Source Water Discovery
Lesson Plan

Grade Level
8-12

Time Required

To complete the lesson plan as written requires two class periods, plus homework for the students. The first lesson introduces source water core concepts, and the second lesson introduces and begins the assessment worksheet. The lesson plan can be easily modified or shortened to accommodate different schedules or levels of involvement.

Objective

Students learn about source water and related concepts by using the Idaho Department of Environmental Quality's (DEQ's) Source Water Assessment Online tool.

Focus

Source water; source water assessment; source water protection; natural and man-made contaminants; ground water; surface water; aquifers; hydrogeology; geographic information system (GIS). Students complete the assessment worksheet by navigating through DEQ's Source Water Assessment Online tool. The exercise encourages an understanding of various environmental and hydrogeologic concepts while interacting with an online mapping application, GIS layers, and the components of a source water assessment report. Students are challenged to learn a new tool, follow directions, think critically, and learn about where drinking water comes from, its vulnerability, and the value of protection.

Materials

Computer and Internet access
Worksheet

Background

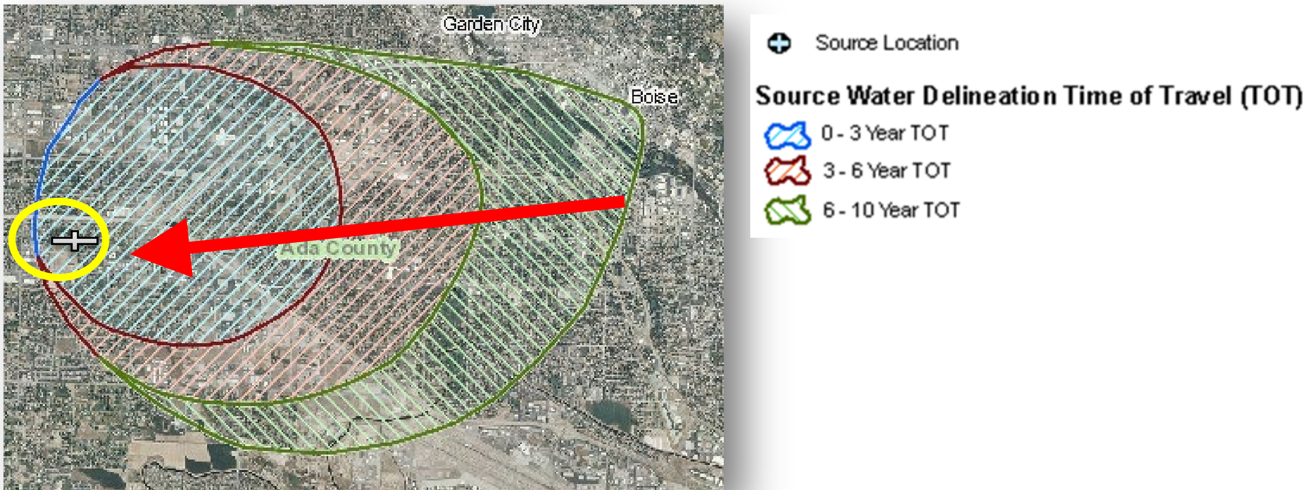
Source water is the untreated ground water (aquifers and springs) and surface waters (rivers, streams, and lakes) used to supply drinking water for private, domestic wells and public water systems. Ground water and surface water used for drinking water supplies are often vulnerable to contamination from land use practices (such as farming) and potential contaminant sources (such as gas stations) within the vicinity of drinking water wells and intakes.

Ninety-five percent of Idahoans receive their drinking water from a ground water source. Ground water replenishes our streams and rivers and provides fresh water for irrigation, industry, and communities. When large quantities of ground water fill all of the spaces between rocks and sediment, the combination of geologic material and ground water is called an aquifer. In an aquifer, ground water can move sideways, up, or down in response to gravity, differences in elevation, differences in pressure, and differences in the physical properties of the aquifer. Depending on the aquifer, the water can move from very fast (as much as hundreds of feet per day in fractured rock aquifers) to very slow (as little as a few feet per year in very fine-grained, sedimentary aquifers). Approximately 70 major aquifers have been identified in Idaho. These aquifers are found throughout the state (Appendix A).

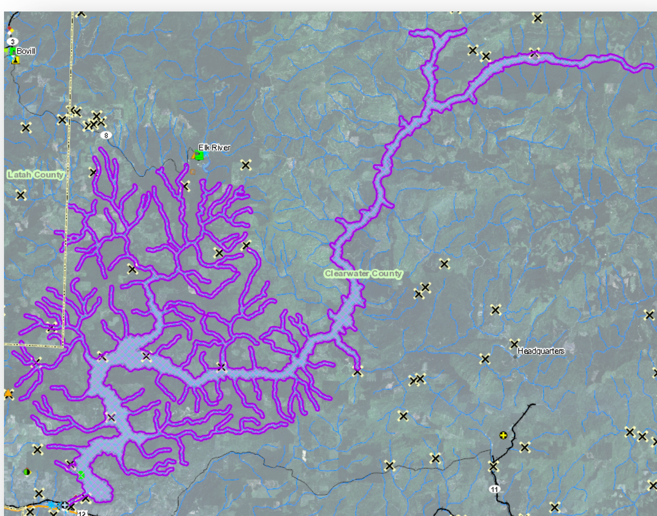
A source water assessment provides information on the potential contaminant threats to public drinking water sources (wells, springs, and surface water intakes). As required by the Safe Drinking Water Act, assessments of all recognized public water sources in Idaho have been completed by DEQ. Each source water assessment report addresses the following:

- Defines the zone of contribution or delineation, which is that portion of the watershed or subsurface area contributing water to the well or surface water intake. Examples of delineations are provided below:
    1. Fixed radius delineation—Used for transient systems or systems that serve different people through the year. It typically has one time-of-travel zone (TOT) that equals a 1,000 foot radius. Often campgrounds meet the definition of a transient system and have a fixed radius delineation.

2. Refined analytical delineation—Used for community systems or nontransient systems that serve at least 25 people for a certain amount of time throughout the year. It typically has three TOT zones that indicate how the water is moving towards the well in 3-, 6-, or 10-year TOT zones. Systems that serve homes, businesses, and schools are examples of a refined analytical delineation.



3. Surface water delineation—Includes systems that use surface water intakes located in lakes, rivers, and creeks. Depending on the source, a buffer of a certain length and distance will be used around the water body extending from the intake.



- Identifies the man-made and natural potential sources of drinking water contamination in those areas (potential contaminant source inventory).
- Determines the likelihood that the water supply will become contaminated (susceptibility analysis). For each well, spring, or surface water intake in a public water system,

susceptibility to contamination is scored as high, moderate, or low. Susceptibility scores take into account (1) construction of the well, spring, or surface water intake; (2) land use characteristics within the delineation and potentially significant contaminant sources; and (3) hydrologic and geologic conditions surrounding the well, spring, or surface water intake.

Source water assessments are the cornerstone for source water protection. Local communities can use the information gathered through the assessment process to create a broader source water protection program to address current problems and prevent future threats to the quality of their drinking water supplies.

Although the quality of ground water in Idaho is generally good, ground water quality monitoring shows that in specific areas of the state, Idaho's ground water has been significantly degraded. This localized degradation negatively impacts water quality and potentially threatens domestic water supplies, aquaculture, agriculture, mining, industry, and other ground water beneficial uses.

Nitrate is one of the contaminants responsible for this degradation and is one of the most widespread ground water contaminants in Idaho. Nitrate is a form of nitrogen, an element whose compounds are vital components of foods and fertilizers. It is an essential nutrient for plant growth. Nitrate comes from a variety of sources, such as plants and other organic matter that return nitrate to the soil as they decompose. Septic sewer systems, waste from animal feedlots, and nitrogen-based fertilizers also discharge nitrates to the environment.

Nitrate that is not used by plants can build up in and move through the soil. Precipitation, irrigation, and sandy soils (and highly fractured rock) allow nitrate to move around and find its way into surface water and ground water. While nitrate is just one of the potential ground water contaminants in Idaho, more is known about nitrate in ground water in Idaho than other contaminants. In addition, the presence of nitrate is a good indicator of other potential water quality problems.

As part of DEQ's goal of restoring degraded ground water, DEQ has developed a list of degraded ground water areas. This list focuses on nitrate and ranks the nitrate-degraded areas (referred to as *nitrate priority areas*) in the state based on the severity of the degradation. Areas are ranked based on criteria such as population, existing water quality, water quality trends, and other factors. The process also takes into account impacts on beneficial uses other than water supply.

Vocabulary

An aquifer is a natural underground area where large quantities of ground water fill the spaces between rocks and sediment. According to the Idaho "Ground Water Quality Rule" (IDAPA 58.01.11.007.02), to be considered an aquifer in Idaho, the area must produce "economically significant quantities of water to wells and springs."

Delineation (delineate) is the process of defining or mapping the boundary of the area that contributes water to a particular water source (well, spring, and surface water intake) used as a public water supply. Delineations can vary in size and shape depending on the analytical method used, type of water source, the influence of recharge from surface water and precipitation, and the ability of ground water to move through the aquifer media (hydraulic conductivity).

GIS (geographic information system) is a collection of computer hardware, software, geographic data, and interactive maps used to efficiently capture, store, update, analyze, and display the delineation and potential contaminant sources for source water assessments.

A GIS layer is a set of geographic data organized by subject matter, such as right-of-ways, rivers, or political boundaries.

Ground water is water beneath the earth's surface. It is the water that fills the natural open spaces in soil and rocks underground in much the same way as water fills a sponge. It can be found at various depths at any location beneath the earth's surface.

Ground water flow is the movement of ground water through openings in sediment and rock that occurs in the zone of saturation. This flow is typically under the influence of gravity and pressure.

Hydraulic conductivity is a term used to characterize an aquifer. In simple terms, it is the measure of how easy or hard it is for water to move through soil or rock (subsurface geologic material). If water can move though a soil or subsurface material easily, the soil or material has a high hydraulic conductivity. If it is difficult for water to move through a soil, the soil has a low hydraulic conductivity. An in-depth explanation of hydraulic conductivity is that it is a function of properties of both the porous medium (how interconnected the pore spaces are) and the fluid passing through it. The movement is measured by length and time, and the units commonly used are feet per day or meters per day (Fetter 1994).

DEQ conducts a potential contaminant inventory (PCI) to locate and describe facilities, land uses, and environmental conditions within the source water assessment delineation that are potential sources of contamination to ground water or surface water. PCI is one of three factors used in the susceptibility analysis to evaluate the overall potential contamination risk to a drinking water supply. During the first PCI phase, known as the primary contaminant inventory, DEQ staff use computer databases and GIS maps created by DEQ to identify and document potential contaminant sources within the water system’s source water assessment delineation. During the second PCI phase, known as the enhanced inventory, DEQ contacts the water system to review the list of potential contaminants identified in the first phase and add any additional potential contaminants not already identified. (Appendix B provides a list of potential contaminants.)

A public water system (PWS) supplies drinking water to at least 25 people or has at least 15 service connections.

Springs are ground water that flows to the surface of the earth from underground.

Source water is defined as any aquifer, surface water body, or watercourse from which water is taken either periodically or continuously by a public water system for drinking or food processing purposes. Simply, source water is drinking water prior to reaching the public water system.

Source water assessments summarize the likelihood of individual drinking water sources becoming contaminated (usually a short-term *contamination event*) and serve as a foundation for public water systems to prepare source water (drinking water) protection plans and implement protection measures. Each source water assessment report defines the delineation, identifies the significant potential sources of drinking water contamination in those areas, and determines the likelihood that the water supply will become contaminated.

DEQ's Source Water Assessment Online tool provides access to source water assessment reports including the potential contaminant inventory, susceptibility report, and delineation, which can be viewed through an interactive mapping application.

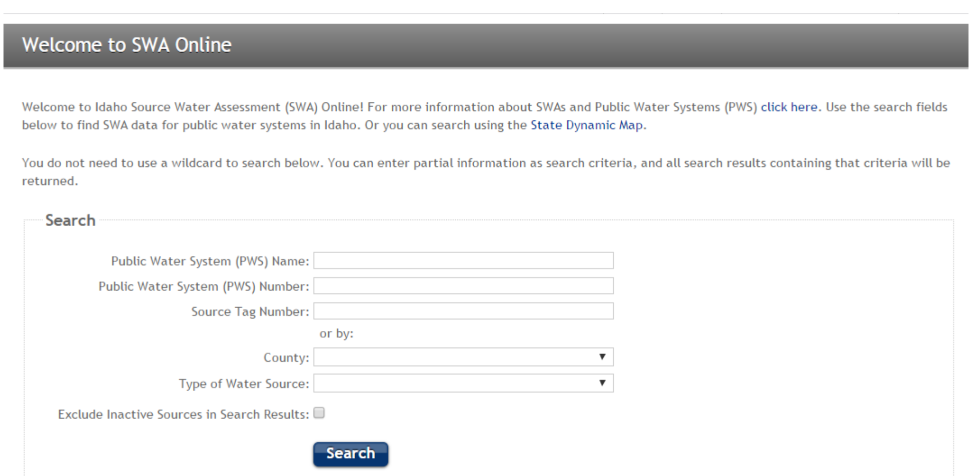
Source water protection refers to regulatory and nonregulatory measures used to protect source water, such as agricultural best management practices, education campaigns, land use ordinances, and septic system construction regulations.

A susceptibility score (susceptibility analysis) determines the likelihood that the water supply will become contaminated.

Transmissivity (transmissive) is a measure of the amount of water that can be transmitted (conveyed or moved) horizontally through a unit width by the full saturated thickness of the aquifer under a hydraulic gradient of 1. So, the transmissivity is the product of the hydraulic conductivity and the saturated thickness of the aquifer. Aquifer transmissivity is a concept that assumes flow through the aquifer to be horizontal. In some cases, this is a valid assumption; in others, it is not (Fetter 1994).

Procedure

1. Teacher: Navigate to *http://www2.deq.idaho.gov/water/swaOnline/Search*. Consider navigating through the tool, prior to beginning the assignment so you can answer questions if students get stuck. Use the search options to locate a public water system.



Once you locate the public water system of interest, five links allow navigation to various parts of the source water assessment including the susceptibility summary and scoring detail, the table of potential contaminants, a dynamic map of the delineation and surrounding potential contaminants (note the tool bar, layers, and legend), a similar static map, and a comprehensive summary of the entire source water assessment.

PWS #	PWS Name	Source Name	County					
ID1050003	CAMP SANDERS	WELL #1	BENEWAH	Susceptibility Summary	Potential Contaminants	Dynamic Map	Static Map	Summary Report

2. Provide students background information on key concepts. Before handing out the assignment, provide students with the URL and encourage them to navigate through the website, particularly the Dynamic Map.

3. Split the class into four groups (optional). Assign each group (or student) one of the following public water system numbers and source name (feel free to deviate if you have other public water systems in mind or have students use the system supplying water to their own home):

   a. PWS #: 4010016 Source Name: Victory Well – Treasure Valley Aquifer
   b. PWS #: 5270011 Source Name: Marshall Well – Eastern Snake River Plain Aquifer
   c. PWS #: 2350015 Source Name: Well 4 – Lewiston Basin Aquifer
   d. PWS #: 1280123 Source Name: Well 2 – Rathdrum Prairie Aquifer

   Each drinking water source assigned to students is located within one of four major aquifers in Idaho. After assigning the public water systems, have the students work independently or in pairs (or in larger groups) to complete the assessment worksheet beginning with determining which aquifer their source is located in. They can use the dynamic map and its tool bar to zoom out and find the closest city or county. They can then research Idaho aquifers online and compare the location of their source with the locations of the various aquifers (see *http://www.deq.idaho.gov/water-quality/ground-water/aquifers.aspx* or Appendix C). If the characteristics and locations of the various Idaho aquifers have already been covered in lecture, students can refer to their class notes.

4. Using the Map Legend, identify the number of time-of-travel (TOT) zones. As discussed earlier, TOT may vary depending on what type of source it is and what the geographical features surrounding the source are. For example, transient sources will only have one TOT zone due to the nature of who is served, but community sources likely have two or three TOT zones. The Dynamic Map should default to the view with the Source Water Delineation (TOT) layer on, but remind students to verify that the appropriate GIS layers are turned on (or off).

5. Which direction is ground water flowing? Ground water flow always moves towards a well or spring, beginning at the 10-year TOT zone towards the well. Pumping the well can affect the direction of ground water flow near the well, which can be observed very close to the well, where the 0–3 year TOT indicates the ground water is moving *backwards* compared to the regional flow direction from the 10-year TOT.

6. Describe or draw the shape of the delineation and what that could mean about the aquifer. The shape of the delineation can indicate how fast ground water is moving and from what direction, how deep the aquifer is, and the influence of surface water, if any. Students can brainstorm what they think is happening or they may use their knowledge of the aquifer and its properties. For example, if the delineation is long and skinny or narrow, the aquifer supplying the water may have a higher hydraulic conductivity or may be more transmissive compared to a short and wide delineation.

7. Is this source (source location or delineation) located within a Nitrate Priority Area (NPA)? This question requires students to use the *Map Legend* tab to turn on the NPA GIS coverage, and use the legend tab to answer the question. If the concept of an NPA has not been discussed, direct students to conduct their own research to learn about NPAs: *http://www.deq.idaho.gov/water-quality/ground-water/nitrate.aspx*.

8. What is the predominant Land Use for each TOT? This question requires students to use the *Map Legend* tab to turn on the Agriculture Land Use GIS coverage and use the legend tab to answer the question.

9. Using the *zoom in* tool, zoom to the 0–3 year TOT. List all Potential Contaminant Sources within the 0–3 TOT. This requires students use to the *Potential Contaminant Inventory Locations* section of the Map Legend tab. Students may want to turn off the Source Water Delineation (TOT) temporarily to more easily see the potential contaminant symbols. They can also use the Potential Contaminant Inventory link in the Source Water Assessment Online tool main page to compare findings from the Dynamic Map. This section provides a table with all of the potential contaminants listed and the TOT zone within which they are located.

10. a. Identify the closest potential contaminant to the source by using the *Identify* tool and the PCI Location tab;
    b. Using the *Hotlink*, describe the source of contamination and why it might be a concern.

11. Roads, surface water bodies, and railroads can be potential sources of contamination to source water. Are there any of these potential contaminant sources within the TOT zones? Students must turn on the appropriate layers by using the *Map Legend* tab to identify these sources. Students should understand that even natural features such as surface water bodies can impact source water.

12. Using the Summary Report in the Source Water Assessment Online tool, identify the final Susceptibility Scores for this source. Students must return to the main Source Water Assessment Online tool web page where they accessed the Dynamic Map, and view the Summary Report to find the appropriate Susceptibility Score table.

13. If the source has any *Auto High* ratings for its final ranking, select *Click for Details* in the Susceptibility Score table and describe what led to the automatic high susceptibility score. (Hint: Is it a source or a detected contaminant?) Sources are ranked as Auto High if there is a source (e.g. livestock, septic tank, or canal) within 50 feet of a well, 100 feet of a spring, or

within 1,000 feet of the surface water intake, or if there is a confirmed detection of the following types of analytes: volatile organic compounds (VOC), synthetic organic compounds (SOC), or Microbe, or an inorganic compound (IOC) detection over the maximum contaminant level (e.g., a nitrate detection of 10 milligrams per liter or higher) at the source.

14. Ask students to split into the four groups they were assigned (if applicable) for a short discussion of their results. Ask them to write down characteristics of their assigned source, delineation, and aquifer including the significance of nearby potential contaminants and how that affected its susceptibility score. Ask one or two students from the group to present their findings in front of the class. You may also want to ask them to discuss options for mitigation if their source received an Auto High susceptibility score or what protection measures the public water system could implement to prevent contamination of their source water.

Questions for Discussion

1. What can the type of land use within the source's delineation tell us about the susceptibility of the source?
2. Why did some delineations only have one or two TOT zones rather than three? (Hint: Was there a geologic or hydrologic feature that intercepted the delineation?)
3. What are protection measures that local governments, public water systems, businesses, and individuals could take?

Additional Resources on DEQ's Website

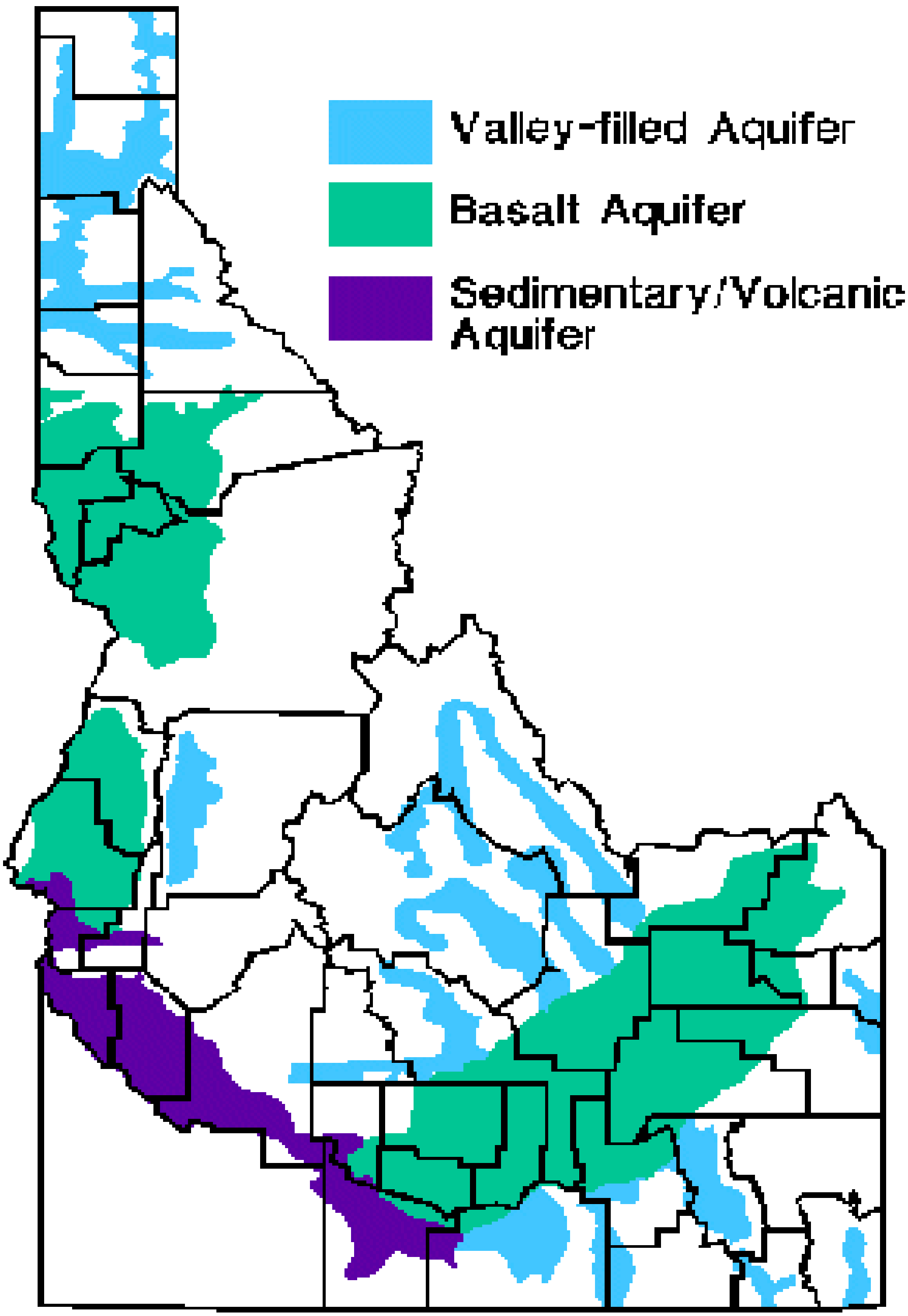
DEQ Ground Water Program
www.deq.idaho.gov/water-quality/ground-water.aspx

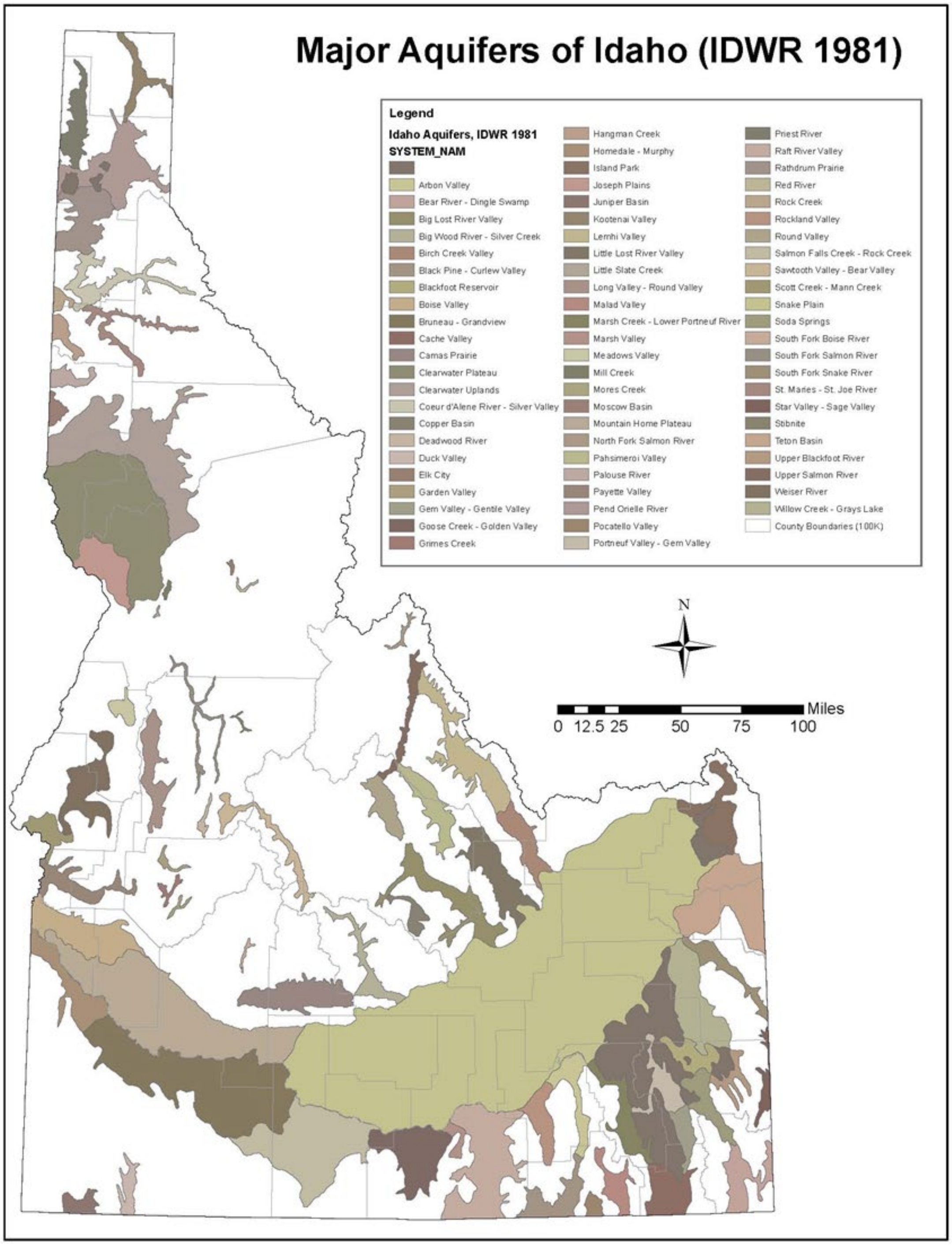
DEQ Source Water Program
www.deq.idaho.gov/water-quality/source-water.aspx

References

Fetter, C.W. 1994. Applied Hydrogeology. Prentice-Hall, Inc. Pg. 115-116.

Appendix A—Idaho Aquifers




Major Aquifers of Idaho (IDWR 1981)
Legend
Idaho Aquifers, IDWR 1981
SYSTEM_NAM
Arbon Valley
Bear River - Dingle Swamp
Big Lost River Valley
Big Wood River - Silver Creek
Birch Creek Valley
Black Pine - Curlew Valley
Blackfoot Reservoir
Boise Valley
Bruneau - Grandview
Cache Valley
Camas Prairie
Clearwater Plateau
Clearwater Uplands
Coeur d'Alene River - Silver Valley
Copper Basin
Deadwood River
Duck Valley
Elk City
Garden Valley
Gem Valley - Gentile Valley
Goose Creek - Golden Valley
Grimes Creek
Hangman Creek
Homedale - Murphy
Island Park
Joseph Plains
Juniper Basin
Kootenai Valley
Lemhi Valley
Little Lost River Valley
Little Slate Creek
Long Valley - Round Valley
Malad Valley
Marsh Creek - Lower Portneuf River
Marsh Valley
Meadows Valley
Mill Creek
Mores Creek
Moscow Basin
Mountain Home Plateau
North Fork Salmon River
Pahsimeroi Valley
Palouse River
Payette Valley
Pend Orielle River
Pocatello Valley
Portneuf Valley - Gem Valley
Priest River
Raft River Valley
Rathdrum Prairie
Red River
Rock Creek
Rockland Valley
Round Valley
Salmon Falls Creek - Rock Creek
Sawtooth Valley - Bear Valley
Scott Creek - Mann Creek
Snake Plain
Soda Springs
South Fork Boise River
South Fork Salmon River
South Fork Snake River
St. Maries - St. Joe River
Star Valley - Sage Valley
Stibnite
Teton Basin
Upper Blackfoot River
Upper Salmon River
Weiser River
Willow Creek - Grays Lake
County Boundaries (100K)
N
Miles
0 12.5 25 50 75 100

Appendix B—Potential Contaminants

Brownfield Site—A brownfields site is a vacant or underutilized property where redevelopment or reuse is complicated by actual or perceived environmental contamination.

CERCLA (Comprehensive Environmental Response Compensation and Liability Act) Site—More commonly known as *Superfund*, CERCLA is federal legislation passed in 1980 designed to clean up hazardous waste sites that are on the U.S. Environmental Protection Agency's National Priorities List.

Toxics Release Inventory (TRI) Site—These sites may be indicated on the delineation and potential contaminant sources maps. TRI sites indicate locations of potential contaminants identified on the federal Toxics Release Inventory, which is a database made available to the public by the U.S. Environmental Protection Agency. The TRI contains information on toxic chemical releases and waste management activities reported annually by certain industries and federal facilities. The TRI list was developed as part of the federal Emergency Planning and Community Right to Know Act passed in 1986. This act requires the reporting of any release of a chemical found on the TRI list. Visit *www.epa.gov/tri/trichemicals/* for a full list of chemicals on the TRI.

General Waste Site—A site where the DEQ Waste and Remediation Program has initiated remediation actions including aboveground storage tanks, leaking underground storage tanks, Resource Conservation and Recovery Act, mining, and emergency response sites.

Underground Storage Tank (UST)/ Leaking Underground Storage Tank (LUST) Site—While many types of storage tanks may be buried underground, the term *underground storage tank* refers specifically to certain types of tanks that are regulated under the federal Resource Conservation Recovery Act. These tanks are buried at least 10% underground and store either petroleum products (gasoline, diesel, kerosene, jet fuel) or certain hazardous substances. The underground piping connected to the tanks is also considered part of the UST. USTs are most often found at gas stations and other fueling facilities. Petroleum releases from *leaking underground storage tanks* pose numerous potential threats to human health and the environment.

Dairy—A place or premise where one or more milking cows, sheep, or goats are kept, and from which all or a portion of the milk produced is sold for human consumption. Dairies are regulated by the Idaho State Department of Agriculture.

Feedlot—A lot or facility where slaughter and feeder cattle or dairy heifers are confined and fed for a total of 45 days or more during any 12-month period, and crops, vegetation forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility.

Deep Injection Well—These sites may be indicated on the delineation and potential contaminant sources maps. An injection well is a well used as a means to dispose of or store fluids in the subsurface. Deep injection wells, generally used for disposing of stormwater runoff or agricultural field drainage, are deeper than 18 feet below ground surface and are regulated by the Idaho Department of Water Resources.

Shallow Injection Well—A well less than or equal to 18 feet deep in which fluids are injected as a means of disposal or for storage in the subsurface, such as stormwater, agricultural water, and facility heating/cooling water.

National Pollutant Discharge Elimination System (NPDES) Location—These sites, which represent sites with NPDES permits, may be indicated on the delineation and potential contaminant sources map. The federal Clean Water Act requires that any discharge of a pollutant to waters of the United States from a point source must be authorized by an NPDES permit.

Resource Conservation and Recovery Act (RCRA) Site—RCRA establishes a federal program to manage hazardous wastes for its entire existence to ensure that hazardous waste is handled in a manner that protects human health and the environment. Facilities that receive hazardous wastes for treatment, storage, or disposal are regulated by RCRA, which serves as the basis for developing and issuing permits.

Drain Location—Historical method of draining excess water resulting from flood irrigation on agricultural fields by digging a hole from the land surface to an underlying tunnel.

Road Salt Location—A location where the Idaho Transportation Department stores road salt and sand.

Mine Site—A site where geologic materials are extracted from the earth.

Tier II—Computer-Aided Management of Emergency Operations (CAMEO) Chemical Facility—A facility that stores or uses hazardous material and is included in the CAMEO Database, which is maintained by the U.S. Environmental Protection Agency and National Oceanic and Atmospheric Administration.

Tunnels and Drains—A drainage tunnel historically constructed to drain excess flood irrigation water from agricultural fields. A series of drains in the field empties the excess water into the tunnel.

Phosphate Mine—Sites where phosphate ore is extracted from the earth.

Water Reuse Area—Areas where municipal or industrial wastewater is applied to land for the purpose of land treatment.

Wastewater Lagoon—Man-made impoundments used for storing or treating wastewater.

Landfill—Areas of land or excavations in which wastes are placed for permanent disposal.

Pesticide Management Area—An area that is susceptible to pesticide contamination of ground water indicated by elevated pesticide detections in the ground water and requires additional restrictions on pesticide use as determined by the Idaho State Department of Agriculture.

Nitrate Priority Area—Area where greater than 25% of wells and/or springs that have been sampled have nitrate concentrations greater than or equal to 5 milligrams per liter.

Appendix C—Aquifer Research

Aquifers

An aquifer is a natural underground area where large quantities of ground water fill the spaces between rocks and sediment. According to the Idaho "Ground Water Quality Rule" (IDAPA 58.01.11.007.02), to be considered an aquifer in Idaho, the area must produce "economically significant quantities of water to wells and springs."

In an aquifer, ground water can move sideways, up, or down in response to gravity, differences in elevation, differences in pressure, and differences in the physical properties of the aquifer. Depending on the aquifer, the water can move from very fast (as much as hundreds of feet per day in fractured rock aquifers) to very slow (as little as a few feet per year in very fine grained sedimentary aquifers).

Types of Aquifers

An aquifer is defined according to the types of rocks and sediment in which it resides and the geologic conditions that formed or surround it. Just a few of the ways an aquifer can be described include the following:

- Confined—An aquifer overlain by one or more layers of impermeable rock or soil that restrict water to within the aquifer. The water is confined under pressure. Drilling a well into a confined aquifer releases that pressure and causes the water to rise in the well. These wells are sometimes called artesian wells.
- Unconfined—An aquifer that is not overlain by a layer of impermeable rock or soil. Water in a well will naturally stay at the level of the water table. As water is removed from the well, the water table at that place is lowered, causing the surrounding ground water to flow toward the well.
- Fractured—An aquifer where the water fills spaces produced by broken or shattered rock that would otherwise be impervious, such as basalt or granite.
- Sedimentary—An aquifer located in sedimentary materials, such as loose gravels and sands.
- Perched—A small aquifer that is separated from a main aquifer below it by an impermeable layer of rock or soil and an unsaturated zone (an area where air fills most of the spaces in the soil and rock).

These categories are not mutually exclusive. For example, an aquifer may be described as a confined, fractured basalt aquifer.

Idaho's Aquifer System

Approximately 70 major aquifers have been identified in Idaho. These aquifers are found throughout the state. Below are descriptions of some of the major types of aquifers found in Idaho. View a *map of Idaho's major aquifers*.

Valley Fill Aquifers

Valley fill aquifers are generally found in the state's intermountain valleys. The sediments and rocks comprising these aquifers were loosely deposited some time ago by air, water, or glacial activity on the earth's surface. As more material was deposited, these sediments and rocks generally remained in a loose configuration with many spaces between each other to hold water. One example of a valley fill aquifer is the *Spokane Valley-Rathdrum Prairie Aquifer* located in northern Idaho.

Fractured Basalt Aquifers

Fractured basalt aquifers are found in southern Idaho, the Lewiston-Moscow basin, and the Weiser area. Basalt is a fine-grained rock formed by the cooling and hardening of volcanic material. It tends to contain many fractures through which water easily moves. In addition, thin areas of sediment have been deposited between the basalt layers. These areas provide additional space for water storage or movement. Idaho's major basalt aquifer is the *Eastern Snake River Plain Aquifer*.

Sedimentary and Volcanic Aquifers

Sedimentary and volcanic aquifers are found primarily in southern Idaho. They typically contain a mixture of the loose gravels, sands, silts, and clays that comprise valley fill aquifers, intermixed with areas containing basalt, shale, and sandstone rocks that have a more consistent structure. One example of this type of aquifer is the Boise Valley Aquifer.

Aquifer Categorization

Aquifers in Idaho are categorized based on vulnerability of the ground water, existing and future beneficial uses of the ground water (such as domestic, industrial, agricultural, or aquaculture water supply), existing water quality, and social and economic considerations. The Idaho "Ground Water Quality Rule" (IDAPA 58.01.11.150.02) defines three aquifer categories in Idaho; each receives a different level of protection.

Sensitive Resource

Sensitive resource aquifers require the strongest level of protection. The *Spokane Valley-Rathdrum Prairie Aquifer* is the only aquifer designated as a sensitive resource aquifer in Idaho. Standards stricter than those outlined in the Idaho "Ground Water Quality Rule" can be applied to sensitive resource aquifers.

General Resource

General resource aquifers are protected by the standards in the Idaho "Ground Water Quality Rule." All aquifers in Idaho other than the Spokane Valley-Rathdrum Prairie Aquifer are general resource aquifers.

Other Resource

Other resource aquifers require the lowest level of protection and may have standards that are less strict than those in the Idaho "Ground Water Quality Rule." There are currently no aquifers in Idaho designated as other resource aquifers.

Sole Source Aquifers

A sole source aquifer is an aquifer that has been designated by U.S. Environmental Protection Agency (EPA) as the sole or principal source of drinking water for an area. As such, a designated sole source aquifer receives special protection. EPA designates an aquifer as a sole source based upon a petition from an individual, company, association, or government entity.

Three of Idaho's aquifers—Eastern Snake River Plain Aquifer, Spokane Valley-Rathdrum Prairie Aquifer, and Lewiston Basin Aquifer—are classified as sole source aquifers. View a *map of Sole Source Aquifers in EPA Region 10 (including Idaho)*.

Eastern Snake River Plain Aquifer

The Eastern Snake River Plain Aquifer was designated a sole source aquifer in 1991. It provides the sole source of drinking water for nearly 200,000 people in southeastern and south central Idaho.

The aquifer stretches across much of south central Idaho and is Idaho's largest basalt aquifer, covering an area of approximately 10,800 square miles. In 1980 alone, around 630 billion gallons of water were withdrawn from the aquifer to irrigate approximately 900,000 acres of farmland. The aquifer also discharges nearly 2.6 trillion gallons of water each year to the Snake River. The ability to supply these large quantities of water makes it one of the most productive aquifers in the nation.

The most productive part of the aquifer is the upper 300–500 feet, where ground water flows the most rapidly (the total thickness of the aquifer is estimated to be more than 5,000 feet). In this upper portion, the water flows generally from northeast to southwest. The total ground water storage in the upper 500 feet of the aquifer is estimated at 200 to 300 million acre-feet, which is approximately the equivalent of Lake Erie.

Spokane Valley-Rathdrum Prairie Aquifer

Designated as a sole source aquifer in 1978, the Spokane Valley-Rathdrum Prairie Aquifer was the first aquifer in Idaho and the second in the nation to receive sole source designation. The aquifer originates at the southern end of Lake Pend Oreille in northern Idaho and extends west under the Rathdrum Prairie in Idaho and the Spokane Valley in Washington, underlying approximately 321 square miles of land.

The aquifer serves as the principal source of drinking water for more than 400,000 people. Because of this, the Spokane Valley-Rathdrum Prairie Aquifer is specially categorized by Idaho as a sensitive resource aquifer as well as being designated by the EPA as a sole source aquifer. Both of these designations afford the aquifer special protection. Through Idaho's sensitive resource designation, the aquifer cannot be degraded unless it is demonstrated that the change is a justifiable result of necessary economic or social development.

The aquifer is an unconfined, valley fill aquifer. This means no barrier limits or blocks the flow of water down into the aquifer from the surface. Because the rocks and sediments in the aquifer fit very loosely together, water moves relatively quickly through the aquifer. In some places, water has been estimated to move at a rate of 50 feet per day.

Lewiston Basin Aquifer

The Lewiston Basin Aquifer (previously called the Russell Aquifer) was designated a sole source aquifer in 1988. The aquifer provides all domestic water to Clarkston, Washington, and the

Lewiston Orchards Irrigation District in Idaho, in addition to providing some domestic water for the city of Lewiston, Idaho.