Quality Assurance Project Plan

City of Goldendale ASR Program Evaluation and Aquifer Testing

Goldendale City Limits (2007)

October 2024, Publication 24-12-019

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WROCR-2123-CiGold-00035

Publication Information

Each study conducted or funded by the Washington State Department of Ecology (Ecology) must have an approved Quality Assurance Project Plan (QAPP). The QAPP describes the objectives of the study and the procedures to be followed to achieve those objectives.

This QAPP was prepared by a licensed hydrogeologist. A signed and stamped copy of the report is available upon request. This QAPP is available via Ecology's publication database and upon request. The Ecology publication number for this QAPP is 24-12-019. This QAPP is valid through October 31, 2029.

Field data collected for this project will be uploaded to Ecology's Environmental Information Management (EIM) database under Study ID: WROCR-2123-CiGold-00035

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COVER PHOTO: View from City of Goldendale. Photo by Aspect Consulting.

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Published October 2024

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2.0 Abstract

This Quality Assurance Project Plan (QAPP) was prepared by Aspect Consulting (Aspect) for the City of Goldendale (City) to outline the procedures for data collection to support an evaluation of an Aquifer Storage and Recovery (ASR) program being considered by the City. The proposed ASR program is being evaluated as a component of the City's long-term water supply strategy to address declining groundwater levels and surface water availability in summer months.

The City previously completed an ASR Feasibility Study which concluded that ASR could be successfully implemented to re-time seasonally available spring flow from the City's Simcoe Springs to recharge the Wanapum Basalt aquifer via the City's Dingmon Well. The Feasibility Study was conducted in 2008 through funding provided by the Washington Department of Ecology (Water Storage Project Pre-Construction Grant Number G0600292).

This QAPP covers water quality sampling of the City's drinking water distribution system (Simcoe Springs water, an existing approved drinking water source) and its Dingmon well and the collection of water level data and conducting a pumping test at the City's Dingmon Well. The Dingmon Well is being considered as an ASR well and was tested for a short duration as part of the 2008 Feasibility Study. Water quality results and water level data will be compared to existing data and augment the previous analyses presented in the City's 2008 Feasibility Study, including hydrogeologic constraints to implementing the ASR program and addressing ASR permitting requirements in Washington Administrative Code (WAC) 173-157.

Key sections of this QAPP that describe the tasks to be completed and data collection procedures are as follows:

- Section 3.2.3: Provides a description of the water quality constituents to be evaluated;
- Section 4.4: Presents the details of the tasks to be completed, in sequential order;
- Section 5: Outlines the project schedule and team;
- Section 6.2: Measurement Quality Objectives;
- Section 7.2: Describes water quality sampling locations and frequency (sampling schedule); and
- Section 8.2: Details the water quality sampling and well/aquifer testing procedures.

3.0 Background

3.1 Introduction and Problem Statement

As a component of its long-term water supply strategy, the City of Goldendale (City) is evaluating development of an Aquifer Storage and Recovery (ASR) program to offset declining water levels in the Wanapum Basalt aquifer, which is the City's primary source of water supply and has experienced declines in aquifer levels and well yields, particularly in summer months. ASR is implemented by diverting excess surface water when its available for storage within a suitable aquifer, then later recovering that water through pumping. In the 2000 session, the Washington State Legislature expanded the definition of "reservoir" in RCW 90.03.370 to include "any naturally occurring underground geological formation where water is collected and stored for subsequent use as part of an underground artificial storage and recovery project." In March 2003, Ecology adopted a regulation (Chapter 173-157 WAC) pertaining to ASR projects which defines water rights/permitting requirements, the process and information requirements for obtaining an ASR permit, and Ecology's process for reviewing ASR permit applications.

Under the ASR program, the City proposes to capture seasonal peak flows from the City's Simcoe Springs existing drinking water supply source. During winter and spring, surplus water from the Simcoe Springs collector system overflows into the West Prong Little Klickitat River (also referred to as Emerson Creek). Rather than overflowing to the river, the City would store the seasonal surplus water in the Wanapum Basalt Aquifer (storage aquifer) via the Dingmon Well. Groundwater would later be recovered by the City through pumping from the Dingmon well.

The previously completed Feasibility Study (FS) in 2008 concluded that ASR is feasible for the City, based on hydrogeologic, legal, environmental, and operational considerations (Aspect Consulting, 2008). Much of the information required for an ASR reservoir permit application was documented through the FS; however, data gaps including well and aquifer performance testing and groundwater quality warranted additional data collection under this study. This QAPP addresses the following elements:

- Aquifer test design and tasks to be completed;
- Data and measurement quality objectives;
- Field and laboratory procedures;
- Quality control methods;
- Data verification and validation protocols;
- Data management procedures; and
- Reporting

This QAPP follows Ecology's *Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies* (Ecology, 2004; updated 2016). It has been developed to conduct water level and water quality data collection effectively and accurately as part of the study.

The development of this QAPP is funded under Ecology Office of Columbia River (OCR) Grant (Agreement No. WROCR-2123-CiGold-00035) between the City and Ecology. Aspect is under contract to the City to prepare this QAPP and complete the study.

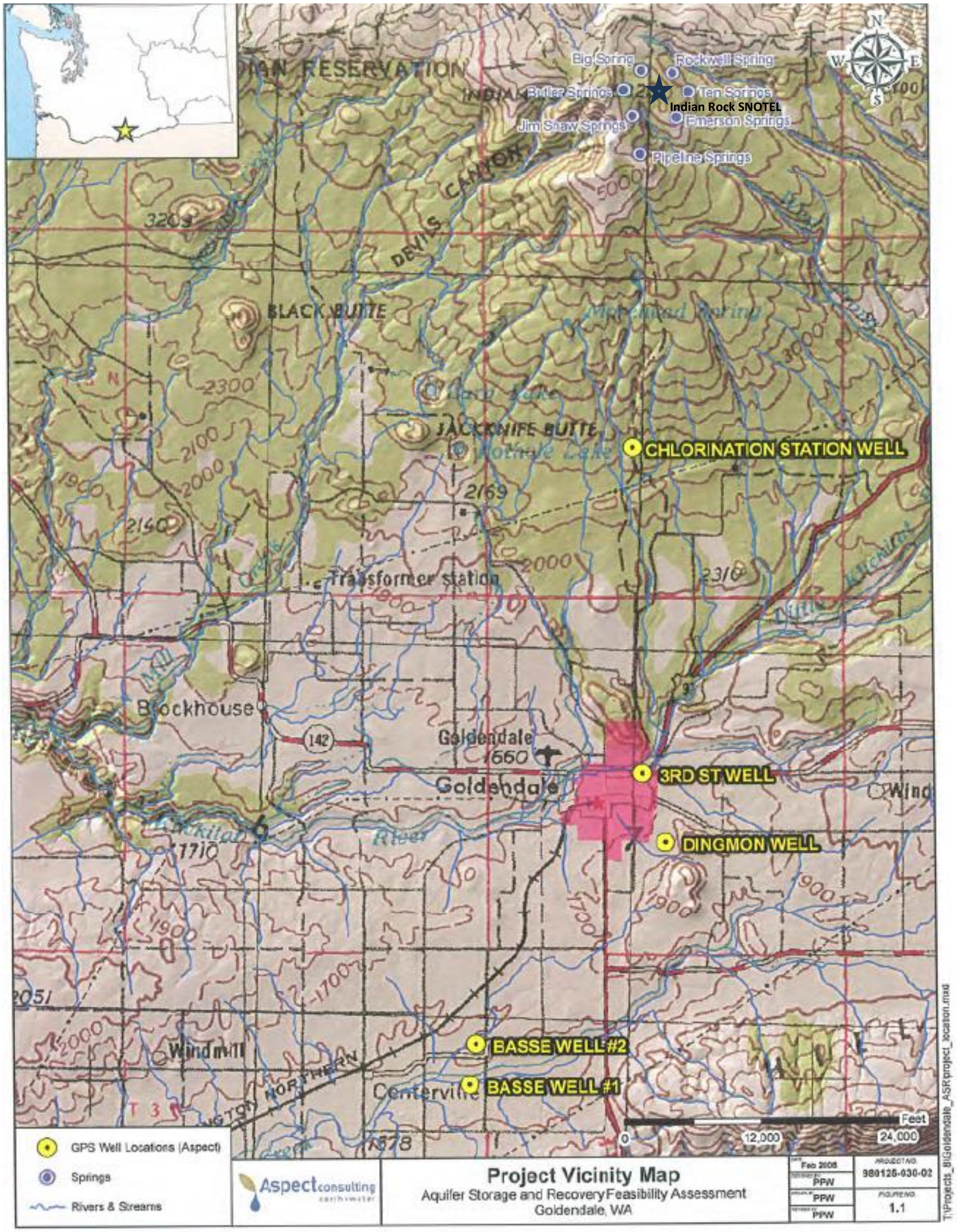
3.2 Study Area and Surroundings

The City of Goldendale is in Klickitat County, within the Little Klickitat River subbasin of Water Resources Inventory Area (WRIA) 30 (Figure 1). The area is drained by the Little Klickitat River and Bloodgood Creek, whose headwaters are in the Simcoe Mountains. The Little Klickitat River flows west through the City of Goldendale and is bounded by the Simcoe Mountains to the north and the Horseshoe Bend structural anticline to the south.

The primary geologic units present in the Goldendale area include (from youngest to oldest): surficial stream deposits (alluvium), units of the Simcoe Mountain Volcanics, and members of the Columbia River Basalt Group. The City's groundwater supply wells are completed within the Simcoe Mountain Volcanics and the Columbia River Basalt Group. The Simcoe Mountain Volcanics are generally composed of basalt flows and volcanic cinder erupted from a series of low shield volcanoes and subsidiary cinder cones within the local area. The older Columbia River Basalts consist of a widespread extrusion of numerous basalt flows from vents located to the east, in the Pasco, Washington area. The Columbia River Basalt Group stratigraphy includes geologic formations—Wanapum Basalt and Grand Ronde Basalt in the Goldendale area—which are further subdivided into members, individual basalt flow packages, and sedimentary interbeds. Sedimentary interbeds are composed of silt, sand, and gravel, deposited between individual basalt flows. Surficial geologic mapping of the Goldendale area and a cross-section of subsurface geology depicted SW-NE through the Dingmon Well is shown in Figures 2 and 3 respectively. As discussed in the 2008 Feasibility Study, and depicted in Figure 3, multiple interflow zones within the Frenchman Springs Member of the Wanapum formation are the current targets for groundwater enhancement through ASR.

The City's water supply includes its Simcoe Springs diversion and a collection of three groundwater wells (the Chlorination Station well and two wells that comprise the Basse Wellfield), all of which are existing drinking water sources approved through the Department of Health (DOH) and monitored routinely for water quality. A well owned by the City and evaluated under the 2008 Feasibility Study, referred to as the Dingmon Well, has been offline for an extended period and is not a currently active City source. The Dingmon Well is located in the easternmost part of the City's water service area and is being considered for service as the ASR recharge and recovery well. The City's Simcoe Springs, located to the north of the City in the Simcoe Mountains would provide ASR source water, with conveyance through the City's existing drinking water distribution system.

Figure 1. Map Study Area and Key Water Supplies [1]



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[1] The City's 3rd Street Well is not an active water supply source for the City.

Figure 2. Geologic Map of Goldendale Area.

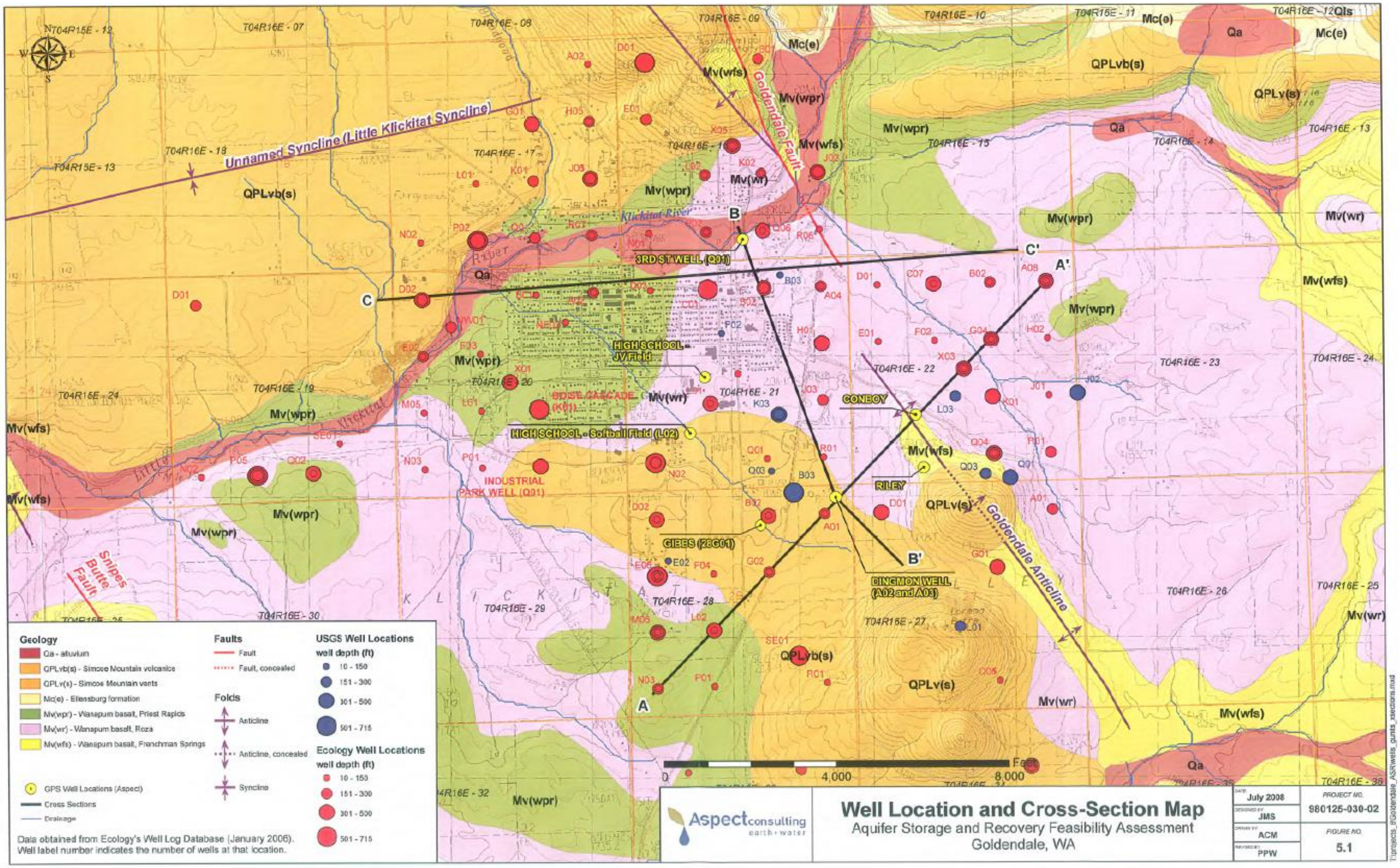
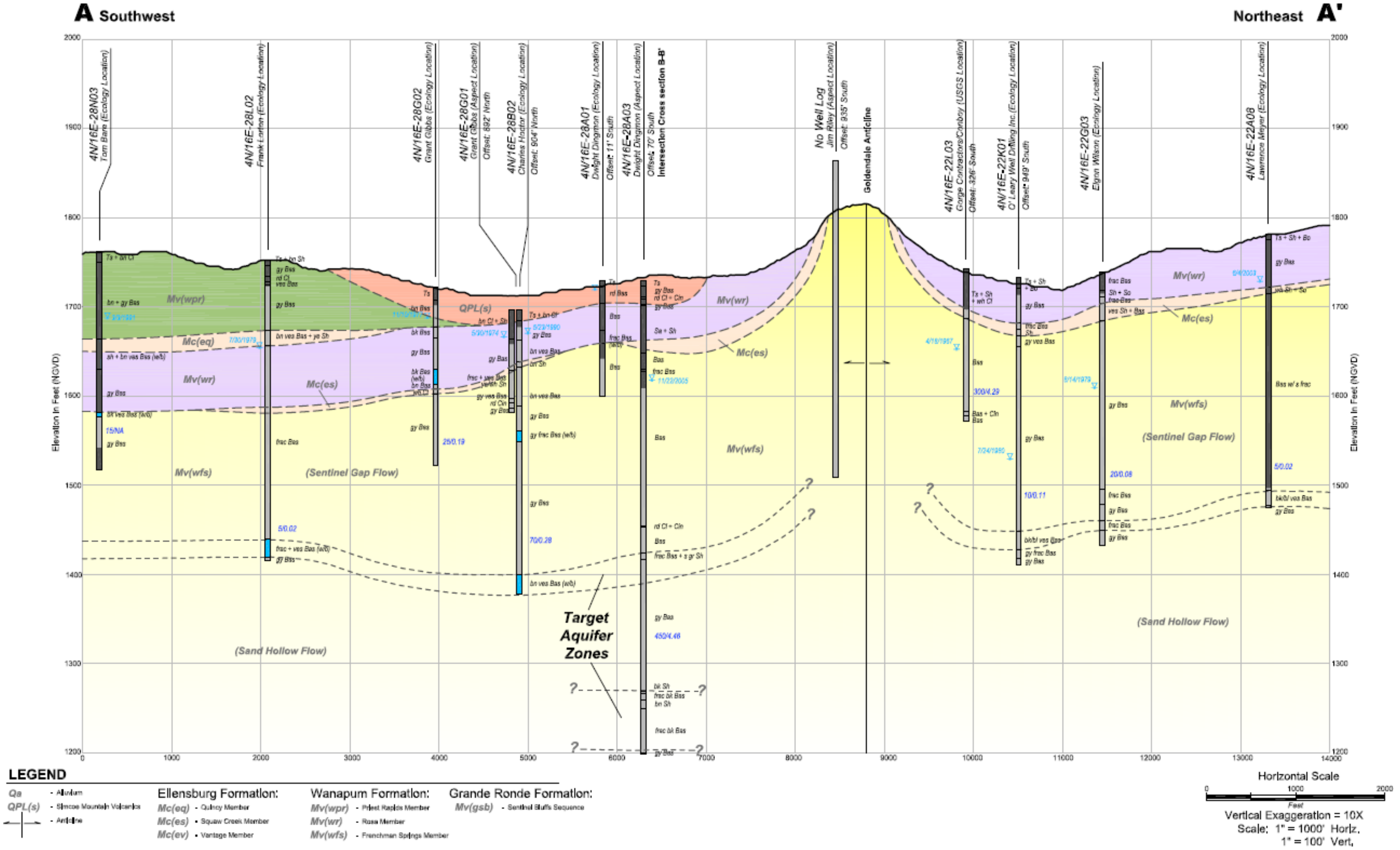


Figure 3. Geologic Cross-section Through A-A' near Goldendale.



3.2.1 History of Study Area

The City relies on a diminishing groundwater supply from the Wanapum Basalt Aquifer, particularly during high-demand summer months, and is pursuing ASR to improve sustainability of its water supply and support economic growth. Water level declines in the Wanapum Basalt Aquifer result in the lowering of pumping levels in City wells, and a decline in specific capacity (yield per foot of drawdown). Well yields have decreased by as much as 29 percent in Basse Well 1 and 11 percent in Basse Well 2 from 2017 to 2021; significant reductions have also been observed for the City's Chlorination Station Well (see Figure 4). The City is addressing increased drawdown by implementing well rehabilitation and working with the agricultural community to minimize pumping interference but expects seasonal drawdown trends to continue because of increasing well reliance by the City and its industrial users, most notably Puget Sound Energy's (PSE) gas-fired power facility which is a major water user. In recent years PSE's power facility has operated continuously which has significantly increased the demand on the City's water supply.

The City's other supply well, the Chlorination Station Well, taps the Simcoe Volcanics and has experienced declines in yield of over 50 percent in recent years. Recent analysis by the City identified water level declines of 45 feet in this well since 2004. The Simcoe Mountains are the recharge area for the Simcoe Volcanics and the Wanapum Basalt Aquifer within the Little Klickitat River subbasin therefore, observed declines of groundwater levels within the Simcoe Volcanics may forecast future declines in the Wanapum Basalt Aquifer and baseflows in the Little Klickitat River.

As with the Chlorination Station Well, Simcoe Springs is supplied by the Simcoe Volcanics aquifer. This aquifer is recharged directly from infiltration of rain and snow, which continues to be impacted by climate change. The timing and volume of annual precipitation and snowpack is strongly correlated to spring discharge from the Simcoe Volcanics. SNOTEL data for the Simcoe Springs watershed at Indian Rock Station (Figure 5) illustrates progressive trend towards lower annual snowpack accumulation, and earlier melt-out of the snowpack by almost 30 days since 2010. Accordingly, while winter and spring flows at Simcoe Springs typically remain high, peak summer flows have declined, with average August flows having declined by as much as 50 percent since 1999. This illustrates the vulnerability of the City's water supply to climate change and anticipated reduction in future supply.

Figure 4 Chlorination Station Well Hydrographs and Flow Data

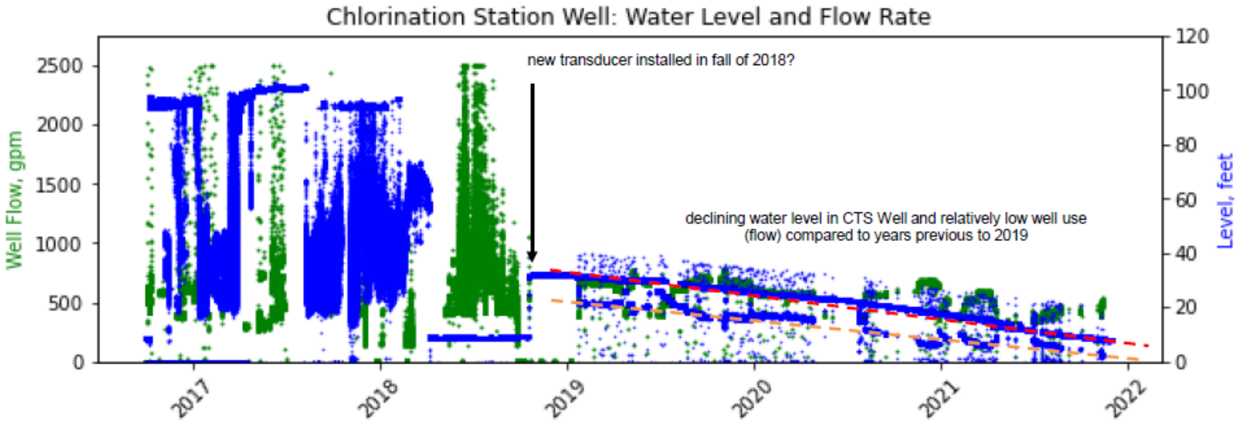
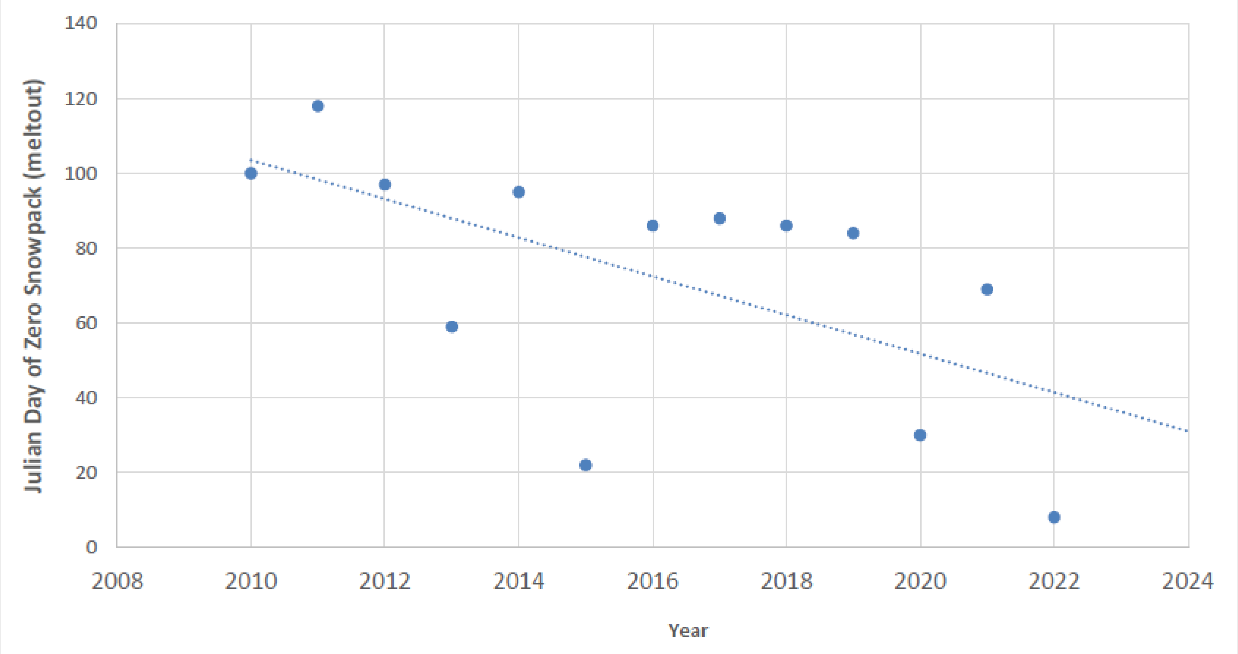


Figure 5 Simcoe Springs Catchment Area Snowmelt*



* Figure 5 indicates the Julian date (days since January 1) that a snowpack of zero was measured at the Indian Rock SNOTEL site, located

3.2.2 Summary of Previous Studies and Existing Data

ASR options in the Little Klickitat subbasins were evaluated during the water storage planning process for WRIA 30 and the City's ASR program has been identified in the Klickitat River Basin Watershed Management Plan (Watershed Professionals Networks and Aspect Consulting, 2005) as a method to ensure water supplies meet future water demands within WRIA 30.

The City completed an ASR Feasibility Study (FS) with Ecology funding (Aspect, 2008; Water Storage Project Pre-Construction Grant Number G0600292) to evaluate the viability of implementing an ASR program. A detailed reconnaissance of geology, hydrology, and water chemistry was included in the study. Previous water quality sampling at both the potential ASR source water (Simcoe Springs) and groundwater at the Dingmon Well indicated drinking water standards are met, and that the chemistry of these water is compatible during storage. The water quality of Simcoe Springs is actively monitored by the City as a municipal water supply source.

In March 2006, a 24-hour aquifer test was performed at the Dingmon Well as part of the process of testing and permitting the well as a permanent municipal water supply source. The analysis results provided information on the aquifer characteristics and were discussed in the ASR FS.

3.2.3 Parameters of Interest and Potential Sources

This study includes up to four water quality sample collections, as described in Section 7. At a minimum, one water quality sample will be collected from the Dingmon Well after pump startup, and near the end of aquifer testing to evaluate water quality with the Washington State Groundwater Quality Standards (Chapter 173-200-040 Washington Administrative Code [WAC]) and Drinking Water Standards (Chapter 246-290 WAC) to support future DOH Source Approval of the Dingmon Well. Depending on the duration of the test, additional samples may be collected at regular intervals to begin defining background groundwater quality in accordance with Chapter 173-200 WAC. Field parameters, including dissolved oxygen and redox potential (see Section 7.2) will be measured during each of the sample events using a closed flow through cell system. The sample from the Dingmon Well collected near the end of the test will be analyzed for the test panels required by DOH for drinking water source approval of groundwater (referred to by DOH as "IOCs, VOCs, herbicides, pesticides, insecticides, EDB, DBCP, ammonia, and heterotrophic plate count [HPC]); the analytes in these test panels are included in the suites described in the following sections. Note that Source Approval for the Dingmon Well is a future task and not part of this study. Data collected will be used to begin evaluating the background water quality conditions needed for a future AKART analysis, if needed.

Depending on the duration of the pumping test at the Dingmon Well (Section 7.0), up to two additional water quality samples will be collected from the Dingmon Well during the aquifer test and will be analyzed for the general chemistry suite to evaluate the variability of major chemical constituents in groundwater. One water quality sample will also be collected from the City’s distribution system near the Dingmon Well to reflect Simcoe Springs source water conveyed within the distribution system; this sample will be tested for the general chemistry and disinfection byproduct analyte suites.

The schedule for monitoring these constituents during the Study is presented in Section 7.2.1. The following sections describe the water quality analytes selected for this investigation.

Field Parameters

Field parameters will be measured during all sampling events to provide independent corroboration of laboratory results, and to analyze constituents that have short hold times and can be readily measured in the field. These include:

- Electrical Conductivity
- Dissolved Oxygen
- Oxidation Reduction Potential (ORP)
- pH
- Temperature
- Turbidity

Primary and Secondary Inorganic Compounds and Metals (General Chemistry)

This general chemistry suite includes inorganic constituents and conventional water quality parameters. Groundwater samples will be analyzed for this suite of constituents in both the dissolved (field-filtered to 45 microns) and total fractions. This analytical suite will also be used to confirm source treatment requirements in the context of Chapter 173-200 WAC (Groundwater Quality Standards) and WAC 246-290-310 (Drinking Water Standards) for the Dingmon Well. Constituents will include:

Alkalinity
Bicarbonate
Chloride
Total Dissolved Solids (TDS)
Total Suspended Solids (TSS)
Total Organic Carbon (TOC)
Dissolved Organic Carbon (DOC)
Phosphorus
Bromide
Fluoride
Nitrate+Nitrite-N
Sulfate

Silica
Arsenic
Antimony
Aluminum
Barium
Beryllium
Cadmium
Calcium
Chromium
Copper
Iron
Zinc

Lead
Magnesium
Manganese
Mercury
Nickel
Potassium
Selenium
Silver
Sodium
Thallium
Uranium
Titanium

Volatile and Semivolatile Organic Compounds (VOCs and SOCs)

As described in Section 3.2.2, baseline characterization studies have been completed for native groundwater in the target storage aquifer (Wanapum Basalt aquifer at the City's Dingmon during the ASR Feasibility Study). The previous FS included analysis of volatile organic compounds (VOCs) measured under U.S. Environmental Protection Agency (EPA) Method 524.2 (59 individual compounds). Semivolatile (synthetic) organic compounds (SOC) under EPA Method 525.2 (48 individual compounds) were not previously analyzed.

Under this study, both VOCs and SOCs will be measured in native groundwater at the Dingmon Well. The Study will also evaluate the groundwater source for both herbicides and pesticides. This will include the analytes specified in U.S. Environmental Protection Agency (EPA) Methods for:

- Chlorinated Pesticides
- Chlorinated Acid Herbicides
- Pesticides as carbamates
- Herbicides – diquat, paraquat, endothall, and glyphosate

Disinfectants/Disinfection By-products (DBPs)

DBPs are a subset of volatile compounds. The following DBPs will be measured in Simcoe Springs water within the City's distribution system near the Dingmon Well:

- Trihalomethane Compounds (THMs): chloroform (trichloromethane), Bromodichloromethane, dibromochloromethane, and bromoform. The combined concentration of these four constituents will be considered total THMs (TTHM)
- Haloacetic Acids (HAAs): monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, and dibromoacetic acid. The combined concentration of these constituents is referenced to as HAA5.

Microorganisms

Bacteriological constituents will be measured in native groundwater to determine baseline conditions of the storage aquifer at the Dingmon Well. The following constituents will be measured:

- E. coli (presence/absence)
- Total coliforms (heterotrophic plate count)
- Fecal Coliform
- Iron reducing bacteria
- Heterotrophic Plate Count (HPC)

Radionuclides

Radionuclides will be analyzed for at City's Dingmon Well:

- Radium 226 + Radium 228
- Gross Alpha radiation

- Gross Beta radiation
- Uranium

3.2.4 Regulatory Criteria or Standards

A Preliminary Permit will be requested under pending Application No. G4-35137 for the Dingmon Well, assuming such direction is given by Ecology. Water produced during testing of the Dingmon Well will be discharged to ground, so drinking water standards and water right permitting for beneficial use of water from the Dingmon Well do not apply to the activities described in this QAPP. However, the purpose of this study is to evaluate regulatory compliance considerations for future ASR operations, where the introduction of recharge water to the storage aquifer is subject to the Antidegradation Rule and numerical groundwater quality standards defined in Chapter 173-200 WAC. During future operations, water recovered to the drinking water system through ASR must also meet Drinking Water Criteria in WAC 246-290-310. Drinking Water Source Approval for the Dingmon Well will be addressed outside of this study at a future date. Section 3.2.2 above describes water quality analytes selected for this investigation. Table 1 below presents the regulatory criteria by analyte method that will be evaluated as part of this project for compliance considerations for a future ASR program.

Table 1. Water Quality Analytes and Applicable Standards

Analyte	**Unit**	**Groundwater Quality Standard WAC 173-200-040**	**Primary Drinking Water Quality[1] Standard WAC 246-290**	**Secondary Drinking Water Quality[1] Standard WAC 246-290**
EPA 200.8 (General Chemistry)				
Aluminum	ug/L	--	--	--
Barium	ug/L	1,000	2,000	--
Calcium	ug/L	--	--	--
Copper	ug/L	1,000	1,300	1,000
Iron	ug/L	300	--	300
Magnesium	ug/L	--	--	--
Manganese	ug/L	50	--	50
Potassium	ug/L	--	--	--
Silica (SiO2)	ug/L	--	--	--
Sodium	ug/L	--	--	--
Zinc	ug/L	5,000	--	5,000

Analyte	Unit	Groundwater Quality Standard WAC 173-200-040	Primary Drinking Water Quality^1 Standard WAC 246-290	Secondary Drinking Water Quality^1 Standard WAC 246-290
Antimony	ug/L	--	6	--
Arsenic	ug/L	0.05	10	--
Beryllium	ug/L	--	4	--
Cadmium	ug/L	10	5	--
Chromium	ug/L	50	100	--
Lead	ug/L	50	15	--
Nickel	ug/L	--	--	--
Selenium	ug/L	10	50	--
Silver	ug/L	50	--	100
Thallium	ug/L	--	2	--
Titanium	ug/L	--	--	--
Uranium	ug/L	--	30	--
EPA 300.0 (General Chemistry)				
Bromide	mg/L	--	--	--
Chloride	mg/L	250	--	250
Fluoride	mg/L	4	4	2
Sulfate	mg/L	250	--	250
SM2320B (General Chemistry)				
Alkalinity as Carbonate	mg/L	--	--	--
Bicarbonate Ion	mg/L	--	--	--
SM2540C (General Chemistry)				
Total Dissolved Solids	mg/L	500	--	500
SM2540D (General Chemistry)				
Total Suspended Solids	mg/L	--	--	--
SM4500NO3F (General Chemistry)				
Nitrate as Nitrogen	mg/L	10	10	--

Analyte	Unit	Groundwater Quality Standard WAC 173-200-040	Primary Drinking Water Quality[1] Standard WAC 246-290	Secondary Drinking Water Quality[1] Standard WAC 246-290
Nitrite as Nitrogen	mg/L	--	1	--
SM5310C (General Chemistry)				
Total Organic Carbon	mg/L	--	--	--
EPA 365.3 (General Chemistry)				
Phosphorus	mg/L	--	--	--
EPA 515.4 (Pesticides and Herbicides)				
2,4-D	ug/L	--	--	--
2,4-DB	ug/L	--	--	--
3,5-Dichlorobenzoic acid	ug/L	--	--	--
Acifluorfen	ug/L	--	--	--
Chloramben	ug/L	--	--	--
Chlorthal	ug/L	--	--	--
Dalapon	ug/L	--	200	--
Dicamba	ug/L	--	--	--
Dichloroprop	ug/L	--	--	--
Dinoseb	ug/L	--	7	--
Pentachlorophenol	ug/L	--	1	--
Picloram	ug/L	--	500	--
Silvex	ug/L	10	50	--
EPA 524.2 (VOCs and SVOCs)				
1,1,1,2-Tetrachloroethane	ug/L	--	--	--
1,1,1-Trichloroethane	ug/L	200	200	--
1,1,2,2-Tetrachloroethane	ug/L	--	--	--
1,1,2-Trichloroethane	ug/L	--	5	--
1,1-Dichloroethane	ug/L	1	--	--
1,1-Dichloroethene	ug/L	--	7	--

Analyte	Unit	Groundwater Quality Standard WAC 173-200-040	Primary Drinking Water Quality[1] Standard WAC 246-290	Secondary Drinking Water Quality[1] Standard WAC 246-290
1,1-Dichloropropene	ug/L	--	--	--
1,2,3-Trichlorobenzene	ug/L	--	--	--
1,2,3-Trichloropropane	ug/L	--	--	--
1,2,4-Trichlorobenzene	ug/L	--	70	--
1,2,4-Trimethylbenzene	ug/L	--	--	--
1,2-Dibromo-3-chloropropane	ug/L	--	0.2	--
1,2-Dibromoethane (EDB)	ug/L	0.001	0.05	--
1,2-Dichlorobenzene	ug/L	--	600	--
1,2-Dichloroethane (EDC)	ug/L	0.5	5	--
1,2-Dichloropropane	ug/L	0.6	5	--
1,3,5-Trimethylbenzene	ug/L	--	--	--
1,3-Dichlorobenzene	ug/L	--	--	--
1,3-Dichloropropane	ug/L	--	--	--
1,4-Dichlorobenzene	ug/L	4	75	--
2,2-Dichloropropane	ug/L	--	--	--
2-Chlorotoluene	ug/L	--	--	--
4-Chlorotoluene	ug/L	--	--	--
Benzene	ug/L	1	5	--
Bromobenzene	ug/L	--	--	--
Bromochloromethane	ug/L	--	--	--
Bromodichloromethane	ug/L	0.3	80	--
Bromoform	ug/L	5	80	--
Bromomethane	ug/L	--	--	--
Carbon Tetrachloride	ug/L	0.3	5	--
Chlorobenzene	ug/L	--	100	--
Chloroethane	ug/L	--	--	--

Analyte	Unit	Groundwater Quality Standard WAC 173-200-040	Primary Drinking Water Quality[1] Standard WAC 246-290	Secondary Drinking Water Quality[1] Standard WAC 246-290
Chloroform	ug/L	7	80	--
Chloromethane	ug/L	--	--	--
cis-1,2-Dichloroethene (DCE)	ug/L	--	7	--
cis-1,3-Dichloropropene	ug/L	--	--	--
Dibromochloromethane	ug/L	0.5	80	--
Dibromomethane	ug/L	--	--	--
Dichlorodifluoromethane	ug/L	--	--	--
Ethylbenzene	ug/L	--	700	--
Hexachlorobutadiene	ug/L	--	--	--
Isopropylbenzene	ug/L	--	--	--
m,p-Xylenes	ug/L	--	10,000	--
Methyl tert-butyl ether (MTBE)	ug/L	--	--	--
Methylene Chloride	ug/L	5	5	--
Naphthalene	ug/L	--	--	--
n-Butylbenzene	ug/L	--	--	--
n-Propylbenzene	ug/L	--	--	--
o-Xylene	ug/L	--	10,000	--
p-Isopropyltoluene	ug/L	--	--	--
sec-Butylbenzene	ug/L	--	--	--
Styrene	ug/L	--	100	--
tert-Butylbenzene	ug/L	--	--	--
Tetrachloroethene (PCE)	ug/L	0.8	5	--
Toluene	ug/L	--	1,000	--
trans-1,2-Dichloroethene	ug/L	--	100	--
trans-1,3-Dichloropropene	ug/L	--	--	--
Trichloroethene (TCE)	ug/L	3	5	--

Analyte	**Unit**	**Groundwater Quality Standard WAC 173-200-040**	**Primary Drinking Water Quality^1 Standard WAC 246-290**	**Secondary Drinking Water Quality^1 Standard WAC 246-290**
Trichlorofluoromethane	ug/L	--	--	--
Vinyl Chloride	ug/L	0.02	2	--
EPA 525.2 (VOCs and SVOCs)				
Alachlor	ug/L	--	2	--
Atrazine	ug/L	--	3	--
Benzo(a)pyrene	ug/L	0.008	0.2	--
Bis(2-ethylhexyl) adipate	ug/L	--	400	--
Bis(2-ethylhexyl) phthalate	ug/L	6	6	--
Bromacil	ug/L	--	--	--
Butachlor	ug/L	--	--	--
Fluorene	ug/L	--	--	--
Hexachlorobenzene	ug/L	0.05	1	--
Hexachlorocyclopentadiene	ug/L	--	50	--
Metolachlor	ug/L	--	--	--
Metribuzin	ug/L	--	--	--
Propachlor	ug/L	--	--	--
Simazine	ug/L	--	4	--
EPA 531 (Pesticides and Herbicides)				
3-Hydroxycarbofuran	ug/L	--	--	--
Aldicarb	ug/L	--	--	--
Aldicarb Sulfoxide	ug/L	--	--	--
Aldoxycarb	ug/L	--	--	--
Carbaryl	ug/L	--	--	--
Carbofuran	ug/L	--	40	--
Methiocarb	ug/L	--	--	--
Methomyl	ug/L	--	--	--

Analyte	Unit	Groundwater Quality Standard [WAC 173-200-040]	Primary Drinking Water Quality[1] Standard [WAC 246-290]	Secondary Drinking Water Quality[1] Standard [WAC 246-290]
Oxamyl	ug/L	--	200	--
Propoxur	ug/L	--	--	--
EPA 547 (Pesticides and Herbicides)				
Glyphosate	ug/L	--	700	--
EPA 548.1 (Pesticides and Herbicides)				
Endothall	ug/L	--	100	--
EPA 549.2 (Pesticides and Herbicides)				
Diquat	ug/L	--	20	--
Paraquat	ug/L	--	--	--
SM9215B (Bacteriological)				
Heterotrophic Plate Count (HPC)	CFU/mL	--	--	--
SM9221B (Bacteriological)				
Fecal Coliform	CFU/100mL	--	--	--
SM9223B (Bacteriological)				
E. coli	CFU/100mL	--	--	--
Total Coliform	CFU/100mL	1/100	--	--
Field Parameters				
Specific conductance	uS/cm	--	--	700
Turbidity	NTU	--	5*	--
pH	SU	--	--	6.5-8.5

mg/L = milligrams per liter. ug/L = micrograms per liter. µS/cm = micosiemens per centimeter. SU = standard units. NTU = Nephelometric Turbidity Units

* drinking water limit for turbidity is based on a treatment technique in lieu of a Maximum Contaminant Level, where unfiltered surface water cannot exceed 5 NTU (WAC 246-290-632).

3.3 Water Quality Impairment Studies

Not applicable.

3.4 Effectiveness Monitoring Studies

Not applicable.

4.0 Project Description

The proposed ASR program is being considered as a component of the City's long-term water supply strategy to offset declining groundwater supplies. The 2008 Feasibility Study concluded that ASR could be successfully implemented to re-time seasonally available spring flow from the City's existing Simcoe Springs to augment groundwater supply in the Wanapum Basalt aquifer (the "storage aquifer") via the Dingmon Well. This study is being conducted to collect additional hydrogeologic and water quality data to expand on the 2008 Feasibility Study and meet the ASR reservoir permit application requirements.

4.1 Project Goals

The overall project goal is to collect informative hydrogeologic testing data that allows for expansion of the analyses presented in the City's 2008 ASR Feasibility Study. This includes successful aquifer testing at the Dingmon Well. To augment the water quality analyses presented in the City's 2008 Feasibility Study, additional water quality data will be collected to confirm assumptions of past geochemical modeling regarding ASR at the Dingmon well.

4.2 Project Objectives

The objectives of this study include:

Objective 1 – collect water quality samples from the Dingmon Well and to evaluate overall water quality and variability of major groundwater chemistry in the Wanapum aquifer and compare to past assumptions for geochemical modeling impacts.

Objective 2 – collect water quality samples from the City's distribution system near the Dingmon well to evaluate the quality of Simcoe Springs water that has been conveyed with the City's drinking water distribution system.

Objective 3 – conduct an extended pumping test to assess the performance of the Dingmon Well and evaluate the Wanapum aquifer conditions (transmissivity, storage coefficient, recharge and no-flow boundary conditions, water level response, etc.,) at the Dingmon Well and vicinity.

Objective 4 – compare results to the findings of the 2008 Feasibility Study and update recommendations regarding ASR program development as necessary.

4.3 Information Needed and Sources

Additional water quality data is needed for the Dingmon Well to evaluate comprehensive water quality and evaluate variability in major chemistry (see Section 3.2.3). Groundwater quality samples will be collected from the Dingmon Well and evaluated for the analytes listed in Section 7.2.1 during aquifer testing. A water quality sample will also be collected from the City's distribution system near the Dingmon Well to represent source water for a future ASR program. This information will be compared to water quality data collected as part of the past ASR Feasibility Study, which relied on a single comprehensive water quality sample from the City's Dingmon Well and 3rd Street well to represent ambient groundwater quality in the geochemical model

Water level measurements from well and aquifer testing are needed to further refine 2008 FS estimates of storage performance of the Wanapum aquifer during ASR. Water level measurements will be continuously collected in the Dingmon Well and up to two nearby observations wells during a constant-rate pumping test. Dataloggers will be installed in the wells and maintained prior to aquifer testing and will remain in the wells for at least 10 days after test completion to evaluate pre- and post-testing water level trends. Information collected during this study will be compared to past data collected as part of the ASR Feasibility Study.

Additional details on the project design are provided in Section 7.3.

4.4 Tasks Required

Study objectives require completing the following tasks. Although not detailed in this QAPP, each project task will involve coordination with the City, Ecology, and DOH to ensure regulatory requirements are met.

Task 1: Water Quality Sampling and Analysis

This task includes collecting up to four water quality samples to characterize ambient water quality of the Wanapum Aquifer (the "storage aquifer"), support future DOH Source Approval of the Dingmon Well, and begin to address requirements in WAC 173-157-120 and -130. One of these four samples will be collected from the City's distribution system to reflect ASR source water from Simcoe Springs. A schedule of water quality sample collection is presented in Section 7.2.1.

Task 2: Wellhead Assessment and Well Testing

Work under this task will be completed to further evaluate the storage aquifer conditions (transmissivity, storage coefficient, boundary conditions, etc.) and to assess the performance of the City's Dingmon Well. Results collected during this task will provide information required in WAC 173-157-120 and -130.

Task 2.1: Complete test preparation. A detailed assessment of the Dingmon wellhead, well appurtenances, conveyance infrastructure, and design constraints will be completed. Access to take manual water level measurements and install temporary equipment (dataloggers) will be assessed at the Dingmon Well and the proposed observation wells. The Dingmon Well and two additional wells will be instrumented with appropriately ranged datalogging pressure transducers (as access allows). Dataloggers will be installed and maintained one month prior to the pumping tests and for at least 10 days after test completion. A brief memorandum will be prepared to document test preparation activities.

Task 2.2: Conduct step-rate pumping test. A step-rate pumping test will be conducted using best practices at the Dingmon Well to evaluate well capacity and performance. The results of the step-rate test will be analyzed to determine the sustainable yield of the constant-rate pumping test.

Task 2.3: Conduct constant-rate pumping test. A constant-rate pumping test will be conducted for a minimum of 2 days and up to 10 days at the City's Dingmon Well. The pumping rate will be the maximum rate that is anticipated to be practically maintained within the constraints of the well, existing conveyance infrastructure. Infrastructural constraints include the discharge location for test water, which is expected to include a "pump-to-waste" area near the Dingmon Well. All work will be documented in field forms.

Task 3: Reporting and Analysis

Work under this task will be completed to analyze and document the methods and results of the study.

Task 3.1: The methods, findings, conclusions, and recommendations of the tasks described above will be documented in a project report, along with an assessment of anticipated ASR performance that incorporates the findings of the 2008 ASR Feasibility Study.

Recommendations regarding design, permitting, and testing of the proposed ASR program will be presented. Water level data will be plotted and analyzed using conventional pumping test analytical methods and the performance of the Dingmon Well and target storage aquifer will be evaluated. A draft report will be prepared and submitted to Ecology, then a final report will be prepared that addresses Ecology's comments.

4.5 Systematic Planning Process

This QAPP has been prepared to satisfy the systematic planning needs for this project.

5.0 Organization and Schedule

5.1 Key Individuals and Their Responsibilities

Table 2 shows the responsibilities of those who will be involved in this project.

Table 2. Organization of Project Staff and Responsibilities

Staff	Title	Responsibilities
Scott Tarbutton Ecology Water Resources Office of the Columbia River Phone: (509) 329-3539	Project Manager and Quality Assurance Coordinator	Provides oversight of the Study and Ecology Grant. Clarifies scope of the project. Provides internal review of the QAPP and approves the final QAPP.
Chris Duncan Ecology Water Resources Phone: 509-490-5183	Hydrogeologist	Provides technical oversight and review of the study, provides technical and permitting support.
Sandy Wells City of Goldendale Phone: 509-773-3771	Project Manager/ Finance Officer	Reviews the draft and final QAPP and project deliverables, manages the project budget and submittals for the Ecology grant.
Andy O'Connor City of Goldendale Phone: 509-773-4346	Water System Operator	Supports design and operation of Test infrastructure.
Andrew Austreng Aspect Consulting Phone: 206-838-5843	Principal Investigator and Project Manager	Co-author of QAPP, Aspect Project Manager, approach development, data analysis, QA/QC
Ryan Mullen Aspect Consulting Phone: 360-810-3513	Project Hydrogeologist	Co-author of QAPP, develops and oversees field programs, plans/schedules field dates/logistics. Collects data and records field information, performs data analysis.
Ian Lauer Aspect Consulting Phone: 509-888-1527	Field Hydrogeologist	Plans/schedules field dates/logistics. Procures equipment. Collects data and records field information.
Lea Beard Aspect Consulting Phone: (206) 780-7749	Data Scientist	Reviews and uploads EIM data.
Analytical Laboratory Brock Gerger Anatek Labs, Inc. Phone: 509-838.3999	Lab Director	Prepares of lab reports, QA Coordinator.

QAPP = Quality Assurance Project Plan

5.2 Special Training and Certifications

A hydrogeologist licensed in the State of Washington will perform all analysis and interpretation of field data and provide oversight of hydrogeologic data collection. All field staff involved in this project will have either the relevant experience in the required standard operating procedures (SOPs) or be trained by more senior field staff or the project manager who has the required experience. The experienced staff will then lead the field data collection and oversee/mentor less-experienced staff.

5.3 Organization Chart

Not applicable – See Table 2.

5.4 Proposed Project Schedule

Table 3 below provides the anticipated project schedule proposed under this project.

Table 3. Tentative Project Schedule

Task	Completion date	Notes
Final QAPP	October 31, 2024	--
Letter for Preliminary Permit	March 31, 2024	Letter to Ecology requesting issuance of preliminary permit to conduct Task 4 testing
Well Preparation Memo	September 30, 2024	--
Water Quality Assessment and Dingmon Well Testing	December 2024	Water quality samples will be collected from the Dingmon Well approximately every two days throughout the duration of the aquifer test.
Complete Laboratory Analyses	February 2025	--
Draft Project Report	April 2025	For Ecology review
Final Project Report	June 30, 2025	--
Water Quality and Water Levels Database upload	June 30, 2025	Uploaded to EIM

5.5 Budget and Funding

The City has received a grant from Ecology OCR (Agreement No. WROCR-2123-CiGold-0035) to complete all tasks, as described in Section 4.4. This work is a follow-up to an ASR feasibility study that the City completed under previous Ecology OCR funding.

6.0 Quality Objectives

6.1 Data Quality Objectives [2]

The first data quality objective (DQO) for this study is to collect up to four water quality samples from the proposed injection well (Dingmon Well) and to have them analyzed at sufficient accuracy and precision to allow comparison to past geochemical modeling assumptions and results. The analysis will use common methodologies to evaluate geochemistry and water quality criteria that meet the measurement quality objectives (MQOs) described below.

The second DQO for this study is to collect groundwater level and pumping rate measurements to characterize the performance of the Dingmon Well and allow estimation of hydrogeologic parameters. Water levels and flow data will be collected in the Dingmon Well and water levels will be collected at a minimum of one other observation well prior to, during, and after the aquifer test. The aquifer testing procedure is designed to include baseline data collection, water-level measurements, and discharge rate measurements, as described below.

- Baseline water level measurements – are important for establishing aquifer conditions prior to aquifer testing and collected to determine static (non-pumping) water levels to evaluate any antecedent trends that may affect the interpretation of aquifer test results. Baseline data collection will include manual and automated barometric pressure and water-level measurements in the test and observation well(s) using the procedures described in Section 7. Automated measurements collected at 15-minute frequency for the month prior to testing will provide confidence characterizing antecedent conditions.
- Water-level measurements during aquifer testing– will be collected in accordance with the aquifer testing procedures described in Section 7. The high frequency measurements collected during the step-rate and early and late periods for the constant-rate test will all for analysis of well efficiency and provide distinction between aquifer and well performance. Collecting water level measurements at least 15-minnute intervals during the test will allow for development of time-drawdown plots to determine the radial locations of aquifer boundary conditions relative to the pumping (Dingmon) well and observation well(s). Water level recovery will be monitored for a minimum of 2 weeks after the testing) of the aquifer test for comparison to drawdown data to determine sustainable well yield and validate parameters estimated from the drawdown phase of the test.

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[2] DQO can also refer to ***Decision*** Quality Objectives. The need to identify Decision Quality Objectives during the planning phase of a project is less common. For projects that do lead to important decisions, DQOs are often expressed as tolerable limits on the probability or chance (risk) of the collected data leading to an erroneous decision. And for projects that intend to estimate present or future conditions, DQOs are often expressed in terms of acceptable uncertainty (e.g., width of an uncertainty band or interval) associated with a point estimate at a desired level of statistical confidence.

- Discharge rate measurements – will be collected using a flowmeter with a calibrated range that spans all pumping test rates (50 to 500 gpm). The discharge rate will be adjusted based on flow meter readings as needed to ensure consistent pumping rate throughout testing. Meter accuracy and precision of less than 5% will allow for acceptable determination of aquifer parameters, which will be estimated to no more than two significant digits.

After completion of the aquifer test and all data collection, data correction and analysis will occur. Data correction includes evaluation of whether water level data has been influenced by changes in barometric pressure by determining barometric efficiency (rate of water level change to barometric pressure change). A graphical method will be used to determine the barometric efficiency to correct water-level measurements. Corrected water level data will then be used to estimate hydraulic properties and aquifer performance (described in Section 7.3 below).

6.2 Measurement Quality Objectives

Measurement Quality Objectives (MQOs) are statements of the precision, bias, and lower measurement limits necessary to meet the Study objectives. Precision and bias together express data accuracy, whereas other considerations include the representativeness, completeness, and comparability of the data.

The investigation will be conducted to measure water levels, collect representative water samples for analyses, and measure water quality field parameters. The MQOs for the field investigation are described by the analytical methods and field equipment used to collect measurements, and the standard operating procedures employed to make decisions in the field. The data collection instrumentation will meet the measurement quality objectives listed in Table 4, and the water quality samples will be analyzed using standard methods that meet the MQOs listed in Table 5.

Table 4. Field Method MQOs and Field Equipment Information

Parameter	Equipment/ Method	Bias (median)	Precision Field Duplicates (median)	Equipment Information			Expected Range
				Accuracy	Resolution	Range	
Air Monitoring							
Temperature	Van Essen Baro-Diver	--	--	0.1°C	0.01°C	-10 to 50°C	-7 to 31°C
Barometric Pressure	Van Essen Baro-Diver	--	--	0.016 ft-H_2O	0.001 ft-H_2O	--	29 to 33 ft- H_2O
Groundwater Level Measurements							
Temperature	Van Essen TD-Diver D1801	--	--	0.1°C	0.01°C	0 to 50°C	1 to 25°C

Parameter	Equipment/ Method	Bias (median)	Precision Field Duplicates (median)	Equipment Information			Expected Range
				Accuracy	Resolution	Range	
Pressure	Van Essen TD-Diver D1801	--	--	0.016 ft-H_2O	0.007 ft-H_2O	Max 330 ft-H_2O	20 to 200 ft-H_2O
Depth to Water	Waterline Electric Tape	--	--	0.05 ft	0.01 ft	--	100 to 400 ft
Wellhead Position (GPS)	Trimble R1 GNSS Receiver	--	--	>3.3 ft	0.01 ft	--	--
Aquifer Testing Measurements							
Discharge Rate	Discharge valve and Flowmec 4-inch flow meter (or the equivalent)	--	--	± 3.0%	TBD	TBD	60 to 600 gpm
Field Water Quality Parameters							
pH	In-Situ AquaTroll 500 (with flow-through cell)	--	--	±0.1 SU	0.01 SU	0 to 14 SU	6.5 to 8.5 SU
Specific Conductivity		--	--	±0.5% + 1 µS/cm	0.1 µS/cm	0 to 350,000 µS/cm	150 to 500 µS/cm
Dissolved Oxygen		--	--	± 0.1 mg/L	0.01 mg/L	0 to 20 mg/L	0 to 10 mg/L
Oxidation-Reduction Potential		--	--	±5 mV	0.1 mV	-1400 to +1400 mV	-300 to +300 mV
Temperature		--	--	±0.1°C	0.01°C	-5 to 50°C	1 to 25°C

mV – millivolts. ft H_2O = feet of water. mg/L = milligrams per liter. µS/cm = micosiemens per centimeter. SU = standard units.

Table 5. Laboratory MQOs of Groundwater Samples

Analytical Method	Analyte	Method Detection Limit	Method Reporting Limit	Units	Field Dup. (RPD)	Matrix Spike (%Rec)	Matrix Spike Dup. (RPD)	Blank Spike (%Rec)	Blank Spike Dup. (RPD)
General Chemistry, Inorganics in Drinking Water									
EPA 300.0	Bromide	0.0030	0.100	mg/L	-	80-120	20	90-110	20
EPA 300.0	Chloride	0.0300	0.150	mg/L	-	80-120	20	90-110	20
EPA 300.0	Fluoride	0.0320	0.100	mg/L	-	80-120	20	90-110	20
EPA 300.0	Nitrate/N	0.0570	0.100	mg/L	20	80-120	20	90-110	20
EPA 300.0	Nitrite/N	0.0360	0.100	mg/L	-	80-120	20	90-110	20
EPA 300.0	Sulfate	0.0450	0.150	mg/L	-	80-120	20	90-110	20
SM 2320 B	Alkalinity	1.91	5.00	mg/L	20	85-115	20	85-115	20
SM 2320 B	Bicarbonate	2.11	5.00	mg/L	20	80-120	20	85-115	20
SM 2540 C	TDS	--	--	mg/L	20	--	--	80-120	20
SM 2540 D	TSS	--	--	mg/L	20	-	-	90-110	20
SM 4500-P F	Total P	0.00300	0.00500	mg/L	-	80-120	20	90-110	20
SM 5310 B	DOC	0.100	0.500	mg/L	-	70-130	30	80-120	20
SM 5310 B	TOC	0.0600	0.100	mg/L	-	70-130	30	85-115	15
Metals by ICP in Drinking Water									
EPA 200.8	Aluminum	0.000520	0.0100	mg/L	-	70-130	20	85-115	-
EPA 200.8	Antimony	0.000350	0.00100	mg/L	-	70-130	20	85-115	-
EPA 200.8	Arsenic	0.000190	0.00100	mg/L	-	70-130	20	85-115	-
EPA 200.8	Barium	0.000150	0.00100	mg/L	-	70-130	20	85-115	-
EPA 200.8	Beryllium	0.000150	0.000300	mg/L	-	70-130	20	85-115	-
EPA 200.8	Cadmium	0.000180	0.00100	mg/L	-	70-130	20	85-115	-
EPA 200.8	Chromium	0.000210	0.00100	mg/L	-	70-130	20	85-115	-
EPA 200.8	Copper	0.000110	0.00100	mg/L	-	70-130	20	85-115	-
EPA 200.8	Lead	0.000160	0.00100	mg/L	-	70-130	20	85-115	-
EPA 200.8	Manganese	0.000160	0.00100	mg/L	-	70-130	20	85-115	-
EPA 200.8	Mercury	0.0000200	0.000100	mg/L	-	70-130	20	85-115	-
EPA 200.8	Nickel	0.000120	0.00100	mg/L	-	70-130	20	85-115	-
EPA 200.8	Selenium	0.000200	0.00100	mg/L	-	70-130	20	85-115	-
EPA 200.8	Silver	0.0000600	0.00100	mg/L	-	70-130	20	85-115	-
EPA 200.8	Thallium	0.0000700	0.00100	mg/L	-	70-130	20	85-115	-
EPA 200.8	Uranium	0.180	1.00	ug/L	-	70-130	20	85-115	-
EPA 200.8	Zinc	0.000250	0.00100	mg/L	-	70-130	20	85-115	-
Metals by ICP-MS in Drinking Water									
EPA 200.7	Calcium	0.0182	0.100	mg/L	20	70-130	20	85-115	20
EPA 200.7	Iron	0.00720	0.0100	mg/L	20	70-130	20	85-115	20
EPA 200.7	Magnesium	0.0154	0.100	mg/L	20	70-130	20	85-115	20
EPA 200.7	Potassium	0.0521	0.500	mg/L	20	70-130	20	85-115	20
EPA 200.7	Silica (as SiO_2)	0.0930	0.214	mg/L	-	-	-	-	-
Metals by ICP-MS in Drinking Water									
EPA 200.8	Aluminum	0.000600	0.0100	mg/L	-	70-130	20	85-115	-

Analytical Method	Analyte	Method Detection Limit	Method Reporting Limit	Units	Field Dup. (RPD)	Matrix Spike (%Rec)	Matrix Spike Dup. (RPD)	Blank Spike (%Rec)	Blank Spike Dup. (RPD)
EPA 200.8	Antimony	0.0000600	0.00100	mg/L	-	70-130	20	85-115	-
EPA 200.8	Arsenic	0.000140	0.00100	mg/L	-	70-130	20	85-115	-
EPA 200.8	Barium	0.0000800	0.00100	mg/L	-	70-130	20	85-115	-
EPA 200.8	Beryllium	0.0000700	0.00100	mg/L	-	70-130	20	85-115	-
EPA 200.8	Cadmium	0.0000600	0.00100	mg/L	-	70-130	20	85-115	-
EPA 200.8	Calcium	0.0425	0.100	mg/L	-	70-130	20	85-115	-
EPA 200.8	Chromium	0.000110	0.00100	mg/L	-	70-130	20	85-115	-
EPA 200.8	Copper	0.000100	0.00100	mg/L	-	70-130	20	85-115	-
EPA 200.8	Iron	0.000600	0.0100	mg/L	-	70-130	20	85-115	-
EPA 200.8	Lead	0.000100	0.00100	mg/L	-	70-130	20	85-115	-
EPA 200.8	Magnesium	0.0401	0.100	mg/L	-	70-130	20	85-115	-
EPA 200.8	Manganese	0.000160	0.00100	mg/L	-	70-130	20	85-115	-
EPA 200.8	Nickel	0.0000800	0.00100	mg/L	-	70-130	20	85-115	-
EPA 200.8	Potassium	0.0957	0.100	mg/L	-	70-130	20	85-115	-
EPA 200.8	Selenium	0.000270	0.00100	mg/L	-	70-130	20	85-115	-
EPA 200.8	Silver	0.0000600	0.00100	mg/L	-	70-130	20	80-120	-
EPA 200.8	Sodium	0.0875	0.100	mg/L	-	70-130	20	85-115	-
EPA 200.8	Thallium	0.0000670	0.00100	mg/L	-	70-130	20	85-115	-
EPA 200.8	Uranium	0.0000400	0.00100	mg/L	-	70-130	20	85-115	-
EPA 200.8	Zinc	0.000220	0.00100	mg/L	-	70-130	20	85-115	-
Mercury in Water									
EPA 245.1	Mercury	0.0710	0.100	ug/L	18	70-130	20	85-115	-
Metals by ICP in Drinking Water									
EPA 200.7	Calcium	0.0182	0.100	mg/L	20	70-130	20	85-115	20
EPA 200.7	Iron	0.00720	0.0100	mg/L	20	70-130	20	85-115	20
EPA 200.7	Magnesium	0.0154	0.100	mg/L	20	70-130	20	85-115	20
EPA 200.7	Potassium	0.0521	0.500	mg/L	20	70-130	20	85-115	20
EPA 200.7	Silica (as SiO2)	0.0930	0.214	mg/L	-	-	-	-	-
EPA 200.7	Silicon	0.100	0.100	mg/L	20	70-130	20	85-115	20
EPA 200.7	Sodium	0.0124	0.100	mg/L	20	70-130	20	85-115	20
Radiochemistry in Drinking Water									
EPA 900.0	Gross Alpha	3.00	3.00	pCi/L	20	70-130	20	80-120	20
EPA 900.0	Gross Beta	4.00	4.00	pCi/L	20	70-130	20	80-120	20
EPA 903.0	Radium 226	0.200	1.00	pCi/L	20	70-130	20	80-120	20
EPA 903.0	Barium Carrier			Surrogate	-	-	-	-	-
EPA 904.0	Radium 228	0.100	1.00	pCi/L	20	70-130	20	80-120	20
EPA 904.0	Barium Carrier			Surrogate	-	-	-	-	-
EPA 904.0	Yttrium Carrier			Surrogate	-	-	-	-	-
Semivolatiles in Drinking Water									
EPA 505	alpha-BHC	0.00260	0.100	ug/L	25	65-135	25	70-130	20

Analytical Method	Analyte	Method Detection Limit	Method Reporting Limit	Units	Field Dup. (RPD)	Matrix Spike (%Rec)	Matrix Spike Dup. (RPD)	Blank Spike (%Rec)	Blank Spike Dup. (RPD)
EPA 505	Aroclor 1016 (PCB-1016)	0.0422	0.0800	ug/L	25	65-135	25	70-130	20
EPA 505	Aroclor 1221 (PCB-1221)	0.500	20.0	ug/L	25	65-135	25	70-130	20
EPA 505	gamma-BHC (Lindane)	0.00320	0.0200	ug/L	25	65-135	25	70-130	20
EPA 505	beta-BHC	0.00510	0.100	ug/L	25	65-135	25	70-130	20
EPA 505	delta-BHC	0.00320	0.100	ug/L	25	65-135	25	70-130	20
EPA 505	Heptachlor	0.00360	0.0400	ug/L	25	65-135	25	70-130	20
EPA 505	Aldrin	0.00480	0.100	ug/L	25	65-135	25	70-130	20
EPA 505	Heptachlor epoxide	0.00160	0.0200	ug/L	25	65-135	25	70-130	20
EPA 505	4,4'-DDE	0.00180	0.100	ug/L	25	65-135	25	70-130	20
EPA 505	Endosulfan I	0.00190	0.100	ug/L	25	65-135	25	70-130	20
EPA 505	Dieldrin	0.00170	0.100	ug/L	25	65-135	25	70-130	20
EPA 505	Endrin	0.00240	0.0100	ug/L	25	65-135	25	70-130	20
EPA 505	4,4'-DDD	0.00210	0.100	ug/L	25	65-135	25	70-130	20
EPA 505	Endosulfan II	0.00230	0.100	ug/L	25	65-135	25	70-130	20
EPA 505	4,4'-DDT	0.00520	0.100	ug/L	25	65-135	25	70-130	20
EPA 505	Endrin aldehyde	0.00370	0.100	ug/L	25	65-135	25	70-130	20
EPA 505	Methoxychlor	0.00460	0.100	ug/L	25	65-135	25	70-130	20
EPA 505	Endosulfan sulfate	0.00410	0.100	ug/L	25	65-135	25	70-130	20
EPA 505	Endrin ketone	0.00350	0.100	ug/L	25	65-135	25	70-130	20
EPA 505	Aroclor 1232 (PCB-1232)	0.100	0.500	ug/L	25	65-135	25	70-130	20
EPA 505	Aroclor 1242 (PCB-1242)	0.100	0.300	ug/L	25	65-135	25	70-130	20
EPA 505	Aroclor 1248 (PCB-1248)	0.100	0.100	ug/L	25	65-135	25	70-130	20
EPA 505	Aroclor 1254 (PCB-1254)	0.100	0.100	ug/L	25	65-135	25	70-130	20
EPA 505	Aroclor 1260 (PCB-1260)	0.0375	0.200	ug/L	25	65-135	25	70-130	20
EPA 505	PCBs	0.0950	0.500	ug/L	25	65-135	25	70-130	20
EPA 505	Chlordane	0.0715	0.200	ug/L	25	65-135	25	70-130	20
EPA 505	Toxaphene	0.227	1.00	ug/L	25	65-135	25	70-130	20
EPA 505	DCB			Surrogate	-	-	-	-	-
EPA 515.4	Dalapon	0.531	1.00	ug/L	20	70-130	30	70-130	20
EPA 515.4	Dicamba	0.0710	0.200	ug/L	20	70-130	30	70-130	20
EPA 515.4	Dichloroprop	0.260	0.500	ug/L	20	70-130	30	70-130	20
EPA 515.4	2,4-D	0.0330	0.100	ug/L	20	70-130	30	70-130	20
EPA 515.4	Pentachlorophenol	0.00900	0.0400	ug/L	20	70-130	30	70-130	20
EPA 515.4	2,4,5-TP (Silvex)	0.0350	0.200	ug/L	20	70-130	30	70-130	20
EPA 515.4	2,4,5-T	0.0570	0.400	ug/L	20	70-130	30	70-130	20
EPA 515.4	2,4-DB	0.240	1.00	ug/L	20	70-130	30	70-130	20
EPA 515.4	Dinoseb	0.0680	0.200	ug/L	20	70-130	30	70-130	20
EPA 515.4	Dacthal	0.0110	0.0200	ug/L	20	70-130	30	70-130	20
EPA 515.4	Picloram	0.0480	0.100	ug/L	20	70-130	30	70-130	20
EPA 515.4	3,5-Dichlorobenzoic Acid	0.156	0.500	ug/L	20	70-130	30	70-130	20
EPA 515.4	Chloramben	0.0490	0.200	ug/L	20	70-130	30	70-130	20
EPA 515.4	Bentazon	0.105	0.500	ug/L	20	70-130	30	70-130	20
EPA 515.4	Acifluorofen	0.322	1.00	ug/L	20	70-130	30	70-130	20

Analytical Method	Analyte	Method Detection Limit	Method Reporting Limit	Units	Field Dup. (RPD)	Matrix Spike (%Rec)	Matrix Spike Dup. (RPD)	Blank Spike (%Rec)	Blank Spike Dup. (RPD)
EPA 515.4	Total Dacthal	0.0110	0.0200	ug/L	20	70-130	30	70-130	20
EPA 515.4	DCINA			Surrogate	-	-	-	-	-
EPA 525.2	4,4'-DDD	0.0500	0.100	ug/L	30	20-130	30	20-130	25
EPA 525.2	4,4'-DDE	0.0900	0.100	ug/L	30	20-130	30	20-130	25
EPA 525.2	4,4'-DDT	0.0350	0.100	ug/L	30	20-130	30	20-130	25
EPA 525.2	Acenaphthene	0.0300	0.200	ug/L	30	20-130	30	20-130	25
EPA 525.2	Acenaphthylene	0.0240	0.200	ug/L	30	20-130	30	20-130	25
EPA 525.2	Alachlor	0.0550	0.200	ug/L	30	20-130	30	20-130	25
EPA 525.2	Aldrin	0.0280	0.100	ug/L	30	20-130	30	20-130	25
EPA 525.2	alpha-BHC	0.0480	0.200	ug/L	30	20-130	30	20-130	25
EPA 525.2	Anthracene	0.0240	0.200	ug/L	30	20-130	30	20-130	25
EPA 525.2	Atrazine	0.0670	0.100	ug/L	30	20-130	30	20-130	25
EPA 525.2	Benzo[a]anthracene	0.0260	0.200	ug/L	30	20-130	30	20-130	25
EPA 525.2	Benzo[a]pyrene	0.0100	0.0200	ug/L	30	20-130	30	20-130	25
EPA 525.2	Benzo[b]fluoranthene	0.0550	0.200	ug/L	30	20-130	30	20-130	25
EPA 525.2	Benzo[ghi]perylene	0.0530	0.200	ug/L	30	20-130	30	20-130	25
EPA 525.2	Benzo[k]fluoranthene	0.0480	0.200	ug/L	30	20-130	30	20-130	25
EPA 525.2	beta-BHC	0.0420	0.200	ug/L	30	20-130	30	20-130	25
EPA 525.2	bis(2-Ethylhexyl)phthalate	0.127	0.600	ug/L	30	20-150	30	20-150	25
EPA 525.2	bis-2(ethylhexyl)adipate	0.0690	0.600	ug/L	30	20-150	30	20-150	25
EPA 525.2	Bromacil	0.0500	0.100	ug/L	30	20-130	30	20-130	25
EPA 525.2	Butachlor	0.0590	0.100	ug/L	30	20-130	30	20-130	25
EPA 525.2	Butyl benzyl phthalate	0.0630	1.00	ug/L	30	20-150	30	20-150	25
EPA 525.2	Chlorpyrifos	0.0590	0.200	ug/L	30	20-130	30	20-130	25
EPA 525.2	Chrysene	0.0280	0.200	ug/L	30	20-130	30	20-130	25
EPA 525.2	cis-Chlordane	0.100	0.100	ug/L	30	20-130	30	20-130	25
EPA 525.2	Cyanazine	0.100	0.200	ug/L	30	20-130	30	20-130	25
EPA 525.2	delta-BHC	0.0450	0.200	ug/L	30	20-130	30	20-130	25
EPA 525.2	Diazinon	0.0500	0.200	ug/L	30	20-130	30	20-130	25
EPA 525.2	Dibenz[a,h]anthracene	0.0540	0.200	ug/L	30	20-130	30	20-130	25
EPA 525.2	Dieldrin	0.0670	0.100	ug/L	30	20-130	30	20-130	25
EPA 525.2	Diethyl phthalate	0.0550	1.00	ug/L	30	20-150	30	20-150	25
EPA 525.2	Dimethyl phthalate	0.0350	1.00	ug/L	30	20-150	30	20-150	25
EPA 525.2	Di-n-butyl phthalate	0.0470	1.00	ug/L	30	20-150	30	20-150	25
EPA 525.2	Endrin	0.0700	0.200	ug/L	30	20-130	30	20-130	25
EPA 525.2	EPTC	0.0560	0.100	ug/L	30	20-130	30	20-130	25
EPA 525.2	Ethyl parathion	0.100	0.200	ug/L	30	20-130	30	20-130	25
EPA 525.2	Fluoranthene	0.0300	0.200	ug/L	30	20-130	30	20-130	25
EPA 525.2	Fluorene	0.0350	0.200	ug/L	30	20-130	30	20-130	25
EPA 525.2	gamma-BHC (Lindane)	0.0152	0.0400	ug/L	30	20-130	30	20-130	25
EPA 525.2	Heptachlor	0.0350	0.0400	ug/L	30	20-130	30	20-130	25
EPA 525.2	Heptachlor epoxide	0.0200	0.0200	ug/L	30	20-130	30	20-130	25
EPA 525.2	Hexachlorobenzene	0.0370	0.100	ug/L	30	20-130	30	20-130	25

Analytical Method	Analyte	Method Detection Limit	Method Reporting Limit	Units	Field Dup. (RPD)	Matrix Spike (%Rec)	Matrix Spike Dup. (RPD)	Blank Spike (%Rec)	Blank Spike Dup. (RPD)
EPA 525.2	Hexachlorocyclopentadiene	0.0410	0.100	ug/L	30	20-130	30	20-130	25
EPA 525.2	Indeno[1,2,3-cd]pyrene	0.0510	0.200	ug/L	30	20-130	30	20-130	25
EPA 525.2	Malathion	0.0690	0.200	ug/L	30	20-130	30	20-130	25
EPA 525.2	MCPA	0.100	0.200	ug/L	30	20-130	30	20-130	25
EPA 525.2	Methoxychlor	0.0480	0.200	ug/L	30	20-130	30	20-130	25
EPA 525.2	Metolachlor	0.0550	0.100	ug/L	30	20-130	30	20-130	25
EPA 525.2	Metribuzin	0.0570	0.100	ug/L	30	20-130	30	20-130	25
EPA 525.2	Molinate	0.0590	0.100	ug/L	30	20-130	30	20-130	25
EPA 525.2	Naphthalene	0.0840	0.200	ug/L	30	20-130	30	20-130	25
EPA 525.2	Parathion ethyl	0.100	0.200	ug/L	30	20-130	30	20-130	25
EPA 525.2	Pendimethalin	0.0300	0.200	ug/L	30	20-130	30	20-130	25
EPA 525.2	Permethrin	0.0320	0.200	ug/L	30	20-130	30	20-130	25
EPA 525.2	Perylene-d12			Surrogate	-	-	30	-	-
EPA 525.2	Phenanthrene	0.0490	0.200	ug/L	30	20-130	30	20-130	25
EPA 525.2	Prometon	0.0299	0.200	ug/L	30	20-130	30	20-130	25
EPA 525.2	Pronamide	0.100	0.200	ug/L	30	20-130	30	20-130	25
EPA 525.2	Propachlor	0.0540	0.100	ug/L	30	20-130	30	20-130	25
EPA 525.2	Pyrene	0.0430	0.200	ug/L	30	20-130	30	20-130	25
EPA 525.2	Simazine	0.0630	0.0700	ug/L	30	20-130	30	20-130	25
EPA 525.2	Terbacil	0.0790	0.100	ug/L	30	20-130	30	20-130	25
EPA 525.2	trans-Chlordane	0.133	0.200	ug/L	30	20-130	30	20-130	25
EPA 525.2	trans-Nonachlor	0.200	0.200	ug/L	30	20-130	30	20-130	25
EPA 525.2	Triadimefon	0.175	0.200	ug/L	30	20-130	30	20-130	25
EPA 525.2	Trifluralin	0.0490	0.100	ug/L	30	20-130	30	20-130	25
EPA 525.2	Triphenyl phosphate (TPP)			Surrogate	-	-	30	-	-
EPA 525.2	DMNB			Surrogate	-	-	30	-	-
EPA 525.2	Pyrene-d10			Surrogate	-	-	30	-	-
EPA 531.2	3-Hydroxycarbofuran	0.281	2.00	ug/L	20	70-130	25	70-130	20
EPA 531.2	Aldicarb	0.426	0.500	ug/L	20	70-130	25	70-130	20
EPA 531.2	Aldicarb Sulfone	0.416	0.800	ug/L	20	70-130	25	70-130	20
EPA 531.2	Aldicarb Sulfoxide	0.295	0.500	ug/L	20	70-130	25	70-130	20
EPA 531.2	Carbaryl	0.179	2.00	ug/L	20	70-130	25	70-130	20
EPA 531.2	Carbofuran	0.277	0.900	ug/L	20	70-130	25	70-130	20
EPA 531.2	Methiocarb	0.210	1.00	ug/L	20	70-130	25	70-130	20
EPA 531.2	Methomyl	0.276	4.00	ug/L	20	70-130	25	70-130	20
EPA 531.2	Oxamyl	0.361	2.00	ug/L	20	70-130	25	70-130	20
EPA 531.2	Propoxur	0.469	1.00	ug/L	20	70-130	25	70-130	20
EPA 531.2	BDMC			Surrogate	-	-	-	-	-
EPA 533	11Cl-PF3OUdS	1.00	2.00	ng/L	-	70-130	30	50-150	30
EPA 533	9Cl-PF3ONS	1.00	2.00	ng/L	-	70-130	30	50-150	30
EPA 533	ADONA	1.00	2.00	ng/L	-	70-130	30	50-150	30
EPA 533	HFPO-DA	1.00	2.00	ng/L	-	70-130	30	50-150	30

Analytical Method	Analyte	Method Detection Limit	Method Reporting Limit	Units	Field Dup. (RPD)	Matrix Spike (%Rec)	Matrix Spike Dup. (RPD)	Blank Spike (%Rec)	Blank Spike Dup. (RPD)
EPA 533	NFDHA	1.00	2.00	ng/L	-	70-130	30	50-150	30
EPA 533	PFBA	1.00	2.00	ng/L	-	70-130	30	50-150	30
EPA 533	PFBS	1.00	2.00	ng/L	-	70-130	30	50-150	30
EPA 533	8:2FTS	1.00	2.00	ng/L	-	70-130	30	50-150	30
EPA 533	PFDA	1.00	2.00	ng/L	-	70-130	30	50-150	30
EPA 533	PFDoA	1.00	2.00	ng/L	-	70-130	30	50-150	30
EPA 533	PFEESA	1.00	2.00	ng/L	-	70-130	30	50-150	30
EPA 533	PFHpS	1.00	2.00	ng/L	-	70-130	30	50-150	30
EPA 533	PFHpA	1.00	2.00	ng/L	-	70-130	30	50-150	30
EPA 533	4:2FTS	1.00	2.00	ng/L	-	70-130	30	50-150	30
EPA 533	PFHxS	1.00	2.00	ng/L	-	70-130	30	50-150	30
EPA 533	PFHxA	1.00	2.00	ng/L	-	70-130	30	50-150	30
EPA 533	PFMPA	1.00	2.00	ng/L	-	70-130	30	50-150	30
EPA 533	PFMBA	1.00	2.00	ng/L	-	70-130	30	50-150	30
EPA 533	PFNA	1.00	2.00	ng/L	-	70-130	30	50-150	30
EPA 533	6:2FTS	1.00	2.00	ng/L	-	70-130	30	50-150	30
EPA 533	PFOS	1.00	2.00	ng/L	-	70-130	30	50-150	30
EPA 533	PFOA	1.00	2.00	ng/L	-	70-130	30	50-150	30
EPA 533	PFPeA	1.00	2.00	ng/L	-	70-130	30	50-150	30
EPA 533	PFPeS	1.00	2.00	ng/L	-	70-130	30	50-150	30
EPA 533	PFUnA	1.00	2.00	ng/L	-	70-130	30	50-150	30
EPA 533	13C4-PFBA IDA			Surrogate	-	-	-	-	-
EPA 533	13C5-PFPeA IDA			Surrogate	-	-	-	-	-
EPA 533	13C3-PFBS IDA			Surrogate	-	-	-	-	-
EPA 533	13C2-4:2FTS IDA			Surrogate	-	-	-	-	-
EPA 533	13C5-PFHxA IDA			Surrogate	-	-	-	-	-
EPA 533	13C3-HFPO-DA IDA			Surrogate	-	-	-	-	-
EPA 533	13C4-PFHpA IDA			Surrogate	-	-	-	-	-
EPA 533	13C3-PFHxS IDA			Surrogate	-	-	-	-	-
EPA 533	13C2-6:2FTS IDA			Surrogate	-	-	-	-	-
EPA 533	13C8-PFOA IDA			Surrogate	-	-	-	-	-
EPA 533	13C9-PFNA IDA			Surrogate	-	-	-	-	-
EPA 533	13C8-PFOS IDA			Surrogate	-	-	-	-	-
EPA 533	13C2-8:2FTS IDA			Surrogate	-	-	-	-	-
EPA 533	13C4-PFOS IS			Surrogate	-	-	-	-	-
EPA 533	13C6-PFDA IDA			Surrogate	-	-	-	-	-
EPA 533	13C3-PFBA IS			Surrogate	-	-	-	-	-
EPA 533	13C7-PFUnA IDA			Surrogate	-	-	-	-	-
EPA 533	13C2-PFDoA IDA			Surrogate	-	-	-	-	-
EPA 533	13C2-PFOA IS			Surrogate	-	-	-	-	-
EPA 547	Glyphosate	3.55	5.00	ug/L	20	70-130	20	70-130	20
EPA 548.1	Endothall	1.39	9.00	ug/L	20	65-105	20	70-110	20
EPA 548.1	2,4-DCPA			Surrogate	-	-	-	-	-

Analytical Method	Analyte	Method Detection Limit	Method Reporting Limit	Units	Field Dup. (RPD)	Matrix Spike (%Rec)	Matrix Spike Dup. (RPD)	Blank Spike (%Rec)	Blank Spike Dup. (RPD)
EPA 549.2	Diquat	0.208	0.400	ug/L	20	70-130	25	70-130	20
Volatiles in Drinking Water									
EPA 524.2	Dichlorodifluoromethane	0.270	0.500	ug/L	-	-	-	-	-
EPA 524.2	Chloromethane	0.300	0.500	ug/L	-	-	-	-	-
EPA 524.2	Vinyl Chloride	0.270	0.500	ug/L	-	-	-	-	-
EPA 524.2	Bromomethane	0.410	0.500	ug/L	-	-	-	-	-
EPA 524.2	Chloroethane	0.250	0.500	ug/L	-	-	-	-	-
EPA 524.2	1,1-Dichloroethene	0.120	0.500	ug/L	-	70-130	20	70-130	-
EPA 524.2	Carbon disulfide	0.110	0.500	ug/L	-	-	-	-	-
EPA 524.2	Acrolein	0.220	0.500	ug/L	-	-	-	-	-
EPA 524.2	Methylene chloride	0.320	0.500	ug/L	-	-	-	-	-
EPA 524.2	methyl-t-butyl ether (MTBE)	0.220	0.500	ug/L	-	-	-	-	-
EPA 524.2	Acrylonitrile	0.190	0.500	ug/L	-	-	-	-	-
EPA 524.2	trans-1,2-Dichloroethene	0.130	0.500	ug/L	-	-	-	-	-
EPA 524.2	1,1-Dichloroethane	0.120	0.500	ug/L	-	-	-	-	-
EPA 524.2	2,2-Dichloropropane	0.190	0.500	ug/L	-	-	-	-	-
EPA 524.2	cis-1,2-dichloroethene	0.0900	0.500	ug/L	-	-	-	-	-
EPA 524.2	Bromochloromethane	0.0800	0.500	ug/L	-	-	-	-	-
EPA 524.2	1,2-Dichlorobenzene	0.0700	0.500	ug/L	-	-	-	-	-
EPA 524.2	Chloroform	0.0700	0.500	ug/L	-	-	-	-	-
EPA 524.2	1,1,1-Trichloroethane	0.180	0.500	ug/L	-	-	-	-	-
EPA 524.2	1,1-dichloropropene	0.140	0.500	ug/L	-	-	-	-	-
EPA 524.2	Carbon Tetrachloride	0.190	0.500	ug/L	-	-	-	-	-
EPA 524.2	Benzene	0.0900	0.500	ug/L	-	70-130	20	70-130	-
EPA 524.2	1,2-Dichloroethane	0.0900	0.500	ug/L	-	-	-	70-130	-
EPA 524.2	Trichloroethene	0.130	0.500	ug/L	-	70-130	20	70-130	-
EPA 524.2	1,2-Dichloropropane	0.100	0.500	ug/L	-	-	-	-	-
EPA 524.2	Dibromomethane	0.130	0.500	ug/L	-	-	-	-	-
EPA 524.2	Bromodichloromethane	0.0800	0.500	ug/L	-	-	-	-	-
EPA 524.2	cis-1,3-Dichloropropene	0.120	0.500	ug/L	-	-	-	-	-
EPA 524.2	Toluene	0.0800	0.500	ug/L	-	70-130	20	70-130	-
EPA 524.2	trans-1,3-Dichloropropene	0.210	0.500	ug/L	-	-	-	-	-
EPA 524.2	1,1,2-Trichloroethane	0.0700	0.500	ug/L	-	-	-	-	-
EPA 524.2	Tetrachloroethene	0.220	0.500	ug/L	-	70-130	20	70-130	-
EPA 524.2	1,3-Dichloropropane	0.0800	0.500	ug/L	-	-	-	-	-
EPA 524.2	Dibromochloromethane	0.100	0.500	ug/L	-	-	-	-	-
EPA 524.2	EDB (Screening)		0.500	ug/L	-	-	-	-	-
EPA 524.2	Chlorobenzene	0.100	0.500	ug/L	-	70-130	20	70-130	-
EPA 524.2	1,1,1,2-Tetrachloroethane	0.0900	0.500	ug/L	-	-	-	-	-
EPA 524.2	Ethylbenzene	0.100	0.500	ug/L	-	70-130	20	70-130	-
EPA 524.2	m+p-Xylene	0.180	0.500	ug/L	-	-	-	-	-

Analytical Method	Analyte	Method Detection Limit	Method Reporting Limit	Units	Field Dup. (RPD)	Matrix Spike (%Rec)	Matrix Spike Dup. (RPD)	Blank Spike (%Rec)	Blank Spike Dup. (RPD)
EPA 524.2	o-Xylene	0.0800	0.500	ug/L	-	70-130	20	70-130	-
EPA 524.2	Total Xylene	0.100	0.500	ug/L	-	-	-	-	-
EPA 524.2	Styrene	0.100	0.500	ug/L	-	-	-	-	-
EPA 524.2	Isopropylbenzene	0.100	0.500	ug/L	-	-	-	-	-
EPA 524.2	trans-1-4-Dichloro-2-butene	0.490	0.500	ug/L	-	-	-	-	-
EPA 524.2	Bromobenzene	0.100	0.500	ug/L	-	-	-	-	-
EPA 524.2	1,2,3-Trichloropropane	0.0700	0.500	ug/L	-	-	-	-	-
EPA 524.2	n-Propylbenzene	0.120	0.500	ug/L	-	-	-	-	-
EPA 524.2	2-Chlorotoluene	0.110	0.500	ug/L	-	-	-	-	-
EPA 524.2	4-Chlorotoluene	0.0800	0.500	ug/L	-	-	-	-	-
EPA 524.2	1,3,5-Trimethylbenzene	0.0900	0.500	ug/L	-	-	-	-	-
EPA 524.2	tert-Butylbenzene	0.150	0.500	ug/L	-	-	-	-	-
EPA 524.2	1,2,4-Trimethylbenzene	0.100	0.500	ug/L	-	-	-	-	-
EPA 524.2	sec-Butylbenzene	0.140	0.500	ug/L	-	-	-	-	-
EPA 524.2	p-isopropyltoluene	0.140	0.500	ug/L	-	-	-	-	-
EPA 524.2	1,3-Dichlorobenzene	0.0700	0.500	ug/L	-	-	-	-	-
EPA 524.2	Bromoform	0.130	0.500	ug/L	-	-	-	-	-
EPA 524.2	1,1,2,2-Tetrachloroethane	0.0900	0.500	ug/L	-	-	-	-	-
EPA 524.2	1,4-Dichlorobenzene	0.120	0.500	ug/L	-	-	-	-	-
EPA 524.2	Methyl ethyl ketone (MEK)	0.700	2.50	ug/L	-	-	-	-	-
EPA 524.2	n-Butylbenzene	0.160	0.500	ug/L	-	-	-	-	-
EPA 524.2	1,2-Dibromo-3-chloropropane (DBCP)	0.130	0.500	ug/L	-	-	-	-	-
EPA 524.2	1,2,4-Trichlorobenzene	0.0700	0.500	ug/L	-	-	-	-	-
EPA 524.2	Hexachlorobutadiene	0.170	0.500	ug/L	-	-	-	-	-
EPA 524.2	Naphthalene	0.130	0.500	ug/L	-	-	-	-	-
EPA 524.2	Trichlorofluoromethane	0.130	0.500	ug/L	-	-	-	-	-
EPA 524.2	1,2,3-Trichlorobenzene	0.110	0.500	ug/L	-	-	-	-	-
EPA 524.2	Toluene-d8	0.100	0.500	Surrogate	-	-	-	-	-
EPA 524.2	4-Bromofluorobenzene	0.100	0.500	Surrogate	-	-	-	-	-
EPA 524.2	1,2-Dichlorobenzene-d4	0.100	0.500	Surrogate	-	-	-	-	-
Bacteriological									
SM 9223B	E. coli	1 cfu/100mL	--	cfu	--	--	--	--	--
SM9222D	Fecal Coliform	1 cfu/100mL	--	cfu	--	--	--	--	--
SM9215B	Heterotrophic Plate Count	1 cfu/100mL	--	cfu	--	--	--	--	--
SM 9223B	Total Coliform	1 cfu/100mL	--	cfu	--	--	--	--	--

Dup. = Duplicate Sample, RPD = relative percent difference, LCS = laboratory control sample, %Rec = percent recovered, Surr. = Surrogate.

Groundwater Level Monitoring

The MQOs for the groundwater level monitoring of both the Dingmon Well and two observation wells are as follows:

- Obtain horizontal well locations within 2-meter (6.5 feet) accuracy.
- Obtain the elevation (if not already obtained) of the wellhead or water level reference point relative to ground surface.
- Obtain ground surface elevations within a 3-foot accuracy (using GPS measurements, with elevations cross-referenced with a 10-meter digital elevation model available from the Department of Natural Resources).
- Obtain ground water level measurements within a 0.1-foot accuracy.
- Continuous measurement of groundwater levels is conducted using a datalogging pressure transducer. Measurement of barometric pressure is necessary to correct measured water level data for the effects of changes in atmospheric pressure. Calibration and maintenance of pressure transducers are provided by the manufacturer and must be reviewed ahead of instrument deployment. Table 4 provides accuracy and resolution for Van Essen Baro- and TD-Divers that will be used in this Study.
- Record discharge rate measurements using an appropriate flowmeter with a calibrated range appropriate to the pumping rate (Table 4), which is anticipated to range from 50 to 500 gpm based on past testing of the Dingmon Well (Aspect, 2008).

A description of the water level monitoring techniques that will be used to obtain the MQOs for the water level measurements and well locations is provided in the *Field Procedures* section (Section 8.2). Water level monitoring during well and aquifer testing (discharge and recovery testing) will be conducted per Ecology's *Aquifer Test Procedures* (Ecology, 2023b).

Water Quality Analyses

The MQOs for the water quality analyses are summarized above in Table 5. Water quality sampling will be performed using industry-standard procedures, Section 8.2, to minimize bias and maximize precision. All sampling equipment will be decontaminated before and after completion of sampling activities.

Anatek Labs, Inc. (Anatek) is accredited by Ecology for all analytical procedures performed for this project and by the National Environmental Laboratory Accreditation Program (NELAP) for a comprehensive analytical laboratory accreditation. The laboratory is responsible for ensuring that all procedures performed comply with all requirements specified in the accreditation programs, laboratory quality assurance (QA) manuals, individual analytical methods, and this QAPP. Copies of the lab accreditation for Anatek are included as Appendix A.

6.2.1 Targets for Precision, Bias, and Sensitivity

Table 5 outlines expected precision of sample duplicates and method reporting limits. Pumping test procedures are provided in the referenced SOPs and anticipated pumping rates, etc., are provided in Section 8.2.5. The reporting limits of the methods listed in the table are appropriate for the expected range of results and the required level of sensitivity to meet project objectives.

The quality and usability of data collected will be determined, based on the outcomes of data verification and validation, and expressed as measurement quality objectives (MQOs): precision, accuracy (bias), representativeness, comparability, completeness, and sensitivity. The MQOs routinely obtained by the laboratory for the analytical procedures performed for this project are considered adequate. The definitions of the MQOs are presented as follows:

6.2.1.1 Precision

Precision is defined as the degree of agreement between or among independent, similar, or repeated measurements. Precision is a measure of variability in the results of replicate measurements due to random error. Precision is usually assessed by analyzing duplicate field measurements and random error is imparted by the variation in field procedures. Therefore, field sampling precision is addressed by collection of replicate measurements.

For manual water level measurements, the electric tape will be slowly raised and lowered in and out of the water column to ensure consistent reading. Measurements to the nearest 0.01-foot will be recorded and repeated to ensure reproducibility. Repeat measurements should be within the following accuracy standard depending on the depth of application (Ecology, 2023b):

- ±0.02 feet for electric-tape measurements <250 feet deep,
- ±0.04 feet for electric-tape measurements between 250-500 feet deep, or
- ±0.1 feet for electric-tape measurements >500 feet deep.

Replicate measurements of the discharge rate and read from the flowmeter while pumping will be recorded on field log during aquifer testing.

Precision is also expressed in terms of analytical variability. For this investigation, analytical variability will be measured as the relative percent difference (RPD) or coefficient of variation between analytical laboratory duplicates and between the matrix spike (MS) and matrix spike duplicate (MSD) analyses. Precision will be calculated as the RPD as follows:

$$RPD\ (\%) = 100 \times \frac{|S - D|}{(S + D)/2}$$

where:

S = analyte concentration in a sample

D = analyte concentration in a duplicate sample

The resultant RPD will be compared with criteria established by this QAPP in Table 5, and deviations from these criteria will be reported. If the QAPP criteria are not met, the laboratory will supply a justification of why the limits were exceeded and implement the appropriate corrective actions. The RPD will be evaluated during data review and validation. The data reviewer will note deviations from the specified limits and will comment on the effect of the deviations on the reported data.

6.2.1.2 Bias

Bias is the difference between the sample mean and the true value. It will be measured as the percent recoveries of MS and MSD, organic surrogate compounds, and the blank spike. Additional potential bias will be assessed using calibration standards and blank samples (e.g., method blanks). In cases where accuracy is determined from spiked samples, accuracy will be expressed as the percent recovery. The closer these values are to 100 percent, the more accurate the data. Surrogate recovery will be calculated as follows:

$$\text{Recovery (\%)} = \frac{MC}{SC} \times 100$$

Where:

SC = spiked concentration

MC = measured concentration

MS percent recovery will be calculated as follows:

$$\text{Recovery (\%)} = \frac{MC - USC}{SC} \times 100$$

where:

SC = spiked concentration

MC = measured concentration

USC = unspiked sample concentration

MSD percent recovery will be calculated as follows:

$$\text{Recovery (\%)} = \frac{MDC - USC}{SC} \times 100$$

where:

SC = spiked concentration

MDC = measured duplicate spike concentration

USC = unspiked sample concentration

and

$$\text{RPD}\ (\%) = \frac{MC - MDC}{(MC+MDC)/2} \times 100,$$

where:

RPD = relative percent difference.

The resultant percentage recoveries will be compared with criteria established by this QAPP in Table 5, and deviations from these criteria will be reported (and in laboratory limits for RPD reported by the lab in individual reports). If the objective criteria are not met, the laboratory will supply a justification of why the limits were exceeded and implement the appropriate corrective actions. Percent recoveries will be evaluated during data review and validation, and the data reviewer will comment on the effect of the deviation on the reported data.

6.2.1.3 Sensitivity

Sensitivity will be determined by reviewing Method Reporting Limits (MRLs). MRLs will be set low enough to allow meaningful comparisons with screening criteria to the extent possible, considering matrix effects. The laboratory will be directed to report compounds detected above the Method Detection Limit (MDL) and positively identified below the MRL as estimated (J flag).

6.2.2 Targets for Comparability, Representativeness, and Completeness

6.2.2.1 Comparability

Comparability is the degree to which the data can be compared to historical data, reference values (such as background), and reference materials. This will be achieved through the use of standard techniques to collect samples, EPA-approved methods to analyze samples, and consistent units to report analytical results. Ecology standard operating procedures will be followed for the data collection supporting the aquifer test. The standard operating procedures that will be followed for this project are listed in Section 8.2. Data comparability also depends on data quality. Data of unknown quality cannot be compared.

6.2.2.2 Representativeness

Representativeness is the degree to which sample results represent the system under study. This component is generally considered during the design phase of a program. This program will use the results of all analyses to evaluate the data in terms of its intended use.

Representativeness of the sample will be ensured during the collection process by: (1) employing proper decontamination procedures and (2) thorough purging of the well and ensuring stability of field parameters prior to collecting groundwater samples (Section 6.3). The representativeness of analytical results will be determined by evaluating hold times, sample preservation, and blank contamination. Samples with expired hold times, improper preservation, or contamination may not be representative.

6.2.2.3 Completeness

Completeness will be calculated as follows:

$$Completeness\ (\%) = \frac{V}{P} \times 100$$

where:

V = number of valid measurements

P = number of planned measurements

Valid and invalid data (i.e., data qualified with the R flag [rejected]) will be identified during data validation. The completeness target for the study is 100 percent of water quality samples.

6.3 Acceptance Criteria for Quality of Existing Data

Existing data was collected at the Dingmon Well and Simcoe Springs by Aspect Consulting, LLC during the 2008 Feasibility Study period. All water quality samples collected for analysis and methods of aquifer testing followed approved standards and procedures. Water quality analyses were conducted at accredited laboratory facilities.

6.4 Model Quality Objectives

Not applicable.

7.0 Study Design

A narrative of the overall study design is provided in Section 4. This section provides the details of the data collection and analysis.

7.1 Study Boundaries

The study area is shown on Figure 1. The Dingmon Well and the potential proposed observation wells to be monitored during aquifer testing are shown in Figure 6.

Figure 6. Map showing Dingmon Well and Observation Wells

7.2 Field Data Collection

7.2.1 Sampling Locations and Frequency

Water Quality Sampling

This study includes the collection of up to four water quality samples. One water quality sample will be collected from the Dingmon Well and analyzed for the comprehensive suite of parameters needed to support a future Source Approval request to DOH (see full list of analyte suites in Table 1), characterization of background groundwater quality, evaluation of past geochemical modeling assumptions, and future considerations for compliance with AKART implementation, if necessary. Additional water quality samples will be collected from the Dingmon Well during the aquifer test and analyzed for general chemistry to assess variability in groundwater quality during pumping. Samples will be collected near the beginning, middle, and end of the 10-day contrast-rate pumping test. One water quality sample will also be collected from the City's distribution system to reflect the Simcoe Springs source and analyzed for general chemistry (to confirm water quality inputs to previous geochemical modeling) and DBPs (to assess considerations for future AKART considerations, if necessary).

Table 6. Proposed Water Quality Sampling Schedule

Analyte/Suite Anticipated Sampling Schedule	**Dingmon Well**			**Distribution System (Simcoe Springs)**
	Start of Aquifer Test	**Middle of Aquifer Test**	**End of Aquifer Test**	**Fall, 2024**
Field Parameters	X	X	X	X
General Chemistry	X	X	X	X
VOCs & SOCs			X	
DBPs			X	X
Microorganisms			X	
Radionuclides			X	

Water Level Measurements

Groundwater depth-to-water measurements will be collected at the Dingmon Well and at a minimum of one observation well during the aquifer testing program. Dataloggers will be installed and maintained a minimum of one month prior to aquifer testing to collect background water level trends and will remain in the wells for at least two weeks after test completion. Additional details on groundwater monitoring are provide in Section 8.2.2.

The 2008 ASR Feasibility Study identified the greatest potential for impacts associated with the ASR program is to water levels in neighboring wells. Therefore, monitoring of water levels in neighboring wells during the aquifer testing program provides for quantification of these potential impacts. Observation wells will also allow for the estimation of hydraulic parameters at various locations within the aquifer, determination of aquifer boundary conditions, and will provide an understanding of the aquifer's interconnection between stratigraphic units.

Six nearby domestic water wells were identified as potential observation wells; four of these wells served as observation wells in a 2006 pumping test conducted at the Dingmon Well. No new nearby wells were identified in Ecology's Washington State Well Report Viewer. Observation wells were identified based on several factors, including well construction and completion depth, interpreted stratigraphy, distance from the pumping well, and proximity to mapped geologic structures (faults, folds, etc.,); selection of the candidate wells based on these criteria and is summarized below in order of preferred selection to best characterize the system. Well logs are included in Appendix B. Final selection of observation wells will depend largely on site and wellhead access. A one-day recon is planned to further evaluate suitability for observation well selection.

- The Grant Gibbs well (T04N/R16E-28B) is located about 0.35 miles west of the Dingmon well in an open field adjacent to Highway 97. The well is completed to a depth of 115 ft with an open hole from 38 to 115 ft below ground surface. The well taps both the Simcoe Mountain Volcanics and the Frenchman Springs Member of the Wanapum Basalt. This relatively shallow well is expected to provide good insight on the vertical confinement of the aquifer tapped by the Dingmon Well and evaluate the magnitude of water level changes experienced by typical users of shallow, domestic wells.
- The Goldendale School District well (T04N/R16E-21L) is located adjacent to the High School softball field. The well is completed to a depth of 360 ft with an open hole from 20 to 360 ft below ground surface. The well taps the Roza and Frenchman Springs Members of the Wanapum Basalt. The well is located about 0.75 miles northwest of the Dingmon Well. Drawdown in the Goldendale School District well was observed during the 24-hour pumping test of the Dingmon Well completed in 2006. Observing water levels in this well during an extended test is expected to provide additional insight on aquifer hydraulics and/or boundary conditions distal to the Dingmon Well.
- The Riley well (T04N/R16E-22P), is located directly east of the Dingmon well. No water well report was available for the Riley well but the owner, Jim Riley has indicated that the well was constructed to a depth of approximately 355 ft below ground surface. Based on geologic mapping, the well is likely completed in the Roza and Frenchman Springs Members of the Wanapum Basalt Formation. The well is located near the Goldendale fault/anticline – approximately 3,000 feet east of the Dingmon Well. Observations of water levels in the Riley well during testing may be used to assess

hydraulic impacts from boundary conditions associated with the Goldendale fault/anticline.

- The Hoctor well (T03N/R16E-4F) is located greater than 1 mile south of the Dingmon well in an open field adjacent to Hoctor Road. The well is completed to a depth of 512 ft and is an open well between 48 to 512 ft below ground surface. The well is interpreted to penetrate both the Simcoe Mountain Volcanics and the Frenchman Springs Member of the Wanapum Basalt. The well likely taps a water-bearing zone at a similar elevation to the target aquifer zone within the Frenchman Springs member and would be used to evaluate the magnitude of water level changes at a greater distance from the Dingmon Well.
- The Hoctor Family well (T04N/R16E-28) is located immediately south of the Dingmon Well. No water well report was available, but the well is understood to be competed to a depth of around 600 ft below ground surface. Based on interpretations of geologic mapping, the well is likely completed within the Simcoe Mountains Basalt and Wanapum Basalt Formations. This well may provide good insight on the vertical confinement of the aquifer tapped by the Dingmon Well.
- The Charles Hoctor well (T04N/R16E-28B02) is located approximately 0.35 miles west of the Dingmon Well, near the Grant Gibbs Well. The well is completed to a depth of 318 ft below ground surface, tapping both the Simcoe Mountains Basalt and the Frenchman Springs Member of the Wanapum Basalt. Based on interpretations of geologic mapping, the Charles Hoctor well likely taps the same water-bearing zone within the Frenchman Springs Member as the Dingmon Well.

7.2.2 Field Parameters and Laboratory Analytes to be Measured

Field parameters will be measured using a AquaTroll 500 multimeter, as described in Section 8.2, to provide independent corroboration of laboratory results, and to analyze constituents that have short hold times and can be reliably measured in the field. These include:

- Electrical conductivity
- Dissolved Oxygen
- ORP
- pH
- Temperature
- Turbidity

Manual measurements of the above constituents during sampling events will be collected until values are stable, as described in Section 8.2.

One iron-reducing bacteria sample will also be collected as part of the microorganism sampling at the end of the aquifer test (Table 6). The sample will be collected in the field using a Biological Activity Reaction Test (BART) kit by Canon Water Technology or equivalent and allowed to incubate in a room temperature location for the time specified in the testing kit. Bacterial growth will be monitored in accordance with the test kit instructions and reported in the project report.

At the end of the aquifer test (concurrent with the sampling for BART), one sample will also be collected and analyzed for heterotrophic plate count. This sample results will be evaluated alongside the BART results to further characterize biologic activity in the well screen vicinity. Heterotrophic plate count will be analyzed by Anatek Labs, Inc.

Groundwater depth-to-water measurements will be conducted using an electronic water level indicator in accordance with EAP052 standard operating procedures (Ecology, 2023b). A dedicated pressure transducer will be installed in the Dingmon Well and two observation wells to collect continuous groundwater level measurements.

Laboratory analytes to be measured throughout the Study are listed above in Table 6.

7.3 Modeling and Analysis Design

No modeling will be completed as part of this project. Aquifer and well performance will be estimated using conventional analytical methods for confined aquifers as follows:

- Aquifer transmissivity and storativity will be determined using conventional analytical methods for time-drawdown and distance-drawdown data collected at each of the wells during the pumping test (e.g., Theis curve fitting or Cooper-Jacob methods).
- Well efficiency testing will be conducted using analytical methods for step-rate pumping (e.g., the Hantush-Bierschenk method).

The published underlying assumptions for the analytical methods used will be verified as being met prior to selecting a specific analytical method.

7.4 Assumptions of Study Design

This Study assumes that existing water quality and groundwater level data are of sufficient quality to compare with data collected under this QAPP and sufficient budget to complete tasks. There are also several assumptions around designing a pumping test and analyzing the collected results. These assumptions include:

- The equipment used in the pumping test (flow meters, water level data loggers, water level indicators, etc.,) can give accurate readings when they are installed, used, and calibrated properly.
- Discharge from the pump will not recharge the aquifer.
- A constant yield is maintained during the entirety of the pumping test.

- A determination on how the changes in barometric pressures affect the drawdown data is made.
- Appropriate selection of solution used to analyze aquifer test data. Analytical solutions have several built-in assumptions that are incorporated into this study, including:
    - The aquifer has infinite areal extent;
    - The aquifer is homogeneous, isotropic and of uniform thickness;
    - Flow to the pumping well is horizontal;
    - The aquifer is nonleaky, confined;
    - Flow is unsteady;
    - Water is released instantaneously from storage with decline in hydraulic head;
    - Diameter of the pumping well is very small so that storage in the well can be neglected.
- Proper selection of observation wells:
    - The observation wellhead is accessible for water level collection.
    - The observation well is completed within a unit that is hydraulically connected with the Frenchman Springs Member or completed in a unit that is isolated from the Frenchman Springs Member.
    - The observation well is located so that they exhibit sufficient drawdown to produce usable data.

7.5 Possible Challenges and Contingencies

7.5.1 Logistical Problems

Logistical problems that interfere with measurement collection may occur during fieldwork. These problems include:

1. Inability to access groundwater measurement locations (observation wells);
2. Inability to install pressure transducers in observation wells;
3. The existing pump in the Dingmon Well or other well appurtenances are inoperable, and the project is delayed due to additional effort being required.
4. Water quality samples meeting hold times and temperature criteria when shipping samples to laboratory for analysis.

7.5.2 Practical Constraints

Practical constraints that can interfere with a project include scheduling problems with personnel, equipment failure, or availability of adequate resources. Funding opportunities are typically the greatest limitation to collection of baseline data.

7.5.3 Schedule Limitations

No schedule limitations have been currently identified, but could potentially arise from sources, such as unforeseen circumstances.

8.0 Field Procedures

8.1 Invasive Species Evaluation

Field staff will follow Ecology's SOP EAP070 (publicly available in digital format on Ecology's website), minimizing the spread of invasive species (Ecology, 2023c). At the end of each field visit, field staff will clean field gear in accordance with the SOP for minimizing the spread of invasive species for areas of both moderate and extreme concern.

Field staff will minimize the spread of invasive species after conducting field work by:

- Inspecting and cleaning all equipment by removing any visible soil, vegetation, vertebrates, invertebrates, plants, algae, or sediment. If necessary, a scrub brush will be used and then rinsed with clear water either from the site or brought for that purpose. The process will be continued until all equipment is clean.
- Draining all water in samplers or other equipment that may harbor water from the site. This step will take place before leaving the sampling site or at an interim site. If cleaning after leaving the sampling site, field staff will ensure that no debris will leave the equipment and potentially spread invasive species during transit or cleaning.

Established Ecology procedures will be followed if an unexpected contamination incident occurs.

8.2 Measurement and Sampling Procedures

The procedures used in this study are typical for any hydrogeologic investigations. SOPs to be followed are publicly available in digital format online and include the following:

- Ecology's Aquifer Test Procedures (Ecology, 2023a),
- Standard Operating Procedure EAP052, Version 1.4 – Manual Well-Depth and Depth-to-Water Measurements (Ecology, 2023b),
- Standard Operating Procedure EAP070, Version 2.3 – Minimize the Spread of Invasive Species (Ecology, 2023c),
- Standard Operating Procedure EAP099, Version 1.2 – Collecting Groundwater Samples: Purging and Sampling Monitoring Wells for General Chemistry Parameters (Ecology, 2023d),
- Standard Operating Procedure EAP074, Version 1.2 – Use of Submersible Pressure Transducers During Groundwater Studies (Ecology, 2019a),
- Standard Operating Procedure EAP098, Version 1.1 – Collecting Groundwater Samples for Metals Analysis from Water Supply Wells (Ecology, 2019b)
- Washington State Department of Health General Sampling Procedure (DOH, 2023).

8.2.1 Well Location Survey

The horizontal location of the Dingmon Well and selected observation wells will be determined using a Trimble GPS. Care will be taken to collect a GPS location within a horizontal accuracy of better than 6.5 feet, as discussed in the *Quality Objectives* section (Section 6). The ground surface elevation will also be determined based on the Trimble GPS and shall have a vertical accuracy of equal to, or better than, 3 feet.

8.2.2 Groundwater Sampling

Groundwater quality samples from Dingmon Well will be collected in general accordance with Ecology (2023d); Ecology (2019b); and DOH (2023) standard procedures when using existing turbine pumps. Groundwater samples will be collected from the existing sample port during operation of the existing pump. The well will be purged for a minimum of 10 minutes (or three well volumes) prior to the collection of any groundwater samples or until the water quality parameters stabilize, whichever is longer (note that SOP EAP098 does not include this provision for a minimum purge volume).

Field water quality parameters (temperature, pH, specific conductivity, dissolved oxygen, ORP, and turbidity) will be monitored using a closed flow through cell during sample collection. Water quality parameters will be considered stable when three successive measurements indicate that the parameters fall within the stabilization criteria established in Standard Operating Procedure EAP098 Collecting Groundwater Samples for Metals Analysis from Water Supply Wells. (Ecology, 2019b) and shown in Table 7 below. Once the water quality parameters have stabilized, the groundwater quality samples shall be collected from the respective sampling port.

Table 7. Field Parameter Stabilization Criteria

Parameter	Value	Units
pH	±0.1	SU
Specific Conductance	±10.0	uS/cm
Dissolved Oxygen	± 0.05 for values < 1 mg/L ± 0.2 for values > 1 mg/L	mg/L
Temperature	±0.1	Celsius
ORP	±10	millivolts

8.2.3 Distribution System Sampling

A sample will be collected from the City's distribution system at an existing sample tap used for distribution system monitoring near the Dingmon Well. Prior to sampling, City staff will confirm that Simcoe Springs has been supplying the distribution system for a minimum of two weeks. The sample will be collected after purging for at least 10 minutes and recording field parameters in accordance with Table 7.

Data Validation Samples

Field quality control (QC) is accomplished through the analysis of controlled data validation (DV) samples that are introduced to the laboratory from the field. Field duplicates and trip blanks will be collected and submitted to the investigation laboratory to provide a means of assessing the quality of data resulting from the field sampling program.

Trip Blank

Trip blank samples will be used to monitor any possible cross-contamination that occurs during the transport of VOCs and samples. Trip blank samples are prepared by the laboratory using organic-free reagent-grade water into a VOA vial prior to the collection of field samples. Two vials per trip blank sample are placed with and accompany the VOCs samples through the entire transport process. Trip blank samples will be prepared and analyzed only for VOCs.

Field Duplicates

Field duplicate samples are used to check for sampling and analysis reproducibility. Field duplicate samples will be collected at a frequency of 10 percent of the field samples for every matrix and analytical method.

A set of DV samples will be collected for at least every 10 water samples collected. The DV sample set will include the following (see Section 6 for calculation of DV parameters and acceptance criteria, and Section 9 for description of lab procedures):

- A MS/MSD
- A “blind” field duplicate (i.e., not indicated to the lab as a field duplicate)
- Trip blanks (for VOCs, bacteria, and inorganic constituent suites)

Except for the trip blank, the chemical analysis of DV samples will include the entire list of chemical analytes (Section 5). The trip blank will include only analysis of VOCs. The blind field duplicate will be labeled in a manner that does not indicate its true sample location, and the MS/MSD will be labeled, as such, for laboratory processing.

8.2.3 Groundwater Level Monitoring

Groundwater levels will be measured at the Dingmon Well and at two selected observation wells with an electronic water level indicator. Automated water level data will also be obtained from pressure transducers installed in each well.

Water levels will be collected using an electrical water level meter with engineer’s scale accurate to a hundredth of a food (0.01 feet). A permanent measuring point (MP) will be made from which all depth-to-water measurements are taken at each well to ensure data comparability. An MP will be established, or the existing MP will be used if already established.

Establish a permanent measuring point (MP) via the method below:

1. MPs are normally established on the top rim of the actual well casing; this position is commonly referred to as “top of casing” (TOC). Locate the MP at a convenient place from which to measure the water level. If the TOC is level, collect the measurement from the north edge.
2. Clearly mark the MP. The MP must be as permanent as possible and be clearly visible and easily located. The MP may be marked using a permanent black marker, bright colored paint stick, or with a notch filed into the TOC.
3. Describe the position of the MP clearly in the field-data sheets.
4. The MP height is established in reference to a land surface datum (LSD). The LSD is generally chosen to be approximately equivalent to the average altitude of ground surface around the well.
5. Measure the height of the MP in fee relative to the LSD. Generally, MPs are established to the nearest 0.1 feet using a pocket tape to measure the distance from the MP to the LSD. Note that values for measuring points that lie below land surface should be preceded by a minus sign (-). Record the height of the MP and the date it was established.
6. MPs and the LSD may change over time, the distance between the two should be checked whenever there have been activities, such as land development that could have affected either the MP or LSD at the site. Such changes must be measured as accurately as possible, documented and dated in field-data sheets, and in any database(s) into which the water-level data are entered.

All subsequent water level measurements should be referenced to the established MP. The MP value will be used to convert measurements into values that are relative to land surface.

After a permanent MP is stablished for each well, continue sampling using the following process:

1. Open the top of the well and note any “popping” sounds that would indicate pressure buildup, any odors, and the condition of the well head.
2. If there is a pressure transducer attached to the well cap carefully note the initial position of the cap (mark cap position on casing with permanent marker). If the well was airtight, wait a few minutes for the water level to return to equilibrium with atmospheric pressure.
3. Turn the water level meter on and slowly lower the probe into the well until it makes a tone indicated contact with the water level. To confirm contact, slowly raise and lower the electric-tape probe in and out of the water column. If necessary, adjust the sensitivity setting of the meter to provide a “crisp” indication of the water surface. Measure the depth of water against the MP and mark the date and time the reading was made.
4. At the precise location the indicator shows contact with the water surface, pinch the tape between your fingernails at the MP. Read the depth-to-water.
5. Repeat the measurement to ensure that the water level is stable (not rising or falling over time).

6. When the probe is pulled back up, make a note of any mud, staining, or anything else on the tip. Before moving on to the next well, decontaminate the probe with a brush or paper towel, then rinse with distilled water and 10 percent bleach.

On occasion, condensation on the interior casing of the well can prematurely trigger the electric-tape indicator giving a false positive reading. In this situation, it can help to center the tape in the well casing above the water level and lightly shake the tape to remove the excess water on the probe.

8.2.4 Atmospheric Pressure Monitoring

A barometric pressure transducer and datalogger will be deployed within the project limits. Data from this transducer will be used to correct measured well water levels for barometric effects at the Dingmon well and the observation wells. Barometric efficiency can affect the representativeness of water level measurements from vented and unvented transducers (see Spane, 2002). Corrections for barometric efficiency of wells will be made, as appropriate.

8.2.5 Aquifer and Well Testing

Well and aquifer testing will be performed in accordance with the EPA *Technical Guidance Manual for Hydrogeologic Investigations* (EPA, 1995) and as described in Ecology's *Aquifer Test Procedure* (Ecology, 2023a). A licensed hydrogeologist will oversee all testing activities by staff listed in Table 2 and ensure data collection is conducted in accordance with professional standards.

Step-Rate Pumping Tests

A step-rate pumping test will be conducted at the Dingmon Well using best practices to evaluate well capacity and performance. The results of the step-rate test will be analyzed to determine the sustainable yield of the constant rate pumping test.

The anticipated duration and rates for the step-rate pumping test are summarized in Table 8.

Table 8. Step-rate Pumping Test Rates

Step No.	Pumping Rate (gpm)
1	100
2	225
3	350
4	*475*

With the current pump configuration, the sustainable production capacity of the Dingmon Well is expected to be approximately 450 gpm. During the step-rate test, the lowest pumping rate will depend on the ability of existing infrastructure to restrict pumping rates and will be determined during the Task 1 efforts ahead of conducting the step-rate testing (Section 4.4). The final (maximum) pumping rate will be the maximum rate that is sustainable for approximately 1 hour (note that this duration differs from Ecology's Aquifer Test Procedures

[Ecology, 2023b]). A 1-hour duration is planned for each step to limit the amount of time necessary to significantly restrict the output of the City's existing pump during the initial step rates, and stability in the rate of drawdown (derivative of the drawdown at each step) will be confirmed prior to advancing to the 2nd step. Each subsequent step will be equivalent in duration to the last. The duration of each step will be of equivalent length of 1 hour or more, which will allow for conventional analysis of the test data to determine turbulent and laminar flow losses.

Constant Rate Pumping Tests

A constant rate pumping test will be conducted for a minimum of 2 days and up to 10 days at the City's Dingmon Well using best practices. The pumping rate will be the maximum rate that is anticipated to be practically maintained within the constraints of the well and existing conveyance infrastructure (i.e., the sustainable yield). Infrastructure constraints include the discharge location for test water, which is expected to include a pump-to-waste" area near the Dingmon Well.

8.3 Containers, Preservation Methods, Holding Times

The sample bottles and respective preservatives for each sample will be provided by the laboratory and filled accordingly. A description of the sample bottles, preservatives and analytical methods are provided in Table 9. Latex gloves will be worn at all times during the collection of the water quality parameters and samples. Samples for dissolved metal analyses shall be filtered with a 0.45-micron pore-size filter. All bottles shall be clearly labeled with a unique sample name, date, time, and preservative. Samples shall be stored in a cooler at 4 degrees Celsius (°C) and delivered to the laboratory under standard chain-of-custody protocols, within the hold times provided in Table 9.

Table 9. Containers, Preservation Methods, and Holding Times
*Will require a separate bottle for each preservative.

Parameter	Container	Preservative	Holding Time
General Chemistry / Water Quality Parameters (all metals and Dissolved fractions)			
Alkalinity (mg/L)	250 mL Plastic	Unpreserved	14 days
Bicarbonate (mg/L)	1 L Plastic*	Unpreserved	14 days
Chloride (mg/L)	1 L Plastic*	Unpreserved	28 days
TDS (mg/L)	1 L Plastic*	Unpreserved	7 days
TSS (mg/L)	1 L Plastic*	Unpreserved	7 days
Total Organic Carbon (mg/L)	1 L Plastic*	H2SO4	28 days
Phosphorous, Total (mg/L)	1 L Plastic*	H2SO4	28 days
Bromide (mg/L)	1 L Plastic*	Unpreserved	28 days

Parameter	Container	Preservative	Holding Time
Fluoride (mg/L)	1 L Plastic*	Unpreserved	28 days
Nitrate-N (mg/L)	1 L Plastic*	Unpreserved	48 hours
Nitrite-N (mg/L)	1 L Plastic*	Unpreserved	48 hours
Sulfate (mg/L)	1 L Plastic*	Unpreserved	28 days
Silica (silicon) (µg/L)	1 L Plastic*	HNO3	6 months
Arsenic (µg/L)	1 L Plastic	HNO3	6 months
Antimony (µg/L)	1 L Plastic	HNO3	6 months
Aluminum (µg/L)	1 L Plastic	HNO3	6 months
Barium (µg/L)	1 L Plastic	HNO3	6 months
Beryllium (µg/L)	1 L Plastic	HNO3	6 months
Cadmium (µg/L)	1 L Plastic	HNO3	6 months
Calcium (µg/L)	1 L Plastic	HNO3	6 months
Chromium (µg/L)	1 L Plastic	HNO3	6 months
Copper (µg/L)	1 L Plastic	HNO3	6 months
Iron (µg/L)	1 L Plastic	HNO3	6 months
Lead (µg/L)	1 L Plastic	HNO3	6 months
Magnesium (µg/L)	1 L Plastic	HNO3	6 months
Manganese (µg/L)	1 L Plastic	HNO3	6 months
Mercury (ug/L)	1 L Plastic	HNO3	28 days
Nickel (µg/L)	1 L Plastic	HNO3	6 months
Potassium (µg/L)	1 L Plastic	HNO3	6 months
Selenium (µg/L)	1 L Plastic	HNO3	6 months
Silver (µg/L)	1 L Plastic	HNO3	6 months
Sodium (µg/L)	1 L Plastic	HNO3	6 months
Thallium (µg/L)	1 L Plastic	HNO3	6 months
Volatile Organic Compounds (VOCs)			
All VOCs	40 mL VOA	Na2S203	14 Days
Synthetic Organic Compounds (SOCs)			
SOCs Measured Via EPA Methods 508.1 and 525.2	1 L Amber	HCl + Na2SO3	14 Days

Parameter	Container	Preservative	Holding Time
SOCs Measured Via EPA Method 515.4	250 mL Amber	Na2SO3	14 Days
Herbicides and Pesticides			
Chlorinated Pesticides	1 L Amber	HCl + Na2SO3	14 Days
Chlorinated Acid Herbicides	G, Amber, Teflon-Lined Cap	<6ºC	14 days until extraction, 21 days after extraction
Pesticides as carbamates	60 mL glass container	30mL/L of C2H3ClO2, 80mg/L of Na2S2O3.[1] Cool 4ºC	28 Days
Herbicides – diquat and paraquat	G, Amber, Teflon-Lined Cap	100mg/L of Na2S2O3, 4ºC	14 days until extraction, 21 days after extraction
Herbicides – endothall	G, Amber, Teflon-Lined Cap	4ºC	14 days until extraction, 21 days after extraction
Herbicides – glyphosate	Glass Container	100mg/L Na2S2O3, 4ºC	14 Days
Bacteriological			
E. coli	250 mL sterile plastic	Na2S2O3	30 hours
Total Coliform			

[1] After the addition of C2H3ClO2 and Na2S2O3, seal and shake sample bottle for 1 min prior to storage.

8.4 Equipment Decontamination

Water samples are collected from dedicated sampling equipment or directly into laboratory provided containers to prevent cross-contamination. All sampling equipment will be decontaminated before and after completion of all sampling activities. Sampling equipment will be decontaminated with an industry standard, phosphorous-free detergent and brush or paper towel, then rinsed with distilled water.

8.5 Sample ID

All bottles shall be clearly labeled with a unique sample name, date, time, and preservative. Samples shall be stored in a cooler at 4°C and delivered to the laboratory under standard chain-of-custody protocols, within the hold times provided in Table 9.

8.6 Chain of Custody

After collection, samples will be maintained in Aspect's custody until formally transferred to the analytical laboratory. For purposes of this work, custody of the samples will be defined as follows:

- In plain view of the field representatives
- Inside a cooler that is in plain view of the field representative
- Inside any locked space, such as a cooler, locker, car, or truck to which the field representative has the only immediately available key(s)

A chain-of-custody record provided by the laboratory will be initiated at the time of sampling for all samples collected. The record will be signed by the field representative and others who subsequently take custody of the samples. Couriers or other professional shipping representatives are not required to sign the chain-of-custody form; however, shipping receipts will be collected and maintained as a part of custody documentation in the project files. A copy of the chain-of-custody form with appropriate signatures will be maintained in Aspect's files and included as an appendix to the project report.

8.7 Field Log Requirements

During the collection of any field samples accompanying field documentation must be made clearly stating:

- Name and location of project
- Field personnel
- Sequence of events
- Any changes or deviations from the QAPP or SOPs
- Environmental conditions
- Date, time, location, ID, and description of each sample
- Field instrument calibration procedures
- Field measurement results
- Identity of QC samples collected
- Unusual circumstances that might affect interpretation of results

For this Study, data collected in the field will be contained in a field log (a binder backed by electronic scans of documents) that will consist of field notes (freehand notes) and Aspect field data sheets (Appendix C).

Field notes should be bound, waterproof notebooks with prenumbered pages (Rite in the Rain®). Permanent, waterproof ink should be used for all entries. Corrections should be made with single-line strikethroughs, initials, and date of correction. Use of white-out or correction fluid is not permitted.

While conducting field work, the field hydrogeologist or technician (Table 2) will document general pertinent observations and events in waterproof field notes and, when warranted, provide photographic documentation of specific sampling efforts. Data collected during the sample collection procedures will be recorded on standard Aspect field data sheets (Appendix C). Field notes will include a description of each field activity, sample descriptions, and associated details, such as the date, time, and field conditions. The laboratory chain-of-custody forms will be filled out before leaving the site. Upon completion of a field task, the field personnel will then scan field notes and Aspect field data sheets into computer files and provide the original versions to the Aspect Project Manager. Copies of Aspect field data sheet and laboratory chain of custody are provided in Appendix C.

8.8 Other activities

Not applicable.

9.0 Laboratory Procedures

9.1 Lab Procedures Table

Table 10. presents the lab procedures for each analyte including the sample matrix, number of samples, expected range of results, reporting limit, and analytical method.

Table 10. Laboratory Procedures

(See Table 6 for Anticipated Sample Schedule and Table 1 and Section 3.23 for list of analytes in each analyte suite).

Analytical Method	Analyte	Sample Matrix	Number of Samples^1	Expected Range of Results	Method Reporting Limit	Units
General Chemistry, Inorganics in Drinking Water						
EPA 300.0	Bromide	Water	TBD	Unknown	0.100	mg/L
EPA 300.0	Chloride	Water	TBD	Unknown	0.100	mg/L
EPA 300.0	Fluoride	Water	TBD	Unknown	0.100	mg/L
EPA 300.0	Nitrate/N	Water	TBD	Unknown	0.100	mg/L
EPA 300.0	Nitrite/N	Water	TBD	Unknown	0.100	mg/L
EPA 300.0	Sulfate	Water	TBD	Unknown	0.100	mg/L
SM 2320 B	Alkalinity	Water	TBD	Unknown	2.00	mg/L
SM 2320 B	Bicarbonate	Water	TBD	Unknown	2.00	mg/L
SM 2540 C	TDS	Water	TBD	Unknown	50.0	mg/L
SM 2540 D	TSS	Water	TBD	Unknown	1.00	mg/L
SM 4500-P F	Total P	Water	TBD	Unknown	0.0100	mg/L
SM 5310 B	DOC	Water	TBD	Unknown	0.500	mg/L
SM 5310 B	TOC	Water	TBD	Unknown	0.100	mg/L
Metals by ICP in Drinking Water (All metals are total and dissolved)						TBD
EPA 200.7	Aluminum	Water	TBD	Unknown	0.0100	mg/L
EPA 200.7	Calcium	Water	TBD	Unknown	0.100	mg/L
EPA 200.7	Iron	Water	TBD	Unknown	0.0100	mg/L
EPA 200.7	Magnesium	Water	TBD	Unknown	0.100	mg/L
EPA 200.7	Potassium	Water	TBD	Unknown	0.500	mg/L
EPA 200.7	Silica (as SiO2)	Water	TBD	Unknown	0.214	mg/L
EPA 200.7	Sodium	Water	TBD	Unknown	0.100	mg/L
Metals by ICP-MS in Drinking Water						
EPA 200.8	Antimony	Water	TBD	Unknown	0.00100	mg/L
EPA 200.8	Arsenic	Water	TBD	Unknown	0.00100	mg/L
EPA 200.8	Barium	Water	TBD	Unknown	0.000130	mg/L

Analytical Method	Analyte	Sample Matrix	Number of Samples[1]	Expected Range of Results	Method Reporting Limit	Units
EPA 200.8	Beryllium	Water	TBD	Unknown	0.000300	mg/L
EPA 200.8	Cadmium	Water	TBD	Unknown	0.00100	mg/L
EPA 200.8	Chromium	Water	TBD	Unknown	0.00100	mg/L
EPA 200.8	Copper	Water	TBD	Unknown	0.00100	mg/L
EPA 200.8	Lead	Water	TBD	Unknown	0.00100	mg/L
EPA 200.8	Manganese	Water	TBD	Unknown	0.00100	mg/L
EPA 200.8	Nickel	Water	TBD	Unknown	0.00100	mg/L
EPA 200.8	Selenium	Water	TBD	Unknown	0.00100	mg/L
EPA 200.8	Silver	Water	TBD	Unknown	0.00100	mg/L
EPA 200.8	Thallium	Water	TBD	Unknown	0.00100	mg/L
EPA 200.8	Uranium	Water	TBD	Unknown	0.00100	mg/L
EPA 200.8	Zinc	Water	TBD	Unknown	0.00100	mg/L
Mercury in Water						
EPA 245.7	Mercury	Water	TBD	Unknown	0.00100	ug/L
Semivolatiles in Drinking Water						
EPA 505	gamma-BHC (Lindane)	Water	TBD	<RL	0.0200	ug/L
EPA 505	Heptachlor	Water	TBD	<RL	0.0400	ug/L
EPA 505	Aldrin	Water	TBD	<RL	0.100	ug/L
EPA 505	Heptachlor epoxide	Water	TBD	<RL	0.0200	ug/L
EPA 505	4,4'-DDE	Water	TBD	<RL	0.100	ug/L
EPA 505	Dieldrin	Water	TBD	<RL	0.100	ug/L
EPA 505	Endrin	Water	TBD	<RL	0.0100	ug/L
EPA 505	4,4'-DDD	Water	TBD	<RL	0.100	ug/L
EPA 505	4,4'-DDT	Water	TBD	<RL	0.100	ug/L
EPA 505	Methoxychlor	Water	TBD	<RL	0.100	ug/L
EPA 505	Aroclor 1232 (PCB-1232)	Water	TBD	<RL	0.500	ug/L
EPA 505	Aroclor 1242 (PCB-1242)	Water	TBD	<RL	0.300	ug/L
EPA 505	Aroclor 1248 (PCB-1248)	Water	TBD	<RL	0.100	ug/L
EPA 505	Aroclor 1254 (PCB-1254)	Water	TBD	<RL	0.100	ug/L
EPA 505	Aroclor 1260 (PCB-1260)	Water	TBD	<RL	0.200	ug/L
EPA 505	PCBs	Water	TBD	<RL	0.500	ug/L
EPA 505	Chlordane	Water	TBD	<RL	0.200	ug/L
EPA 505	Toxaphene	Water	TBD	<RL	1.00	ug/L
EPA 515.4	Dalapon	Water	TBD	<RL	1.00	ug/L
EPA 515.4	Dicamba	Water	TBD	<RL	0.200	ug/L
EPA 515.4	Dichloroprop	Water	TBD	<RL	0.500	ug/L
EPA 515.4	2,4-D	Water	TBD	<RL	0.100	ug/L
EPA 515.4	Pentachlorophenol	Water	TBD	<RL	0.0400	ug/L
EPA 515.4	2,4,5-TP (Silvex)	Water	TBD	<RL	0.200	ug/L
EPA 515.4	2,4-DB	Water	TBD	<RL	1.00	ug/L
EPA 515.4	Dinoseb	Water	TBD	<RL	0.200	ug/L
EPA 515.4	Picloram	Water	TBD	<RL	0.100	ug/L
EPA 515.4	3,5-Dichlorobenzoic Acid	Water	TBD	<RL	0.500	ug/L
EPA 515.4	Chloramben	Water	TBD	<RL	0.200	ug/L

Analytical Method	Analyte	Sample Matrix	Number of Samples[1]	Expected Range of Results	Method Reporting Limit	Units
EPA 515.4	Acifluorofen	Water	TBD	<RL	1.00	ug/L
EPA 525.2	Alachlor	Water	TBD	<RL	0.200	ug/L
EPA 525.2	Atrazine	Water	TBD	<RL	0.100	ug/L
EPA 525.2	Benzo[a]pyrene	Water	TBD	<RL	0.0200	ug/L
EPA 525.2	bis(2-Ethylhexyl)phthalate	Water	TBD	<RL	0.600	ug/L
EPA 525.2	bis-2(ethylhexyl)adipate	Water	TBD	<RL	0.600	ug/L
EPA 525.2	Bromacil	Water	TBD	<RL	0.100	ug/L
EPA 525.2	Butachlor	Water	TBD	<RL	0.100	ug/L
EPA 525.2	Fluorene	Water	TBD	<RL	0.200	ug/L
EPA 525.2	gamma-BHC (Lindane)	Water	TBD	<RL	0.0400	ug/L
EPA 525.2	Hexachlorobenzene	Water	TBD	<RL	0.100	ug/L
EPA 525.2	Hexachlorocyclopentadiene	Water	TBD	<RL	0.100	ug/L
EPA 525.2	Methoxychlor	Water	TBD	<RL	0.200	ug/L
EPA 525.2	Metribuzin	Water	TBD	<RL	0.100	ug/L
EPA 525.2	Propachlor	Water	TBD	<RL	0.100	ug/L
EPA 525.2	Simazine	Water	TBD	<RL	0.0700	ug/L
EPA 549.2	Diquat	Water	TBD	<RL	0.400	ug/L
SM 6251 B	Monochloroacetic acid	Water	TBD	<RL	2.00	ug/L
SM 6251 B	Monobromoacetic acid	Water	TBD	<RL	1.00	ug/L
SM 6251 B	Dichloroacetic acid	Water	TBD	<RL	1.00	ug/L
SM 6251 B	Trichloroacetic acid	Water	TBD	<RL	1.00	ug/L
SM 6251 B	Bromochloroacetic acid (BCAA)	Water	TBD	<RL	1.00	ug/L
SM 6251 B	Dibromoacetic acid	Water	TBD	<RL	1.00	ug/L
SM 6251 B	Total HAA5	Water	TBD	<RL	1.00	ug/L
Volatiles in Drinking Water						
EPA 524.3	1,3-Dichloropropene	Water	TBD	<RL	0.500	ug/L
EPA 524.3	Total Trihalomethane	Water	TBD	<RL	0.500	ug/L
EPA 524.3	Benzene	Water	TBD	<RL	0.500	ug/L
EPA 524.3	Bromochloromethane	Water	TBD	<RL	0.500	ug/L
EPA 524.3	Bromodichloromethane	Water	TBD	<RL	0.500	ug/L
EPA 524.3	Bromoform	Water	TBD	<RL	0.500	ug/L
EPA 524.3	Bromomethane	Water	TBD	<RL	0.500	ug/L
EPA 524.3	Carbon Tetrachloride	Water	TBD	<RL	0.500	ug/L
EPA 524.3	Chlorobenzene	Water	TBD	<RL	0.500	ug/L
EPA 524.3	Chloroform	Water	TBD	<RL	0.500	ug/L
EPA 524.3	Chloromethane	Water	TBD	<RL	0.500	ug/L
EPA 524.3	cis-1,2-dichloroethene	Water	TBD	<RL	0.500	ug/L
EPA 524.3	cis-1,3-Dichloropropene	Water	TBD	<RL	0.500	ug/L
EPA 524.3	1,2-Dibromo-3-chloropropane (DBCP)	Water	TBD	<RL	0.500	ug/L
EPA 524.3	1,2-Dibromoethane (EDB)	Water	TBD	<RL	0.500	ug/L
EPA 524.3	1,2-Dichlorobenzene	Water	TBD	<RL	0.500	ug/L
EPA 524.3	1,3-Dichlorobenzene	Water	TBD	<RL	0.500	ug/L
EPA 524.3	1,4-Dichlorobenzene	Water	TBD	<RL	0.500	ug/L

Analytical Method	Analyte	Sample Matrix	Number of Samples[1]	Expected Range of Results	Method Reporting Limit	Units
EPA 524.3	Dichlorodifluoromethane	Water	TBD	<RL	0.500	ug/L
EPA 524.3	1,1-Dichloroethane	Water	TBD	<RL	0.500	ug/L
EPA 524.3	1,2-Dichloroethane	Water	TBD	<RL	0.500	ug/L
EPA 524.3	1,1-Dichloroethene	Water	TBD	<RL	0.500	ug/L
EPA 524.3	trans-1,2-Dichloroethene	Water	TBD	<RL	0.500	ug/L
EPA 524.3	1,2-Dichloropropane	Water	TBD	<RL	0.500	ug/L
EPA 524.3	trans-1,3-Dichloropropene	Water	TBD	<RL	0.500	ug/L
EPA 524.3	Ethylbenzene	Water	TBD	<RL	0.500	ug/L
EPA 524.3	Hexachlorobutadiene	Water	TBD	<RL	0.500	ug/L
EPA 524.3	Isopropylbenzene	Water	TBD	<RL	0.500	ug/L
EPA 524.3	Methylene chloride	Water	TBD	<RL	0.500	ug/L
EPA 524.3	Naphthalene	Water	TBD	<RL	0.500	ug/L
EPA 524.3	Styrene	Water	TBD	<RL	0.500	ug/L
EPA 524.3	1,1,1,2-Tetrachloroethane	Water	TBD	<RL	0.500	ug/L
EPA 524.3	1,1,2,2-Tetrachloroethane	Water	TBD	<RL	0.500	ug/L
EPA 524.3	Tetrachloroethene	Water	TBD	<RL	0.500	ug/L
EPA 524.3	Toluene	Water	TBD	<RL	0.500	ug/L
EPA 524.3	1,2,4-Trichlorobenzene	Water	TBD	<RL	0.500	ug/L
EPA 524.3	1,1,1-Trichloroethane	Water	TBD	<RL	0.500	ug/L
EPA 524.3	1,1,2-Trichloroethane	Water	TBD	<RL	0.500	ug/L
EPA 524.3	Trichloroethene	Water	TBD	<RL	0.500	ug/L
EPA 524.3	Trichlorofluoromethane	Water	TBD	<RL	0.500	ug/L
EPA 524.3	1,2,3-Trichloropropane	Water	TBD	<RL	0.500	ug/L
EPA 524.3	Vinyl Chloride	Water	TBD	<RL	0.500	ug/L
EPA 524.3	m+p-Xylene	Water	TBD	<RL	0.500	ug/L
EPA 524.3	o-Xylene	Water	TBD	<RL	0.500	ug/L
EPA 524.3	Total Xylene	Water	TBD	<RL	0.500	ug/L
EPA 524.3	1,1-dichloropropene	Water	TBD	<RL	0.500	ug/L
EPA 524.3	1,2,3-Trichlorobenzene	Water	TBD	<RL	0.500	ug/L
EPA 524.3	1,2,4-Trimethylbenzene	Water	TBD	<RL	0.500	ug/L
EPA 524.3	Chloroethane	Water	TBD	<RL	0.500	ug/L
EPA 524.3	1,3,5-Trimethylbenzene	Water	TBD	<RL	0.500	ug/L
EPA 524.3	2,2-Dichloropropane	Water	TBD	<RL	0.500	ug/L
EPA 524.3	1,3-Dichloropropane	Water	TBD	<RL	0.500	ug/L
EPA 524.3	2-Chlorotoluene	Water	TBD	<RL	0.500	ug/L
EPA 524.3	4-Chlorotoluene	Water	TBD	<RL	0.500	ug/L
EPA 524.3	Bromobenzene	Water	TBD	<RL	0.500	ug/L
EPA 524.3	Dibromochloromethane	Water	TBD	<RL	0.500	ug/L
EPA 524.3	Dibromomethane	Water	TBD	<RL	0.500	ug/L
EPA 524.3	methyl-t-butyl ether (MTBE)	Water	TBD	<RL	0.500	ug/L
EPA 524.3	n-Butylbenzene	Water	TBD	<RL	0.500	ug/L
EPA 524.3	n-Propylbenzene	Water	TBD	<RL	0.500	ug/L
EPA 524.3	p-isopropyltoluene	Water	TBD	<RL	0.500	ug/L
EPA 524.3	sec-Butylbenzene	Water	TBD	<RL	0.500	ug/L
EPA 524.3	tert-Butylbenzene	Water	TBD	<RL	0.500	ug/L

Analytical Method	Analyte	Sample Matrix	Number of Samples[1]	Expected Range of Results	Method Reporting Limit	Units
EPA 524.3	Acetone	Water	TBD	<RL	2.50	ug/L
EPA 524.3	MTBE-d3	Water	TBD	<RL		Surr.
EPA 524.3	4-Bromofluorobenzene	Water	TBD	<RL		Surr.
EPA 524.3	1,2-Dichlorobenzene-d4	Water	TBD	<RL		Surr.

Note:

1. See Section 7.2.1 and Table 6 for sampling schedule.

9.2 Sample Preparation Method(s)

Samples will be prepared and extracted by an accredited lab in accordance with industry standards and analytical methods. The selected laboratory is discussed in Section 9.4.

9.3 Special Method Requirements

Not applicable.

9.4 Laboratories Accredited for Methods

Analysis of water quality samples will be performed by Anatek Labs, Inc. of Spokane, Washington. Anatek is accredited by Ecology for analysis of all parameters included in this project (see Appendix A).

Contact information for the laboratory is:

Anatek labs, Inc.
504 E. Sprague Ave #D
Spokane, WA 99202

Project Manager: Brock Gerger
Phone: 509.838.3999
Email: brockg@anateklabs.com

10.0 Quality Control Procedures

Implementing QC procedures provides the information needed to assess the quality of the data that is collected. These procedures also help identify problems or issues associated with data collection or data analysis while the project is underway.

10.1 Table of Field and Laboratory Quality Control

Standard EPA Level II procedures will be followed by the laboratory for one standard check, method blank, analytical duplicate, and matrix spike per laboratory batch (typically 10 to 20, as accommodated by laboratory autosampling equipment and sample backlog). Field procedures will follow standard guidelines and SOPs for the relevant field activity.

Data Validation Samples

Field quality control (QC) is accomplished through the analysis of controlled data validation (DV) samples that are introduced to the laboratory from the field. Field duplicates and trip blanks will be collected and submitted to the investigation laboratory to provide a means of assessing the quality of data resulting from the field sampling program.

Trip Blank

Trip blank samples will be used to monitor any possible cross-contamination that occurs during the transport of VOCs and samples. Trip blank samples are prepared by the laboratory using organic-free reagent-grade water into a VOA vial prior to the collection of field samples. Two vials per trip blank sample are placed with and accompany the VOCs samples through the entire transport process. Trip blank samples will be prepared and analyzed only for VOCs.

Field Duplicates

Field duplicate samples are used to check for sampling and analysis reproducibility. Field duplicate samples will be collected at a frequency of 10 percent of the field samples for every matrix and analytical method.

A set of DV samples will be collected for at least every 10 water samples collected. The DV sample set will include the following for calculation of DV parameters and acceptance criteria, and Section 9 for description of lab procedures):

- A MS/MSD
- A “blind” field duplicate (i.e., not indicated to the lab as a field duplicate)
- Trip blanks (for VOCs, bacteria, and inorganic constituent suites)

Except for the trip blank, the chemical analysis of DV samples will include the entire list of chemical analytes (Section 6). The trip blank will include only analysis of VOCs. The blind field duplicate will be labeled in a manner that does not indicate its true sample location, and the MS/MSD will be labeled, as such, for laboratory processing.

10.2 Corrective Action Processes

The laboratory will follow the analytical method for corrective action procedures when the sample results do not meet the QC acceptance criteria. The laboratory will notify the Aspect Hydrogeologist that submitted the samples and include a narrative in the laboratory report when following the analytical method corrective action procedures results in a sample result not meeting the QC acceptance criteria. Findings will be reviewed by the Aspect project manager. QC results may indicate problems with data during the course of the project. Corrective action processes (such as recalibration) will be used if:

- Activities are inconsistent with the QAPP
- Field instruments yield unusual results
- Results do not meet MQOs or performance expectations
- If some other unforeseen problem arises

11.0 Data Management Procedures

11.1 Data Recording and Reporting Requirements

Field technicians will record all field data in a water-resistant field notebook, electronic data forms, or Aspect standard field data sheet. Before leaving each site, staff will check field notebooks, data sheets, or electronic data forms for missing or improbable measurements. Field technicians will enter field-generated data into spreadsheets or a project database as soon as practical after they return from the field. For data collected electronically, data will be backed up on servers when staff return from the field. Raw data files will be stored separate from processed data files.

The Aspect field hydrogeologist and field technician will check data entry against the field notebook data for errors and omissions. The hydrogeologist will notify the Aspect Project Manager of missing or unusual data.

Data will be uploaded to Ecology's EIM database as described in Section 11.4.

11.2 Laboratory Data Package Requirements

All continuous and laboratory data will be stored in a project database that includes station location information and data QA information. This database will facilitate summarization and graphical analysis of the data.

11.3 Electronic Transfer Requirements

The lab will provide an EPA Level II data package as a pdf and an electronic data deliverable (EDD), in the format of a csv or xls file (comma-separated value and Excel workbook). The data package will include the following sections: Case narrative; Chain-of-custody (COC) documentation; Summary of results for environmental samples; Summary of QA/QC results; and Raw data.

11.4 Data Upload Procedures

Following completion of the QC procedures described in Section 10 and the DV procedures described in Section 8.2, all quality assured data will be formatted and uploaded to Ecology's EIM database by an Aspect data scientist using Study ID: WROCR-2123-CiGold-00035.

11.5 Model Information Management

Not applicable.

12.0 Audits and Reports

12.1 Audits

Field technicians will be required to review this QAPP prior to each monitoring event and to maintain a copy of the QAPP and its appendices in the field. Field technicians may be audited at any time by the appropriate project manager or the Aspect data manager (Table 2) to ensure that field work is being completed according to this QAPP, work plan, and published SOPs.

12.2 Responsible Personnel

Personnel responsible for the audits are as follows:

- Field audit: Aspect Project Manager
- Field consistency review: experienced (at least 3 years) staff (senior hydrogeologist or project manager)
- Data analysis: Aspect hydrogeologists (field, senior, and principal, as required for specific analysis)

Personnel assigned to these roles are listed in Table 2.

12.3 Frequency and Distribution of Reports

Results of the field data collection, data quality assessment, and any data analysis will be documented in a published report. The final report will be distributed to all other stakeholders involved or interested in the study as determined by the City and Ecology.

Field and Laboratory Data will be entered into EIM when data collection is complete.

12.4 Responsibility for Reports

The Aspect Project Manager is responsible for verifying data completeness and usability before the data are used in the technical report and entered into Environmental Information Management (EIM) database. The Aspect Project Manager is also responsible for writing the final technical report or memo, unless an alternate author is agreed upon and documented at the start of the project.

The Aspect Project Manager is responsible for assigning a peer reviewer with the appropriate expertise for the technical report. A draft report will be prepared and submitted to Ecology, then a final report will be prepared that addresses Ecology’s comments. The peer reviewer is responsible for working with the report author to resolve or clarify any issues with the report.

13.0 Data Verification

Data verification is the process of evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual requirements.

13.1 Field Data Verification, Requirements, and Responsibilities

Field notebooks, data sheets, and electronic information storage will be checked for missing or improbable measurements, and initial data will be verified before leaving each site. This process involves checking the data sheet (written or electronic) for omissions or outliers. If measurement data are missing or a measurement is determined to be an outlier, the measurement will be flagged in the data sheet and repeated if possible. The field hydrogeologist or field technician is responsible for in-field data verification.

Upon returning from the field, data are either manually entered (data recorded on paper) or downloaded from instruments and then uploaded into the appropriate database or project folder (see Data Management Section). Manually entered data will be verified/checked by a staff member who did not enter the data. Downloaded electronic data files will also be checked for completeness and appropriate metadata (such as file name, time code).

Following data entry verification, raw field measurement data will undergo a quality analysis verification process to evaluate the performance of the sensors. Field measurement data may be adjusted for bias or drift (increasing bias over time) based on the results of fouling, field, or standards checks following general USGS guidelines (Wagner, 2007) and this process:

Review Discrete Field QC Checks

The field check of instrumentation will consist of a manual measurement for water levels, and measurement of water quality standards in the field (checks with water quality standards will be completed separate from calibration events). The post check data for field QC instrument check (water quality and water level) will be reviewed, and the result will be qualified, rejected, or accepted as appropriate.

Review/Adjust Time Series (Continuous) Data

1. Plot raw time series with field checks.
2. Reject data based on deployment/retrieval times, site visit disruption, blatant fouling events, and sensor/equipment failure.
3. Review sensor offsets for both recalibration and post-deployment buffer/standard checks. Flag any potential chronic drift or bias issues specific to the instrument.
4. If applicable, review fouling check and make drift adjustment, if necessary. In some situations, an event fouling adjustment may be warranted.

5. Review residuals from both field checks and post-checks, together referred to as QC checks. Adjust data, as appropriate, using a weight-of-evidence approach. Give the most weight to post-checks with National Institute of Standards and Technology standards (for pH, specific conductance, and ORP), then field checks are accepted, rejected, or qualified. Do not use field checks rated poor. Potential data adjustments include:
    a. **Bias** – Data are adjusted by the average difference between the QC checks and deployed instrument. Majority of QC checks must show bias to use this method.
    b. **Regression** – Data adjusted using regression, typically linear, between QC checks and deployed instrument. This accounts for both a slope and bias adjustment. The regression must have at least five data points and an R^2 value of >0.95 to use for adjustment. Do not extrapolate regressions beyond the range of the QC checks.
    c. **Calibration/Sensor Drift** – Data adjusted using linear regression with time from calibration or deployment to post-check or retrieval. Majority of QC checks, particularly post-checks, must confirm pattern of drift.
6. Typically, choose the adjustment that results in the smallest residuals and bias between the adjusted values and QC checks. Best professional judgement and visual review are necessary to confirm adjustment.
7. If the evidence is weak, or inconclusive, do not adjust the data.

It will be noted in the final report if any data is adjusted. Data adjustment must be performed or reviewed by an Aspect Project Manager, or personnel, with the appropriate training and experience in processing raw sensor data.

13.2 Laboratory Data Verification

The lab will provide an EPA Level II data package. Additional laboratory data validation (check batch QC) will be conducted by Aspect's project data scientist (Table 2). Laboratory validation results will be summarized in the laboratory reports, and Aspect's validation results will be summarized in the final report. An Aspect hydrogeologist will verify the validated laboratory results.

13.3 Validation Requirements, if necessary

Not applicable.

13.4 Model Quality Assessment

Not applicable.

14.0 Data Quality (Usability) Assessment

14.1 Process for Determining Project Objectives were met

The Aspect Project Manager will assess all data (qualified and unqualified), results or verification, compliance with MQOs, and the overall quality of the data set to provide a final determination regarding usability in the context of the project-specific goals and objectives. The final report will document whether the final, acceptable-quality data set meets the needs of the project (allows desired conclusion/decisions to be made with the desired level of certainty).

14.2 Treatment of non-detects

Non-detects will be reported as the MRL for that analyte with the appropriate flag ("<") indicating it as a non-detect.

14.3 Data Analysis and Presentation Methods

Data found to be of acceptable quality for project objectives will be analyzed before being summarized. Any relevant and interesting data analysis will be presented in the final report using a combination of tables and plots of various kinds, such as time-series plots, histograms, and box plots.

The report will contain a summary table of chemistry; figures of continuous data (water level hydrographs, potentiometric maps, etc.); discussion of results pertaining to each sample location (well); and a map of the study area. Aquifer response to pumping will be analyzed spatially and temporally. Aquifer conditions (transmissivity, storage coefficient, boundary conditions, etc.,) will be evaluated.

14.4 Sampling Design Evaluation

The Aspect Project Manager will decide whether (1) the data package meets the MQOs, and criteria for completeness, representativeness, and comparability; and (2) meaningful conclusions (with enough statistical power) can be drawn from summary statistics. If so, the sampling design will be considered effective. If the sampling design is found ineffective, the approach will be modified in accordance with Ecology, and/or the study will be halted for redesign.

14.5 Documentation of Assessment

In the final report, the Aspect Project Manager will include a summary and detailed description of the data quality assessment and model quality evaluation findings. This summary is usually included in the Data Quality section of reports. The final report will also provide results of the data analysis, uncertainty analysis, and margin of safety.

15.0 References

Aspect Consulting, LLC, 2008. City of Goldendale Aquifer Storage and Recovery Feasibility Assessment.

Spane, F. A., 2002. Considering Barometric Pressure in Groundwater Flow Investigations. J. Water Resources Research, Vol. 38, No. 6. Published June 18, 2002.

WAC 173-201A. Water Quality Standards for Surface Waters in the State of Washington.

WAC 173-157. Underground Artificial Storage and Recovery.

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Wagner, R.J., Kimbrough, R.A., and Turney, G.L., 2007, Quality-assurance plan for water-quality activities in the U.S. Geological Survey Washington Water Science Center: U.S. Geological Survey Open-File Report 2007–1307, 48 p.

Washington State Department of Ecology (Ecology), 2019b, Standard Operating Procedure EAP098, Version 1.1: Collecting Groundwater Samples for Metals Analysis from Water Supply Wells, Prepared by Pitz, C, Washington State Department of Ecology, Olympia.

Washington State Department of Ecology (Ecology), 2004, Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies, Publication No. 04-03-030, July 2004 (Revised December 2016).

Washington State Department of Ecology (Ecology), 2023b, Standard Operating Procedure for Manual Well-Depth and Depth-to-Water Measurements Version 1.4, EAP052 Pub. No. 23-03-204, Prepared by Pamela Marti, Environmental Assessment Program, Washington State Department of Ecology. https://apps.ecology.wa.gov/publications/SummaryPages/2303204.html.

Washington State Department of Ecology (Ecology), 2023c, Standard Operating Procedure to Minimize the Spread of Invasive Species, Version 2.3, EAP070 Pub. No. 23-03-225, Prepared by Parsons, J., Hallock, D., Seiders, K., Ward, B., Coffin, C., Newell, E., Deligeannis, C., and Welch K., Environmental Assessment Program, Washington State Department of Ecology. https://apps.ecology.wa.gov/publications/SummaryPages/2303225.html.

Washington State Department of Ecology (Ecology), 2023d, Standard Operating Procedure for Collecting Groundwater Samples: Purging and Sampling Monitoring Wells for General Chemistry Parameters, Version 1.2, EAP099 Pub. No. 23-03-209, Prepared by Carey, B., Environmental Assessment Program, Washington State Department of Ecology. https://apps.ecology.wa.gov/publications/SummaryPages/2303209.html

Washington State Department of Ecology (Ecology), 2019a, Standard Operating Procedure EAP074, Version 1.2: Use of Submersible Pressure Transducers During Groundwater Studies. Washington State Department of Ecology, Olympia. https://fortress.wa.gov/ecy/publications/SummaryPages/1903205.html

Washington State Department of Ecology (Ecology), 2019b, Standard Operating Procedure EAP098, Version 1.1: Collecting Groundwater Samples for Metals Analysis from Water Supply Wells, Washington State Department of Ecology, Olympia. https://fortress.wa.gov/ecy/publications/SummaryPages/1903204.html.

Washington State Department of Ecology (Ecology), 2023a, Aquifer Test Procedures, Publication No. 20-11-093, October 2020.Watershed Professional Network and Aspect Consulting, LLC, 2005. Klickitat Basin (WRIA 30) Watershed Management Plan. Prepared for WRIA 30 Watershed Planning Unit, May 2005.

16.0 Appendices

Appendix A. Laboratory Accreditations

Appendix B. Well Logs for Potential Observation Wells

Appendix C. Aspect Field Data Sheets

Appendix D. Glossaries, Acronyms, and Abbreviations

Appendix A. Laboratory Accreditations

The State of Washington
Department of Ecology

Anatek Labs, Inc - Spokane
Spokane, WA

has complied with provisions set forth in Chapter 173-50 WAC and is hereby recognized by the Department of Ecology as an ACCREDITED LABORATORY for the analytical parameters listed on the accompanying Scope of Accreditation.

This certificate is effective November 16, 2022 and shall expire November 15, 2023.

Witnessed under my hand on November 22, 2022.

Rebecca Wood
Lab Accreditation Unit Supervisor

Laboratory ID
C585

WASHINGTON STATE DEPARTMENT OF ECOLOGY

ENVIRONMENTAL LABORATORY ACCREDITATION PROGRAM

SCOPE OF ACCREDITATION

Anatek Labs, Inc - Spokane

Spokane, WA

is accredited for the analytes listed below using the methods indicated. Full accreditation is granted unless stated otherwise in a note. EPA is the U.S. Environmental Protection Agency. SM is "Standard Methods for the Examination of Water and Wastewater." SM refers to EPA approved method versions. ASTM is the American Society for Testing and Materials. USGS is the U.S. Geological Survey. AOAC is the Association of Official Analytical Chemists. Other references are described in notes.

Matrix/Analyte	Method	Notes
Drinking Water		
Turbidity	EPA 180.1_2_1993	
Chloride	EPA 300.0_2.1_1993	
Fluoride	EPA 300.0_2.1_1993	
Nitrate	EPA 300.0_2.1_1993	
Nitrate + Nitrite	EPA 300.0_2.1_1993	
Nitrite	EPA 300.0_2.1_1993	
Orthophosphate	EPA 300.0_2.1_1993	
Sulfate	EPA 300.0_2.1_1993	
Cyanide, Total	EPA 335.4_1_1993	
Color	SM 2120 B-2011	
Alkalinity	SM 2320 B-2011	
Hardness (calc.)	SM 2340 B-2011	
Hardness, Total (as CaCO3)	SM 2340 C-2011	
Specific Conductance	SM 2510 B-2011	
Solids, Total Dissolved	SM 2540 C-2011	
Cyanide, Total	SM 4500-CN$^-$ E-2011	
pH	SM 4500-H+ B-2011	
Nitrate (calc.)	SM 4500-NO3$^-$ F-2011	
Nitrate + Nitrite	SM 4500-NO3$^-$ F-2011	
Nitrite	SM 4500-NO3$^-$ F-2011	
Orthophosphate	SM 4500-P F-2011	
UV Absorbing Organics	SM 5910 B-2011	3
Aluminum	EPA 200.8_5.4_1994	
Antimony	EPA 200.8_5.4_1994	
Arsenic	EPA 200.8_5.4_1994	
Barium	EPA 200.8_5.4_1994	

Matrix/Analyte	Method	Notes
Drinking Water		
Beryllium	EPA 200.8_5.4_1994	
Cadmium	EPA 200.8_5.4_1994	
Chromium	EPA 200.8_5.4_1994	
Copper	EPA 200.8_5.4_1994	
Lead	EPA 200.8_5.4_1994	
Manganese	EPA 200.8_5.4_1994	
Mercury	EPA 200.8_5.4_1994	
Nickel	EPA 200.8_5.4_1994	
Selenium	EPA 200.8_5.4_1994	
Silver	EPA 200.8_5.4_1994	
Thallium	EPA 200.8_5.4_1994	
Total Uranium	EPA 200.8_5.4_1994	
Zinc	EPA 200.8_5.4_1994	
1,1,1,2-Tetrachloroethane	EPA 524.2_4.1_1995	
1,1,1-Trichloroethane	EPA 524.2_4.1_1995	
1,1,2,2-Tetrachloroethane	EPA 524.2_4.1_1995	
1,1,2-Trichloroethane	EPA 524.2_4.1_1995	
1,1-Dichloroethane	EPA 524.2_4.1_1995	
1,1-Dichloroethylene	EPA 524.2_4.1_1995	
1,1-Dichloropropene	EPA 524.2_4.1_1995	
1,2,3-Trichlorobenzene	EPA 524.2_4.1_1995	
1,2,3-Trichloropropane	EPA 524.2_4.1_1995	
1,2,4-Trichlorobenzene	EPA 524.2_4.1_1995	
1,2,4-Trimethylbenzene	EPA 524.2_4.1_1995	
1,2-Dichlorobenzene	EPA 524.2_4.1_1995	
1,2-Dichloroethane (Ethylene dichloride)	EPA 524.2_4.1_1995	
1,2-Dichloropropane	EPA 524.2_4.1_1995	
1,3,5-Trimethylbenzene	EPA 524.2_4.1_1995	
1,3-Dichlorobenzene	EPA 524.2_4.1_1995	
1,3-Dichloropropane	EPA 524.2_4.1_1995	
1,4-Dichlorobenzene	EPA 524.2_4.1_1995	
2,2-Dichloropropane	EPA 524.2_4.1_1995	
2-Butanone (Methyl ethyl ketone, MEK)	EPA 524.2_4.1_1995	
2-Chlorotoluene	EPA 524.2_4.1_1995	
2-Hexanone	EPA 524.2_4.1_1995	
4-Chlorotoluene	EPA 524.2_4.1_1995	
4-Isopropyltoluene (p-Cymene)	EPA 524.2_4.1_1995	

Matrix/Analyte	Method	Notes
Drinking Water		
4-Methyl-2-pentanone (MIBK)	EPA 524.2_4.1_1995	
Acetone	EPA 524.2_4.1_1995	
Acrolein (Propenal)	EPA 524.2_4.1_1995	
Acrylonitrile	EPA 524.2_4.1_1995	
Benzene	EPA 524.2_4.1_1995	
Bromobenzene	EPA 524.2_4.1_1995	
Bromochloromethane	EPA 524.2_4.1_1995	
Bromodichloromethane	EPA 524.2_4.1_1995	
Bromoform	EPA 524.2_4.1_1995	
Carbon disulfide	EPA 524.2_4.1_1995	
Carbon tetrachloride	EPA 524.2_4.1_1995	
Chlorobenzene	EPA 524.2_4.1_1995	
Chlorodibromomethane	EPA 524.2_4.1_1995	
Chloroethane (Ethyl chloride)	EPA 524.2_4.1_1995	
Chloroform	EPA 524.2_4.1_1995	
cis-1,2-Dichloroethylene	EPA 524.2_4.1_1995	
cis-1,3-Dichloropropene	EPA 524.2_4.1_1995	
Dibromomethane	EPA 524.2_4.1_1995	
Dichlorodifluoromethane (Freon-12)	EPA 524.2_4.1_1995	
Dichloromethane (DCM, Methylene chloride)	EPA 524.2_4.1_1995	
Ethylbenzene	EPA 524.2_4.1_1995	
Hexachlorobutadiene	EPA 524.2_4.1_1995	
Isopropylbenzene	EPA 524.2_4.1_1995	
Methyl bromide (Bromomethane)	EPA 524.2_4.1_1995	2
Methyl chloride (Chloromethane)	EPA 524.2_4.1_1995	
Methyl tert-butyl ether (MTBE)	EPA 524.2_4.1_1995	
m-Xylene	EPA 524.2_4.1_1995	
Naphthalene	EPA 524.2_4.1_1995	
n-Butylbenzene	EPA 524.2_4.1_1995	
n-Propylbenzene	EPA 524.2_4.1_1995	
o-Xylene	EPA 524.2_4.1_1995	
p-Xylene	EPA 524.2_4.1_1995	
sec-Butylbenzene	EPA 524.2_4.1_1995	
Styrene	EPA 524.2_4.1_1995	
tert-Butylbenzene	EPA 524.2_4.1_1995	
Tetrachloroethylene (Perchloroethylene)	EPA 524.2_4.1_1995	
Toluene	EPA 524.2_4.1_1995	

Matrix/Analyte	Method	Notes
Drinking Water		
Total Trihalomethanes	EPA 524.2_4.1_1995	
trans-1,2-Dichloroethylene	EPA 524.2_4.1_1995	
trans-1,3-Dichloropropylene	EPA 524.2_4.1_1995	
trans-1,4-Dichloro-2-butene	EPA 524.2_4.1_1995	
Trichloroethene (Trichloroethylene)	EPA 524.2_4.1_1995	
Trichlorofluoromethane (Freon 11)	EPA 524.2_4.1_1995	
Vinyl chloride	EPA 524.2_4.1_1995	
Xylene (total)	EPA 524.2_4.1_1995	
Gross Alpha	EPA 900.0-80	1
Gross Beta	EPA 900.0-80	1
Radium-226	EPA 903.0-80	1
Radium-228	EPA 904.0-80	1
Heterotrophic Bacteria	SM 9215 B (PCA)	
Heterotrophic Bacteria	SM 9215 E SimPlate®	
Fecal coliform-count	SM 9221 B+E1+C (LTB/BGB/EC-MPN)	
Total coliforms-count	SM 9221 B+E1+C (LTB/BGB/EC-MPN)	
E.coli-count	SM 9221 B+F+C (LTB/BGB/EC Mug-MPN)	
Total coliforms-count	SM 9221 B+F+C (LTB/BGB/EC Mug-MPN)	
Total coli/E.coli - detect	SM 9221 D+F (PA Broth/BGB/EC Mug-PA)	
Fecal coliform-count	SM 9222 D (mFC)-06	
Total coli/E.coli - detect	SM 9223 B Colilert 18® (PA)	
E.coli-count	SM 9223 B Colilert 18® QTray®	
Total coliforms-count	SM 9223 B Colilert 18® QTray®	
Non-Potable Water		
non-Polar Extractable Material (TPH)	EPA 1664B (SGT-HEM)	3
n-Hexane Extractable Material (O&G)	EPA 1664B -10 (HEM)	3
Turbidity	EPA 180.1_2_1993	
Mercury	EPA 245.1_3_1994	3
Chloride	EPA 300.0_2.1_1993	
Fluoride	EPA 300.0_2.1_1993	
Nitrate	EPA 300.0_2.1_1993	
Nitrate + Nitrite	EPA 300.0_2.1_1993	
Nitrite	EPA 300.0_2.1_1993	
Orthophosphate	EPA 300.0_2.1_1993	
Sulfate	EPA 300.0_2.1_1993	
Cyanide, Total	EPA 335.4_1_1993	
Chemical Oxygen Demand (COD)	EPA 410.4_2_1993	

Matrix/Analyte	Method	Notes
Non-Potable Water		
Total Organic Halides (TOX)	EPA 9020B_2_1994	2
Alkalinity	SM 2320 B-2011	
Hardness, Total (as CaCO3)	SM 2340 C-2011	
Specific Conductance	SM 2510 B-2011	
Solids, Total	SM 2540 B-2011	
Solids, Total Dissolved	SM 2540 C-2011	
Solids, Total Suspended	SM 2540 D-2011	
Solids, Total Volatile	SM 2540 E-2011	2
Chromium, Hexavalent	SM 3500-Cr B-2011	3,5
Cyanide, Total	SM 4500-CN¯ E-2011	
pH	SM 4500-H+ B-2011	
Ammonia	SM 4500-NH3 H-2011	
Nitrate	SM 4500-NO3¯ F-2011	
Nitrate + Nitrite	SM 4500-NO3¯ F-2011	
Nitrite	SM 4500-NO3¯ F-2011	
Nitrogen, Total Kjeldahl	SM 4500-Norg C-2011	
Orthophosphate	SM 4500-P G-2011	
Phosphorus, Total	SM 4500-P H-2011	
Biochemical Oxygen Demand (BOD)	SM 5210 B-2011	
Carbonaceous BOD (CBOD)	SM 5210 B-2011	
UV Absorbing Organics	SM 5910 B-2011	3
Aluminum	EPA 200.8_5.4_1994	1
Antimony	EPA 200.8_5.4_1994	1
Arsenic	EPA 200.8_5.4_1994	1
Barium	EPA 200.8_5.4_1994	1
Beryllium	EPA 200.8_5.4_1994	1
Cadmium	EPA 200.8_5.4_1994	1
Calcium	EPA 200.8_5.4_1994	
Chromium	EPA 200.8_5.4_1994	1
Cobalt	EPA 200.8_5.4_1994	1
Copper	EPA 200.8_5.4_1994	1
Iron	EPA 200.8_5.4_1994	
Lead	EPA 200.8_5.4_1994	1
Magnesium	EPA 200.8_5.4_1994	
Manganese	EPA 200.8_5.4_1994	1
Mercury	EPA 200.8_5.4_1994	1
Molybdenum	EPA 200.8_5.4_1994	1

Matrix/Analyte	Method	Notes
Non-Potable Water		
Nickel	EPA 200.8_5.4_1994	1
Potassium	EPA 200.8_5.4_1994	
Selenium	EPA 200.8_5.4_1994	1
Silver	EPA 200.8_5.4_1994	1
Sodium	EPA 200.8_5.4_1994	
Thallium	EPA 200.8_5.4_1994	1
Total Uranium	EPA 200.8_5.4_1994	1
Vanadium	EPA 200.8_5.4_1994	1
Zinc	EPA 200.8_5.4_1994	1
1,1,1,2-Tetrachloroethane	EPA 624.1	3
1,1,1-Trichloroethane	EPA 624.1	3
1,1,2,2-Tetrachloroethane	EPA 624.1	3
1,1,2-Trichloroethane	EPA 624.1	3
1,1-Dichloroethane	EPA 624.1	3
1,1-Dichloroethylene	EPA 624.1	3
1,2,3-Trichlorobenzene	EPA 624.1	3
1,2-Dibromoethane (EDB, Ethylene dibromide)	EPA 624.1	3
1,2-Dichlorobenzene	EPA 624.1	3
1,2-Dichloroethane (Ethylene dichloride)	EPA 624.1	3
1,2-Dichloropropane	EPA 624.1	3
1,3-Dichlorobenzene	EPA 624.1	3
1,4-Dichlorobenzene	EPA 624.1	3
2-Butanone (Methyl ethyl ketone, MEK)	EPA 624.1	3
4-Isopropyltoluene (p-Cymene)	EPA 624.1	3
Acetone	EPA 624.1	3
Acrolein (Propenal)	EPA 624.1	3
Acrylonitrile	EPA 624.1	3
Benzene	EPA 624.1	3
Bromodichloromethane	EPA 624.1	3
Bromoform	EPA 624.1	3
Carbon tetrachloride	EPA 624.1	3
Chlorobenzene	EPA 624.1	3
Chlorodibromomethane	EPA 624.1	3
Chloroethane (Ethyl chloride)	EPA 624.1	3
Chloroform	EPA 624.1	3
cis-1,3-Dichloropropene	EPA 624.1	3
Dibromochloropropane	EPA 624.1	3

Matrix/Analyte	Method	Notes
Non-Potable Water		
Dichloromethane (DCM, Methylene chloride)	EPA 624.1	3
Ethylbenzene	EPA 624.1	3
Methyl bromide (Bromomethane)	EPA 624.1	2,3
Methyl chloride (Chloromethane)	EPA 624.1	3
Methyl tert-butyl ether (MTBE)	EPA 624.1	3
Methylene chloride (Dichloromethane)	EPA 624.1	3
Styrene	EPA 624.1	3
Tetrachloroethylene (Perchloroethylene)	EPA 624.1	3
Toluene	EPA 624.1	3
trans-1,2-Dichloroethylene	EPA 624.1	3
trans-1,3-Dichloropropylene	EPA 624.1	3
Trichloroethene (Trichloroethylene)	EPA 624.1	3
Trichlorofluoromethane (Freon 11)	EPA 624.1	3
Vinyl chloride	EPA 624.1	3
Gross Alpha	EPA 900.0-80	1
Gross Beta	EPA 900.0-80	1
Radium-226	EPA 903.0-80	1
Radium-228	EPA 904.0-80	1
Heterotrophic Bacteria	SM 9215 B (PCA)	
Heterotrophic Bacteria	SM 9215 E SimPlate®	
E.coli-count	SM 9221 B+F+C (LTB/BGB/EC Mug-MPN)	
Total coliforms-count	SM 9221 B+F+C (LTB/BGB/EC Mug-MPN)	
Fecal coliform-count	SM 9221 E2+C (A1-MPN)	
Fecal coliform-count	SM 9222 D (mFC)-06	
E.coli-count	SM 9223 B Colilert 18® QTray®	
Total coliforms-count	SM 9223 B Colilert 18® QTray®	
Salmonella	SM 9260 D (MF-counts)	
Solid and Chemical Materials		
Chloride	EPA 300.0_2.1_1993	4
Fluoride	EPA 300.0_2.1_1993	
Nitrate	EPA 300.0_2.1_1993	
Nitrite	EPA 300.0_2.1_1993	
Sulfate	EPA 300.0_2.1_1993	
Cyanide, Total	EPA 335.4_1_1993	
Extractable Organic Halides	EPA 9023-96	
pH	EPA 9045D_2002	
Chlorine	EPA 9076	

Matrix/Analyte	Method	Notes
Solid and Chemical Materials		
Solids, Total Volatile	SM 2540 G-2011	
Cyanide, Total	SM 4500-CN¯ E-2011	
Ammonia	SM 4500-NH3 H-2011	
Nitrate + Nitrite	SM 4500-NO3¯ F-2011	
Nitrogen, Total Kjeldahl	SM 4500-Norg C-2011	
Orthophosphate	SM 4500-P F-2011	
Phosphorus, Total	SM 4500-P F-2011	
Aluminum	EPA 6020B_(7/14)	1
Antimony	EPA 6020B_(7/14)	1
Arsenic	EPA 6020B_(7/14)	1
Barium	EPA 6020B_(7/14)	1
Beryllium	EPA 6020B_(7/14)	1
Boron	EPA 6020B_(7/14)	
Cadmium	EPA 6020B_(7/14)	1
Calcium	EPA 6020B_(7/14)	1
Chromium	EPA 6020B_(7/14)	1
Cobalt	EPA 6020B_(7/14)	1
Copper	EPA 6020B_(7/14)	1
Iron	EPA 6020B_(7/14)	
Lead	EPA 6020B_(7/14)	1
Magnesium	EPA 6020B_(7/14)	1
Manganese	EPA 6020B_(7/14)	1
Mercury	EPA 6020B_(7/14)	1
Molybdenum	EPA 6020B_(7/14)	1
Nickel	EPA 6020B_(7/14)	1
Potassium	EPA 6020B_(7/14)	1
Selenium	EPA 6020B_(7/14)	1
Silver	EPA 6020B_(7/14)	1
Sodium	EPA 6020B_(7/14)	1
Strontium	EPA 6020B_(7/14)	
Thallium	EPA 6020B_(7/14)	1
Tin	EPA 6020B_(7/14)	
Titanium	EPA 6020B_(7/14)	
Total Uranium	EPA 6020B_(7/14)	1
Vanadium	EPA 6020B_(7/14)	1
Zinc	EPA 6020B_(7/14)	1
Mercury	EPA 7471B_(2/07)	4

Matrix/Analyte	Method	Notes
Solid and Chemical Materials		
Benzene	EPA 8021B_2_(12/96)	
Ethylbenzene	EPA 8021B_2_(12/96)	
m+p-xylene	EPA 8021B_2_(12/96)	
o-Xylene	EPA 8021B_2_(12/96)	
Toluene	EPA 8021B_2_(12/96)	
Xylene (total)	EPA 8021B_2_(12/96)	
Aroclor-1016 (PCB-1016)	EPA 8082A_(2/07)	
Aroclor-1221 (PCB-1221)	EPA 8082A_(2/07)	
Aroclor-1232 (PCB-1232)	EPA 8082A_(2/07)	
Aroclor-1242 (PCB-1242)	EPA 8082A_(2/07)	
Aroclor-1248 (PCB-1248)	EPA 8082A_(2/07)	
Aroclor-1254 (PCB-1254)	EPA 8082A_(2/07)	
Aroclor-1260 (PCB-1260)	EPA 8082A_(2/07)	
Diesel range organics (DRO)	WDOE NWTPH-Dx_(1997)	
Gasoline range organics (GRO)	WDOE NWTPH-Gx_(1997)	
1,1,1,2-Tetrachloroethane	EPA 8260D_4_(6/18)	3
1,1,1-Trichloro-2,2,2-trifluoroethane	EPA 8260D_4_(6/18)	3
1,1,1-Trichloro-2-propanone	EPA 8260D_4_(6/18)	3
1,1,1-Trichloroethane	EPA 8260D_4_(6/18)	3
1,1,2,2-Tetrachloroethane	EPA 8260D_4_(6/18)	3
1,1,2-Trichloroethane	EPA 8260D_4_(6/18)	3
1,1,2-Trichlorofluoroethane	EPA 8260D_4_(6/18)	3
1,1-Dichloroethane	EPA 8260D_4_(6/18)	3
1,1-Dichloroethylene	EPA 8260D_4_(6/18)	3
1,1-Dichloropropene	EPA 8260D_4_(6/18)	3
1,2,3-Trichlorobenzene	EPA 8260D_4_(6/18)	3
1,2,3-Trichloropropane	EPA 8260D_4_(6/18)	3
1,2,3-Trimethylbenzene	EPA 8260D_4_(6/18)	3
1,2,4-Trichlorobenzene	EPA 8260D_4_(6/18)	3
1,2,4-Trimethylbenzene	EPA 8260D_4_(6/18)	3
1,2-Dibromo-3-chloropropane (DBCP)	EPA 8260D_4_(6/18)	3
1,2-Dibromoethane (EDB, Ethylene dibromide)	EPA 8260D_4_(6/18)	3
1,2-Dichlorobenzene	EPA 8260D_4_(6/18)	3
1,2-Dichloroethane (Ethylene dichloride)	EPA 8260D_4_(6/18)	3
1,2-Dichloropropane	EPA 8260D_4_(6/18)	3
1,3,5-Trimethylbenzene	EPA 8260D_4_(6/18)	3
1,3-Dichlorobenzene	EPA 8260D_4_(6/18)	3

Matrix/Analyte	Method	Notes
Solid and Chemical Materials		
1,3-Dichloropropane	EPA 8260D_4_(6/18)	3
1,3-Dichloropropene	EPA 8260D_4_(6/18)	3
1,4-Dichlorobenzene	EPA 8260D_4_(6/18)	3
2,2-Dichloropropane	EPA 8260D_4_(6/18)	3
2-Butanone (Methyl ethyl ketone, MEK)	EPA 8260D_4_(6/18)	3
2-Chlorotoluene	EPA 8260D_4_(6/18)	3
2-Hexanone	EPA 8260D_4_(6/18)	3
2-Hexene	EPA 8260D_4_(6/18)	3
4-Bromofluorobenzene	EPA 8260D_4_(6/18)	3
4-Chlorotoluene	EPA 8260D_4_(6/18)	3
4-Isopropyltoluene (p-Cymene)	EPA 8260D_4_(6/18)	3
4-Methyl-2-pentanone (MIBK)	EPA 8260D_4_(6/18)	3
Acetone	EPA 8260D_4_(6/18)	3
Acrolein (Propenal)	EPA 8260D_4_(6/18)	3,4
Acrylonitrile	EPA 8260D_4_(6/18)	3
Benzene	EPA 8260D_4_(6/18)	3
Bromobenzene	EPA 8260D_4_(6/18)	3
Bromochloromethane	EPA 8260D_4_(6/18)	3
Bromodichloromethane	EPA 8260D_4_(6/18)	3
Bromoethane (Ethyl Bromide)	EPA 8260D_4_(6/18)	3
Bromoethene	EPA 8260D_4_(6/18)	3
Bromoform	EPA 8260D_4_(6/18)	3
Carbon disulfide	EPA 8260D_4_(6/18)	3
Carbon tetrachloride	EPA 8260D_4_(6/18)	3
Chlorobenzene	EPA 8260D_4_(6/18)	3
Chlorodibromomethane	EPA 8260D_4_(6/18)	3
Chloroethane (Ethyl chloride)	EPA 8260D_4_(6/18)	3
Chloroform	EPA 8260D_4_(6/18)	3
cis & trans-1,2-Dichloroethene	EPA 8260D_4_(6/18)	3
cis-1,2-Dichloroethylene	EPA 8260D_4_(6/18)	3
cis-1,3-Dichloropropene	EPA 8260D_4_(6/18)	3
Dibromomethane	EPA 8260D_4_(6/18)	3
Ethylbenzene	EPA 8260D_4_(6/18)	3
Hexachlorobutadiene	EPA 8260D_4_(6/18)	3
Iodomethane (Methyl iodide)	EPA 8260D_4_(6/18)	3
Isopropylbenzene	EPA 8260D_4_(6/18)	3
m+p-xylene	EPA 8260D_4_(6/18)	3

Matrix/Analyte	**Method**	**Notes**
Solid and Chemical Materials		
Methyl bromide (Bromomethane)	EPA 8260D_4_(6/18)	3
Methyl chloride (Chloromethane)	EPA 8260D_4_(6/18)	3
Methyl tert-butyl ether (MTBE)	EPA 8260D_4_(6/18)	3
Methylene chloride (Dichloromethane)	EPA 8260D_4_(6/18)	3
Naphthalene	EPA 8260D_4_(6/18)	3
n-Butylbenzene	EPA 8260D_4_(6/18)	3
n-Propylbenzene	EPA 8260D_4_(6/18)	3
o-Xylene	EPA 8260D_4_(6/18)	3
sec-Butylbenzene	EPA 8260D_4_(6/18)	3
Styrene	EPA 8260D_4_(6/18)	3
tert-Butylbenzene	EPA 8260D_4_(6/18)	3
Tetrachloroethylene (Perchloroethylene)	EPA 8260D_4_(6/18)	3
Toluene	EPA 8260D_4_(6/18)	3
trans-1,2-Dichloroethylene	EPA 8260D_4_(6/18)	3
trans-1,3-Dichloropropylene	EPA 8260D_4_(6/18)	3
trans-1,4-Dichloro-2-butene	EPA 8260D_4_(6/18)	3
Trichloroethene (Trichloroethylene)	EPA 8260D_4_(6/18)	3
Trichlorofluoromethane (Freon 11)	EPA 8260D_4_(6/18)	3
Vinyl acetate	EPA 8260D_4_(6/18)	3,4
Vinyl chloride	EPA 8260D_4_(6/18)	3
Xylene (total)	EPA 8260D_4_(6/18)	3
Fecal coliform-count	EPA 1680 Biosolids (LTB/EC-MPN)	
Salmonella	EPA 1682 Biosolids (MSRV)	
Fecal coliform-count	SM 9221 E2+C (A1-MPN)	

Accredited Parameter Note Detail

1) Accreditation based in part on recognition of Florida NELAP accreditation. 2) Provisional accreditation pending acceptable PT completion. 3) Interim accreditation pending the successful completion of an on-site audit to verify method capabilities (WAC 173-50-100). 4) Accreditation is limited to liquid matrix. 5) Provisional accreditation pending an acceptable response to the technical report.

Rebecca Wood

Authentication Signature
Rebecca Wood, Lab Accreditation Unit Supervisor

12/02/2022

Date

Appendix B. Well Logs for Potential Observation Wells

WATER WELL REPORT

Original & 1st copy – Ecology, 2nd copy – owner, 3rd copy – driller

ECOLOGY

Construction/Decommission (*"x" in circle*)
☒ Construction
○ Decommission *ORIGINAL INSTALLATION Notice of Intent Number* 186525

CURRENT
Notice of Intent No. ALG 602
Unique Ecology Well ID Tag No. W 205211
Water Right Permit No. Emergency Drought Permit G4-35032
Property Owner Name City of Goldendale
Well Street Address So. end Dingmon Rd
City Goldendale County Klickitat
Location NE 1/4-1/4 NE 1/4 Sec 28 Twn 4N R 16E EWM or WWM circle one
Lat/Long (s, t, r Still **REQUIRED**) Lat Deg ______ Lat Min/Sec ______ Long Deg ______ Long Min/Sec ______
Tax Parcel No. ______

PROPOSED USE: ☐ Domestic ☐ Industrial ☒ Municipal ☐ DeWater ☐ Irrigation ☐ Test Well ☐ Other ______

TYPE OF WORK: Owner's number of well (if more than one) ______
☐ New well ☒ Reconditioned *Method:* ☐ Dug ☐ Bored ☐ Driven
☐ Deepened ☐ Cable ☐ Rotary ☐ Jetted

DIMENSIONS: Diameter of well 10" inches, drilled ______ ft.
Depth of completed well 534 ft.

CONSTRUCTION DETAILS
Casing Installed: ☐ Welded Existing 10" Diam. from ______ ft. to 29'7 ft.
☐ Liner installed 8" Diam. from + 1' ft. to 120'2 ft.
☐ Threaded ______" Diam. from ______ ft. to ______ ft.

Perforations: ☐ Yes ☒ No
Type of perforator used ______
SIZE of perfs ______ in. by ______ in. and no. of perfs ______ from ______ ft. to ______ ft

Screens: ☐ Yes ☒ No ☐ K-Pac Location ______
Manufacturer's Name ______
Type ______ Model No. ______
Diam. ______ Slot size ______ from ______ ft. to ______ ft.
Diam. ______ Slot size ______ from ______ ft. to ______ ft.

Gravel/Filter packed: ☐ Yes ☒ No ☐ Size of gravel/sand ______
Materials placed from ______ ft. to ______ ft.

Surface Seal: ☒ Yes ☐ No To what depth? 29' / 120'2 ft.
Material used in seal Cement / Cement grout
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? ______ Depth of strata ______
Method of sealing strata off ______

PUMP: Manufacturer's Name ______
Type: ______ H.P. ______

WATER LEVELS: Land-surface elevation above mean sea level ______ ft.
Static level 99'6 ft. below top of well Date 11-22-05
Artesian pressure ______ lbs. per square inch Date ______
Artesian water is controlled by ______ (cap, valve, etc.)

WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☒ No If yes, by whom? ______
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test 11-14-05
Bailer test ______ gal./min. with ______ ft. drawdown after ______ hrs.
Airtest 300+ gal./min. with stem set at 530 ft. for 1 hrs.
Artesian flow ______ g.p.m. Date ______
Temperature of water ______ Was a chemical analysis made? ☐ Yes ☒ No

CONSTRUCTION OR DECOMMISSION PROCEDURE

Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information. (USE ADDITIONAL SHEETS IF NECESSARY.)

MATERIAL	FROM	TO
Reamed existing 10" hole to		
120 ft. w/10" stabilizer &		
bit to straighten hole.		
Set 120 ft. 2" of 8" casing		
with cementing shoe pressure		
grouted thru 2" pipe & shoe		
with 50 sks. neat cement,		
Drilled cement shoe off,		
clean well out to 534 ft		

RECEIVED
DEC 1 4 2005
Washington State Department of Ecology

Start Date 11-8-05 Completed Date 11-22-05

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

☐ Driller ☐ Engineer ☐ Trainee Name (Print) Matt Golec
Driller/Engineer/Trainee Signature
Driller or trainee License No. 2502

If TRAINEE,
Driller's Licensed No. ______
Driller's Signature ______

Drilling Company Hansen Drilling Co. Inc.
Address 6711 NE. 58th Ave.
City, State, Zip Vancouver, Wa 98661
Contractor's Registration No. HANSED*377NT Date 11-30-05

Ecology is an Equal Opportunity Employer

ECY 050-1-20 (Rev 3/05) The Department of Ecology does NOT warranty the Data and/or Information on this Well Report.

File Original and First Copy with
Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Application No
Permit No.

(1) **OWNER:** Name Grant Gibbs Address Loop Drive, Goldendale, Wa.

(2) **LOCATION OF WELL:** County Klickitat — SW ¼ NE ¼ Sec. 28 T. 4 N., R. 16 W.M.

uring and distance from section or subdivision corner

(3) **PROPOSED USE:** Domestic ☒ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐

(4) **TYPE OF WORK:** Owner's number of well (if more than one) ....

New well ☒ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☐ Driven ☐
Reconditioned ☐ Rotary ☒ Jetted ☐

(5) **DIMENSIONS:** Diameter of well 6 inches.
Drilled 115 ft. Depth of completed well 115 ft.

(6) **CONSTRUCTION DETAILS:**

Casing installed: 6" Diam. from +1 ft. to 38 ft.
Threaded ☐ ...." Diam. from .... ft. to .... ft.
Welded ☒ ...." Diam. from .... ft. to .... ft.

Perforations: Yes ☐ No ☒
Type of perforator used....
SIZE of perforations .... in. by .... in.
.... perforations from .... ft. to .... ft.
.... perforations from .... ft. to .... ft.
.... perforations from .... ft. to .... ft.

Screens: Yes ☐ No ☒
Manufacturer's Name....
Type.... Model No....
Diam. .... Slot size .... from .... ft. to .... ft.
Diam. .... Slot size .... from .... ft. to .... ft.

Gravel packed: Yes ☐ No ☒ Size of gravel: ....
Gravel placed from .... ft. to .... ft.

Surface seal: Yes ☒ No ☐ To what depth? 38' ft.
Material used in seal Cement + Bentonite
Did any strata contain unusable water? Yes ☐ No ☒
Type of water?.... Depth of strata....
Method of sealing strata off....

(7) **PUMP:** Manufacturer's Name Berkeley
Type: Sub H.P. 1

(8) **WATER LEVELS:** Land-surface elevation above mean sea level.... ft.
Static level 30 ft. below top of well Date 5/30/74
Artesian pressure .... lbs. per square inch Date....
Artesian water is controlled by .... (Cap, valve, etc.)

(9) **WELL TESTS:** Drawdown is amount water level is lowered below static level

Was a pump test made? Yes ☐ No ☒ If yes, by whom?....

Yield:	gal./min. with	ft. drawdown after	hrs.
"	"	"	"
"	"	"	"

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test ....
Bailer test 60+ gal./min. with 50 ft. drawdown after 1 hrs.
Artesian flow .... g.p.m. Date....
Temperature of water 54° Was a chemical analysis made? Yes ☐ No ☒

(10) **WELL LOG:**

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
Clay + Shale Brown	0	32'
Basalt, Grey	32'	68'
Conglomerate, Frac. Ves. Basalt + Claystones Yellow + White	68'	99'
Basalt Ves., Grey	99'	104'
Cinder Red	104'	110'
Basalt, Grey	110'	115'

RECEIVED
NOV 25 1974
DEPARTMENT OF ECOLOGY
CENTRAL REGIONAL OFFICE

Work started 5/30, 1974 Completed 5/30, 1974

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME O'Leary Well Drilling Inc. (Person, firm, or corporation) (Type or print)
Address P.O. Box 247-A Goldendale, Wa.
[Signed] Russell L. O'Leary (Well Driller)
License No. 0375 Date 6/15, 1974

(USE ADDITIONAL SHEETS IF NECESSARY)

S. F. No. 7356—OS—(Rev. 4-71).

3

Softball Field

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Application No. ....

Permit No. ....

98620

(1) **OWNER:** Name GOLDENDALE SCHOOL DIST. No. 404 Address 603 S ROOSEVELT AVE GOLDENDALE WA

(2) **LOCATION OF WELL:** County KLICKITAT — NE ¼ [illegible] ¼ Sec. [illegible] T. 4 N., R. 16 W.M.
Bearing and distance from section or subdivision corner SW 21

(3) **PROPOSED USE:** Domestic ☐ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐

(4) **TYPE OF WORK:** Owner's number of well (if more than one) #1
New well ☒ Deepened ☐ Reconditioned ☐
Method: Dug ☐ Bored ☐ Cable ☐ Driven ☐ Rotary ☒ Jetted ☐

(5) **DIMENSIONS:** Diameter of well 6 inches.
Drilled 360 ft. Depth of completed well 360 ft.

(6) **CONSTRUCTION DETAILS:**

Casing installed: 6" Diam. from — ft. to 20 ft.
Threaded ☐ ......" Diam. from ...... ft. to ...... ft.
Welded ☐ ......" Diam. from ...... ft. to ...... ft.

Perforations: Yes ☐ No ☒
Type of perforator used ....
SIZE of perforations ...... in. by ...... in.
...... perforations from ...... ft. to ...... ft.
...... perforations from ...... ft. to ...... ft.
...... perforations from ...... ft. to ...... ft.

Screens: Yes ☐ No ☒
Manufacturer's Name ....
Type .... Model No. ....
Diam. ...... Slot size ...... from ...... ft. to ...... ft.
Diam. ...... Slot size ...... from ...... ft. to ...... ft.

Gravel packed: Yes ☐ No ☒ Size of gravel: ....
Gravel placed from ...... ft. to ...... ft.

Surface seal: Yes ☒ No ☐ To what depth? 19 ft.
Material used in seal cement grout & bentonite
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? .... Depth of strata ....
Method of sealing strata off ....

(7) **PUMP:** Manufacturer's Name ....
Type: .... H.P. ....

(8) **WATER LEVELS:** Land-surface elevation above mean sea level .... ft.
Static level 50 ft. below top of well Date 7-29
Artesian pressure .... lbs. per square inch Date ....
Artesian water is controlled by .... (Cap, valve, etc.)

(9) **WELL TESTS:** Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☒ If yes, by whom? ....
Yield: ...... gal./min. with ...... ft. drawdown after ...... hrs.

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test ....
Bailer test 35 gal./min. with ...... ft. drawdown after ...... hrs.
Artesian flow .... g.p.m. Date ....
Temperature of water .... Was a chemical analysis made? Yes ☐ No ☐

(10) **WELL LOG:**

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.

MATERIAL	FROM	TO
Top Soil	0	8'
basalt, brown & brown clay	8'	13'
basalt, brown, med hard	13'	20'
basalt gray, hard	20'	56'
basalt, brown & brown clay & black clay (water bearing) (4 gpm)	56'	61'
basalt, brown & brown white clay (water bearing	61'	65'
basalt, black, hard	65'	77'
basalt, gray, hard	77'	117'
basalt, gray & black, hard, crevised, (water bearing 7 gpm)	117'	123'
basalt, gray, hard	123'	190'
basalt, gray & black, hard	190'	200'
basalt, gray, hard	200'	292'
basalt, black, porous (water bearing 25 gpm)	292'	298'
basalt, gray, hard	298	360'

Work started 7-27- 1978. Completed 7-29- 1978

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME M-K DRILLING CO. (Person, firm, or corporation) (Type or print)

Address ST. RT. 2 Box 100 LYLE, WA 98635

[Signed] Charles S Moore (Well Driller)

License No. 0833 Date 8-4-, 1978

(USE ADDITIONAL SHEETS IF NECESSARY)

ECY 050-1-20

File Original and First Copy with
Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT
STATE OF WASHINGTON

Application No. ....
Permit No. G4-25678P

(1) **OWNER:** Name Ed Hoctor Address Star Rt 607 Bx 65

(2) **LOCATION OF WELL:** County Klickitat 98620 — SE ¼ NW ¼ Sec. 4 T. 3 N., R. 16E W.M.

Bearing and distance from section or subdivision corner

F

(3) **PROPOSED USE:** Domestic ☐ Industrial ☐ Municipal ☐ Irrigation ☒ Test Well ☐ Other ☐

(4) **TYPE OF WORK:** Owner's number of well (if more than one) 1
New well ☒ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☐ Driven ☐
Reconditioned ☐ Rotary ☒ Jetted ☐

(5) **DIMENSIONS:** Diameter of well 12 inches.
Drilled 537 ft. Depth of completed well 512 ft.

(6) **CONSTRUCTION DETAILS:**
Casing installed: 10" Diam. from +1 ft. to 48 ft.
Threaded ☐ ......" Diam. from ...... ft. to ...... ft.
Welded ☒ ......" Diam. from ...... ft. to ...... ft.

Perforations: Yes ☐ No ☒
Type of perforator used ......
SIZE of perforations ...... in. by ...... in.
...... perforations from ...... ft. to ...... ft.
...... perforations from ...... ft. to ...... ft.
...... perforations from ...... ft. to ...... ft.

Screens: Yes ☐ No ☒
Manufacturer's Name ......
Type ...... Model No. ......
Diam. ...... Slot size ...... from ...... ft. to ...... ft.
Diam. ...... Slot size ...... from ...... ft. to ...... ft.

Gravel packed: Yes ☐ No ☒ Size of gravel: ......
Gravel placed from ...... ft. to ...... ft.

Surface seal: Yes ☒ No ☐ To what depth? 38 ft.
Material used in seal Cement & Bentonite
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? ...... Depth of strata ......
Method of sealing strata off ......

(7) **PUMP:** Manufacturer's Name ......
Type: ...... H.P. ......

(8) **WATER LEVELS:** Land-surface elevation above mean sea level...... ft.
Static level 110 ft. below top of well Date 2-7-81
Artesian pressure ...... lbs. per square inch Date ......
Artesian water is controlled by ...... (Cap, valve, etc.)

(9) **WELL TESTS:** Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☒ If yes, by whom? ......
Yield: gal./min. with ft. drawdown after hrs.
" Air Test 280 " 2 "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test ......
Bailer test ...... gal./min. with ...... ft. drawdown after ...... hrs.
Artesian flow ...... g.p.m. Date ......
Temperature of water ...... Was a chemical analysis made? Yes ☐ No ☐

(10) **WELL LOG:**

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
Overburden	0	7
Basalt Gray	7	35
Basalt Fractured	35	45
Basalt Gray	45	85
Volcanic Rock	85	104
Hole was Cemented to 115'		
with Pressure Grout		
(Neat Cement)		
Basalt Gray	104	360
Basalt Gray Hard	360	460
Volcanic Flow	460	480
Basalt Fractured	480	497
Volcanic Flow	497	537

Work started 11-6 1980 Completed 2-9 1981

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Don Foreman Drilling (Person, firm, or corporation) (Type or print)
Address P.O Bx 296 Estacada Ore
[Signed] Don Foreman (Well Driller)
License No. 0144 Date 2/7, 1981

(USE ADDITIONAL SHEETS IF NECESSARY)

√DK 2.11.81

ECY 050-1-20

Appendix C. Aspect Field Data Sheets

ANATEK LABS

Chain of Custody Record

Anatek Labs, Inc.
1282 Alturas Drive, Moscow ID 83843 (208) 883-2839
504 E Sprague Ste D, Spokane WA 99202 (509) 838-3999

Company Name:
Address:
City: State: Zip:
Phone:
Email Address(es):

Project Manager:
Project Name & # :
Purchase Order #:
Sampler Name & Phone:

Turn Around Time & Reporting

Please refer to our normal turn around times at www.anateklabs.com/pricing-lists

__Normal
Next Day*
2nd Day*
__Other*

__Phone
__Email

*All rush order requests must have prior approval

List Analyses Requested

				Preservative:											
Lab ID	Sample Identification	Sampling Date/Time	Matrix	# of Containers	Sample Volume										

	Printed Name	Signature	Company	Date	Time
Relinquished by					
Received by					
Relinquished by					
Received by					
Relinquished by					
Received by					

Note Special Instructions/Comments

Inspection Checklist

Received Intact?	Y	N
Labels & Chains Agree?	Y	N
Containers Sealed?	Y	N
No VOC Head Space?	Y	N
Cooler?	Y	N
Ice/Ice Packs Present?	Y	N

Temperature (°C):____________________
Number of Containers:________________
Shipped Via:_________________________
Preservative:________________________
____
Date & Time:_________________________
Inspected By:________________________

Samples submitted to Anatek Labs may be subcontacted to other accredited labs if necessary. This message serves as notice of this possibility. Subcontracted analyses will be clearly noted on the analytical report.

Aspect
CONSULTING

DAILY REPORT

350 Madison Avenue North
Bainbridge Island, Washington 98110
(206) 780-9370

710 Second Avenue, Suite 550
Seattle, Washington 98104
(206) 328-7443

DATE: Field - Enter Date Mo/Day/Year	**PROJECT NO.** Field - Enter Project No.	**WEATHER:**
PROJECT NAME: Enter - Project Name	**CLIENT:**	
EQUIPMENT USED:	**PROJECT LOCATION:**	

THE FOLLOWING WAS NOTED:

COPIES TO: File, Client	**Aspect Consulting PROJECT MANAGER:** Name, Designation
Document1	**Page 1 of 1** **FIELD REP.:** Name, Designation

GROUNDWATER SAMPLING RECORD	**WELL NUMBER:** _______ **Page:**____ **of** ____

Project Name: ____________________ Project Number:____________________

Date: ____________________

Developed by: ____________________

Measuring Point of Well:____________________

Screened Interval (ft. TOC)____________________

Filter Pack Interval (ft. TOC) ____________________

Starting Water Level (ft TOC):____________________

Casing Stickup (ft):____________________

Total Depth (ft TOC):____________________

Casing Diameter (inches):____________________

Casing Volume ___________ (ft Water) x ___________ (Lpfv)(gpf) = ___________ (L)(gal)

Casing volumes: 2" = 0.16 gpf 4" = 0.65 gpf 6" = 1.47 gpf

2" = 0.62 Lpf 4" = 2.46 Lpf 6" = 5.56 Lpf

Sample Intake Depth (ft TOC):___________

PURGING MEASUREMENTS

Criteria:		Typical 0.1-0.5 Lpm	Stable and minimal and	na	± 3%	± 10%	± 0.1	± 10 mV	± 10%	
Time	Cumul. Volume (gal or L)	Purge Rate (gpm or Lpm)	Water Level (ft)	Temp. (C or F)	Specific Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	pH	Eh ORP (mv)	Turbidity (NTU)	Comments

Total Gallons Purged: ____________________ Total Casing Volumes Removed: ____________

Ending Water Level (ft TOC): ____________________ Ending Total Depth (ft TOC):____________

SAMPLE INVENTORY

Time	Volume	Bottle Type		Quantity	Filtration	Preservation	Appearance		Remarks
							Color	Turbidity & Sediment	

METHODS

Sampling Equipment with IDs: ____________________

Purging Equipment: ____________________ Decon Equipment: ____________________

Disposal of Discharged Water: ____________________

Observations/Comments: ____________________

____

Aspect
CONSULTING

PUMPING TEST DATA

Page ____ of ____

Project: ______________________________ Project No. __________
Date: ______________________________
Pumping well: ______________________________
Water level measuring point: ______________________________
MP to ground surface (ft): ______________________________
Depth to initial static water level (ft):

Date & Clock Time	Elapsed Time (minutes)	Depth to Water (feet)	Drawdown Below Initial SWL (feet)	Flow Totalizer (gallons)	Discharge Rate (gpm)	

Appendix D. Glossaries, Acronyms, and Abbreviations

Glossary of General Terms

Ambient: Background or away from point sources of contamination. Surrounding environmental condition.

Conductivity: A measure of water's ability to conduct an electrical current. Conductivity is related to the concentration and charge of dissolved ions in water.

Dissolved oxygen (DO): A measure of the amount of oxygen dissolved in water.

Fecal coliform (FC): That portion of the coliform group of bacteria which is present in intestinal tracts and feces of warm-blooded animals as detected by the product of acid or gas from lactose in a suitable culture medium within 24 hours at 44.5 plus or minus 0.2 degrees Celsius. Fecal coliform bacteria are "indicator" organisms that suggest the possible presence of disease-causing organisms. Concentrations are measured in colony forming units per 100 milliliters of water (cfu/100 mL).

Margin of safety: Required component of TMDLs that accounts for uncertainty about the relationship between pollutant loads and quality of the receiving water body.

pH: A measure of the acidity or alkalinity of water. A low pH value (0 to 7) indicates that an acidic condition is present, while a high pH (7 to 14) indicates a basic or alkaline condition. A pH of 7 is considered to be neutral. Since the pH scale is logarithmic, a water sample with a pH of 8 is ten times more basic than one with a pH of 7.

Sediment: Soil and organic matter that is covered with water (for example, river or lake bottom).

Streamflow: Discharge of water in a surface stream (river or creek).

Total suspended solids (TSS): Portion of solids retained by a filter.

Turbidity: A measure of water clarity. High levels of turbidity can have a negative impact on aquatic life.

Watershed: A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

Acronyms and Abbreviations

DO	Dissolved oxygen
DOC	Dissolved organic carbon
e.g.	For example
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management database

EPA	U.S. Environmental Protection Agency
et al.	And others
FC	Fecal coliform
FS	Feasibility Study
GPS	Global Positioning System
i.e.	In other words
MQO	Measurement quality objective
NPDES	National Pollutant Discharge Elimination System
PBDE	Polybrominated diphenyl ethers
QA	Quality assurance
QC	Quality control
RPD	Relative percent difference
RSD	Relative standard deviation
SOP	Standard operating procedures
SRM	Standard reference materials
TOC	Total organic carbon
TSS	Total suspended solids
USFS	United States Forest Service
USGS	United States Geological Survey
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WQA	Water Quality Assessment
WRIA	Water Resource Inventory Area

Units of Measurement

°C	degrees centigrade
cfs	cubic feet per second
cfu	colony forming units
cms	cubic meters per second, a unit of flow
dw	dry weight
ft	feet
g	gram, a unit of mass

kcfs	1000 cubic feet per second
kg	kilograms, a unit of mass equal to 1,000 grams
kg/d	kilograms per day
km	kilometer, a unit of length equal to 1,000 meters
L/s	liters per second (0.03531 cubic foot per second)
m	meter
mm	millimeter
mg	milligram
mgd	million gallons per day
mg/d	milligrams per day
mg/kg	milligrams per kilogram (parts per million)
mg/L	milligrams per liter (parts per million)
mg/L/hr	milligrams per liter per hour
mL	milliliter
mmol	millimole or one-thousandth of a mole
mole	an International System of Units (IS) unit of matter
ng/g	nanograms per gram (parts per billion)
ng/kg	nanograms per kilogram (parts per trillion)
ng/L	nanograms per liter (parts per trillion)
NTU	nephelometric turbidity units
pg/g	picograms per gram (parts per trillion)
pg/L	picograms per liter (parts per quadrillion)
psu	practical salinity units
s.u.	standard units
µg/g	micrograms per gram (parts per million)
µg/kg	micrograms per kilogram (parts per billion)
µg/L	micrograms per liter (parts per billion)
µm	micrometer
µM	micromolar (a chemistry unit)
µmhos/cm	micromhos per centimeter
µS/cm	microsiemens per centimeter, a unit of conductivity

ww	wet weight

Quality Assurance Glossary

Accreditation: A certification process for laboratories, designed to evaluate and document a lab's ability to perform analytical methods and produce acceptable data (Kammin, 2010). For Ecology, it is defined according to WAC 173-50-040: "Formal recognition by [Ecology] that an environmental laboratory is capable of producing accurate and defensible analytical data."

Accuracy: The degree to which a measured value agrees with the true value of the measured property. USEPA recommends that this term not be used, and that the terms *precision* and *bias* be used to convey the information associated with the term *accuracy* (USEPA, 2014).

Analyte: An element, ion, compound, or chemical moiety (pH, alkalinity) which is to be determined. The definition can be expanded to include organisms, e.g., fecal coliform, Klebsiella (Kammin, 2010).

Bias: Discrepancy between the expected value of an estimator and the population parameter being estimated (Gilbert, 1987; USEPA, 2014).

Blank: A synthetic sample, free of the analyte(s) of interest. For example, in water analysis, pure water is used for the blank. In chemical analysis, a blank is used to estimate the analytical response to all factors other than the analyte in the sample. In general, blanks are used to assess possible contamination or inadvertent introduction of analyte during various stages of the sampling and analytical process (USGS, 1998).

Calibration: The process of establishing the relationship between the response of a measurement system and the concentration of the parameter being measured (Ecology, 2004).

Check standard: A substance or reference material obtained from a source independent from the source of the calibration standard; used to assess bias for an analytical method. This is an obsolete term, and its use is highly discouraged. See Calibration Verification Standards, Lab Control Samples (LCS), Certified Reference Materials (CRM), and/or spiked blanks. These are all check standards but should be referred to by their actual designator, e.g., CRM, LCS (Kammin, 2010; Ecology, 2004).

Comparability: The degree to which different methods, data sets and/or decisions agree or can be represented as similar; a data quality indicator (USEPA, 2014; USEPA, 2020).

Completeness: The amount of valid data obtained from a project compared to the planned amount. Usually expressed as a percentage. A data quality indicator (USEPA, 2014; USEPA 2020).

Continuing Calibration Verification Standard (CCV): A quality control (QC) sample analyzed with samples to check for acceptable bias in the measurement system. The CCV is usually a midpoint calibration standard that is re-run at an established frequency during the course of an analytical run (Kammin, 2010).

Control chart: A graphical representation of quality control results demonstrating the performance of an aspect of a measurement system (Kammin, 2010; Ecology 2004).

Control limits: Statistical warning and action limits calculated based on control charts. Warning limits are generally set at +/- 2 standard deviations from the mean, action limits at +/- 3 standard deviations from the mean (Kammin, 2010).

Data integrity: A qualitative DQI that evaluates the extent to which a data set contains data that is misrepresented, falsified, or deliberately misleading (Kammin, 2010).

Data quality indicators (DQI): Commonly used measures of acceptability for environmental data. The principal DQIs are precision, bias, representativeness, comparability, completeness, sensitivity, and integrity (USEPA, 2006).

Data quality objectives (DQO): Qualitative and quantitative statements derived from systematic planning processes that clarify study objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions (USEPA, 2006).

Data set: A grouping of samples organized by date, time, analyte, etc. (Kammin, 2010).

Data validation: The process of determining that the data satisfy the requirements as defined by the data user (USEPA, 2020). There are various levels of data validation (USEPA, 2009).

Data verification: Examination of a data set for errors or omissions, and assessment of the Data Quality Indicators related to that data set for compliance with acceptance criteria (MQOs). Verification is a detailed quality review of a data set (Ecology, 2004).

Detection limit (limit of detection)**:** The concentration or amount of an analyte which can be determined to a specified level of certainty to be greater than zero (Ecology, 2004).

Duplicate samples: Two samples taken from and representative of the same population, and carried through and steps of the sampling and analytical procedures in an identical manner. Duplicate samples are used to assess variability of all method activities including sampling and analysis (USEPA, 2014).

Field blank: A blank used to obtain information on contamination introduced during sample collection, storage, and transport (Ecology, 2004).

Initial Calibration Verification Standard (ICV): A QC sample prepared independently of calibration standards and analyzed along with the samples to check for acceptable bias in the measurement system. The ICV is analyzed prior to the analysis of any samples (Kammin, 2010).

Laboratory Control Sample (LCS)/LCS duplicate: A sample of known composition prepared using contaminant-free water or an inert solid that is spiked with analytes of interest at the midpoint of the calibration curve or at the level of concern. It is prepared and analyzed in the same batch of regular samples using the same sample preparation method, reagents, and analytical methods employed for regular samples. Monitors a lab’s performance for bias and precision (USEPA, 2014).

Matrix spike/Matrix spike duplicate: A QC sample prepared by adding a known amount of the target analyte(s) to an aliquot of a sample to check for bias and precision errors due to interference or matrix effects (Ecology, 2004).

Measurement Quality Objectives (MQOs)**:** Performance or acceptance criteria for individual data quality indicators, usually including precision, bias, sensitivity, completeness, comparability, and representativeness (USEPA, 2006).

Measurement result: A value obtained by performing the procedure described in a method (Ecology, 2004).

Method: A formalized group of procedures and techniques for performing an activity (e.g., sampling, chemical analysis, data analysis), systematically presented in the order in which they are to be executed (USEPA, 2001).

Method blank: A blank prepared to represent the sample matrix, prepared and analyzed with a batch of samples. A method blank will contain all reagents used in the preparation of a sample, and the same preparation process is used for the method blank and samples (Ecology, 2004; Kammin, 2010).

Method Detection Limit (MDL): The minimum measured concentration of a substance that can be reported with 99% confidence that the measured concentration is distinguishable from method blank results (USEPA, 2016). MDL is a measure of the capability of an analytical method of distinguished samples that do not contain a specific analyte from a sample that contains a low concentration of the analyte (USEPA, 2020).

Minimum level: Either the sample concentration equivalent to the lowest calibration point in a method or a multiple of the method detection limit (MDL), whichever is higher. For the purposes of NPDES compliance monitoring, EPA considers the following terms to be synonymous: “quantitation limit,” “reporting limit,” and “minimum level” (40 CFR 136).

Parameter: A specified characteristic of a population or sample. Also, an analyte or grouping of analytes. Benzene and nitrate + nitrite are all parameters (Kammin, 2010; Ecology, 2004).

Population: The hypothetical set of all possible observations of the type being investigated (Ecology, 2004).

Precision: The extent of random variability among replicate measurements of the same property; a data quality indicator (USGS, 1998).

Quality assurance (QA): A set of activities designed to establish and document the reliability and usability of measurement data (Kammin, 2010).

Quality Assurance Project Plan (QAPP): A document that describes the objectives of a project, and the processes and activities necessary to develop data that will support those objectives (Kammin, 2010; Ecology, 2004).

Quality control (QC): The routine application of measurement and statistical procedures to assess the accuracy of measurement data (Ecology, 2004).

Relative Percent Difference (RPD): RPD is commonly used to evaluate precision. The following formula is used:

$$RPD = [Abs(a-b)/((a + b)/2)] * 100\%$$

where “Abs()” is absolute value and a and b are results for the two replicate samples. RPD can be used only with 2 values. Percent Relative Standard Deviation is (%RSD) is used if there are results for more than 2 replicate samples (Ecology, 2004).

Relative Standard Deviation (RSD): A statistic used to evaluate precision in environmental analysis. It is determined in the following manner:

$$RSD = (100\% * s)/x$$

where s is the sample standard deviation and x is the mean of results from more than two replicate samples (Kammin, 2010).

Replicate samples: Two or more samples taken from the environment at the same time and place, using the same protocols. Replicates are used to estimate the random variability of the material sampled (USGS, 1998).

Reporting level: Unless specified otherwise by a regulatory authority or in a discharge permit, results for analytes that meet the identification criteria (i.e., rules for determining qualitative presence/absence of an analyte) are reported down to the concentration of the minimum level established by the laboratory through calibration of the instrument. EPA considers the terms “reporting limit,” “quantitation limit,” and “minimum level” to be synonymous (40 CFR 136).

Representativeness: The degree to which a sample reflects the population from which it is taken; a data quality indicator (USGS, 1998).

Sample (field): A portion of a population (environmental entity) that is measured and assumed to represent the entire population (USGS, 1998).

Sample (statistical): A finite part or subset of a statistical population (USEPA, 1992).

Sensitivity: In general, denotes the rate at which the analytical response (e.g., absorbance, volume, meter reading) varies with the concentration of the parameter being determined. In a specialized sense, it has the same meaning as the detection limit (Ecology, 2004).

Spiked blank: A specified amount of reagent blank fortified with a known mass of the target analyte(s); usually used to assess the recovery efficiency of the method (USEPA, 2014).

Spiked sample: A sample prepared by adding a known mass of target analyte(s) to a specified amount of matrix sample for which an independent estimate of target analyte(s) concentration is available. Spiked samples can be used to determine the effect of the matrix on a method's recovery efficiency (USEPA, 2014).

Split sample: A discrete sample subdivided into portions, usually duplicates (Kammin, 2010).

Standard Operating Procedure (SOP): A document which describes in detail a reproducible and repeatable organized activity (Kammin, 2010).

Surrogate: For environmental chemistry, a surrogate is a substance with properties similar to those of the target analyte(s). Surrogates are unlikely to be native to environmental samples. They are added to environmental samples for quality control purposes, to track extraction efficiency and/or measure analyte recovery. Deuterated organic compounds are examples of surrogates commonly used in organic compound analysis (Kammin, 2010).

Systematic planning: A step-wise process which develops a clear description of the goals and objectives of a project, and produces decisions on the type, quantity, and quality of data that will be needed to meet those goals and objectives. The DQO process is a specialized type of systematic planning (USEPA, 2006).

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