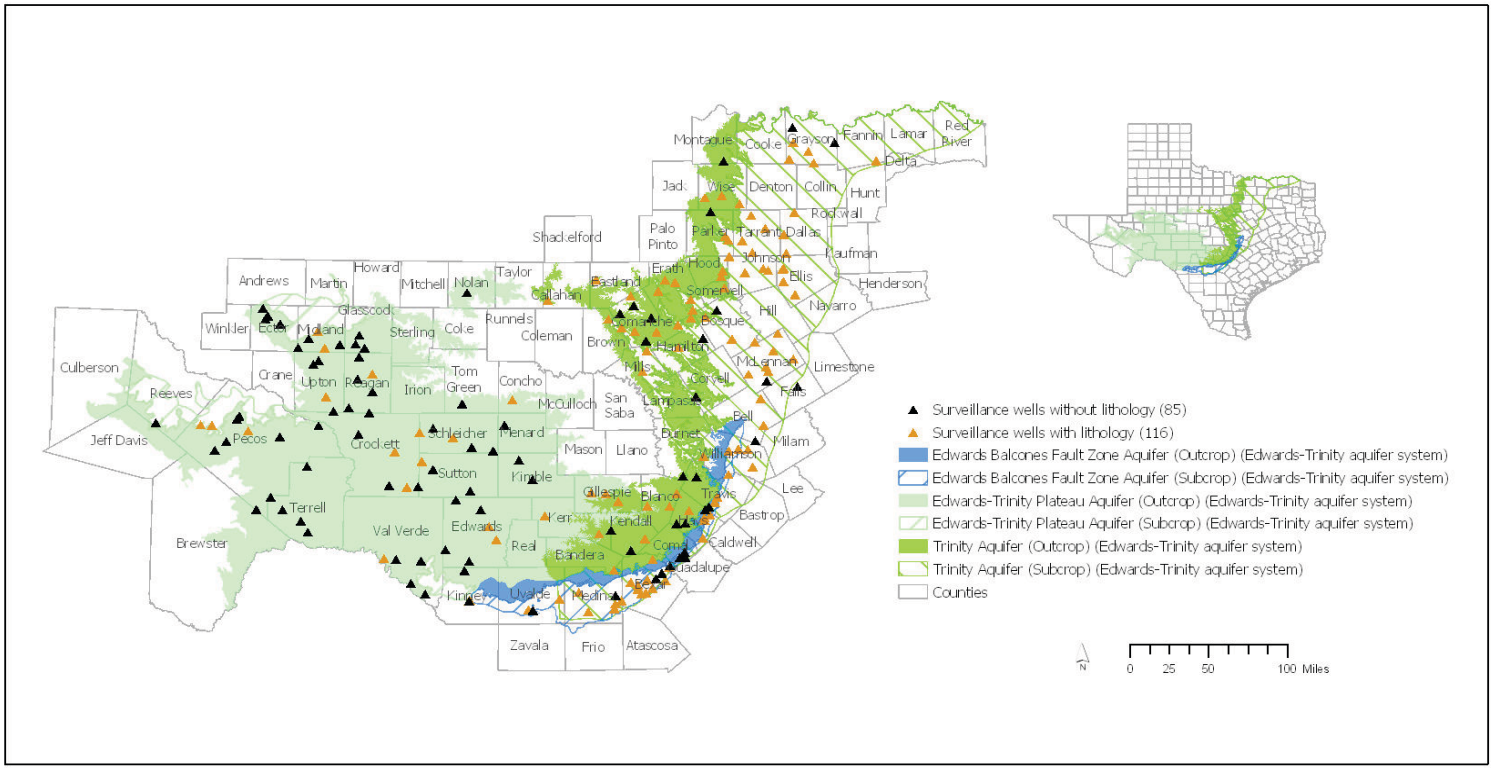


Figure 8. Surveillance water-quality subnetwork wells in the Edwards-Trinity aquifer system with lithology now accessible through the portal.

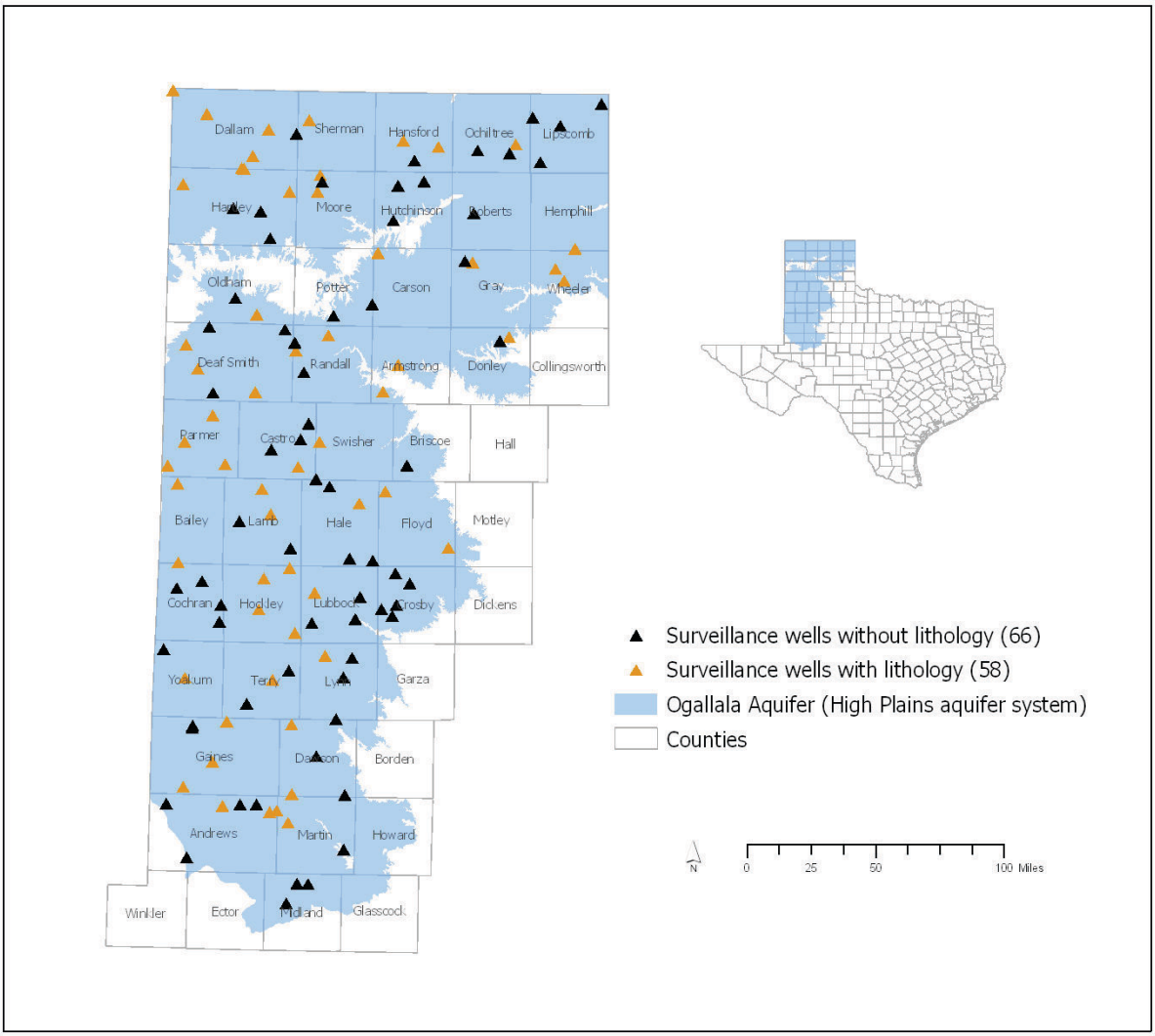


Figure 9. Surveillance water-quality subnetwork wells in the High Plains aquifer system with lithology now accessible through the portal.

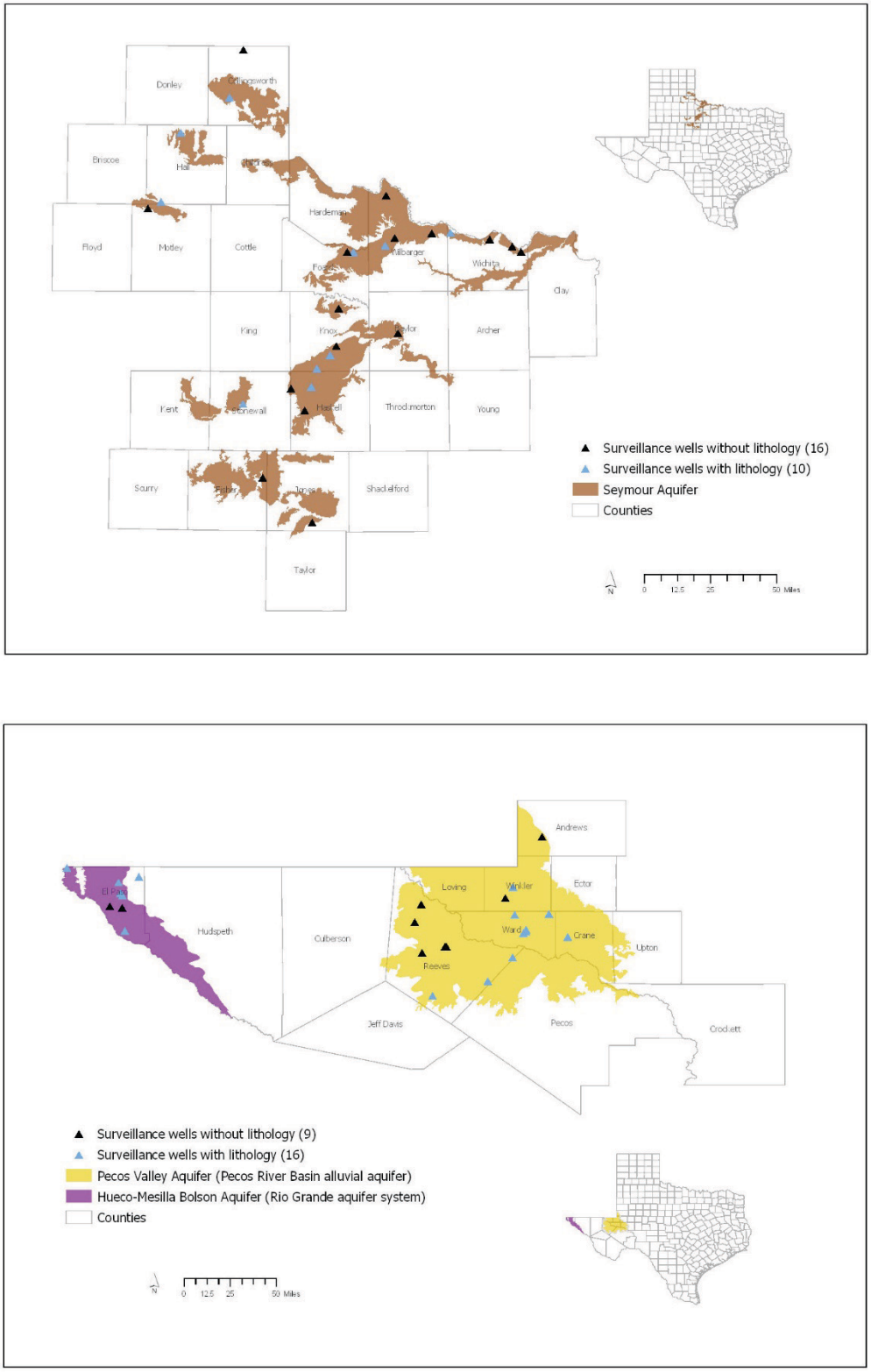


Figure 10. Surveillance water-quality subnetwork wells in the Seymour, Pecos River Basin, and Rio Grande aquifer systems with lithology now accessible through the portal.

TWDB data collection methods

TWDB's data collection methods are in accordance with standardized field procedures consistent with the standards outlined in Appendix 5 of the Framework Document (SOGW, 2013). Water-level monitoring field procedures (http://www.twdb.texas.gov/groundwater/docs/UMs/UM-52.pdf) were revised during 2016 to adhere more closely to standards in the Framework Document, and sampling protocols are included in a separate manual (http://www.twdb.texas.gov/groundwater/docs/UMs/UM-51.pdf?d=2974.485). TWDB followed site selection criteria and the classification process when adding new sites as described in the final report for work performed under previous award number G15AC00465.

TWDB quality assurance procedures

As noted, TWDB staff adhere to procedures in the field and throughout the data collection process as described in its two user's manuals that address water-level measuring and water-quality sampling. These practices are further reiterated and specified in several Standard Operating Procedures, or Work Process Documents, that the Groundwater Monitoring Section updates every two years. TWDB field personnel are also now entering data using ESRI's Collector App, intended to reduce the number of errors that could occur when transcribing information from field books into the agency's groundwater database.

Although the Groundwater Monitoring Section receives no funds from the US Environmental Protection Agency (USEPA), it prepares (or updates) the TWDB Quality Management Plan (QMP) yearly as other parts of the agency rely on the Monitoring Section's data in support of water-management strategies that may be partly funded by the USEPA. The QMP describes the quality system implemented by the agency for data-collection activities and is documentation required by the USEPA.

TWDB collects water-quality data in almost all Network wells; however, cooperators measure water levels in more than 50 percent of Network wells and provide the TWDB with this information annually for uploading in the groundwater database. Additional quality assurance checks include automated flagging of anion-cation balance exceeding five percent when reviewing water-quality data and automated comparison/verification of outlier water-level measurements against previous values for TWDB and cooperator measurement data.

Serving data to the NGWMN data portal

Lithology elements are listed in the Minimum Elements Data tip sheet, and TWDB had web services configured to provide these elements. However, TWDB did not have a "lithology ID" field in addition to its site identification number; and the "Observation Method," while currently only determined through driller's logs, must include possible other methods that may eventually be used.

Only changes in web services involving those serving water-quality data are anticipated in the next two years.

References

Subcommittee on Ground Water (SOGW), 2013, A National Framework for Ground-Water Monitoring in the United States, 182 p, https://acwi.gov/sogw/ngwmn_framework_report_july2013.pdf.

Texas Water Development Board *Quality Management Plan*, 2017, prepared for the U.S. Environmental Protection Agency, Region VI.