THE SPATIAL DISTRIBUTION OF ELEVATED URANIUM IN THE TREASURE VALLEY AQUIFER SYSTEM, SOUTHWEST IDAHO

by

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DEDICATION

This thesis is dedicated to Elise Chevalier for her unwavering support, love, and encouragement throughout the project.

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ABSTRACT

The Treasure Valley Aquifer System (TVAS) in southwestern Idaho contains well-documented uranium concentrations over the U.S. Environmental Protection Agency maximum contaminant level of 30 µg/L. With a population in the Treasure Valley projected to reach 1.6 million by 2065, in-depth horizontal and vertical spatial knowledge of the contaminant is needed. This study evaluates the horizontal and vertical spatial nature of uranium in the TVAS and interprets those observations to provide both a conceptual model of uranium behavior, and recommendations for water resource management. A large water quality dataset was compiled, and supplemented by data collected during a field sampling campaign, targeting increased vertical resolution in the aquifer system. To assess the questions posed by the study, statistical tests, spatial analyses, and chemical modeling were performed on the compiled and collected data. Uranium concentrations were found to be low in deep, reduced waters of the TVAS, and ranged from low to very high (0 – 240 µg/L) in the shallow, oxidized portions of the system. The contaminant exhibits high variability and elevated levels across the region but does not follow any significant horizontal spatial trends. Redox conditions were found to control uranium mobility throughout the system. Waters high in calcium and carbonates, which readily complex with uranium in the system, likely increase uranium mobility and contribute to elevated concentrations in oxic waters. Domestic well users are at risk for consuming elevated dissolved uranium due to limited monitoring and well depth completion in the shallow portion of the TVAS. To address this risk, measurements of alkalinity and dissolved oxygen can be used as a low-cost screening method for predicting the risk of elevated uranium. Groundwater with alkalinity greater than 150 mg/L and dissolved oxygen greater than 1 mg/L predicts the potential for elevated uranium (43% of these wells are above drinking water standard), while measurements below these values predict low potential for elevated uranium (100% of wells are below drinking water standard). Additionally, drilling deeper into reducing waters and increased uranium monitoring will protect from elevated uranium concentrations.

TABLE OF CONTENT

DEDICATION iv

ACKNOWLEDGEMENTS v

ABSTRACT vi

TABLE OF CONTENT viii

LIST OF FIGURES xii

LIST OF TABLES xvi

1. INTRODUCTION 1

    1.1. Uranium in Treasure Valley 1

    1.2. Spatial Characterization of Uranium in the TVAS 2

    1.3. Geochemical Controls on Uranium Mobility 3

        1.3.1 Uranium and Redox Status 3

        1.3.2. Uranium Complexation and the Presence of Calcium Carbonates 3

    1.4. Geology 5

    1.5. Hydrology/Hydrogeology 6

    1.6. Study Goals 6

2. MATERIALS AND METHODS 8

    2.1. Water Quality Dataset Compilation 8

    2.2. Meridian Sampling Campaign 9

        2.2.1. Field Measurements 10

2.2.2. Cation and Dissolved Metal Analyses..10

2.2.3. Anion Analysis...10

2.3. Analytical Methods 11

2.3.1. MINTEQ Modeling...11

2.3.2. GIS Analyses 11

2.3.3. Hexagonal Area Mapping..11

2.3.4. Domestic vs. Public Supply Wells 12

2.4. Cross Section Construction..12

2.4.1. Compiled Dataset Cross Sections 12

2.4.2. Meridian Field Sampling Cross Sections 13

2.5. Uranium Plots at Depth 13

2.6. Redox Status 14

3. RESULTS...15

3.1. Compiled Water Quality Dataset 15

3.2. Spatial Nature of Uranium...16

3.3. Uranium at Depth..16

3.3.1. Depth 16

3.3.2. Redox..17

3.4. Meridian Sampling Campaign 17

3.4.1. Depth and Redox..18

3.4.2. Stratigraphy vs Redox 18

3.4.3. Visual MINTEQ...19

3.5. Water Quality Correlations...20

3.6. Domestic vs Public Supply 20

4. DISCUSSION 22

4.1. Spatial Distribution of Elevated Uranium Concentrations 22

4.1.1. Horizontal Spatial Nature of Uranium across the TVAS 22

4.1.2. Uranium at Depth 22

4.1.3. Stratigraphy vs Redox 23

4.1.4. Uranium Source 24

4.2. Geochemical Predictors of Elevated Uranium 25

4.2.1. Redox Environment and Potential for Elevated Uranium 25

4.2.2. Calcium Carbonates and Uranium in Oxic Waters 26

4.3. Conceptual Model 26

4.3.1. Reducing Waters 27

4.3.2. Oxic, Low Calcium-Carbonate Waters 28

4.3.3. Oxic, High Calcium-Carbonate Waters 29

4.4. Recommendations/Observations 30

4.4.1. Domestic Wells and Uranium 30

4.4.2. Affordable Uranium Screening 31

5. CONCLUSIONS 33

5.1. Drilling and Sampling Implications 33

5.2. Temporal-Scale Uranium Monitoring 33

5.3. Multilevel Uranium Monitoring 34

5.4. Domestic Wells Users at Risk 34

5.5. Further Work 35

REFERENCES....66

APPENDIX A....70

APPENDIX B....101

APPENDIX C....107

APPENDIX D....109

Idaho Department of Water Resources Statewide Ambient Ground Water Quality Monitoring Program SOP....109

APPENDIX E....124

LIST OF FIGURES

Figure 1 Study Area. Well locations from the compiled study dataset, Southwestern Idaho. All wells largely reside within the Western Snake River Aquifer System (Newton, 1991). The main focus of the study is on the Treasure Valley Aquifer System defined by Ada and Canyon Counties (Hutchings & Petrich, 2002b). 36

Figure 2 Meridian Sampling Campaign Wells. Targeted wells in the Meridian Sampling Campaign, city of Meridian. Cross section lines show section W-E and section NW-SE. Well #10 was not sampled, and uranium data for the well was taken from Squires (2012). 37

Figure 3 Cross section of the Meridian Sampling Dataset running west to east across the city of Meridian. The thin black lines represent stratigraphy boundaries while the dotted black line is the interpolated stratigraphic boundary (Squires, 2012; Squires, 2014). The dashed gray line represents the Sediment Redox Transition. The double-sided arrows represent the screened interval of the zone and are not visible where dot size exceeds interval size. 38

Figure 4 Cross section of the Meridian Sampling Dataset, northwest to southeast across the City of Meridian. The thin black lines represent stratigraphy boundaries while the dotted black line is the interpolated stratigraphic boundary (Squires, 2012; Squires, 2014). The dashed gray line represents the Sediment Redox Transition. The double-sided arrows represent the screened interval of the zone and are not visible where dot size exceeds interval size. 39

Figure 5 Uranium concentrations across Ada and Canyon Counties. The 5-square-mile hexagons show the exceedance probability of the highest uranium concentrations from all wells within each hexagon. Uranium concentrations are highly variable and elevated across the region. 40

Figure 6 Domestic Uranium Monitoring. Maximum uranium values from monitored domestic wells are compared to total domestic well density in Ada and Canyon Counties. Domestic well density is presented as wells per 1 mile density. Elevated uranium is present in areas with >20 total domestic wells per square mile but low monitoring density....................41

Figure 7 Compiled Dataset distribution. Probability density functions and density histograms for uranium in the Compiled Dataset and Ada and Canyon County wells. 42

Figure 8 Dissolved Uranium Redox Status. The relationship between redox status and uranium concentration shows elevated uranium concentrations are present in oxic waters. Suboxic waters exhibit low uranium concentrations. Redox status developed from scoring criteria based on redox active species concentrations....43

Figure 9 Uranium concentration at depth from water table, compiled study dataset. Each dot represents the highest measured uranium concentration at a well location, and the depth represents the screen average or bottom of well opening.The dotted red line highlights the MCL of 30 µg/L. Uranium concetrations decrease as depth increases. 44

Figure 10 Uranium at Depth from Sediment Redox Transition. Elevated uranium concentrations are found only at depths above the Sediment Redox Transition, represented by the dotted red line. Below the Sediment Redox Transition, low uranium concentrations are found....45

Figure 11 Uranium concentration at depth from water table, Meridian Sampling Campaign dataset. Each dot represents the uranium measurement recorded at a well location, and the depth represents the screen average. The dotted red line highlights the MCL of 30 µg/L. 46

Figure 12 TVAS Uranium-Calcium-Carbonate Complexes. Modeled dominant UO2+2 species in wells 15 and 16 from the Meridian Sampling Campaign. Uranium-calcium-carbonate complexes constitute the dominant share of uranium species in the system. Complexes below 3% of total dissolved uranium were excluded from the figure. 47

Figure 13 Dissolved Oxygen and depth from Sediment Redox Transition. Dissolved oxygen acts as an accurate predictor of aquifer redox status. Dissolved oxygen >1 mg/L predicts oxic waters. Dissolved oxygen <1 mg/L predicts reducing waters. 48

Figure 14 The effect of dissolved oxygen and calcium on uranium concentrations. Measured Uranium concentrations that exceeded the MCL were always in water with dissolved oxygen > 1 mg/L and calcium > 40 mg/L.The red dots indicate uranium concentrations exceeding the MCL of 30 µg/L. 49

Figure 15 The effect of dissolved oxygen and alkalinity on uranium concentrations. Measured Uranium concentrations that exceeded the MCL were always in water with dissolved oxygen > 1 mg/L and alkalinity > 150 mg/L. The red dots indicate uranium concentrations exceeding the MCL of 30 µg/L. 50

Figure 16 Uranium, alkalinity, and calcium plotted at depth, Meridian Sampling Campaign. The change in uranium concentration at depth is reflected by changes in alkalinity and calcium concentrations. Concentrations peak in shallow waters and decrease at greater depth. All elevated uranium concentrations (>30 µg/L) are present in oxic waters. 51

Figure 17 Uranium adsorption release mechanism. The complexation of uranium with calcium carbonates initiates disequilibrium in the system. The system responds by facilitating the release of free uranium from aquifer sediments. The result is an increase in total dissolved uranium concentration. 52

Figure 18 Conceptual model of the nature of dissolved uranium in the TVAS. Three main geochemical conditions dictate the fate of uranium in the TVAS. Suboxic waters yield low uranium concentrations via reduction to U(IV) and subsequent immobilization. Oxic waters with low alkalinity yield low uranium concentrations as a result of uranium adsorption to aquifer sediments. Oxic waters with high alkalinity yield elevated uranium concentrations above the drinking water standard of 30 µg/L as U-Ca-CO_3 complex formation desorbs uranium from aquifer sediments. 53

Figure 19 Uranium Screening Flow Chart. Well depths and alkalinity provide parameters that estimate the potential for elevated uranium in the TVAS. Shallow wells (<500 feet below ground surface) and high alkalinity waters (>150 mg/L) estimate high potential for elevated uranium concentrations. 54

Figure 20 Compiled Dataset Cross Sections. Cross sections completed during the data exploration portion of the study. 102

Figure 21 Cross Section A-A', compiled study dataset. The Sediment Redox Transition from Busbee et al. (2009) where indicated by black arrows, otherwise interpolated using the depth of the blue clay layer in the corresponding well logs. Elevated uranium concentrations are only present above the sediment redox transition. 103

Figure 22 Cross Section D-D', compiled study dataset. Cross Section D-D' showing uranium concentrations and the correlating water table and Sediment Redox Transition. The Sediment Redox Transition has been interpolated using the depth of the blue clay layer in the corresponding well logs. ...104

Figure 23 Cross Section E-E', Compiled Study Dataset. The Sediment Redox Transition from Busbee et al. (2009) where indicated by black arrows, otherwise interpolated using the depth of the blue clay layer in the corresponding well logs. 105

Figure 24 Cross Section F-F', Compiled Study Dataset. Cross Section F-F' showing uranium concentrations and the correlating water table and Sediment Redox Transition. The Sediment Redox Transition has been interpolated using the depth of the blue clay layer in the corresponding well logs. ...106

Figure 25 Treasure Valley Sediment Redox Transition. Map of the Treasure Valley Sediment Redox Transition, digitized from Busbee et al. (2009)...........108

LIST OF TABLES

Table 1. Analysis Information for Meridian Sampling Campaign 55

Table 2. Monitoring well information, Meridian Sampling Campaign 56

Table 3. Complete Geochemical Data for Meridian Sampling Campaign 58

Table 4. Meridian Sampling Dataset Spearman Coefficients 62

Table 5. Compiled Dataset Spearman Coefficients 63

Table 6. Domestic and Public Supply Wells, Compiled Dataset 64

Table 7. Domestic Well Monitoring Estimates, Compiled Dataset........................65

Table 8. Uranium Measurements from the Compiled Water Quality Dataset 71

Table 9. Replicate Results for Meridian Sampling Campaign 125

Table 10. Field Blank Results for Meridian Sampling Campaign..........................128

1. INTRODUCTION

1.1. Uranium in Treasure Valley

Elevated levels of uranium in drinking water represent a global water quality issue (Langmuir, 1997). Uranium groundwater concentrations commonly range from < 0.1 µg/L to 100 µg L^{-1} (Siegel, 2005). The health effects connected to consumption of uranium include increased cancer risk and kidney toxicity (Environmental Protection Agency, 2018). In the United States, uranium is regulated by the US Environmental Protection Agency (EPA) with a maximum contaminant level (MCL) in drinking water of 30 µg/L.

The Treasure Valley Aquifer System (TVAS) in western Idaho contains documented uranium concentrations well above the MCL, with levels up to 110 µg/L observed (Hanson, 2011). Elevated uranium concentrations are known to exist with high spatial variability throughout the region (Hanson, 2011; Cosgrove & Taylor, 2007). Previous studies of uranium in the system did not identify a source or source release mechanism for uranium, critical knowledge for effective contaminant management. Groundwater uranium is of concern to local water resource managers, especially as the main source of drinking water is groundwater (Bartolino & Vincent, 2017). The area is home to over 630,000 people, and the population is projected to reach 1.6 million by 2065 (Bartolino & Vincent, 2017; SPF Water Engineering, 2016). With over 34,000 total wells and more than 8100 domestic wells in Ada and Canyon Counties, effective management requires more knowledge of the spatial extent of uranium in the groundwater; such knowledge can also better constrain the uranium source and source release mechanism (Bartolino & Vincent, 2017; Idaho Department of Water Resources, 2019).

We hypothesize that a diffuse solid phase source of uranium exists throughout the TVAS and that release to the groundwater is controlled by geochemical factors. The overall objective of this study is to evaluate this hypothesis and create a conceptual model that can explain why elevated levels of uranium are found in the TVAS. We hope that this conceptual model can assist water resource professionals manage this important drinking water supply for the Treasure Valley.

1.2. Spatial Characterization of Uranium in the TVAS

The spatial characteristics of uranium in the TVAS have been presented in two main studies, Hanson (2011) and Cosgrove and Taylor (2007). Hanson (2011) used a dataset made up of samples from 100 public water system wells and 60 private systems to explore the spatial characterization of uranium in the Treasure Valley. Cosgrove and Taylor (2007) also explored the spatial nature of uranium in the region, mostly restricted to the spatial extent of Canyon County using 29 wells. Each study found widespread, elevated uranium concentrations with high spatial variability. Hanson (2011) also highlighted the positive correlation between uranium and carbonates and suggested a carbonate-assisted uranium release mechanism.

Uranium monitoring on a large scale in the TVAS began in 2003 with the EPA designation of a dissolved uranium drinking water standard (Environmental Protection Agency, 2018). Hanson (2011) and Cosgrove and Taylor (2007) used uranium datasets that were limited at the time, as uranium monitoring had only occurred for 4 years and 8 years, respectively. Thus, the conclusions for each study were limited in scope and reach by the small datasets.

1.3. Geochemical Controls on Uranium Mobility

1.3.1 Uranium and Redox Status

Dissolved uranium in groundwater is greatly affected by the redox status of the environment. In oxic and suboxic waters, uranium is typically present in the hexavalent form, U(VI), and in anoxic waters uranium is present and stable in the tetravalent form, U(IV) (Campbell, Gallegos, & Landa, 2015; Cumberland, Douglas, Grice, & Moreau, 2016). U(VI) has significantly higher solubility and mobility than U(IV) (Cumberland et al., 2016). As U(VI) passes from oxic to anoxic waters, it can be reduced to U(IV) and precipitated out of solution in the form of U-oxides, such as uraninite (Cumberland et. al, 2016; Stewart, 2008).

Reduction from U(VI) to U(IV) can be facilitated chemically, by Fe(II) and sulfide, or biologically, by dissimilatory metal reducing and sulfate reducing bacteria (Stewart, 2008; Lovley, Phillips, Gorby, & Landa, 1991).

1.3.2. Uranium Complexation and the Presence of Calcium Carbonates

The presence and concentration of dissolved uranium in groundwater can be attributed to the system’s redox status, presence of complexing agents, sorption capability, or direct contact with a uranium source (Hanson, 2011; McKinley, Zachara, Wan, McCready, & Heald, 2007). In oxidizing natural waters, uranium is commonly present in its U(VI) form as a uranyl oxycation, UO_2^{2+} or UO_2OH^+, and can react with aqueous anions and cations to form complexes that can greatly affect the nature of the contaminant in a given system (Hanson, 2011; McKinley et al., 2007). The specific uranium complexes that form, such as UO_2F^- or $UO_2(CO_3)_2^{2-}$, are dependent on the pH and specific geochemistry of the water (Fetter, 1992). Uranium in carbonate-rich, oxidizing waters at mid to high pH readily forms uranyl-carbonate complexes, increasing the mobility and dissolved concentrations of uranium, while decreasing its adsorption to mineral surfaces (Cumberland et al., 2016; Stewart, 2008).

Complexation is the bonding of an anion and cation in aqueous solution to form a species with properties that are distinct from the individual ions (Langmuir, 1997). The formation of a complex reduces the free ion concentration in the solution, causing a constituent response to disequilibrium in the form of ions dissolved from the source material (Langmuir, 1997). The effect of complexation on the concentration of dissolved species is explained by Le Chatelier's Principle, which states that a change in concentration of a constituent within a system will disrupt the equilibrium of the system, leading to reactionary changes that seek to rebalance the system (Langmuir, 1997).

U(VI) mobility in natural waters can be greatly reduced by sorption to aquifer sediments and soils (Cumberland et al., 2016; Davis, Meece, Kohler, & Curtis, 2004). However, the presence of calcium carbonates in a uranium-contaminated groundwater system can restrict adsorption of U(VI), preventing the removal of U(VI) and subsequent decrease in total U concentrations (Stewart, 2008). Furthermore, the presence of calcium can limit bacterial reduction of U(VI) to U(IV), again preventing removal of U(VI) from the system (Brooks et al., 2003).

1.4. Geology

The TVAS resides within the Western Snake River Plain, an intracontinental rift basin of Neogene age in southwestern Idaho (Wood & Clemens, 2002; Newton, 1991). The regional Snake River Plain spans the southern half of Idaho in an arcuate shape (Neely & Crockett, 1998). The Western Snake River Plain basin, about 300 km long and 70 km wide and bounded by the Boise Front Foothills to the northeast and the Owyhee Foothills to the southwest, trends southeast to northwest and is filled with 2-3 km of Idaho Batholith-derived sedimentary fill that overlies basaltic rock (Wood & Clemens, 2002; Neely & Crockett, 1998). Granite-derived sedimentary rock can contain uranium concentrations well above the average crustal concentration of 1-3 ppm U (Cumberland et al., 2016).

The deep sedimentary fill in the basin is made up of the homogenous mudstones of the Chalk Hills and Glenns Ferry Formations and the overlying 60 to 90 meters of interbedded silts, mudstones, and sandstones of the Glenns Ferry and Pierce Park Formations, formed in an active rift environment consisting of the episodic formation and drainage of ancient lakes (Wood & Clemens, 2002). The basin's shallow sediments are composed of gravels, fluvial sediments, and alluvium, formed in a fluvial dominated depositional environment (Wood & Clemens, 2002; Hanson, 2011).

A basin-wide sediment color transition from yellow brown (overlying) to gray or blue (below) exists within the Snake River Group sediments (Petrich & Urban, 2004). This transition is referred to as the 'Sediment Redox Transition' by Busbee, Kocar, & Benner (2009) and is likely a signature from the historic water table, at which the redox environment is oxidized above and reduced below.

1.5. Hydrology/Hydrogeology

The TVAS consists of a group of aquifers within the sedimentary units of the Idaho Group and the Snake River Group (Petrich & Urban, 2004). The system is generally divided into two main flow systems. A shallow, local system consists of gravels, fluvial sediments, and alluvium, and a deep, regional system is made up of ancient lake sediments and monotonous sandstones (Hutchings & Petrich, 2002b; Petrich & Urban, 2004). The general direction of groundwater flow is west, southwest, and northwest, depending on location and depth (Neely & Crockett, 1998). Recharge in the shallow aquifer system is mainly derived from seepage attributed to the canal system in the region and infiltration from agricultural irrigation (Hutchings & Petrich, 2002a). Smaller contributions come from mountain front and tributary groundwater recharge, underflow from the Idaho batholith, and Treasure Valley precipitation (Hutchings & Petrich, 2002b).

1.6. Study Goals

Elevated uranium concentrations are present in the TVAS, but there is a lack of spatial knowledge of the contaminant both horizontally and vertically that is critical to its effective management. The goals of this thesis are to (1) spatially characterize TVAS uranium in the vertical and horizontal dimensions, (2) determine the relationship between uranium and the redox status of the environment, (3) identify water quality constituents that can be correlated with elevated uranium and (4) evaluate the current state of groundwater uranium monitoring in the TVAS. The study aims to develop management recommendations for water resource professionals in the Treasure Valley to minimize the risk of uranium to human health. To fulfill the goals stated above, a large water quality dataset was compiled and used for spatial, statistical, and chemical analyses. Data gaps in the large dataset were identified and used to pinpoint and sample additional wells in the city of Meridian. This new dataset was then used to develop a proposed conceptual model of uranium behavior in the TVAS.

2. MATERIALS AND METHODS

2.1. Water Quality Dataset Compilation

A large water quality dataset has been compiled for the Treasure Valley from three main sources: the IDWR Statewide Monitoring Program, the Department of Environmental Quality's Public Water System Database, and the United States Geological Survey's National Water Information System (Idaho Department of Water Resources, 2019; Idaho Department of Environmental Quality, 2019; United States Geological Survey, 2019). Uranium data from Cosgrove and Taylor (2007) was used where applicable (water quality correlations), but specific well locations were not present, limiting their utility in spatial analysis. Uranium measurements were gathered from 649 wells across Ada, Canyon, Elmore, Gem, Owyhee, and Payette Counties for a total of 2019 individual uranium measurements (Figure 1). The data were gathered from wells within the WSRP to provide information about the regional nature of groundwater uranium in southwest Idaho. The majority of the wells in the dataset are located in the TVAS, represented by Ada and Canyon Counties (511 wells). The bulk of study analyses were completed using the wells within Ada and Canyon Counties. ArcGIS was used to visualize the uranium concentrations at the specific well locations to examine possible trends among the data and to highlight areas of elevated dissolved uranium. Field parameters, cations, and anions from the dataset were used to explore potential correlations with uranium concentrations. Water table elevation, well depth, and physical attributes of the well such as type of opening and casing depth were used to examine spatial and vertical trends and the quality of well construction, and to highlight and examine the error involved in measurements from such wells. All uranium measurements from the compiled dataset are presented in Appendix A.

2.2. Meridian Sampling Campaign

A groundwater sampling campaign was completed primarily during the month of March 2019 in the city of Meridian, Idaho. The campaign targeted the multi-level monitoring wells owned and operated by the city of Meridian. A total of 13 wells and 51 separate zones were sampled (Figure 2). All wells contain one or more separated zones, with each zone reaching a distinct depth in the aquifer system.

The multi-level Meridian wells are the only vertically-nested wells in the Treasure Valley and were designed to limit vertical inter-well transfer (Squires, 2012). The prevention of vertical flow between wells reduces the uncertainty inherent in groundwater sampling and provides an unparalleled view into the vertical distribution of water chemistry in the TVAS.

The Standard Operating Procedure (SOP) from the Idaho Department of Water Resources Statewide Monitoring Program was followed for the sampling campaign (Appendix D). The IDWR SOP requires a well purge of at least 20 minutes and three consecutive stable parameter readings before samples can be gathered. The stable parameters used were temperature, pH, specific conductivity, dissolved oxygen, and oxidation reduction potential (ORP) and were measured every five minutes. To access the water in the wells, a Grundfos Rediflo2 submersible pump connected to ½ inch polyethylene tubing was used. Prior to and after insertion in each well, the pump was decontaminated with deionized water and Alconox. After decontamination, the water was then directed into a flow-through cell where the stable parameters were measured using multi-meters by way of four separate probes. After 20 minutes of purging and stable parameter measurements were reached, a 0.45 µm (micron) filter was applied to the tubing and samples were gathered. Samples intended for anion analysis were filtered and not acidified, while samples intended for cation analysis and ammonia analysis were acidified with nitric acid (HNO_3) and sulfuric acid (H_2SO_4), respectively. All samples were stored on ice to below 4˚C. Over the course of the sampling campaign, eight triplicate measurements and 12 deionized water field blanks were collected to provide insight into the error involved in the sampling and analysis processes.

2.2.1. Field Measurements

Field measurements were taken prior to and following sample extraction. Temperature, pH, ORP, specific conductivity, and dissolved oxygen were measured prior to sample extraction and used as markers of stable field parameters. Alkalinity, a measurement of the acid-neutralizing capability of water and typically expressed as mg/L $CaCO_3$, was measured following sample extraction using a HACH titration kit.

2.2.2. Cation and Dissolved Metal Analyses

Cation and dissolved metals were analyzed by Inductively Coupled Plasma Mass Spectrometry by Energy Laboratories in Casper, Wyoming. A full list of analytes, analysis methods followed, and the reporting limits can be found in Table 1.

2.2.3. Anion Analysis

Anion analysis of the groundwater samples was completed by the Idaho Bureau of Laboratories and by Energy Laboratories in Casper, Wyoming. Nitrate was analyzed by Ion Chromatography by Idaho Bureau of Laboratories and fluoride, sulfate, and chloride were analyzed by Ion Chromatography by Energy Laboratories. Table 1 lists the analysis methods and detection limits for each analyte.

2.3. Analytical Methods

2.3.1. MINTEQ Modeling

Chemical speciation and complexation for the Meridian Sampling Campaign results were modelled using the aqueous chemical modelling software, Visual MINTEQ (Gustafsson, 2011). The multi-problem generator was used to sweep through an Excel spreadsheet detailing the chemical results of all samples and model the system speciation and complexation. The model output provides a prediction of the chemical species distribution likely present at each sample location. The predictions can be used to make observations about the dominant carbonate and uranium species and complexes in the groundwater system.

2.3.2. GIS Analyses

The Analysis toolbox and the Spatial Analysis toolbox in ArcPro were used to analyze the spatial nature of uranium in the TVAS. Various existing tools were used to map and model uranium concentrations. The maximum concentration at each well was used on the maps to account for the highest potential impact on human health.

2.3.3. Hexagonal Area Mapping

Adapted from a United States Geological Survey study, uranium concentrations across Ada and Canyon County were presented in five-square-mile hexagons showing the 75th percentile concentration from the wells within the area (Figure 5) (Ryker, 2001). To create the map, the following method was used: (1) the Generate Tessellation tool found in ArcPro was used to set a five-square-mile grid of hexagons across Ada and Canyon

Counties, (2) the Spatial Join tool connected the hexagon IDs to Ada and Canyon County wells and the associated uranium concentrations, (3) the joined information was exported and the coding software R was used to find the 75th quantile, or value exceeded by 25% of the wells, of uranium concentrations within each hexagon, and (4) the 75th quantile values were added back into ArcPro and joined to the hexagon layer.

2.3.4. Domestic vs. Public Supply Wells

The distribution of domestic and public supply wells within the dataset and in the Treasure Valley were examined using ArcPro and basic statistics (Figure 6). The domestic and public supply wells in the dataset from Ada and Canyon Counties were separated and mapped as points. These points were layered on top of a layer showing the density of all domestic wells found in the Treasure Valley, constructed using the Point Density tool in the ArcPro Density toolset (Idaho Department of Water Resources, 2019).

2.4. Cross Section Construction

Cross sections were created to provide information about the vertical nature of uranium in the TVAS. Land surface, water table surface, and sediment redox transition were included where data were available. A one-mile buffer on each side of the section lines were used as the criteria to select wells to include in the cross section. ArcGIS and a Digital Elevation Model (DEM) were used to gather the land surface and well locations. Error bars were included, where applicable, to indicate the extent of the screened interval for each well.

2.4.1. Compiled Dataset Cross Sections

Four cross sections were created using the compiled dataset (Appendix B). The specific locations were placed to maximize the number of wells in each section and to provide a vertical view into the system in a variety of directions. Well logs created at the date of drilling were used to provide depths for each well and to provide water levels if current levels were not available. The location of the sediment redox transition was found using one of three methods in decreasing credibility: (1) redox-active water chemistry data, (2) the digitized sediment redox transition map created by Busbee et al. (2009), derived from sediment color change shown in well logs (Appendix C), and (3) sediment color change from light brown to blue/gray or the presence of a blue clay layer as specified in the well logs.

2.4.2. Meridian Field Sampling Cross Sections

Cross sections were created using data from the Meridian field sampling campaign. Two sections were created in north-south and east-west directions (Figures 2, 3, & 4). Water table levels collected from the field sampling campaign were used, and stratigraphic information and well dimensions were gathered from City of Meridian cross sections created by Hydro Logic, Inc. (Squires, 2014a; Squires, 2014b; Squires, 2012). The sediment redox transition surface was determined using water chemistry data gathered during the field sampling campaign and from the stratigraphic information provided by the City of Meridian cross sections (Squires, 2014a; Squires, 2014b; Squires, 2012).

2.5. Uranium Plots at Depth

Uranium concentrations were plotted as a function of feet below water table (ft bwt) or feet below Sediment Redox Transition to examine potential trends in the vertical direction (Figures 9, 10, & 11). The maximum concentration measured at a given well was plotted and sourced from both the compiled dataset and the Meridian field sampling campaign. Water table information was gathered from the time of sampling, if available. Typically, only current water levels or those recorded at the construction of the well were available. Well depth information was gathered from well logs. Not all wells in the dataset were included in the plots, as well depth information, Sediment Redox Transition depth, and water levels were not available for all wells.

2.6. Redox Status

IDWR Statewide Ambient Monitoring data were used to create a redox score correlating to each uranium sample based on scoring criteria borrowed from Busbee et al. (2009) (Figure 8). The criteria are gleaned from water chemistry data using constituents commonly indicative of redox status: O_2, NO_3, Fe, Mn, and NH_3. The following criteria result in a (+1) to the overall redox score, indicating an oxidizing environment: (1) dissolved oxygen (O_2) greater than 0.5 mg/L and (2) combined nitrate/nitrite (NO_3/NO_2) greater than 0.5 mg/L. The following criteria each result in a (-1) to the overall redox score, indicating a reducing environment: (1) ammonia (NH_3) concentrations greater than nitrate/nitrite concentrations, (2) dissolved iron (Fe) greater than 100 µg/L, and (3) dissolved manganese (Mn) greater than 50 µg/L. For each groundwater uranium sample the redox score is summed, providing insight into the sampled environment. The more negative a score, the more reducing the environment. Uranium data were only used if all five redox scoring criteria were present in the corresponding water quality data.

3. RESULTS

3.1. Compiled Water Quality Dataset

Data compilation for this study featured significant increases in uranium measurements and wells compared to prior Treasure Valley uranium studies. Hanson (2011) and Cosgrove and Taylor (2007) studied uranium data from ~170 wells and 29 wells, respectively. In comparison, this study compiled uranium data from 649 wells in the region (Figure 1). The main reasons for increased data availability are continued uranium monitoring by IDWR and DEQ, the inclusion of USGS data, and the expansion of the targeted geographic area beyond the margins of the Treasure Valley.

The basic statistical analysis of the compiled dataset considered the maximum uranium concentration measured at every well. The mean maximum uranium concentration is 17.8 µg/L, the median is 7 µg/L, and the maximum is 240 µg/L. The percentage of wells with at least one measurement exceeding the MCL of 30 µg/L is 17.1%, while 25.6% of the wells have at least one measurement exceeding 20 µg/L. The distributions of the compiled dataset and Ada and Canyon Counties are presented as probability density functions and density histograms in Figure 7. Of the counties with wells included in the dataset, Ada, Canyon, and Payette Counties have significant well counts (>50) in the dataset. Ada County has the highest well count in the dataset and the highest mean, 21.2 µg/L, highest median, 7 µg/L, and highest percent exceeding the MCL, at 22.6%. The maximum measurement in the dataset, 240 µg/L, is from a Gem County well.

3.2. Spatial Nature of Uranium

The various spatial analyses of uranium, including hexagon mapping and cross sections, reveal high variability and elevated concentrations across the TVAS.

The hexagon map (Figure 5) and cross sections (Figures 3 & 4) highlight the presence of elevated concentrations across the TVAS and do not indicate directional trends. Notable areas of elevated uranium concentrations are observed in the city of Meridian, southwest of Lake Lowell, and northwest of the city of Caldwell.

The hexagon map and cross sections also highlight the high variability of uranium in the region. Low uranium concentrations are interspersed with elevated concentrations across the system. High uranium levels in Meridian lie directly next to low uranium levels in north Boise. Similar variability is observed north (elevated uranium) and south (low uranium) of the Boise River in Canyon County.

3.3. Uranium at Depth

The spatial nature of uranium in the TVAS was analyzed using cross sections and depth plots, with an emphasis on vertical dimension exploration (Appendix B).

3.3.1. Depth

Uranium concentrations in the TVAS follow several consistent vertical trends (Figure 9). The highest uranium concentrations are present at 100-200 ft bwt. Concentrations exceed the MCL of 30 µg/L from the water table surface to ~500 ft bwt. Below 500 ft bwt, no measurements exceed the MCL. A marked increase in uranium concentrations is observed from near-surficial depths (<50 ft bwt) to shallow aquifer depths (~100-200 ft bwt).

The specific cross section profiles provide spatially specific examples of the same distinct vertical trend in uranium concentrations in the TVAS, where elevated uranium is present in the shallow waters of the system and low concentrations are found in the deep waters (Appendix B).

3.3.2. Redox

The cross sections highlight the Sediment Redox Transition as a divide between the presence of elevated uranium concentrations and strictly low uranium concentrations (Figures 3 & 4). Uranium levels from undetectable to elevated are recorded in the oxic waters above the transition. Low uranium levels under the MCL are recorded in the reducing waters below the transition.

Uranium concentrations at depth from Sediment Redox Transition further highlight the clear relationship between redox conditions and uranium (Figure 10). Elevated uranium concentrations are found above the Sediment Redox Transition in oxic waters. Below the Sediment Redox Transition in suboxic conditions, only low levels of uranium are found.

The Redox Score indicates that elevated concentrations of uranium only occur where the water chemistry reflects an oxidizing environment (Figure 8). Elevated concentrations above 20 µg/L are present at redox scores of +1 and +2, while concentrations above the MCL of 30 µg/L only occur at the redox score of +2. Low uranium concentrations occur across the entire range of redox environments.

3.4. Meridian Sampling Campaign

The multi-level monitoring wells of the city of Meridian provided an opportunity to collect samples with high vertical precision across a wide range of depths in the aquifer system in a constrained geographical area. Previous sampling from Squires (2012) also provided evidence that the region contains elevated levels of uranium in the groundwater.

3.4.1. Depth and Redox

Uranium at depth in the Meridian Sampling Campaign follows similar patterns to those shown in the large compiled dataset (Figure 11). Uranium concentrations peak in the shallow to intermediate portions of the TVAS and drop significantly at greater depth. Peak uranium concentrations exceeding the MCL appear at 200-500 ft bwt. Uranium concentrations do not exceed the MCL at surficial depths, 0-200 ft bwt, and at greater depths in the system, >500 ft bwt.

3.4.2. Stratigraphy vs Redox

The Meridian Sampling Campaign cross sections (Figures 3 & 4) show uranium concentrations, sediment redox transition, and local stratigraphic boundaries. The sections reveal stratigraphy boundaries that tend to loosely follow the sediment redox transition. The alluvial sediments, part of the Snake River Group, are largely present above the sediment redox transition. The majority of the Pierce Gulch Sand, part of the Idaho Group, sits below the sediment redox transition. However, several points in the system below Meridian show the sediment redox transition falling into the Pierce Gulch Sand and rising up into the overlying alluvial sediments.

Where the sediment redox transition falls into the Pierce Gulch Sand, subjecting these sediments to oxidizing conditions, increased uranium concentration are often observed compared to the underlying reducing conditions within the same multi-level well. This is most evident in the east portion of the W-E section (Figure 3), where the sediment redox transition drops into the Pierce Gulch Sand and uranium concentrations exceed 60 µg/L for all three zones.

The presence of the sediment redox transition in the shallower alluvial sediments correlates with lower uranium concentrations than those in the overlying oxidizing sediments of the same multi-level well. This is evident in Well # 16-B of the NW-SE section (Figure 4), where a large decrease in uranium concentrations occurs below the sediment redox transition but above the stratigraphy boundary.

3.4.3. Visual MINTEQ

Visual MINTEQ chemical modeling utilizes known physical aquifer characteristics (pH, temperature, element concentrations, and alkalinity) to predict species distribution in the system. Carbonate speciation and complex formation are important factors governing uranium mobility and concentrations in groundwater systems. Chemical modeling of the Meridian Sampling Campaign dataset provides important insight into the interaction of calcium carbonates and uranium in the TVAS.

The results from chemical speciation and complexation modelling in Visual MINTEQ reveal bicarbonate, HCO_3^-, as the dominant carbonate species in the groundwater system below Meridian. Uranium-calcium-carbonate complexes are the dominant form of mobile uranium, UO_2^{+2}, in the oxic portions of the TVAS, present as $Ca_2UO_2(CO_3)_3$ and $CaUO_2(CO_3)_3^2$ (Figure 12). The formation of the main uranium-calcium-carbonate complex in the system is presented in the equation below:

$$2Ca^{2+} + UO_2^{2+} + 3HCO_3^- \leftrightarrow Ca_2UO_2(CO_3)_3\,(aq) + H^+$$

3.5. Water Quality Correlations

Spearman correlation analyses show uranium is highly positively correlated with several water quality constituents. In the Meridian Sampling Campaign dataset, uranium is highly positively correlated and statistically significant ($\rho > 0.8$, p-value < 0.05) with alkalinity, calcium, magnesium, and nitrate (Table 3). In the compiled study dataset, uranium is moderately to highly positively correlated and statistically significant ($\rho > 0.6$, p-value < 0.05) with alkalinity, calcium, and nitrate (Table 4).

3.6. Domestic vs Public Supply

The distribution and density of domestic and public supply well uranium monitoring in Ada and Canyon Counties were assessed using spatial (Figure 6) and statistical analyses (Table 5). Density contours of total domestic wells were created using the Density tool in ArcPro (Figure 6).

Public supply sampling outweighs domestic sampling, with 366 public supply wells monitored versus 112 domestic wells across the two counties. Domestic well sampling for uranium covers 1.37% of the total domestic wells currently documented in Ada and Canyon County (Idaho Department of Water Resources, 2019).

In Ada County, 37% of the domestic wells included in the dataset (54 wells) exceed the MCL of 30 µg/L, compared to 18.5% of the public supply wells (210 wells) (Table 5). The compiled dataset covers 1.90% of the total domestic wells (2836 wells) currently documented in Ada County (Idaho Department of Water Resources, 2019).

In Canyon County, 15.5% of the domestic wells included in the dataset (58 wells) exceed the MCL of 30 µg/L, compared to 14.1% of the public supply wells (156 wells)

(Table 5). The compiled dataset covers 1.09% of the total domestic wells (5343 wells) currently documented in Canyon County (Idaho Department of Water Resources, 2019).

Spatial analysis of domestic uranium monitoring compared total domestic wells in Ada and Canyon Counties to wells supplying the compiled dataset (Figure 6). Total domestic wells far outnumber monitored wells, most notably in areas where elevated uranium concentrations are found.

4. DISCUSSION

4.1. Spatial Distribution of Elevated Uranium Concentrations

4.1.1. Horizontal Spatial Nature of Uranium across the TVAS

Sampled groundwater wells across the TVAS exhibit a wide distribution of uranium concentrations. There are elevated uranium concentrations found throughout the TVAS, but these elevated values are often interspersed with very low or undetectable concentrations. There are some areas where more elevated concentrations are observed, in the Meridian area for example, but even within these locations, both high and low values are often found in close proximity. The lack of obvious horizontal trends and high variability of uranium concentrations in the current dataset suggest limited capacity to predict elevated levels in the horizontal dimension in the TVAS.

The majority of compiled dataset wells are concentrated in Treasure Valley urban areas such as Meridian and Caldwell. Conversely, large expanses of the TVAS are sparsely monitored and may be underrepresented in spatial analyses. Increased monitoring of underrepresented areas may reveal spatial patterns with predictive properties.

4.1.2. Uranium at Depth

Depth is a predictor of the potential for elevated uranium concentrations exceeding the drinking water standard in the TVAS (Figures 9 & 11). At shallow depths in the TVAS (< 500 ft bwt) there is potential for elevated uranium concentrations. 32% of compiled dataset wells with a depth <500 ft bwt exhibit at least one measurement above

30 µg/L. At greater depths (> 500 ft bwt) there is limited potential for elevated uranium concentrations. 0% of compiled dataset wells with a depth >500 ft bwt exhibit at least one measurement above 30 µg/L.

4.1.3. Stratigraphy vs Redox

The Sediment Redox Transition represents a significant geochemical boundary in the TVAS separating oxic sediments above and reducing sediments below (Busbee et al., 2009). The oxic sediments exhibit a yellow-brown color, while the reducing sediments are grey-blue (Petrich & Urban, 2004). Busbee et al. (2009) found that the Sediment Redox Transition is independent of stratigraphy and likely a result of the historic Treasure Valley water table.

The Meridian Sampling Campaign cross sections (Figures 3 and 4) and the associated well logs allow for a detailed look into both sediment redox status and stratigraphy as they relate to uranium concentrations in the aquifer system. This provides points where oxidizing and reducing environments can be viewed for each sediment group, allowing for an estimation of whether redox environment or stratigraphy controls uranium concentrations in the TVAS.

The cross sections show elevated uranium concentrations within oxic portions of the Pierce Gulch Sand and consistent low uranium concentrations in the alluvial sediments where subjected to reducing conditions. No elevated uranium concentrations are present in reduced sediments. The potential for elevated concentrations is only present where sediments are oxidized and associated waters are oxic. Uranium concentrations are likely controlled by redox conditions and not by stratigraphy in the aquifer system underlying the City of Meridian. The local aquifer system beneath the

City of Meridian contains the same redox indicators as the TVAS described by Busbee et al. (2009), sediment color indicative of redox status and a distinct Sediment Redox Transition. Thus, the conclusion that uranium concentrations are likely controlled by redox conditions and not by stratigraphy can be translated across the TVAS.

4.1.4. Uranium Source

Hanson (2011) suggests a surficial uranium source exists in the TVAS based on leaching tests and isotope results. However, this study's uranium versus depth analysis indicates that a surficial sediment source is unlikely in the TVAS. A surficial sediment source, such as is suggested by Busbee et al. (2009) for TVAS arsenic, would be represented on the uranium versus depth graph by the highest uranium concentrations in the surficial portions of the system (Figure 9). Moving deeper, the uranium concentrations would decrease. However, uranium measurements from the TVAS consistently show the highest uranium levels at 100-400 ft below the water table. Assuming the system is at steady-state, the most plausible source of the elevated U concentrations is the aquifer sediments, not infiltration from the surface.

This study does not support the hypothesis that there is a specific geologic unit source for elevated uranium in the TVAS. Rather, these observations suggest uranium is widely available in the aquifer sediments and elevated dissolved concentrations are induced by specific geochemical conditions. Cross section data suggests that stratigraphy is a poor predictor of uranium concentration (Figures 3 & 4). Busbee et al. (2009) also asserts that the Sediment Redox Transition is independent of stratigraphic controls. Furthermore, the elevated uranium concentrations found across the TVAS and beyond its borders do not support a specific stratigraphic unit or formation as the sole uranium source.

It is more likely that a diffuse source of uranium exists in the TVAS, controlled by geochemical factors. The high zone of elevated uranium at depth in the TVAS coincides with high calcium content and alkalinity and is present in oxic waters (Figure 16). As typical controls of uranium mobility and concentration in groundwater systems, the positive correlation between uranium with these geochemical factors supports the diffuse-source hypothesis.

4.2. Geochemical Predictors of Elevated Uranium

4.2.1. Redox Environment and Potential for Elevated Uranium

The relationship between depth and uranium is likely a result of the effect of redox on uranium concentrations. The division of high and low uranium concentration potential in shallow and deep waters of the system, respectively, strongly follows the division of shallow, oxidized waters and deep, reduced waters.

Redox status is a strong predictor of the potential for elevated uranium concentrations (Figures 8 & 10). In oxic waters, there is potential for uranium concentrations exceeding the drinking water standard of 30 µg/L. For study wells with sufficient information to accurately designate redox status, all uranium measurements above the drinking water standard were gathered in oxic waters. In the Meridian Sampling Campaign dataset, 31% of the zones in oxic waters (8 of 26) contain uranium >30 µg/L. In reducing waters, there is low potential for elevated uranium concentrations.

Dissolved oxygen generally serves as an accurate indicator of redox status (Figure 13). In the Meridian Sampling Campaign Dataset, all well zones located below the

Sediment Redox Transition, in reducing waters, contain dissolved oxygen <0.5 mg/L. Of the wells zones located above the Sediment Redox Transition, in oxic waters, 89% contain dissolved oxygen >0.5 mg/L. Every zone in the Meridian Sampling Campaign dataset with a uranium measurement exceeding 30 µg/L (8 zones) contains dissolved oxygen >4.7 mg/L and is located above the Sediment Redox Transition.

4.2.2. Calcium Carbonates and Uranium in Oxic Waters

Redox status predicts the potential for elevated uranium but cannot accurately predict uranium concentrations in oxic waters. Measurements of calcium and carbonate, measured as alkalinity, allow for the improved prediction of high uranium concentrations in the shallow, oxic portions of the TVAS.

Calcium and alkalinity are positively correlated with uranium in the TVAS (Tables 3 & 4). High calcium and carbonate measurements in the system's oxic waters are good predictors of a high likelihood for elevated uranium concentrations (Figure 16). 37% (n=60) of uranium measurements in the study exceed 30 µg/L when alkalinity >150 mg/L $CaCO_3$ and dissolved oxygen is >1 mg/L (Figure 14). 43% (n=40) of uranium measurements exceed 30 µg/L when calcium >40 mg/L $CaCO_3$ and dissolved oxygen >1 mg/L (Figure 14). Low calcium and carbonate content in oxic waters predicts low uranium concentrations. 0% of uranium measurements exceed 30 µg/L when alkalinity <150 mg/L and dissolved oxygen >1 mg/L (n=15) or when calcium <40 mg/L and dissolved oxygen >1 mg/L (n=26) (Figures 14 & 15).

4.3. Conceptual Model

We propose a conceptual model describing uranium mobility and availability in the TVAS based on uranium source, system redox status, uranium-calcium-carbonate complex formation, and a uranium adsorption release mechanism. A diffuse source of uranium in the TVAS is likely. We propose that it is not the presence of uranium in the sediments that dictates elevated values, but rather that specific geochemical conditions lead to high and low U concentrations in the TVAS.

The mobility and potential for elevated dissolved uranium concentrations in the TVAS can be conceptualized falling into three geochemically-defined conditions: (1) reducing conditions, generally found in the deeper aquifer, (2) oxic, and low calcium-carbonate waters, found in portions of the shallow aquifer, and (3) oxic, and high calcium-carbonate waters, also generally found in the shallow aquifer (Figure 18).

Within shallow, oxic, and high calcium carbonate waters, uranium-calcium-carbonate complex formation is driving desorption of uranium from aquifer sediments into aqueous phase. The conceptual model provides a basis for proposing a simple screening tool to predict elevated uranium concentration potential in the TVAS.

4.3.1. Reducing Waters

Reducing waters span the deep flow system in the TVAS and typically begin at 300-600 ft below the water table. Redox conditions have been shown to strongly control uranium mobility in groundwater by numerous studies in a variety of aquifer settings (Campbell et al., 2015; Cumberland et al., 2016; Crawford, Lofts, & Liber, 2017).

In the deep, reducing waters of the TVAS, uranium is likely present as the immobile, low solubility U(IV) species. U(VI) that may enter the reduced zone is reduced to U(IV) in redox reactions with other redox-active elements or by microbial reduction (Cumberland et al., 2016; McKinley et al., 2007). As water moves from oxic to reducing conditions, redox-active elements such as iron, sulfate, or manganese can form a redox gradient (Campbell et al., 2015; Cumberland et al., 2016). The redox score (Figure 8) and correlation results from the Meridian Sampling Campaign, where negative correlations are shown between iron and manganese and uranium (Table 3) support the idea of iron- or manganese-aided reduction of U(VI) in the TVAS. These elements allow for electron exchange in redox reactions (Cumberland et al. 2016). As a result, U(VI) can reduce to U(IV) as it gains electrons and readily precipitates out of solution as uranium-oxides (Cumberland et al., 2016).

The results of the reduction of U(VI) to U(IV) in the deep, reduced system are dissolved uranium concentrations below the drinking water standard (Figures 3 & 4). The potential exists for reoxidation and remobilization of U(IV) to U(VI) if oxic conditions prevail (Cumberland et al., 2016; Stewart, 2008). Such a scenario is unlikely, unless poor well design introduces oxic waters to the deep, reduced portion of the TVAS.

4.3.2. Oxic, Low Calcium-Carbonate Waters

The shallow, oxic waters of the TVAS contain variable calcium and carbonate content (Figure 16). Low calcium-carbonate waters support favorable conditions for the adsorption of dissolved uranium to aquifer sediments.

In oxic groundwater systems, UO_2^{2+} can readily adsorb to aquifer sediments, particularly in low-carbonate waters (Crawford et al., 2017; Stewart, 2008). Adsorption removes UO_2^{2+} from solution and decreases its mobility potential (Stewart, 2008).

In the TVAS, we suggest that adsorption of UO_2^{2+} to aquifer sediments maintains low dissolved uranium concentrations in oxic, low calcium-carbonate waters (Figure 18).

4.3.3. Oxic, High Calcium-Carbonate Waters

The role of high calcium-carbonate waters in increasing dissolved concentrations of uranium in groundwater has been studied extensively, particularly at US Department of Energy contamination sites such as the Hanford Site in south-central Washington (Stewart, 2008; Dong et al., 2005). In oxic waters, aqueous speciation plays a large role in the availability of free uranium by affecting such processes as adsorption, reduction, and precipitation (Maher, Bargar, & Brown, 2012). The presence of dissolved calcium carbonates can drastically alter total uranium concentrations due to the formation of uranium-calcium-carbonate complexes (Stewart, 2008; Elless & Lee, 1998). Uranium-calcium-carbonate complex formation is presented below:

$$2Ca^{2+} + UO_2^{2+} + 3HCO_3^- \leftrightarrow Ca_2UO_2(CO_3)_3\,(aq) + H^+$$

Uranium-calcium-carbonate complex formation decreases free uranyl ion concentration in the system, creating disequilibrium. The system responds by dissolving uranium from its source, resupplying free uranyl ion concentrations and leading to increased total uranium concentration (Stewart, 2008; Fox, Davis, & Zachara, 2006).

In oxic, high calcium-carbonate waters of the TVAS, we suggest the local source is UO_2^{2+} adsorbed to aquifer sediments. Stewart (2008) used adsorption release tests to show a strong link between decreasing adsorption capacity of sediments and increased U-Ca-CO_3 formation. Visual MINTEQ chemical modeling results of the Meridian Campaign samples reveal carbonate-uranium complexes make up an average of 99.9% of dissolved uranium in these waters. An average of 97% of dissolved uranium is made up of calcium-carbonate-uranium complexes. The dominance of U-Ca-CO_3 complex formation in the oxic portions of the TVAS and correlated high uranium concentrations suggest adsorption controls uranium release from sediments.

A diagram outlining the proposed uranium release mechanism is displayed in Figures 17 & 18. Le Chatelier's Principle acts as the foundation for the model. As calcium carbonate content increases, the system's equilibrium is disrupted. The equation shifts to the right to incorporate excess calcium and carbonates, increasing $Ca_2UO_2(CO_3)_3^0$ concentrations. The $Ca_2UO_2(CO_3)_3^0$ complex is generally stable in solution, partly due to its lack of charge that decreases its sorption potential (Fox et al., 2006). Consequentially, free UO_2^{2+} in the system is depleted as it is pulled into the $Ca_2UO_2(CO_3)_3^0$ complex (Equation 2). The decrease in free UO_2^{2+} leads to further disequilibrium in the system. To restore equilibrium, UO_2^{2+} desorbs from sediments into aqueous solution, shown in equation (3). Total uranium concentrations rise as a result, a combination of free UO_2^{2+} and uranium present in $Ca_2UO_2(CO_3)_3^0$.

The proposed uranium adsorption release mechanism in oxic, high calcium-carbonate waters of the TVAS results in the potential for elevated dissolved uranium concentrations (Figure 18).

4.4. Recommendations/Observations

4.4.1. Domestic Wells and Uranium

Domestic wells in the Treasure Valley are commonly completed to shallow depths and in oxic waters (<500 ft bwt). These predictors suggest that Treasure Valley domestic wells are accessing groundwater with the potential for elevated uranium concentrations.

The extent of domestic well monitoring in the TVAS is not adequate when considering the high potential for elevated uranium in the region’s domestic wells (Figure 6). The study dataset reveals that less than 2% of total domestic wells in Ada and Canyon Counties are monitored for uranium. Uranium concentrations exceeding the MCL are estimated in 37% of domestic wells in Ada County and 15.5% of domestic wells in Canyon County. Using United States Census Bureau estimates for household size in Ada and Canyon Counties from 2013-2017, over 5,500 people in Ada and Canyon Counties combined are potentially consuming dissolved uranium over the MCL if their well water is left untreated (Table 4) (United States Census Bureau, n.d.).

4.4.2. Affordable Uranium Screening

The strong correlations of elevated uranium concentrations and the easily measured parameters of well depth, dissolved oxygen, and alkalinity provides the basis for a simple screening approach to predict if a well is likely to have elevated uranium. This screening tool may be useful in mitigating the adverse health and economic effects of uranium on residents and municipalities of the Treasure Valley.

Water quality testing can be an expensive process when considering labor and laboratory analysis costs. For example, uranium testing can range from \$30-\$44 per sample in the Treasure Valley on top of payment to a contractor to perform the tests (Analytical Laboratories Inc 2014, Idaho Department of Water Resources n.d.). Testing can take weeks to months for collection, transport, and analysis of samples.

To avoid costly uranium testing for domestic well owners and water managers, a screening tool using the results of this study can limit testing to the most at-risk wells. This study highlights two key geochemical predictors of elevated dissolved uranium in the TVAS. Redox status predicts the mobility of uranium, while calcium and carbonate content predict the level of concentration and availability of uranium in the system. Easily measured parameters can be used to estimate the two predictors: dissolved oxygen (DO) for redox status and alkalinity for calcium and carbonate content. Figure 15 highlights the relationship between uranium and DO and alkalinity, where elevated uranium concentrations only appear in the upper right quadrant as alkalinity exceeds 150 mg/L and DO exceeds 1 mg/L, resulting in 43% of samples above the MCL of 30 µg/L. To further simplify testing, well depth can estimate DO: wells <500 ft below ground surface likely have DO >1 mg/L, while wells >500 ft below ground surface likely have DO <1 mg/L. Thus, shallow wells with alkalinity above 150 mg/L have the potential for dissolved uranium above the MCL. Figure 19 presents a simple flowchart that can be used for elevated uranium screening.

5. CONCLUSIONS

This study can help water resource managers mitigate the adverse effects of uranium in the TVAS. Drilling, monitoring, and risk implications provide valuable new information and highlight potential actions that may help address uranium contamination in the system.

5.1. Drilling and Sampling Implications

The nearly universal observation of low U concentrations in the reduced, deeper, aquifer sediments of the TVAS suggests that deeper well installation is a potential mitigation strategy, although such an approach may pose challenges to protecting the deeper aquifer from surface contaminant sources.

When wells are finished in the shallower, oxic aquifer, the easily measured parameter of alkalinity can be used to screen for wells with high risk of elevated uranium. For those shallow wells with elevated alkalinity, more precise measurements of alkalinity and dissolved oxygen can be utilized. For those wells identified as likely to have elevated uranium based on confirmed high alkalinity and high dissolved oxygen, analysis for uranium concentration should be initiated.

5.2. Temporal-Scale Uranium Monitoring

The current statewide monitoring program sampling protocol wherein wells are revisited approximately once every 5 years hampers the ability to detect changes in aquifer chemistry over time. To address questions about groundwater uranium change over time, select wells should be identified for annual sampling. A discrete sampling campaign should also be initiated to sample a select set of wells monthly over a 1-year cycle to evaluate the potential of seasonal variations.

Increased monitoring of water quality constituents associated with uranium would aid predictions of elevated uranium in the TVAS. Widespread monitoring of alkalinity, calcium, and dissolved oxygen would allow for spatial analysis of oxic, calcium carbonate-rich water in the system and prediction of potential for elevated zones of uranium.

5.3. Multilevel Uranium Monitoring

The Meridian multilevel monitoring wells represent an important un-tapped source of well constrained water quality data. These wells are the only location in the Treasure Valley where robust well installation methods created the ability to collect a discrete vertical profile of TVAS water quality. Given the dramatic differences in vertical water quality and the importance of the TVAS as a primary drinking water source, integration of these wells into the IDWR Statewide Ambient Water Quality Monitoring network is warranted.

5.4. Domestic Wells Users at Risk

Based on the trends we observe in the compiled groundwater quality dataset, it is highly likely that thousands of Treasure Valley residents are currently consuming groundwater with unsafe uranium levels. Domestic well users may be unaware of uranium contamination in the region and/or may be hesitant to cover the costs of monitoring their own wells. We recommend increased monitoring of domestic wells in the TVAS to minimize domestic well user risk. Monitoring should be coupled with an information campaign to domestic well users outlining the health risks of consuming dissolved uranium. The screening approach outlined above may provide an affordable template to achieve these goals.

5.5. Further Work

Further work would provide more information to better assess the nature of dissolved uranium in the TVAS. Uranium adsorption-release tests of aquifer sediments with high calcium carbonate content could test our hypothesis of calcium carbonate-induced uranium adsorption release. Time series analysis of the recommended high temporal scale uranium monitoring could elucidate if uranium concentrations are increasing over time in the TVAS. Additionally, further analysis of uranium in Ada and Canyon County domestic wells could address data gaps and provide a more comprehensive picture of TVAS uranium.

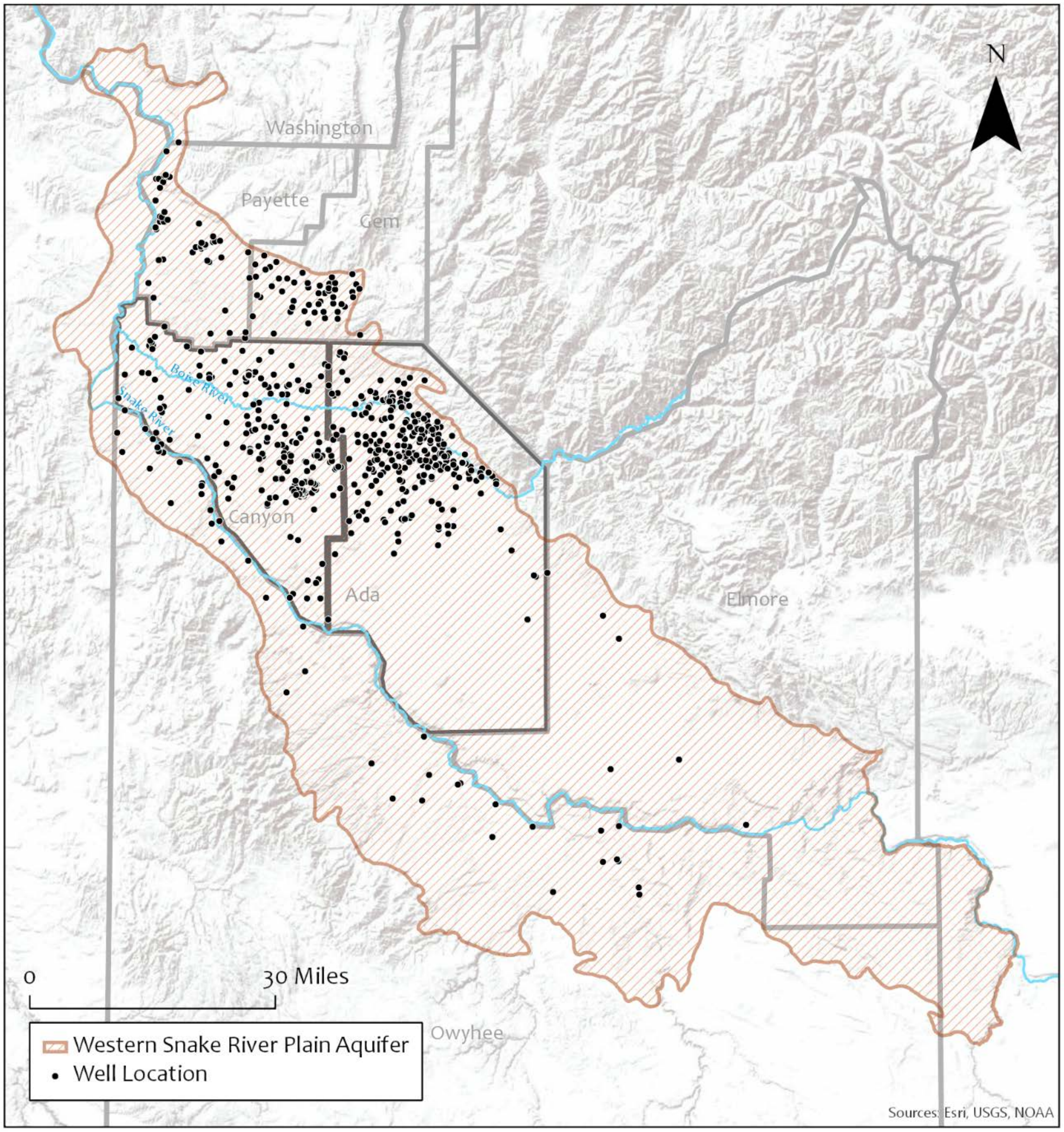

Figure 1 Study Area. Well locations from the compiled study dataset, Southwestern Idaho. All wells largely reside within the Western Snake River Aquifer System (Newton, 1991). The main focus of the study is on the Treasure Valley Aquifer System defined by Ada and Canyon Counties (Hutchings & Petrich, 2002b).

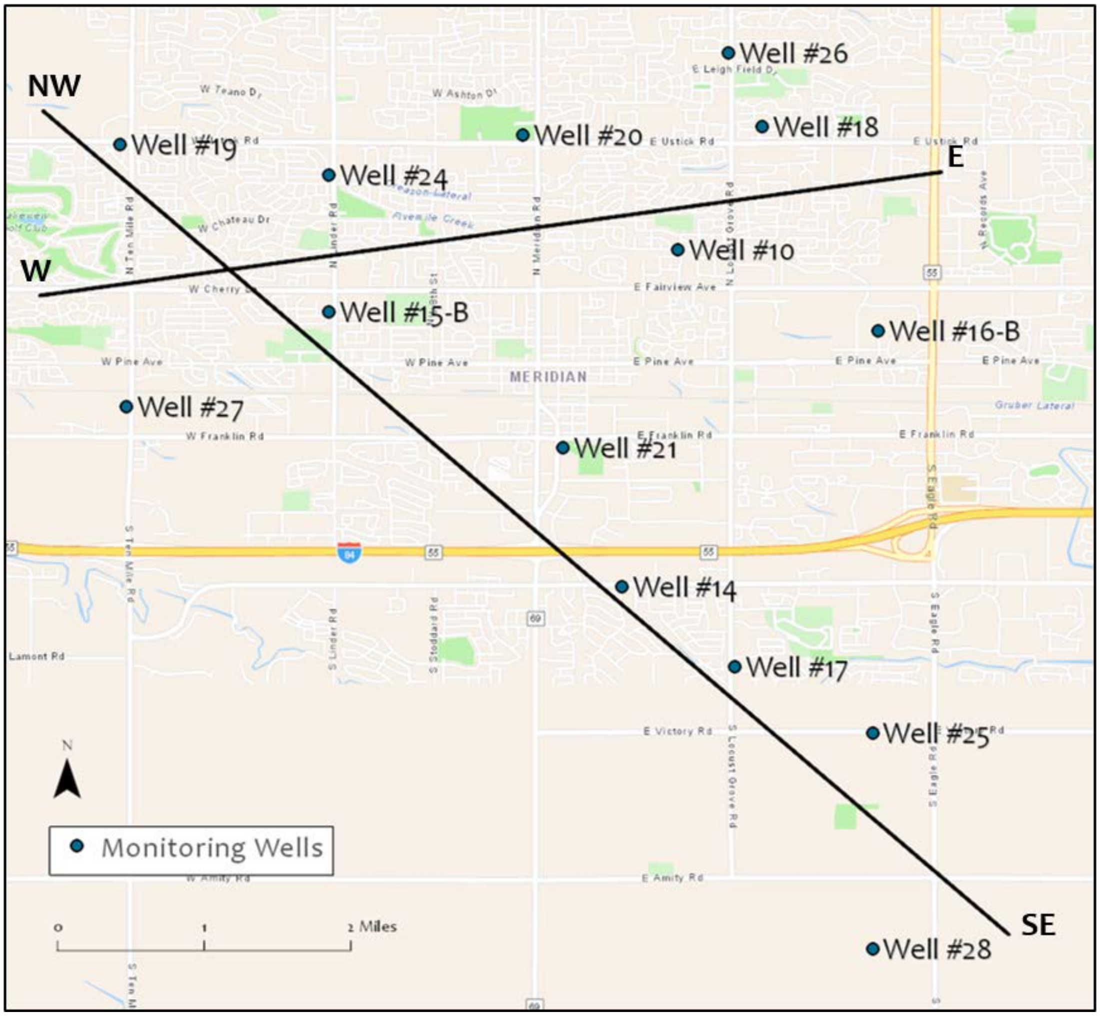

Figure 2 Meridian Sampling Campaign Wells. Targeted wells in the Meridian Sampling Campaign, city of Meridian. Cross section lines show section W-E and section NW-SE. Well #10 was not sampled, and uranium data for the well was taken from Squires (2012).

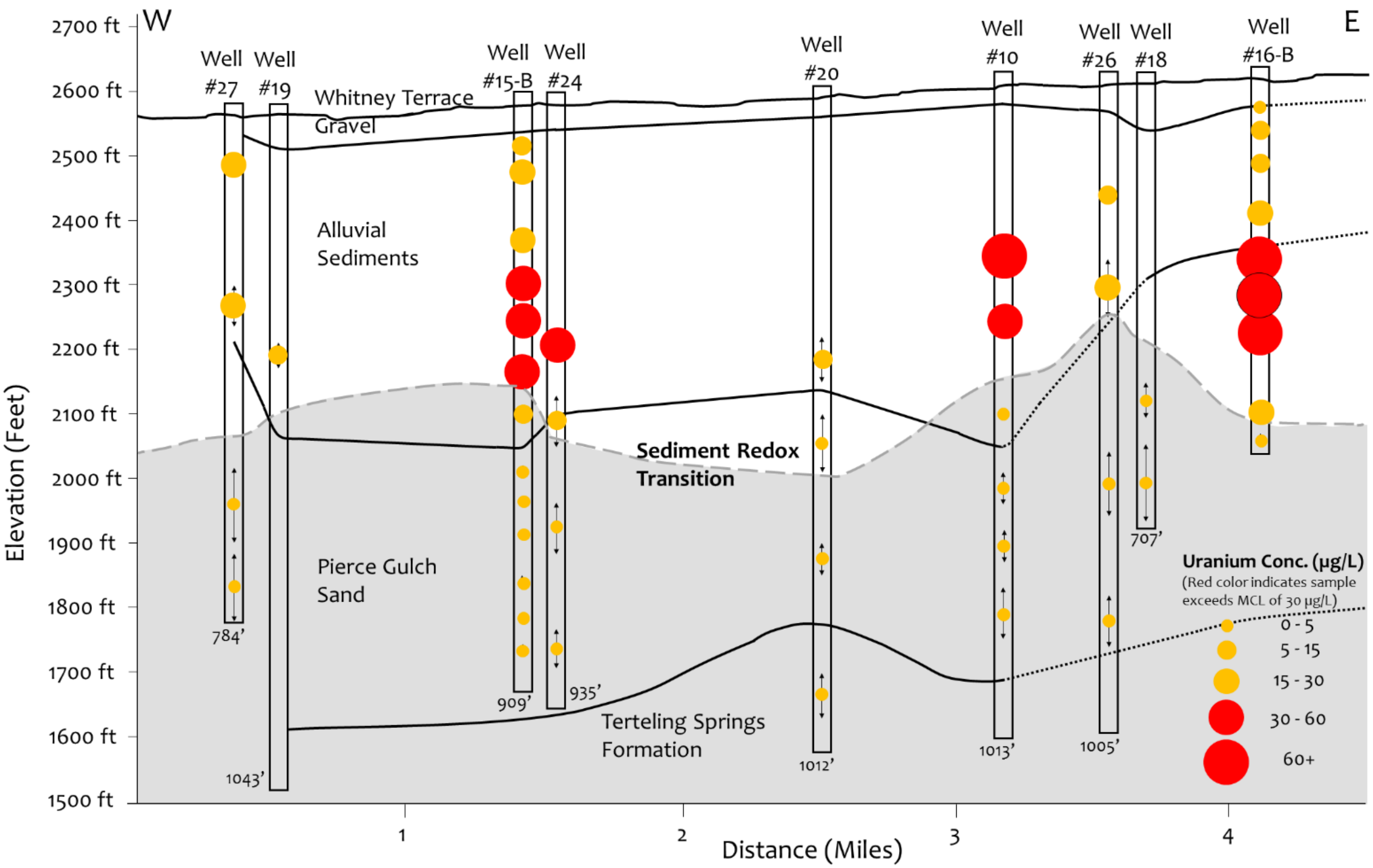

Figure 3 Cross section of the Meridian Sampling Dataset running west to east across the city of Meridian. The thin black lines represent stratigraphy boundaries while the dotted black line is the interpolated stratigraphic boundary (Squires, 2012; Squires, 2014). The dashed gray line represents the Sediment Redox Transition. The double-sided arrows represent the screened interval of the zone and are not visible where dot size exceeds interval size.

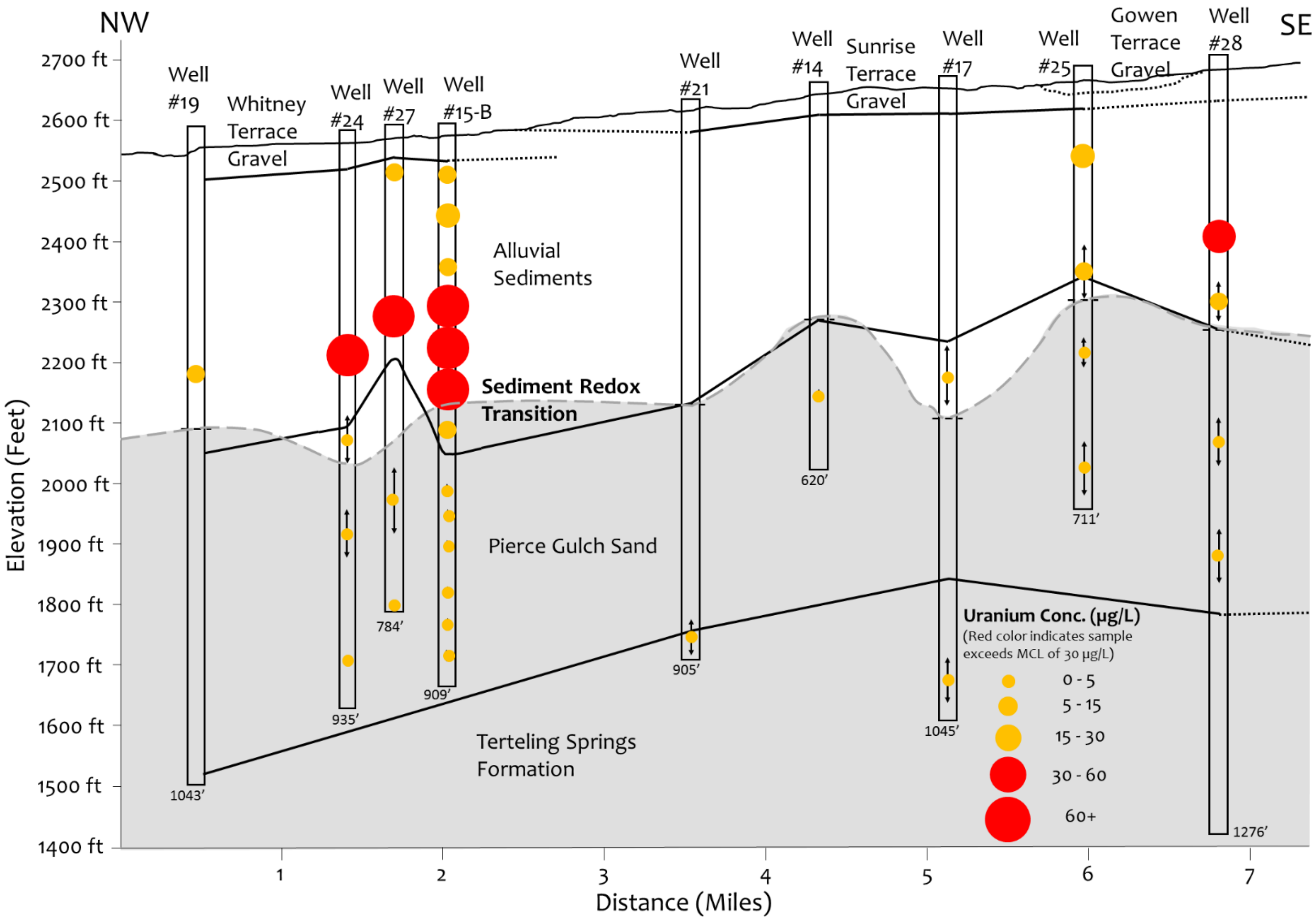

Figure 4 Cross section of the Meridian Sampling Dataset, northwest to southeast across the City of Meridian. The thin black lines represent stratigraphy boundaries while the dotted black line is the interpolated stratigraphic boundary (Squires, 2012; Squires, 2014). The dashed gray line represents the Sediment Redox Transition. The double-sided arrows represent the screened interval of the zone and are not visible where dot size exceeds interval size.

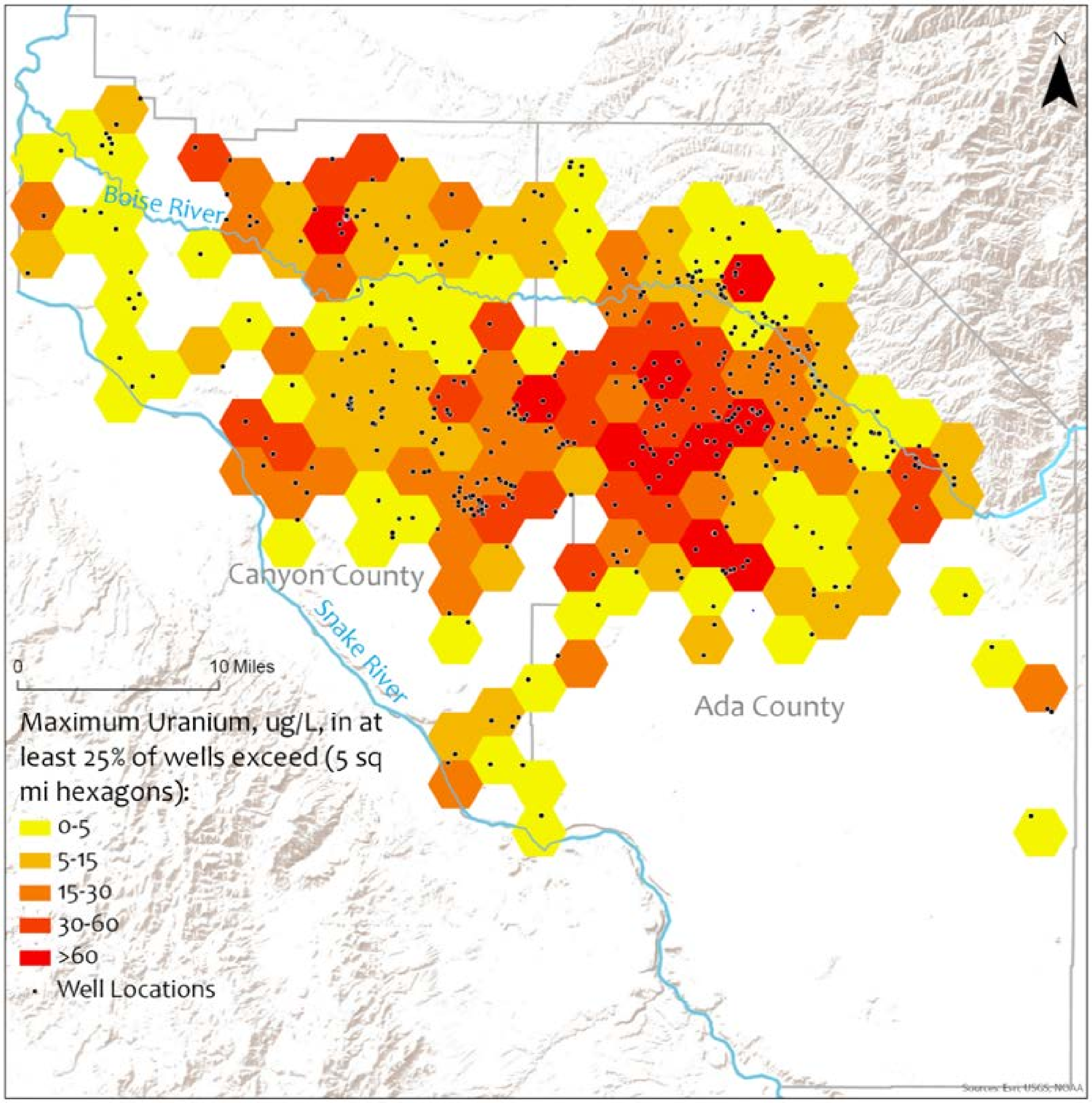

Figure 5 Uranium concentrations across Ada and Canyon Counties. The 5-square-mile hexagons show the exceedance probability of the highest uranium concentrations from all wells within each hexagon. Uranium concentrations are highly variable and elevated across the region.

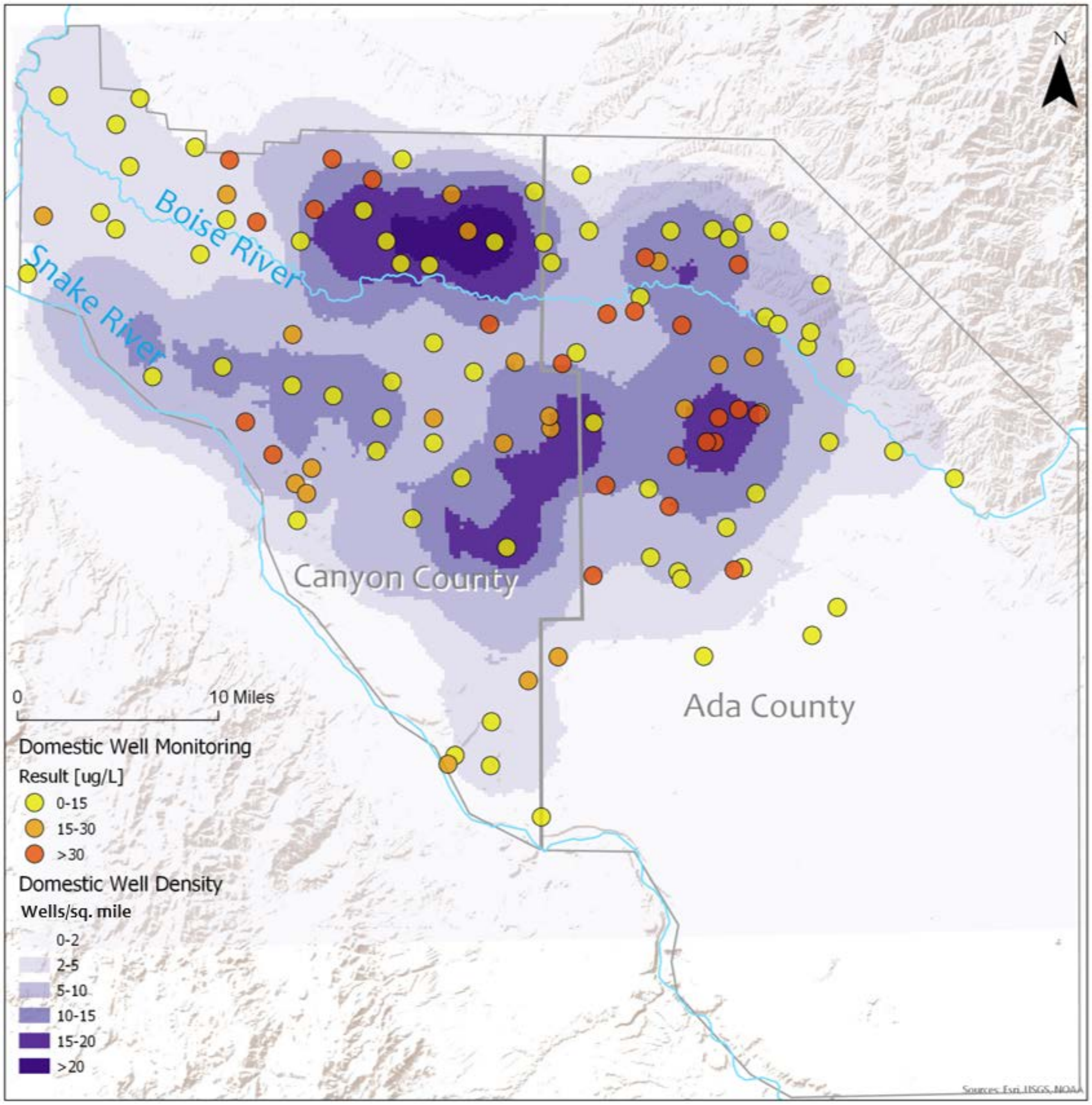

Figure 6 Domestic Uranium Monitoring. Maximum uranium values from monitored domestic wells are compared to total domestic well density in Ada and Canyon Counties. Domestic well density is presented as wells per 1 mile density. Elevated uranium is present in areas with >20 total domestic wells per square mile but low monitoring density.

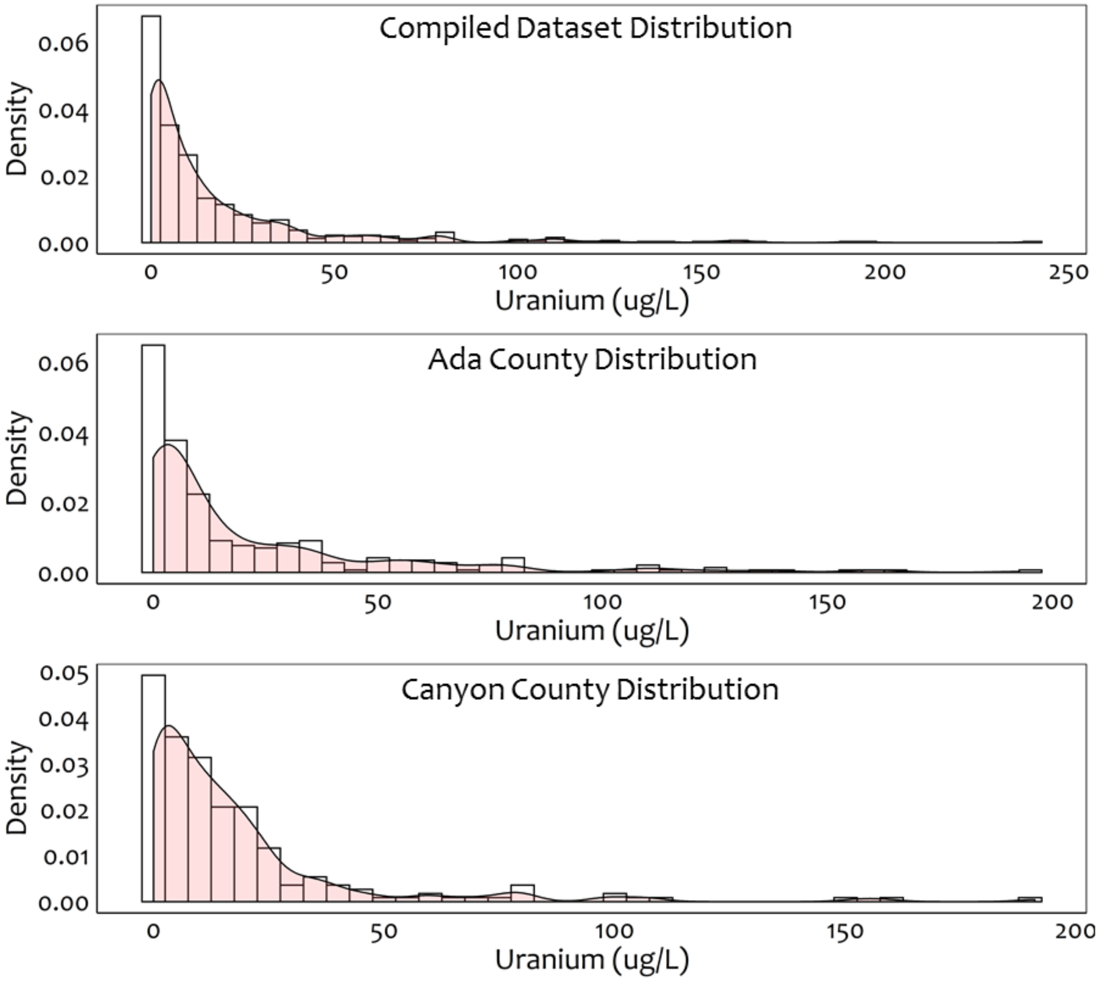

Figure 7 Compiled Dataset distribution. Probability density functions and density histograms for uranium in the Compiled Dataset and Ada and Canyon County wells.

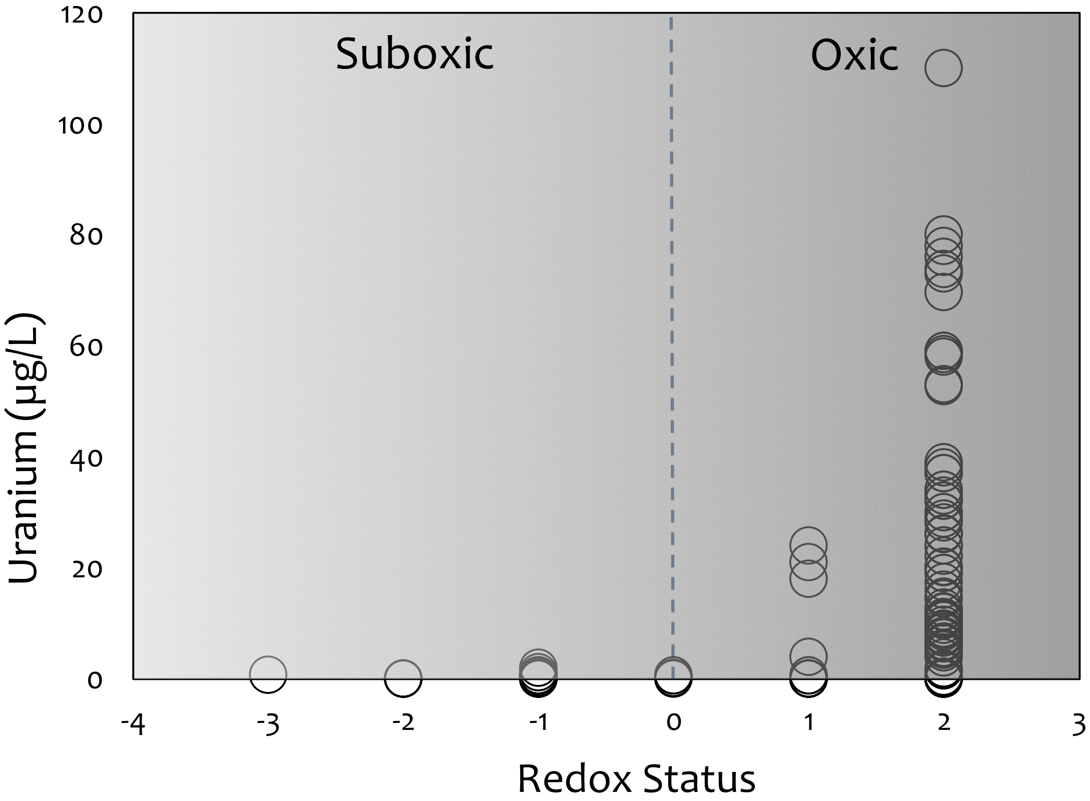

Figure 8 Dissolved Uranium Redox Status. The relationship between redox status and uranium concentration shows elevated uranium concentrations are present in oxic waters. Suboxic waters exhibit low uranium concentrations. Redox status developed from scoring criteria based on redox active species concentrations.

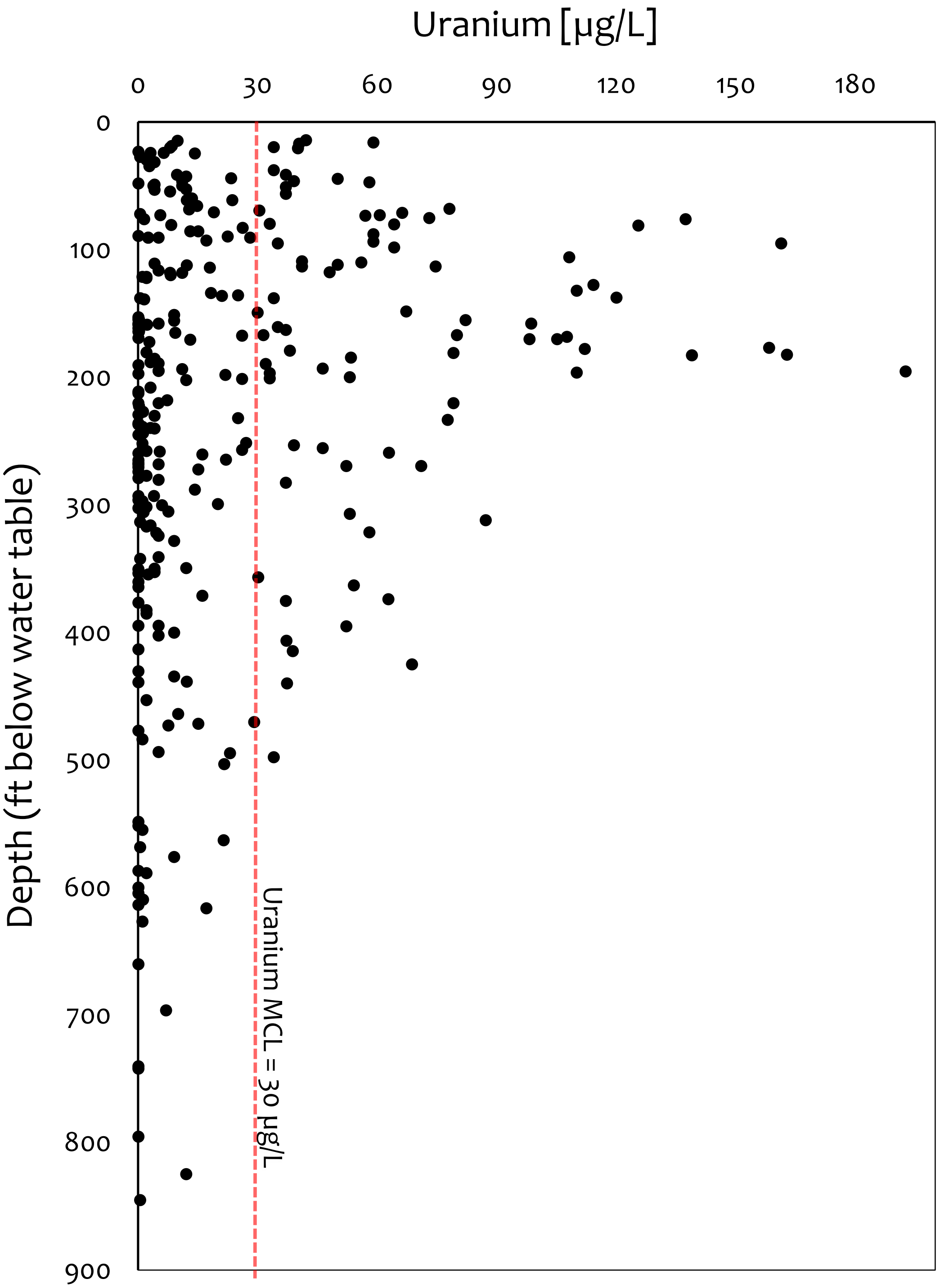

Figure 9 Uranium concentration at depth from water table, compiled study dataset. Each dot represents the highest measured uranium concentration at a well location, and the depth represents the screen average or bottom of well opening.The dotted red line highlights the MCL of 30 µg/L. Uranium concetrations decrease as depth increases.

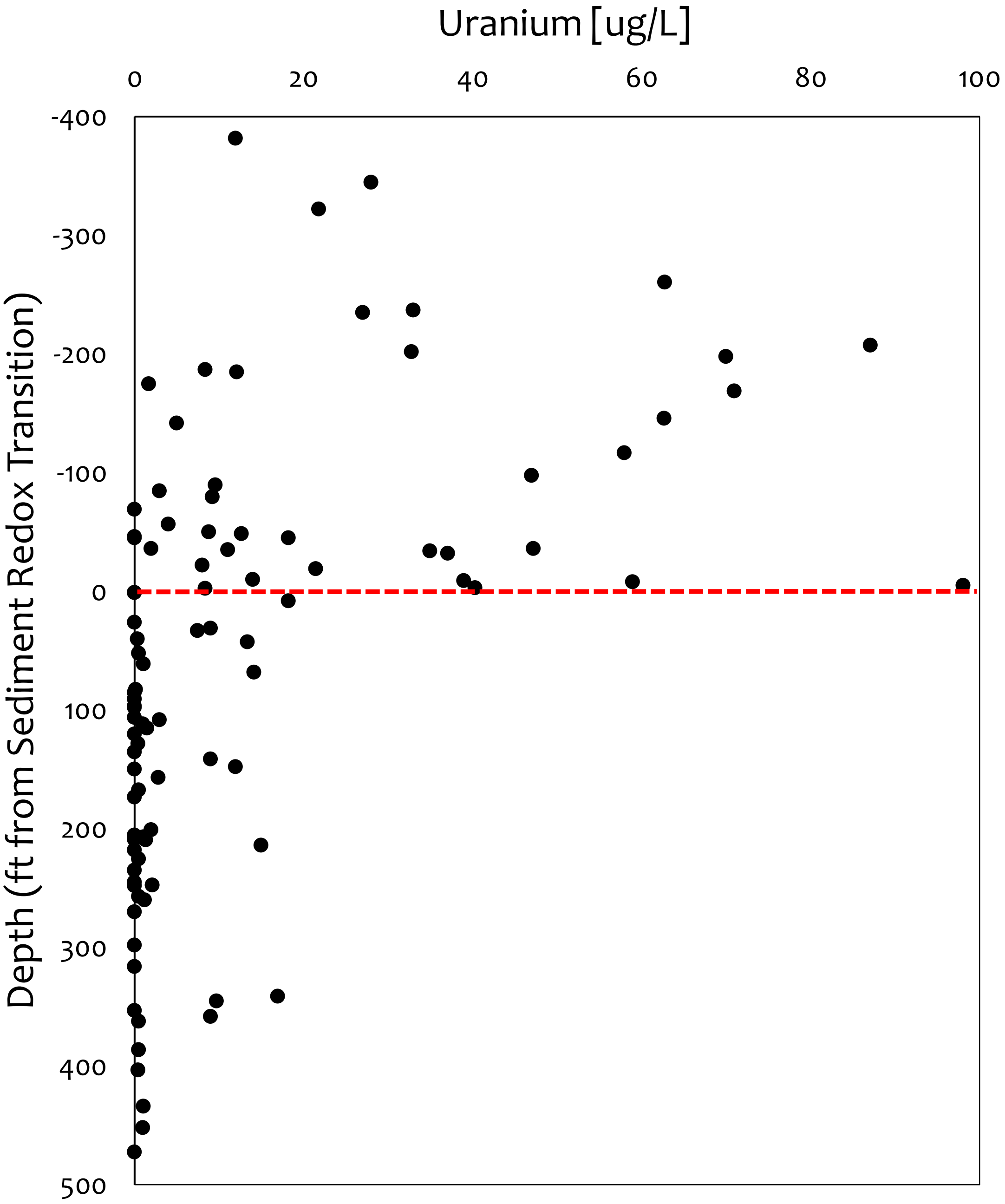

Figure 10 Uranium at Depth from Sediment Redox Transition. Elevated uranium concentrations are found only at depths above the Sediment Redox Transition, represented by the dotted red line. Below the Sediment Redox Transition, low uranium concentrations are found.

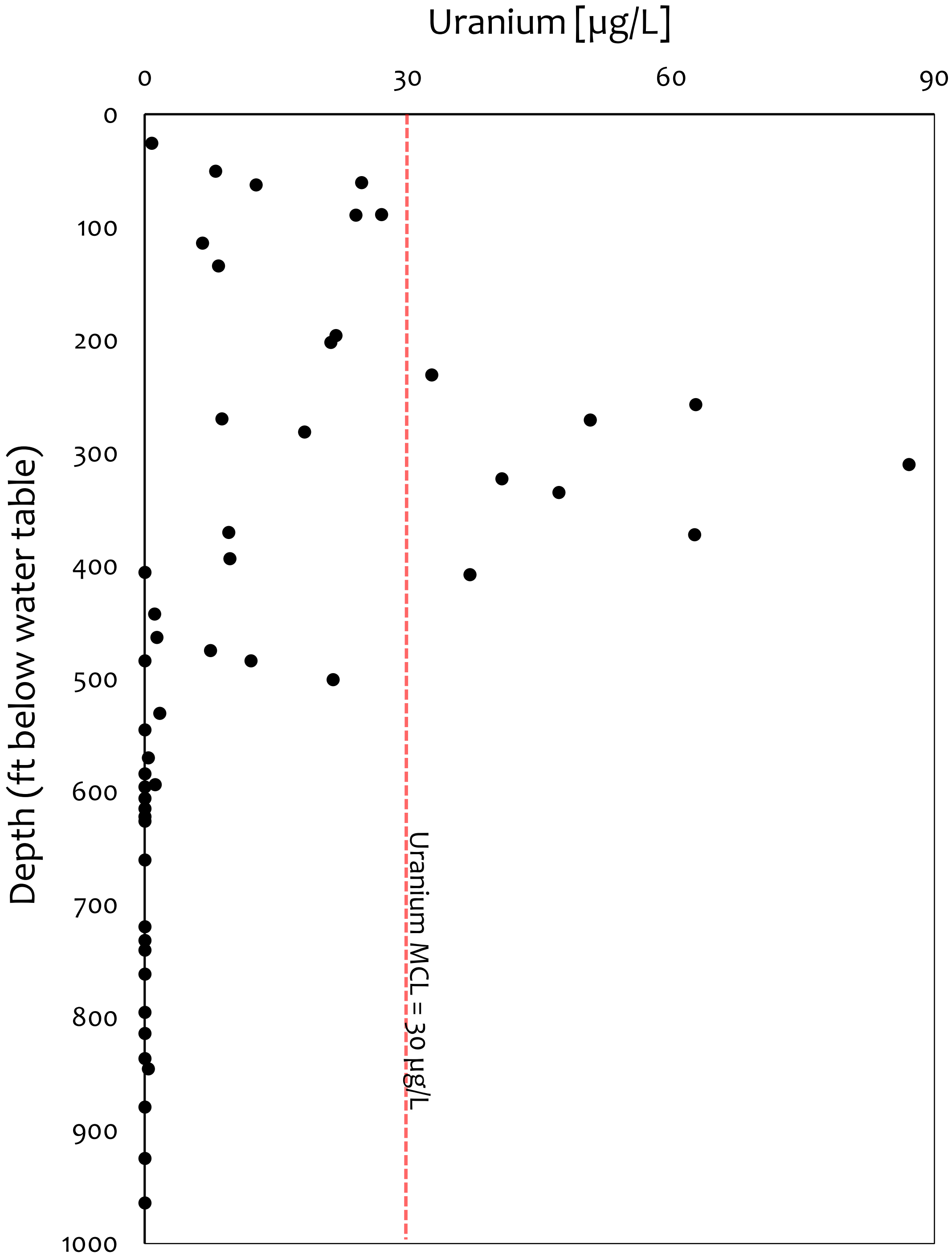

Figure 11 Uranium concentration at depth from water table, Meridian Sampling Campaign dataset. Each dot represents the uranium measurement recorded at a well location, and the depth represents the screen average. The dotted red line highlights the MCL of 30 µg/L.

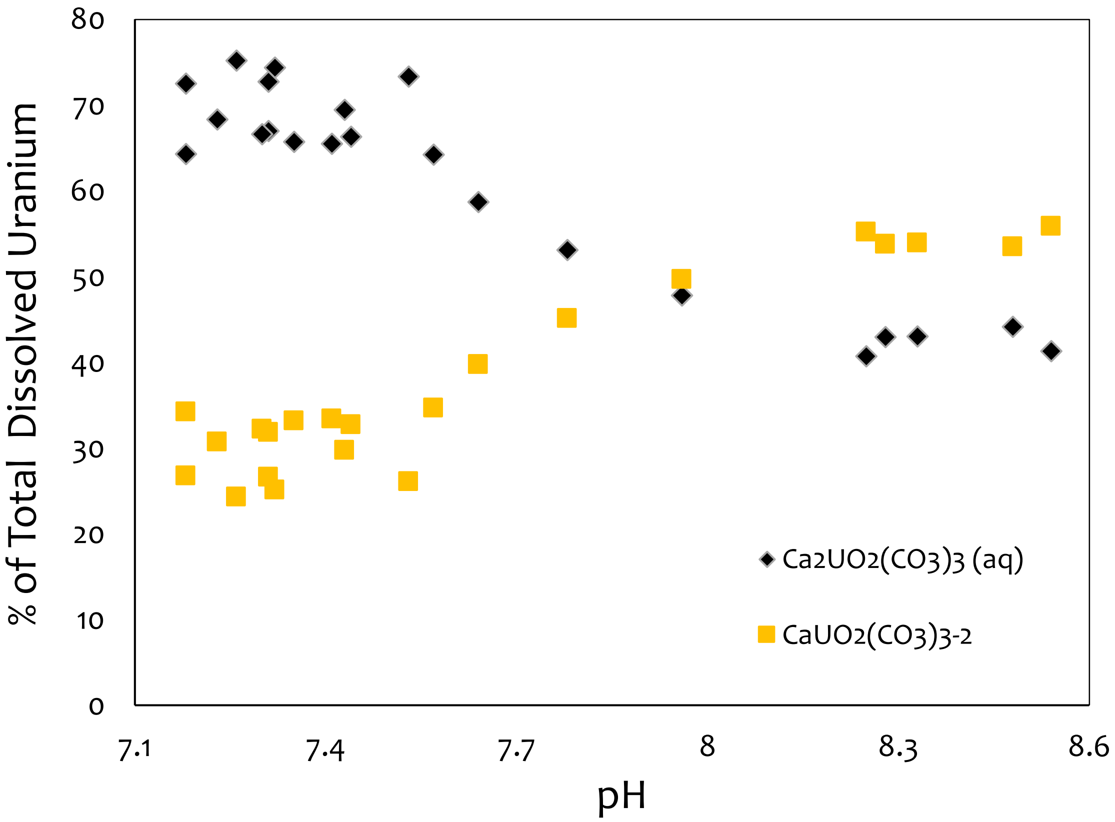

Figure 12 TVAS Uranium-Calcium-Carbonate Complexes. Modeled dominant UO2+2 species in wells 15 and 16 from the Meridian Sampling Campaign. Uranium-calcium-carbonate complexes constitute the dominant share of uranium species in the system. Complexes below 3% of total dissolved uranium were excluded from the figure.

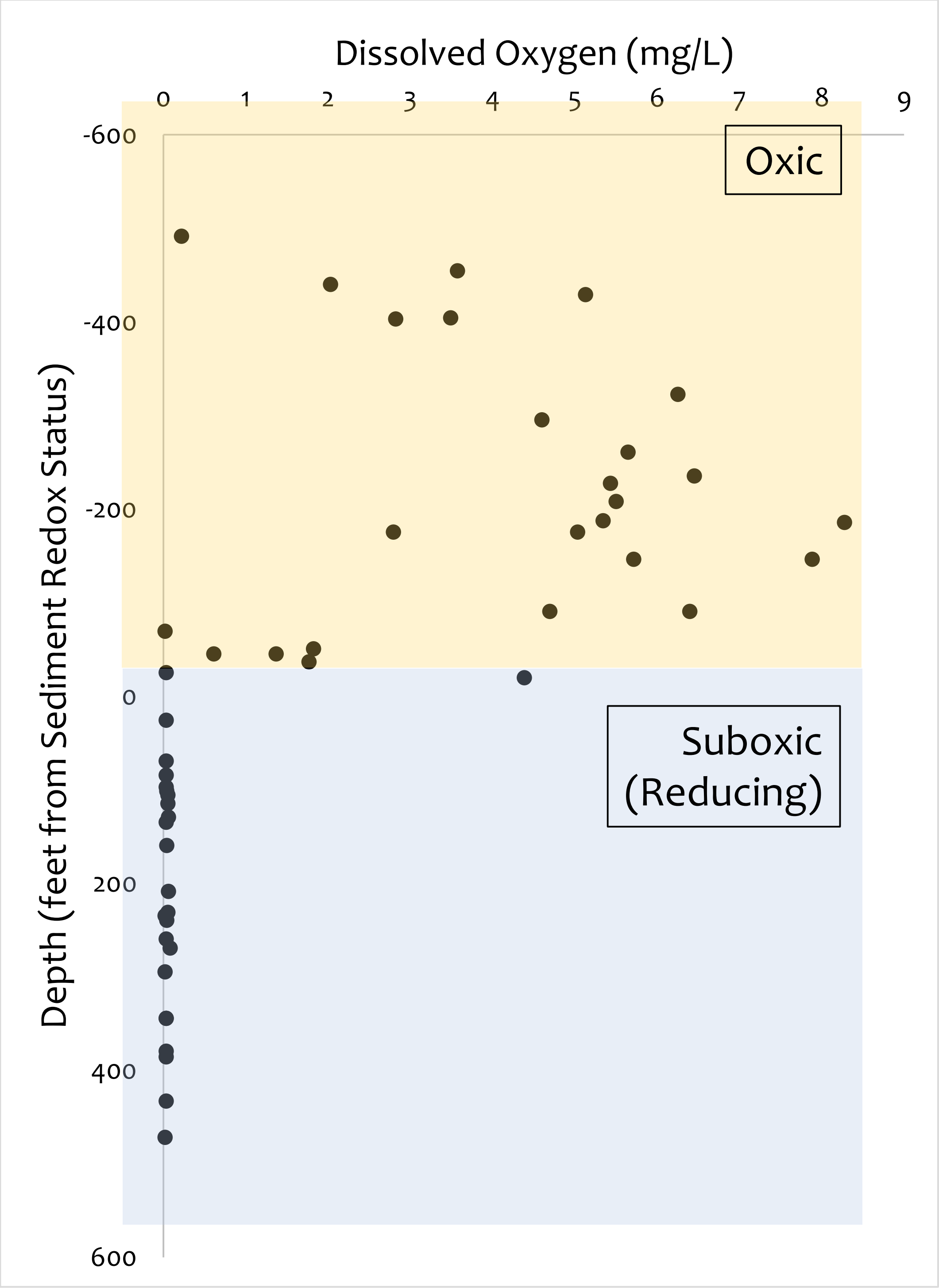

Figure 13 Dissolved Oxygen and depth from Sediment Redox Transition. Dissolved oxygen acts as an accurate predictor of aquifer redox status. Dissolved oxygen >1 mg/L predicts oxic waters. Dissolved oxygen <1 mg/L predicts reducing waters.

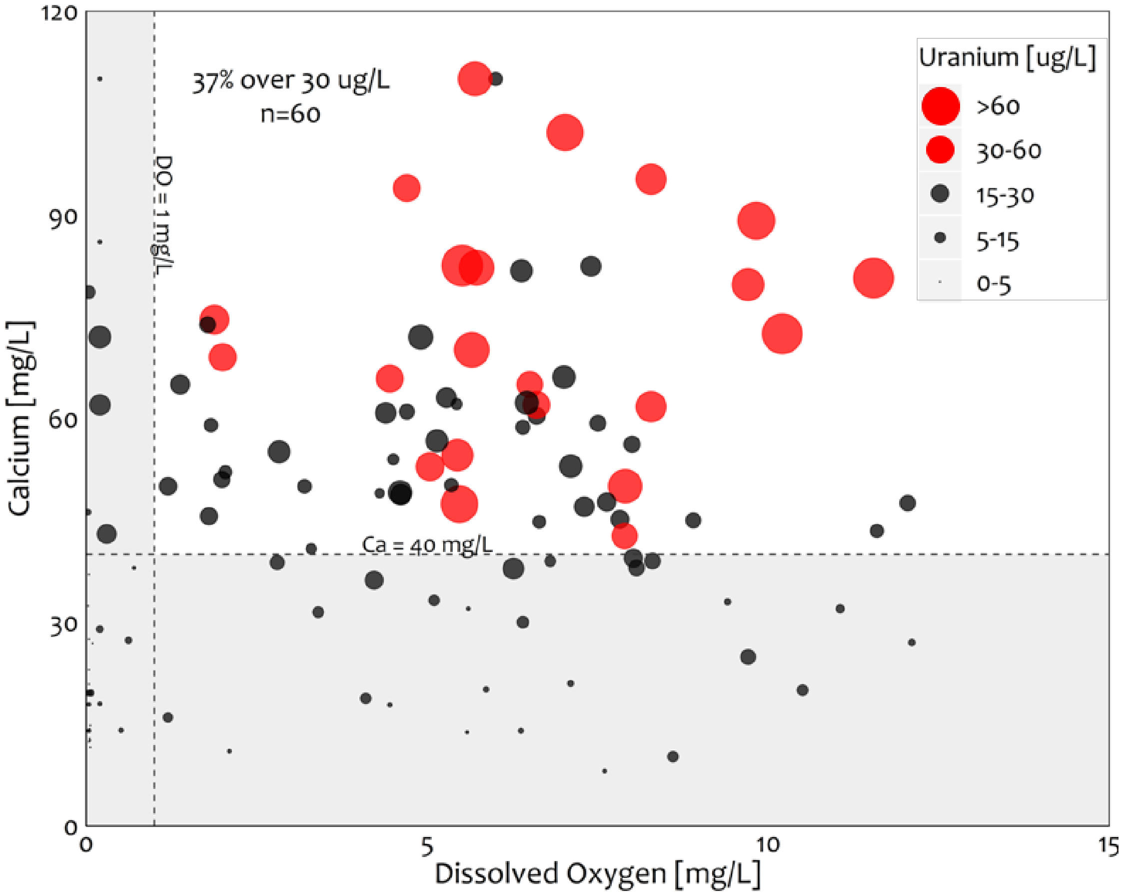

Figure 14 The effect of dissolved oxygen and calcium on uranium concentrations. Measured Uranium concentrations that exceeded the MCL were always in water with dissolved oxygen > 1 mg/L and calcium > 40 mg/L.The red dots indicate uranium concentrations exceeding the MCL of 30 µg/L.

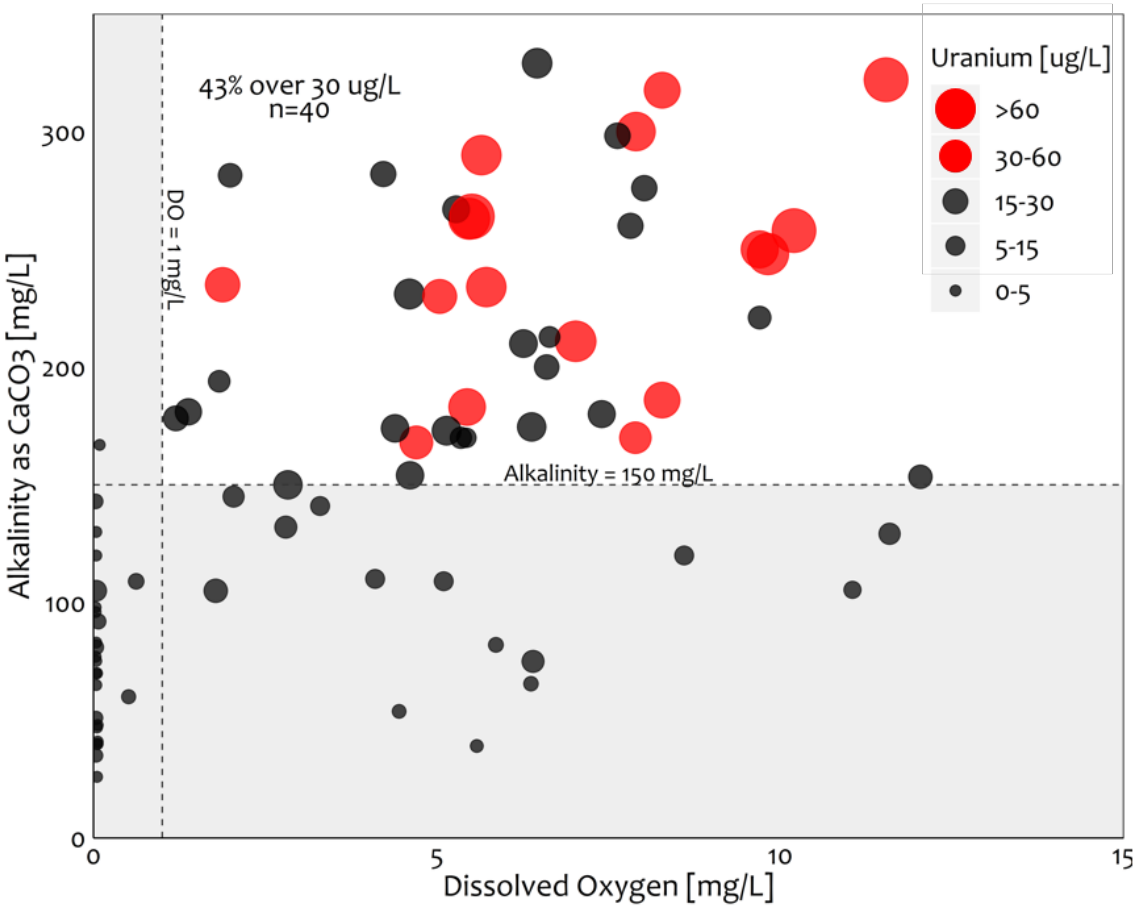

Figure 15 The effect of dissolved oxygen and alkalinity on uranium concentrations. Measured Uranium concentrations that exceeded the MCL were always in water with dissolved oxygen > 1 mg/L and alkalinity > 150 mg/L. The red dots indicate uranium concentrations exceeding the MCL of 30 µg/L.

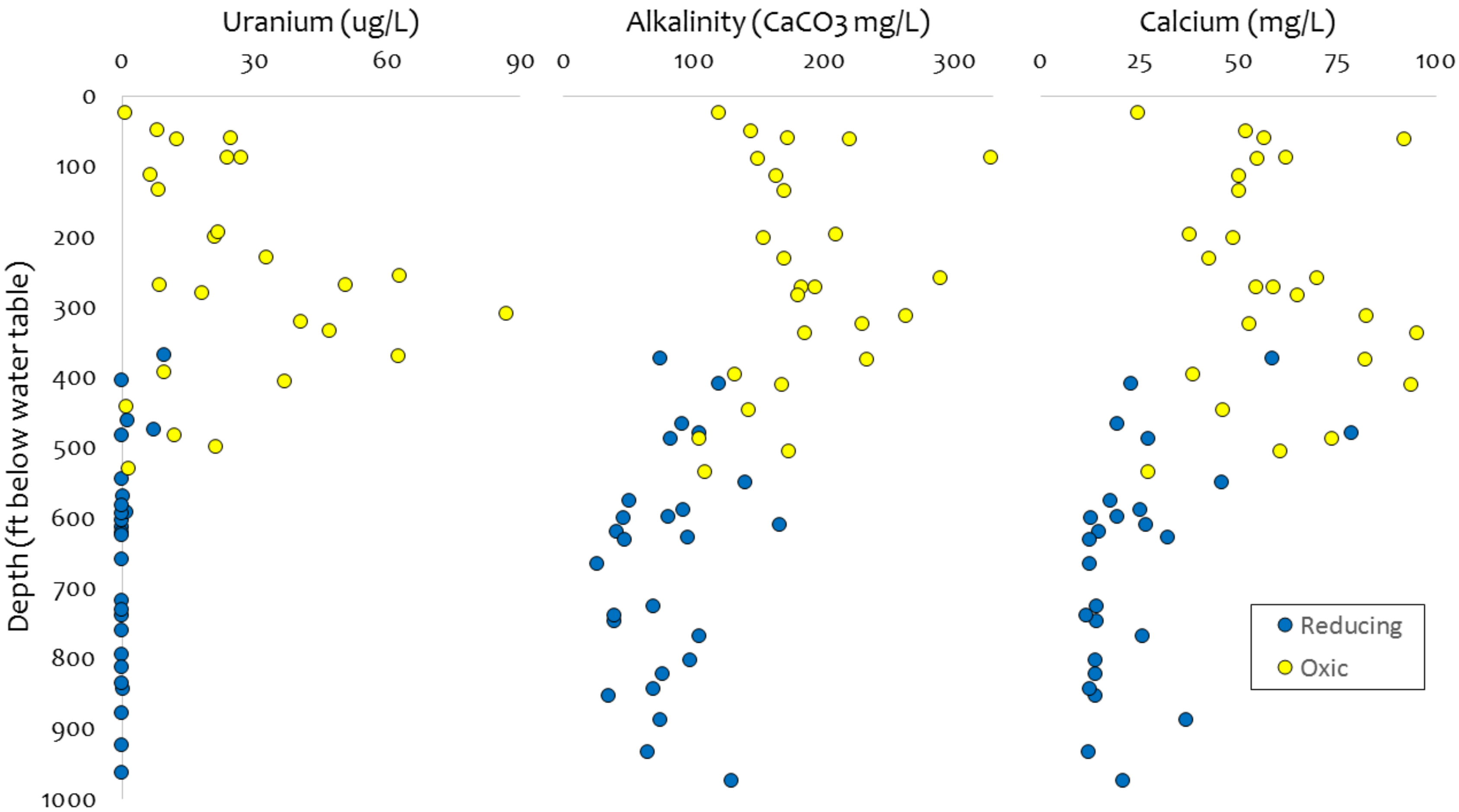

Figure 16 Uranium, alkalinity, and calcium plotted at depth, Meridian Sampling Campaign. The change in uranium concentration at depth is reflected by changes in alkalinity and calcium concentrations. Concentrations peak in shallow waters and decrease at greater depth. All elevated uranium concentrations (>30 µg/L) are present in oxic waters.

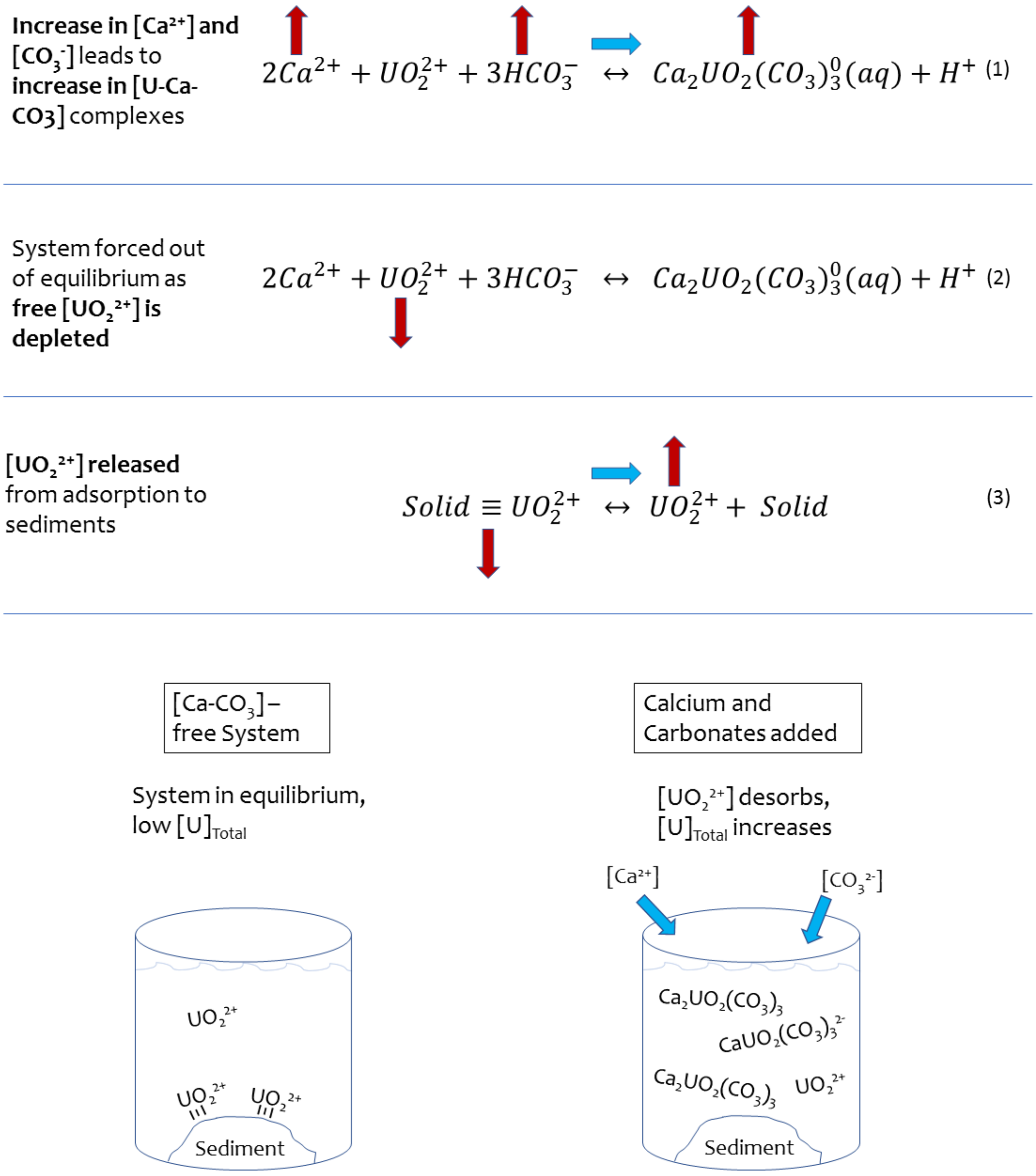

Figure 17 Uranium adsorption release mechanism. The complexation of uranium with calcium carbonates initiates disequilibrium in the system. The system responds by facilitating the release of free uranium from aquifer sediments. The result is an increase in total dissolved uranium concentration.

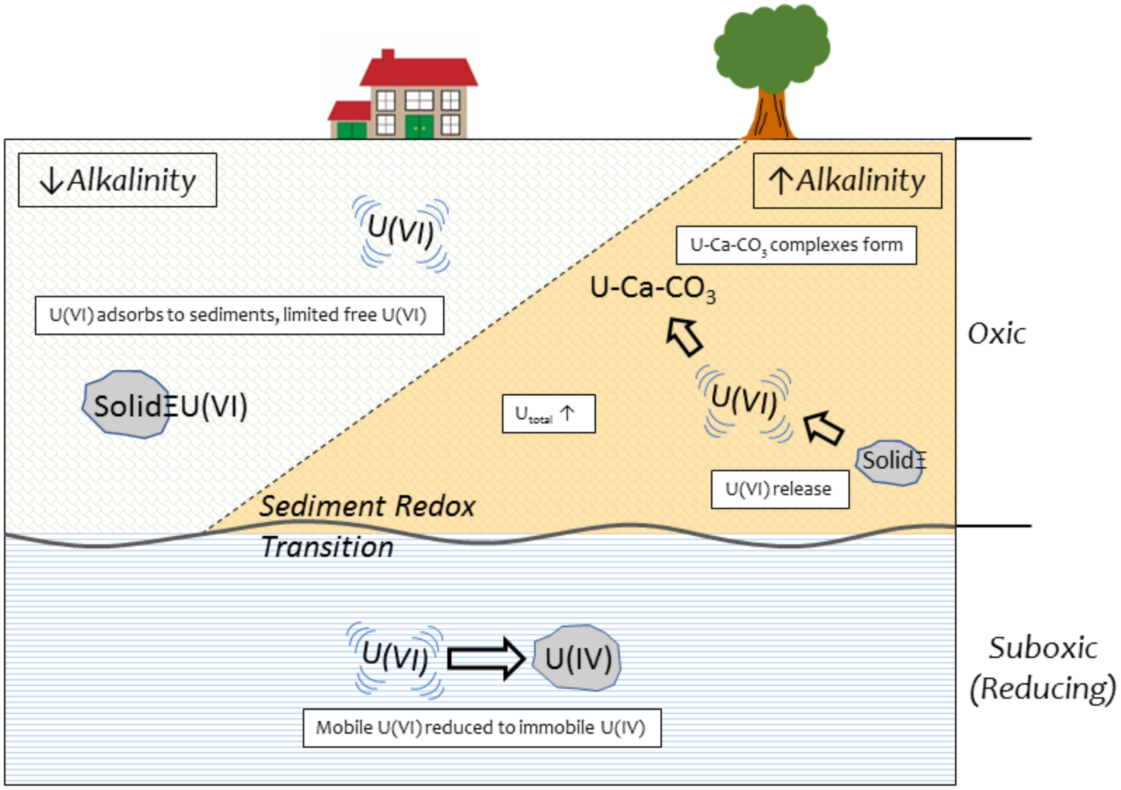

Figure 18 Conceptual model of the nature of dissolved uranium in the TVAS. Three main geochemical conditions dictate the fate of uranium in the TVAS. Suboxic waters yield low uranium concentrations via reduction to U(IV) and subsequent immobilization. Oxic waters with low alkalinity yield low uranium concentrations as a result of uranium adsorption to aquifer sediments. Oxic waters with high alkalinity yield elevated uranium concentrations above the drinking water standard of 30 µg/L as U-Ca-CO$_3$ complex formation desorbs uranium from aquifer sediments.

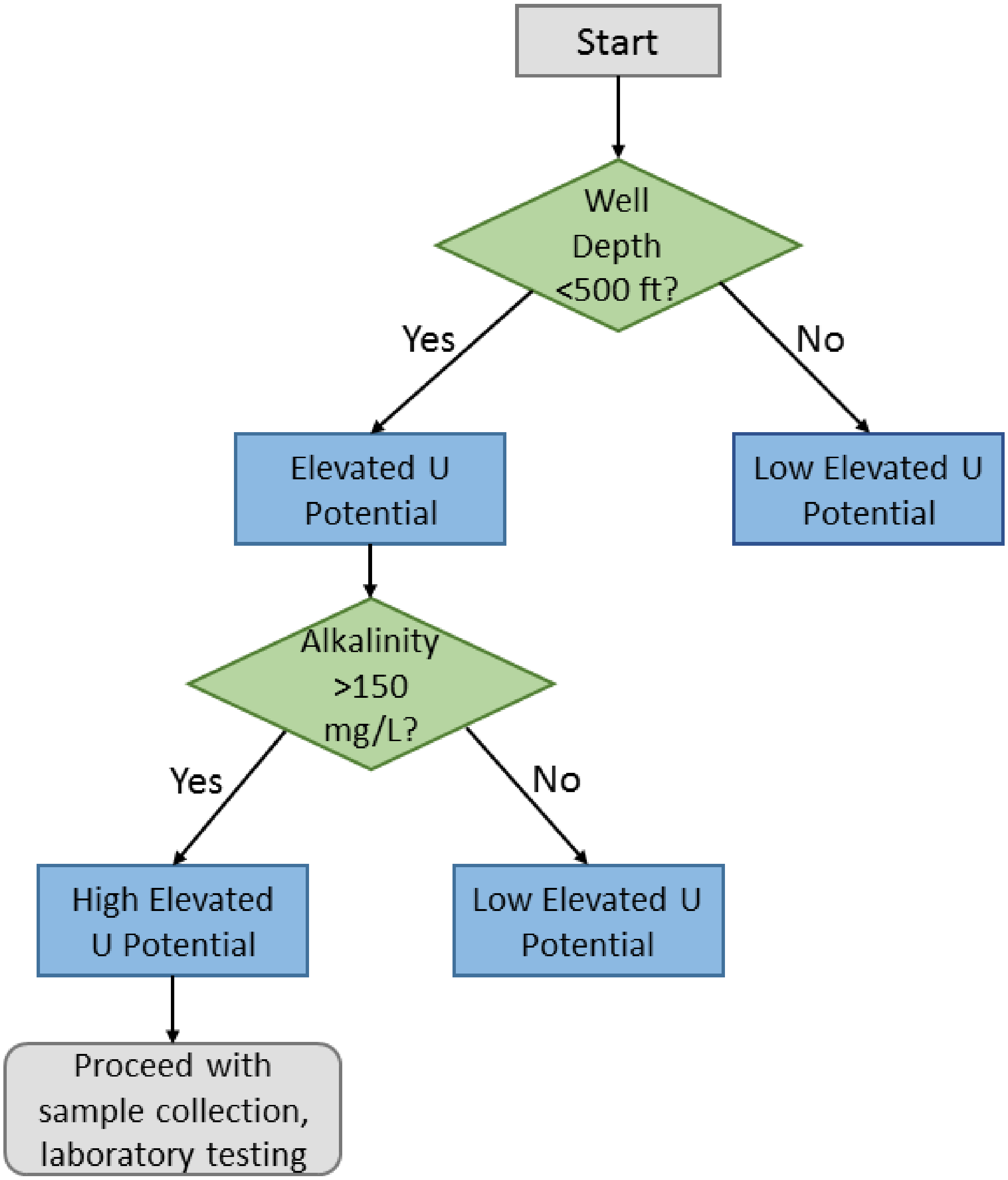

Figure 19 Uranium Screening Flow Chart. Well depths and alkalinity provide parameters that estimate the potential for elevated uranium in the TVAS. Shallow wells (<500 feet below ground surface) and high alkalinity waters (>150 mg/L) estimate high potential for elevated uranium concentrations.

Table 1. **Analysis Information for Meridian Sampling Campaign**

Analyte	Units	Analytical Instrument	Detection Limit	Method
Chloride	(mg/L)	Ion Chromatography	1	E300.0
Fluoride	(mg/L)	Ion Chromatography	0.1	A4500-F C
Sulfate	(mg/L)	Ion Chromatography	1	E300.0
Calcium	(mg/L)	Ion Chromatography	0.5	E200.7
Magnesium	(mg/L)	Ion Chromatography	0.5	E200.7
Potassium	(mg/L)	Ion Chromatography	0.5	E200.7
Sodium	(mg/L)	Ion Chromatography	0.5	E200.7
Nitrogen, Ammonia as N	(mg/L)	ICP-MS	0.05	E350.1
Arsenic	(mg/L)	ICP-MS	0.001	E200.8
Cadmium	(mg/L)	ICP-MS	0.001	E200.8
Copper	(mg/L)	ICP-MS	0.005	E200.8
Iron	(mg/L)	ICP-MS	0.02	E200.8
Manganese	(mg/L)	ICP-MS	0.001	E200.8
Selenium	(mg/L)	ICP-MS	0.001	E200.8
Silica	(mg/L)	ICP-MS	0.4	E200.7
Uranium	(µg/L)	ICP-MS	0.3	E200.8
Nitrate as N	(mg/L)	Ion Chromatography	0.018	E300.0
Field Parameters			**Instrument Accuracy**	**Instrument Precision**
Alkalinity (mg/L $CaCO_3$)	(mg/L $CaCO_3$)	field kit	15%	15%
pH	std. unit	multi-meter	0.1 std. unit	0.05 std. unit
Dissolved Oxygen (mg/L)	(mg/L)	multi-meter	1.5 mg/L	1.0 mg/L
Spec. Cond. (µS)	(µS/cm)	multi-meter	15%	15%
ORP (mV)	(mV)	multi-meter	25%	5%

Analytical Instruments: ICP-MS = Inductively coupled plasma mass spectrometry.

Table 2. Monitoring well information, Meridian Sampling Campaign

Monitoring Well	Zone	Latitude	Longitude	Collection Date	Screened Interval Depth (ft bgl)	Total Well Depth (ft bgl)
14	1	43.5900139	116.385278	3/20/2019	490-510	620
15-B	1	43.6171222	116.414167	3/1/2019	835-855	909
15-B	2	43.6171222	116.414167	3/1/2019	790-800	909
15-B	3	43.6171222	116.414167	3/1/2019	730-750	909
15-B	4	43.6171222	116.414167	3/4/2019	650-670	909
15-B	5	43.6171222	116.414167	3/4/2019	610-620	909
15-B	6	43.6171222	116.414167	3/7/2019	560-580	909
15-B	7	43.6171222	116.414167	3/7/2019	470-480	909
15-B	8	43.6171222	116.414167	3/7/2019	400-420	909
15-B	9	43.6171222	116.414167	3/7/2019	320-330	909
15-B	10	43.6171222	116.414167	3/8/2019	263-283	909
15-B	11	43.6171222	116.414167	3/8/2019	195-215	909
15-B	12	43.6171222	116.414167	3/8/2019	90-105	909
15-B	13	43.6171222	116.414167	3/8/2019	55-65	909
16-B	1	43.61525	116.36	3/21/2019	550-570	580
16-B	2	43.61525	116.36	3/26/2019	505-525	580
16-B	3	43.61525	116.36	3/26/2019	378-398	580
16-B	4	43.61525	116.36	3/26/2019	319-334	580
16-B	5	43.61525	116.36	3/26/2019	266-281	580
16-B	6	43.61525	116.36	3/26/2019	202-222	580
16-B	7	43.61525	116.36	3/26/2019	120-140	580
16-B	8	43.61525	116.36	3/26/2019	70-90	580
16-B	9	43.61525	116.36	3/26/2019	38-48	580
17	1	43.5820472	116.374167	3/28/2019	935-1010	1045
17	2	43.5820472	116.374167	3/29/2019	420-520	1045

(ft bgl): Feet Below Ground Level

Table 2 continued. Monitoring well information, Meridian Sampling Campaign

Monitoring Well	Zone	Latitude	Longitude	Collection Date	Screened Interval Depth (ft bgl)	Total Well Depth (ft bgl)
18	1	43.6353778	116.371389	3/20/2019	575-695	707
18	2	43.6353778	116.371389	3/20/2019	470-525	707
19	1	43.6336472	116.434722	3/1/2019	350-390	1043
20	1	43.6345889	116.395	3/15/2019	890-960	1012
20	2	43.6345889	116.395	3/15/2019	690-740	1012
20	3	43.6345889	116.395	3/15/2019	490-580	1012
20	4	43.6345889	116.395	3/15/2019	370-440	1012
21	1	43.6036556	116.391111	3/29/2019	837-897	905
24	1	43.6306722	116.414167	2/28/2019	821-851	935
24	2	43.6306722	116.414167	2/28/2019	586-666	935
24	3	43.6306722	116.414167	2/28/2019	444-524	935
24	4	43.6306722	116.414167	2/28/2019	315-355	935
25	1	43.575525	116.360556	11/29/2018	580-690	711
25	2	43.575525	116.360556	11/27/2018	425-475	711
25	3	43.575525	116.360556	11/29/2018	270-360	711
25	4	43.575525	116.360556	11/27/2018	120-140	711
26	1	43.6426889	116.374722	3/18/2019	792-872	1005
26	2	43.6426889	116.374722	3/18/2019	570-670	1005
26	3	43.6426889	116.374722	3/18/2019	270-360	1005
26	4	43.6426889	116.374722	3/18/2019	153-193	1005
27	1	43.6077722	116.434167	2/28/2019	679-784	784
27	2	43.6077722	116.434167	2/27/2019	544-660	784
27	4	43.6077722	116.434167	2/27/2019	54-89	784
28	2	43.5541722	116.360556	3/29/2018	759-869	1316
28	3	43.5541722	116.360556	3/29/2019	577-697	1316
28	5	43.5541722	116.360556	11/29/2018	252-312	1316

Table 3. Complete Geochemical Data for Meridian Sampling Campaign

Analyte	Units	Well 14	Well 15-B Monitoring Well											
		z1	z1	z2*	z3	z4	z5	z6	z7	z8	z9	z10	z11	z12	z13
Chloride	(mg/L)	4	ND	ND	2	ND	1	2	20	20	8	7	5	16	16
Fluoride	(mg/L)	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.1	0.2	0.2	0.1	0.2	0.1
Sulfate	(mg/L)	15	4	4	7	4	6	10	91	103	69	74	32	47	37
Calcium	(mg/L)	19.5	14.0	14.0	14.5	13.0	15.0	18.0	79.0	94.0	53.0	55.0	49.0	55.0	52.0
Magnesium	(mg/L)	4.0	2.0	2.0	2.5	2.0	2.5	3.0	14.0	16.0	8.5	8.5	8.0	11.0	10.5
Potassium	(mg/L)	2.0	1.0	1.0	1.0	1.0	1.0	1.0	2.0	2.5	2.0	2.0	2.0	2.0	2.0
Sodium	(mg/L)	17.0	12.5	11.0	12.5	11.0	11.0	11.0	21.5	35.5	82.0	73.0	43.0	55.0	38.0
Nitrogen, Ammonia as N	(mg/L)	0.35	0.1	0.1	0.05	0.05	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	(mg/L)	ND	0.001	ND	ND	ND	0.001	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	(mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Copper	(mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron	(mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Manganese	(mg/L)	0.018	0.121	0.078	0.087	0.046	0.054	0.052	0.041	ND	ND	ND	ND	ND	ND
Selenium	(mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silica	(mg/L)	42.8	33.1	34.7	34.2	33.9	34.7	32.6	32.8	34.7	30.3	31.2	33.3	31.3	34.4
Uranium	(µg/L)	1.4	0. 4	ND	ND	ND	ND	0. 4	7.5	37.1	40.7	50.8	21.2	24.1	8.1
Nitrate as N	(mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	2.28	3.92	2.82	2.75	4.48	4.40
Field Parameters															
Alkalinity	(mg/L $CaCO_3$)	92	35	98	40	26	41	51	105	168	230	183	154	150	145
pH	std. unit	7.5	8.3	8.6	8.3	8.3	8.5	8.0	7.5	7.3	7.6	7.4	7.4	7.3	7.3
Dissolved Oxygen	(mg/L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7**	5.0	5.5	4.5	3.0	2.0
Spec. Cond.	(µS/cm)	180	135	130	145	115	120	140	510	630	590	570	415	530	455
ORP	(mV)	-50	0	-50	0	-50	-100	-50	50	150	150	250	200	150	150

* Indicates average value from 3 replicate samples

**Measurement not collected during Meridian Sampling Campaign. Value borrowed from Squires (2014), taken January 13, 2014. ND: Non-Detect

Table 3 continued. Complete Geochemical Data for Meridian Sampling Campaign

Analyte	Units	Well 16-B Monitoring Well									Well 17		Well 18	
		z1	z2	z3*	z4	z5	z6	z7	z8	z9	z1*	z2	z1*	z2
Chloride	(mg/L)	11	16	19	19	21	7	29	120	17	5	18	5	18
Fluoride	(mg/L)	0.3	0.2	0.2	0.2	0.3	0.4	0.7	0.5	0.3	0.4	0.3	0.4	0.3
Sulfate	(mg/L)	45	65	78	66	51	26	14	22	4	ND	53	ND	53
Calcium	(mg/L)	46.0	61.0	82.0	82.5	70.0	38.0	50.5	92.0	25.0	21.0	46.0	21.0	46.0
Magnesium	(mg/L)	10.5	14.0	17.5	16.0	14.5	7.5	15.0	33.0	8.5	4.0	9.5	4.0	9.5
Potassium	(mg/L)	1.5	2.0	2.5	2.5	2.5	2.0	1.0	2.5	2.5	5.0	2.5	5.0	2.5
Sodium	(mg/L)	18.0	35.0	55.0	55.5	82.0	81.0	26.0	39.0	13.0	38.5	27.5	38.5	27.5
Nitrogen, Ammonia as N	(mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND	4.0	0.6	4.0	0.6
Arsenic	(mg/L)	0.004	ND	ND	ND	0.001	0.001	0.005	0.008	0.009	0.003	ND	0.003	ND
Cadmium	(mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Copper	(mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron	(mg/L)	0.22	ND	ND	ND	ND	ND	ND	ND	ND	0.10	0.04	0.10	0.04
Manganese	(mg/L)	0.062	ND	ND	ND	ND	ND	ND	ND	0.101	0.196	0.252	0.196	0.252
Selenium	(mg/L)	ND	0.001	0.002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silica	(mg/L)	29.2	30.4	38.0	27.6	27.3	25.9	52.8	56.1	34.4	80.5	51.1	80.5	51.1
Uranium	(µg/L)	ND	21.5	62.7	87.1	62.8	21.8	6.6	12.7	0.8	ND	1.1	ND	1.1
Nitrate as N	(mg/L)	ND	1.37	2.59	3.92	5.03	3.23	2.57	3.41	0.18	ND	ND	ND	ND
Field Parameters														
Alkalinity	(mg/L $CaCO_3$)	140	174	234	264	290	210	164	220	120	130	143	130	143
pH	std. unit	7.2	7.2	7.2	7.3	7.4	7.7	7.5	7.3	7.8	7.3	7.3	7.3	7.3
Dissolved Oxygen	(mg/L)	0.0	4.4	5.5	5.5	5.5	6.0	3.5	3.5	0.0	0.0	0.0	0.0	0.0
Spec. Cond.	(µS/cm)	345	475	610	645	635	480	400	755	210	280	365	280	365
ORP	(mV)	0	-150	-50	0	-50	-50	-50	0	0	-50	100	-50	100

* Indicates average value from 3 replicate samples. ND: Non-Detect

Table 3 continued. Complete Geochemical Data for Meridian Sampling Campaign

Analyte	Units	Well 19	Well 20				Well 21	Well 24				Well 25			
		z1	z1	z2	z3*	z4	z1*	z1	z2	z3	z4	z1	z2	z3	z4
Chloride	(mg/L)	21	ND	ND	4	6	13	ND	ND	18	23	5.48	5.98	17.7	13.5
Fluoride	(mg/L)	0.2	0.3	0.3	0.2	0.2	0.2	0.3	0.3	0.1	0.2	0.5	0.5	0.4	0.7
Sulfate	(mg/L)	69	5	6	17	28	41	5	4	83	111	11	12	74	59
Calcium	(mg/L)	59.0	12.0	14.0	27.5	39.0	37.0	13.0	13.0	74.0	95.0	27.0	23.0	59.0	62.0
Magnesium	(mg/L)	10.0	2.0	2.5	4.5	6.5	7.0	2.0	2.5	13.0	16.0	4.0	3.0	8.5	18.5
Potassium	(mg/L)	2.0	1.5	1.0	1.0	1.0	2.0	1.0	1.0	2.0	2.5	2.5	2.5	3.0	1.5
Sodium	(mg/L)	18.0	10.0	10.0	11.5	13.0	18.0	10.5	11.5	19.0	41.0	29.0	33.5	60.5	66.5
Nitrogen, Ammonia as N	(mg/L)	ND	0.50	0.10	ND	ND	0.65	0.10	0.10	ND	ND	NA	NA	NA	NA
Arsenic	(mg/L)	ND	ND	ND	ND	0.003	ND	ND	ND	ND	ND	ND	ND	ND	0.003
Cadmium	(mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Copper	(mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron	(mg/L)	ND	ND	ND	ND	ND	0.16	ND	0.02	ND	ND	0.05	0.06	ND	1.05
Manganese	(mg/L)	ND	0.079	0.054	ND	ND	0.206	0.103	0.072	ND	ND	0.183	0.136	0.181	0.0295
Selenium	(mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.001	ND	ND	ND	ND
Silica	(mg/L)	33.9	35.6	33.3	33.7	31.7	36.8	34.0	34.2	34.6	32.2	46.0	49.9	36.3	40.6
Uranium	(µg/L)	9.6	ND	ND	1.7	9.7	ND	ND	ND	12.1	47.2	ND	ND	8.8	25.9
Nitrate as N	(mg/L)	1.35	ND	ND	0.33	0.73	ND	ND	ND	0.78	2.57	0.09	0.21	1.72	5.35
Field Parameters															
Alkalinity	(mg/L $CaCO_3$)	75	65	70	109	132	75.2	70	48	105	186	167	120	194	329
pH	std. unit	7.3	7.7	7.6	7.2	7.2	7.5	7.9	7.9	7.2	7.1	7.8	7.8	7.7	7.5
Dissolved Oxygen	(mg/L)	6.5	0.0	0.0	0.5	3.0	0.0	0.0	0.0	2.0	8.5	0.0	0.0	2	6.5
Spec. Cond.	(µS/cm)	450	110	115	195	265	275	110	110	700	935	320	350	665	755
ORP	(mV)	50	-100	-150	-100	-50	-50	0	0	0	0	-100	-50	0	-50

* Indicates average value from 3 replicate samples. ND: Non-Detect

Table 3 continued. Complete Geochemical Data for Meridian Sampling Campaign

Analyte	Units	Well 26				Well 27			Well 28		
		z1	z2	z3	z4	z1*	z2	z4	z2*	z3*	z5
Chloride	(mg/L)	ND	1	5	5	ND	2	8	8	8	NA
Fluoride	(mg/L)	0.3	0.3	0.2	0.2	0.3	0.3	0.2	0.3	0.3	NA
Sulfate	(mg/L)	3	8	28	14	3	6	45	20	20	NA
Calcium	(mg/L)	14.0	20.0	65.0	50.0	12.0	13.0	57.0	26.0	25.5	43.0
Magnesium	(mg/L)	3.0	3.5	9.5	7.0	1.0	1.5	14.0	1.0	2.5	7.5
Potassium	(mg/L)	2.0	1.0	2.0	2.0	1.0	1.0	2.5	1.0	1.5	2.0
Sodium	(mg/L)	9.0	10.0	37.0	35.5	17.5	14.5	45.0	40.0	40.0	83.5
Nitrogen, Ammonia as N	(mg/L)	1.35	ND	ND	ND	0.35	0.30	ND	0.35	0.10	NA
Arsenic	(mg/L)	ND	ND	ND	ND	ND	ND	0.003	ND	ND	0.002
Cadmium	(mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Copper	(mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron	(mg/L)	0.20	0.05	0.30	ND	ND	ND	ND	ND	ND	0.07
Manganese	(mg/L)	0.136	0.149	0.008	ND	0.089	0.086	ND	0.033	0.0543	0.003
Selenium	(mg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Silica	(mg/L)	41.7	26.8	30.5	24.2	38.1	33.6	36.8	28.6	29.2	27.6
Uranium	(µg/L)	ND	1.2	18.2	8.4	ND	ND	24.7	ND	ND	32.7
Nitrate as N	(mg/L)	ND	ND	0.76	3.75	ND	ND	3.36	ND	ND	1.73
Field Parameters											
Alkalinity	(mg/L $CaCO_3$)	77	81	181	170	40	47	173	105	93	170
pH	std. unit	7.7	7.5	6.9	7.2	8.0	8.0	7.2	8.2	8.0	7.7
Dissolved Oxygen	(mg/L)	0.0	0.0	1.5	5.5	0.0	0.0	5.0	0.0	0.0	8.0
Spec. Cond.	(µS/cm)	120	135	425	375	175	150	605	300	290	680
ORP	(mV)	-100	-50	0	100	150	-250	50	50	-200	50

* Indicates average value from 3 replicate samples. ND: Non-Detect

Table 4. Meridian Sampling Dataset Spearman Coefficients

Analyte	**Spearman P**	**p-value**
Chloride	0.66	1.30E-07
Fluoride	-0.37	0.007
Sulfate	0.77	5.27E-11
Calcium	0.82	1.63E-13
Magnesium	0.80	3.08E-12
Potassium	0.49	2.29E-04
Sodium	0.73	1.51E-09
Nitrate	0.86	4.44E-16
Nitrite	0.05	0.747
Nitrogen, Ammonia as N	-0.69	2.70E-08
Arsenic	0.15	0.286
Cadmium	NA	NA
Copper	NA	NA
Iron	-0.35	0.011
Manganese	-0.76	9.10E-11
Selenium	0.33	0.017
Silica	-0.34	0.016
Alkalinity	0.80	2.03E-12
pH	-0.51	1.23E-04
Temperature	-0.66	1.59E-07

Table 5. Compiled Dataset Spearman Coefficients

Analyte	Spearman P	p-value
Alkalinity	0.65	5.24E-11
Ammonia	-0.49	2.11E-06
Arsenic	0.43	4.15E-12
Barium	0.72	0.008
Cadmium	0.56	3.31E-09
Calcium	0.63	1.33E-15
Chloride	0.25	0.009
Copper	0.57	5.23E-09
Dissolved Oxygen	0.19	0.078
Fluoride	-0.25	0.011
Hardness	0.23	0.120
Iron	0.45	3.62E-06
Lead	0.28	0.056
Magnesium	0.52	7.96E-10
Manganese	0.40	4.16E-05
Nickel	0.84	0.009
Nitrate	0.66	8.88E-16
pH	-0.06	0.534
Phosphate, ortho	-0.06	0.646
Phosphorus	0.17	0.693
Potassium	0.30	0.001
Selenium	0.42	1.28E-05
Silica	-0.04	0.690
Sodium	0.57	1.11E-11
Specific Conductance	0.60	6.97E-14
Sulfate	0.39	3.41E-06
Total Dissolved Solids	0.38	0.005
Temperature	-0.32	0.002

Table 6. **Domestic and Public Supply Wells, Compiled Dataset**

County	Well Type	Mean (µg/L)	Median (µg/L)	Max (µg/L)	Count (µg/L)	% > 30 µg/L	% ≥ 20 µg/L	75th percentile (µg/L)	95th percentile (µg/L)	99th percentile (µg/L)
Ada	Domestic	24.1	11.5	110	54	37	40.7	37	76.9	110
	Public Supply	19.9	6	192.5	210	18.5	27.1	22	91.9	159.2
Canyon	Domestic	17.2	11.5	79	58	15.5	32.8	24	60.7	76.7
	Public Supply	18.3	10	191	156	14.1	23.7	19	80.0	154.9

Table 7. **Domestic Well Monitoring Estimates, Compiled Dataset**

County	Total Domestic Well Count	% Monitored by Uranium Dataset	Percent Estimated over Uranium MCL	Wells Estimated over Uranium MCL	Total Est. Domestic Wells Users	Estimated People Affected
Ada	2836	1.90	37	1106	7374	>2720
Canyon	5343	1.09	15.5	919	15708	>2400

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APPENDIX A

Table 8. Uranium Measurements from the Compiled Water Quality Dataset

Station	County	LatDec	LongDec	Water Use	Uranium (µg/L)	Units	Date of Collection	Agency Source
03N 01E 07DCB1	Ada	43.6075	-116.383	Irrigation	34	µg/L	9/25/2012	IDEQ
03N 01E 15CBB1	Ada	43.595555	-116.332	Domestic	37	µg/L	9/25/2012	IDEQ
03N 01E 21DCA2	Ada	43.578333	-116.342	Unknown	58.47	µg/L	9/12/2009	IDEQ
03N 01E 30DDC1	Ada	43.562777	-116.377	Domestic	76	µg/L	9/12/2012	IDEQ
03N 01E 31CAB1	Ada	43.552222	-116.389	Domestic	73	µg/L	9/12/2012	IDEQ
03N 01W 34BCD1	Ada	43.554166	-116.331	Domestic	32	µg/L	9/12/2012	IDEQ
04N 01E 29BAB1	Ada	43.661944	-116.367	Domestic	58	µg/L	9/5/2012	IDEQ
04N 01E 34BDD1	Ada	43.6425	-116.324	Domestic	59	µg/L	9/25/2012	IDEQ
04N 01E 21DDB1	Ada	43.665	-116.354	Irrigation	78	µg/L	9/5/2012	IDEQ
ANDERSON CIRCLE WATER CORP WELL #1	Ada	43.581317	-116.201	Public Supply	14	µg/L	11/5/2013	IDEQ
ARROWROCK RANCH WELL #1 (NORTH)	Ada	43.458862	-116.334	Public Supply	5	µg/L	11/14/2013	IDEQ
ARROWROCK RANCH WELL #2 (SOUTH)	Ada	43.458758	-116.334	Public Supply	4	µg/L	11/14/2013	IDEQ
BELMONT HEIGHTS WELL #1	Ada	43.576433	-116.481	Public Supply	51	µg/L	3/24/2008	IDEQ
BELMONT HEIGHTS WELL #2 BACK UP WELL	Ada	43.575772	-116.474	Public Supply	67	µg/L	3/16/2004	IDEQ
BRIAN SUB WATER USERS ASSOCIATION WELL #1	Ada	43.547835	-116.096	Public Supply	8	µg/L	12/16/2013	IDEQ
CAPITOL WATER CORP OLD WELL #5 - ABANDONED	Ada	43.624947	-116.256	Public Supply	18	µg/L	12/6/1994	IDEQ
CAPITOL WATER CORP WELL #3	Ada	43.629208	-116.272	Public Supply	37	µg/L	12/28/2006	IDEQ
CAPITOL WATER CORP WELL #5 (NEW)	Ada	43.625	-116.256	Public Supply	9	µg/L	9/29/2008	IDEQ
CAPITOL WATER CORP WELL #7	Ada	43.63417	-116.277	Public Supply	46	µg/L	3/1/2006	IDEQ

CHAPARRAL WATER ASSN WELL #1	Ada	43.775766	-116.468	Public Supply	4	µg/L	3/11/2009	IDEQ
CLOVERLEAF TRAILER COURT WELL #1	Ada	43.585328	-116.179	Public Supply	2.1	µg/L	12/5/2003	IDEQ
DELL SUBD WATER ASSN WELL #1	Ada	43.697861	-116.361	Public Supply	8.1	µg/L	4/16/2003	IDEQ
DESERT VIEW ESTATES WATER CORP WELL #2	Ada	43.484886	-116.325	Public Supply	125	µg/L	3/9/2005	IDEQ
DESERT VIEW ESTATES WATER CORP WELL #3	Ada	43.485001	-116.317	Public Supply	161	µg/L	8/17/2006	IDEQ
DESERT VIEW ESTATES WATER CORP WELL #4	Ada	43.482986	-116.322	Public Supply	137	µg/L	11/7/2005	IDEQ
DESERT VIEW ESTATES WATER CORP WELL #5	Ada	43.485244	-116.317	Public Supply	0	µg/L	2/5/2010	IDEQ
EAGLE GLEN HOMEOWNERS ASSN INC WELL #1	Ada	43.69659	-116.357	Public Supply	2	µg/L	2/12/2013	IDEQ
EAGLE PARK INC WELL #1	Ada	43.687817	-116.329	Public Supply	3	µg/L	10/8/2013	IDEQ
EAGLE POINT COMMUNITY WELL #1	Ada	43.694092	-116.349	Public Supply	8	µg/L	12/12/2013	IDEQ
EAGLE WATER COMPANY INC WELL #1	Ada	43.70047	-116.353	Public Supply	5	µg/L	10/18/2013	IDEQ
EAGLE WATER COMPANY INC WELL #2	Ada	43.701135	-116.35	Public Supply	5	µg/L	10/18/2013	IDEQ
EAGLE WATER COMPANY INC WELL #4	Ada	43.6911	-116.331	Public Supply	5	µg/L	10/18/2013	IDEQ
EAGLE WATER COMPANY INC WELL #6	Ada	43.695386	-116.372	Public Supply	4.5	µg/L	9/6/2005	IDEQ
EAGLE WATER COMPANY INC WELL #7	Ada	43.681782	-116.324	Public Supply	12	µg/L	1/17/2007	IDEQ
EAGLE WATER COMPANY INC WELL #8	Ada	43.683989	-116.329	Public Supply	4	µg/L	9/20/2013	IDEQ
EAGLE WEST SUBD WATER ASSN WELL #1	Ada	43.693075	-116.358	Public Supply	12	µg/L	10/7/2013	IDEQ
EAGLE, CITY OF (EASTERN ZONE) WELL #3 - BROOKWOOD	Ada	43.70775	-116.353	Public Supply	1	µg/L	11/14/2016	IDEQ
EAGLE, CITY OF (EASTERN ZONE) WELL 1 - LEXINGTON HILLS	Ada	43.707711	-116.333	Public Supply	25	µg/L	9/27/2013	IDEQ
EAGLE, CITY OF (WESTERN ZONE) WELL #4 (LEGACY)	Ada	43.702091	-116.426	Public Supply	2	µg/L	11/14/2016	IDEQ
EAGLE, CITY OF (WESTERN ZONE) WELL #5 (EAGLEFIELD)	Ada	43.69843	-116.423	Public Supply	2	µg/L	11/14/2016	IDEQ
ELM GROVE TRAILER PARK WELL #1	Ada	43.617436	-116.387	Public Supply	114	µg/L	2/24/2005	IDEQ

EUGENE OUTLOOK WATER CORP WELL #1	Ada	43.668092	-116.264	Public Supply	1	µg/L	10/3/2013	IDEQ
EVANS WATER CORP WELL #1	Ada	43.697197	-116.328	Public Supply	0.01	µg/L	2/25/2003	IDEQ
FLOATING FEATHER MOBILE HOME PARK WELL #1	Ada	43.700214	-116.315	Public Supply	78	µg/L	6/19/2007	IDEQ
FLYING H TRAILER RANCH INC WELL #2	Ada	43.633613	-116.278	Public Supply	23	µg/L	9/13/1995	IDEQ
FLYING H TRAILER RANCH INC WELL #3	Ada	43.6319	-116.279	Public Supply	19	µg/L	12/19/2013	IDEQ
FLYING H TRAILER RANCH INC WELL #4	Ada	43.633684	-116.278	Public Supply	16	µg/L	4/16/2008	IDEQ
FORREY HEIGHTS WELL #1	Ada	43.459439	-116.448	Public Supply	3	µg/L	12/11/2013	IDEQ
FRANKLIN DOMESTIC WATER USERS WELL #1	Ada	43.603489	-116.319	Public Supply	163	µg/L	7/7/2006	IDEQ
GARDEN CITY WATER AND SEWER SYSTEM WELL #10	Ada	43.660628	-116.314	Public Supply	1.0	µg/L	12/29/2003	IDEQ
GARDEN CITY WATER AND SEWER SYSTEM WELL #11-SHENAN BACK UP WELL	Ada	43.670899	-116.287	Public Supply	1.0	µg/L	12/29/2003	IDEQ
GARDEN CITY WATER AND SEWER SYSTEM WELL #12-MILLST BACK UP WELL	Ada	43.657691	-116.294	Public Supply	2.1	µg/L	12/29/2003	IDEQ
GARDEN CITY WATER AND SEWER SYSTEM WELL #3	Ada	43.635864	-116.248	Public Supply	0	µg/L	12/29/2003	IDEQ
GARDEN CITY WATER AND SEWER SYSTEM WELL #4	Ada	43.62639	-116.238	Public Supply	6	µg/L	5/13/2013	IDEQ
GARDEN CITY WATER AND SEWER SYSTEM WELL #5	Ada	43.641903	-116.257	Public Supply	2.1	µg/L	12/29/2003	IDEQ
GARDEN CITY WATER AND SEWER SYSTEM WELL #6	Ada	43.66068	-116.288	Public Supply	4.0	µg/L	12/29/2003	IDEQ
GARDEN CITY WATER AND SEWER SYSTEM WELL #7	Ada	43.66465	-116.277	Public Supply	1	µg/L	5/20/2016	IDEQ
GARDEN CITY WATER AND SEWER SYSTEM WELL #8	Ada	43.654483	-116.296	Public Supply	1.0	µg/L	12/29/2003	IDEQ
GARDEN CITY WATER AND SEWER SYSTEM WELL #9	Ada	43.66813	-116.297	Public Supply	0	µg/L	12/29/2003	IDEQ
GRANT TRAILER PARK WELL #1	Ada	43.584869	-116.176	Public Supply	2	µg/L	12/18/2013	IDEQ
GREENHILLS ESTATES 3 WELL #4	Ada	43.601957	-116.355	Public Supply	41	µg/L	7/15/2015	IDEQ
GROUSE POINT WATER COMPANY LLC WELL #1 EMERGENCY	Ada	43.51161	-116.334	Public Supply	112	µg/L	3/18/2004	IDEQ

GROUSE POINT WATER COMPANY LLC WELL #2 EMERGENCY	Ada	43.511705	-116.333	Public Supply	107	µg/L	3/18/2004	IDEQ
HAMPTON HOMES HOME OWNERS ASSN WELL #1	Ada	43.613322	-116.308	Public Supply	27	µg/L	7/19/2005	IDEQ
HI VALLEY RV PARK WELL #1	Ada	43.698326	-116.314	Public Supply	61	µg/L	2/5/2014	IDEQ
HI VIEW WATER WELL #1	Ada	43.492042	-116.301	Public Supply	7.0	µg/L	12/4/2003	IDEQ
HILLSDALE ESTATES HOMEOWNERS ASSN WELL #3 (STAR RIDGE #1)	Ada	43.736539	-116.525	Public Supply	0	µg/L	10/10/2016	IDEQ
HILLSDALE ESTATES HOMEOWNERS ASSN WELL #4	Ada	43.744055	-116.473	Public Supply	2	µg/L	3/13/2017	IDEQ
IDAHO STATE CORRECTIONAL CENTER (ISCC) WELL #1	Ada	43.47163	-116.235	Public Supply	7.8	µg/L	10/12/2011	IDEQ
IDAHO STATE CORRECTIONAL CENTER (ISCC) WELL #2	Ada	43.467548	-116.235	Public Supply	6.8	µg/L	12/28/2016	IDEQ
ISLAND VILLAGE MOBILE HOME PARK WELL #1	Ada	43.685792	-116.406	Public Supply	0	µg/L	9/17/2013	IDEQ
KIMBERLY MANOR WELL #1	Ada	43.658733	-116.264	Public Supply	1	µg/L	10/3/2013	IDEQ
KLUGHERZ WATER CORP WELL #1	Ada	43.591567	-116.3	Public Supply	0	µg/L	9/16/2013	IDEQ
KUNA CITY OF WELL #10 (CHAPPAROSA)	Ada	43.5118	-116.407	Public Supply	12	µg/L	3/29/2013	IDEQ
KUNA CITY OF WELL #11	Ada	43.498071	-116.421	Public Supply	17	µg/L	10/5/2016	IDEQ
KUNA CITY OF WELL #3 (BUTLER PARK)	Ada	43.498386	-116.421	Public Supply	0	µg/L	10/5/2016	IDEQ
KUNA CITY OF WELL #4 (CEDAR)	Ada	43.490327	-116.429	Public Supply	3	µg/L	7/21/2016	IDEQ
KUNA CITY OF WELL #5 (DISCOVERY CREEK)	Ada	43.495739	-116.434	Public Supply	22	µg/L	11/6/2013	IDEQ
KUNA CITY OF WELL #6 (SHORTLINE PARK)	Ada	43.483535	-116.41	Public Supply	0	µg/L	10/16/2013	IDEQ
KUNA CITY OF WELL #8 - (LARGE DANSKIN)	Ada	43.531813	-116.432	Public Supply	28	µg/L	7/19/2016	IDEQ
KUNA CITY OF WELL #9	Ada	43.490299	-116.429	Public Supply	25	µg/L	7/20/2010	IDEQ
LEISURE LANE WELL #1	Ada	43.620953	-116.408	Public Supply	64	µg/L	7/11/2005	IDEQ
LINDA VISTA MOBILE HOME PARK WELL #1	Ada	43.632228	-116.3	Public Supply	34	µg/L	4/14/2009	IDEQ

MALAD AND HILTON WATER COMPANY INC. WELL #1	Ada	43.578147	-116.246	Public Supply	2	µg/L	11/5/2013	IDEQ
MAPLE HILLS MOBILE HOME PARK WELL #1	Ada	43.600475	-116.296	Public Supply	100	µg/L	10/10/1994	IDEQ
MERIDIAN HEIGHTS WATER & SEWER DISTRICT WELL #1 BACK UP WELL - HARRIS	Ada	43.568314	-116.394	Public Supply	82	µg/L	3/16/2007	IDEQ
MERIDIAN HEIGHTS WATER & SEWER DISTRICT WELL #2 - WINNIPEG	Ada	43.572456	-116.398	Public Supply	124	µg/L	12/14/2004	IDEQ
MERIDIAN HEIGHTS WATER & SEWER DISTRICT WELL#3- KENTUCKY	Ada	43.573725	-116.405	Public Supply	139	µg/L	6/22/2004	IDEQ
MERIDIAN WATER DEPT WELL #10	Ada	43.62315	-116.38	Public Supply	52	µg/L	3/8/2004	IDEQ
MERIDIAN WATER DEPT WELL #10B	Ada	43.623134	-116.38	Public Supply	0	µg/L	7/5/2013	IDEQ
MERIDIAN WATER DEPT WELL #11	Ada	43.607322	-116.366	Public Supply	30	µg/L	6/14/2004	IDEQ
MERIDIAN WATER DEPT WELL #12	Ada	43.620158	-116.432	Public Supply	0	µg/L	2/14/2014	IDEQ
MERIDIAN WATER DEPT WELL #14	Ada	43.589897	-116.385	Public Supply	54	µg/L	7/6/2013	IDEQ
MERIDIAN WATER DEPT WELL #15	Ada	43.616956	-116.414	Public Supply	1	µg/L	12/21/2016	IDEQ
MERIDIAN WATER DEPT WELL #16 - EMERGENCY	Ada	43.615208	-116.36	Public Supply	34	µg/L	8/9/2010	IDEQ
MERIDIAN WATER DEPT WELL #16B	Ada	43.615261	-116.36	Public Supply	30	µg/L	8/25/2016	IDEQ
MERIDIAN WATER DEPT WELL #16C	Ada	43.615286	-116.36	Public Supply	19	µg/L	11/16/2016	IDEQ
MERIDIAN WATER DEPT WELL #17	Ada	43.582053	-116.374	Public Supply	2	µg/L	10/31/2012	IDEQ
MERIDIAN WATER DEPT WELL #18	Ada	43.635404	-116.37	Public Supply	0	µg/L	11/19/2014	IDEQ
MERIDIAN WATER DEPT WELL #19	Ada	43.633702	-116.435	Public Supply	0	µg/L	12/17/2014	IDEQ
MERIDIAN WATER DEPT WELL #20	Ada	43.634265	-116.394	Public Supply	1	µg/L	5/6/2014	IDEQ
MERIDIAN WATER DEPT WELL #22	Ada	43.58388	-116.403	Public Supply	21.4	µg/L	10/30/2012	IDEQ
MERIDIAN WATER DEPT WELL #23 - EMERGENCY	Ada	43.58864	-116.35	Public Supply	79	µg/L	4/25/2003	IDEQ

MERIDIAN WATER DEPT WELL #24	Ada	43.6308	-116.414	Public Supply	7	µg/L	12/17/2014	IDEQ
MERIDIAN WATER DEPT WELL #25	Ada	43.575469	-116.36	Public Supply	31.3	µg/L	2/28/2006	IDEQ
MERIDIAN WATER DEPT WELL #26	Ada	43.6599	-116.375	Public Supply	0	µg/L	12/20/2016	IDEQ
MERIDIAN WATER DEPT WELL #7 BACK UP WELL	Ada	43.622708	-116.403	Public Supply	68.7	µg/L	6/14/2004	IDEQ
MERIDIAN WATER DEPT WELL #8	Ada	43.603764	-116.391	Public Supply	38.8	µg/L	3/8/2004	IDEQ
MERIDIAN WATER DEPT WELL #9	Ada	43.605636	-116.403	Public Supply	1.1	µg/L	10/31/2012	IDEQ
MERIDIAN WATER DEPT WELL 20B	Ada	43.634265	-116.394	Public Supply	41	µg/L	9/10/2014	IDEQ
MERIDIAN WATER DEPT WELL#21	Ada	43.6011	-116.389	Public Supply	7	µg/L	9/12/2013	IDEQ
NORTH HILLS MOBILE VILLAGE WELL #1	Ada	43.685963	-116.308	Public Supply	0	µg/L	12/17/2013	IDEQ
PARADISE ESTATES WATER CORP WELL #1 E	Ada	43.593383	-116.32	Public Supply	35	µg/L	3/30/2016	IDEQ
PARADISE ESTATES WATER CORP WELL #2 W	Ada	43.593208	-116.322	Public Supply	48	µg/L	12/27/2005	IDEQ
RILEY TRAILER PARK WELL #1	Ada	43.645111	-116.241	Public Supply	7	µg/L	3/25/2004	IDEQ
RIM ACRES MUTUAL WATER WELL # 1	Ada	43.563708	-116.272	Public Supply	9.2	µg/L	8/21/2012	IDEQ
RIVERLAND TERRACE NONPROFIT WATER CORP WELL #3	Ada	43.561975	-116.105	Public Supply	0	µg/L	11/22/2016	IDEQ
RIVERVINE SUBDIVISION WELL #1	Ada	43.688627	-116.439	Public Supply	0	µg/L	6/30/2015	IDEQ
RIVIERA ESTATES MOBILE PARK WELL #1	Ada	43.683175	-116.408	Public Supply	2	µg/L	7/16/2013	IDEQ
RUSTIC ACRES MOBILE HOME PARK WELL #1	Ada	43.615669	-116.32	Public Supply	14.2	µg/L	11/24/2003	IDEQ
SBX COMPLEX WELL #3A	Ada	43.473747	-116.213	Public Supply	4.9	µg/L	2/1/2011	IDEQ
SBX COMPLEX WELL #3B	Ada	43.473511	-116.213	Public Supply	2.4	µg/L	3/4/2015	IDEQ
SBX COMPLEX WELL #4A	Ada	43.473454	-116.199	Public Supply	2.9	µg/L	2/1/2011	IDEQ
SBX COMPLEX WELL #4B	Ada	43.473594	-116.2	Public Supply	7.2	µg/L	6/12/2015	IDEQ
SCOTTYS MOBILE HOME PARK WELL 2/DUNYON WELL	Ada	43.683055	-116.327	Public Supply	11	µg/L	11/12/2013	IDEQ

SCOTTYS MOBILE HOME PARK WELL1/PARKINSON	Ada	43.689322	-116.325	Public Supply	1	µg/L	11/15/2013	IDEQ
SEAMANS SECOND SUBD WATER ASSN WELL #1	Ada	43.620908	-116.283	Public Supply	30	µg/L	9/30/2005	IDEQ
SIERRA WATER CORP WELL #1	Ada	43.692867	-116.371	Public Supply	8.1	µg/L	11/18/2003	IDEQ
STANLEY POND INC WELL #1	Ada	43.580928	-116.242	Public Supply	2	µg/L	11/5/2013	IDEQ
STAR SEWER AND WATER DIST WATER SYSTEM WELL #1	Ada	43.70223	-116.493	Public Supply	0	µg/L	8/10/2011	IDEQ
STAR SEWER AND WATER DIST WATER SYSTEM WELL #3	Ada	43.70687	-116.484	Public Supply	0	µg/L	4/30/2014	IDEQ
SUEZ 16TH ST WELL	Ada	43.612464	-116.227	Public Supply	0	µg/L	6/27/2016	IDEQ
SUEZ 27TH ST WELL #1	Ada	43.61843	-116.224	Public Supply	0	µg/L	6/4/2015	IDEQ
SUEZ AMITY #2	Ada	43.560898	-116.283	Public Supply	10	µg/L	12/17/2015	IDEQ
SUEZ AMITY WELL	Ada	43.560855	-116.283	Public Supply	5	µg/L	8/27/1996	IDEQ
SUEZ ARCTIC WELL	Ada	43.617928	-116.235	Public Supply	0	µg/L	6/27/2016	IDEQ
SUEZ BALI HAI WELL	Ada	43.62689	-116.319	Public Supply	0	µg/L	7/11/2017	IDEQ
SUEZ BELMONTS HIGHTS #1	Ada	43.576825	-116.48	Public Supply	33	µg/L	9/17/2008	IDEQ
SUEZ BETHEL WELL	Ada	43.606009	-116.271	Public Supply	12	µg/L	2/28/2012	IDEQ
SUEZ BIF WELL	Ada	43.564498	-116.199	Public Supply	26	µg/L	7/15/2008	IDEQ
SUEZ BROADWAY WELL	Ada	43.576664	-116.194	Public Supply	0	µg/L	4/10/2012	IDEQ
SUEZ BROOK HOLLOW	Ada	43.598022	-116.315	Public Supply	23	µg/L	8/2/2011	IDEQ
SUEZ CASSIA #1 WELL	Ada	43.596427	-116.216	Public Supply	16	µg/L	6/21/2017	IDEQ
SUEZ CASSIA #2	Ada	43.596413	-116.216	Public Supply	0	µg/L	6/27/2016	IDEQ
SUEZ CENTENNIAL WELL	Ada	43.567615	-116.163	Public Supply	0	µg/L	5/20/2013	IDEQ
SUEZ CHAMBERLAIN #1	Ada	43.587286	-116.2	Public Supply	6	µg/L	5/30/1996	IDEQ
SUEZ CLIFFSIDE WELL	Ada	43.602359	-116.211	Public Supply	9	µg/L	7/17/2009	IDEQ

SUEZ CLINTON WELL	Ada	43.60902	-116.248	Public Supply	0	µg/L	6/28/2016	IDEQ
SUEZ COLE WELL	Ada	43.58071	-116.275	Public Supply	6	µg/L	7/9/2013	IDEQ
SUEZ COUNTRY CLUB	Ada	43.572788	-116.231	Public Supply	22	µg/L	5/27/2009	IDEQ
SUEZ COUNTRY SQUARE	Ada	43.588569	-116.311	Public Supply	1	µg/L	7/11/2013	IDEQ
SUEZ COUNTRYMAN WELL	Ada	43.58552	-116.308	Public Supply	12.1	µg/L	7/23/2003	IDEQ
SUEZ DURHAM	Ada	43.568855	-116.115	Public Supply	7	µg/L	6/23/2016	IDEQ
SUEZ EDGEVIEW WELL	Ada	43.59944	-116.335	Public Supply	0	µg/L	7/3/2008	IDEQ
SUEZ FISK WELL	Ada	43.620326	-116.257	Public Supply	20	µg/L	5/28/2015	IDEQ
SUEZ FIVE MILE #12	Ada	43.568194	-116.332	Public Supply	9	µg/L	8/28/2017	IDEQ
SUEZ FOXTAIL #2	Ada	43.663855	-116.4	Public Supply	5	µg/L	8/3/2017	IDEQ
SUEZ FRANKLIN PARK	Ada	43.601268	-116.263	Public Supply	13	µg/L	6/4/1996	IDEQ
SUEZ FRONTIER WELL 2	Ada	43.637618	-116.326	Public Supply	10	µg/L	9/17/2017	IDEQ
SUEZ GODDARD #2	Ada	43.645185	-116.289	Public Supply	15	µg/L	5/30/2017	IDEQ
SUEZ H P WELL	Ada	43.656013	-116.318	Public Supply	1	µg/L	7/6/2016	IDEQ
SUEZ HIDDEN VALLEY 1	Ada	43.53326	-116.315	Public Supply	13	µg/L	6/14/2011	IDEQ
SUEZ HIDDEN VALLEY 2	Ada	43.537822	-116.325	Public Supply	15	µg/L	10/13/2008	IDEQ
SUEZ HILLCREST WELL	Ada	43.582662	-116.234	Public Supply	0	µg/L	6/29/2016	IDEQ
SUEZ HILTON WELL	Ada	43.594236	-116.246	Public Supply	0	µg/L	6/24/2016	IDEQ
SUEZ HOPE BACK-UP WELL	Ada	43.615563	-116.335	Public Supply	52	µg/L	7/31/2006	IDEQ
SUEZ IDAHO WELL	Ada	43.622156	-116.231	Public Supply	29	µg/L	8/30/2017	IDEQ
SUEZ ISLAND WOODS #1	Ada	43.683166	-116.35	Public Supply	0	µg/L	8/2/2016	IDEQ
SUEZ ISLAND WOODS #2	Ada	43.676838	-116.353	Public Supply	0	µg/L	7/9/2013	IDEQ

SUEZ JR FLAT WELL	Ada	43.542427	-116.193	Public Supply	7	µg/L	5/20/2013	IDEQ
SUEZ KIRKWOOD WELL	Ada	43.587522	-116.257	Public Supply	26	µg/L	5/31/2017	IDEQ
SUEZ LAGRANGE WELL	Ada	43.552286	-116.325	Public Supply	6	µg/L	5/20/2013	IDEQ
SUEZ LICORICE	Ada	43.568891	-116.113	Public Supply	4	µg/L	7/10/2013	IDEQ
SUEZ LOGGER WELL	Ada	43.584531	-116.171	Public Supply	0	µg/L	6/28/2016	IDEQ
SUEZ LONGMEADOW WELL	Ada	43.600151	-116.173	Public Supply	0	µg/L	3/4/2014	IDEQ
SUEZ MAC WELL	Ada	43.5572	-116.253	Public Supply	0	µg/L	7/9/2013	IDEQ
SUEZ MAPLE HILL WELL #1	Ada	43.601336	-116.297	Public Supply	12	µg/L	8/2/2006	IDEQ
SUEZ MAPLE HILL WELL #2 (ASR)	Ada	43.601344	-116.297	Public Supply	78	µg/L	11/23/2004	IDEQ
SUEZ MARKET WELL	Ada	43.559069	-116.186	Public Supply	2	µg/L	6/24/2015	IDEQ
SUEZ MCMILLAN WELL	Ada	43.648706	-116.35	Public Supply	11	µg/L	6/21/2012	IDEQ
SUEZ OREGON TRL WELL	Ada	43.553348	-116.145	Public Supply	1	µg/L	7/7/2010	IDEQ
SUEZ OVERLAND WELL	Ada	43.589317	-116.267	Public Supply	4	µg/L	6/22/2017	IDEQ
SUEZ PARADISE #1	Ada	43.595462	-116.317	Public Supply	9	µg/L	7/15/2015	IDEQ
SUEZ PIONEER WELL	Ada	43.501818	-116.199	Public Supply	6	µg/L	7/31/2012	IDEQ
SUEZ PLEASANT VALLEY	Ada	43.501924	-116.227	Public Supply	3	µg/L	6/27/2011	IDEQ
SUEZ RAPTOR WELL	Ada	43.516706	-116.252	Public Supply	5	µg/L	7/25/2017	IDEQ
SUEZ REDWOOD CREEK	Ada	43.69972	-116.39	Public Supply	10	µg/L	7/17/2012	IDEQ
SUEZ RIVER RUN WELL	Ada	43.578538	-116.158	Public Supply	0	µg/L	6/21/2011	IDEQ
SUEZ ROOSEVELT #1	Ada	43.600886	-116.233	Public Supply	1	µg/L	6/25/2012	IDEQ
SUEZ ROOSEVELT #3	Ada	43.600925	-116.233	Public Supply	0	µg/L	7/24/2015	IDEQ
SUEZ SETTLERS #1 WELL	Ada	43.648252	-116.306	Public Supply	9	µg/L	9/3/1996	IDEQ

SUEZ SETTLERS #2 WELL	Ada	43.648361	-116.305	Public Supply	63	µg/L	3/9/2004	IDEQ
SUEZ SPURWING WELL	Ada	43.668735	-116.424	Public Supply	14	µg/L	5/14/2009	IDEQ
SUEZ SUNSET W WELL	Ada	43.551242	-116.274	Public Supply	5	µg/L	3/11/2013	IDEQ
SUEZ SWIFT # 2 - TREATED	Ada	43.648994	-116.261	Public Supply	3	µg/L	6/5/2013	IDEQ
SUEZ SWIFT #1	Ada	43.649615	-116.261	Public Supply	2	µg/L	7/20/2017	IDEQ
SUEZ TAGGART #1	Ada	43.588077	-116.217	Public Supply	0	µg/L	6/9/2015	IDEQ
SUEZ TAGGART #2	Ada	43.588062	-116.217	Public Supply	17	µg/L	3/5/2009	IDEQ
SUEZ TEN MILE WELL	Ada	43.512569	-116.236	Public Supply	4	µg/L	5/16/2013	IDEQ
SUEZ TERTELING WELL	Ada	43.556797	-116.161	Public Supply	21	µg/L	6/5/2013	IDEQ
SUEZ VETERAN'S WELL	Ada	43.634428	-116.236	Public Supply	4	µg/L	5/17/2013	IDEQ
SUEZ VICTORY WELL	Ada	43.575508	-116.319	Public Supply	1	µg/L	3/4/2014	IDEQ
SUEZ VISTA WELL	Ada	43.574639	-116.214	Public Supply	5	µg/L	6/5/2013	IDEQ
SUEZ WESTMORELAND	Ada	43.639588	-116.271	Public Supply	0	µg/L	7/9/2013	IDEQ
SUEZ WILLOW LANE #1	Ada	43.644392	-116.252	Public Supply	7	µg/L	8/5/2014	IDEQ
SUEZ WILLOW LANE #2	Ada	43.643903	-116.252	Public Supply	11	µg/L	8/9/2013	IDEQ
TERRA GRANDE WATER COMPANY WELL #1 HATCH	Ada	43.588664	-116.282	Public Supply	79	µg/L	7/20/2004	IDEQ
TERRA GRANDE WATER COMPANY WELL#2 ASH PARK	Ada	43.589192	-116.282	Public Supply	64	µg/L	7/20/2004	IDEQ
TERRA GRANDE WATER COMPANY WELL#3 PENNIGER	Ada	43.587486	-116.283	Public Supply	75	µg/L	7/20/2004	IDEQ
TERRACE WATER CORP INC WELL #1	Ada	43.588528	-116.392	Public Supply	15.2	µg/L	11/21/2011	IDEQ
THUNDERBIRD MOBILE MANOR WELL #1	Ada	43.561847	-116.135	Public Supply	193	µg/L	4/3/2007	IDEQ
WEST MEADOWS ESTATES NEW WELL #1	Ada	43.612999	-116.316	Public Supply	39	µg/L	9/21/2011	IDEQ
WEST MEADOWS ESTATES WELL #1	Ada	43.612744	-116.316	Public Supply	30	µg/L	9/12/2016	IDEQ

WILLOWBROOK ESTATES PROPERTY OWNERS WELL #1 NORTH	Ada	43.77897	-116.479	Public Supply	4.03	µg/L	11/12/2003	IDEQ
WILLOWBROOK ESTATES PROPERTY OWNERS WELL #2 SOUTH	Ada	43.775448	-116.48	Public Supply	4	µg/L	11/14/2013	IDEQ
WILLOWTREE ESTATES HOMEOWNER ASSOCIATION WELL #1	Ada	43.575391	-116.131	Public Supply	0	µg/L	5/20/2015	IDEQ
ALPINE MOBILE HOME PARK WELL #1	Canyon	43.544647	-116.532	Public Supply	21	µg/L	12/28/2004	IDEQ
APACHE HEIGHTS SUBDIVISION (2) WELL 1	Canyon	43.530506	-116.543	Public Supply	11	µg/L	12/13/2003	IDEQ
AURORA SUBD WELL 1	Canyon	43.535725	-116.581	Public Supply	0	µg/L	10/9/2013	IDEQ
BELLE AIRE ACRES 2 WELL #1-BELLE AIRE DR	Canyon	43.548622	-116.546	Public Supply	17	µg/L	7/30/2013	IDEQ
BELLE AIRE ACRES 2 WELL #2-VENTURA	Canyon	43.55025	-116.547	Public Supply	16	µg/L	7/30/2013	IDEQ
BURNIE SUBD WELL #1	Canyon	43.614536	-116.629	Public Supply	7.5	µg/L	12/20/2004	IDEQ
CALDWELL CITY OF NEW WELL #4	Canyon	43.688323	-116.676	Public Supply	0	µg/L	1/20/2016	IDEQ
CALDWELL CITY OF WELL #11	Canyon	43.645306	-116.646	Public Supply	0	µg/L	9/25/2013	IDEQ
CALDWELL CITY OF WELL #12	Canyon	43.640944	-116.684	Public Supply	5	µg/L	9/25/2013	IDEQ
CALDWELL CITY OF WELL #14	Canyon	43.650047	-116.702	Public Supply	4	µg/L	9/25/2013	IDEQ
CALDWELL CITY OF WELL #15	Canyon	43.639328	-116.691	Public Supply	20	µg/L	7/29/2010	IDEQ
CALDWELL CITY OF WELL #17	Canyon	43.611851	-116.675	Public Supply	13	µg/L	5/4/2010	IDEQ
CALDWELL CITY OF WELL #18	Canyon	43.633503	-116.611	Public Supply	0	µg/L	1/20/2016	IDEQ
CALDWELL CITY OF WELL #19	Canyon	43.657601	-116.633	Public Supply	1	µg/L	9/28/2011	IDEQ
CALDWELL CITY OF WELL #1-A	Canyon	43.675267	-116.676	Public Supply	0	µg/L	9/25/2013	IDEQ
CALDWELL CITY OF WELL #21	Canyon	43.588133	-116.671	Public Supply	11	µg/L	9/29/2014	IDEQ
CALDWELL CITY OF WELL #6	Canyon	43.659217	-116.676	Public Supply	3	µg/L	9/25/2013	IDEQ
CALDWELL CITY OF WELL #7	Canyon	43.646436	-116.661	Public Supply	3	µg/L	1/20/2016	IDEQ

CALDWELL CITY OF WELL #8	Canyon	43.664161	-116.704	Public Supply	4	µg/L	9/25/2013	IDEQ
CALDWELL HOUSING AUTHORITY WELL #3	Canyon	43.702664	-116.709	Public Supply	21	µg/L	3/20/2013	IDEQ
CALDWELL HOUSING AUTHORITY WELL #4 (NEW)	Canyon	43.702031	-116.708	Public Supply	19	µg/L	6/22/2016	IDEQ
CALDWELL HOUSING AUTHORITY WELL #5	Canyon	43.702536	-116.709	Public Supply	34	µg/L	3/8/2013	IDEQ
CAMELOT WATER ASSN INC WELL #2-LOWER	Canyon	43.585697	-116.597	Public Supply	7	µg/L	11/21/2013	IDEQ
CHAROLAIS MOTEL WELL 2	Canyon	43.592175	-116.524	Public Supply	38	µg/L	12/8/2008	IDEQ
CHERRY LANE ACRES WATER SYSTEM WELL #1	Canyon	43.620347	-116.593	Public Supply	20	µg/L	4/18/2016	IDEQ
CHRISTIS MOBILE PARK WELL #1	Canyon	43.627156	-116.654	Public Supply	2.1	µg/L	1/27/2004	IDEQ
CHURCH OF GOD OF PROPHECY WELL 1	Canyon	43.582448	-116.624	Public Supply	4	µg/L	6/30/2011	IDEQ
COUNTRY CLUB SUBDIVISIONS WATER ASSN WELL #2	Canyon	43.738022	-116.691	Public Supply	2	µg/L	7/7/2016	IDEQ
COUNTRY MEADOWS SUBD WELL 1	Canyon	43.584447	-116.501	Public Supply	13	µg/L	9/29/2016	IDEQ
COUNTRY STYLE TRAILER COURT 1 WELL #1	Canyon	43.619101	-116.584	Public Supply	66.2	µg/L	8/10/2000	IDEQ
COUNTRY STYLE TRAILER COURT 1 WELL #2	Canyon	43.618364	-116.583	Public Supply	152	µg/L	11/29/2004	IDEQ
COVERT WATER USERS ASSOCIATION LOWER PALMER #1	Canyon	43.537539	-116.574	Public Supply	12	µg/L	12/3/2010	IDEQ
COVERT WATER USERS ASSOCIATION SUNRISE RIM #3	Canyon	43.535733	-116.575	Public Supply	12	µg/L	12/26/2003	IDEQ
COVERT WATER USERS ASSOCIATION UPPER PALMER #2	Canyon	43.537094	-116.575	Public Supply	15	µg/L	12/3/2010	IDEQ
D AND S PURPLE SAGE RANCHETTES WELL #1-MAIN	Canyon	43.721864	-116.661	Public Supply	16	µg/L	10/14/2010	IDEQ
DANSKIN WELL #2	Canyon	43.530956	-116.133	Public Supply	46	µg/L	3/20/2006	IDEQ
DECOY INN AND RV PARK WELL #1	Canyon	43.640039	-116.952	Public Supply	5.9	µg/L	2/12/2013	IDEQ
DONNAS DAYCARE WELL 1	Canyon	43.613302	-116.912	Public Supply	0	µg/L	3/21/2011	IDEQ
DRAKE SUBD WELL #1 (MAIN WELL)	Canyon	43.731789	-116.672	Public Supply	7.8	µg/L	9/6/2012	IDEQ
EAST LIZARD BUTTE WATER CORP EAST WELL #5	Canyon	43.557267	-116.781	Public Supply	39	µg/L	3/14/2005	IDEQ

EAST LIZARD BUTTE WATER CORP WELL #6	Canyon	43.557216	-116.781	Public Supply	0	µg/L	3/2/2016	IDEQ
EL RANCHO HEIGHTS WELL #1	Canyon	43.598664	-116.695	Public Supply	8.1	µg/L	4/30/2003	IDEQ
EL RANCHO HEIGHTS WELL #2	Canyon	43.599833	-116.697	Public Supply	8.1	µg/L	4/30/2003	IDEQ
EL RANCHO HEIGHTS WELL #3	Canyon	43.5998	-116.697	Public Supply	5	µg/L	2/11/2016	IDEQ
ELDER SUBD WELL #1	Canyon	43.549278	-116.56	Public Supply	24	µg/L	3/14/2007	IDEQ
EVERGREEN MOBILE PARK WELL #1	Canyon	43.614297	-116.619	Public Supply	2	µg/L	12/11/2013	IDEQ
FAIRWAYS HOMEOWNERS ASSOCIATION WELL 1	Canyon	43.737726	-116.701	Public Supply	24	µg/L	11/28/2003	IDEQ
FAIRWAYS HOMEOWNERS ASSOCIATION WELL 2	Canyon	43.736907	-116.702	Public Supply	30	µg/L	11/28/2003	IDEQ
FAIRWAYS HOMEOWNERS ASSOCIATION WELL 3	Canyon	43.738361	-116.702	Public Supply	18	µg/L	11/28/2003	IDEQ
FAIRWAYS HOMEOWNERS ASSOCIATION WELL 4	Canyon	43.737092	-116.701	Public Supply	108	µg/L	11/28/2003	IDEQ
FAIRWAYS HOMEOWNERS ASSOCIATION WELL 5	Canyon	43.736448	-116.701	Public Supply	98	µg/L	11/28/2003	IDEQ
FAIRWAYS HOMEOWNERS ASSOCIATION WELL 6	Canyon	43.738154	-116.702	Public Supply	99	µg/L	11/28/2003	IDEQ
FAIRWAYS HOMEOWNERS ASSOCIATION WELL 7	Canyon	43.735904	-116.702	Public Supply	105	µg/L	11/28/2003	IDEQ
FAIRWAYS HOMEOWNERS ASSOCIATION WELL 8	Canyon	43.737622	-116.702	Public Supply	80	µg/L	11/28/2003	IDEQ
FREEMAN DEVELOPMENT WELL 1	Canyon	43.530125	-116.588	Public Supply	19	µg/L	11/18/2003	IDEQ
H AND L PARK WELL 1	Canyon	43.664414	-116.637	Public Supply	1	µg/L	10/1/2013	IDEQ
INDIAN VILLAGE WELL #1	Canyon	43.536058	-116.534	Public Supply	11	µg/L	12/7/2007	IDEQ
INDIAN VILLAGE WELL #2 (BACK UP)	Canyon	43.538444	-116.538	Public Supply	14	µg/L	1/8/2004	IDEQ
KARCHER RANCHETTE WATER CORP WELL #1	Canyon	43.599914	-116.664	Public Supply	16.24	µg/L	9/16/2001	IDEQ
KARCHER RANCHETTE WATER CORP WELL #2 BACK UP	Canyon	43.598369	-116.665	Public Supply	6.1	µg/L	12/27/2003	IDEQ
KARCHER VILLAGE MOBILE HOME PARK WELL #1	Canyon	43.6085	-116.608	Public Supply	10.1	µg/L	12/31/2003	IDEQ
KIMPTON ACRES THIRD SUBD WELL 1	Canyon	43.738286	-116.64	Public Supply	15	µg/L	11/19/2013	IDEQ

LAKEVIEW HILLS WATER USERS ASSOCIATION WELL #1	Canyon	43.519978	-116.646	Public Supply	0	µg/L	12/13/2003	IDEQ
LAKEVIEW WATER COMPANY 1 W WELL #2	Canyon	43.603981	-116.695	Public Supply	4.7	µg/L	2/26/2014	IDEQ
LAKEYS CAFE AND TRAILER PARK WELL 3 WEST	Canyon	43.663589	-116.636	Public Supply	0	µg/L	12/9/2013	IDEQ
LANSING MEADOWS SUBDIVISION WELL #1	Canyon	43.712125	-116.57	Public Supply	3.0	µg/L	12/27/2003	IDEQ
LANSING MEADOWS SUBDIVISION WELL #3	Canyon	43.709536	-116.558	Public Supply	0	µg/L	3/30/2016	IDEQ
LEISURE HEIGHTS HOMEOWNERS ASSOCIATION LOWER WELL #1	Canyon	43.572483	-116.488	Public Supply	18	µg/L	9/22/1994	IDEQ
LEISURE HEIGHTS HOMEOWNERS ASSOCIATION UPPER WELL #2	Canyon	43.575061	-116.485	Public Supply	16	µg/L	5/9/2005	IDEQ
LINDENWOOD WATER ASSN WELL #1	Canyon	43.534285	-116.567	Public Supply	10	µg/L	6/14/2011	IDEQ
LOCUST SUBD WELL 1	Canyon	43.529975	-116.542	Public Supply	12	µg/L	11/18/2003	IDEQ
M AND M MOUNTAIN VIEW SUBD EM2 WELL #1A (NEW WELL 1)	Canyon	43.526319	-116.492	Public Supply	33	µg/L	2/20/2013	IDEQ
M AND T WATER CORP WELL #1	Canyon	43.527389	-116.575	Public Supply	19	µg/L	2/17/2010	IDEQ
M AND T WATER CORP WELL #2	Canyon	43.5279	-116.574	Public Supply	22	µg/L	9/3/2008	IDEQ
MANGUM HEIGHTS SUBD WELL 1	Canyon	43.523267	-116.572	Public Supply	24	µg/L	7/13/2005	IDEQ
MELBA CITY OF WELL #1-N	Canyon	43.377831	-116.526	Public Supply	5	µg/L	7/16/2013	IDEQ
MELBA CITY OF WELL #2-S	Canyon	43.370903	-116.532	Public Supply	7	µg/L	7/16/2013	IDEQ
MIDDLETON CITY OF WELL #4	Canyon	43.720614	-116.602	Public Supply	1	µg/L	5/6/2013	IDEQ
MIDDLETON CITY OF WELL #5	Canyon	43.717917	-116.632	Public Supply	0	µg/L	5/6/2013	IDEQ
MIDDLETON CITY OF WELL #6	Canyon	43.704189	-116.607	Public Supply	0	µg/L	7/3/2013	IDEQ
MIDDLETON CITY OF WELL #7	Canyon	43.686919	-116.608	Public Supply	2	µg/L	6/12/2017	IDEQ
MIDDLETON CITY OF WELL #9	Canyon	43.715638	-116.652	Public Supply	0	µg/L	12/14/2012	IDEQ

NAMPA CITY OF COVENTRY WELL - #15	Canyon	43.524569	-116.563	Public Supply	9	µg/L	11/17/2016	IDEQ
NAMPA CITY OF INACTIVE WELL #10	Canyon	43.546742	-116.569	Public Supply	3	µg/L	9/17/2009	IDEQ
NAMPA CITY OF NEW WELL #10	Canyon	43.546219	-116.568	Public Supply	5	µg/L	11/17/2016	IDEQ
NAMPA CITY OF WELL #11	Canyon	43.546666	-116.541	Public Supply	12	µg/L	12/4/2013	IDEQ
NAMPA CITY OF WELL #12	Canyon	43.596217	-116.52	Public Supply	25	µg/L	11/17/2016	IDEQ
NAMPA CITY OF WELL #14	Canyon	43.567728	-116.604	Public Supply	6	µg/L	12/5/2013	IDEQ
NAMPA CITY OF WELL #16	Canyon	43.606358	-116.505	Public Supply	0	µg/L	8/9/2017	IDEQ
NAMPA CITY OF WELL #17 CARRIAGE HILLS	Canyon	43.553922	-116.622	Public Supply	6	µg/L	11/17/2016	IDEQ
NAMPA CITY OF WELL #20	Canyon	43.641758	-116.563	Public Supply	15	µg/L	10/7/2016	IDEQ
NAMPA CITY OF WELL #4	Canyon	43.585242	-116.562	Public Supply	5	µg/L	12/19/2013	IDEQ
NAMPA CITY OF WELL #5	Canyon	43.584889	-116.559	Public Supply	11	µg/L	12/19/2013	IDEQ
NAMPA CITY OF WELL #6	Canyon	43.568958	-116.556	Public Supply	8	µg/L	12/19/2013	IDEQ
NAMPA CITY OF WELL #7	Canyon	43.599097	-116.599	Public Supply	3	µg/L	11/17/2016	IDEQ
NAMPA CITY OF WELL #8 BACK UP WELL	Canyon	43.59745	-116.539	Public Supply	13	µg/L	2/9/2004	IDEQ
NAMPA CITY OF WELL #9	Canyon	43.599861	-116.612	Public Supply	3	µg/L	11/17/2016	IDEQ
NORTHRIDGE ESTATES WATER ASSN WELL #1	Canyon	43.718308	-116.607	Public Supply	10	µg/L	12/17/2013	IDEQ
NORTHSIDE ESTATES HOA INC WELL #1	Canyon	43.63379	-116.578	Public Supply	3	µg/L	12/12/2007	IDEQ
NOTUS CITY OF WELL #3 BACK UP WELL	Canyon	43.737102	-116.798	Public Supply	12	µg/L	12/19/1996	IDEQ
NOTUS CITY OF WELL #4	Canyon	43.73053	-116.798	Public Supply	0	µg/L	5/2/2013	IDEQ
OK WATER ASSN BONNEVILLE WELL	Canyon	43.597199	-116.599	Public Supply	15	µg/L	8/14/2013	IDEQ
OK WATER ASSN WILLOW WELL	Canyon	43.595771	-116.597	Public Supply	17	µg/L	8/14/2013	IDEQ
PAR ESTATES HOMEOWNERS ASSN WELL #3 (1998)	Canyon	43.742848	-116.701	Public Supply	18	µg/L	9/12/2013	IDEQ

PARMA CITY OF WELL #10	Canyon	43.7924	-116.939	Public Supply	2.1	µg/L	11/24/2003	IDEQ
PARMA CITY OF WELL #12	Canyon	43.795693	-116.942	Public Supply	0	µg/L	10/23/2014	IDEQ
PARMA CITY OF WELL #6	Canyon	43.788311	-116.936	Public Supply	0	µg/L	4/13/2016	IDEQ
PARMA CITY OF WELL #7	Canyon	43.787044	-116.946	Public Supply	9.1	µg/L	11/24/2003	IDEQ
PARMA CITY OF WELL #8	Canyon	43.781461	-116.937	Public Supply	0	µg/L	11/24/2003	IDEQ
PARMA CITY OF WELL #9	Canyon	43.788461	-116.936	Public Supply	3.0	µg/L	11/24/2003	IDEQ
PLEASANT VIEW MANOR WELL 1	Canyon	43.662361	-116.798	Public Supply	0	µg/L	11/20/2013	IDEQ
PRECEPT WINE WELL 2	Canyon	43.577286	-116.779	Public Supply	60.6	µg/L	4/17/2003	IDEQ
PURPLE SAGE COMMUNITY WELL #1	Canyon	43.732128	-116.708	Public Supply	18.3	µg/L	3/8/2007	IDEQ
RICH SUBD WELL 1	Canyon	43.726033	-116.706	Public Supply	77.6	µg/L	7/20/2006	IDEQ
ROSWELL WATER USERS COOP COMPANY WELL #2	Canyon	43.739708	-116.962	Public Supply	0	µg/L	5/1/2013	IDEQ
RUSHMORE MOBILE HOME PARK WELL 1	Canyon	43.592922	-116.523	Public Supply	81	µg/L	1/17/2006	IDEQ
SHALIMAR SUBD WELL #1	Canyon	43.54025	-116.587	Public Supply	9	µg/L	11/21/2013	IDEQ
SHALIMAR SUBD WELL #2	Canyon	43.543121	-116.586	Public Supply	10	µg/L	3/15/2004	IDEQ
SHAMROCK VILLA WATER ASSN WELL #1 BACK UP WELL	Canyon	43.545186	-116.535	Public Supply	22	µg/L	6/21/2005	IDEQ
SHAMROCK VILLA WATER ASSN WELL #2	Canyon	43.544114	-116.534	Public Supply	18	µg/L	6/21/2005	IDEQ
SHARI HILL ESTATES WELL 1	Canyon	43.525168	-116.813	Public Supply	158	µg/L	3/4/2005	IDEQ
SHIPMAN PLACE SUBD WELL 1	Canyon	43.532411	-116.567	Public Supply	43	µg/L	6/2/2005	IDEQ
SILVER SPUR SUBDIVISION WELL #1	Canyon	43.624598	-116.493	Public Supply	24	µg/L	9/19/2016	IDEQ
SKY RANCH ESTATES WELL #1	Canyon	43.510037	-116.652	Public Supply	0	µg/L	9/14/2016	IDEQ
SKY RANCH ESTATES WELL #2	Canyon	43.506735	-116.652	Public Supply	0	µg/L	10/23/2013	IDEQ
SKYLINE WATER ASSN WELL #1-NEW	Canyon	43.532906	-116.564	Public Supply	12	µg/L	11/18/2013	IDEQ

SOUTHGATE SUBD WELL #2	Canyon	43.634258	-116.705	Public Supply	16.5	µg/L	12/28/2000	IDEQ
SOUTHSHORE WATER WELL 1	Canyon	43.5332	-116.666	Public Supply	0	µg/L	6/25/2014	IDEQ
SOUTHWEST IDAHO TREATMENT CENTER WELL #3 BACK UP WELL	Canyon	43.603244	-116.53	Public Supply	191	µg/L	8/4/2003	IDEQ
SOUTHWEST IDAHO TREATMENT CENTER WELL #4	Canyon	43.60035	-116.533	Public Supply	45	µg/L	7/7/2017	IDEQ
SSI FOOD SERVICE WELL 6	Canyon	43.695547	-116.915	Public Supply	0	µg/L	4/16/2013	IDEQ
STECHER MUTUAL WATER COMPANY WELL 1	Canyon	43.606925	-116.695	Public Supply	18	µg/L	11/4/2013	IDEQ
STECHER MUTUAL WATER COMPANY WEST WELL #2	Canyon	43.60702	-116.695	Public Supply	16	µg/L	11/4/2013	IDEQ
STECHER WATER USERS ASSN WELL 1	Canyon	43.605667	-116.696	Public Supply	6.1	µg/L	5/22/2015	IDEQ
SUNNYRIDGE 3 WATER CORP WELL #1	Canyon	43.526067	-116.565	Public Supply	31	µg/L	11/8/2004	IDEQ
SUNNYRIDGE 3 WATER CORP WELL #2	Canyon	43.526303	-116.567	Public Supply	34	µg/L	5/6/2003	IDEQ
SUNNYRIDGE I SUBD WELL 1	Canyon	43.531394	-116.564	Public Supply	22	µg/L	1/31/2006	IDEQ
SUNNYRIDGE PROPERTY OWNERS WELL #1	Canyon	43.529773	-116.56	Public Supply	36	µg/L	11/22/2004	IDEQ
SUNNYRIDGE SUBD 2 WELL #1	Canyon	43.527458	-116.565	Public Supply	14	µg/L	2/23/2010	IDEQ
TOWNS VILLAGE WELL #1	Canyon	43.684978	-116.689	Public Supply	1	µg/L	10/15/2013	IDEQ
TWIN BRIDGES SUBD WELL #1	Canyon	43.538836	-116.476	Public Supply	7	µg/L	11/21/2013	IDEQ
VALLEY VIEW WATER WELL 1	Canyon	43.592811	-116.526	Public Supply	8.1	µg/L	11/11/2013	IDEQ
VANAL HEIGHTS SWEET WATER WELL 1	Canyon	43.601788	-116.696	Public Supply	6	µg/L	2/12/2014	IDEQ
VANAL HEIGHTS WELL ASSN WELL 1	Canyon	43.602261	-116.698	Public Supply	4.1	µg/L	7/17/2013	IDEQ
VERDE HILLS WATER USERS ASSN INC WELL #1 E (WELLFIELD)	Canyon	43.554558	-116.617	Public Supply	7	µg/L	12/15/2004	IDEQ
WESTVIEW SHERVIK SUBD WELL #1	Canyon	43.577656	-116.611	Public Supply	12	µg/L	12/7/2004	IDEQ
WILDER CITY OF WELL #2 (SOUTH)CHULA VISTA	Canyon	43.669764	-116.912	Public Supply	0	µg/L	12/8/2016	IDEQ

WILDER CITY OF WELL #3 GOLDEN GATE	Canyon	43.67648	-116.917	Public Supply	3	µg/L	12/26/2013	IDEQ
WILDER CITY OF WELL #4	Canyon	43.679998	-116.907	Public Supply	2	µg/L	9/24/2013	IDEQ
WOODVIEW ACRES PROPERTY OWNERS NEW WELL #3-SOUTH	Canyon	43.512972	-116.608	Public Supply	21	µg/L	2/26/2010	IDEQ
WOODVIEW ACRES PROPERTY OWNERS WELL #1-NORTH	Canyon	43.537056	-116.592	Public Supply	10	µg/L	2/13/2014	IDEQ
WOODVIEW ACRES PROPERTY OWNERS WELL #2-MIDDLE	Canyon	43.532569	-116.588	Public Supply	18	µg/L	2/13/2014	IDEQ
06N 02W 15AAC	Gem	43.863	-116.556	Public Supply	5	µg/L	11/17/2015	IDEQ
BONNIE LAURA SUBD WELL 3	Gem	43.883489	-116.518	Public Supply	0	µg/L	11/28/2016	IDEQ
CHERRY RIDGE REHAB WELL #2	Gem	43.892973	-116.508	Public Supply	5	µg/L	12/19/2013	IDEQ
EDGEMONT SUBD WELL 1(OUTSIDE)	Gem	43.888388	-116.508	Public Supply	0	µg/L	9/11/2013	IDEQ
EMMETT CITY OF WELL #6	Gem	43.877067	-116.495	Public Supply	0	µg/L	7/21/2011	IDEQ
EMMETT CITY OF WELL #8	Gem	43.865208	-116.496	Public Supply	0	µg/L	6/28/2012	IDEQ
EMMETT CITY OF WELL #9	Gem	43.864717	-116.476	Public Supply	0	µg/L	8/15/2011	IDEQ
R AND V MOBILE HOME PARK WELL 1	Gem	43.850635	-116.486	Public Supply	2	µg/L	12/18/2013	IDEQ
05S 02E 02DAA	Owyhee	43.017879	-116.178	Domestic	24	µg/L	11/23/2015	IDEQ
05S 02E 02DBC	Owyhee	43.016313	-116.186	Domestic	26	µg/L	11/23/2015	IDEQ
05S 02E 18CBD	Owyhee	42.98712	-116.272	Domestic	0.125	µg/L	11/23/2015	IDEQ
BRUNEAU WATER AND SEWER DIST WELL #1	Owyhee	42.881475	-115.798	Public Supply	0	µg/L	12/18/1995	IDEQ
GRAND VIEW CITY OF E WELL #1	Owyhee	42.981342	-116.095	Public Supply	14	µg/L	11/14/2013	IDEQ
GRAND VIEW CITY OF W WELL #2	Owyhee	42.981347	-116.096	Public Supply	8	µg/L	11/14/2013	IDEQ
HOMEDALE CITY OF WELL #6 USTICK	Owyhee	43.633692	-116.925	Public Supply	0	µg/L	12/2/2014	IDEQ
HOMEDALE CITY OF WELL #7 RIVERSIDE	Owyhee	43.621288	-116.932	Public Supply	0	µg/L	12/2/2014	IDEQ
HOPE HOUSE (OWYHEE) WELL 1	Owyhee	43.497947	-116.791	Public Supply	1.5	µg/L	4/6/2004	IDEQ

MARSING CITY OF WELL #1 CITY HA	Owyhee	43.544589	-116.811	Public Supply	0	µg/L	6/13/2006	IDEQ
MARSING CITY OF WELL #7	Owyhee	43.544589	-116.811	Public Supply	33	µg/L	6/13/2006	IDEQ
MARSING CITY OF WELL #8	Owyhee	43.542794	-116.811	Public Supply	9	µg/L	6/2/2010	IDEQ
MARSING CITY OF WELL #9	Owyhee	43.542563	-116.811	Public Supply	9	µg/L	6/2/2010	IDEQ
MURPHY WATER SYSTEM WELL #2-MAIN	Owyhee	43.214433	-116.557	Public Supply	1.0	µg/L	12/29/2003	IDEQ
PIONEER MOBILE HOME PARK LLC WELL 4	Owyhee	43.601363	-116.918	Public Supply	0	µg/L	12/27/2016	IDEQ
PIONEER MOBILE HOME PARK LLC WELL 5	Owyhee	43.600531	-116.918	Public Supply	0	µg/L	12/12/2013	IDEQ
SNAKE RIVER RESORT WELL 1	Owyhee	43.598857	-116.907	Public Supply	0	µg/L	11/11/2016	IDEQ
07N 04W 02ADD	Payette	43.974333	-116.774	Domestic	0.125	µg/L	12/2/2013	IDEQ
07N 04W 02CBC	Payette	43.971138	-116.792	Unknown	8.2	µg/L	4/27/2015	IDEQ
07N 04W 02CBD	Payette	43.972416	-116.787	Domestic	9.1	µg/L	12/2/2013	IDEQ
07N 04W 03CCC	Payette	43.967277	-116.811	Domestic	12	µg/L	12/2/2013	IDEQ
07N 04W 08CDD	Payette	43.953111	-116.844	Domestic	20	µg/L	12/3/2013	IDEQ
07N 04W 08DCC	Payette	43.953638	-116.843	Domestic	0.125	µg/L	4/27/2015	IDEQ
07N 04W 09AAA	Payette	43.96611	-116.813	Domestic	7.6	µg/L	4/27/2015	IDEQ
07N 04W 10BCB	Payette	43.963444	-116.812	Domestic	7	µg/L	8/19/2013	IDEQ
07N 04W 15CDC	Payette	43.938638	-116.806	Domestic	40	µg/L	12/2/2013	IDEQ
07N 04W 22ABB	Payette	43.936694	-116.801	Domestic	39	µg/L	4/27/2015	IDEQ
07N 04W 22ABC	Payette	43.93525	-116.8	Domestic	31	µg/L	12/2/2013	IDEQ
08N 04W 35CCC	Payette	43.982194	-116.792	Domestic	0.125	µg/L	4/27/2015	IDEQ
DECKER ADDITION WELL #1	Payette	44.077186	-116.917	Public Supply	0	µg/L	8/29/2013	IDEQ
FRUITLAND CITY OF WELL #1	Payette	44.006822	-116.913	Public Supply	0	µg/L	3/17/2003	IDEQ

FRUITLAND CITY OF WELL #11	Payette	44.023467	-116.912	Public Supply	14	µg/L	3/17/2003	IDEQ
FRUITLAND CITY OF WELL #15	Payette	44.014808	-116.919	Public Supply	9.1	µg/L	3/17/2003	IDEQ
FRUITLAND CITY OF WELL #16	Payette	44.016003	-116.923	Public Supply	40	µg/L	11/7/2006	IDEQ
FRUITLAND CITY OF WELL #20	Payette	44.005746	-116.913	Public Supply	0	µg/L	3/17/2003	IDEQ
FRUITLAND CITY OF WELL #6	Payette	44.007114	-116.922	Public Supply	22.4	µg/L	12/6/2000	IDEQ
IDAHO WEST ESTATES WELL 1	Payette	43.939583	-116.912	Public Supply	0	µg/L	12/11/2008	IDEQ
IDAHO WEST ESTATES WELL 2	Payette	43.939586	-116.913	Public Supply	0	µg/L	3/15/2016	IDEQ
LAZY RIVER MOBILE HOME PARK 1 WELL 1	Payette	44.131629	-116.91	Public Supply	0	µg/L	10/16/2013	IDEQ
LOMA LINDA WATER CORP WELL #1 - NORTH	Payette	43.996208	-116.933	Public Supply	11	µg/L	3/8/2007	IDEQ
LOMA LINDA WATER CORP WELL #2 - SOUTH	Payette	43.992986	-116.933	Public Supply	9.2	µg/L	3/8/2007	IDEQ
NEW PLYMOUTH CITY OF WELL #6 BACK UP WELL	Payette	43.970111	-116.821	Public Supply	12.1	µg/L	7/1/2003	IDEQ
NEW PLYMOUTH CITY OF WELL #7	Payette	43.960166	-116.82	Public Supply	11.0	µg/L	5/16/2003	IDEQ
NEW PLYMOUTH CITY OF WELL #8	Payette	43.963555	-116.822	Public Supply	23.3	µg/L	5/16/2003	IDEQ
NEW PLYMOUTH CITY OF WELL #9	Payette	43.961722	-116.834	Public Supply	0	µg/L	9/21/2016	IDEQ
PAYETTE CITY OF WELL #15	Payette	44.078708	-116.915	Public Supply	0	µg/L	8/21/2015	IDEQ
PAYETTE CITY OF WELL #18	Payette	44.078675	-116.922	Public Supply	0	µg/L	8/21/2015	IDEQ
PAYETTE CITY OF WELL #19	Payette	44.080783	-116.922	Public Supply	0	µg/L	8/21/2015	IDEQ
PAYETTE CITY OF WELL #20	Payette	44.082694	-116.927	Public Supply	2	µg/L	8/21/2015	IDEQ
PAYETTE CITY OF WELL #21	Payette	44.08599	-116.902	Public Supply	13.39	µg/L	6/13/2000	IDEQ
PAYETTE CITY OF WELL #22	Payette	44.07758	-116.919	Public Supply	0	µg/L	7/24/2014	IDEQ
PAYETTE CITY OF WELL #23	Payette	44.082472	-116.934	Public Supply	0	µg/L	9/6/2011	IDEQ
01N 01E 03CCC1	Ada	43.445667	-116.333	Irrigation	8.7	ug/L	7/16/2018	IDWR

01N 01E 16ACC1	Ada	43.4235	-116.343	Domestic	12	ug/L	7/25/2018	IDWR
01N 01W 17CAB1	Ada	43.422222	-116.487	Domestic	17	ug/L	8/16/1994	IDWR
01N 02E 08ADA3	Ada	43.439111	-116.236	Domestic	2.3	µg/L	7/16/2018	IDWR
01N 02W 04DDC1	Canyon	43.445833	-116.577	Irrigation	<1.0	µg/L	7/21/2016	IDWR
01N 02W 05ADD1	Canyon	43.452111	-116.595	Irrigation	30	µg/L	7/21/2016	IDWR
01N 02W 24DAC1	Canyon	43.404861	-116.517	Domestic	16	µg/L	8/19/2008	IDWR
01N 02W 35CDB1	Canyon	43.375194	-116.553	Domestic	9.1	µg/L	7/23/2018	IDWR
01N 04E 27CBD1	Elmore	43.391083	-115.971	Domestic	<1.0	µg/L	6/30/2017	IDWR
01N 04W 12BAA1	Owyhee	43.442167	-116.763	Stock	<1.0	µg/L	7/20/2018	IDWR
01S 01W 30DBB1	Ada	43.306722	-116.502	Domestic	<1.0	µg/L	7/23/2018	IDWR
01S 02W 08DCD1	Canyon	43.344194	-116.595	Domestic	24	µg/L	9/21/1994	IDWR
01S 02W 09CBA1	Canyon	43.350556	-116.588	Domestic	9.1	µg/L	7/26/2018	IDWR
01S 02W 13ABBC2	Canyon	43.343056	-116.521	Stock	3.1	µg/L	6/28/2017	IDWR
01S 02W 15AAA1	Canyon	43.3434	-116.553	Domestic	1.4	µg/L	7/26/2018	IDWR
01S 02W 34BDD1	Owyhee	43.294083	-116.562	Domestic	<1.0	µg/L	8/31/2017	IDWR
01S 03W 11DDC1	Owyhee	43.344	-116.653	Domestic	<1.0	µg/L	7/13/2017	IDWR
01S 05E 23CCC1	Elmore	43.315667	-115.836	Domestic	<1.0	µg/L	7/12/2017	IDWR
02N 01E 01BCBC1	Ada	43.541056	-116.293	Domestic	2.6	µg/L	7/17/2018	IDWR
02N 01E 07AAB1	Ada	43.531416	-116.378	Domestic	48	µg/L	8/31/1993	IDWR
02N 01E 15ABA1	Ada	43.516472	-116.321	Domestic	<1.0	µg/L	6/26/2017	IDWR
02N 01E 21BBDD1	Ada	43.499722	-116.352	Irrigation	<0.67	µg/L	7/18/2006	IDWR
02N 01E 26BAAB2	Ada	43.487777	-116.305	Domestic	1.8	µg/L	8/1/2016	IDWR

02N 01E 26BBC1	Ada	43.486056	-116.314	Domestic	110	µg/L	6/27/2018	IDWR
02N 01E 29BDB1	Ada	43.484222	-116.369	Domestic	4.2	µg/L	6/26/2017	IDWR
02N 01E 29CAD1	Ada	43.479109	-116.366	Domestic	6.3	µg/L	6/28/2016	IDWR
02N 01W 01ABD1	Ada	43.544055	-116.399	NULL	10.72	µg/L	6/6/2006	IDWR
02N 01W 03ABB1	Ada	43.546027	-116.442	Domestic	53	µg/L	8/16/1994	IDWR
02N 01W 27BCC1 DESTROYED	Ada	43.481274	-116.453	Unused	53	µg/L	7/16/1992	IDWR
02N 02E 34CCD1	Ada	43.459333	-116.211	Domestic	5.2	µg/L	6/29/2016	IDWR
02N 02W 07CBC1	Canyon	43.521055	-116.633	Domestic	1.5	µg/L	7/7/2016	IDWR
02N 02W 09ACC1	Canyon	43.52675	-116.582	Public Supply	22	µg/L	9/14/1993	IDWR
02N 02W 23ABD1	Canyon	43.500806	-116.539	Domestic	6.3	µg/L	7/17/2018	IDWR
02N 03W 06BBA1	Canyon	43.545138	-116.749	Domestic	16	µg/L	8/2/1994	IDWR
02N 03W 06DBA1	Canyon	43.538111	-116.738	Domestic	21	µg/L	9/14/1993	IDWR
02N 03W 07CDB1	Canyon	43.51875	-116.747	Domestic	<1.0	µg/L	8/1/2016	IDWR
02N 04W 04ADA1	Owyhee	43.540417	-116.813	Irrigation	2.8	µg/L	8/23/2018	IDWR
02N 04W 25CAD1	Canyon	43.478028	-116.768	Domestic	<1.0	µg/L	7/6/2018	IDWR
02N 04W 26CCD1	Owyhee	43.473888	-116.788	Domestic	110	µg/L	9/13/1993	IDWR
02N 05W 13BCD1	Owyhee	43.509639	-116.886	Stock	14	µg/L	8/7/2017	IDWR
02S 05E 01DDA1	Elmore	43.275444	-115.797	Irrigation	2.8	µg/L	7/21/2017	IDWR
03N 01E 01DBA1	Ada	43.626278	-116.282	Irrigation	11	µg/L	8/9/2017	IDWR
03N 01E 03BBA1	Ada	43.633472	-116.33	Domestic	30	µg/L	7/16/1991	IDWR
03N 01E 13BCC1	Ada	43.598194	-116.291	Domestic	37	µg/L	8/4/2016	IDWR
03N 01E 13BDB1-DESTROYED	Ada	43.599332	-116.289	Unused	24	µg/L	8/10/1993	IDWR

03N 01E 14BBD1	Ada	43.601583	-116.31	Domestic	56	µg/L	10/1/1991	IDWR
03N 01E 15CBD1	Ada	43.595583	-116.33	Domestic	50	µg/L	7/3/2018	IDWR
03N 01E 21DCA1	Ada	43.578027	-116.342	Domestic	110	µg/L	7/15/1992	IDWR
03N 01E 22CCC1	Ada	43.577942	-116.334	Domestic	37	µg/L	8/13/1992	IDWR
03N 01E 29CBA1	Ada	43.567777	-116.371	Domestic	33	µg/L	7/18/1994	IDWR
03N 01W 05BAA1	Canyon	43.63375	-116.486	Domestic	79	µg/L	8/6/1992	IDWR
03N 01W 16DDD1	Ada	43.591111	-116.454	Domestic	11	µg/L	7/6/2016	IDWR
03N 01W 18DAC1	Canyon	43.595666	-116.498	Domestic	30	µg/L	8/27/1993	IDWR
03N 01W 19ADB1	Canyon	43.586722	-116.497	Domestic	16	µg/L	9/17/1993	IDWR
03N 02E 03BAAD2	Ada	43.632167	-116.204	Domestic	9.7	µg/L	6/20/2017	IDWR
03N 02E 05DAB1	Ada	43.626444	-116.238	Public Supply	5.5	µg/L	6/30/2016	IDWR
03N 02E 16BBD1	Ada	43.601388	-116.229	Irrigation	1.4	µg/L	6/28/2016	IDWR
03N 02E 16DBB1	Ada	43.596	-116.223	Irrigation	19	µg/L	8/11/1992	IDWR
03N 02E 21DCA1	Ada	43.578444	-116.22	Domestic	<1.0	µg/L	7/28/2016	IDWR
03N 02E 25AAC1	Ada	43.571944	-116.156	Domestic	3.8	µg/L	7/28/2016	IDWR
03N 02W 04ADD1	Canyon	43.627056	-116.573	Domestic	1.7	µg/L	7/6/2018	IDWR
03N 02W 05BBB1	Canyon	43.63375	-116.611	Public Supply	<1.0	µg/L	8/9/2017	IDWR
03N 02W 12BAB1	Canyon	43.619388	-116.528	Stock	40	µg/L	9/21/1994	IDWR
03N 02W 13CBBC1	Canyon	43.595944	-116.532	Irrigation	26	µg/L	8/4/2016	IDWR
03N 02W 17CCB2	Canyon	43.593494	-116.613	Domestic	16	µg/L	8/31/1993	IDWR
03N 02W 26BAA1	Canyon	43.575694	-116.543	Domestic	21	µg/L	6/28/2017	IDWR
03N 02W 29BBBB1	Canyon	43.575416	-116.613	Domestic	9	µg/L	7/11/2016	IDWR

03N 02W 31BCC1	Canyon	43.554194	-116.633	Irrigation	24	µg/L	8/3/1994	IDWR
03N 02W 33CAD1	Canyon	43.550994	-116.585	Unused	12	µg/L	8/3/1994	IDWR
03N 03E 30DAAD2	Ada	43.566805	-116.134	Public Supply	1.8	µg/L	6/23/2016	IDWR
03N 03E 32BBA1	Ada	43.560168	-116.132	Unused	37	µg/L	7/8/1994	IDWR
03N 03E 33DAA1	Ada	43.552778	-116.096	Domestic	<1.0	µg/L	6/29/2017	IDWR
03N 03W 02DDDC1	Canyon	43.619444	-116.655	Domestic	11	µg/L	7/7/2016	IDWR
03N 03W 09CBC1	Canyon	43.608806	-116.713	Domestic	6.8	µg/L	7/26/2017	IDWR
03N 03W 14CDA1	Canyon	43.593388	-116.664	Domestic	12.06	µg/L	7/27/2006	IDWR
03N 03W 22AAA1	Canyon	43.589055	-116.673	Irrigation	5.36	µg/L	7/27/2006	IDWR
03N 03W 26BCDD1	Canyon	43.569389	-116.669	Domestic	12	µg/L	7/3/2018	IDWR
03N 03W 31ADA1	Canyon	43.556305	-116.733	Domestic	26	µg/L	8/4/1992	IDWR
03N 04W 04BDA1	Canyon	43.62877	-116.823	Domestic	12	µg/L	7/7/2016	IDWR
03N 04W 12AAD2	Canyon	43.615833	-116.754	Domestic	<1.0	µg/L	8/15/2017	IDWR
03N 04W 15DCC1	Canyon	43.589055	-116.799	Domestic	34	µg/L	9/22/1993	IDWR
03N 04W 19CBA1	Owyhee	43.581194	-116.866	Domestic	<1.0	µg/L	7/14/2016	IDWR
03N 04W 25CBB1	Canyon	43.565992	-116.772	Domestic	35	µg/L	7/31/1992	IDWR
03N 05W 02DDA1	Canyon	43.621	-116.892	Domestic	<1.0	µg/L	7/6/2018	IDWR
03N 05W 10CAA1	Owyhee	43.607306	-116.922	Domestic	<1.0	µg/L	7/13/2017	IDWR
03N 05W 28ACB1	Owyhee	43.570111	-116.939	Domestic	10	µg/L	7/20/2018	IDWR
03N 06W 13BCA1	Owyhee	43.598416	-117.007	Stock	37	µg/L	7/30/1993	IDWR
04N 01E 06CCDB1	Ada	43.707638	-116.391	Domestic	19	µg/L	7/6/2016	IDWR
04N 01E 11BBB1	Ada	43.705861	-116.312	Domestic	59	µg/L	8/8/1991	IDWR

04N 01E 24CADA1	Ada	43.667943	-116.284	Domestic	<1.0	µg/L	6/21/2018	IDWR
04N 01E 24DDB1	Ada	43.664722	-116.277	Public Supply	1.1	µg/L	6/30/2016	IDWR
04N 01E 29BABD2	Ada	43.662083	-116.367	Domestic	34	µg/L	7/6/2016	IDWR
04N 01E 35DAA1	Ada	43.639444	-116.296	Domestic	28.14	µg/L	6/8/2006	IDWR
04N 01E 36ADB1	Ada	43.643138	-116.279	Irrigation	30	µg/L	6/30/2016	IDWR
04N 01W 01CAA1	Ada	43.710555	-116.404	Domestic	31	µg/L	8/8/1991	IDWR
04N 01W 06BAAB1	Ada	43.720833	-116.505	Domestic	12	µg/L	7/6/2016	IDWR
04N 01W 07ABA1	Ada	43.706139	-116.497	Domestic	2.2	µg/L	8/22/2018	IDWR
04N 01W 13CBD1	Ada	43.682027	-116.409	Domestic	1.9	µg/L	6/28/2016	IDWR
04N 01W 22DBB1	Ada	43.669777	-116.442	Domestic	56	µg/L	8/3/1992	IDWR
04N 01W 23ADD1	Ada	43.671944	-116.414	Domestic	35	µg/L	8/4/1992	IDWR
04N 01W 31AAA1	Ada	43.647278	-116.494	Irrigation	<1.0	µg/L	6/27/2018	IDWR
04N 01W 33CBB1	Ada	43.641583	-116.472	Domestic	12	µg/L	6/27/2018	IDWR
04N 02E 19CCCD1	Ada	43.663278	-116.272	Domestic	1.8	µg/L	6/26/2018	IDWR
04N 02E 28CCC1	Ada	43.6488	-116.232	Domestic	<1.0	µg/L	7/26/2017	IDWR
04N 02E 29ACA1	Ada	43.6575	-116.239	Domestic	8.4	µg/L	6/28/2016	IDWR
04N 02E 32ABBC1	Ada	43.647556	-116.243	Domestic	4.1	µg/L	7/17/2018	IDWR
04N 02W 03AAAA1	Canyon	43.720694	-116.554	Domestic	6.9	µg/L	8/8/2017	IDWR
04N 02W 07ABC1	Canyon	43.703778	-116.619	Domestic	<1.0	µg/L	6/29/2018	IDWR
04N 02W 27AAB1	Canyon	43.661416	-116.558	Domestic	38	µg/L	7/11/2016	IDWR
04N 02W 31AAA1	Canyon	43.647417	-116.614	Domestic	<1.0	µg/L	6/29/2018	IDWR
04N 02W 36CCC1	Canyon	43.634306	-116.533	Domestic	25	µg/L	8/23/2018	IDWR

04N 03W 02ABBB1	Canyon	43.720611	-116.661	Domestic	12.73	µg/L	7/17/2006	IDWR
04N 03W 06BABA1	Canyon	43.719833	-116.747	Domestic	14.74	µg/L	8/3/2006	IDWR
04N 03W 12BACC1	Canyon	43.704638	-116.647	Domestic	<1.0	µg/L	8/3/2016	IDWR
04N 03W 21CDD1	Canyon	43.664138	-116.704	Public Supply	3.9	µg/L	8/4/2016	IDWR
04N 04W 05CAC1	Canyon	43.709416	-116.846	Domestic	<1.0	µg/L	7/7/2016	IDWR
04N 04W 25DAA1	Canyon	43.652638	-116.754	Domestic	26.13	µg/L	7/27/2006	IDWR
04N 05W 23BCC1	Canyon	43.669833	-116.912	Public Supply	<1.0	µg/L	6/25/2018	IDWR
04N 06W 11DCA1	Canyon	43.693777	-117.018	Domestic	5.5	µg/L	8/3/2016	IDWR
04N 06W 24BDA1	Owyhee	43.6715	-117.003	Domestic	<1.0	µg/L	8/8/2017	IDWR
04N 06W 35DCC1	Owyhee	43.632102	-117.02	Domestic	42	µg/L	9/12/1994	IDWR
04S 01E 30BBB1	Owyhee	43.052306	-116.395	Domestic	<1.0	µg/L	7/20/2018	IDWR
04S 02E 06CDA1	Owyhee	43.101139	-116.267	Domestic	<1.0	µg/L	7/11/2018	IDWR
04S 05E 26DAD1	Elmore	43.044528	-115.817	Irrigation	<1.0	µg/L	7/21/2017	IDWR
04S 07E 20CAB1	Elmore	43.061139	-115.652	Irrigation	7.1	µg/L	6/30/2017	IDWR
05N 01E 26CDDC1	Ada	43.735472	-116.307	Domestic	3.1	µg/L	7/30/2018	IDWR
05N 01E 31ACA2	Ada	43.73	-116.379	Domestic	5.7	µg/L	6/27/2017	IDWR
05N 01E 33ADB1	Ada	43.730944	-116.337	Domestic	1	µg/L	6/27/2018	IDWR
05N 01E 34DCD2	Ada	43.724722	-116.321	Domestic	2.7	µg/L	6/29/2016	IDWR
05N 01W 16CBD1	Ada	43.769667	-116.469	Domestic	<1.0	µg/L	8/6/2018	IDWR
05N 01W 19CBD2	Ada	43.754806	-116.508	Irrigation	5.8	µg/L	6/20/2017	IDWR
05N 01W 33ACD1	Ada	43.729444	-116.461	Domestic	2.7	µg/L	7/16/2018	IDWR
05N 02E 31BCC1	Ada	43.730472	-116.271	Domestic	1.5	µg/L	8/4/2017	IDWR

05N 02W 20DAC1	Canyon	43.754611	-116.597	Domestic	18	µg/L	7/11/2016	IDWR
05N 02W 24DAB2	Canyon	43.757194	-116.515	Domestic	5.5	µg/L	7/11/2016	IDWR
05N 02W 33ACC1	Canyon	43.728611	-116.581	Domestic	27	µg/L	9/1/1994	IDWR
05N 03W 04BCB1	Canyon	43.802583	-116.712	Domestic	9	µg/L	8/3/1993	IDWR
05N 03W 08DDC1	Canyon	43.779472	-116.716	Domestic	50	µg/L	9/6/1991	IDWR
05N 03W 12CCA1	Canyon	43.779389	-116.647	Domestic	7.2	µg/L	8/8/2017	IDWR
05N 03W 15DDC1	Canyon	43.764861	-116.676	Domestic	59	µg/L	7/11/2016	IDWR
05N 03W 27CAA1	Canyon	43.742556	-116.685	Domestic	1.4	µg/L	6/25/2018	IDWR
05N 03W 30ADD1	Canyon	43.742889	-116.733	Domestic	57	µg/L	7/19/2017	IDWR
05N 04W 08BCC1	Canyon	43.786611	-116.853	Domestic	<1.0	µg/L	7/19/2017	IDWR
05N 04W 16ABA1	Canyon	43.777888	-116.819	Domestic	75	µg/L	8/31/1994	IDWR
05N 04W 21DCBB1	Canyon	43.752972	-116.821	Domestic	24	µg/L	8/3/2016	IDWR
05N 04W 24ABA1	Canyon	43.761611	-116.76	Irrigation	7.6	µg/L	8/15/2017	IDWR
05N 04W 28CDC1	Canyon	43.7345	-116.821	Domestic	<1.0	µg/L	7/3/2018	IDWR
05N 04W 35BBB1	Canyon	43.733194	-116.791	Domestic	70	µg/L	6/25/2018	IDWR
05N 05W 03BCBC1	Canyon	43.802361	-116.932	Domestic	<1.0	µg/L	7/8/2016	IDWR
05N 05W 28CDBB1	Canyon	43.738444	-116.946	Domestic	<1.0	µg/L	7/8/2016	IDWR
05N 05W 34BCC1	Canyon	43.726861	-116.931	Domestic	<1.0	µg/L	8/15/2017	IDWR
05N 06W 25CDD1	Canyon	43.735472	-117.003	Domestic	21	µg/L	7/8/2016	IDWR
05S 01E 16ACC2	Owyhee	42.990805	-116.342	Domestic	<1.0	µg/L	7/14/2016	IDWR
05S 04E 32DCB1	Owyhee	42.941916	-116.005	Domestic	<1.0	µg/L	7/14/2016	IDWR
05S 05E 36DAD1	Owyhee	42.943888	-115.797	Domestic	32	µg/L	7/14/2016	IDWR

05S 08E 34DBA1	Elmore	42.945583	-115.49	Domestic	<1.0	µg/L	7/12/2017	IDWR
06N 01W 03CBB2	Gem	43.886	-116.45	Domestic	<1.0	µg/L	8/6/2018	IDWR
06N 02W 08DADA1	Gem	43.86975	-116.593	Domestic	<1.0	µg/L	7/30/2018	IDWR
06N 02W 20ABB2	Gem	43.849889	-116.602	Domestic	<1.0	µg/L	8/24/2017	IDWR
06N 02W 24DAD1	Gem	43.83909	-116.516	Domestic	240	µg/L	8/24/2017	IDWR
06N 03W 10BAA1	Gem	43.879139	-116.682	Domestic	<1.0	µg/L	8/3/2017	IDWR
06N 03W 22CBB1	Gem	43.8415	-116.692	Domestic	5.4	µg/L	7/24/2018	IDWR
06N 03W 31CBD1	Payette	43.81125	-116.748	Domestic	15	µg/L	7/12/2016	IDWR
06N 03W 33CBA2	Gem	43.81275	-116.71	Domestic	2.8	µg/L	8/5/2008	IDWR
06N 04W 24ABB1	Payette	43.850667	-116.761	Domestic	37	µg/L	8/3/2017	IDWR
06N 04W 34DDB1	Payette	43.809606	-116.796	Domestic	2.1	µg/L	7/10/2018	IDWR
06N 05W 09DAA1	Payette	43.871394	-116.936	Domestic	6.1	µg/L	8/15/2018	IDWR
06N 05W 35BAC1	Canyon	43.821194	-116.909	Domestic	9.7	µg/L	8/25/2017	IDWR
06S 05E 03AAD1	Owyhee	42.93545	-115.839	Unused	63	µg/L	8/13/1992	IDWR
06S 05E 26BBB1	Owyhee	42.880111	-115.835	Public Supply	120	µg/L	8/14/2017	IDWR
07N 01W 31CAB1	Gem	43.900611	-116.506	Domestic	4.5	µg/L	8/24/2018	IDWR
07N 02W 30CCC1	Gem	43.908888	-116.63	Domestic	26	µg/L	8/10/1993	IDWR
07N 02W 34ACC1	Gem	43.901528	-116.56	Domestic	32	µg/L	7/24/2018	IDWR
07N 03W 09CDB1	Gem	43.954666	-116.707	Domestic	2.5	µg/L	7/12/2016	IDWR
07N 04W 13CBB1	Payette	43.945166	-116.772	Domestic	<1.0	µg/L	7/12/2016	IDWR
07N 05W 15CDC1	Payette	43.938472	-116.925	Domestic	1.2	µg/L	8/15/2018	IDWR
07N 05W 33CDB1	Payette	43.898	-116.949	Domestic	6.8	µg/L	8/15/2018	IDWR

07S 04E 10DAD1	Owyhee	42.826561	-115.955	Domestic	16	µg/L	8/26/1994	IDWR
07S 06E 16ABB2	Owyhee	42.821917	-115.747	Dewatering	1.3	µg/L	8/18/2017	IDWR
08N 04W 28BCD1	Payette	44.004028	-116.828	Domestic	<1.0	µg/L	7/24/2018	IDWR
08N 05W 03BAD1	Payette	44.066666	-116.924	Irrigation	2.4	µg/L	7/12/2016	IDWR
08N 05W 09DAD1	Payette	44.044331	-116.935	Domestic	<1.0	µg/L	8/18/2017	IDWR
08N 05W 26ABB1	Payette	44.010528	-116.904	Domestic	11	µg/L	7/24/2018	IDWR
09N 05W 01ACD1	Payette	44.147167	-116.88	Domestic	3.1	µg/L	8/13/2018	IDWR
09N 05W 26CBB1	Payette	44.088972	-116.911	Domestic	9.38	µg/L	8/17/2006	IDWR
09N 05W 27DAA1	Payette	44.088055	-116.913	Domestic	5.1	µg/L	7/12/2016	IDWR
09N 05W 34ADD	Payette	44.075611	-116.915	Public Supply	8.3	µg/L	9/25/2013	IDWR
09N 05W 35CBB	Payette	44.074166	-116.913	Public Supply	1.4	µg/L	9/25/2013	IDWR
01N 02W 36CAA1	Canyon	43.37775	-116.526	Monitoring	6.12	µg/L	6/29/2004	USGS
01N 03E 11DDB1	Ada	43.430833	-116.058	Monitoring	1.09	µg/L	11/17/2011	USGS
01N 04E 29DCC1	Ada	43.386111	-116.003	Monitoring	27	µg/L	8/4/2011	USGS
01N 04E 32AAB1	Ada	43.384028	-115.999	Monitoring	0.292	µg/L	8/4/2011	USGS
01S 04E 30ADC1	Ada	43.308833	-116.018	Monitoring	0.566	µg/L	11/22/2011	USGS
02N 03E 34ACC1	Ada	43.468056	-116.085	Monitoring	2.93	µg/L	3/29/2012	USGS
03N 01W 26DDDC1	Ada	43.561553	-116.415	Monitoring	26	µg/L	8/31/1995	USGS
03N 02E 19DCC1	Ada	43.577111	-116.262	Monitoring	19	µg/L	8/31/1994	USGS
03N 02E 32BBB1	Ada	43.559611	-116.253	Monitoring	157	µg/L	8/25/1994	USGS
06N 01W 10BBC1	Gem	43.876722	-116.448	Monitoring	0.915	µg/L	10/20/2015	USGS
06N 01W 16BCA1	Gem	43.859361	-116.469	Monitoring	0.089	µg/L	9/16/2015	USGS

06N 01W 20CDB01	Gem	43.838528	-116.485	Monitoring	0.588	µg/L	11/2/2015	USGS
06N 02W 12CACC01	Gem	43.868389	-116.527	Monitoring	0.15	µg/L	11/9/2015	USGS
06N 02W 14AAA1	Gem	43.864056	-116.533	Monitoring	0.388	µg/L	9/17/2015	USGS
06N 02W 15CDC1	Gem	43.8515	-116.567	Monitoring	0.015	µg/L	10/22/2015	USGS
06N 02W 1CBCC1	Gem	43.883583	-116.532	Monitoring	4.39	µg/L	10/1/2015	USGS
06N 02W 23ABB01	Gem	43.84925	-116.542	Monitoring	0	µg/L	10/30/2017	USGS
06N 02W 27ADC01	Gem	43.829722	-116.556	Monitoring	0.876	µg/L	11/12/2015	USGS
06N 03W 10ADAB01	Gem	43.875417	-116.675	Monitoring	3.65	µg/L	11/16/2015	USGS
06N 03W 36DBC1	Gem	43.811306	-116.641	Monitoring	0.657	µg/L	10/8/2015	USGS
07N 01W 27BCB1	Gem	43.918167	-116.45	Monitoring	0.058	µg/L	9/24/2015	USGS
07N 01W 31CBD01	Gem	43.898278	-116.508	Monitoring	1.01	µg/L	11/4/2015	USGS
07N 01W 34DBA1	Gem	43.8995	-116.44	Monitoring	3.24	µg/L	9/8/2015	USGS
07N 02W 28AAD01	Gem	43.918869	-116.573	Monitoring	11.8	µg/L	11/4/2015	USGS
07N 02W 29CCD1	Gem	43.908861	-116.609	Monitoring	9.87	µg/L	9/29/2015	USGS
07N 02W 32ADD1	Gem	43.902139	-116.593	Monitoring	6.7	µg/L	9/28/2015	USGS
07N 02W 34DCD1	Gem	43.893528	-116.559	Monitoring	22	µg/L	10/6/2015	USGS
07N 02W 36CCBA01	Gem	43.896861	-116.53	Monitoring	3.23	µg/L	11/5/2015	USGS
07N 03W 13DCDD01	Gem	43.937972	-116.637	Monitoring	7.17	µg/L	11/3/2015	USGS
07N 03W 22BCA1	Gem	43.932444	-116.688	Monitoring	0	µg/L	10/30/2017	USGS
07N 03W 23CDD01	Gem	43.923611	-116.663	Monitoring	15.3	µg/L	11/17/2015	USGS
07N 03W 24CBC1	Gem	43.928611	-116.652	Monitoring	4.97	µg/L	10/19/2015	USGS
07N 03W 28CDD1	Payette	43.909361	-116.702	Monitoring	0.648	µg/L	10/1/2015	USGS

APPENDIX B

Compiled Dataset Cross Sections

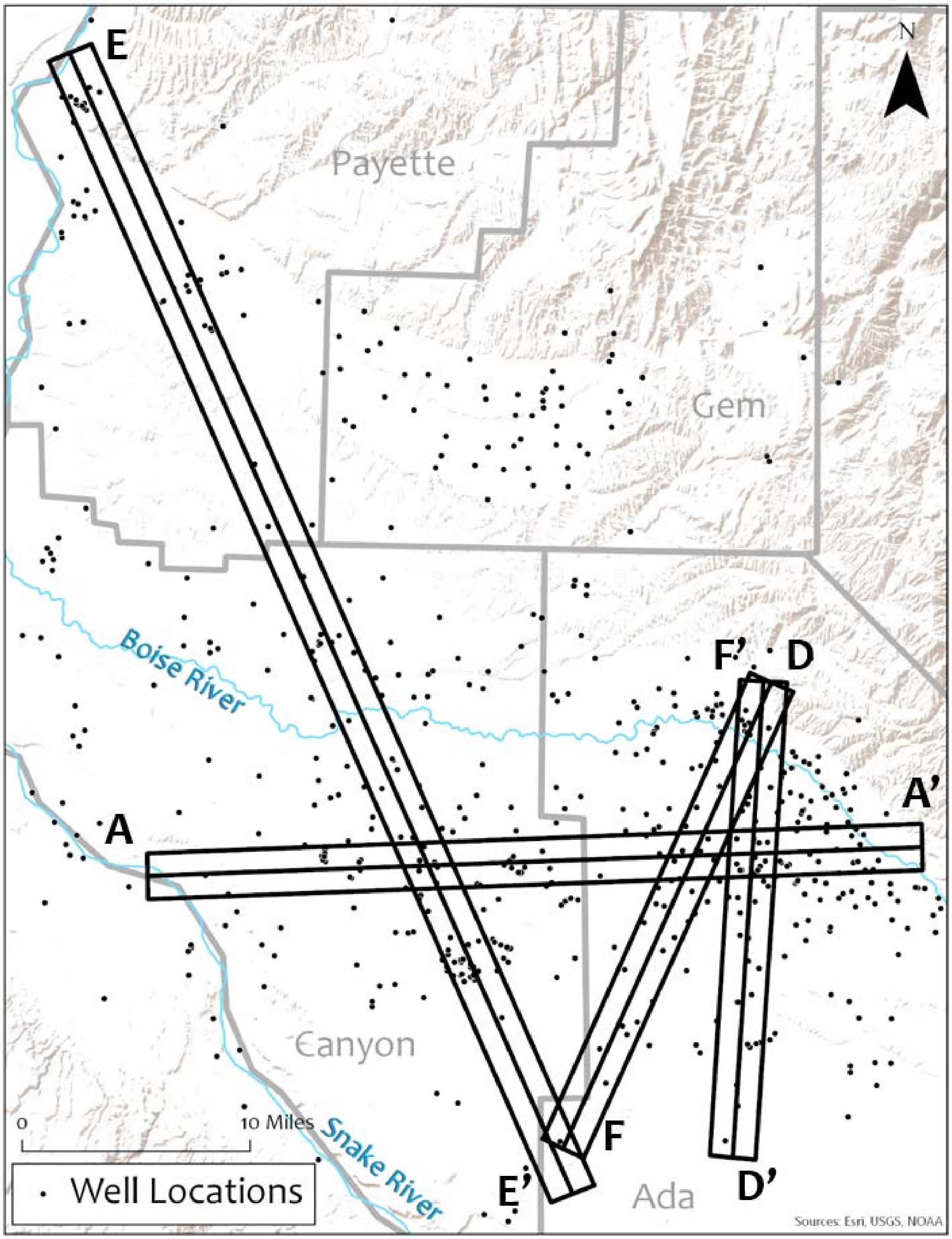

Figure 20 **Compiled Dataset Cross Sections. Cross sections completed during the data exploration portion of the study.**

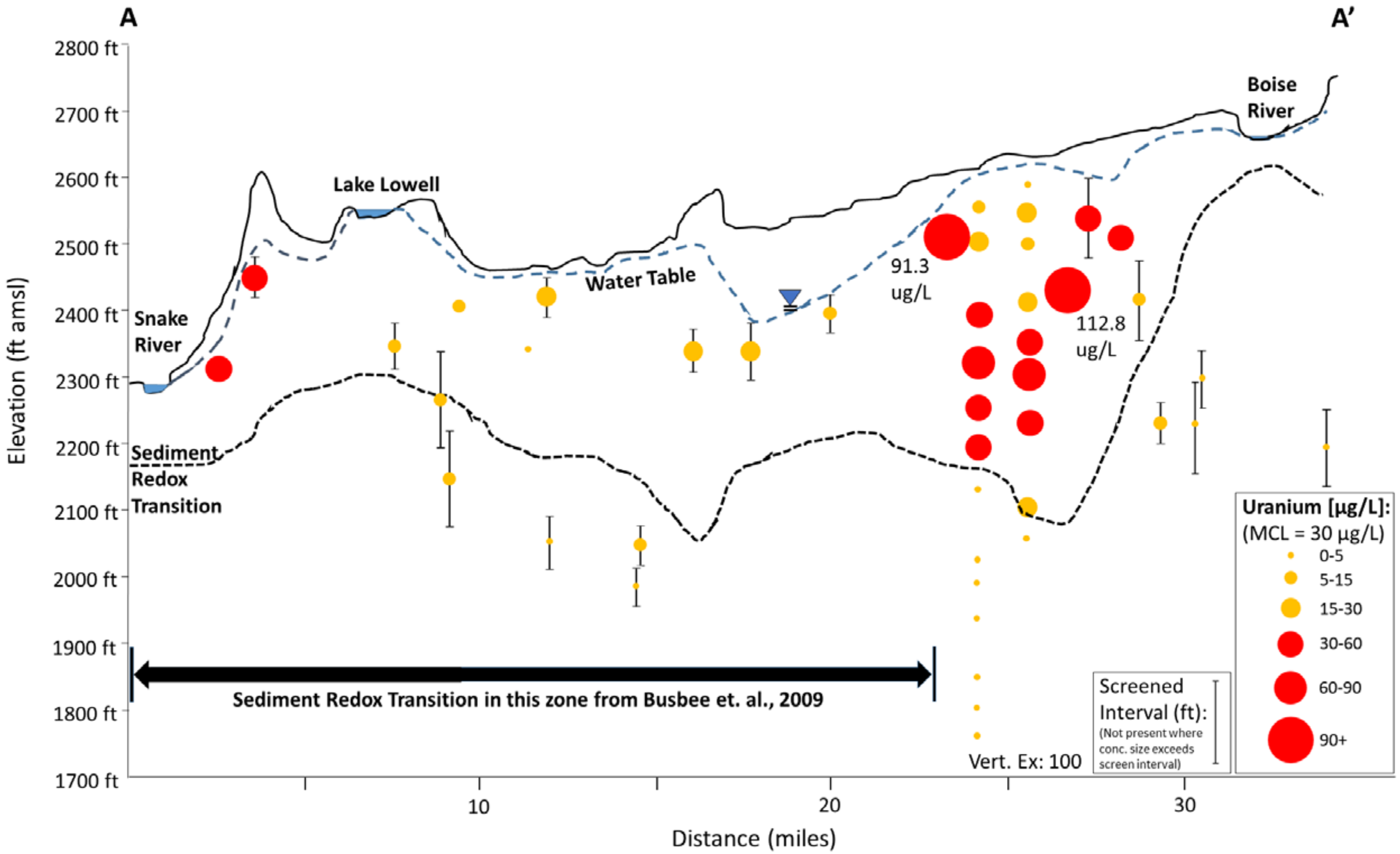

Figure 21 Cross Section A-A', compiled study dataset. The Sediment Redox Transition from Busbee et al. (2009) where indicated by black arrows, otherwise interpolated using the depth of the blue clay layer in the corresponding well logs. Elevated uranium concentrations are only present above the sediment redox transition.

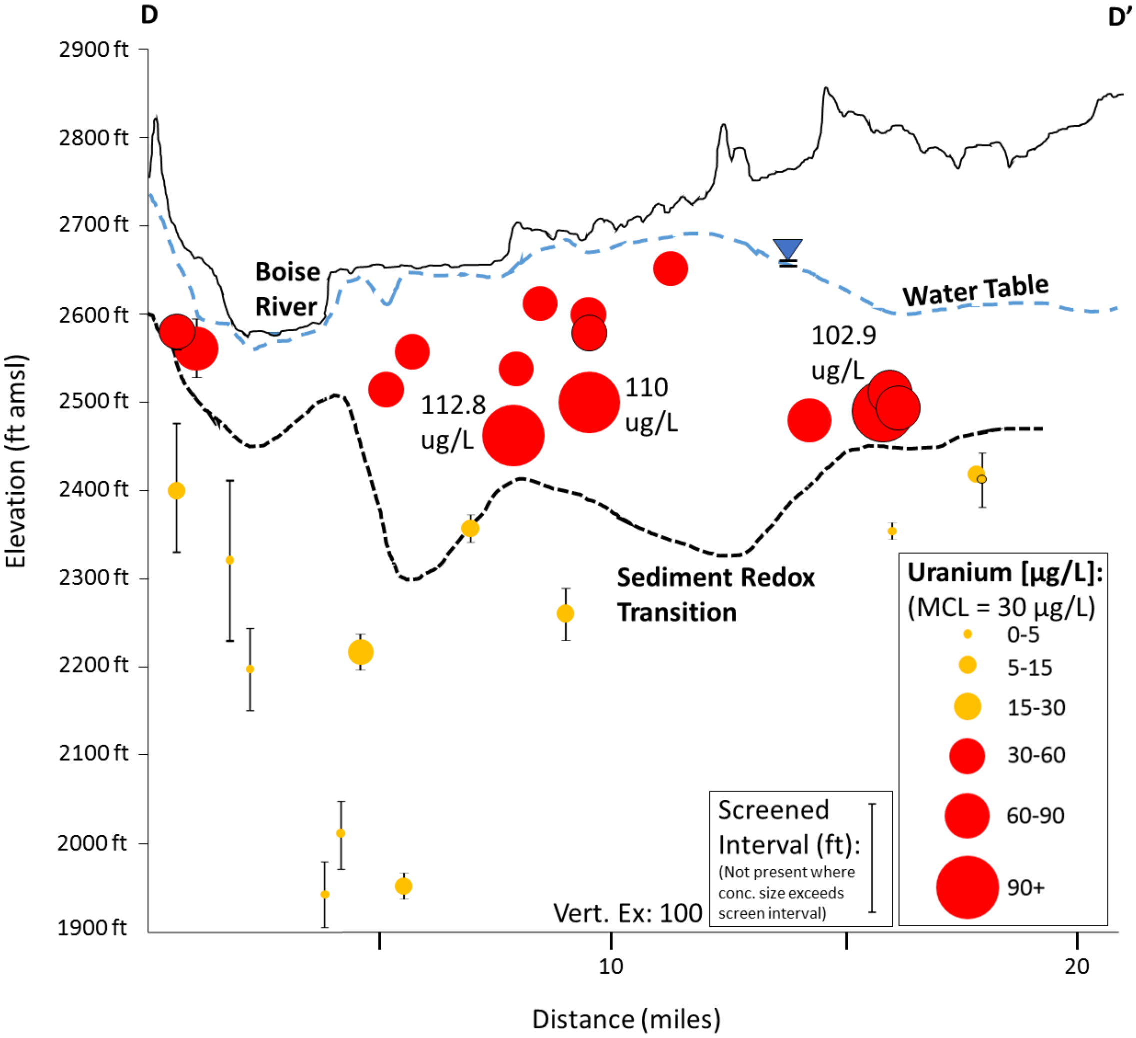

Figure 22 Cross Section D-D', compiled study dataset. Cross Section D-D' showing uranium concentrations and the correlating water table and Sediment Redox Transition. The Sediment Redox Transition has been interpolated using the depth of the blue clay layer in the corresponding well logs.

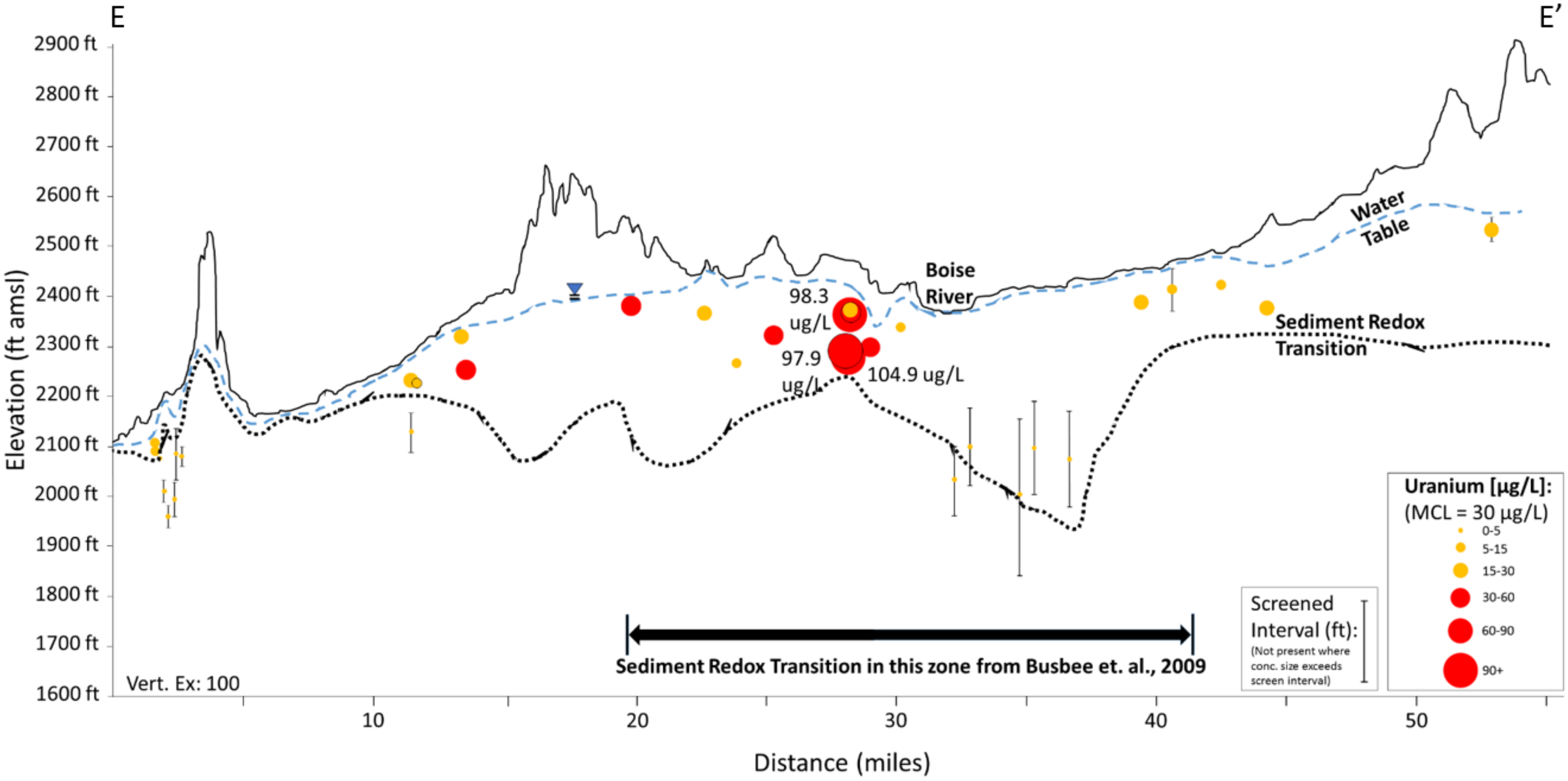

Figure 23 Cross Section E-E', Compiled Study Dataset. The Sediment Redox Transition from Busbee et al. (2009) where indicated by black arrows, otherwise interpolated using the depth of the blue clay layer in the corresponding well logs.

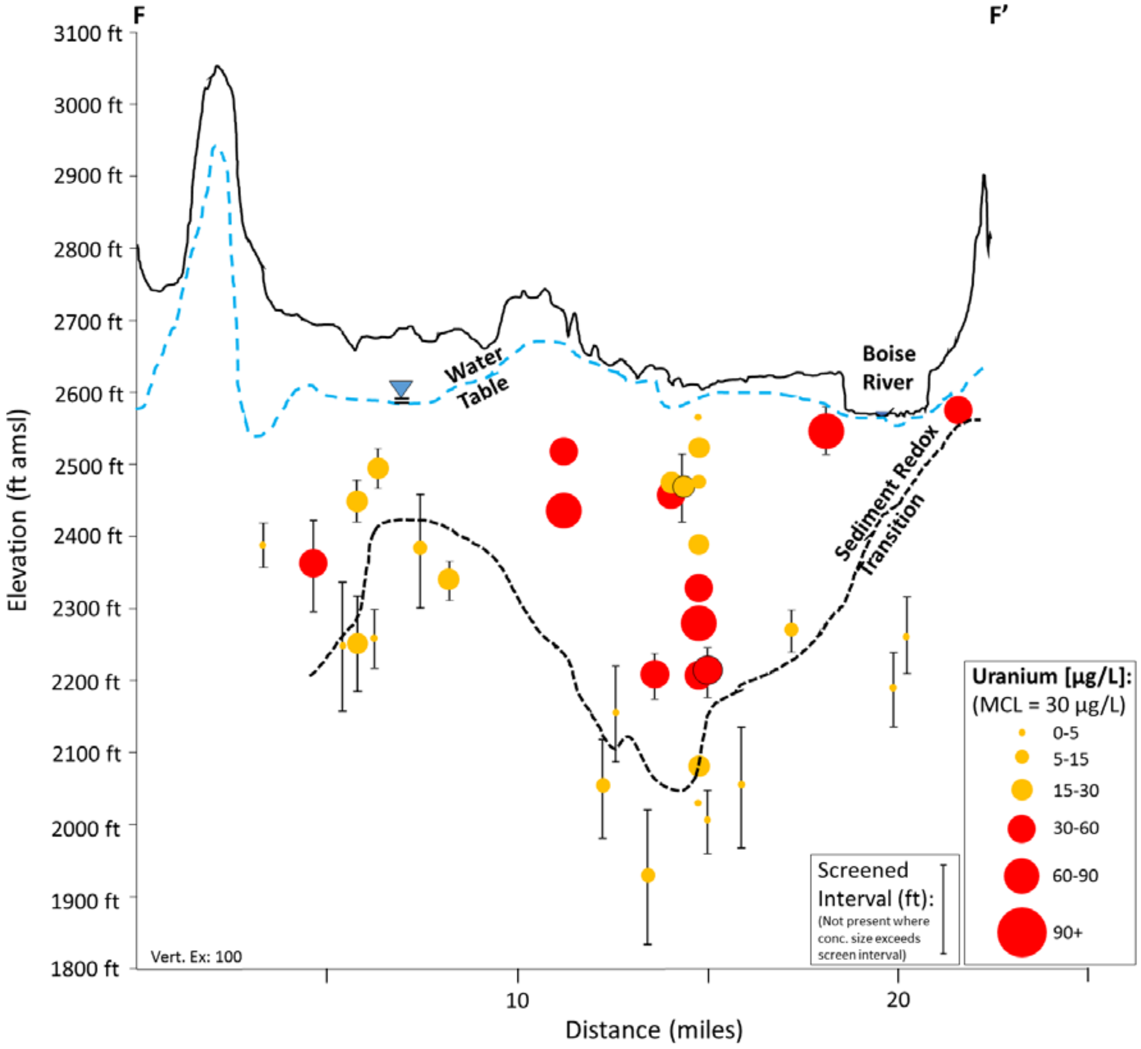

Figure 24 Cross Section F-F', Compiled Study Dataset. Cross Section F-F' showing uranium concentrations and the correlating water table and Sediment Redox Transition. The Sediment Redox Transition has been interpolated using the depth of the blue clay layer in the corresponding well logs.

APPENDIX C

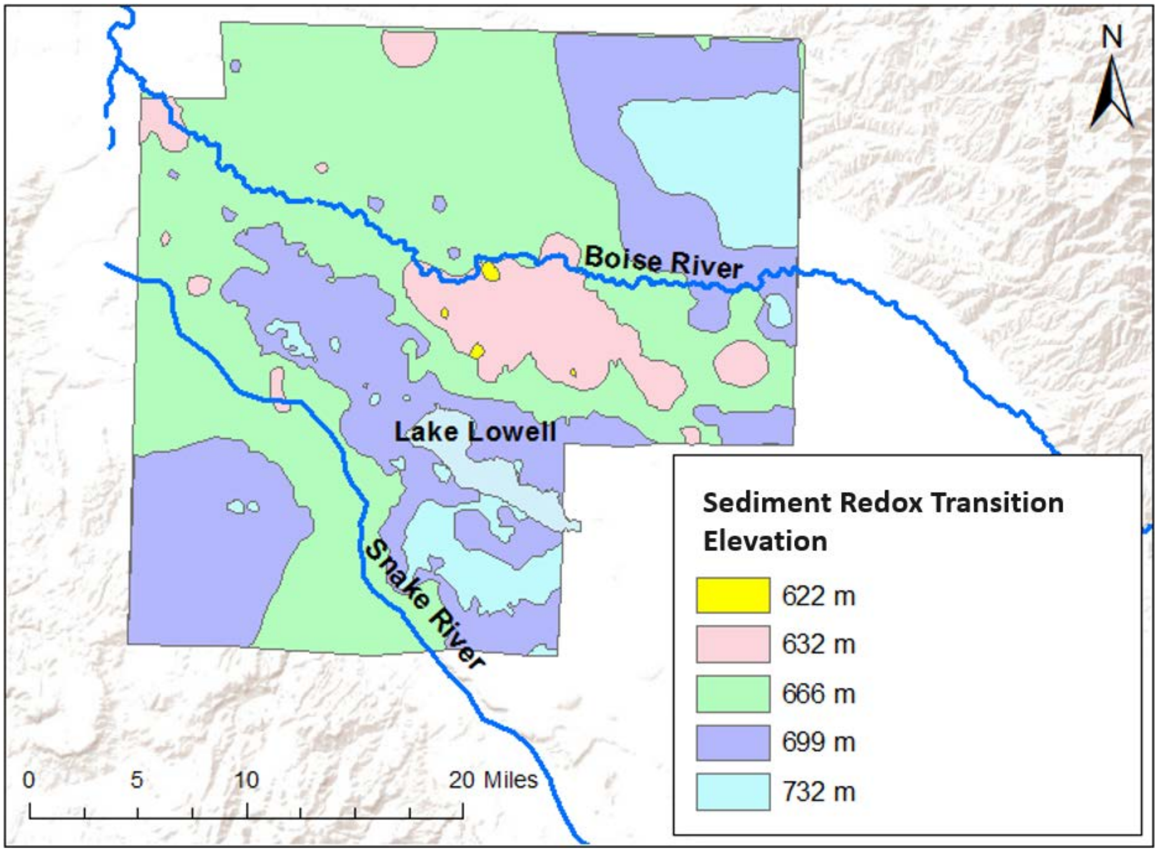

Figure 25 Treasure Valley Sediment Redox Transition. Map of the Treasure Valley Sediment Redox Transition, digitized from Busbee et al. (2009).

APPENDIX D

Idaho Department of Water Resources Statewide Ambient Ground Water Quality Monitoring Program SOP

Idaho Department of Water Resources

Standard Operating Procedures

for the Statewide Ground Water Quality Monitoring Program

Idaho Department of Water Resources

Hydrology Section

Effective Date:

05/29/2018

Table of Contents

General Information **1**

Purpose 1

Summary of Procedures 1

Safety 1

Equipment and Supplies 2

Procedures **2**

Ground Water Level Measurements 2

Encountering Stuck Electrical Tape 3

Well Purging 4

Field Parameter Stabilization 5

Sample Collection 5

Unfiltered Samples 6

Filtered Samples 7

Other Samples 7

Storage of Samples 8

Shipping Ground Water Quality Samples 8

Mailing Field Notes 9

Quality Assurance/Quality Control **10**

Blanks and Replicate Samples 10

Table 1. Collecting QC Samples 11

Table 2. Labeling QC Samples 11

Field Forms and Other Documents **12**

Attachment A (IDWR Field Safety Guidelines) 13

Attachment B (Sampling Equipment) 18

Attachment C (Ground Water Quality Field Notes) 19

Attachment D (Well Water Level Measurement Problem Documentation) 21

Attachment E (Methane Gas Analysis Using IsoFlask®) 22

Attachment F (Sample Submittal Form Example) 24

Attachment G (Shipping Form Example) 25

General Information

Purpose

The Idaho Department of Water Resources (IDWR) collects ground water quality samples across Idaho each year through its Statewide Ground Water Quality Monitoring Program (Statewide Program). This document outlines the standard operating procedures (SOPs) for collection of ground water samples as part of the Statewide Program, and also provides guidelines for measuring ground water levels in wells.

The Statewide Program was established in 1990 following The Ground Water Quality Protection Act of 1989. The main objectives set by this program include 1) characterizing ground water quality of the state's major aquifers, 2) describing trends and changes in ground water quality, and 3) identifying potential ground water quality problem areas.[1] Ground water quality data is processed and stored internally by IDWR, and provided to participating well owners. Data is also provided to the public through the Environmental Data Management System[2].

Summary of Procedures

Field technicians should follow procedures outlined in this SOP to collect ground water quality samples. Wells are purged for approximately 20 minutes using field parameters (e.g., pH, water temperature) as a guide to ensure water is coming from the aquifer and not stagnant water, and is unaffected by the well, borehole, or piping system. Ground water levels are measured in wells prior to purging; however, wells that are pumping should never be measured.

Samples are collected immediately after the well purging procedure is complete. Field technicians wear nitrile gloves and use Tygon® tubing[3] to collect samples in laboratory supplied bottles. Water samples may require filtration and/or the addition of a preservative. Samples are then stored on ice in coolers, and shipped or hand-delivered to the Idaho Bureau of Laboratories (Lab) for analysis.

Safety

Care should be taken when conducting field work to ensure injuries and property damage are avoided. Well sites can have electrically charged equipment which may include

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[1] https://www.idwr.idaho.gov/water-data/ground-water-quality/

[2] http://maps.idwr.idaho.gov/map/edms

[3] Disclaimer: Any reference in this SOP to a specific product does not constitute the endorsement of the product.

exposed wiring, motors, pumps, panels, fencing, and/or pivots. If a pump is operating, do not attempt to turn it off and avoid measuring ground water levels. IDWR's "Field Safety Guidelines" document (Attachment A) contains additional safety recommendations for general fieldwork.

In addition to general field safety, more specific safety concerns need to be considered when collecting water samples. Field technicians should be cautious when transporting and using preservatives such as nitric acid and sulfuric acid. Although preservatives have been diluted, most are still corrosive and can burn skin and/or clothing. Avoid carrying preservatives in clothing (i.e., in pockets) and dispose of empty vials after use.

Equipment and Supplies

Attachment B contains a list of equipment and supplies needed to conduct water quality sampling following IDWR Statewide Program SOPs. Preservatives and samples should always be stored on ice in coolers. Standards should be kept near room temperature. Transport standards in a cooler, keep out of the sun, and add/remove small blue ice packs to keep near room temperature if needed.

Procedures

Ground Water Level Measurements

Before purging a well, measure the static water level using an electric sounding tape (e-tape). The water table is best represented when static water levels are measured in a non-pumped well. Do not attempt to measure the water level in a well that is pumping because the e-tape could get stuck in the pump. If a pumping well is encountered, or if a pump turns on and impacts a water level measurement, note the status as "pumping" on the Field Notes (Attachment C).

Measurement Method:

1. Check previous field notes for information regarding potential problems measuring the well (e.g., depth at where tape gets caught, oil in the well). Note the previous water level and measuring point (MP). The measuring point is the location where every water level is measured from on the well and allows for water level measurements to be referenced to the same vertical datum. The MP is usually a point near the top of the well casing. If an MP is not indicated in the previous field notes, select a point at the top of the casing and document the location on the current Field Notes.

- Do not measure water levels in: 1) wells actively pumping, 2) irrigation wells, 3) wells with no access for an e-tape, and 4) wells where access or water level measurement is difficult to obtain.

2. Remove well cap by loosening and removing nuts and bolts.
3. Sanitize the e-tape probe and at least three feet above the probe with bleach solution.
4. Turn the knob on the e-tape to the Test setting to make sure the battery is good and the tape is working properly. Turn the knob to the Buzz setting. Set the sensitivity dial to the middle position.
5. Lower tape into well. Be aware of any responses that indicate the tape is not descending freely.
6. Slow descent of tape when anticipated water level is approaching.
7. When water is encountered, an audible beep will be heard and the indicator light will illuminate. Record the water level by reading the tape at the MP. If a reliable water level cannot be obtained with the sensitivity dial in the middle position, the dial can be adjusted up and down for additional measurement attempts.
    a. Make a check measurement. Retract tape about a foot and wait five minutes before lowering.
    b. If the second reading is within two hundredths of a foot (±0.02 ft.) of original reading, record this value. This is the final water level measurement value.
    c. If the second reading is more than ±0.02 ft. different than the first reading, pumping (decreasing water level) or pumping recovery (increasing water level) may be occurring. Wait five minutes for the water level to stabilize, and if it does, measure and record the water level as normal. If it does not stabilize, record one final measurement and indicate “pumping” or “recovering” on the Field Notes.
8. Retract the tape while maintaining a slow, steady pace. If resistance occurs, slow down and try to gently pull through it, moving up and down as needed.

When encountering a stuck e-tape:

1. If the tape gets stuck, try to pull on it firmly but not excessively. Use professional judgment as how much to pull.
2. If unsuccessful in freeing the tape, it may have to be cut and tied off at land surface. Call the Statewide Program manager for assistance. If given direction to cut the tape, or the manager cannot be reached and the cut needs to be made, determine where to tie it (e.g., around the well, on a nearby feature).
3. Estimate how much tape is needed to make the tie. Cut the tape at the length determined, holding on as the cut is made so the tape doesn’t fall into the well.
4. Tie the cut end of the tape to the location identified in step 2.

5. Report the situation to the owner ensuring that the well is still operational and that the stuck tape does not pose a hazard to humans or the well's operation. Inform owner that IDWR will be in contact with them to resolve the situation.

> 💧 Contact Craig Tesch (208-287-4970) immediately. Complete the form for Well Water Level Measurement Problem Documentation (Attachment D) and provide a copy to Craig Tesch as soon as possible.

Well Purging

Wells sampled in the Statewide Program are equipped with a pump, or flow naturally under artesian pressure. Purging is the process of pumping water from a well prior to sampling to ensure the collected sample is representative of ground water from the aquifer and not stagnant water, and is unaffected by the well, borehole, or piping system. This process will typically take field samplers 20-30 minutes. If the well is pumping on arrival, the purging process may only take 15 minutes.

Purge Method:

1. Determine which hydrant should be used for sampling. Homeowners or previous field notes can direct field samplers to the correct hydrant. If the correct hydrant is unknown, use the following rules to guide hydrant selection:
   a. Always sample from a hydrant supplying water that has not previously passed through water treatment or pressure tank systems. If an acceptable hydrant is not available, call the Statewide Program manager for assistance. If the manager cannot be reached, skip the site and await further guidance.
   b. When multiple options exist for the above rule (a), select the hydrant closest in proximity to the wellhead.
   c. If the homeowner requests a particular hydrant, sample from the requested hydrant if rule (a) above is satisfied regarding water treatment and pressure tank locations.
2. Attach a 2-way splitter to the hydrant. Attach a hose to one end of the splitter, with the other end being used to attach Tygon® tubing for sampling.
3. Turn on water and adjust flow as necessary in order to have a steady, moderate discharge. Route water away from the well to avoid creating muddy conditions or impacting the homeowner's property.
4. On the Field Notes, record the time well purging began.
5. Calibrate field equipment (pH, specific conductance, and dissolved oxygen meters) per manufacturer's instructions. The pH probe contains the temperature sensor. Place the probes for each field instrument in the flow-through chamber.

6. Record water temperature, specific conductance, pH, and dissolved oxygen measurements every five minutes, as follows:

Field Parameter Stabilization

Field Parameter	**Stability Criteria**
Temperature (in degrees Celsius)	±0.2 °C
Specific Conductance (SC) (microseimens µS/cm)	±5% for SC ≤ 100 µS/cm ±3% for SC > 100 µS/cm
pH (standard units)	±0.1 unit
Dissolved Oxygen (DO) (mg/L)	±0.3 mg/L

7. When readings stabilize over **three consecutive measurements (**using the above “Stability Criteria”), record final values on the Field Notes and proceed with sample collection. Record the time of sampling on the Field Notes. If readings do not stabilize after 30 minutes, note on the Field Notes, and proceed with sampling.

- Due to excessive quantities of water generated from purging, maximum purge time should not exceed 30 minutes to protect landowner interests.

Sample Collection

Sampling techniques described in the following sections are designed to minimize effects on the chemical and physical integrity of the sample. Adherence to these procedures helps provide a representative sample of ground water, and high quality data for the Statewide Program.

Collection Method:

1. Set up a clean folding table near the sampling point to prepare samples and keep other work materials off the ground.
2. Transport sampling bottles and equipment (splitter, Tygon ® tubing) in a clean cooler to the sampling table. Always transport sampling bottles in a clean cooler. Only remove bottles from cooler to label bottles, preserve bottles, and collect samples; immediately place them back in the cooler when not handling them and after sample collection. Bottles should never touch the ground, or come in contact with foreign surfaces or objects.

3. Use disposable nitrile gloves when labeling, preserving, and collecting all water samples.
    a. If two or more people are working together, separate tasks to minimize chance of sample contamination.

    b. If working alone, change gloves frequently, especially between tasks of collecting and preparing the sample.
4. Do not allow the bottle rims, or the inside of the bottle caps, to touch anything, including fingers, ground, Tygon® tubing, hydrant, etc.
5. Prepare sample bottles. Using a permanent marker, label both the isotope and methane bottles (if required) with date, station name, sample time, and field sampler's initials. The remaining bottles constitute what is termed a "bottle kit", which covers a standard suite of constituents analyzed for each site every year in the Statewide Program. Isotope and methane samples are not collected at every site, and are not part of the standard "bottle kit". Using a permanent marker, label one of the remaining sample bottles in the bottle kit with date, station name, sample time, and field sampler's initials.
6. Attach Tygon tubing to the 2-way hose splitter. Direct and maintain a low level flow to the Tygon ® sample tubing. Let water run through tubing for a few seconds before collecting sample.

> 💧 If sampling from the Tygon® tubing is not possible, remove the hose splitter and collect samples directly from the hydrant. If neither method is possible, use discretion in choosing a sampling point. If alternative methods are used, document on Field Notes.

7. Ensure all samplers are wearing nitrile gloves. Collect water samples by filling supplied laboratory bottles from the Tygon® tubing that is attached to the hose splitter. Use the following bottle-specific collection methods, collecting unfiltered samples before filtered samples:

i. Unfiltered Samples (Part of the bottle kit)

a) Common Ions Sample Bottle (No label, 250 mL plastic)
- Triple rinse the unlabeled, 250mL plastic bottle with native water before collecting sample.
- Fill sample bottle after rinsing, leaving a small amount of headspace to facilitate mixing in lab, cap bottle tightly.

b) Nutrients Sample Bottle (Yellow label, 500 mL plastic)

- Triple rinse yellow-labeled plastic sample bottle with native water before collecting sample.
- Fill sample bottle after rinsing, leaving about an inch of headspace.
- Add sulfuric acid (H_2SO_4) to sample, inverting several times to mix, and cap bottle tightly.

c) Pesticides and Emerging Contaminants Bottle (No label, Amber glass)

- Do not rinse.
- Fill amber glass bottle, leaving about an inch of headspace, and cap bottle tightly.
- Keep amber glass bottles out of direct sunlight.

d) BPA Sample Bottle (Green label, Amber glass)

- Do not rinse.
- Fill the sample bottle halfway, leaving space to add the pre-measured methanol.
- Pour methanol preservative (6 mL vial) into sample bottle.
- Cap tightly and invert bottle several times to mix well.

ii. Filtered Samples (Part of the bottle kit)

a) Metals Sample Bottle (Red label, 500 mL plastic)

- Attach disposable filter to the Tygon® tubing.
- Triple rinse the red-labeled, 500 mL plastic sample bottle by filling it with a small amount of filtered sample water, replacing the cap, and shaking to rinse.
- Fill sample bottle after rinsing, leaving about an inch of headspace.
- Add nitric acid (HNO3) preservative to the sample. Invert bottle several times to mix.
- Cap bottle tightly, dispose of filter.
- In rare cases, it is not possible to attach the hose splitter to a sampling hydrant or discharge point, and therefore, Tygon® tubing and a filter cannot be used. If this happens, collect the sample following the steps above without the filter, recording it on the Field Notes, and informing the Lab that lab filtering is required.

iii. Other Samples (Not part of the bottle kit)

Select sites may require additional samples besides those in the bottle kit listed above. These extra samples will be communicated to field samplers by project management and denoted on the Field Notes.

a) **Methane Sample Bottle (IsoFlask®)**
   - See Attachment E for detailed instructions on sampling with an IsoFlask®
   - After sample is collected, store sample lying flat by returning IsoFlask® to its protective box.

b) **N15 Isotope Sample Bottle (No label, 500 mL plastic)**
   - Triple rinse the unlabeled, 500 mL plastic bottle with native water before collecting sample.
   - Fill bottle about 75% full, unfiltered, leaving headspace for water expansion during freezing.

8. Place all sample bottles, except methane and isotope bottles, into one Ziploc® bag. Isotope and methane bottles will be stored separately, and not in Ziploc® bags. Affix site-specific bar code sticker to the Ziploc® bag and place inside of a second Ziploc® bag.

9. Rinse Tygon® tubing and hose splitter with deionized water before they dry and while wearing nitrile gloves. Store tubing and splitter in sealed bag to keep away from potential sources of contamination.

Storage of Samples:

1. Bagged samples (“bottle kits”) and isotope samples are stored in a cooler with adequate ice to keep cool until received at the Lab.
2. When possible, isotope samples should be stored in a freezer. Opportunities for freezing include the IBL freezer prior to transport to IDWR, or in IDWR’s chest freezer.
3. Methane samples are stored flat in their original protective box, and are not required to be kept cool. However, storing sample(s) in a cooler or box without ice will help secure them during travel.

Shipping and Submitting Ground Water Quality Samples

Secure, timely shipping and submittal of water samples is a critical component of quality data.

Shipping Method:

1. Place bagged bottle kits, N15 samples, and methane samples in cooler(s). If the bottles are handled, or tightness of caps are checked on bottles before shipping, wear nitrile gloves. Amber glass bottle caps sometimes break easily.

Caps should be tightened firmly, but not excessively.

2. Ice should be packed around the samples using either plastic bottles of frozen water (preferred method), well-frozen ice-substitute packs (e.g., blue ice), or ice cubes in Ziploc® bags. Samples are to be shipped with enough ice to keep samples chilled for 24 hours.
3. Add packing material around the bottles to avoid breakage.
4. Place Sample Submission Forms (Attachment F) for all sites in a one-gallon Ziploc® bag. Place a return label in another Ziploc® bag and put it in the Ziploc® bag containing the Sample Submission Forms. Tape the one-gallon Ziploc® bag to the inside of the cooler lid with strapping tape. Close the cooler's lid and tape the lid with strapping tape. Ship on Monday through Thursday mornings.
5. All ground water samples are to be sent to the Idaho Bureau of Laboratories, 2220 Old Penitentiary Road, Boise, ID, 83712.
6. Samples should be shipped using FedEx throughout the state, or Go-Fer It Express in Twin Falls. If using FedEx, IDWR State Office will provide pre-labeled shipping forms (i.e., Attachment G). If using Go-Fer It Express service, use IDWR's account number 2179. Pick up and billing for Go-Fer It Express can be done on the website: http://www.goferitexpress.com/
7. The Lab will ship empty coolers back to the field teams.

Local Submission Method:

1. Place bagged bottle kits, N15 samples, and methane samples in cooler(s). If the bottles are handled, or tightness of caps are checked on bottles before packing, wear nitrile gloves. Amber glass bottle caps sometimes break easily. Caps should be tightened firmly, but not excessively.
2. Ice should be packed around the samples using either plastic bottles of frozen water (preferred method), well-frozen ice-substitute packs (e.g., blue ice), or ice cubes in Ziploc® bags. Samples are to be submitted with enough ice to keep samples chilled for 24 hours.
3. Place Sample Submission Forms for all sites in a one-gallon Ziploc® bag. Tape the one-gallon Ziploc® bag to the inside of the cooler lid with strapping tape.
4. Hand-deliver all ground water samples Monday through Friday to the Idaho Bureau of Laboratories, 2220 Old Penitentiary Road, Boise, ID, 83712.

Mailing Field Notes

Field Notes should be sent to the Statewide Program manager to help track sampled wells.

1. Photocopy or create PDFs of all completed Field Notes before mailing. Keep the photocopies until you receive word that the originals have been received.
2. Each Monday, mail the completed Field Notes from the previous week's sampling to:

Craig Tesch
Idaho Department of Water Resources
322 E. Front Street
Boise, ID 83720

3. At the end of each month, mail any additional paperwork (copies of sample submission forms, previous field notes, shipping receipts, etc.) for completed sites to the address above.

Quality Assurance/Quality Control

Decontaminating Field Equipment

Field equipment must be kept clean and organized to prevent contamination and cross-contamination of ground water samples.

General Guidelines

Field meters (pH, conductivity, and dissolved oxygen) should be kept in the provided carrying case(s). Other sampling equipment (hose splitter and Tygon® tubing) should be stored in plastic bags and away from sources of contaminants (dust, fumes), and only be handled with gloved hands.

The ends of the pH and DO probes should be stored in their respective storage containers. The pH storage container should be kept filled with electrolyte solution or pH 7 standard solution. The DO storage container should have enough water to keep the yellow sponge moist. The end of the conductivity probe can be stored in open air. When calibrating the pH and conductivity meters, rinse the probes with deionized water before calibrating, and in-between calibration standards.

Sample bottles should be stored and transported in a clean cooler. Only remove bottles from the cooler to label bottles, preserve bottles, and collect samples; immediately place them back in the cooler when not handling them and after sample collection. Bottles and sampling equipment (e.g. hose splitter, Tygon® tubing) should never touch the ground. Use disposable nitrile gloves when collecting, labeling, preserving, and handling all water samples. Do not allow the bottle rims or the inside of the bottle caps to touch anything, including fingers, ground, Tygon® tubing, hydrant, etc. Replace bottles, filters, and/or gloves if contamination is suspected.

After sample collection, remove the filter and disconnect the Tygon® tubing from the splitter. Dispose of filter. Disconnect the hose from the splitter. Remove the splitter from the hydrant. Rinse the Tygon® tubing and the splitter with deionized water while wearing nitrile gloves.

Blanks and Replicate Samples

Quality Control (QC) samples are used to evaluate field and laboratory procedures. Fill and label each QC sample bottle according to the tables below at the same time as collecting the normal, non-QC samples. Follow standard sampling protocols to prevent contamination. Chill, store, and submit QC samples to the Lab with the non-QC samples.

Table 1. Collecting Blank and Replicate Samples

QC Type	Frequency	Analyte(s)	Procedure
Blank	1 per 33 samples (8 max for 280 samples)	All	Fill each sample bottle with filtered, certified, deionized water and preserve as though collecting a normal sample. Record the date/time deionized water was taken from the Lab's Millipore system.
Replicate (filtered)	1 per 20 samples (14 max)	Metals	Fill bottle for each replicate type with native water and add preservatives.
Replicate (unfiltered)	1 per 20 samples (14 max)	Common ions, nutrients, immunoassays	Fill bottle for each replicate type with native water and add preservatives.
Spikes	1 per 50 samples (6 max)	1 analyte per spike sample	Select bottle according to spike type. Fill bottle with deionized water and add spike vial.

Table 2. Bottle Labeling for QC Samples

QC Type	Alternate Station/Site ID Label	Time Notations	Field Form Notations
Blank	Station and Site ID with a "-1" on the end	Record time as 10 minutes later than actual sampling time.	In "Other Remarks" on Field Notes Sheet, write "Blank Sample" and the alternate Station/Site ID.
Replicates	Station and Site ID with a "-2" on the end	Record time as 5 minutes later than actual sampling time.	In "Other Remarks" on Field Notes Sheet, write "Replicate Sample" and the alternate Station/Site ID.
Spikes	Station and Site ID with a "-3" on the end	Record time as 5 minutes later than actual sampling time.	In "Other Remarks" on Field Notes Sheet, label "Spike Sample" and the alternate Station/Site ID.

APPENDIX E

Table 9. Replicate Results for Meridian Sampling Campaign

Analyte (mg/L)	Well 15b, z2					Well 16b, z3					Well 17, z1				
	Rep 1	Rep 2	Rep 3	Mean	% Error	Rep 1	Rep 2	Rep 3	Mean	% Error	Rep 1	Rep 2	Rep 3	Mean	% Error
Chloride	ND	ND	ND			20	19	19	19	2.99	5	5	5	5	0
Fluoride	0.3	0.3	0.3	0.3	0	0.2	0.2	0.2	0.2	0	0.4	0.4	0.4	0.4	0
Sulfate	4	4	4	4	0	78	78	78	78	0	ND	ND	ND		
Calcium	14.2	14	14.1	14.1	0.71	83.2	81.8	81.5	82.2	1.10	21	20.8	20.9	20.9	0.48
Magnesium	1.9	1.9	1.9	1.9	0	17.7	17.7	17.5	17.6	0.65	4.1	4	4	4	1
Potassium	0.9	0.9	0.9	0.9	0	2.2	2.3	2.3	2.3	2.5	5	4.9	4.9	4.9	1
Sodium	11.2	11.2	10.9	11.1	1.56	53.5	55.9	56.3	55.2	2.74	38.6	38.6	38.1	38.4	0.75
Nitrogen, Ammonia as N	0.09	0.09	0.09	0.09	0	ND	ND	ND			3.9	4	4	4	1
Arsenic	ND	ND	ND			ND	ND	ND			0.004	0.003	0.003	0.003	17.3
Cadmium	ND	ND	ND			ND	ND	ND			ND	ND	ND		
Copper	ND	ND	ND			ND	ND	ND			ND	ND	ND		
Iron	ND	ND	ND			ND	ND	ND			0.1	0.1	0.09	0.1	5.97
Manganese	0.078	0.078	0.077	0.078	0.74	ND	ND	ND			0.194	0.195	0.199	0.196	1.35
Selenium	ND	ND	ND			0.002	0.002	0.002	0.002	0	ND	ND	ND		
Silica	35	34.5	34.7	34.7	0.72	38.2	37.9	37.8	38.0	0.55	79.2	80.5	81.7	80.5	1.55
Uranium	ND	ND	ND			0.0623	0.0634	0.0623	0.0627	1.01	ND	ND	ND		
Nitrate as N	ND	ND	ND			2.59	2.59	2.59	2.59	0	ND	ND	ND		

ND: Not Detected

Table 9 continued. Replicate Results for Meridian Sampling Campaign

Analyte (mg/L)	Well 20, z3					Well 21, z1					Well 27, z1				
	Rep 1	Rep 2	Rep 3	Mean	% Error	Rep 1	Rep 2	Rep 3	Mean	% Error	Rep 1	Rep 2	Rep 3	Mean	% Error
Chloride	4	4	4	4	0	13	13	13	13	0	ND	ND	ND		
Fluoride	0.2	0.2	0.2	0.2	0	0.2	0.2	0.2	0.2	0	0.3	0.3	0.3	0.3	0
Sulfate	17	17	17	17	0	41	41	41	41	0	3	3	3	3	0
Calcium	27.5	27.1	27.4	27.3	0.76	36.9	37.3	37	37	0.6	11.5	11.5	11.8	11.6	1.49
Magnesium	4.7	4.7	4.7	4.7	0	7	7.2	7.3	7.2	2.1	1.1	1.1	1.2	1.1	5.09
Potassium	1.2	1.2	1.2	1.2	0	2.2	1.9	1.9	2	8.7	0.9	0.9	0.9	0.9	0
Sodium	11.5	11.4	11.4	11.4	0.50	19	18.1	17.6	18.2	3.9	17.6	17.6	17.7	17.6	0.33
Nitrogen, Ammonia as N	ND	ND	ND			0.62	0.63	0.63	0.63	0.92	0.32	0.34	0.34	0.33	3.46
Arsenic	ND	ND	ND			ND	ND	ND			ND	ND	ND		
Cadmium	ND	ND	ND			ND	ND	ND			ND	ND	ND		
Copper	ND	ND	ND			ND	ND	ND			ND	ND	ND		
Iron	ND	ND	ND			0.17	0.16	0.16	0.16	3.5	ND	ND	0.06	0.06	
Manganese	ND	ND	ND			0.211	0.205	0.202	0.206	2.22	0.089	0.089	0.09	0.089	0.65
Selenium	ND	ND	ND			ND	ND	ND			ND	ND	ND		
Silica	33.6	33.7	33.9	33.7	0.45	39.4	35.5	35.6	36.8	6.04	37.9	37.8	38.5	38.1	0.99
Uranium	0.0017	0.0017	0.0017	0.0017	0	ND	ND	ND			ND	ND	ND		
Nitrate as N (mg/L)	0.332	0.326	0.326	0.328	1.06	ND	ND	ND			ND	ND	ND		

ND: Not Detected

Table 9 continued. Replicate Results for Meridian Sampling Campaign

Analyte (mg/L)	Well 28, z2					Well 28, z3				
	Rep 1	Rep 2	Rep 3	Mean	% Error	Rep 1	Rep 2	Rep 3	Mean	% Error
Chloride	8	8	8	8	0	8	8	8	8	0
Fluoride	0.3	0.3	0.3	0.3	0	0.3	0.3	0.3	0.3	0
Sulfate	20	20	20	20	0	20	20	20	20	0
Calcium	26	25.9	26.2	26	0.59	24.7	25.3	26	25	2.6
Magnesium	0.8	0.8	0.7	0.8	7.5	2.1	2.4	2.4	2.3	7.5
Potassium	1	0.9	0.8	0.9	11	1.2	1.4	1.2	1.3	9.1
Sodium	39.6	40.3	40.2	40.0	0.95	38	40.6	42	40.2	5.0
Nitrogen, Ammonia as N	0.35	0.34	0.34	0.34	1.7	0.11	0.11	0.11	0.11	0
Arsenic	ND	ND	ND			ND	ND	ND		
Cadmium	ND	ND	ND			ND	ND	ND		
Copper	ND	ND	ND			ND	ND	ND		
Iron	ND	ND	ND			ND	ND	ND		
Manganese	0.033	0.033	0.034	0.033	1.732	0.055	0.054	0.054	0.054	1.1
Selenium	ND	ND	ND			ND	ND	ND		
Silica	30.7	27.7	27.4	28.6	6.38	28.4	29.1	30.1	29.2	2.9
Uranium	ND	ND	ND			ND	ND	0.0003	0.0003	
Nitrate as N	ND	ND	ND			ND	ND	ND		

ND: Not Detected

Table 10. Field Blank Results for Meridian Sampling Campaign

Analyte (mg/L)	**Well 14**	**Well 17**	**Well 18**	**Well 19**	**Well 24**	**Well 26**	**Well 27**	**Well 28**
	z1	**z2**	**z2**	**z1**	**z3**	**z2**	**z2**	**z3**
Chloride	ND	ND	ND	ND	ND	ND	ND	ND
Fluoride	ND	ND	ND	ND	ND	ND	ND	ND
Sulfate	ND	ND	ND	ND	ND	ND	ND	ND
Calcium	ND	ND	ND	ND	ND	ND	ND	ND
Magnesium	ND	ND	ND	ND	ND	ND	ND	ND
Potassium	ND	ND	ND	ND	ND	ND	ND	ND
Sodium	ND	ND	ND	ND	ND	ND	ND	ND
Nitrogen, Ammonia as N	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	ND	ND	ND	ND	ND	ND	ND	ND
Copper	ND	ND	ND	ND	ND	ND	ND	ND
Iron	ND	ND	ND	ND	ND	ND	ND	ND
Manganese	ND	0.002	ND	ND	ND	ND	ND	ND
Selenium	ND	ND	ND	ND	ND	ND	ND	ND
Silica	ND	ND	ND	ND	ND	ND	ND	ND
Uranium	ND	ND	ND	ND	ND	ND	ND	ND
Nitrate as N	ND	ND	ND	ND	ND	ND	ND	ND

ND: Not Detected