Proposal submitted to: City of Augusta Utilities, Georgia

February 2023

Groundwater resources in the Cretaceous aquifer system, Augusta, Richmond County area, Georgia, 2023

U.S. Department of the Interior

U.S. Geological Survey

Background

The Cretaceous aquifer system is the second most productive aquifer in Georgia and a major source of water in the region (Painter, 2019; Williams, 2007; Fanning, 2003). About 166.4 million gallons per day (Mgal/d) of water was withdrawn from the Cretaceous aquifer system during 2015 in Georgia (Painter, 2019). The Augusta, Richmond County Water System is the largest public water supplier in Richmond County, withdrawing about 7.68 Mgal/d in 2021 from the Cretaceous aquifer system.

The Cretaceous aquifer system extends as a band, roughly 50 to 75 miles wide, from southwest to eastern Georgia. The up-dip limit of the Cretaceous aquifer system is the Fall Line, the boundary between the Piedmont and Coastal Plain Provinces (Clark and Zisa, 1976; fig. 1). Sand and clay units comprise the Cretaceous aquifer system. Underlying the Cretaceous is crystalline rock; overlying the Cretaceous are Tertiary sand and clay deposits that make up the stratigraphic equivalent of the carbonate Floridan aquifer system in coastal Georgia (figs. 1 and 2).

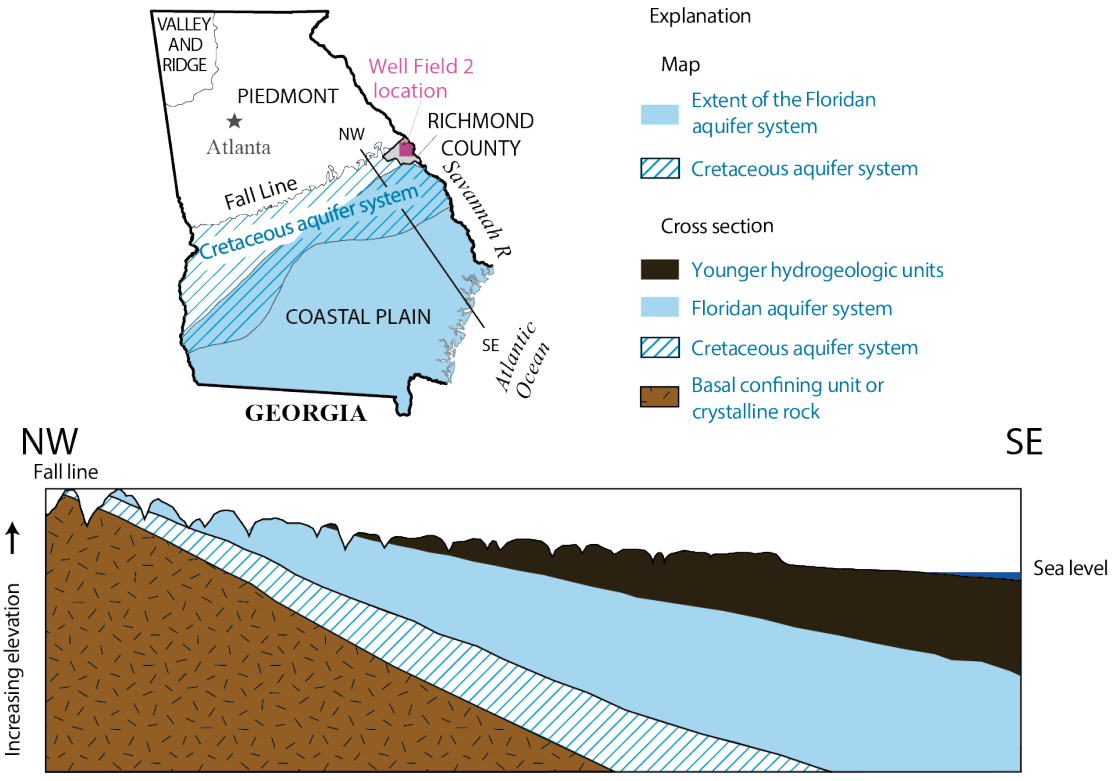
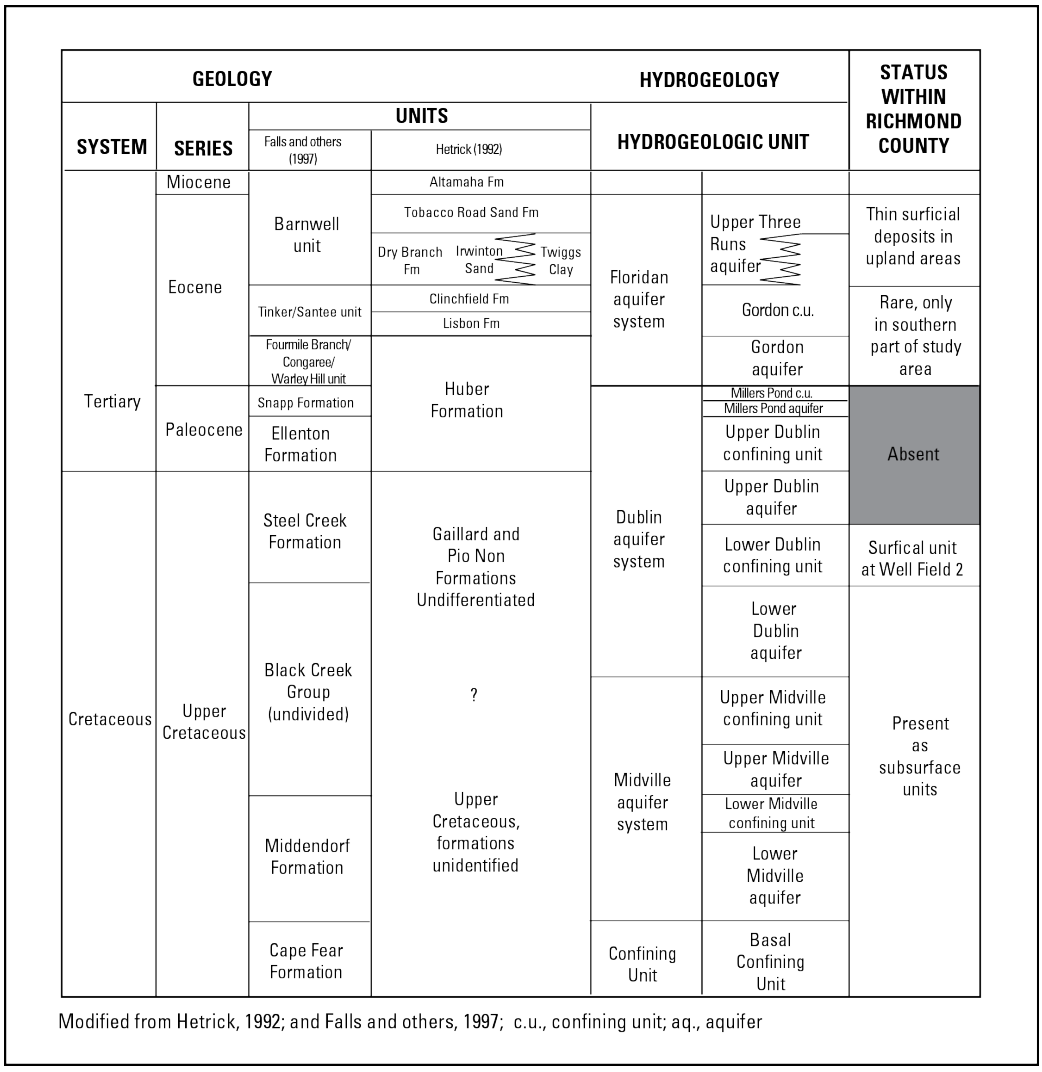


Figure 1. Cretaceous aquifer system, location of Richmond County, Georgia; map and hydrogeologic cross section (map modified from USGS, 2006).



Modified from Hetrick, 1992; and Falls and others, 1997; c.u., confining unit; aq., aquifer

Figure 2. Generalized correlation of geologic and hydrogeologic units in the Augusta, Richmond County area.

All groundwater for the Augusta, Richmond County Water System is from three well fields that withdraw water from the upper and lower Midville aquifers, in the lower part of the Cretaceous aquifer system (fig. 3). In 1999, low levels of volatile organic compounds (VOCs) were detected in water samples from several wells in Augusta's northernmost well field within the up-dip part of the Cretaceous aquifer system (Well Field 1, fig. 3). Detections of the VOCs resulted in the closure of those wells. Also in 1999, the VOCs tetrachloroethene (PCE) and trichloroethene (TCE) were detected in a production well at the northernmost extent of Well Field 2 (fig. 3).

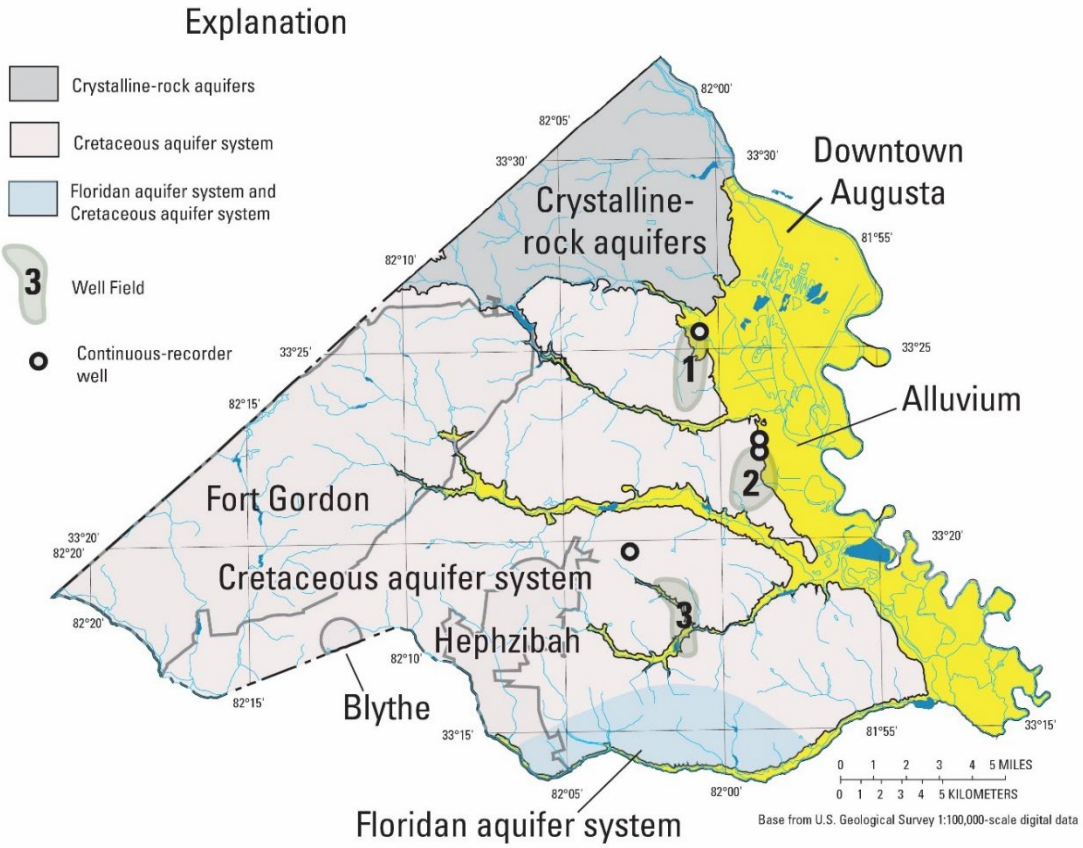


Figure 3. Augusta Utilities three well fields, selected continuous-recorder wells, surface geology, and municipalities, Richmond County, Georgia. The two continuous-recorder wells at the north end of Well Field 2 are schematically shown.

Problem

The Augusta, Richmond County, GA area is dependent upon groundwater resources from the Cretaceous aquifer for water-supply. This resource has been extensively developed by communities within the county and several instances of water-quality impairment have resulted in water-supply wells being abandoned. As mentioned above, Augusta Utilities has closed some wells in the up-dip part of the Cretaceous aquifer system due to contamination. Down-dip of the Augusta, Richmond County area, groundwater levels are steadily declining based on water-level data from wells in Well Field 3 and several continuous recorder wells south of Well Field 3. Groundwater levels and water quality in the study area need to be monitored, long-term, to determine continued sustainability of the groundwater resource. Tracking water-level changes and possible movement of contaminants is essential to management and future development of water-supplies.

Objective and Scope

The main objective of this project is to continue assessing the groundwater resource in the Cretaceous aquifers within the Augusta, Richmond County area, to assist water suppliers with management and planning. Specific objectives for 2023 include:

1. Continue the operation of four continuous-recorder wells.
2. Measure discrete groundwater levels once during the summer at approximately 60 wells throughout the Richmond County area.
3. Collect water-quality samples at approximately 12 wells once during the summer.
4. Measure the discharge rate of each operating Well Field 2 well once during the spring.
5. Provide ongoing technical expertise to review and interpret monitoring results.

Relevance and benefits

This study aligns with at least three USGS Water Science objectives (Evenson and others, 2013): (1) assessment of water resources and their suitability to meet human and ecosystem needs; (2) understanding of human interactions with water availability; (3) development and application of models to predict changes in the quantity and quality of water resources in response to changing climate. Monitoring groundwater levels and water quality will provide key information concerning the sustainability of the groundwater resource, and the nature of local groundwater recharge and discharge in the up-dip (outcrop area) part of the Cretaceous aquifers. The study will provide updated information that can be used in the future to update a groundwater flow model and to simulate the effects of pumping and climate variability on water quality and quantity in the Cretaceous aquifer system. Results will aid in determining how physiographic features such as minor streams, major tributaries, and the Savannah River alluvial plain and channel, and pumping stress affect local flow patterns within the groundwater system. The study will improve understanding of contamination of the aquifer system from surface sources and potential directions and rates of movement of contaminants. Findings from Well Field 2 will be transferrable to the up-dip part of the Cretaceous aquifer system throughout the region.

Approach

Specific objectives for 2023 will be achieved by accomplishing the following tasks. Data-collection efforts (tasks 1-4) are summarized in table 1 and described in more detail within this section and in appendix tables 1 and 2.

Table 1. Summary of monitoring wells and activities supported under this scope of work, Augusta, Georgia, 2023. [Continuous, recorded every 15 minutes; Synoptic, measured once during summer; Furnished, measured by Augusta Sulfate's on-site geologist, once in April and once in October each year; MITE, major ions, trace elements, and physical characteristics; VOCs, volatile organic compounds; Rn-222, radon-222, Discharge, measuring the pumping rate of individual production wells]

Area	Number of wells								Total number of wells per area
	Groundwater levels					Water Quality			
	Continuous Recorder	Continuous Recorder[1]	Synoptic	Synoptic[2]	Furnished	MITE, VOCs, Nutrients[3]	Rn-222[4]	Discharge[5]	
Well Field 1	1	---	---	10	---	---	---	---	11
East Industrial	---	---	5	---	3	---	---	---	8
Near Well Field 2	2	---	7	---	---	3	2	---	9
Well Field 2	---	---	---	10	---	8	7	6	10
Well Field 3	---	---	---	5	---	1	1	---	5
Richmond Factory Pond	---	1	3	---	---	---	---	---	4
Southeast Richmond	1	1	2	---	---	---	---	---	4
Southwest Richmond	---	---	9	---	---	---	---	---	9
West Civilian	---	---	5	---	---	---	---	---	5
Fort Gordon	---	---	7	---	---	---	---	---	7
Total number of wells by activity	4	2	38	25	3	12	10	6	72

[1]Continuous recorder is funded in cooperation with Georgia Environmental Protection Division.
[2]All pumps in the well field are turned off and remain off for at least 4 hours prior to measurement.
[3]Sampled once during summer. Actual numbers may vary slightly due to number of wells in operation.
[4]Radon-222 is sampled once during summer. Actual numbers may vary due to number of wells in operation.
[5]Measure once during spring. Actual numbers may vary due to number of wells in operation.

1. Ongoing operation of four continuous-record wells

The USGS proposes to continue to record groundwater levels at 15-minute intervals at 4 wells, during calendar year 2023 (fig. 3; table 2; appendix table 1). Long-term records are critical for understanding how factors such as nearby well pumping, barometric effects, earth tides, and rainfall events impact water levels and how the aquifer responds to stress. These sites are already established and have been operated for several years.

Table 2. Wells with continuously monitored water levels at 15-minute intervals, 2023. [POR, period of record for continuous water level data].

Well group	Local name	Station number	Station name	POR
Well Field 1	7A	332528082003301	29BB67	Oct 2011-present
Near Well Field 2	Tobacco Road deep well (TRD)	332221081584601	30AA37	Oct 2009-present
Near Well Field 2	Tobacco Road deep well (TRS)	332221081584602	30AA38	Oct 2009-present
Southeast Richmond	Pine Hill Middle School	331944082025501	29AA42	Jun 2010-present

2. Measure discrete water levels throughout Richmond County

The USGS has conducted a summertime synoptic survey of groundwater levels in Richmond County for several years to document long-term groundwater-level trends as well as spatial variations across the study area in individual years. We propose to continue this effort annually during calendar year 2023. With the continued cooperation of well owners, the USGS will measure water levels in approximately 60 wells throughout the Richmond County area over a period of less than two weeks to provide a "snapshot" of groundwater levels throughout the county. Candidate wells are listed in Appendix table 1. In active Augusta Utilities well fields, measurements will be made only after all well-field pumps have been off for at least four hours. This minimizes the effect of pumping on measured water levels from year to year, thereby enhancing the assessment of long-term water-level trends.

3. Assess water quality in selected wells

Water quality samples will be collected from 12 wells annually during the summer, along with quality-control samples. Sampling will focus on production wells in Well Field 2 and "sentinel" wells up-flow from Well Field 2 (appendix table 1). The sentinel wells (wells 101, 102, 108, west Airport well, and the two Tobacco Road wells) have already been early warning beacons for mercury and TCE. Starting in 2021, one Well Field 3 well also has been sampled per year, alternating among the four production wells. Alternating wells in Well Field 3 well each year allows all wells to be sampled over time while minimizing sample cost. Production wells can only be sampled if they are in operation. If a production well that is planned for sampling is not in operation, USGS will attempt to sample another well. A lack of alternate wells may result in fewer sampled wells than was planned.

Field properties (water temperature, dissolved oxygen, specific conductance at 25°C, pH, turbidity, and depth to water below land surface) will be measured at the time of sampling. Water samples will be collected for analysis of additional physical properties, major ions, trace elements, nutrients, radon-222, and volatile organic compounds (table 3; appendix table 2). All samples will be analyzed at USGS laboratories using methods that are adequately sensitive to monitor the low concentrations detected in previous years. Results will characterize current water-quality and also support assessments of trends in potential contaminant concentrations and/or movement of contaminants within the study area—information that is vital for water suppliers.

Table 3. Summary of water-quality properties, analytes, and analyzing entities proposed under this scope of work, Augusta, Georgia, 2023. [USGS, U.S. Geological Survey; NWQL, National Water Quality Lab; SAWSC, South Atlantic Water Science Center; na, not applicable; "various", includes degrees Celsius, milligrams per liter, Nephelometric Turbidity Units, pH units, microSiemens per centimeter, and feet; mg/L, milligrams per liter; ug/L, micrograms per liter; pCi/L, picoCuries per liter]

Analyte group	Number of		Unit of concen-tration for analytes	Analyzing entity	USGS NWQL Schedule (SC) or Lab (LC) code if applicable
	Analytes/ Measure-ments	Lab Surrogates			
Field and physical properties	6	0	various	SAWSC (in-field readings)	na
Lab-run physical properties	5	0	various	USGS NWQL	SC 185
Major ions	8	0	mg/L	USGS NWQL	SC 185
Trace elements	18	0	ug/L	USGS NWQL	SC 185
Nutrients	5	0	mg/L	USGS NWQL	SC 2755
Radon-222	1	0	pCi/L	USGS NWQL	LC 1369
Volatile organic compounds	49	3	ug/L	USGS NWQL	SC 4436
Pesticides	173	17	ng/L	USGS NWQL	LC 9030
Pharmeceuticals	113	14	ng/L	USGS NWQL	LC 12440
Hormones	21	14	ng/L	USGS NWQL	LC 12434
Total	399	48	na	na	na

Major ions provide insight about water chemistry and possible groundwater flow within the system. Trace elements, nutrients, and volatile organic compounds may reveal contamination from surface sources. For example, samples previously collected from Well Field 2 contained detectable concentrations of lead, mercury, beryllium, nitrate plus nitrite, chlorinated ethenes such as TCE, MTBE, and trichloromethane. Radon-222 is a naturally occurring radioactive isotope; however, consumption of water with high concentrations of radon-222 or breathing radon-222 exsolved from running water increases the incidence of cancer (U.S. EPA, 2018). Well Field 2 wells are being sampled for radon-222 for a period of 5 years to assess its presence and possible trends. Radon-222 has already been sampled for two years (2021 and 2022) and will be sampled for another three years (2023 through 2025) to complete the 5-year study period.

4. Measure discharge rate of Well Field 2 wells

Discharge (pumping) rate of wells provides valuable input to a groundwater model and a better understanding of water use. In 2023 and subsequent odd-numbered years, discharge rates will be measured at active production wells in Well Field 2 (wells 103, 104, 105, 106, 107, 112 planned for 2023; appendix table 1) in careful coordination with Augusta Utilities staff. The procedure is relatively easy to perform (performed in 2013, 2014, and 2019) using the existing SCADA system which monitors combined flow from all production wells of a given well field. This procedure has even detected problems when production wells were not pumping. In addition to measuring discharge rate, USGS maintains a dialogue with Augusta about well pump status. This information creates a pump history which is crucial in groundwater modeling work, and assists in planning water-quality data collection.

5. Ongoing technical expertise and review

Continued monitoring into the future will reveal different processes. The USGS will review the data for quality assurance and will also regularly check for new trends and patterns that are important to understand groundwater supply and water quality. As in previous years, findings will be discussed with Augusta Utilities on, at minimum, an annual basis.

Quality Assurance/Quality Control

Groundwater-level and water-quality data will be reviewed and entered into the National Water Information System (NWIS). Water levels are verified by measuring non-pumping wells at least twice and pumping wells at least three times after the pump is shut off, during a single visit. Groundwater-level measurement techniques will adhere to the South Atlantic Water Science Center (SAWSC) Groundwater Quality-Assurance Plan (U.S. Geological Survey, internal document).

All water-quality activities will be conducted in accordance with the Quality-Assurance Plan for Water-Quality Activities of the South Atlantic Water Science Center (U.S. Geological Survey, internal document). Equipment cleaning and sample collection and processing will follow procedures outlined in the USGS National Field Manual for the Collection of Water-Quality Data (U. S. Geological Survey, variously dated). These protocols were developed to prevent contamination of samples containing low-level concentrations of trace elements and have been used by the USGS since 1994. In addition to environmental water-quality samples collected from wells, field blanks, field replicates, and spikes will also be collected. Approximately 25 percent of the water-quality samples will be equipment blanks, field blanks, and field replicate samples for quality assurance of sample collection procedures and laboratory analyses.

Samples collected by USGS will be either analyzed in the field or analyzed at the USGS NWQL in Denver, Colorado, which is accredited by the National Environmental Laboratory Accreditation Conference (table 3). Field parameters (water temperature, dissolved oxygen, specific conductance at 25°C, pH, turbidity, and depth to water below land surface) are measured using techniques described in USGS (variously dated) or Cunningham and Schalk (2011). The NWQL adheres to a comprehensive Quality Management System to ensure the quality of its work processes, products, and services (Maloney, 2005). Project personnel will review all field and laboratory analytical results. Data will be entered into the USGS National Water Information System (NWIS) data base. Data stored in NWIS pass through automated quality-control checks of data consistency and will be available online.

Products

Groundwater-level and water-quality data will be stored in NWIS and available on the internet through NWIS-Web (USGS, 2021). Monthly groundwater withdrawals, by well field, will be compiled and entered in the NWIS (Site-specific Water-Use Data System or "SWUDS"). One or more presentations will be provided each year to the cooperator on project status and outcomes. Other presentations will be given at applicable conferences. A summer annual meeting will be held to discuss plans for the next calendar year. As in previous years, a winter annual meeting will be held to present the state of the groundwater in Richmond County and the well fields based on data collected during the previous summer and from previous years.

Timeline

Study activities throughout 2023 will be similar to previous years (table 4). Annual data collection for synoptic, discrete water levels and collection of water-quality samples occurs in early summer. The available groundwater model may be interrogated to gain insight into the latest data findings. Two annual meetings with Augusta Utilities will be conducted. At the meeting in July (annual summer meeting), we will discuss plans for the following calendar year. At the meeting in December (annual winter meeting), we will discuss the state of the groundwater system based on data collected during the summer and from previous years.

Table 4. Monthly Augusta activities within calendar year 2023. [activity is expected to occur during months where shaded gray].

Task	Calendar year 2023											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
REAL-TIME wells	■	■	■	■	■	■	■	■	■	■	■	■
Data review (water-quality for previous year)				■								
Water-quality assurance spring blank				■								
Discharge measurements Well Field 2 wells				■								
Discrete water-level measurements for about 60 wells (annual synoptic)						■						
Water-quality sampling of 12 wells (Well Field 2 and one well in Well Field 3)						■	■					
Annual summer meeting (plans for next calendar year)							■					
Potentiometric-surface (water-level) map (annual)										■		
Data compilation and interpretation (water-quality and groundwater-levels annual)										■	■	■
Groundwater model runs (simple inspections)											■	■
Annual winter meeting (state of the groundwater)												■

Personnel

One project lead, hydrologist, will oversee the completion of the review and publication of the Scientific Investigations Report and Data Releases, perform annual measurements of groundwater levels and site visits for about 60 wells, assist in water-quality sampling, compile and analyze data, manage the project, discuss plans for next calendar year in annual summer meetings, and present findings and project progress at an annual winter meeting with the Augusta Utilities. Multiple hydrologic technicians will operate the four continuous-recorder wells and collect and send water samples to the National Water-Quality Lab in Denver, Colorado. Other experienced USGS staff will provide expert guidance on data review and entry of collected data, and the review and completion of the Scientific Investigations Report and Data Release.

Potential Future Directions

- Sample one well in Well Field 3, each year, for two cycles. A decision needs to be made whether or not to sample LSC5 which currently is a back-up well on the southern end of the well field. After each well has been sampled twice, and a decision is made about well LSC5, it will be determined if 4 of or all 5 wells in Well Field 3 will be sampled annually.
- Add three additional water-quality wells around Well Field 2.
- A one-time sample collected from Well Field 2 wells for pesticides, pharmaceuticals, and hormones (see appendix table 3)
- Regular production of information products (water-quality trends, modeling TCE, MTBE and mercury, water-level trends).

Project Budget

The multi-year funding agreement is for the period from January 01, 2023, through December 31, 2023. Total cost of the project will be $216,700. The U.S. Geological Survey will contribute $93,300. This leaves $123,400 for Augusta Utilities to contribute to the cost of the project for calendar year 2023.

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Appendix table 1. List of monitoring wells and activities supported under this scope of work, Augusta, Georgia, 2023. [CR, continuous recorders that measure water level once every 15 minutes; Synoptic, discrete water levels that are measured once in the summer each year; Furnished, water levels that are measured by Augusta Sulfate's on-site geologist, once in April and once in October each year; MITE, major ions and trace elements (NWQL SC 185); VOCs, volatile organic compounds (NWQL SC 4436); Nutrients are analyzed under NWQL SC 2755; Rn-222, radon-222 (NWQL LC 1369); Discharge, measuring the pumping rate of individual production wells]

Well Group	Local name	Station ID number	Station Name	Groundwater levels		Water Quality				Discharge
				CR	Synoptic	MITE	VOCs	Nutrients	Rn-222	
Well Field 1	7A	332528082003301	29BB67	CR	---	---	---	---	---	---
Well Field 1	3	332511082010401	29BB59	---	Summer[1]	---	---	---	---	---
Well Field 1	2	332521082011001	29BB86	---	Summer[1]	---	---	---	---	---
Well Field 1	10	332504082005301	29BB01	---	Summer[1]	---	---	---	---	---
Well Field 1	19	332457082011401	29BB85	---	Summer[1]	---	---	---	---	---
Well Field 1	11	332450082005601	29BB08	---	Summer[1]	---	---	---	---	---
Well Field 1	12	332439082011701	29BB09	---	Summer[1]	---	---	---	---	---
Well Field 1	13	332435082003901	29BB10	---	Summer[1]	---	---	---	---	---
Well Field 1	14	332422082004501	29BB20	---	Summer[1]	---	---	---	---	---
Well Field 1	16	332409082010701	29BB05	---	Summer[1]	---	---	---	---	---
Well Field 1	17	332336082010901	29BB84	---	Summer[1]	---	---	---	---	---
East Industrial	Augusta Sulfate DSM-L06D	332612081560303	30BB63	---	Furnished	---	---	---	---	---
East Industrial	Augusta Sulfate OSB-24D	332554081552401	30BB64	---	Furnished	---	---	---	---	---
East Industrial	Augusta Sulfate OSB-16	332614081551001	30BB65	---	Furnished	---	---	---	---	---
East Industrial	Morgan Applied Materials, Well 5	332600082000401	29BB13	---	Summer	---	---	---	---	---
East Industrial	Textron	332325082001201	29BB69	---	Summer	---	---	---	---	---
East Industrial	Prayon, west well	332322081593501	30BB32	---	Summer	---	---	---	---	---
East Industrial	Prayon, east well	332325081592001	30BB33	---	Summer	---	---	---	---	---
East Industrial	Olin, backup well	332040081565501	30AA03	---	Summer	---	---	---	---	---
Near Well Field 2	Bennett Steel, NW well 1	332245081590501	30BB34	---	Summer	---	---	---	---	---
Near Well Field 2	Bennett Steel, SW well 2	332232081585901	30BB35	---	Summer	---	---	---	---	---
Near Well Field 2	Bennett Steel, SSW well 3	332230081585501	30AA39	---	Summer	---	---	---	---	---
Near Well Field 2	Smith Cemetary Road	332227081591201	30AA27	---	Summer	---	---	---	---	---
Near Well Field 2	Tobacco Road deep well (TRD)	332221081584601	30AA37	CR	---	Summer	Summer	Summer	Summer	---
Near Well Field 2	Tobacco Road deep well (TRS)	332221081584602	30AA38	CR	---	Summer	Summer	Summer	Summer	---

Well Field 2	101	332216081583601	30AA06	---	Summer[1]	Summer	Summer	Summer	---	---
Well Field 2	102	332208081583001	30AA07	---	Summer[1]	---	---	---	---	---
Well Field 2	103	332159081582501	30AA08	---	Summer[1]	Summer	Summer	Summer	Summer	Spring
Well Field 2	104	332146081582201	30AA09	---	Summer[1]	Summer	Summer	Summer	Summer	Spring
Well Field 2	105	332141081583601	30AA10	---	Summer[1]	Summer	Summer	Summer	Summer	Spring
Well Field 2	106	332137081581301	30AA11	---	Summer[1]	Summer	Summer	Summer	Summer	Spring
Well Field 2	107	332146081590601	30AA18	---	Summer[1]	Summer	Summer	Summer	Summer	Spring
Well Field 2	108	332141081591901	30AA19	---	Summer[1]	Summer	Summer	Summer	Summer	---
Well Field 2	110	332118081593601	30AA25	---	Summer[1]	---	---	---	---	---
Well Field 2	112	332059081594001	30AA26	---	Summer[1]	Summer	Summer	Summer	Summer	Spring
Near Well Field 2	Goshen Lake Drive	332017082000601	29AA04	---	Summer	---	---	---	---	---
Near Well Field 2	Airport, west, wind-sock	332215081575201	30AA33	---	Summer	Summer	Summer	Summer	---	---
Near Well Field 2	Airport, east, lock and dam	332220081571701	30AA34	---	Summer	---	---	---	---	---
Well Field 3	LSC1	331846082020201	29AA30	---	Summer[1]	---	---	---	---	---
Well Field 3	LSC2	331831082011901	29AA31	---	Summer[1]	---	---	---	---	---
Well Field 3	LSC3	331805082010901	29AA06	---	Summer[1]	Summer	Summer	Summer	Summer	---
Well Field 3	LSC4	331736082011901	29AA32	---	Summer[1]	---	---	---	---	---
Well Field 3	LSC5	331711082012001	29AA33	---	Summer[1]	---	---	---	---	---
Richmond Factory Pond	Cedar Village	332211082042801	29AA34	---	Summer	---	---	---	---	---
Richmond Factory Pond	Brown Road, Pine Hill 1	332045082031001	29AA07	---	Summer	---	---	---	---	---
Richmond Factory Pond	Plantation Road, Pine Hill 2	332107082040901	29AA05	---	Summer	---	---	---	---	---
Richmond Factory Pond	Gracewood Hospital SE	332131082013401	29AA09	CR[2]	---	---	---	---	---	---
Southeast Richmond	Pine Hill Middle School	331944082025501	29AA42	CR	---	---	---	---	---	---
Southeast Richmond	South Haven Baptist Church	331757082030901	29AA36	---	Summer	---	---	---	---	---
Southeast Richmond	McBean	331711081573701	30AA04	CR[2]	---	---	---	---	---	---
Southeast Richmond	County line artesian	331411082024101	29Z002	---	Summer	---	---	---	---	---
Southwest Richmond	SE of Hephzibah red brick well house	331704082050401	29AA37	---	Summer	---	---	---	---	---
Southwest Richmond	Hephzibah Mill Street	331910082054101	29AA03	---	Summer	---	---	---	---	---
Southwest Richmond	Hephzibah Murphey Street	331838082055601	29AA39	---	Summer	---	---	---	---	---
Southwest Richmond	Hephzibah Fulcher Road	331726082082301	28AA06	---	Summer	---	---	---	---	---
Southwest Richmond	Kaolin mine	331854082070801	29AA08	---	Summer	---	---	---	---	---

Southwest Richmond	Blythe East trailer	331847082105201	28AA47	---	Summer	---	---	---	---	---
Southwest Richmond	Blythe Gin House Rd backup, Well 1	331730082120901	28AA01	---	Summer	---	---	---	---	---
Southwest Richmond[3]	Burke Co. Fire Station 3	331446082124702	28Z009	---	Summer	---	---	---	---	---
Southwest Richmond	Blythe West HWY 1	331812082132101	28AA45	---	Summer	---	---	---	---	---
West Civilian	Morgan MHP	332134082082701	28AA48	---	Summer	---	---	---	---	---
West Civilian	Residence near Morgan MHP	332203082074401	28AA50	---	Summer	---	---	---	---	---
West Civilian	Mars MHP	332431082053201	29BB90	---	Summer	---	---	---	---	---
West Civilian	Moto Fino	332706082050001	29BB32	---	Summer	---	---	---	---	---
West Civilian	Bagby MHP	332809082060501	29BB42	---	Summer	---	---	---	---	---
Fort Gordon	Leitner Lake Rec BLDG 467	332209082152101	27AA19	---	Summer	---	---	---	---	---
Fort Gordon	Firing range BLDG 472	332245082134901	28BB11	---	Summer	---	---	---	---	---
Fort Gordon	Forestry Rd BLDG 463	332042082124801	28AA21	---	Summer	---	---	---	---	---
Fort Gordon	Supplies BLDG 460	332029082125901	28AA20	---	Summer	---	---	---	---	---
Fort Gordon	Game Warden BLDG 526	332105082105501	28AA22	---	Summer	---	---	---	---	---
Fort Gordon	Golf Course Green 13 BLDG 543	332241082084201	28BB102	---	Summer	---	---	---	---	---
Fort Gordon	Golf Course Green 4 BLDG 542	332242082080501	28BB101	---	Summer	---	---	---	---	---

[1] All pumps in the well field are turned off and remain off for at least 4 hours prior to measurement.
[2] Continuous recorder is funded in cooperation with Georgia Environmental Protection Division.
[3] Within Burke County near southwest Richmond County.

Appendix table 2. Water-quality properties, analytes, and analyzing entities supported under this sope of work, Augusta, Georgia, 2023. [USGS, U.S. Geological Survey; SAWSC, South Atlantic Water Science Center; NWQL, National Water Quality Lab; °C, degrees Celsius; mg/L, milligrams per liter; uS/cm, microSiemens per centimeter; NTU, Nephelometric Turbidity Unit; ug/L, micrograms per liter; pCi/L, picoCuries per liter; pct, percent recovery; pct, percent recovery of a lab surrogate]

Analyte	NWIS codes		CAS number	Detection level (2023)	Reporting level (2023)	Unit	Analyzing entity
	Parameter	Method					
FIELD AND PHYSICAL PROPERTIES							
Water temperature	10	THM01	---	---	---	°C	USGS SAWSC (in-field readings)
Dissolved oxygen	300	LUMIN	---	---	---	mg/L	
Specific conductance at 25°C	95	SC001	---	---	---	uS/cm	
pH	400	PROBE	---	---	---	pH	
Turbidity	63676	TS196	---	---	---	NTU	
Depth to water below land surface	72019	---	---	---	---	foot	
LAB-RUN PHYSICAL PROPERTIES, MAJOR IONS, AND TRACE ELEMENTS (NWQL SCHEDULE 185)							
Residue, dissolved AT 180°C (TDS)	70300	ROE10	---	---	20	mg/L	USGS NWQL
PH (LABORATORY)	403	EL006	---	0.1	0.1	pH	
Sp. Conductance Lab	90095	WHT03	---	---	5	uS/cm	
Acid Neutralizing Capacity, as CaCO3, Unf, Lab	90410	TT040	471-34-1	4	8	mg/L	
Residue, dissolved AT 105°C SUS	530	SLD04	---	---	15	mg/L	
Calcium, Water, Filtered, ICP	915	PLA11	7440-70-2	0.02	0.04	mg/L	
Magnesium, Water, Filtered, ICP	925	PLA11	7439-95-4	0.01	0.02	mg/L	
Sodium, Water, Filtered, ICP	930	PLA11	7440-23-5	0.4	0.8	mg/L	
Potassium, Water, Filtered, ICP	935	PLO03	7440-09-7	0.3	0.6	mg/L	
Silica, Water, Filtered, ICP	955	PLA11	7631-86-9	0.05	0.1	mg/L	
Chloride, diss IC	940	IC022	16887-00-6	0.02	0.04	mg/L	
Fluoride, diss IC	950	IC003	16984-48-8	0.01	0.02	mg/L	
Sulfate, diss IC	945	IC022	14808-79-8	0.02	0.04	mg/L	
Aluminum, Water, Filtered, cICPMS	1106	PLM10	7429-90-5	3	6	ug/L	
Antimony, Water, Filtered, ICP-MS	1095	PLM43	7440-36-0	0.06	0.12	ug/L	
Arsenic, Water, Filtered, cICP-MS	1000	PLM10	7440-38-2	0.1	0.2	ug/L	
Barium, Water, Filtered, ICP-MS	1005	PLM43	7440-39-3	0.1	0.2	ug/L	
Beryllium, Water, Filtered, ICP-MS	1010	PLM43	7440-41-7	0.01	0.02	ug/L	
Boron, Water, Filtered, ICP	1020	PLA13	7440-42-8	2	4	ug/L	
Cadmium, Water, Filtered, ICP-MS	1025	PLM43	7440-43-9	0.03	0.06	ug/L	
Copper, Water, Filtered, cICP-MS	1040	PLM10	7440-50-8	0.4	0.8	ug/L	
Chromium, Water, Filtered, ICP	1030	PLA11	7440-47-3	1	2	ug/L	
Iron, Water, Filtered, ICP	1046	PLA11	7439-89-6	5	10	ug/L	
Lead, Water, Filtered, ICP-MS	1049	PLM43	7439-92-1	0.02	0.04	ug/L	
Manganese, Water, Filtered, ICP	1056	PLA11	7439-96-5	0.2	0.4	ug/L	
Mercury, fil, CVAF	71890	CV014	7439-97-6	0.005	0.01	ug/L	
Nickel, Water, Filtered, cICP-MS	1065	PLM10	7440-02-0	0.2	0.4	ug/L	
Selenium, Water, Filtered, cICP-MS	1145	PLM10	7782-49-2	0.05	0.1	ug/L	
Silver, Water, Filtered, ICP-MS	1075	PLM43	7440-22-4	1	2	ug/L	
Thallium, Water, Filtered, ICP-MS	1057	PLM40	7440-28-0	0.04	0.08	ug/L	
Zinc, Water, Filtered cICP-MS	1090	PLM10	7440-66-6	2	4	ug/L	
NUTRIENTS (NWQL SCHEDULE 2755)							
Alkaline Persulfate-Nitrogen, FCC	62854	CL063	17778-88-0	0.05	0.1	mg/L	USGS NWQL
Ammonia, Kone	608	SHC02	7664-41-7	0.02	0.04	mg/L	
Nitrite, Kone	613	DZ001	14797-65-0	0.001	0.002	mg/L	
ortho-PO4, Kone	671	PHM01	14265-44-2	0.004	0.008	mg/L	
NO2 + NO3, as N, Kone	631	RED01	14797-65-0 14797-55-8	0.04	0.08	mg/L	
RADON-222 (NWQL LAB CODE 1369)							
Radon-222, wat, unfil, liq scin	82303	LSC01	14859-67-7	20	20	pCi/L	USGS NWQL
VOLATILE ORGANIC COMPOUNDS (NWQL SCHEDULE 4436)							
1,1,1,2-Tetrachloroethane	77562	GCM66	630-20-6	0.02	0.04	ug/L	
1,1,1-Trichloroethane	34506	GCM66	71-55-6	0.015	0.03	ug/L	
1,1,2-Trichloroethane	34511	GCM66	79-00-5	0.023	0.046	ug/L	
1,1-Dichloroethane	34496	GCM66	75-34-3	0.022	0.044	ug/L	
1,1-Dichloroethylene	34501	GCM66	75-35-4	0.012	0.025	ug/L	
1,1-Difluoroethane (HFC-152a)	49538	GCM66	75-37-6	0.012	0.025	ug/L	
1,2,3,4-Tetrahydronapthalene	77323	GCM66	119-64-2	0.04	0.08	ug/L	
1,2,4-Trichlorobenzene	34551	GCM66	120-82-1	0.04	0.08	ug/L	

1,2,4-Trimethylbenzene	77222	GCM66	95-63-6	0.016	0.032	ug/L	
1,2-Dichlorobenzene	34536	GCM66	95-50-1	0.014	0.028	ug/L	
1,2-Dichloroethane	32103	GCM66	107-06-2	0.01	0.08	ug/L	
1,2-Dichlorotetrafluoroethane (CFC-114)	50985	GCM66	76-14-2	0.015	0.03	ug/L	
1,3-Butadiene	68726	GCM66	106-99-0	0.04	0.08	ug/L	
1,4-Dichlorobenzene	34571	GCM66	106-46-7	0.013	0.026	ug/L	
1-Br-4-Fbenzene, S4436/4439/4440, sur	90695	GCM66	460-00-4	---	---	pct	
1-Bromo-3-chloropropane-d6, sur	90576	GCM66	1173018-46-6	---	---	pct	
1-Chloro-1,1-difluoroethane (HCFC-142b)	85668	GCM66	75-68-3	---	0.08	ug/L	
2,2-Dichloro-1,1,1-trifluoroethane (HCFC-123)	62174	GCM66	306-83-2	0.012	0.025	ug/L	
Benzene	34030	GCM66	71-43-2	0.013	0.026	ug/L	
Bromochloromethane	77297	GCM66	74-97-5	0.03	0.06	ug/L	
Bromodichloromethane	32101	GCM66	75-27-4	0.017	0.034	ug/L	
Bromomethane	34413	GCM66	74-83-9	0.1	0.2	ug/L	
Butane	81563	GCM66	106-97-8	0.04	0.08	ug/L	
Carbon disulfide	77041	GCM66	75-15-0	0.05	0.1	ug/L	
Chlorobenzene	34301	GCM66	108-90-7	0.013	0.026	ug/L	
Chlorodifluoromethane (HCFC-22)	45028	GCM66	75-45-6	---	0.04	ug/L	
Chloromethane	34418	GCM66	74-87-3	---	0.2	ug/L	USGS NWQL
Dibromochloromethane	32105	GCM66	124-48-1	0.02	0.12	ug/L	
Dichlorofluoromethane (HCFC-21)	77119	GCM66	75-43-4	0.008	0.025	ug/L	
Dichloromethane	34423	GCM66	75-09-2	---	0.04	ug/L	
Ethylbenzene	34371	GCM66	100-41-4	0.018	0.036	ug/L	
Hexane	81590	GCM66	110-54-3	0.034	0.068	ug/L	
Naphthalene	34696	GCM66	91-20-3	0.03	0.26	ug/L	
Styrene	77128	GCM66	100-42-5	---	0.042	ug/L	
Tetrachloroethylene	34475	GCM66	127-18-4	0.029	0.058	ug/L	
Tetrachloromethane	32102	GCM66	56-23-5	0.03	0.06	ug/L	
Toluene	34010	GCM66	108-88-3	---	0.2	ug/L	
Toluene-d8, S4436/4439/4440, sur	90696	GCM66	2037-26-5	---	---	pct	
Tribromomethane	32104	GCM66	75-25-2	0.07	0.14	ug/L	
Trichloroethylene	39180	GCM66	79-01-6	0.012	0.025	ug/L	
Trichloromethane	32106	GCM66	67-66-3	0.015	0.03	ug/L	
Vinyl chloride	39175	GCM66	75-01-4	0.03	0.06	ug/L	
cis-1,2-Dichloroethene	77093	GCM66	156-59-2	0.012	0.025	ug/L	
cis-1,3-Dichloropropene	34704	GCM66	10061-01-5	0.05	0.1	ug/L	
m- and p-Xylene	85795	GCM66	179601-23-1	0.04	0.08	ug/L	
n-Pentane	81604	GCM66	109-66-0	0.033	0.066	ug/L	
n-Propylbenzene	77224	GCM66	103-65-1	0.018	0.036	ug/L	
o-Xylene	77135	GCM66	95-47-6	0.016	0.032	ug/L	
sec-Butylbenzene	77350	GCM66	135-98-8	0.017	0.034	ug/L	
tert-Butyl methyl ether	78032	GCM66	1634-04-4	0.05	0.1	ug/L	
trans-1,2-Dichloroethylene	34546	GCM66	156-60-5	0.012	0.025	ug/L	
trans-1,3-Dichloropropene	34699	GCM66	10061-02-6	0.05	0.1	ug/L	

Appendix table 3. Suggested (not currently planned) additional analytes, one-time sample collection for pesticides, pharmaceuticals, and hormones, Augusta, Georgia. [USGS, U.S. Geological Survey; NWQL, National Water Quality Lab; pct, percent recovery; ng/L, nanograms per liter; na, not applicable, this is a lab surrogate, pct, percent recovery of a lab surrogate]

Analyte	NWIS codes		CAS number	Detection level (2023)	Reporting level (2023)	Unit	Analyzing entity
	Parameter	Method					
PESTICIDES (NWQL LAB CODE 9030)							
1H-1,2,4-Tri+A2:A183azole	68498	LCM60	288-88-0	11	22	ng/L	
2-(1-Hydroxyethyl)-6-methylaniline (HEMA)	68611	LCM60	196611-19-5	80	160	ng/L	
2-Amino-N-isopropylbenzamide	68503	LCM60	30391-89-0	2	4	ng/L	
2-Aminobenzimidazole	68502	LCM60	934-32-7	4.5	9	ng/L	
2-Chloro-2',6'-diethylacetanilide	68525	LCM60	6967-29-9	2.5	5	ng/L	
2-Chloro-N-(2-ethyl-6-methylphenyl)acetamide	68521	LCM60	32428-71-0	2.5	5	ng/L	
2-Hydroxy-4-isopropylamino-6-amino-s-triazine OIAT	68659	LCM60	19988-24-0	2	4	ng/L	
2-Hydroxy-6-ethylamino-4-amino-s-triazine (OEAT)	68656	LCM60	7313-54-4	50	100	ng/L	
2-Hydroxyatrazine (OIET)	68660	LCM60	2163-68-0	4	8	ng/L	
2-[(2-Ethyl-6-methylphenyl)amino]-1-propanol	68595	LCM60	61520-53-4	2.5	5	ng/L	
3,4-Dichlorophenylurea	68226	LCM60	2327-02-8	27	108	ng/L	
3-Hydroxycarbofuran	68508	LCM60	16655-82-6	8	16	ng/L	
4-Chlorobenzylmethyl sulfoxide	68514	LCM60	24176-68-9	1.6	3.2	ng/L	
4-Hydroxyhexazinone A	68517	LCM60	72576-13-7	1.5	3	ng/L	
Acephate	68519	LCM60	30560-19-1	5	10	ng/L	
Acetochlor	68520	LCM60	34256-82-1	5	10	ng/L	
Acetochlor-d11, sur	90517	LCM60	1189897-44-6	---	---	pct	
Alachlor	65064	LCM60	15972-60-8	9	27	ng/L	
Alachlor-d13, sur	90518	LCM60	1015856-63-9	---	---	pct	
Aldicarb	68528	LCM60	116-06-3	4	8	ng/L	
Aldicarb sulfone	68529	LCM60	1646-88-4	10	20	ng/L	
Aldicarb sulfoxide	68530	LCM60	1646-87-3	1.1	2.2	ng/L	
Ametryn	68533	LCM60	834-12-8	1.3	2.6	ng/L	
Asulam	68536	LCM60	3337-71-1	12	24	ng/L	
Atrazine	65065	LCM60	1912-24-9	3.4	6.8	ng/L	
Azinphos-methyl	65066	LCM60	86-50-0	4	8	ng/L	
Azinphos-methyl oxon	68211	LCM60	961-22-8	7.5	15	ng/L	
Azoxystrobin	66589	LCM60	131860-33-8	1.5	3	ng/L	
Bifenthrin	65067	LCM60	82657-04-3	9.5	19	ng/L	
Bromacil	68542	LCM60	314-40-9	2.8	5.6	ng/L	
Butralin	68545	LCM60	33629-47-9	2.5	5	ng/L	
Butylate	65068	LCM60	2008-41-5	5	10	ng/L	
Carbaryl	65069	LCM60	63-25-2	2.8	5.6	ng/L	
Carbaryl-d7, sur	90519	LCM60	362049-56-7	---	---	pct	
Carbendazim	68548	LCM60	10605-21-7	5	10	ng/L	
Carbendazim-d4, sur	90520	LCM60	291765-95-2	---	---	pct	
Carbofuran	65070	LCM60	1563-66-2	2.5	5	ng/L	
Carbofuran-d3, sur	90521	LCM60	1007459-98-4	---	---	pct	
Chlorimuron-ethyl	68872	LCM60	90982-32-4	4.4	8.8	ng/L	
Chlorpyrifos	65072	LCM60	2921-88-2	1.5	3	ng/L	
Chlorpyrifos oxon	68216	LCM60	5598-15-2	2.2	4.4	ng/L	
Chlorsulfuron	61678	LCM60	64902-72-3	25	50	ng/L	
Cyanazine	66592	LCM60	21725-46-2	25	50	ng/L	
Dechlorometolachlor	68562	LCM60	126605-22-9	1	2	ng/L	
Deethylatrazine (CIAT)	68552	LCM60	6190-65-4	5.5	11	ng/L	
Deethylatrazine-d6, sur	90522	LCM60	na	---	---	pct	
Deiodo flubendiamide	68563	LCM60	1016160-78-3	5	10	ng/L	
Deisopropylatrazine (CEAT)	68550	LCM60	1007-28-9	10	20	ng/L	
Demethyl fluometuron	68591	LCM60	3032-40-4	1.8	3.6	ng/L	
Demethyl hexazinone B	68566	LCM60	56611-54-2	1.5	3	ng/L	
Demethyl norflurazon	68567	LCM60	23576-24-1	2	4	ng/L	
Desamino metribuzin (Metribuzin DA)	68568	LCM60	35045-02-4	4.5	9	ng/L	
Diazinon	65078	LCM60	333-41-5	3.2	6.4	ng/L	
Diazinon-d10 (diethyl-d10), sur	90523	LCM60	100155-47-3	---	---	pct	
Diazoxon	68236	LCM60	333-41-5	2	4	ng/L	
Dichlorvos	68572	LCM60	na	26	52	ng/L	
Dicrotophos	68573	LCM60	141-66-2	2	4	ng/L	
Didealkylatrazine (CAAT)	68547	LCM60	3397-62-4	12	24	ng/L	
Didemethyl hexazinone F (Hexazinone TP F)	68574	LCM60	56611-55-3	5	10	ng/L	
Diflubenzuron	68576	LCM60	35367-38-5	3	6	ng/L	

Diflubenzuron-d4 (4-chlorophenyl-d4), sur	90524	LCM60	1219795-45-5	---	---	pct	
Dimethenamid	68580	LCM60	87674-68-8	1.5	3	ng/L	
Dimethoate	66596	LCM60	60-51-5	2.3	4.6	ng/L	
Disulfoton	67595	LCM60	298-04-4	5.7	11	ng/L	
Disulfoton oxon	68586	LCM60	126-75-0	1	2	ng/L	
Disulfoton oxon sulfone	68588	LCM60	2496-91-5	3	6	ng/L	
Disulfoton oxon sulfoxide	68587	LCM60	2496-92-6	3	6	ng/L	
Disulfoton sulfone	68589	LCM60	2497-06-5	4.5	9	ng/L	
Disulfoton sulfoxide	68590	LCM60	2497-07-6	2	4	ng/L	
Diuron	66598	LCM60	330-54-1	2.5	5	ng/L	
Diuron-d6, sur	90808	LCM60	na	---	---	pct	
EPTC	65080	LCM60	759-94-4	103	206	ng/L	
EPTC R248722	68594	LCM60	65109-69-5	2	4	ng/L	
Ethoprop	68596	LCM60	13194-48-4	2.5	5	ng/L	
Etoxazole	68598	LCM60	153233-91-1	2.1	4.2	ng/L	
Fenamiphos	68599	LCM60	22224-92-6	2.3	4.6	ng/L	
Fenamiphos sulfone	68600	LCM60	31972-44-8	2.5	5	ng/L	
Fenamiphos sulfoxide	68601	LCM60	31972-43-7	2.5	5	ng/L	
Fenbutatin oxide	68602	LCM60	13356-08-6	---	500	ng/L	
Fentin	68603	LCM60	668-34-8	15	30	ng/L	
Flumetsulam	61679	LCM60	98967-40-9	19	38	ng/L	
Fluometuron	68608	LCM60	2164-17-2	1.7	10	ng/L	
Fonofos	65084	LCM60	944-22-9	5.5	11	ng/L	
Halosulfuron-methyl	61680	LCM60	100784-20-1	3	12	ng/L	
Hexazinone	65085	LCM60	51235-04-2	1.8	3.6	ng/L	
Hexazinone TP C	68612	LCM60	72585-88-7	1	2	ng/L	
Hexazinone TP G	68713	LCM60	51235-04-2	11	22	ng/L	
Hexazinone-d6 (N,N-dimethyl-d6), sur	90527	LCM60	1219804-22-4	---	---	pct	
Hydroxy didemethyl fluometuron	68619	LCM60	---	25	50	ng/L	
Hydroxy monodemethyl fluometuron	68617	LCM60	---	6.1	12	ng/L	
Hydroxyacetochlor	68615	LCM60	60090-47-3	10	20	ng/L	
Hydroxyalachlor	68616	LCM60	56681-55-1	3	6	ng/L	
Hydroxydiazinon	68618	LCM60	29820-16-4	5.5	11	ng/L	
Hydroxymetolachlor	68622	LCM60	131068-72-9	1.2	2.4	ng/L	
Hydroxyphthalazinone	68623	LCM60	12167-74-7	7	28	ng/L	
Hydroxysimazine	68624	LCM60	2599-11-3	24	120	ng/L	USGS NWQL
Imazamox	68625	LCM60	114311-32-9	6	30	ng/L	
Imazaquin	61682	LCM60	81335-37-7	5	10	ng/L	
Imazethapyr	61683	LCM60	81335-77-5	4	8	ng/L	
Imidacloprid	68426	LCM60	138261-41-3	8.1	16	ng/L	
Indoxacarb	68627	LCM60	173584-44-6	2.6	5.2	ng/L	
Isoxaflutole	68632	LCM60	141112-29-0	9.1	18	ng/L	
Kresoxim-methyl	67670	LCM60	143390-89-0	2.5	5	ng/L	
Lactofen	68638	LCM60	77501-63-4	5	10	ng/L	
Linuron	68639	LCM60	330-55-2	2.8	5.6	ng/L	
Linuron-d6 (dimethyl-d6), sur	90529	LCM60	1219804-76-8	---	---	pct	
Malaoxon	68240	LCM60	1634-78-2	27	54	ng/L	
Malathion	65087	LCM60	121-75-5	2.7	5.4	ng/L	
Malathion-d10 (diethyl-d10), sur	90552	LCM60	347841-48-9	---	---	pct	
Metalaxyl	68437	LCM60	57837-19-1	3	6	ng/L	
Metconazole	66620	LCM60	125116-23-6	2.5	5	ng/L	
Methamidophos	68644	LCM60	10265-92-6	5	10	ng/L	
Methidathion	65088	LCM60	950-37-8	4.2	8.4	ng/L	
Methomyl	68645	LCM60	16752-77-5	1.5	3	ng/L	
Methomyl oxime	68646	LCM60	13749-94-5	4000	8000	ng/L	
Methoxyfenozide	68647	LCM60	161050-58-4	1.1	2.2	ng/L	
Methyl paraoxon	68648	LCM60	950-35-6	9.5	19	ng/L	
Metolachlor	65090	LCM60	51218-45-2	1.6	3.2	ng/L	
Metolachlor hydroxy morpholinone	68649	LCM60	61520-54-5	5	10	ng/L	
Metolachlor-d6, sur	90553	LCM60	1219803-97-0	---	---	pct	
Metribuzin	68652	LCM60	21087-64-9	10	20	ng/L	
Molinate	65091	LCM60	2212-67-1	7	28	ng/L	
Myclobutanil	66632	LCM60	88671-89-0	3.5	7	ng/L	
N-(3,4-Dichlorophenyl)-N-methylurea (DCPMU)	68231	LCM60	3567-62-2	2.5	5	ng/L	
Naled	68654	LCM60	300-76-5	28	56	ng/L	
Nicosulfuron	61685	LCM60	111991-09-4	5.9	12	ng/L	
Nicosulfuron-d6 (dimethoxy-d6), sur	90554	LCM60	1189419-41-7	---	---	pct	
Norflurazon	67685	LCM60	27314-13-2	1.7	3.4	ng/L	

Novaluron	68655	LCM60	116714-46-6	25	50	ng/L
O-Ethyl O-methyl S-propyl phosphorothioate	68597	LCM60	76960-87-7	2.5	5	ng/L
Omethoate	68661	LCM60	1113-02-6	1	2	ng/L
Orthosulfamuron	68662	LCM60	213464-77-8	3	6	ng/L
Oxamyl	68664	LCM60	23135-22-0	1	2	ng/L
Oxamyl oxime	68665	LCM60	30558-43-1	2.5	5	ng/L
Oxyfluorfen	65093	LCM60	42874-03-3	250	500	ng/L
Paraoxon	68666	LCM60	311-45-5	1.7	3.4	ng/L
Pendimethalin	65098	LCM60	40487-42-1	5	10	ng/L
Phorate	68668	LCM60	298-02-2	5.5	11	ng/L
Phorate oxon	68669	LCM60	2600-69-3	11	55	ng/L
Phorate oxon sulfone	68670	LCM60	2588-06-9	10	20	ng/L
Phorate oxon sulfoxide	68671	LCM60	2588-05-8	3.5	7	ng/L
Phorate sulfone	68672	LCM60	2588-04-7	18	36	ng/L
Phorate sulfoxide	68673	LCM60	2588-03-6	2.3	4.6	ng/L
Phthalazinone	68675	LCM60	90004-07-2	7.5	15	ng/L
Piperonyl butoxide	65102	LCM60	51-03-6	5	25	ng/L
Profenofos	68676	LCM60	41198-08-7	1.5	3	ng/L
Prometon	67702	LCM60	1610-18-0	2	4	ng/L
Prometryn	65103	LCM60	7287-19-6	2.1	4.2	ng/L
Pronamide (Propyzamide)	67706	LCM60	23950-58-5	1.2	2.4	ng/L
Propanil	66641	LCM60	709-98-8	6.2	12	ng/L
Propargite	68677	LCM60	2312-35-8	1	2	ng/L
Propazine	68678	LCM60	139-40-2	1.6	3.2	ng/L
Propiconazole	66643	LCM60	60207-90-1	3	6	ng/L
Propoxur	68679	LCM60	114-26-1	1.6	3.2	ng/L
Prosulfuron	61687	LCM60	94125-34-5	5	10	ng/L
Pyraclostrobin	66646	LCM60	175013-18-0	1.2	2.4	ng/L
Pyridaben	68682	LCM60	96489-71-3	1.2	2.4	ng/L
Pyrimidinol (2-Isopropyl-6-methyl-4-pyrimidinol)	68505	LCM60	2814-20-2	4	8	ng/L
Pyriproxyfen	68683	LCM60	95737-68-1	1.5	3	ng/L
Siduron	68686	LCM60	1982-49-6	2.5	5	ng/L
Simazine	65105	LCM60	122-34-9	3.6	7.2	ng/L
Sulfometuron-methyl	68688	LCM60	74222-97-2	2	4	ng/L
Sulfosulfuron	68689	LCM60	141776-32-1	5.3	11	ng/L
Tebuconazole	66649	LCM60	107534-96-3	2.5	15	ng/L
Tebuconazole-d6, sur	90555	LCM60	na	---	---	pct
Tebufenozide	68692	LCM60	112410-23-8	1	2	ng/L
Tebupirimfos	68693	LCM60	96182-53-5	1	2	ng/L
Tebupirimfos oxon	68694	LCM60	96182-53-5	1	2	ng/L
Tebuthiuron	68695	LCM60	34014-18-1	1.5	3	ng/L
Tebuthiuron TP 104	68575	LCM60	59962-53-7	2.8	5.6	ng/L
Tebuthiuron TP 108	68696	LCM60	39222-73-6	5	10	ng/L
Tebuthiuron TP 109 (OH)	68697	LCM60	139888-73-6	19	38	ng/L
Tebuthurion TP 109	68621	LCM60	59962-54-8	5.5	11	ng/L
Terbacil	68698	LCM60	5902-51-2	10	21	ng/L
Terbufos	68699	LCM60	13071-79-9	3.4	6.8	ng/L
Terbufos oxon	68700	LCM60	56070-14-5	2	4	ng/L
Terbufos oxon sulfone	68701	LCM60	56070-15-6	5.5	11	ng/L
Terbufos oxon sulfoxide	68702	LCM60	56165-57-2	2	4	ng/L
Terbufos sulfone	68703	LCM60	56070-16-7	16	32	ng/L
Terbufos sulfoxide	68704	LCM60	10548-10-4	1.5	3	ng/L
Terbuthylazine	66651	LCM60	5915-41-3	1.8	3.6	ng/L
Tetraconazole	66654	LCM60	112281-77-3	3.5	7	ng/L
Thiobencarb	65107	LCM60	28249-77-6	2.1	4.2	ng/L
Thiobencarb-d10 (diethyl-d10), sur	90556	LCM60	1219804-12-2			pct
Triallate	68710	LCM60	2303-17-5	6.2	12	ng/L
Tribuphos	68711	LCM60	78-48-8	1	2	ng/L
Trifloxystrobin	66660	LCM60	141517-21-7	1.4	2.8	ng/L
cis-Permethrin	68769	LCM60	61949-76-6	2.1	4.2	ng/L
cis-Permethrin-13C6, sur	90558	LCM60	na	---	---	pct
trans-Permethrin	68708	LCM60	61949-77-7	1.9	3.8	ng/L
PHARMACEUTICALS (NWQL LAB CODE 12440)						
1,7-Dimethylxanthine	67446	LCM56	611-59-6	21	88	ng/L
10-Hydroxy-amitriptyline	67995	LCM56	64520-05-4	1.7	8.3	ng/L
Abacavir	68022	LCM56	136470-78-5	1	2	ng/L
Acetaminophen	67436	LCM56	103-90-2	42	84	ng/L
Acetaminophen-d3	91775	LCM56	na	---	---	pct

Acyclovir	67484	LCM56	59277-89-3	4.4	22	ng/L
Albuterol	67437	LCM56	18559-94-9	1.2	6.7	ng/L
Albuterol-d9	91772	LCM56	na	---	---	pct
Alprazolam	68250	LCM56	28981-97-7	6.6	21	ng/L
Amitriptyline	67522	LCM56	50-48-6	19	37	ng/L
Amitriptyline-d3, sur	90364	LCM56	na	---	---	pct
Amphetamine	67461	LCM56	300-62-9	1.1	4.4	ng/L
Amphetamine-d6	91784	LCM56	na	---	---	pct
Antipyrine	67477	LCM56	60-80-0	25	50	ng/L
Atenolol	67502	LCM56	29122-68-7	4.8	13	ng/L
Atrazine	65065	LCM56	1912-24-9	10	20	ng/L
Benztropine	67997	LCM56	86-13-5	22	44	ng/L
Betamethasone	67485	LCM56	378-44-9	57	114	ng/L
Bupropion	67439	LCM56	34911-55-2	3.6	18	ng/L
Caffeine	67440	LCM56	58-08-2	43	91	ng/L
Caffeine-(trimethyl-13C3)	91781	LCM56	na	---	---	pct
Carbamazepine	67441	LCM56	298-46-4	2.2	11	ng/L
Carisoprodol	67498	LCM56	78-44-4	6	20	ng/L
Carisoprodol-d7, sur	90363	LCM56	1218911-16-0	---	---	pct
Chlorpheniramine	67497	LCM56	132-22-9	27	54	ng/L
Cimetidine	67442	LCM56	51481-61-9	60	140	ng/L
Citalopram	67505	LCM56	59729-33-8	3.3	6.6	ng/L
Clonidine	67518	LCM56	4205-90-7	30	61	ng/L
Codeine	67443	LCM56	76-57-3	16	32	ng/L
Codeine-d6	91786	LCM56	371151-94-9	---	---	pct
Cotinine	67444	LCM56	486-56-6	1.7	6.4	ng/L
Cotinine-d3	91783	LCM56	na	---	---	pct
Dehydronifedipine	67445	LCM56	67035-22-7	4	20	ng/L
Desmethyldiltiazem-d4, sur	90372	LCM56	na	---	---	pct
Desvenlafaxine	68251	LCM56	93413-62-8	42	84	ng/L
Dextromethorphan	67468	LCM56	125-71-3	1.6	8.2	ng/L
Diazepam	67499	LCM56	439-14-5	2	4	ng/L
Diazepam-d5	91790	LCM56	65854-76-4	---	---	pct
Diltiazem	67519	LCM56	42399-41-7	5.1	10	ng/L
Diltiazem-d3	91773	LCM56	na	---	---	pct
Diphenhydramine	67447	LCM56	147-24-0	24	48	ng/L
Diphenhydramine-d3	91788	LCM56	na	---	---	pct
Duloxetine	67448	LCM56	116539-59-4	7.3	37	ng/L
Erythromycin	67449	LCM56	114-07-8	27	80	ng/L
Erythromycin-13C,d3, sur	90365	LCM56	959119-26-7	---	---	pct
Ezetimibe	67487	LCM56	163222-33-1	80	205	ng/L
Ezetimibe-d4, sur	90366	LCM56	1093659-90-5	---	---	pct
Fadrozole	68012	LCM56	102676-47-1	6.3	13	ng/L
Famotidine	68000	LCM56	76824-35-6	17	34	ng/L
Fenofibrate	67489	LCM56	49562-28-9	3.2	6.4	ng/L
Fenofibrate-d6, sur	90367	LCM56	1092484-56-4	---	---	pct
Fexofenadine	67510	LCM56	83799-24-0	22	44	ng/L
Fexofenadine-d10, sur	90368	LCM56	1215900-18-7	---	---	pct
Fluconazole	67478	LCM56	86386-73-4	15	30	ng/L
Fluoxetine	67450	LCM56	54910-89-3	13	26	ng/L
Fluoxetine-d6	91789	LCM56	na	---	---	pct
Fluticasone propionate	67529	LCM56	80474-14-2	10	30	ng/L
Fluvoxamine	67521	LCM56	54739-18-3	27	80	ng/L
Fluvoxamine-d4, sur	90369	LCM56	na	---	---	pct
Gabapentin	52817	LCM56	60142-96-3	80	160	ng/L
Glipizide	68001	LCM56	29094-61-9	16	80	ng/L
Glyburide	68002	LCM56	10238-21-8	2	4	ng/L
Guanylurea	52816	LCM56	141-83-3	70	140	ng/L
Hexamethylenetetramine	52815	LCM56	100-97-0	---	55	ng/L
Hydrocodone	67506	LCM56	125-29-1	20	40	ng/L
Hydrocodone-d3	91779	LCM56	na	---	---	pct
Hydrocortisone	67459	LCM56	50-23-7	73	147	ng/L
Hydrocortisone-13C3,sur	90379	LCM56	na	---	---	pct
Hydroxyzine	68005	LCM56	68-88-2	1.5	7.4	ng/L
Iminostilbene	67481	LCM56	256-96-2	73	145	ng/L
Ketoconazole	68014	LCM56	65277-42-1	56	113	ng/L
Ketoconazole-d4, sur	90361	LCM56	na	---	---	pct
Lamivudine	68018	LCM56	134678-17-4	3.2	16	ng/L

Lidocaine	67462	LCM56	137-58-6	2	4	ng/L	
Loperamide	67515	LCM56	53179-11-6	40	80	ng/L	
Loperamide-d6, sur	90370	LCM56	na	---	---	pct	
Loratadine	67488	LCM56	79794-75-5	1.4	7	ng/L	
Loratadine-d4, sur	90371	LCM56	na	---	---	pct	
Lorazepam	67470	LCM56	846-49-1	101	202	ng/L	USGS NWQL
Lorazepam-d4, sur	90359	LCM56	84344-15-0	---	---	pct	
Meprobamate	67464	LCM56	57-53-4	6	12	ng/L	
Metaxalone	67504	LCM56	1665-48-1	7.8	16	ng/L	
Metformin	67492	LCM56	657-24-9	6.6	13	ng/L	
Metformin-d6, IS/sur	90395	LCM56	na	---	---	pct	
Methadone	67500	LCM56	76-99-3	3.8	7.6	ng/L	
Methadone-d9	91777	LCM56	na	---	---	pct	
Methocarbamol	67501	LCM56	532-03-6	5.6	11	ng/L	
Methotrexate	67525	LCM56	59-05-2	26	52	ng/L	
Methyl-1H-benzotriazole	67514	LCM56	29385-43-1	28	80	ng/L	
Metoprolol	67523	LCM56	51384-51-1	5	10	ng/L	
Morphine	67458	LCM56	57-27-2	20	80	ng/L	
N-Desmethyldiltiazem	67999	LCM56	130606-60-9	35	70	ng/L	
Nadolol	68006	LCM56	42200-33-9	4	20	ng/L	
Nevirapine	68017	LCM56	129618-40-2	23	46	ng/L	
Nicotine	67493	LCM56	54-11-5	29	58	ng/L	
Nizatidine	67479	LCM56	76963-41-2	40	80	ng/L	
Nordiazepam	68252	LCM56	1088-11-5	10	20	ng/L	
Norethindrone	67434	LCM56	68-22-4	10	20	ng/L	
Norfluoxetine	67451	LCM56	56161-73-0	40	80	ng/L	
Norfluoxetine-d6	91776	LCM56	na	---	---	pct	
Norsertraline	67532	LCM56	87857-41-8	40	80	ng/L	
Norverapamil	68007	LCM56	67018-85-3	4.3	8.6	ng/L	
Omeprazole + Esomprazole	67512	LCM56	73590-58-6 119141-88-7	8.2	16	ng/L	
Oseltamivir	67511	LCM56	196618-13-0	2.9	15	ng/L	
Oxazepam	67469	LCM56	604-75-1	113	226	ng/L	
Oxazepam-d5, sur	90362	LCM56	65854-78-6	---	---	pct	
Oxycodone	67495	LCM56	76-42-6	5	25	ng/L	
Oxycodone-d3	91778	LCM56	na	---	---	pct	
Paroxetine	67527	LCM56	61869-08-7	36	72	ng/L	
Penciclovir	68021	LCM56	39809-25-1	40	80	ng/L	
Pentoxifylline	67480	LCM56	6493-05-6	4.7	9.4	ng/L	
Phenazopyridine	68008	LCM56	94-78-0	4.1	13	ng/L	
Phendimetrazine	67496	LCM56	634-03-7	5	20	ng/L	
Phenytoin	67466	LCM56	57-41-0	94	188	ng/L	
Piperonyl butoxide	67435	LCM56	51-03-6	20	60	ng/L	
Prednisolone	67483	LCM56	50-24-8	75	150	ng/L	
Prednisone	67467	LCM56	53-03-2	35	105	ng/L	
Promethazine	67524	LCM56	60-87-7	57	114	ng/L	
Promethazine-d6, sur	90373	LCM56	na	---	---	pct	
Propoxyphene	68009	LCM56	469-62-5	14	28	ng/L	
Propoxyphene-d11, sur	90360	LCM56	na	---	---	pct	
Propranolol	67516	LCM56	525-66-6	4.5	26	ng/L	
Pseudoephedrine + Ephedrine	67460	LCM56	90-82-4 299-42-3	1.5	6	ng/L	
Pseudoephedrine-d3	91787	LCM56	na	---	---	pct	
Quinine	68011	LCM56	130-95-0	16	80	ng/L	
Ractopamine	52814	LCM56	97825-25-7	9	20	ng/L	
Raloxifene	67530	LCM56	84449-90-1	40	80	ng/L	
Raloxifene-d10, sur	90374	LCM56	na	---	---	pct	
Ranitidine	67452	LCM56	66357-35-5	96	192	ng/L	
Ranitidine-d6, sur	90375	LCM56	na	---	---	pct	
Sertraline	67528	LCM56	79617-96-2	3.2	16	ng/L	
Sitagliptin	67531	LCM56	486460-32-6	19	97	ng/L	
Sulfadimethoxine	67503	LCM56	122-11-2	7	14	ng/L	
Sulfamethizole	67476	LCM56	144-82-1	21	104	ng/L	
Sulfamethoxazole	67454	LCM56	723-46-6	5	20	ng/L	
Sulfamethoxazole-(phenyl-13C6)	91782	LCM56	na	---	---	pct	
Tamoxifen	68015	LCM56	10540-29-1	---	270	ng/L	
Tamoxifen-d5, sur	90378	LCM56	157698-32-3	---	---	pct	
Temazepam	67471	LCM56	846-50-4	9.2	18	ng/L	

Temazepam-d5	91780	LCM56	na	---	---	pct	
Theophylline	67494	LCM56	58-55-9	40	80	ng/L	
Thiabendazole	67455	LCM56	148-79-8	2	4	ng/L	
Thiabendazole-d4	91769	LCM56	na	---	---	pct	
Tiotropium	67508	LCM56	186691-13-4	25	50	ng/L	
Tiotropium-d3, sur	90376	LCM56	na	---	---	pct	
Tramadol	67517	LCM56	27203-92-5	3.7	7.4	ng/L	
Triamterene	67475	LCM56	396-01-0	2.6	5.2	ng/L	
Trimethoprim	67456	LCM56	738-70-5	1.6	20	ng/L	
Trimethoprim-d9	91774	LCM56	na	---	---	pct	
Valacyclovir	67507	LCM56	124832-26-4	33	163	ng/L	
Venlafaxine	67534	LCM56	93413-69-5	2.6	5.2	ng/L	
Verapamil	67472	LCM56	52-53-9	70	140	ng/L	
Verapamil-d6, sur	90377	LCM56	na	---	---	pct	
Warfarin	67457	LCM56	81-81-2	3	6	ng/L	
HORMONES (NWQL LAB CODE 12434)							
11-Ketotestosterone	64507	GM004	564-35-2	2.5	5	ng/L	USGS NWQL
16-Epiestriol-d2	91676	GM004	366495-94-5	---	---	pct	
17-alpha-Estradiol	64508	GM004	57-91-0	1	2	ng/L	
17-alpha-Ethynylestradiol	64509	GM004	57-63-6	1	2	ng/L	
17-alpha-Ethynylestradiol-d4	90813	GM004	350820-06-3	---	---	pct	
17-b-Estradiol-13C6	91753	GM004	na	---	---	pct	
17-beta-Estradiol	64510	GM004	50-28-2	1	2	ng/L	
3-beta-Coprostanol	64512	GM004	360-68-9	---	200	ng/L	
4,4'-Bisphenol F, wf	51292	GM004	620-92-8	---	5	ng/L	
4-Androstene-3,17-dione	64513	GM004	63-05-8	2.5	5	ng/L	
Bisphenol A	67304	GM004	80-05-7	---	100	ng/L	
Bisphenol A-d16	67308	GM004	96210-87-6	---	---	pct	
Bisphenol F-d10, IDS	90639	GM004	na	---	---	pct	
Cholesterol	64514	GM004	57-88-5	---	400	ng/L	
Cholesterol-d7	90778	GM004	83199-47-7	---	---	pct	
Dihydrotestosterone	64524	GM004	521-18-6	3	6	ng/L	
Epitestosterone	64517	GM004	481-30-1	2	4	ng/L	
Equilenin	64518	GM004	517-09-9	2	4	ng/L	
Equilin	64519	GM004	474-86-2	8	16	ng/L	
Estriol	64520	GM004	50-27-1	1	2	ng/L	
Estriol-2,4,16,17-d4	91615	GM004	na	---	---	pct	
Estrone	64521	GM004	53-16-7	2	4	ng/L	
Estrone-13C6	91754	GM004	na	---	---	pct	
Medroxyprogesterone-d3	91678	GM004	162462-69-3	---	---	pct	
Mestranol	64522	GM004	72-33-3	3	6	ng/L	
Mestranol-2,4,16,16-d4	90821	GM004	na	---	---	pct	
Nandrolone-d3	91679	GM004	120813-22-1	---	---	pct	
Norethindrone	64511	GM004	68-22-4	2	4	ng/L	
Progesterone	64523	GM004	57-83-0	6	12	ng/L	
Progesterone-2,3,4-13C3	90510	GM004	327048-87-3	---	---	pct	
Sample volume	91118	GM004	na	---	---	mL	
Testosterone	64525	GM004	58-22-0	3	6	ng/L	
cis-Androsterone	64515	GM004	53-41-8	1	2	ng/L	
cis-Androsterone-2,2,3,4,4-d5	90816	GM004	89685-22-3	---	---	pct	
trans-Diethylstilbestrol	64516	GM004	56-53-1	---	1.3	ng/L	
trans-Diethylstilbestrol-d8	90817	GM004	91318-10-4	---	---	pct	