USGS National Ground-Water Monitoring Network Cooperative Agreement Final Technical Report

Project Information Summary

1. Project Title: University of Nebraska-Lincoln, Conservation & Survey Division participation as a data provider in the National Ground-Water Monitoring Network.
   The CSD will perform work necessary to add its Real-time Groundwater-Level Monitoring Network of the High Plains Aquifer in Nebraska to the National Ground-Water Monitoring Network.

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Main body of the report

- Overview of work

The Conservation and Survey Division (UNL-CSD, Nebraska Geological Survey), the natural resource survey component of the School of Natural Resources at the University of Nebraska–Lincoln will perform work necessary to add selected wells from its Real-Time Groundwater-Level Monitoring Network in Nebraska to the National Ground-Water Monitoring Network under objective 1: Support to become a new data provider.

- Description of existing water-level and/or water-quality networks including the objectives of the networks.

The UNL-CSD is a unique, multi-disciplinary research, service and data-collection organization established by State statute in 1921. The UNL-CSD's mission is to investigate and record information about Nebraska's geologic history, its rock and mineral resources, the quantity and quality of its water resources, land cover and other aspects of its geography, as well as the nature, distribution and uses of its soils.

The UNL-CSD is the agency designated by statute to investigate and interpret the geologically related natural resources of the State, to make available to the public the results of these investigations, and to assist in the development and conservation of these resources. It consists of program areas in geology, water, soils, and remote sensing-geographic information systems.

The UNL-CSD is authorized to enter into agreements with federal and state agencies to engage in cooperative surveys and investigations of the State.

The UNL-CSD maintains and operates an observation well network throughout Nebraska. This network involves all the principal aquifers of the state. A component of this network is the Real-Time Groundwater-Level Monitoring Network. The principal aquifer monitored by the Real-Time Network is the High Plains Aquifer (Figure 1), with four wells screened in minor aquifers of local importance for Nebraska. The network employs a framework for remote telemetry using smart sensors and wireless telecommunication technology designed and implemented to collect and analyze groundwater hydrologic information from 59 sites across Nebraska. Observation wells were initially chosen for their ability to detect the onset, magnitude and recovery of hydrological drought.

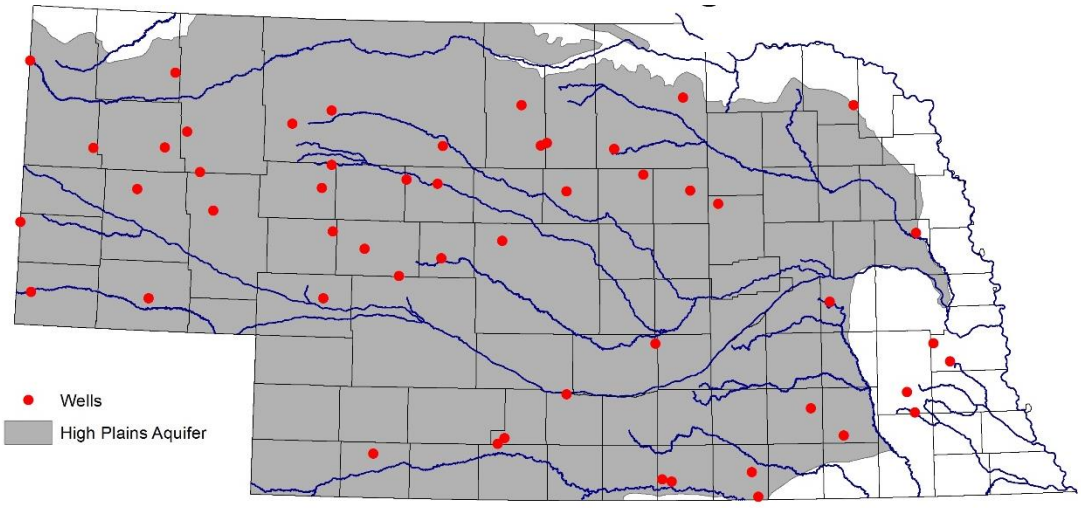

Figure 1: Locations of wells in the Nebraska Real-Time Groundwater-Level Monitoring Network.

- Description of site selection criteria and process.

  Sites were selected for the NGWMN based on the following criteria:
  - Data history. Sites were selected with a reasonably continuous data set of at minimum five years.
  - Wells were located in the High Plains Aquifer, or in an aquifer or location hydrologic importance to Nebraska.
  - Sites where water level information is of regional or local importance.

- Description of process used to assign Subnetworks and Monitoring Categories for both water-level and water-quality networks (as appropriate for your Network).

  - Most wells in the UNL-CSD Network are in the NGWMN Background subnetwork. All wells included in the NGWMN are measured hourly, with daily readings at 12:00 UTC reported to the NGWMN. Wells were evaluated on a well-by-well basis. Thirty-four wells with the following criteria were included in the Background subnetwork:
    - Minimum of 5 years data.
    - Hydrographs were evaluated for signs of human influence, and included if no sign of human influence was detected.
    - Proximity to nearby pumping wells. Minimum distance to nearby pumping wells varies by well location and local aquifer conditions, but must not be close enough to impact water levels in observation well.
  - Ten wells were categorized in the NGWMN Suspected Changes subnetwork. Although these wells may have suspected changes, they are still of great value in evaluating water-level changes. These wells were classified using the following criteria:
    - Minimum of 5 years data.
    - Hydrographs were evaluated, and signs of possible human influence were observed. Signs of influence include:

- High frequency (hours to days), low magnitude (0.5 foot or less) water-level changes. These changes are likely the result of pumping nearby domestic or stock wells.
- Evidence of potential leakage between grouting at nested well sites.
- Wells formerly used as irrigation wells, if evidence of prolonged recovery is suspected.

  - Five wells were categorized in the NGWMN Documented Changes subnetwork. These wells were selected in heavily pumped areas to show long-term trends in regional drawdowns. These wells are screened in aquifers which are heavily pumped for irrigation. The wells have a minimum of five years of data.

  - Although all wells are monitored at the same frequency (hourly, with daily values reported to NGWMN) UNL-CSD has wells classified as both trend and surveillance. Wells with robust data histories, which represent regional changes in an aquifer were placed in the trend category. Wells classified as surveillance are wells that can be compared against trend wells to get an overall picture of groundwater-level changes. Surveillance wells may be screened in secondary aquifers, or locations with different pumping histories than nearby trend wells.

- Description or link to Field techniques for water-level measurement and water-quality sample collection (as appropriate for your network).

  - Automated water level readings at all sites are recorded using pressure transducers manufactured by PMC Engineering. All pressure transducers have a 15 PSI range, except at sites #57 (Alliance), #59 (Burress2), and #58 (Rising City2), which have 30 PSI sensors. All pressure transducers have a reported accuracy of +/-0.1% of the stated pressure range.
  - Wells monitored for groundwater levels as part of the NGWMN are checked for sensor drift annually, using a Solinst model 101-P7 water level meter, Ser# 203199. All wells have been measured with the same tape since 2012. All water levels are recorded from the land surface, any stick-up of the well casing is subtracted from the water-level reading before broadcast.
  - No water quality samples are collected by the CSD as part of the NGWMN.

- Description of data quality and quality assurance processes.

  - Individual wells are checked for sensor drift annually. If sensor drift measured is in excess of 0.10 foot, readings are corrected assuming a linear sensor drift since last measurement. Data recorded in the database is checked monthly for obvious anomalous readings resulting from issues with electronics, weather, or maintenance/pumping at the well site. Any anomalous readings are deleted or field checked for accuracy.

- List of Minimum Data elements and how they are provided to the Data Portal (via the Well Registry or web services).

- Minimum data elements included in the Well Registry include the following fields: Unique Site Number, Site Name, State, County, National Aquifer, Local Aquifer (Where applicable), Site Type, Aquifer Confinement, Latitude, Longitude, Datum Altitude, Altitude Units, Vertical Datum, Water Level Network, Well Depth, and Well Depth Units.
- Minimum data elements provided through web services include data from multiple headings in different tables. From the Construction Table, data elements include: Land Surface Altitude, Vertical Datum, Well Depth, Well Depth Units, Beginning Depth of Casing Interval, Ending Depth of Casing Interval, Casing Interval Material, Beginning Depth of Screen Interval, Ending Depth of Screen Interval, Screen Interval Unit of Measure, and Screen Interval Material. From the Lithology Table, data elements include Lithology ID (dominant sediment/lithology type), Description of Lithology, Observation Method, and Beginning and Ending Depth of Lithologic Unit. Elements provided in the Water Level Table include Sample Time, Water Level, Water Level Units, Measurement Method, and Accuracy.
- Modifications were made to the UNL-CSD database, and Data Intercept Servers to format data fields to match NGWMN specifications. Database and server modifications were completed by the Nebraska State Climate Office (NESCO).

- Notes on any sites that have missing required data elements.

  - Wells in the UNL-CSD dataset have complete data sets, with three exceptions. Well #7 (Buffalo County), and Well #36 (Grant County), are missing construction and lithology data. The UNL-CSD has applied for and received funds in 2017 to replace these two wells during the 2017-2018 field season. When the wells are replaced, construction and lithology data will be available for these locations. Well #49 (O'Neill Well) is missing lithology data. The data likely exists, however it is missing from the USGS and the UNL-CSD archives. When the detailed lithology is located for this well, it will be added.

- Note any sites that do not meet requirements in Table 4.5.1.1 and/or 4.5.2.1 of the Framework Document.

  - Due to the high frequency of water level measurements in UNL-CSD wells, all wells included in the NGWMN meet the minimum frequency of sampling recommendations.

- A description of the web services used or installed for this project.

  - The web service were developed under contract by Phoenix Web Group, based in Waverly, Nebraska using Microsoft .NET framework. The web services attach to a UNL database which stores water-level information collected by the UNL-CSD(See data flow chart). The service allows for retrieval of data on all, or specific wells for a date range. Well construction and lithology data can also be accessed at separate web service links for each well, but do not have date range modifiers, as none are needed. Access of the service will allow USGS, or anyone who has the link, to

retrieve water levels over specified time spans for requested wells which can, in turn, be posted to the USGS repository.

- Analyte list used for sampling networks.
    - Water quality data is not provided for any sites as part of this agreement.
- List of laboratories and their accreditation for analyzing properties and constituents included in the monitoring program.
    - Water quality data is not provided for any sites as part of this agreement.