

USGS National Ground-Water Monitoring Network Cooperative Agreement Final Report

1. USGS Award Number G23AC00308-00

2. Agency Name Conservation and Survey Division, School of Natural Resources, University of Nebraska-Lincoln

3. Project Title: UNL proposal to support persistent data services and video log 12 wells.

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Under USGS cooperative agreement G23AC00308-00 the Conservation and Survey Division (CSD) at the University of Nebraska-Lincoln (UNL) was awarded \$19,999 under Objective 2 to support persistent data services, and \$18,690 under Objective 4 to use a downhole camera to assess the condition of 12 aging observation wells in eastern Nebraska. The award period began July 1st 2023 and ended June 30, 2024.

Objective 2

Under Objective 2, CSD Geologist Aaron Young performed the following work. Assistance with final documentation preparation was provided by CSD Geoscientist Mark Burbach.

- Maintain data flow to the USGS. The NGWMN data provider dashboard was checked at least monthly for data flow problems. Data flow to the NGWMN was disrupted on several occasions during the grant period. Disruptions resulted from changes in UNL-ITS security practices, and issues pertaining to connecting a database housed on UNL servers to an outside software developer. In particular, due to a complex series of database connections, the construction service was redeveloped by the CSD on several occasions to keep data flowing to the USGS. Of the 300 hours budgeted for Objective 2, 160 hours were spent keeping data flowing to the NGWMN. Redeveloping CSD's web services under a recently awarded agreement should minimize or eliminate many of these problems in the future.
- At the request of the USGS Nebraska Water Science Center, well ID's for approximately 200 wells in the NGWMN registry were updated to newly assigned 14-digit USGS ID's. The CSD provides water-level data for many of the water quality wells provided to the NGWMN by the Nebraska Department of Energy and Environment (NDEE). Changing the well ID's required altering web services to supply water-level data to water quality wells served by the NDEE under the new well IDs. Altering the ID's and updating the web services took 40 hours to complete. The impact of future well ID changes will be minimized after the redevelopment of CSD webservices in 2024.
- Reviewing existing sites in the NGWMN registry. Hydrographs for all 5,371 wells in the NGWMN registry supplied by the CSD were evaluated on a well-by-well basis to assess whether they are still applicable to the mission of the NGWMN and the USGS High Plains Aquifer Monitoring Program. The list of wells in the NGWMN registry was further compared against the Nebraska Department of Natural Resources Registered Well Database, and wells that were listed as decommissioned were removed from the registry. This is a time-consuming task, requiring an additional 160 hours of work to complete. As a result of this analysis:
 - Sixty new wells were added to the NGWMN registry.
 - Ten wells were removed from the NGWMN registry, either because they were decommissioned in the previous 12 months, or because recent data collected from the wells was suspect.
 - Once the analysis was complete, changes were committed to the NGWMN registry.

- Add additional data to CSD Databases for wells supplied to the NGWMN. Construction data for wells in Nebraska is constantly being updated. Construction data for approximately 200 wells was added to the CSD database to be provided to the NGWMN. Additional lithology data was also added for many of the wells CSD provides to the NGWMN. This task required an additional 20 hours to complete.

Although the CSD was awarded up to 300 hours to complete these tasks, the actual time required was well in excess of what was awarded. Only 300 hours of salary was billed to this award.

Objective 4

Under Objective 4, 12 wells were camera logged to assess the condition of the well and provide recommendations for future slug testing or repair. All field work and video analysis were performed by CSD Geologist Aaron Young, with documentation preparation assistance provided by CSD Geoscientist Mark Burbach.

Camera logging Methods

All wells were logged with a high-definition Well-VU brand down-hole camera model WVM1000PRO manufactured by Vision Systems LLC. The camera is equipped with three different cameras and lighting heads capable of logging all wells greater than ¾ inch in diameter up to 1000 feet deep. This camera was purchased by the CSD and was not purchased using any NGWMN funds. Videos were recorded from a few inches above the top of the well casing to the bottom of the well, or to a point that is deemed too unstable to advance the camera. Videos are recorded in the field. Recorded videos are analyzed remotely noting the condition of the well and any recommendations for repair or replacement.

Wells logged under objective four include:

NGWMN Site: 412110097101901, 16N 2E 14CC

Well is constructed of 2" PVC threaded casing. DTW is approximately 6.4 feet. The screen is visible starting at 12 feet, and appears clean. All joints appear tight. Silt encountered at 15.6 feet. This well is in excellent condition. This site could benefit from purging to remove silt at the bottom of the well and possibly slug testing in a future proposal to ensure connection to the aquifer.

NGWMN Site: 412801096312301, 17N 8E 4DD

Well 17N 8E 4DD was constructed in 1940, to a reported depth of 31 feet. The well is constructed of 2 inch galvanized steel pipe. This well only has six inches of stickup, and thus is difficult to locate in tall grass, and has been hit multiple times by mowing equipment badly damaging the threads on the top of the casing. Above water, the steel casing is heavily corroded. Depth to water is 12.4 feet from the top of casing. Below the water, the well casing is heavily bio-fouled. Silt was reached at 27.4 feet. From previous experience with wells of this age and construction, the screen on this well is likely a 2-foot brass drive point, with 1/8-inch holes. Due to the damage to the top of the well casing, we were unable to lower a pump into this well to try to improve visibility or remove the silt from the bottom of the well. This well is located in a

road ditch on State-owned property, under a high voltage power line next to a power substation. This well is badly in need of replacement, however, due to the surrounding above and below-ground power lines, finding a suitable replacement location may be challenging.

NGWMN Site: 412810097054501, 17N 3E 4CC

Well 17N 3E 4CC is constructed of 1.5-inch galvanized steel pipe and was installed in 1946 to a reported depth of 16 feet. This well is located in a road ditch, next to a farm field entrance. It has been damaged several times, and the top three feet have been replaced. This well has also been overtopped on several occasions due to local flooding. Above water, the well casing is heavily corroded. There is a corrosion hole about 3/8 inch in diameter at 7.5 feet from the top of the casing. The water level is 11.1 feet from top of casing. Grass and other debris are floating on the surface of the well. Water quality is very poor. Due to the diameter of the well, water was unable to be pumped. The well is silted in to a depth of 14.6 feet. This well is in extremely poor shape. This well was damaged again in late 2023, and was replaced in early 2024 at the expense of the CSD. The new site is about 50 feet to the north of the existing well, on higher ground and in a location that is not subject to flooding or damage from farming equipment. The new well does not yet have an assigned USGS ID, however, it will be added to the NGWMN registry when an ID is assigned.

NGWMN Site: 412839096493401, 17N 5E 2BB

Well 17N 5E 2BB was originally constructed of 1.5-inch steel pipe in 1946 to a reported depth of 13 feet. In fall of 2023, this well was struck by a tractor and destroyed. The old casing was pulled from the ground, and a new well installed in the same bore hole to the same depth as the old well. The replacement cost of the well was completely covered by the CSD. Because the well is constructed in the same borehole as the original well, it was recommended by the USGS Nebraska Water Science Center to keep the original USGS ID for this well. The new well is constructed of 2-inch threaded PVC casing, and screened with a 0.010 slot screen from 13-15 feet from the top of the casing. The new well was video-logged as a baseline for this site. The video shows a well that is properly constructed and in pristine condition. A proper protective casing was installed to prevent future damage from farming equipment.

NGWMN Site: 412959096312301, 18N 8E 28DA

Well 18N 8E 28DA was constructed in 1939 of 2-inch galvanized steel pipe to a reported depth of 85 feet. The well was installed as part of the Nebraska Test Hole Drilling Program in CSD Test Hole 11-F-39. Above water, the casing is extremely corroded, and numerous potential rust holes were observed in the casing. At 20 feet, a threaded joint seems to have broken and is leaking. Near 45 and 70 feet, several rust holes caused the camera to hang in the well bore. The depth to water is 73 feet. Below water, the casing is in good condition, with little bio-fouling. An obstruction was encountered at 101 feet and the camera could not advance further. The well appears to be silted up to a few feet below the camera. In an attempt to determine the true depth of the well, a small diameter pump was lowered to 101 feet to attempt to pump out the silt and obstruction. Shortly after the pump was turned on, the flow stopped. By removing the water from the upper part of the well, outside pressure on the deteriorated casing increased, causing the

casing to fail, collapsing on and destroying the pump. No further attempts were made to lower any instruments down the well.

This well has one of the longest continuous records of measurements for an observation well in Nebraska. Therefore, to ensure the continued collection of data at this site, this well was replaced at the expense of the CSD. Unfortunately, due to the proximity of an overhead power line, the new well had to be located approximately 200 feet north of the original location. A new test hole was drilled at this location to bedrock at a depth of 210 feet, and includes downhole geophysical logging, greatly improving on the test hole drilled in 1939. A nest of two wells was installed in the new location, one screened from a depth of 95-100 feet, which is likely similar to the original well (when change in elevation is considered), and a second observation well screened from 170-180 was installed to monitor water levels in a lower aquifer. This site does not yet have a new USGS ID, however, will be added to the NGWMN registry when available.

NGWMN Site: 413636096425001, 19N 6E 22AAA

Well 19N 6E 22AAA was installed in 1964 and constructed of one-inch galvanized pipe to a reported depth of 36 feet. Above water, the casing is in good shape. Joints appear to be tight, and no obvious corrosion holes were noted. The depth to water is about 21 feet from the top of the casing. Below water, the casing has some minor bio-fouling, but is in good shape. The top of the screen appears to be at 33 feet. Although the camera cannot advance past the threaded joint at the top of the screen, it appears there may be silt not far below the camera. Due to the small diameter of this well, options for purging the silt from this well are limited. Although this well is in good condition for its age, this well should eventually be replaced with a larger diameter well to allow for future purging and slug testing.

NGWMN Site: 413919096333001, 20N 8E 32CCC, Dodge County Real-Time Well

The Dodge County Real-Time Well was installed in 1964 and is constructed of 1-inch galvanized pipe to a reported depth of 125 feet. In 2018, the hydrograph from this well was showing signs of a plugged screen, so this well was airlifted to try to reestablish connection to the aquifer. Although the well seems to respond to changes in local pumping better than before airlifting, the overall condition of the well still needs to be assessed. Unfortunately due to the construction of the well, slug testing is not an option. The well casing appears to be bent starting about 5 feet from the top of the casing. Above water the casing is in good shape, and joints appear to be tight. Beginning at about 51 feet, the casing becomes moderately corroded and bio-fouled. The well is silted to a depth of 115 feet. The depth to water is approximately 58 feet. Below water, the well is moderately bio-fouled. Although this well is in relatively good condition, due to 10 feet of siltation this well should be replaced with a larger diameter well, allowing for future purging and testing.

NGWMN Site: 414428096374101, 21N 7E 32DDCD

Well 21N 7E 32DDCD is constructed of ¾ inch galvanized steel pipe, and was installed to a reported depth of 48 feet in 1964. This site is located on the side of a bridge abutment next to a stream and has been struck by road graders several times. This well was also overtopped in a

flood in 2019. The well casing was recently broken off at a depth of 10 feet, and repaired by CSD. The steel casing below the repair is very heavily corroded. The depth to water is approximately 12 feet from the top of the casing. Grass and debris are floating on the top of the water, and the water is murky. The well is silted up to 45 feet. Due to the proximity of this well to the nearby stream, water levels in this well are heavily influenced by changes in stream level, and do not reflect the true patterns of drawdown and recovery of the local aquifer. Due to the condition of the well, and the lack of suitable locations for replacement, this well should be abandoned.

NGWMN Site: 414617096485201, 21N 5E 23DCC

Well 21N 5E 23DCC was installed in 1964 to a reported depth of 46 feet. This well is constructed of one-inch diameter galvanized steel pipe. The upper portion of the well was struck by a cultivator and broken off in 2012. The top of the well was repaired by CSD staff shortly after. The steel casing above water is in good condition. The depth to water is approximately 12 feet. Below the water, the casing appears to be heavily corroded. The well is silted in to 42 feet. Due to the small diameter of the well, removing the 4 feet of silt and debris from the well would be difficult. This well should be replaced in a future proposal with a larger diameter well to allow for future purging and testing.

NGWMN Site: 414944096292301, 22N 8E 35DC

Well 22N 8E 35DC was installed in 1963 to a reported depth of 21 feet. The well is constructed of ¾ inch steel galvanized pipe. This well was installed in a bored hole which was not properly completed. The well is loose in the annular space below a few feet causing a potential contamination risk. The casing of the well is heavily corroded both above and below water. The depth to water is 17.5 feet from the top of the casing. The well is silted up to 18.5 feet. Because this well could pose a potential contamination risk, it is scheduled to be replaced by CSD in the fall of 2024 at the expense of the CSD.

NGWMN Site: 420748096430801, 25N 6E 22BDB

Well 25N 6E 22BDB was constructed in 1964 of 1-inch galvanized pipe to a reported depth of 39 feet. The well casing is very heavily corroded both above and below water. The depth to water is 26 feet. A threaded joint at 25 feet may be cracked allowing leakage into the well. The well is silted up to 37 feet. Based on this video analysis, this well is scheduled to be replaced at the expense of CSD in early 2025.

NGWMN Site: 421601097151001, 27N 1E 36DD

Well 27N 1E 36DD is a hand-dug well cased in 18-inch diameter concrete rings. The well was originally 30 feet deep, however, the rings have shifted, allowing water and soil to flow through the exposed joints filling the well possibly to a depth of 14 feet. At 13 feet, a great deal of debris was encountered including old wood, pipe, and an old windmill-pump cylinder. For fear of losing the camera, logging was stopped at 13 feet, however, it appears that the bottom of the well is around 14 feet. Due to the extremely poor condition of this well, and the lack of nearby datapoints, this well should be replaced in a future proposal.