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*Quality Water for Idaho*

# Groundwater in Idaho

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Idaho is fortunate to have large quantities of groundwater. Groundwater is essential for almost 95 percent of Idaho's drinking water, more than 1.3 million acres of irrigated agriculture and numerous industries.

Idaho's population is growing daily, and with more people comes an increased threat to groundwater. Groundwater is extremely difficult to clean up once it has been contaminated. Once depleted, aquifers often take decades or centuries to recharge. We must learn to use our groundwater efficiently and to protect it from contamination if we expect to continue to enjoy its benefits.

## What is groundwater?

Groundwater is the underground water found in the cracks of bedrock and in the spaces between gravel and sand particles. It does not form an un-

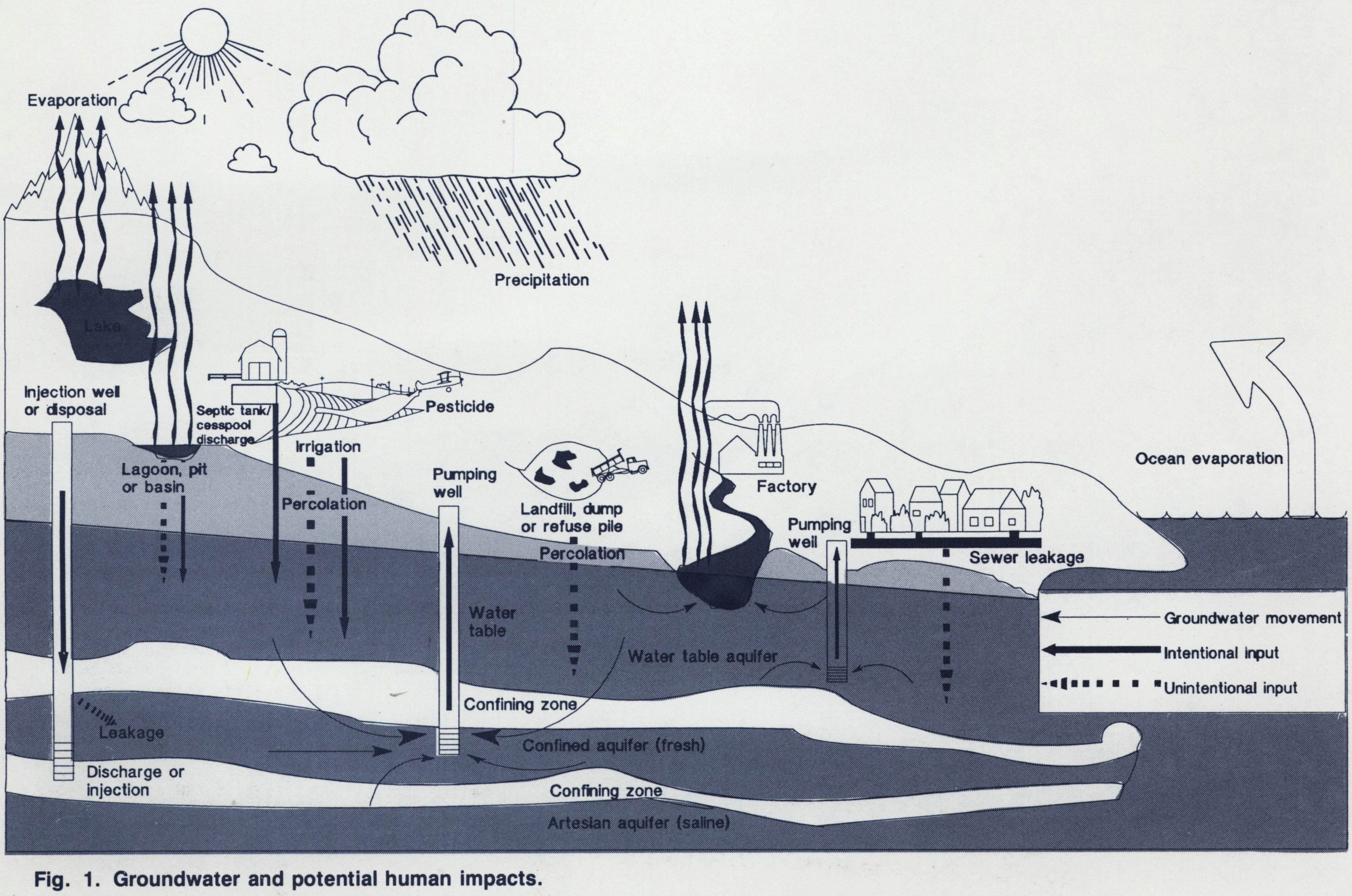


**Fig. 1. Groundwater and potential human impacts.**

derground lake. Groundwater can occur just a few feet from the surface or may be buried several hundred feet down.

## Groundwater and the hydrologic cycle

The hydrologic cycle explains the movement of water through its various phases from vapor in clouds to liquid water on the land surface, in the ground and in the oceans. Groundwater originates as precipitation. When precipitation hits the ground it can evaporate, be taken up by plants or move. If it flows across the top of the ground it becomes surface water such as in lakes and streams. If it moves downward through the soil and rock it becomes groundwater (Fig. 1).

As groundwater moves downward, it passes through the spaces and cracks of the ground material. Near the surface, where the spaces in the ground consist of both air and water, groundwater is referred to as soil water. Below this ''unsaturated zone'' is a zone where all the spaces and cracks are filled with water. This ''saturated zone'' is usually the top of the water table.

Like surface water, groundwater moves horizontally, but it moves at a much slower rate, usually only a few inches or feet per day. Its rate of movement depends upon the porosity and permeability of the soil, sand, gravel and/or bedrock.

Porosity is the amount of pore space in the material and determines how much water the material can hold. Permeability is a measure of the ease with which water can move through the material. It depends on pore size and the path the water must take through the material. For example, water moves freely through the large pores between grains of sand but very slowly through the small pores in clay.

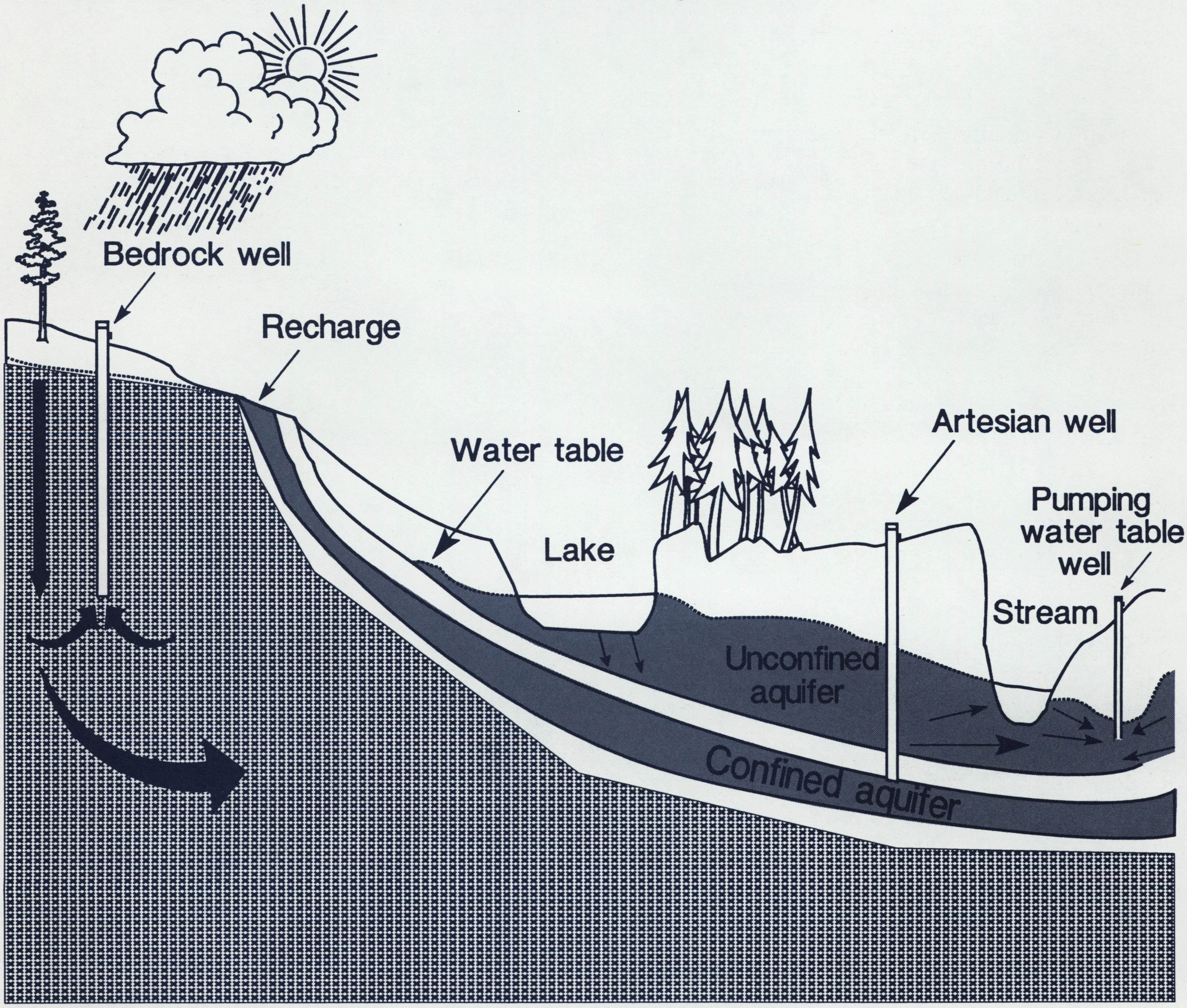


**Fig. 2. Confined and unconfined aquifers.**

Surface permeability is important because it determines whether surface water will reach the groundwater and therefore determines the vulnerability of the groundwater to contamination.

## Idaho's aquifers

Large areas that contain groundwater are called aquifers. Aquifers are either consolidated or unconsolidated. Consolidated aquifers hold water in the cracks of solid rock. The amount of water available depends upon the size and number of cracks. Unconsolidated aquifers hold water in a mixture of sand and gravel. The Snake River aquifer in southern Idaho is a consolidated aquifer, and the Rathdrum aquifer in northern Idaho is an unconsolidated aquifer.

Aquifers are also described as either confined or unconfined (Fig. 2). Confined aquifers have impermeable surfaces on their tops and bottoms. Confinement often puts the water under pressure. When the upper layer is pierced by a well, the groundwater rises toward the surface in an artesian well.

Unconfined aquifers are not under pressure. The water table delineates the top of these aquifers. Idaho has confined and unconfined aquifers throughout the state.

Idaho also has three major aquifer types: (1) valley-filled, (2) basalt and (3) sedimentary/volcanic. Valley-filled aquifers hold water in unconsolidated sedimentary material, usually in intermountain valleys. Basalt aquifers hold water in the cracks of underground basalt rock and in thin sedimentary layers interbedded with the basalt. Sedimentary/volcanic aquifers contain a mixture of unconsolidated sedimentary material, sedimentary rock (sandstone and shale) and basalt. Geothermal water is usually associated with sedimentary/volcanic aquifers (Fig. 3).

## Groundwater in Idaho's past

Groundwater has been used extensively throughout Idaho's modern history. Early pioneers took a lead from native Indians in the territory and used local springs as sources of drinking water.

With development, wells were dug and drilled to supply water to individual homesteads and communities without springs. Irrigation with groundwater began as early as the 1920s and developed on a large scale after World War II. Around 1945, groundwater use rose sharply as irrigated agriculture ran short of surface water. Since then, groundwater use for agriculture has grown steadily.

Approximately 700,000 acres of cropland were irrigated with groundwater in 1966, 1 million acres in 1980 and more than 1.3 million acres in 1986.

## Groundwater use today

Idaho ranks among the top five states for volume of groundwater used. In 1985, more than 4.3 billion gallons were withdrawn from Idaho's aquifers daily, representing 22 percent of total water use. The principal use is for irrigation of more than 1.3 million acres of cropland, primarily in southern Idaho. More than 90 percent of Idaho's groundwater withdrawals are for agriculture, although this represents only 20 percent of all the water used for agriculture in the state.

Other sectors are even more dependent on groundwater. For example, more than 87 percent of domestic and commercial water supplies come from groundwater, including 95 percent of drinking water. In industry and mining, 52.4 percent of water comes from groundwater (Fig. 4).

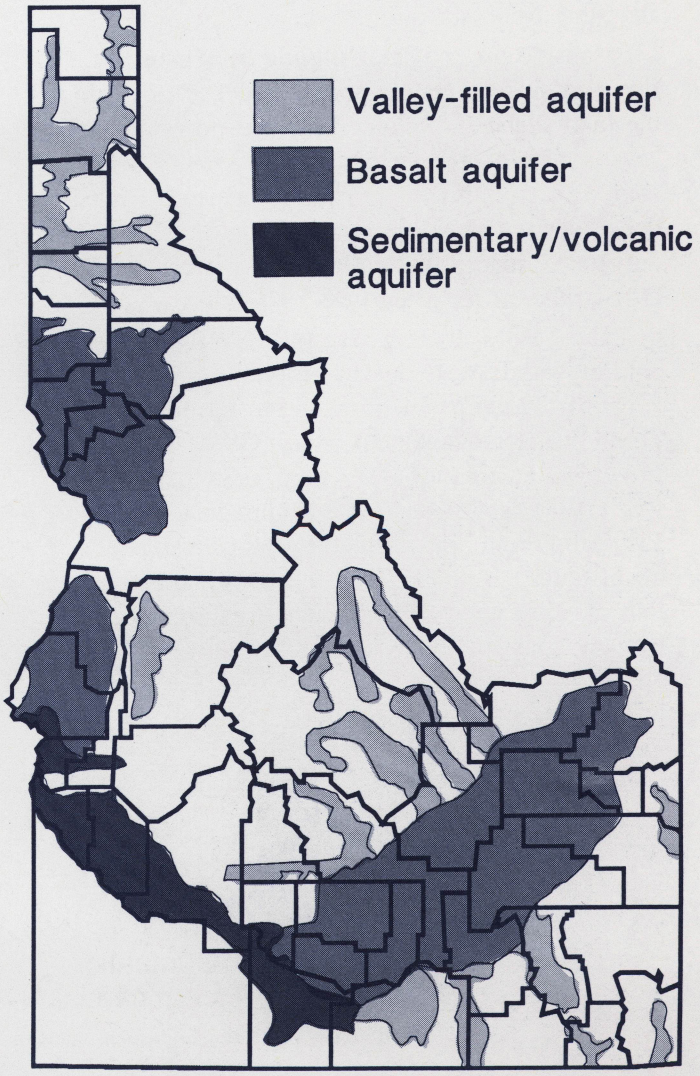


**Fig. 3. Idaho's aquifers.**

# Managing Idaho's groundwater quantity

Groundwater management within Idaho is governed under the Appropriation Doctrine. This system gives priority groundwater rights to the senior (oldest) wells. In times of shortage, withdrawals from the junior (newest) wells can theoretically be curtailed to provide water for the senior wells.

Under this system, the Idaho Department of Water Resources issues permits for new wells on the basis of needs and impacts on existing water rights. The department considers anticipated rates of aquifer recharge and estimated groundwater pumping levels. The Idaho Department of Water Resources (IDWR) is the state's primary water administering agency.

A drop in the water table known as groundwater mining is a problem in some parts of Idaho. It occurs when water is withdrawn from an aquifer more rapidly than it is replenished. As the water table drops, water pumping costs increase. Eventually, the users run out of water.

Extensive groundwater mining may cause reduced flows to surface waters and subsidence (lowering of the land surface). Reduced surface flows occur because groundwater springs are commonly a major source of stream flow during dry periods. Subsidence occurs when the removal of water leaves underground spaces that collapse or when underlying clay strata shrink when dried.

Idaho has 13 areas where the IDWR manages aquifer withdrawals due to groundwater mining (Fig. 5). These problem areas are termed either groundwater management areas (GWMA) or critical groundwater areas (CGWA). In 1988 Idaho listed five GWMAs (Boise Front, Mountain Home, Bruneau-Grand View, Banbury Hot Springs and Twin Falls). In these areas the IDWR must ensure that existing water rights in the area are unaffected by new construction.

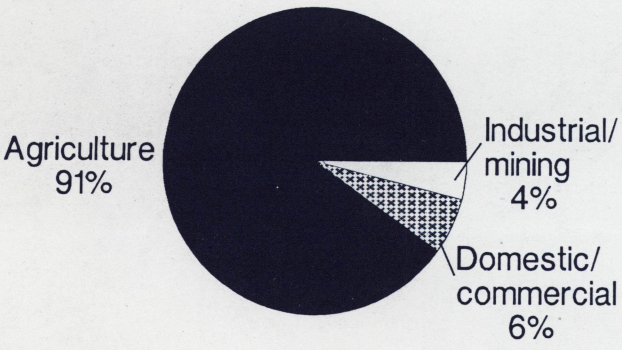


**Fig. 4. Groundwater use in Idaho.**

More serious problems exist in eight CGWAs (Cinder Cone Butte, Blue Gulch, Artesian City, Cottonwood, West Oakley Fan, Oakley-Kenyon, Raft River and Curlew Valley) where groundwater levels are declining at a rate that threatens a reasonably safe supply for existing users. The IDWR issues no new well permits in these areas, and it limits groundwater withdrawals.

For example, the Cottonwood/Oakley Fan aquifer declines an average of about 5 feet per year and pumping lifts are 400 to 600 feet. Continued declines in this area will soon make groundwater pumping for agriculture economically infeasible. Farmers in the CGWAs will either have to increase water use efficiency or reduce irrigated acreage to maintain the groundwater resource.

# Groundwater contamination

Groundwater contamination can occur directly, by injection of contaminants into the groundwater through wells, or indirectly, when the ability of the soil to immobilize or break down contaminants is exceeded. Under the latter condition, contaminants applied at the land's surface move downward and may eventually reach the aquifer.

For example, some wells in Idaho contain excessive levels of nitrates that may come from agricultural fertilizers, septic tanks and/or livestock feeding operations. A recent well survey conducted by the Idaho Farm Bureau in Cassia, Minidoka and Jerome counties showed that about 4 percent of wells sampled failed to meet the federal drinking water standard for nitrates.

In 1985 the Idaho Department of Water Resources and Idaho Department of Health and Welfare ranked potential sources of groundwater contamination in Idaho (Table 1). The ranking was based on two factors. The first was the adequacy of present regulatory programs for land use practices that could be sources of contamination. The second was the relative risk to public health or the environment posed by the potential contamination sources. Petroleum handling and storage was ranked first as posing the greatest risk to groundwater quality in Idaho.

Vulnerable areas exist where groundwater is close to the surface or where soils are thin or very permeable. Also, the potential for contamination is greater where considerable water reaches the land surface as precipitation or irrigation water that can carry contaminants below the root zone.

Idaho's principal aquifers have been evaluated for potential contamination based on population density

**Table 1. Priority ranking of potential sources of groundwater contamination in Idaho.**

| Priority[1] | Potential source of contamination |
|---|---|
| 1 | Petroleum handling and storage |
| 2 | Feedlots and dairies |
| 3 | Landfills and hazardous waste disposal sites |
| 3 | Land application of wastewater |
| 4 | Hazardous material handling and use |
| 5 | Pesticide handling and use |
| 6 | Land spreading of septage and sludge |
| 6 | Surface runoff |
| 6 | Pits, ponds and lagoons |
| 6 | Radioactive substances |
| 7 | Fertilizer application |
| 8 | Septic tank systems |
| 9 | Mining, including oil and gas drilling |
| 10 | Wells: injection, geothermal, domestic |
| 11 | Silvicultural activities |

Note: Rankings by Idaho Department of Health and Welfare and Idaho Department of Water Resources.

[1]Priority ranking based on adequacy of current regulatory program and relative risk of potential contamination to public health and the environment.

(as a measure of land use) and intensity of groundwater use. The most vulnerable major aquifers are the Boise Valley, Eastern Snake Plain and Rathdrum Prairie aquifers (Fig. 6).

## Sources of pollution

Contamination sources are grouped as point or non-point sources. Point sources can be individually identified by point of release. Point source pollution of groundwater in Idaho is primarily from underground injection of waste, solid waste disposal sites (landfills), chemical spills, industrial chemicals and underground fuel storage tanks.

Non-point sources are land uses that are numerous, dispersed and usually individually insignificant in generating groundwater contaminants. It is the cumulative impact of these land uses when occurring in high densities that results in groundwater contamination. Common examples are septic tanks and agriculture. Most non-point source groundwater contamination can be grouped into three major areas: agriculture, septic systems and urban runoff.

Many groundwater contamination problems in Idaho are under investigation or cleanup. The relative importance of non-point sources and point sources of groundwater contamination within Idaho is unknown.

### Point source pollution

**Injection wells** — Underground injection of waste has been a common practice for disposing of irrigation runoff and industrial waste. Injecting waste into the ground has the advantage of being generally inexpensive and of minimizing impacts on surface waters. However, injection wells are often not deep or secure enough to avoid contamination of the local aquifer. Injection wells in parts of Idaho are being closely monitored by state and

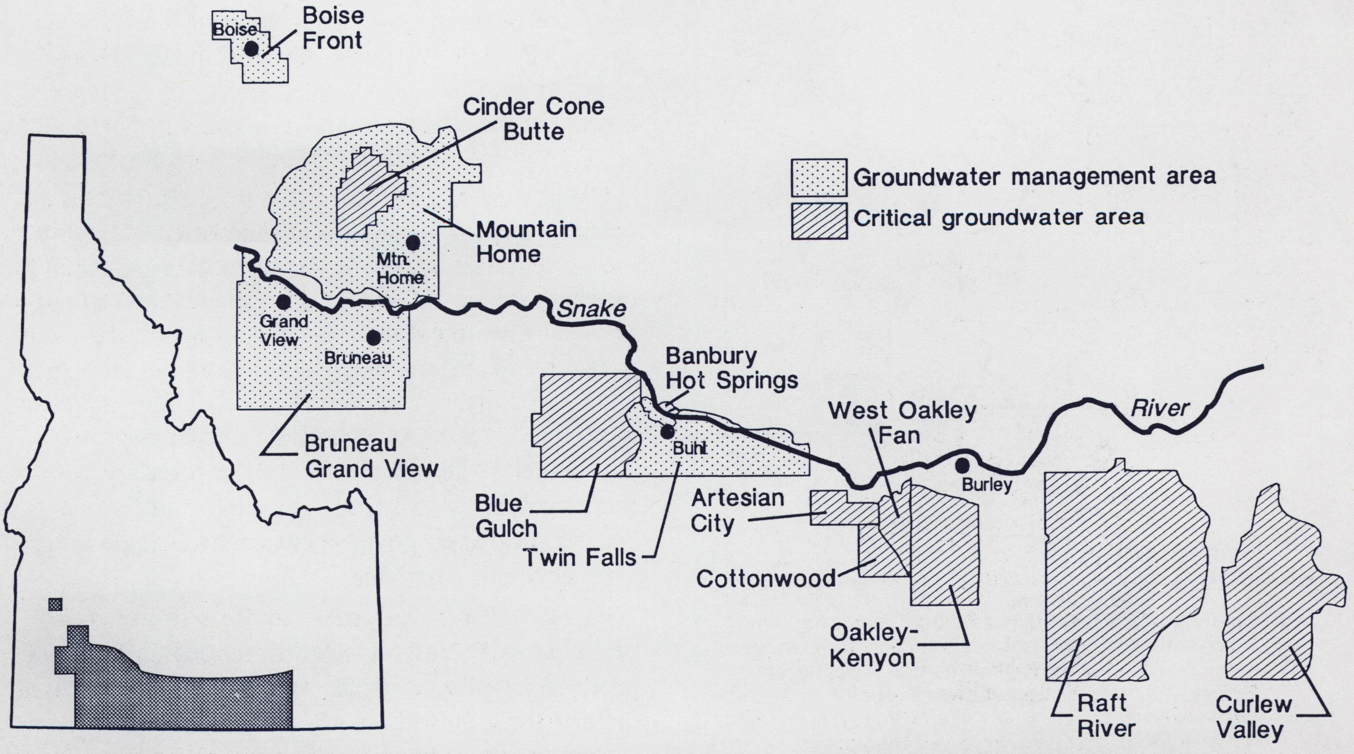


**Fig. 5. Critical groundwater management areas and critical groundwater areas in Idaho. Map at left indicates general vicinity of the groundwater areas, shown in detail at right. (From Idaho Department of Water Resources, June 1987.)**

federal agencies. Because of potential groundwater contamination it is likely that injection wells will be out of use by the end of the decade.

**Solid waste disposal sites** — When precipitation moves downward through solid waste it can dissolve some of the contents and carry them to the groundwater. Although modern solid waste disposal sites are lined to prevent leachate from entering the groundwater, sites that are at least 5 to 10 years old are generally not lined.

**Underground storage tanks** — Underground storage tanks and their contents, whether at the local gas station or a major industrial complex, pose a widespread threat to groundwater. The major cause of leaking is corrosion or leaky pipe fittings. Many underground tanks are made of steel, which usually rusts and will eventually leak unless treated with special precautions.


**Fig. 6. Contamination potential of Idaho's major aquifers, from most potential for contamination to least potential: 1 — Boise; 2 — Snake Plain; 3 — Rathdrum Prairie; 4 — Marsh Creek/Lower Portneuf; 5 — Salmon Falls/Rock Creek; 6 — Payette Valley; 7 — Coeur d'Alene River/Silver Valley; 8 — Mountain Home Plateau; 9 — Moscow Basin; 10 — Clearwater Uplands Plateau; 11 — Goose Creek, Golden Valley.**

**Industrial chemicals** — Most hazardous wastes generated by large industrial facilities are currently regulated as point sources of pollution, but preregulation activities have caused groundwater contamination in many areas. In addition, users and disposers of small amounts of industrial chemicals may not have access to the best available disposal procedures or may not use them. This creates the potential for groundwater contamination.

It is the public's and the government's role to demand careful handling of materials and the use of Best Available Technology in pollution control, chemical storage and waste disposal.

## Non-point source pollution

**Agriculture** — Contamination of groundwater from agricultural activities can occur in several ways. They include (1) mixing and handling fertilizers and pesticides, (2) disposing of excess fertilizers and pesticides after application, (3) cleaning equipment after application and (4) applying fertilizers and pesticides under conditions that result in movement of water and chemicals through the soil to the aquifer (usually poor water management).

Responsible management of fertilizers and pesticides is essential to maintaining and improving Idaho's groundwater resource. Evidence shows that high levels of nitrates (more than 10 parts per million nitrate-nitrogen) can be harmful to infants and livestock. Recent studies, although not conclusive, suggest a link between long-term exposure to high levels of nitrates (more than 25 ppm) and stomach cancer. Pesticides in groundwater appear to be a much greater threat to human health than nitrates; however, measurement and assessment of pesticides is incomplete.

Using Best Management Practices (BMPs) is the primary step in protecting groundwater quality in the agricultural sector. BMPs protect groundwater by encouraging integrated crop management practices such as integrated pest management, efficient irrigation management, and soil sampling and testing for fertilizer recommendations. These practices minimize leaching of chemicals and help protect aquifer recharge areas and wells. BMPs are currently voluntary in Idaho, but they are often encouraged through government cost sharing programs and payments.

Farmers can protect their aquifers by following pesticide and fertilizer label directions and seeking professional advice on the application and handling of fertilizers, pesticides and irrigation. Also, it is essential that all chemicals be safely stored on concrete pads away from wells. Agrichemical equipment should be rinsed far from wells or any areas sensitive to contamination.

**Septic systems** — Approximately 58 percent of Idaho's residents rely on septic systems. Septic systems remove the solids from household sewage and discharge the fluid portion into the soil. If the system is properly designed and maintained, the soil then adsorbs or breaks down the pollutants.

More often, improperly designed or maintained septic systems leach contaminants into the groundwater. Currently, permits are required for septic tank installation, but post-installation monitoring is rare, and most regulations do not control septic system density in vulnerable groundwater settings. In densely populated areas this can threaten groundwater.

Residents can help minimize groundwater problems by having septic systems checked, maintaining the system with frequent pumping and avoiding heavy use that can overload the system (for example, running several loads of laundry in one day).

**Urban runoff** — The quality and quantity of urban runoff varies greatly depending on land uses, but the method of runoff management can determine whether groundwater becomes contaminated. Potentially harmful approaches include diverting untreated runoff into dry wells (shallow injection wells) or into unlined pits and basins. Contaminants found in urban runoff include nutrients, toxic metals and oil and grease. In areas where salt is applied during snow removal, sodium and chloride may reach groundwater. Idaho has no comprehensive program to manage urban runoff, but local governments can modernize urban runoff systems to be more environmentally sound.

We can help decrease the toxicity of urban runoff by carefully handling all toxic materials. For example, garden fertilizers and pesticides should be applied according to label directions, and any excess should be stored carefully. They should never be emptied into a street gutter, poured down a drain or set out with the weekly trash. Dispose of them at a certified hazardous waste disposal site or through a community household hazardous waste disposal program.

Improper disposal of both empty and full chemical containers from urban, agricultural and industrial sources has also caused groundwater contamination. These containers should never be discarded on land but should be taken to a hazardous waste disposal site unless otherwise specified on the label.

## Can we clean up groundwater?

To say groundwater can be cleaned up is actually too optimistic for current technology. It is better economically and practically to simply avoid contamination. Cleanup practices in many areas consist of letting the contaminants dilute and break down on their own while finding a new water source for the previous users of the water.

Another approach uses recovery wells. Recovery wells are drilled to pump contaminated water to the surface, treat it and then return it to the ground. Even this expensive process usually fails to remove all the contaminants from the aquifer's multitude of crevices and particles. Recent research is looking at bioremediation as a way to clean up contaminated groundwater. Bioremediation uses microorganisms to break down the contaminants.

## Groundwater quality in Idaho

Recent surveys have shown that the quality of groundwater in Idaho is generally excellent. Groundwater quality is a problem in only isolated areas of the state. On the whole, groundwater quality in Idaho is much better than in at least 40 other states. Our challenge is to protect this resource through prudent planning and use.

## How can we protect our groundwater?

There are many things we can do to protect Idaho's groundwater. First, we must realize that groundwater does not belong to anyone but is shared among individuals, municipalities and industries. Second, we must realize that each one of us contributes to the threat of groundwater contamination. Finally, we must decide to change the way we conduct our daily activities. For example, we can:

- Regularly inspect underground storage tanks for leaks
- Use agrichemicals according to label directions and recommendations from agricultural scientists
- Use integrated pest management when appropriate
- Maintain septic systems to prolong their life and maximize their ability to remove pollutants
- Use and dispose of household, lawn, garden and auto products according to label directions
- Conserve water with efficient irrigation systems and prudent home use

- Support legislation that encourages groundwater planning and best available technologies for waste management
- Recycle as much waste as possible

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