Final Technical Report: Oregon Water Resources National Ground-Water Monitoring Network
Cooperative Agreement G21AC10476 (11/1/2021 through 10/31/2023, extended through 10/31/2024)

Award Number: G21AC10476

Agency Name: Oregon Water Resources Department

Title: Oregon National Ground-Water Monitoring Network

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Background

The Oregon Water Resources Department (OWRD) manages water supplies in the state of Oregon. The Department monitors groundwater levels throughout the state to evaluate aquifer sustainability, the impacts of groundwater withdrawals on surface water sources, and the availability of groundwater for new proposed uses. Five principal USGS aquifers underlie extensive areas of Oregon (Miller, 1998; Whitehead, 1994): Willamette Lowland basin-fill aquifers, Pacific Northwest basin-fill aquifers, Pacific Northwest basaltic-rock aquifers, Columbia Plateau basin-fill aquifers, and Columbia Plateau basaltic-rock aquifers. Three additional principal aquifers underlie small areas of the state. Snake River Plain basin-fill aquifers and Snake River Plain basaltic-rock aquifers occur in a narrow strip in eastern Oregon, adjacent to Idaho, and Basin and Range basin-fill aquifers occur in southeastern Oregon adjacent to Nevada. A sizable fraction of Oregon is underlain by pre-Miocene rock that hosts low-yield fractured bedrock aquifers. Although these are not defined as a USGS principal aquifer, they represent an important water supply in many areas of the state, especially west of the Cascade Mountains.

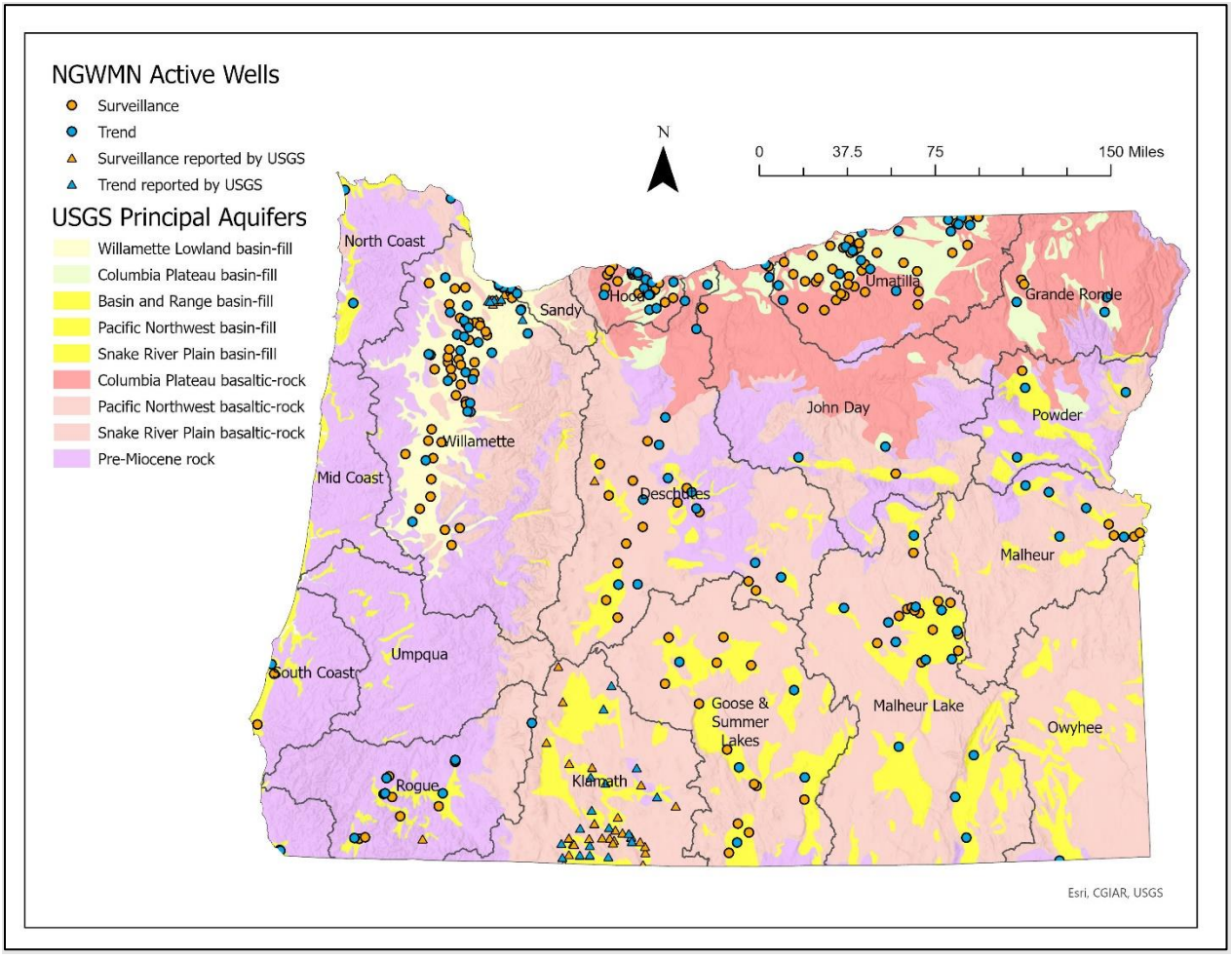

Figure 1: Current OWRD National Groundwater Monitoring Network wells.

OWRD became a new NGWMN provider in 2015 and currently maintains 287 active NGWMN sites that represent 5 USGS principal aquifers and several locally important pre-Miocene bedrock aquifers (Figure 1). Continuous recorders are installed in 61 wells (Table 1).

Table 1: Summary of active OWRD NGWMN wells by aquifer, monitoring category, and recorder use. Trend monitoring provides high-frequency data over a long period of at a limited number of wells, while surveillance monitoring provides higher spatial resolution through measurement of more wells at lower temporal frequency.

USGS Principal Aquifer	Trend	Surveillance	Recorder	Total
Columbia Plateau basaltic-rock aquifers	33	43	15	76
Columbia Plateau basin-fill aquifers	4	8	7	12
Other (Pre-Miocene rock)	6	4	4	10
Pacific Northwest basaltic-rock aquifers	23	44	13	67
Pacific Northwest basin-fill aquifers	29	37	16	66
Willamette Lowland basin-fill aquifers	20	36	6	56
Total	115	172	61	287

Description of Work Done to Support the NGWMN under Award G21AC10476

Award G21AC10476 provided funds to maintain the persistent data services (objective 2), to drill a groundwater monitoring well (objective 5) and to purchase monitoring equipment (objective 6). The completion of all tasks except for the tasks under objective 5 are documented in the following section under each of the major objectives that were listed in the original proposal.

Objective 2: Support Persistent Data Service

During year 1 and 2 of the award period, OWRD's Information Services Section performed routine backup, performance tuning, and stored procedure modifications to ensure continuity of web services.

Task 1: Maintain web services

During the reporting period, OWRD Information Services and Groundwater staff maintained web services including testing and enhancing performance where needed.

Task 2: Update and maintain well registry information for current and replacement sites (including quality assurance of data)

During the reporting period, OWRD staff made routine well registry updates as needed. Quality assurance of data was performed following the procedures outlined in the section titled "Data-Collection Methods and Quality Assurance Procedures" below.

A major review identified 15 wells that have lost access for water level measurement and are potentially in need of replacement for ongoing monitoring of the corresponding water level trends (Table 2). Wells where a replacement observation well could be identified (Figures 1 through 4) were added to the NGWMN registry if not already present (Table 3). For those 3 original wells retained, the Alternate Well ID in the NGWMN portal was set equal to the OWRD ID of the replacement, the relationship set to "Replacement". For the replacement wells, the Alternate Well ID was set equal to the OWRD ID of the original well with a relationship of "Original". Alternate well links were not provided because attempting to set them gave an error of "The specified URL cannot be found." The similarities of trends were noted in the "purpose notes." For the remainder, OWRD is working to identify appropriate replacements.

Table 2: Summary of wells removed from the OWRD NGWMN network along with replacements.

Original Well	NGWMN Registry Status	Replacement Well	Replacement Status
MORR0000508	Displayed	MORR0000509	Added to registry
UMAT0002396	Displayed	UMAT0057007	Added to registry
HARN000755	Displayed	HARN0052102	Replacement already in registry
HARN0001393	Deleted	HARN0001408	Replacement already in registry and covers same time period as original
UNIO001201	Not displayed		Seeking Replacement
POLK00053369	Not displayed		Seeking Replacement
MARI0008847	Not displayed		Seeking Replacement
MARI00012216	Not displayed		Seeking Replacement
JOSE00155318	Not displayed		Seeking Replacement
MARI0015904	Not displayed		Seeking Replacement
JEFF00150734	Not displayed		Seeking Replacement
LAKE0011921	Not displayed		Seeking Replacement
WASC0012760	Not displayed		Seeking Replacement
MORR000595	Not displayed		Seeking Replacement
HARN0051611	Deleted		Will not be replaced

Table 3: Classification of wells added to the NGWMN OWRD network and not already in the NGWMN well registry.

Original Well	Replacement Well	Original Year Last Observed	Replacement Year First Observed	Aquifer System	Subnetwork Type	Monitoring Category
MORR 0000508	MORR 0000509	2016	1980	Columbia Plateau basaltic-rock aquifers	Documented Changes	Surveillance
UMAT 0002396	UMAT 0057007	2017	2012	Columbia Plateau basin-fill aquifers	Suspected Changes	Surveillance

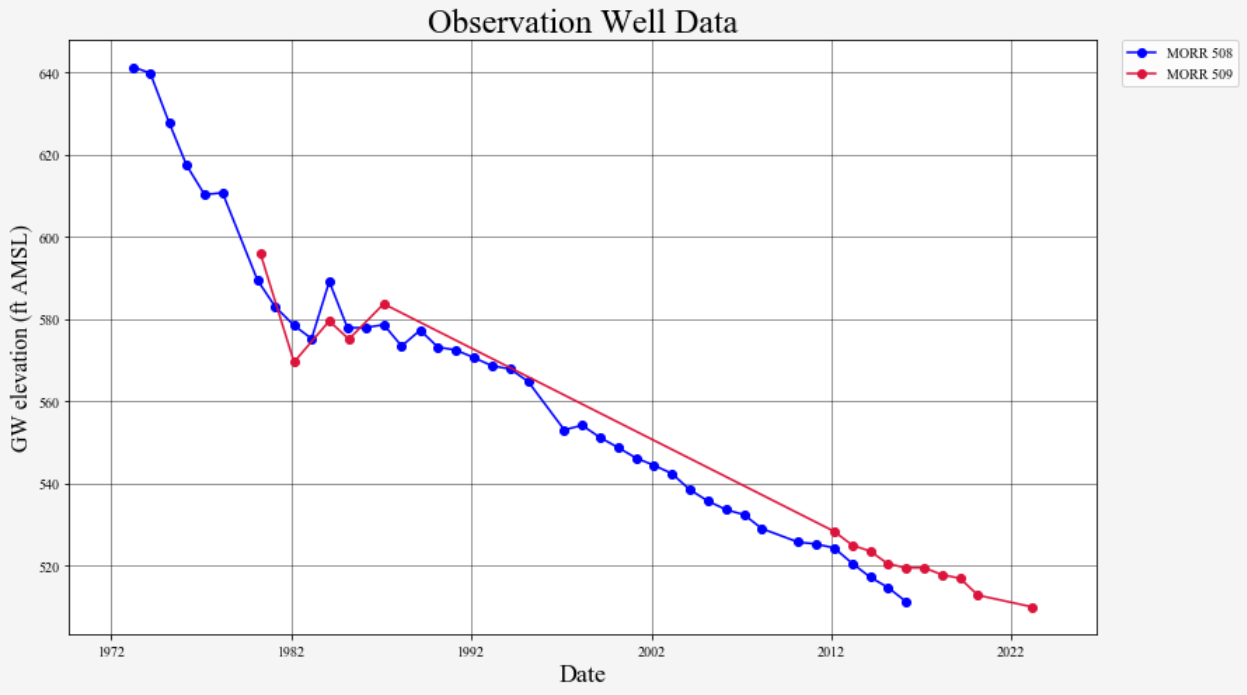

Figure 2: Composite hydrograph for MORR0000508 and MORR0000509.

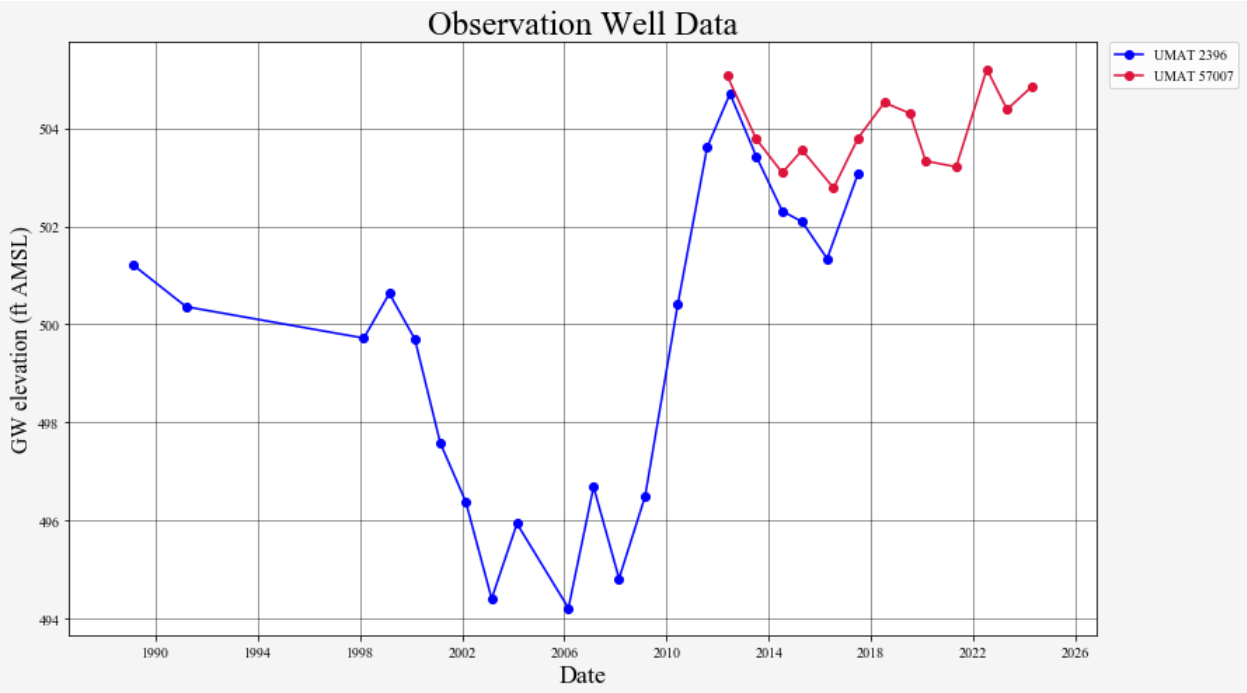

Figure 3: Composite hydrograph for UMAT00002396 and UMAT0057007.

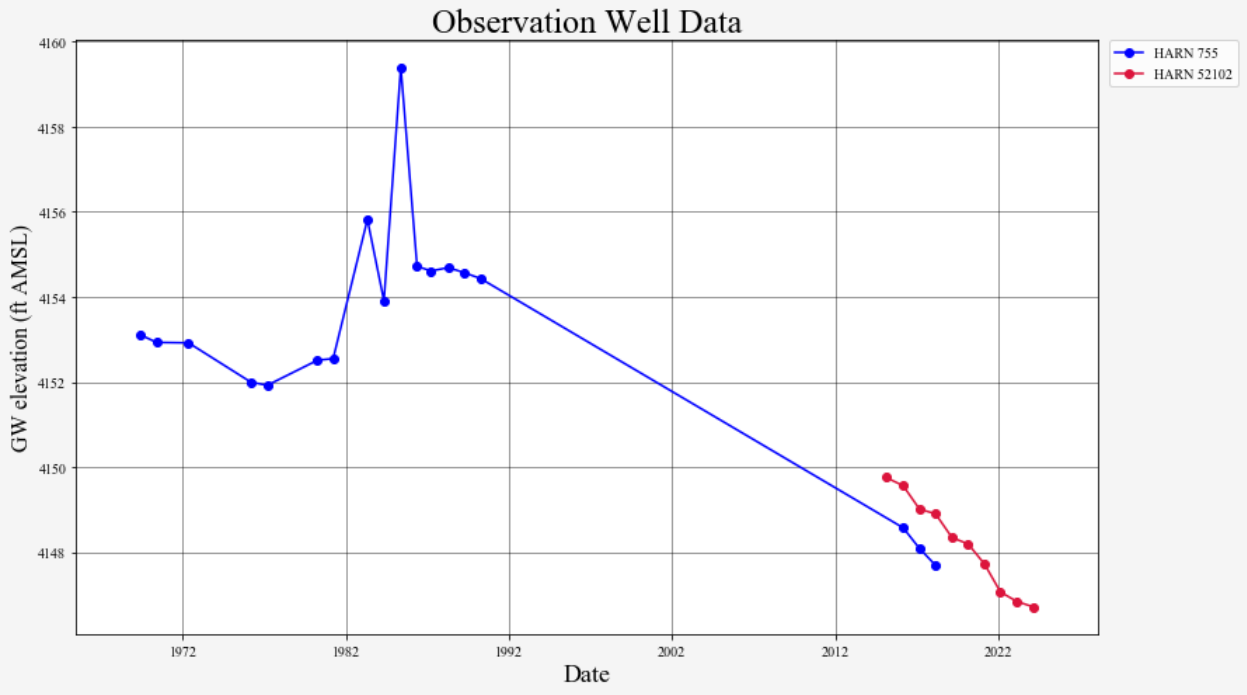

Figure 4: Composite hydrograph of annual high water levels for HARN0000755 and HARN0052102. HARN0052102 was already in the NGWMN registry.

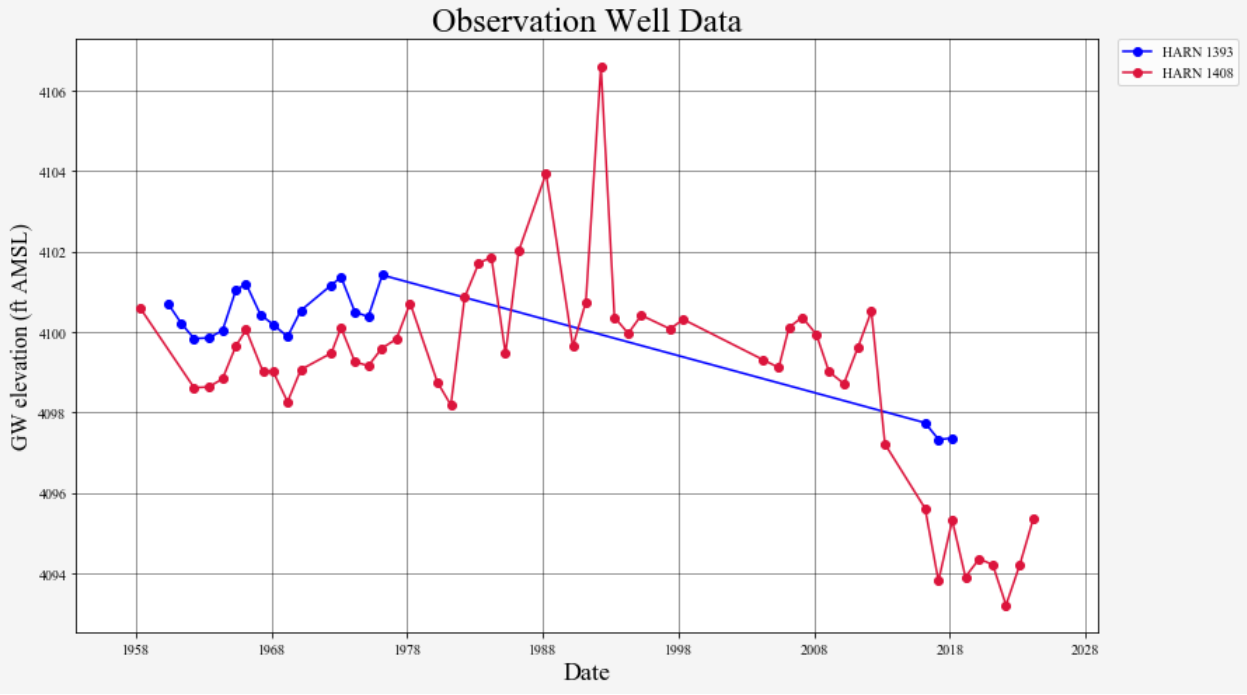

Figure 5: Composite hydrograph of annual high water levels for HARN0001393 and HARN0001408. HARN0001408 was already in the NGWMN registry and spans the record of HARN0001393.

Task 3: Database support

During the reporting period OWRD Information Services staff performed routine database administration procedures such as backup, performance tuning, and stored procedure modifications as needed to ensure the flow of data to the NGWMN.

Objective 5: Well Drilling

Due to challenges with contracting a driller for an acceptable cost, OWRD was unable to complete the observation well installation work associated with objective 5. OWRD groundwater staff and procurement staff issued three solicitations for bids and received no bids on two of the solicitations. The one solicitation that was responded to received only one bid and that bid was cost prohibitive. Repeated attempts to get more drillers to bid were unsuccessful due to concerns related to artesian pressure and the lack of driller availability in the Klamath basin caused by the large number of domestic wells that have gone dry since 2021.

Objective 6: Equipment Purchases

Table 4 below details the list of equipment purchased to ensure that continuous water level recording devices and ancillary equipment remained functional. Staff time and travel to replace equipment has been covered by OWRD, and these trips have been made in conjunction with other routine data collection work so as to minimize any additional cost. Table 5 details the timing of installation of replacement equipment in each of the wells.

Table 4: Equipment purchased to replace total pressure (Levelogger) and barometric pressure (Barologger) transducers and cables in wells covered by this grant.

Description	Water level range (ft)	Cost per unit	Number of units	Cost of equipment
Solinst Barologger		$258.40	6	$1,550.40
Solinst Levelogger M10/F33	33	$493.85	7	$3,456.95
Solinst Levelogger M20/F65	65	$493.85	3	$1,481.55
Solinst Levelogger M100/F300	300	$493.85	1	$493.85
Direct Read Cable (5 ft)		$72.00	6	$432.00
Direct Read Cable (50 ft)		$107.10	2	$214.20
Direct Read Cable (75 ft)		$126.00	1	$126.00
Direct Read Cable (100 ft)		$144.90	3	$434.70
Direct Read Cable (125 ft)		$163.80	2	$327.60
Direct Read Cable (175 ft)		$228.00	2	$456.00
Direct Read Cable (225 ft)		$260.10	1	$260.10
Total				**$9,233.35**

Table 5: Summary of dates of installation of original and replacement loggers of total pressure and barometric pressure, in each of the wells supported under this grant.

Well ID	Total Pressure Start Date	Total Pressure Replaced Date	Barometric Pressure Start Date	Barometric Pressure Replaced Date
HARN0000440	5/12/2014	2/12/2023	N/A	N/A
HARN0001245	5/12/2014	2/13/2023	5/12/2014	2/13/2023
KLAM0010574	8/13/2013	1/18/2023	8/13/2013	4/25/2023
LAKE0052477	10/15/2015	8/25/2022	5/13/2014	8/25/2022
MORR0000955	1/10/2013	4/25/2023	5/16/2012	4/25/2023
MORR0050486	11/5/2012	10/21/2021	N/A	N/A
MORR0051690	2/14/2014	4/25/2023	N/A	N/A
UMAT0003879	2/26/2014	4/25/2023	2/26/2014	7/13/2023
UMAT0003958	10/9/2013	5/26/2023	10/9/2013	7/12/2023
WASC0051820	6/20/2014	10/20/2023	N/A	N/A
YAMH0000599	7/17/2014	10/19/2023	N/A	N/A

In-Kind Data-Collection Activities

During the award period, routine water-level measurements were continued at all active NGWMN sites, and automatic recorders were maintained at 61 sites. All data were routinely entered into OWRD database tables and are now available to the NGWMN via OWRD's web services.

Data-Collection Methods and Quality Assurance Procedures

OWRD collects water-levels and well metadata using procedures and data collection standards that parallel those outlined in the NGWMN Framework document and in Groundwater Technical Procedures of the U.S. Geological Survey (Cunningham and Schalk, 2011). The Department uses steel tapes in a few wells but generally uses commercially available electric tapes from several vendors. Tapes are calibrated annually, or more frequently as needed, using a 500-foot dedicated steel tape that has been calibrated by the USGS Oregon Water Science Center. Calibrated flat tapes (electric tapes with a steel core) are used in all dedicated observation wells without pumps. Coaxial electric tapes are used in all wells with pumps. In flowing artesian wells, calibrated gages are used to measure shut-in pressure. A few of our NGWMN wells are measured using an airline and a calibrated gage. Whenever possible, independent calibrated electric tape measurements are made to verify airline lengths.

Water-level measurement errors are initially assigned to each measurement based on the tool used to obtain the measurement as follows:

- Calibrated steel tapes 0.01 feet

- Calibrated flat electric tapes 0.01 feet
- Calibrated coaxial electric tapes 0.02 feet
- Uncalibrated coaxial electric tapes 0.10 feet
- Calibrated gage measurements used for shut-in pressures 0.25 feet
- Calibrated gage measurements used for airlines with verified airline lengths 2 feet
- Calibrated gage measurements used for airlines with unverified airline lengths 4 feet
- Water levels from a SCADA system 0.10 feet

However, these initial error estimates are adjusted upward as needed based on conditions encountered in the field.

Measuring points are documented relative to land surface at each well along with the horizontal and vertical errors associated with the well location and well-head elevation.

All current recorder data is processed and reviewed using WISKI, a time-series water-information management system developed by the KISTERS Company. A customized processing file is established in WISKI for each monitoring site based on unique site attributes. Standard protocols are used to subtract barometric pressure (most of our transducers are non-vented models), correct for drift using independent measurements made with calibrated electrical or steel tapes during each site visit, and correct for miscellaneous baseline shifts. Some of these processes are automated by the WISKI software but each file is also reviewed at various times by a hydrogeologist to ensure that the final product meets our quality control standards. The data is also processed to provide a table of mean daily levels. The final, corrected unit measurements and the daily mean values are uploaded into SQL tables, which are then available to the NGWMN Portal via OWRD's web services.

Status of OWRD Databases and Web Services

OWRD initially established web services for discrete water levels, mean daily recorder water levels, lithology, and well construction when it became a new data provider in 2015. OWRD continues to maintain it's groundwater database as needed to continue providing persistent data services and delivering data to the NGWMN.

OWRD web service requests currently available at:
https://apps.wrd.state.or.us//apps/gw/gw_data_usgs/IndexUSGS.html

Documentation of the web services is available at:
https://apps.wrd.state.or.us/apps/gw/gw_data_usgs/IndexUSGS.html#hide1

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