Connecting the Iowa Geological Survey’s Iowa Water-Level Network Wells to the National Ground-Water Monitoring Network

12 June 2019

Funded by the
U.S. Geological Survey – Award #G17AC00168
01 July 2017 – 30 July 2019

Submitted by:
Rick Langel
Iowa Geological Survey
University of Iowa
300 Trowbridge Hall
Iowa City, IA 52242-1319
richard-langel@uiowa.edu
319-335-1575

The National Ground-Water Monitoring Network (NGWMN), which was established to assess long-term water-level and water-quality trends at a national scale, provides a unique opportunity to collect and share date from different states, agencies, and others. The Iowa Geological Survey (IGS) at the University of Iowa joined the NGWMN in 2017 to cover a gap in the network's Midwest coverage through cooperative agreement G17AC00168.

This agreement covers a two-year project, which runs from 1 July 2017 through 30 June 2019. The agreement provides funding for IGS to become a NGWMN data provider in the first year of the agreement. During the first year, the IGS accomplished the following

1. selected sites appropriate for the NGWMN from the IGS' network of 60 dedicated groundwater monitoring wells;
2. verified the selected wells had an electronic record in the IGS databases that meet all the NGWMN Well Registry minimum data requirements; and.
3. developed web services that connected the IGS GeoSam database to the NGWMN portal.

For project year two, the agreement provided funding to maintain data and web services, and to document field techniques and quality assurance processes.

This report describes the work performed under this award from July 2017 through June 2019.

Description of the IGS network

The IGS groundwater level network consists of 60 dedicated monitoring wells (figure 1). The IGS network wells are primarily in the Cretaceous (USGS national code N300lLCRTCS) and Silurian-Devonian (N400SLRDVN) aquifers, but include some wells in the Mississippian (N500MSSPPI) and Cambrian-Ordovician (S300CAMORD) aquifers. Quaternary wells co-located at sites with bedrock wells are also measured as part of the network. Many of the wells have long-term historical records because they were part of the IGS/Iowa Dept. of Natural Resources (IDNR)/United States Geological Survey (USGS) groundwater level network.

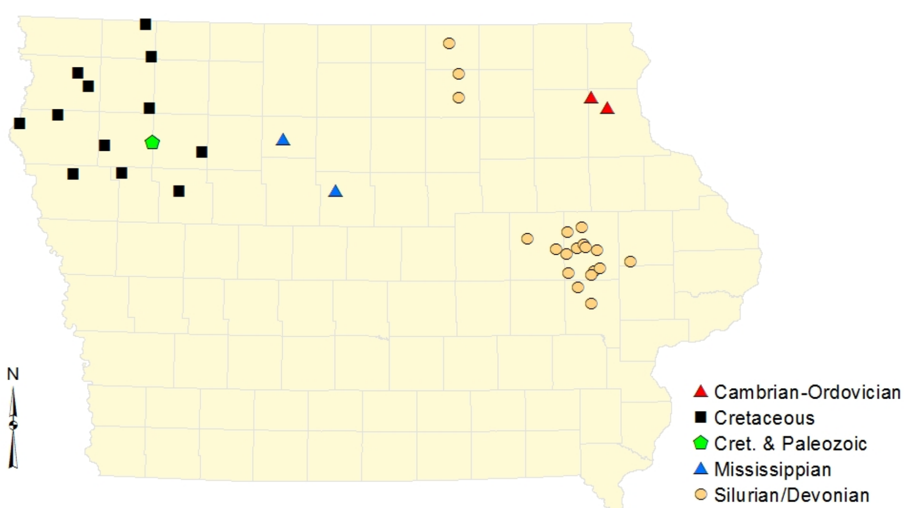

Figure 1. Location of IGS network wells.

One primary goal of the IGS network is to provide data for calibration of groundwater models to evaluate aquifer sustainability. Comprehensive assessments of the Dakota and Silurian aquifers utilized water-level data collected from this network. The Dakota aquifer assessment identified two areas where water production is currently at or near sustainable thresholds (Gannon and others, 2008). The Silurian aquifer assessment revealed significant, local decline in the water-levels near some Iowa municipalities (Gannon and others, 2011).

Another primary goal of the IGS network is to provide a historical record of the water-level changes in the state's aquifers. Research conducted on the IGS/USGS groundwater-level network found that 13 of 36 Silurian-Devonian wells had declining groundwater levels and 27 of 39 Dakota wells had declining groundwater levels from 1995-2004 (PI's unpublished data). Annual hydrograph checks show the declining trends continue in a majority of the Dakota aquifer wells in the IGS network (PI's unpublished data).

Description of NGWMN site selection

The IGS selected wells from its water-level network using guidance provided in the "Framework" document (SOGW, 2013), using guidance found in "Tip Sheets" obtained from the National Ground Water Monitoring web page (http://cida.usgs.gov /ngwmn/learnmore.jsp), and in consultion with United States Geological Survey (USGS) staff. Steps in the IGS selection include –

1. initial review and update, if necessary, of the metadata for the IGS network wells to ensure the metadata met the NGWMN minimum data requirements;
2. identification of the geologic formation(s) that supply water to each IGS network well; and
3. evaluation of the density of wells in specific aquifers.

The IGS selected 40 wells for inclusion into the NGWMN. Table 1 provides summary details about the selected wells. Figure 2 shows the location of the NGWMN selected wells. Appendix A provides additional details on the NGWMN selected wells. Appendix B provides details on wells that were rejected from incorporation into the NGWMN. The reasons for rejecting wells varies by aquifer. In the Mississippian aquifer, the IGS network consists of six (6) wells located in two (2) wellnests. Multiple wells are open to the same geologic formations at each wellnest. Only the well with the greatest penetration through the formation at each wellnest was selected for inclusion in the NGWMN. In the Silurian-Devonian aquifer, the IGS network contains twenty (20) wells located in six (6) wellnests and thirteen individual wells. Within the wellnests, multiple wells are open to the same geologic formations. Like the Mississippian aquifer, the well with the greatest penetration was incorporated into the NGWMN. Many of the IGS' Silurian-Devonian wells are in a single county, so some wells were rejected to maintain consistency with the NWMGN recommended well density. In the Lower Cretaceous aquifer, two (2) of the IGS' thirteen wells have been damaged to the point that reliable water-level measurements are not possible. The IGS is looking at its options, including well abandonment, for these wells. Since the future of these wells are unclear, the IGS decided not to add them to the NGWMN.

Aquifer	Num. of IGS network wells	Num. added to NGWMN	Assigned NGWMN subnetwork		
			Background	Suspected Changes	Documented Changes
Cambrian-Ordovician	2	2	2	0	0
Cretaceous	13	10	3	7	0
Mississippian	6	4	4	0	0
Silurian/Devonian	33	24	13	10	1
Other	6	0	0	0	0

Table 1. Summary of wells added to NGWMN

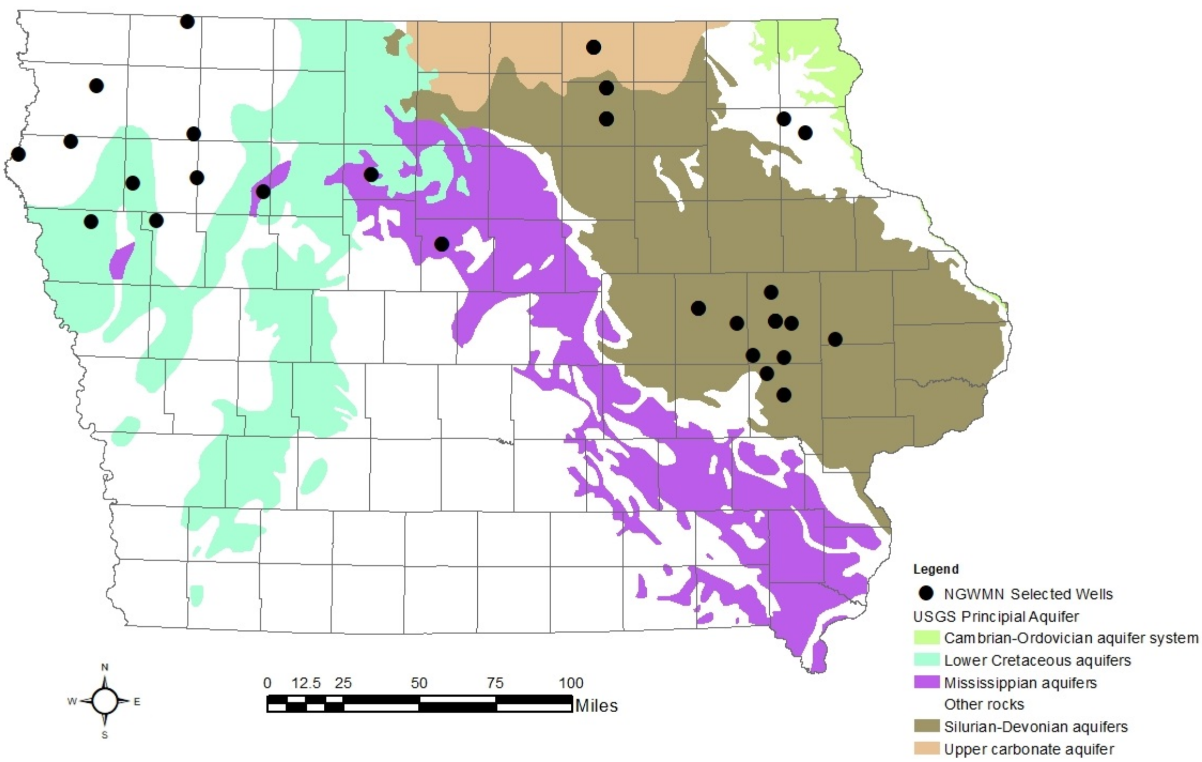

Figure 2. Location of IGS wells selected for incorporation into the NGWMN.

Subnetwork and Monitoring Category Assignments

The IGS assigned NGWMN selected wells to subnetworks and monitoring categories using guidance provided in the "Framework" document (SOGW, 2013) and "Tip Sheets" obtained from the National Ground Water Monitoring web page (http://cida.usgs.gov /ngwmn/learnmore.jsp). Steps in the IGS process included:

1. determining if each site had five (5) years of data to start the 'Baseline Process;'

2. plotting and conducting linear regression analysis on water-level data to establish if trends exist in the data (trends established by the linear regression where tested at the 95% confidence level);
3. establishing if the well was location with the 2, 5, or 10-year capture zone of a public well;
4. identifying the number of "Water Use" wells that are within a three (3) miles radius of the well. "Water Use" wells are wells that pump at least 25,000 gallons in a 24-hour period (examples of water use wells are public water systems, industrial wells, irrigations wells, and quarry dewatering wells)
5. identifying the number of animal feeding operations within a one (1) mile radius of the well; and
6. evaluating groundwater model outputs to determine if the well is in an area subject to pumping pressure.

All the IGS network wells are dedicated monitoring wells and most have long-term water-level records. Consequently, all IGS network wells selected for the NGWMN are "trend" sites. The classification of wells into subnetworks largely depended on the well location and the aquifer to which each well is open. Table 1 summarizes the number of wells assigned to each subnetwork by aquifer. No major groundwater withdrawals occur near the NGWMN selected wells in the Cambrian-Ordovician and Mississippian aquifers. Consequently, the wells in these aquifers were assigned to the "Background" category.

The IGS' Dakota aquifer groundwater model suggests many of the IGS wells in the Dakota aquifer are influenced by pumping stresses. Furthermore, declining water-level trends were identified in the linear regression analysis of many IGS Dakota wells. After consultations with IGS hydrogeologists, the majority of NWGMN selected wells in the Dakota aquifer were assigned to the "Suspected Changes" category. The remain Dakota wells, which are in areas not showing significant pumping influences or water-level declines, were assigned to the "Background" category.

The IGS network measure two distinct portions of the Silurian-Devonian aquifer. No major groundwater withdrawals occur in IGS wells in north-central Iowa. The wells in this area selected for the NGWMN were assigned to the "Background" category. However, the IGS wells in east-central Iowa are located near major cities and quarries. Thirteen of the wells selected for the NGWMN had multiple "water use" wells within a 3-mile radius and were assigned to the "Suspected Changes" category. Four wells, located farther away from cities, were assigned to the "Background" category. The water-levels in one well has been documented to decline with the pumping of nearby wells and was assigned to the "Documented" category.

Data Collection Techniques and Management

The IGS uses established procedures to collect water level measurements. Water-level data is entered into the IGS' GeoSam database. Appendix C contains the IGS' standard operating procedures for water-level collection and quality assurance processes.

The IGS GeoSam database contains all the NGWMN minimum data elements. Appendix D contains a listing of these fields and how they were provided to the NGWMN Portal.

Webservices
For this project the web service is queried by submitting a URL-based request with a known ID number of a well already in the NGWMN system. The web service returns an XML-formatted web document in which that NGWMN is able to merge information from multiple sources and return them to its users as a single data set. The IGS Web Services were developed as an extension to the GeoSam application and created on a custom platform of PHP. The workload is handled by multiple apache servers that returns the resulted query in five different components (casing, screens, construction, lithology, and water levels). The web service supports REST protocol and returns XML-formatted web documents.

Casing Method
This method returns an XML-formatted document listing the site number, depth (specified as "from" and "to" along with units), material used in construction, and diameter (and unit) of the casing. Example method result:
https://www.iihr.uiowa.edu/igs/geosam/api/ngwmn/v2/GetWellCasings/30000

Screens Method
This method returns an XML-formatted document listing the site number, depth (specified as "from" and "to" along with units), material used in construction, diameter (and unit) of the screen, and slot size (and unit). Example method result:
https://www.iihr.uiowa.edu/igs/geosam/api/ngwmn/v2/GetWellScreens/30000

Construction Method
This method returns an XML-formatted document listing the combination of both the screens and casing methods. The resulting document displays casings first then screens that were individually found in the casing and screens methods. Example method result:
https://www.iihr.uiowa.edu/igs/geosam/api/ngwmn/v2/GetWellConstruction/50000

Lithology Method
The lithology webservice was upgraded in December 2018. The lithology ID in the initial version was a code that related the record number in the GeoSam database. The lithology ID was changed to contain the geologic stratigraphic unit that ties rock description as an enhancement of the data submitted to the NGWMN.

The current method returns an XML-formatted document listing the site number, a lithology ID related to the geologic stratigraphic unit, description of the color, the source of the description (ex. an entry on a driller’s log), and the depth (specified as "from" and "to" along with units). Example method result:
https://www.iihr.uiowa.edu/igs/geosam/api/ngwmn/v2/GetWellLithology/30000

Water Level Method
This method returns an XML-formatted document listing the site number, water level (and unit) at the time of test, date (formatted in yyyy-mm-dd), time (formatted in hh:mm), time zone, measurement method used, and the accuracy (and unit) of the test. Example method result:
https://www.iihr.uiowa.edu/igs/geosam/api/ngwmn/v2/GetWellWaterLevels/30000

The IDNR is also a NGWMN data provider, submitting well water quality data to the portal. The IGS' GeoSam database stores construction and lithological data for the IDNR sites. Consequently, the IGS web services also transfer well data to the NGWMN Portal for the IDNR.

Summary

The IGS has achieved all of the project goals. Specifically, we successfully added 40 Iowa wells to the National Ground-Water Monitoring Network representing Cambrian-Ordovician, Cretaceous, Mississippian, Silurian-Devonian, and Quaternary aquifers. Relevant data from these wells is now being actively shared with the NGWMN via web services developed as an extension of the IGS' GeoSam database.

References

Gannon, J.M.., Witzke, B., Bunker, B., Howes, M., Rowden, R., and Anderson, R., 2008, Groundwater Availability Modeling of the Lower Dakota Aquifer in Northwest Iowa , WRI-1A, Iowa Geological Survey.

Gannon, J.M., Witzke, B.J., and Langel, R.J., 2011, Groundwater Availability Modeling of the Silurian Aquifer in East-Central Iowa, WRI-5, Iowa Geological Survey.

Cunningham, W.L., and Schalk, C.W., comps., 2011, Groundwater Technical Procedures of the U.S. Geological Survey: U.S. Geological Survey Techniques and Methods 1–A1, 151 p.

Subcommittee on Ground Water (SOGW), 2013, A National Framework for the Ground-Water Monitoring in the United States, 182 p.

APPENDIX A

INFORMATION ON WELLS SELECTED FOR THE NGWMN

Site No	Site Name	County	National Aquifer	Local Aquifer
23183	Stockpile	Linn	Silurian-Devonian aquifers	Dev. Wapsi Grp.+Silurian
23268	Alice	Linn	Silurian-Devonian aquifers	Dev. Wapsi Grp.+Silurian
23336	Parkers Grove	Benton	Silurian-Devonian aquifers	Dev. Wapsi Grp.+Silurian
23440	Garrison 340	Benton	Silurian-Devonian aquifers	Dev. Cedar Valley & Wapsi Grp.+Silurian
23766	Ely NW	Linn	Silurian-Devonian aquifers	Silurian
23785	Marion	Linn	Silurian-Devonian aquifers	Silurian
23891	White Oak Cr.	Jones	Silurian-Devonian aquifers	Silurian
23925	Plum Cr.	Johnson	Silurian-Devonian aquifers	Dev. Cedar Valley & Wapsi Grp.+Silurian
24556	D-2	Plymouth	Lower Cretaceous aquifers	Dakota Fm.
24557	D-3	O'Brien	Lower Cretaceous aquifers	Dakota Fm.
24735	D-9	Ida	Lower Cretaceous aquifers	Dakota Fm.
25108	D-13	Osceola	Lower Cretaceous aquifers	Dakota Fm.
25114	D-11	Cherokee	Lower Cretaceous aquifers	Dakota Fm.
25525	D-24	Buena Vista	Lower Cretaceous aquifers	Dakota Fm.
25593	D-32	Woodbury	Lower Cretaceous aquifers	Dakota Fm.
25736	D-35	Plymouth	Lower Cretaceous aquifers	Dakota Fm.
25941	D-44	Sioux	Lower Cretaceous aquifers	Dakota Fm.
30000	Oakdale-Sil.	Johnson	Silurian-Devonian aquifers	Silurian Aquifer
30096	BS-4	Clayton	Cambrian-Ordovician aquifer system	St. Peter Fm.
30500	Oakdale-Dev	Johnson	Silurian-Devonian aquifers	Devonian aquifer
50000	Briggs Woods #3	Hamilton	Mississippian aquifers	Maynes Creek Fm.
54285	Briggs Woods #2	Hamilton	Mississippian aquifers	St. Louis Fm.
54830	Rutland Marsh #5	Humboldt	Mississippian aquifers	Maynes Creek Fm.
55575	Rutland Marsh #3	Humboldt	Mississippian aquifers	Gilmore City Fm.
56819	Westfield #1	Linn	Silurian-Devonian aquifers	Silurian
56978	FM1-2	Floyd	Silurian-Devonian aquifers	Upper Devonian
56979	FM1-3	Floyd	Silurian-Devonian aquifers	Middle Devonian
56980	FM1-4	Floyd	Silurian-Devonian aquifers	Lower Devonian
56983	FM2-2	Mitchell	Silurian-Devonian aquifers	Upper Devonian
56984	FM2-3	Mitchell	Silurian-Devonian aquifers	Middle Devonian
56985	FM2-4	Mitchell	Silurian-Devonian aquifers	Lower Devonian
56988	FM3-2	Floyd	Silurian-Devonian aquifers	Upper Devonian
56989	FM3-3	Floyd	Silurian-Devonian aquifers	Middle Devonian
56990	FM3-4	Floyd	Silurian-Devonian aquifers	Lower Devonian
57355	Westfield #2	Linn	Silurian-Devonian aquifers	Lower Devonian & Silurian
57356	Westfield #3	Linn	Silurian-Devonian aquifers	Devonain
64073	D-29	Cherokee	Lower Cretaceous aquifers	Dakota Fm.
71158	Garrison 170	Benton	Silurian-Devonian aquifers	Devonain
71159	Garrison 109	Benton	Silurian-Devonian aquifers	Devonain
86249	BS-2G	Clayton	Cambrian-Ordovician aquifer system	St. Peter Fm.

Site No	Site Name	Well Depth	Well Type	Well Subnetwork
23183	Stockpile	569 ft	Trend	Suspected / Anticipated Changes
23268	Alice	435 ft	Trend	Background
23336	Parkers Grove	590 ft	Trend	Background
23440	Garrison 340	538 ft	Trend	Suspected / Anticipated Changes
23766	Ely NW	401 ft	Trend	Suspected / Anticipated Changes
23785	Marion	481 ft	Trend	Suspected / Anticipated Changes
23891	White Oak Cr.	517 ft	Trend	Background
23925	Plum Cr.	535 ft	Trend	Background
24556	D-2	571 ft	Trend	Suspected / Anticipated Changes
24557	D-3	352 ft	Trend	Suspected / Anticipated Changes
24735	D-9	424 ft	Trend	Suspected / Anticipated Changes
25108	D-13	923 ft	Trend	Background
25114	D-11	390 ft	Trend	Suspected / Anticipated Changes
25525	D-24	357 ft	Trend	Suspected / Anticipated Changes
25593	D-32	221 ft	Trend	Background
25736	D-35	581 ft	Trend	Background
25941	D-44	682 ft	Trend	Suspected / Anticipated Changes
30000	Oakdale-Sil.	532 ft	Trend	Known Changes
30096	BS-4	580 ft	Trend	Background
30500	Oakdale-Dev	301 ft	Trend	Suspected / Anticipated Changes
50000	Briggs Woods #3	410 ft	Trend	Background
54285	Briggs Woods #2	110 ft	Trend	Background
54830	Rutland Marsh #5	280 ft	Trend	Background
55575	Rutland Marsh #3	150 ft	Trend	Background
56819	Westfield #1	445 ft	Trend	Suspected / Anticipated Changes
56978	FM1-2	138 ft	Trend	Background
56979	FM1-3	240 ft	Trend	Background
56980	FM1-4	357 ft	Trend	Background
56983	FM2-2	150 ft	Trend	Background
56984	FM2-3	250 ft	Trend	Background
56985	FM2-4	348 ft	Trend	Background
56988	FM3-2	207 ft	Trend	Background
56989	FM3-3	297 ft	Trend	Background
56990	FM3-4	360 ft	Trend	Background
57355	Westfield #2	200 ft	Trend	Suspected / Anticipated Changes
57356	Westfield #3	40 ft	Trend	Suspected / Anticipated Changes
64073	D-29	340 ft	Trend	Suspected / Anticipated Changes
71158	Garrison 170	237 ft	Trend	Suspected / Anticipated Changes
71159	Garrison 109	110 ft	Trend	Suspected / Anticipated Changes
86249	BS-2G	343 ft	Trend	Background

APPENDIX B

INFORMATION ON WELLS SELECTED FOR THE NGWMN

site no.	name	county	reason
23201	Lincoln Church	Linn	Eliminated to reduce well density.
23254	Bridge Hole	Linn	Eliminated to reduce well density.
23309	Hiawatha	Linn	Eliminated to reduce well density.
23732	Ely N	Linn	Eliminated to reduce well density.
23838	Bertram	Linn	Eliminated to reduce well density.
25319	D-16	Sac	Multiple aquifers are open in well.
25520	Robins	Linn	Eliminated to reduce well density.
25529	D-28	Cherokee	Multiple aquifers are open in well.
25899	D-39	Osceola	Unable to utilize. Casing bent. Well may need to be plugged.
25965	D-43	Sioux	Unable to utilize. Casing bent. Well may need to be plugged.
31000	ODW #3	Johnson	Well completed in a Quaternary till unit.
54286	Briggs Woods #1	Hamilton	Well completed in a Quaternary till unit.
55574	Rutland Marsh #4	Humboldt	Redundant. Another NGWMN selected well is open to the same formation.
55576	Rutland Marsh #2	Humboldt	Redundant. Another NGWMN selected well is open to the same formation.
55577	Rutland Marsh #1	Humboldt	Well completed in a Quaternary till unit.
56977	FM1-1	Floyd	Redundant. Another NGWMN selected well is open to the same formation.
56981	FM2-T	Mitchell	Well completed in a Quaternary till unit.
56982	FM2-1	Mitchell	Redundant. Another NGWMN selected well is open to the same formation.
56986	FM3-T	Floyd	Well completed in a Quaternary till unit.
56987	FM3-1	Floyd	Redundant. Another NGWMN selected well is open to the same formation.

APPENDIX C

IGS STANDARD OPERATION PROCEDURES

FOR COLLECTING WATER-LEVEL MEASUREMENT

Standard Operating Procedure for Collecting Water-Level Measurements

Version: 2018

PURPOSE
To outline a standard procedure to ensure that accurate and consistent water-level measurements are made in the field.

MATERIALS AND INSTRUMENTS

- Steel surveyors tape, of appropriate length, graduated in 0.01 foot increments. Carpenters chalk.
- Electrical line or tape (sounder), graduated in 0.01 foot increments.
- Sonic sounder.
- Pencil or pen, blue or black ink.
- Water-level measurement field form, or handheld computer for data entry.
- Cleaner for tape (clorox diluted with water in a spray bottle, a container of disinfecting wipes, paper towel or cloth rag).
- Extra batteries.
- Tool kit (plumbers tape, wrenches, pliers, etc…).

ESTABLISH A SITE AND MEASURING POINT
A clearly established measuring point (typically the top of the well casing), should be established where water levels are to be measured. Guidance for establishing a measuring point can be found in Cunningham and Schalk (2011). Document the distance between the land surface and the measuring point. The measuring point for a flowing well should be placed as close to the outlet as possible.

INSTRUCTIONS
All water level measurements should be conducted prior to any other activities occurring within the well.

Steel Tape Measurements

1. Apply chalk to the first several feet of the tape by pulling the tape across a piece of carpenters chalk resulting in a smooth coating of chalk on the tape.
2. Lower the tape into the well from the measuring point until a short length of the tape is submerged.
3. When the tape is submerged, hold the tape at the measuring point and read the value and record the "hold" value on the field form.
4. Retrieve the tape from the well and note the water mark, or "cut" mark, on the chalked part of the tape. Record the "cut" mark on the field form.
5. Subtract the "cut" reading from the "hold" reading to determine the distance to water below the measuring point. Record the resulting distance to water value on the field form.

6. Repeat the measurement by lowering the tape into the well a second time and "holding" at a point on the tape 1 foot greater than the initial "hold" point. Subtract the new "cut" mark and determine a second distance-to-water value for the well. If two measurements made within a few minutes do not agree within 0.02 foot repeat measurements until a reason for the lack of agreement is determined, the results are shown to be reliable, or until it is determined that an accurate measurement is not possible.
7. After completing the water-level measurement, disinfect, rinse, and dry the portion of the tape that was submerged.

Electric Line (Tape) Measurements

1. Test the probe by dipping it in water and observing the indicator or by activating the "test" switch.
2. Lower the probe slowly into the well until contact with the water surface is indicated.
3. Read the electric line at the measuring point while the probe is just touching the water surface, and record the distance to water. Record the measurement on the field form.
4. Repeat the measurement. If the two measurements of static water level made within one minute do not agree within 0.02 foot, repeat the measurements until a reason for the lack of agreement is determined, the results are shown to be reliable, or until it is determined that an accurate measurement is not possible. Record measurement on field form.
5. After completing the water-level measurement, disinfect, rinse, and dry the portion of the tape that was submerged.

Sonic Measurements

1. Power on the probe and adjust temperature settings to the average air temperature in the well casing. Maps and tables found in the meter case provide data appropriate setting to use.
2. Use the cover cap (also found in the meter case) to cover the top of the well. Insert meter probe through small opening in cap.
3. Power on meter. Meter will emit five (5 “pings.” Record the displayed measurement on field form.
4. Repeat the measurement. If the two measurements of static water level made within one minute do not agree within 1 foot, repeat the measurements until a reason for the lack of agreement is determined, the results are shown to be reliable, or until it is determined that an accurate measurement is not possible. Record the measurement on the field form.

DATA QUALITY AND QUALITY ASSURANCE PROCESSES

Quality control will be maintained by collecting two consecutive water level measurements within acceptable agreement for the procedure used.

Field forms will be scanned as pdfs and stored on the IGS file servers, which are backed up on schedules set by University of Iowa IIHR-Hydroscience & Engineering IT staff.

Data from the field forms will be uploaded to the IGS' GeoSam database. IGS staff will enter raw data into an Excel spreadsheet. Once all data has been entered into the spreadsheet, the staff member will check 10% of the records to verify the data are entered correctly. Any erroneous data found will be corrected at this time. Using a series of formula, the Excel spreadsheet will generate an import file that contains all the required fields for GeoSam. The file is sent to IT staff to upload to GeoSam. After successfully loading the data to GeoSam, the IGS staff will then check 10% of the records against the field forms to ensure the data are correct. Any erroneous data found will be corrected.

On a yearly basis, all data for a given well will be graphed. Any point that is flagged as an outlier, for example results with values +/- 1.5 standard deviations from a trend line plotted through the data, shall be verified against the field forms to ensure the data are entered correctly.

References

Cunningham, W.L., and Schalk, C.W., comps., 2011, Groundwater technical procedures of the U.S. Geological Survey: U.S. Geological Survey Techniques and Methods 1–A1, 151 p.

APPENDIX D

NGWMN DATA ELEMENTS

IGS Data Elements provided to the NGWMN by

Direct Entry to Well Registry

Site Information

- Altitude
- Altitude Accuracy
- Altitude Datum
- Altitude Method
- Altitude Units
- Aquifer Type
- County
- Horizontal Dataum
- Latitude/Longitude Accuracy
- Latitude/Longitude Method
- Latitude
- Local Aquifer Code
- Longitude
- National Aquifer Code
- Site Name
- Site type
- State
- Well Depth
- Well Depth Units

Web Services

Lithology

- Beginning depth of lithologic unit
- Decripton of Lithology of the unit
- Ending depth of lithologic unit
- Lithology ID
- Observation Method

Construction methods

- Beginning depth of casing interval
- Ending depth of casing interval
- Casing depth unit of measure
- Casing interval
- Casing Material
- Beginning depth of screen interval
- Ending depth of Screen interval
- Screen depth unit of measure
- Screen interval material

Water-levels

- Accuracy of water-level measurements
- Date/Time of water-level measurement
- Depth to Water
- Method of water-level measurements
- Water-level units