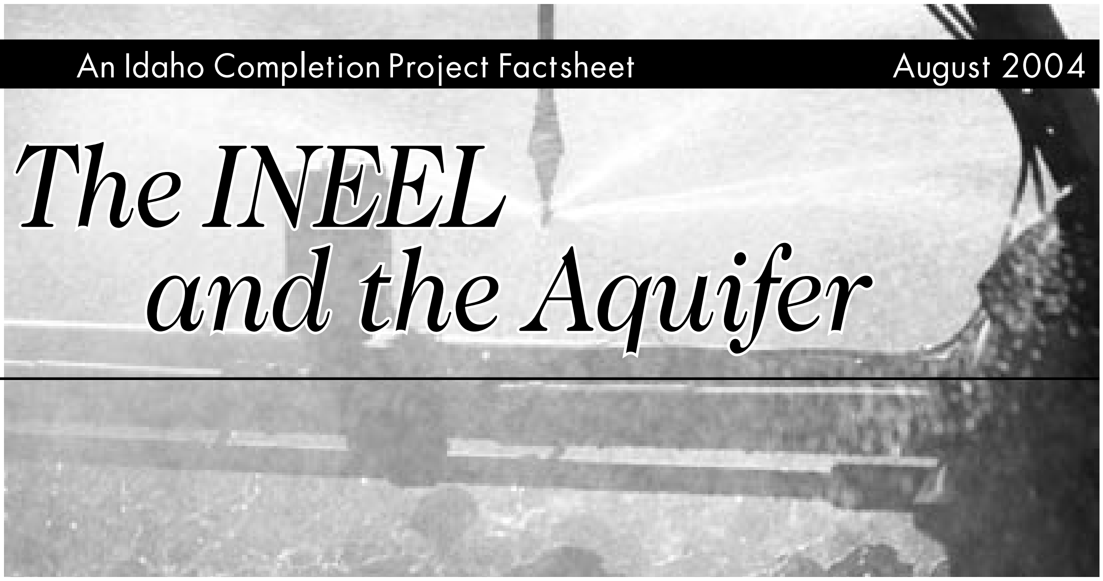
An Idaho Completion Project Factsheet August 2004

Idaho Completion Project

Bechtel BWXT Idaho, LLC



The INEEL and the Aquifer

Introduction

The Snake River Plain Aquifer is one of the most productive *groundwater* resources in the United States. Each year, about 2 million *acre-feet* of water is drawn from the *aquifer*, of which the vast majority (about 95 percent) is used for irrigation. Just 2 percent is used for industry and 3 percent for public supply. The aquifer is the primary drinking water source for more than 280,000 people in southeastern Idaho.

info *Terms with special meanings to groundwater professionals are set in italics and defined in the glossary on page 7 of this factsheet.*

The quality of the aquifer, as well as the quantity available for use, has been affected by agricultural, industrial, municipal, and private activities, including historic activities at the Idaho National Engineering and Environmental Laboratory (INEEL). In the past, the INEEL used waste disposal practices that included disposing of wastes through injection wells, placing liquid waste in unlined disposal ponds, or disposing of solid waste in unlined landfills. This led to the contamination of the groundwater below some areas of the INEEL with *radioactive, organic,* and *inorganic* contaminants. Once acceptable and routine, these waste disposal practices have long been suspended and are now prohibited under current environmental regulations.

For more than a decade, the U.S. Department of Energy (DOE), governed by federal and state laws, has conducted cleanup activities at the INEEL to protect the groundwater and ensure the aquifer remains safe. In 50 years of groundwater monitoring, no contaminants have been detected near or outside the INEEL boundary in concentrations above federal *drinking water standards (MCLs)*.

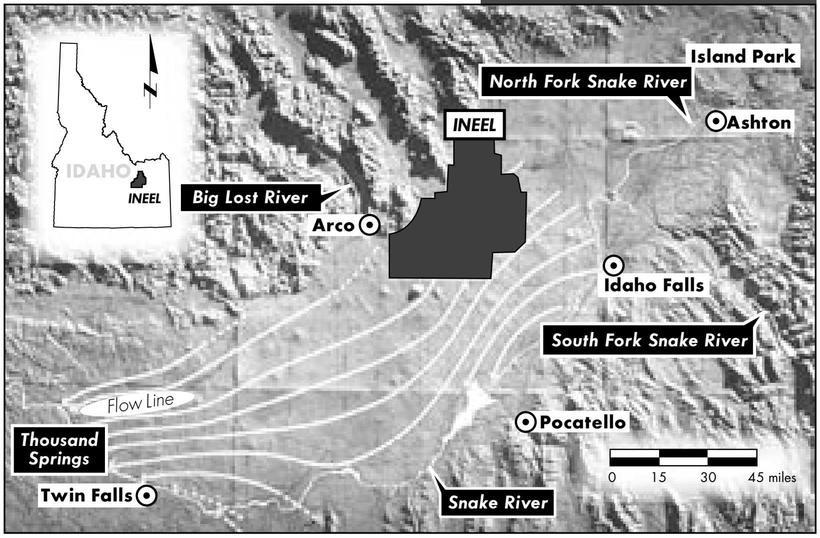
Facility and INEEL-wide Risk Studies Undertaken

The DOE and its regulating agencies, the U.S. Environmental Protection Agency (EPA) and the Idaho Department of Environmental Quality (DEQ), conducted studies at the nine facility areas at the INEEL to determine whether past activities contaminated the groundwater.

With seven studies completed, the agencies determined that activities at Test Area North, the Test Reactor Area, and the Central Facilities Area contributed contaminants to the aquifer in concentrations requiring cleanup. The aquifer was unaffected by activities at four other facilities, the Naval Reactors Facility, Experimental Breeder Reactor-I, the Power Burst Facility/Auxiliary Reactor Area, and Argonne National Laboratory–West.

Studies continue two facilities: the Idaho Nuclear Technology and Engineering Center and the Radioactive Waste Management Complex. Contaminants from both facilities have migrated to the aquifer. Also ongoing is the INEEL-wide study for cumulative risk from INEEL activities.

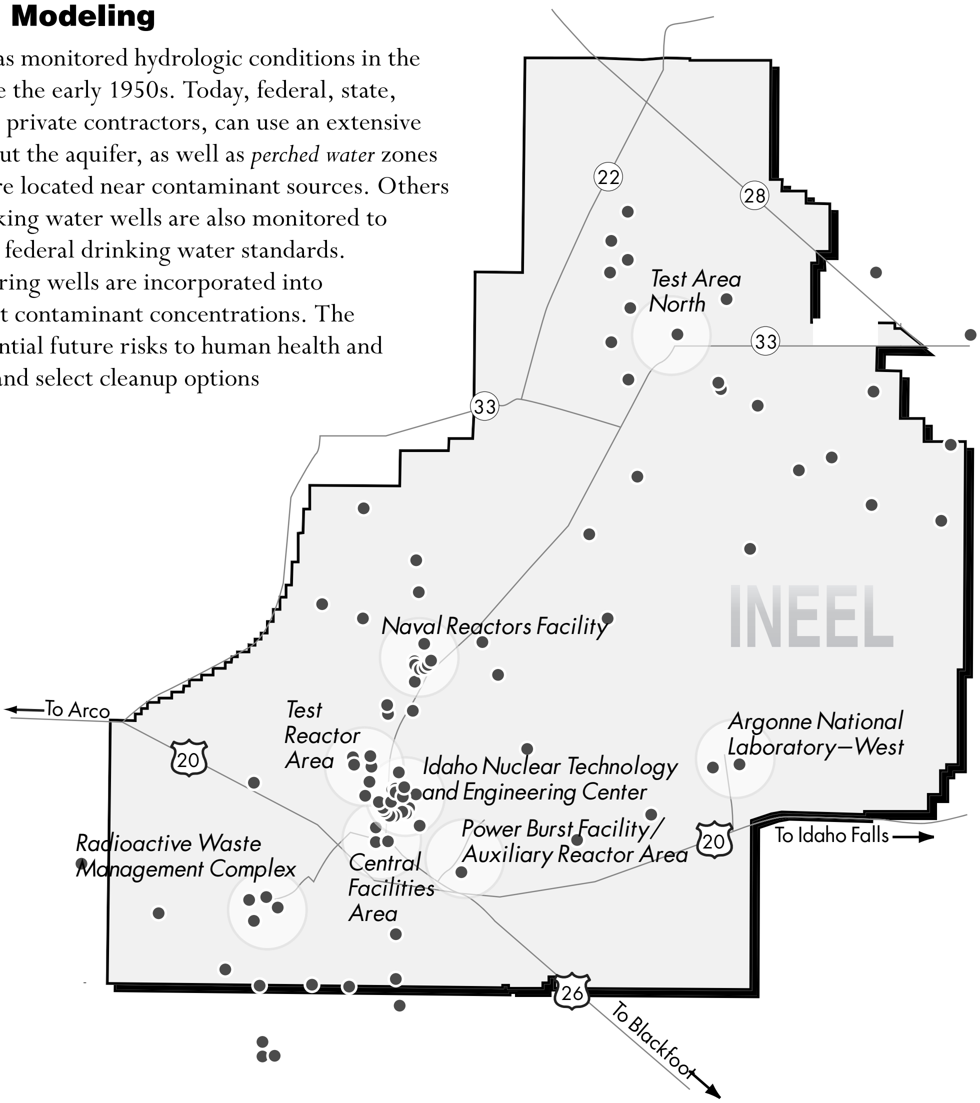
Groundwater in the Snake River Plain Aquifer flows southwestward from Ashton, Idaho to Thousand Springs near Hagerman, Idaho.



Groundwater Monitoring and Modeling

The U.S. Geological Survey (USGS) has monitored hydrologic conditions in the Snake River Plain Aquifer at the INEEL since the early 1950s. Today, federal, state, and local agencies, as well as universities and private contractors, can use an extensive network of *monitoring wells* to learn more about the aquifer, as well as *perched water* zones and the *vadose zone*. Most monitoring wells are located near contaminant sources. Others are at various locations off the INEEL. Drinking water wells are also monitored to ensure the water they supply remains within federal drinking water standards.

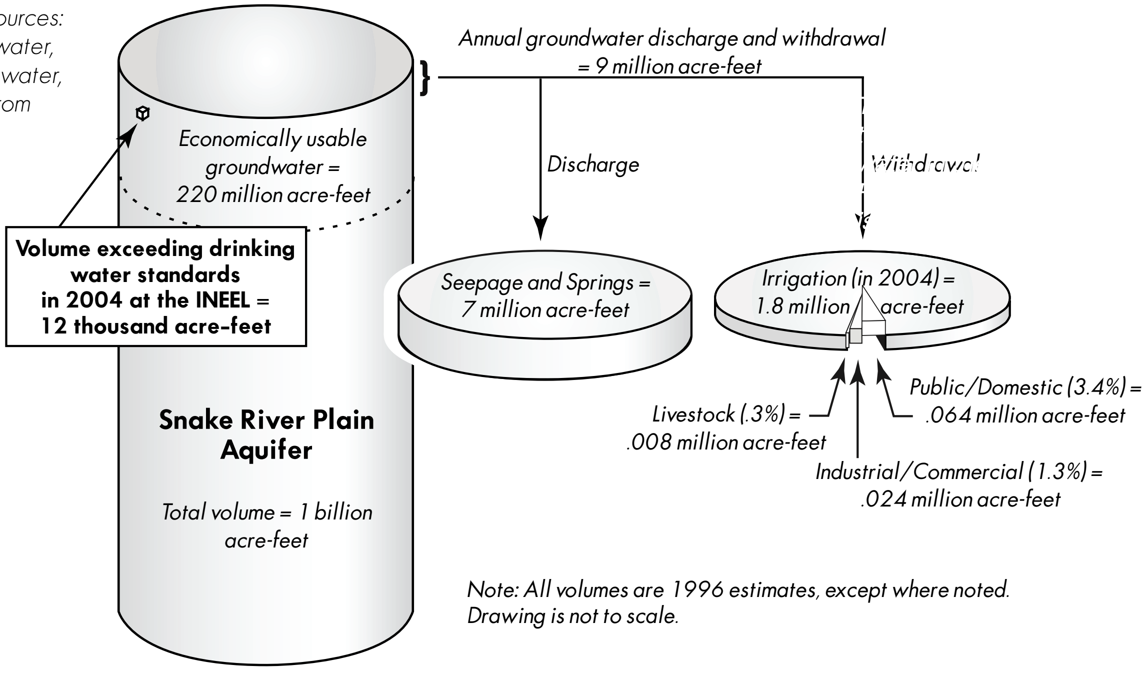
Sample data collected from the monitoring wells are incorporated into computer models that are designed to predict contaminant concentrations. The modeling results help scientists identify potential future risks to human health and the environment, and help managers define and select cleanup options and verify remedies are effective.



A map of the INEEL identifies both major facilities and the general locations of an extensive network of monitoring wells.

At the current time, approximately 2.2 million acres on the Snake River Plain are irrigated from ground and surface water sources:

- *40 percent with groundwater,*
- *40 percent with surface water,*
- *20 percent with water from both sources.*



Note: All volumes are 1996 estimates, except where noted. Drawing is not to scale.

Cleanup Progressing at Three Facilities

Test Area North

From 1953 to 1972, wastewater that contained contaminants was injected into the aquifer. Contaminants continue to leach from sludge that accumulated in the fractured basalt adjacent to the waste injection well.

Contaminants of Interest *Test Area North*

Volatile organic contaminants	*Maximum Concentration **	*MCL*
trichloroethene (TCE)	12,000–32,000 ppb	5 ppb
tetrachloroethene (PCE)	110 ppb	5 ppb
cis-1,2-dichloroethene (DCE)	3,200–7,500 ppb	70 ppb
trans-1,2-dichloroethene (DCE)	1,300–3,900 ppb	100 ppb
Radioactive contaminants		
cesium-137 (Cs-137)	1,600–2,150 pCi/L	119 pCi/L
strontium-90 (Sr-90)	530–1,880 pCi/L	8 pCi/L

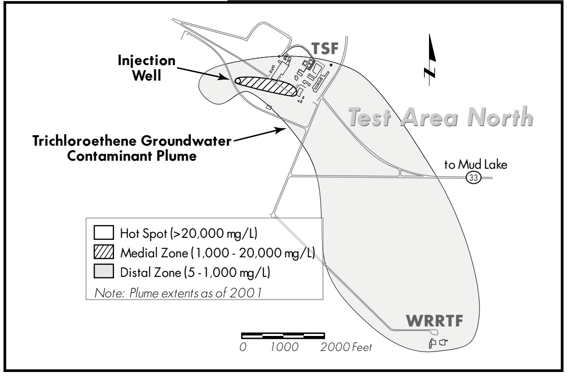
** (2001, Record of Decision Amendment for the Test Area North, Operable Unit 1-07B)*

What's being done to clean up the aquifer?

In 2001, the agencies signed a Record of Decision amendment to supplement the 1995 remedy of pumping out and treating contaminated groundwater ("pump-and-treat") with *in situ bioremediation* and monitored natural *attenuation*. The remedy was amended because bioremediation and natural attenuation performed more effectively than pump-and-treat alone. The amended remedy is expected to reduce the total time and cost of cleaning up the *contaminant plume*.

Trichloroethene concentrations are decreasing around the injection well due to the effectiveness of the new remedy. Concentrations of radioactive contaminants are expected to continue decreasing through attenuation and *dispersion* to meet safe drinking water standards within the next several decades.

This diagram of the trichloroethene contaminant plume at Test Area North shows the plume's extent in 2001, prior to beginning in situ bioremediation and monitored natural attenuation.



Test Reactor Area

Until 1972, wastewater that contained contaminants was injected into the aquifer. Water also seeped into the ground from cooling ponds and carried contaminants through the vadose zone into the aquifer. Contaminants identified for the aquifer are chromium and tritium. In 2003, tritium levels in all aquifer wells were below the drinking water standard and are expected to continue to decrease because of radioactive decay and dilution. In 2003, chromium concentrations exceeded drinking water standard at two wells. Chromium levels have shown a decreasing trend since 1990 and are expected to decline below the drinking water standard by 2012 for all wells.

Contaminants of Interest *Test Reactor Area*

Inorganic contaminants	*Maximum Concentration **	*MCL*
chromium	< 0.2 mg/L	0.1 mg/L
Radioactive contaminants		
tritium (H-3)	18,800 pCi/L	20,000 pCi/L

** (2003, 5-year Review Report for the Test Reactor Area, Operable Unit 2-13)*

What's being done to clean up the aquifer?

The cooling ponds were lined in 1993 to stop seepage. In 1997, the agencies signed a Record of Decision that called for monitoring the groundwater. Concentrations of contaminants are decreasing through attenuation and dispersion and are expected to meet safe drinking water standards by 2012.

Central Facilities Area

In 1999, concentrations of dissolved nitrates were detected in samples taken from two wells downgradient (southwest) of the Central Facilities Area. The agencies determined the most likely source was the sewage plant drainfield, which was used from 1944 until 1995 to dispose of waste from laboratories and from maintenance and laundry facilities.

Contaminants of Interest *Central Facilities Area*

Inorganic contaminants	*Maximum Concentration **	*MCL*
nitrate (counted as nitrogen)	11–20 mg/L	10 mg/L

** (2000, Final Comprehensive Record of Decision for Central Facilities Area, Operable Unit 4-13)*

What's being done to clean up the aquifer?

In 2000, the agencies signed a Record of Decision that stated an expectation that nitrate concentrations in the groundwater will decrease through dispersion to below the safe drinking water standard by 2009. In addition, this site was remediated in 2003. Groundwater monitoring will continue and include an annual review of nitrate concentrations as well as a 5-year evaluation of trends to determine if any further actions are needed.

Two Remaining Facility Studies Underway

Idaho Nuclear Technology and Engineering Center

The primary sources of groundwater contamination at the Idaho Nuclear Technology and Engineering Center are an injection well, which was used from 1952 to 1984 to dispose of wastewater, and soils surrounding the tank farm, which has been used continuously since 1952 to store liquid wastes. Though the tanks have not leaked, the piping and valves have leaked. Rain and snow are carrying the contaminants through the vadose zone into the perched water and the aquifer below the facility.

By 1968, tritium contained in the wastewater disposed of in the injection well had commingled with a plume of tritium that originated under the Test Reactor Area. Attenuation and dispersion have reduced the combined tritium concentrations in the groundwater from a high of 3,440,000 picocuries per liter (pCi/L) in 1962 to a maximum of 13,700 pCi/L in 2004. Similarly, iodine-129 has also dropped through attenuation and dispersion from a high of 41 pCi/L in 1981 to a maximum of 0.77 pCi/L in 2004. Currently, concentrations of tritium and iodine-129 are below the safe drinking water standards.

Contaminants of Interest *Idaho Nuclear Technology and Engineering Center*

Radioactive contaminants	*Maximum Concentration **	*MCL*
iodine-129 (I-129)	0.77 pCi/L	1 pCi/L
strontium-90 (Sr-90)	33.9 pCi/L	8 pCi/L
technetium-99 (Tc-99)	2,840 pCi/L	900 pCi/L
tritium (H-3)	13,700 pCi/L	20,000 pCi/L

** (2004 groundwater sampling data)*

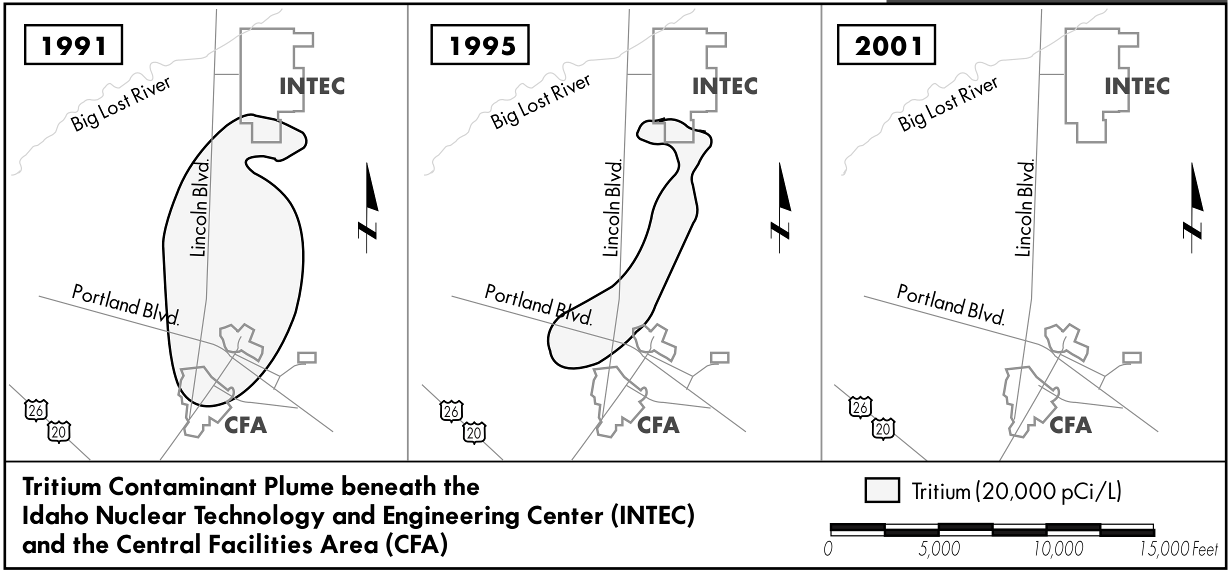
Strontium-90 in the groundwater still exceeds the safe drinking water standard, but concentrations are expected to continue declining through attenuation and dispersion to meet the safe drinking water standard before 2095.

An analysis of groundwater from a new monitoring well inside the Idaho Nuclear Technology and Engineering Center fence line, approximately 300 ft. (91 m) north of the tank farm, revealed technetium-99 at concentrations of 2,000–2,840 pCi/L. The concentrations are above the safe drinking water standard and higher than previously observed. An evaluation indicates that leaks in piping systems at the tank farm are the source of the technetium-99. Concentrations of technetium-99 in groundwater samples taken from other monitoring wells in the area are within the safe drinking water standard and are expected to remain at safe levels in the future.

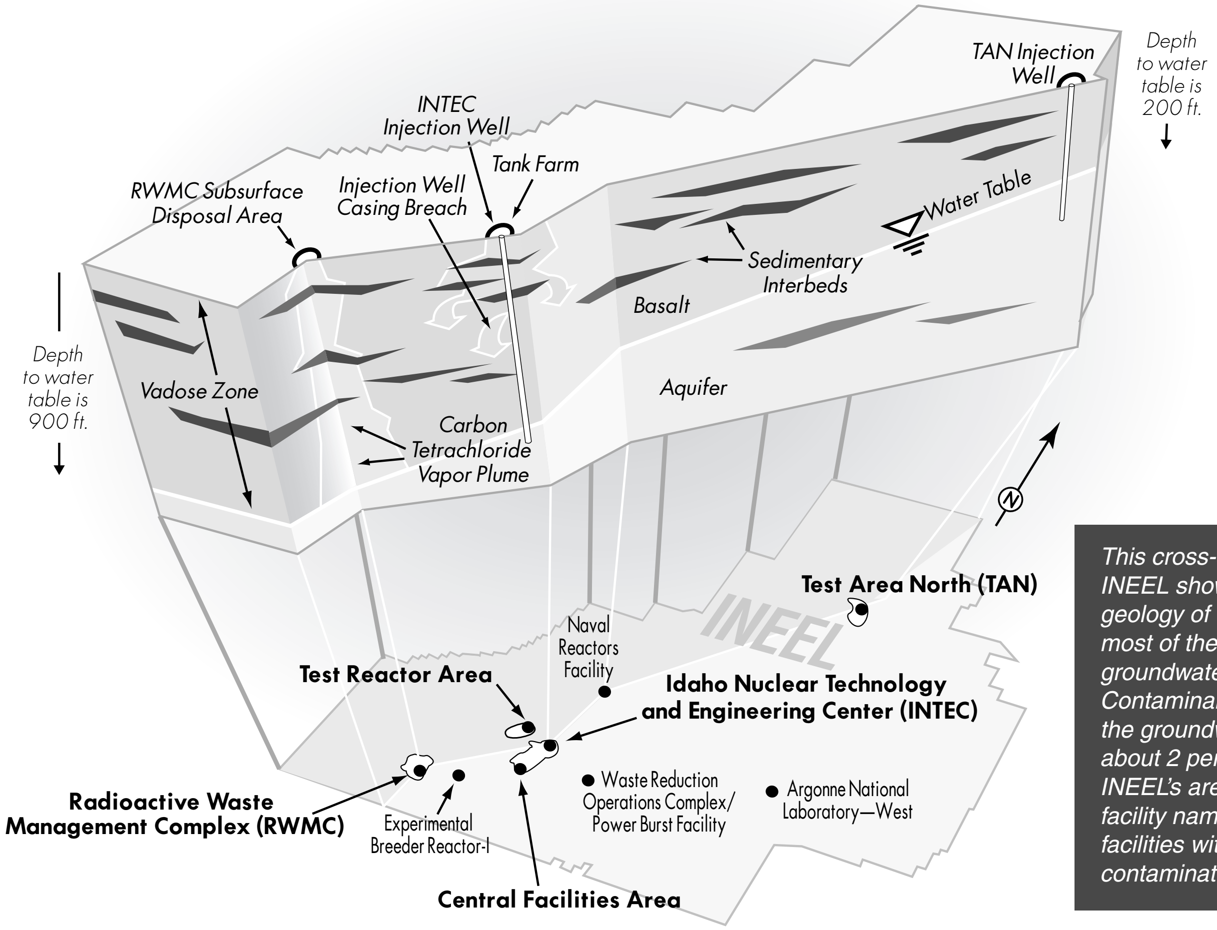
What's being done to clean up the aquifer?

To reduce water infiltration that could carry contamination to the aquifer, an impermeable barrier was installed over the tank farm in the late 1970s. The agencies authorized an Interim Action in 1999 to further reduce water infiltration at the tank farm. Two new more distantly located percolation ponds were constructed in 2002. These replaced ponds located near the facility that were a significant source of water infiltration. Lawn irrigation was reduced in 2003, and concrete-lined stormwater ditches were installed around the tank farm to divert runoff to a newly-constructed, lined evaporation pond outside the Idaho Nuclear Technology and Engineering Center fence line. A further step to reduce infiltration of precipitation is the construction of an asphalt pad over parts of the tank farm. The pad is expected to be completed in 2004.

The diagram shows the steady reduction of tritium concentrations beneath the Idaho Nuclear Technology and Engineering Center and Central Facilities Area from 1991 to 2001. The concentrations were reduced to below the safe drinking water standard in 2001 through dispersion and attenuation by radioactive decay.



Tritium Contaminant Plume beneath the Idaho Nuclear Technology and Engineering Center (INTEC) and the Central Facilities Area (CFA)



This cross-section of the INEEL shows the basic geology of the aquifer and most of the sources of groundwater contamination. Contaminant plumes in the groundwater underlie about 2 percent of the INEEL's area. Boldfaced facility names indicate facilities with groundwater contamination.

The effectiveness of natural processes as well as remedial actions will be assessed through ongoing groundwater monitoring. Additional studies will be conducted to determine if further remediation is necessary to protect the aquifer below the facility.

Radioactive Waste Management Complex

Radioactive and hazardous waste, buried between the early 1950s and 1970 in the 97-acre Subsurface Disposal Area, is the primary source of contamination at the Radioactive Waste Management Complex. The majority of the waste was generated by nuclear weapons production at the Rocky Flats Plant near Golden, Colorado. Vapors containing volatile organic compounds have migrated from the waste into the vadose zone and aquifer. One contaminant, carbon tetrachloride, is consistently detected in the aquifer at concentrations exceeding the safe drinking water standard. Without action, concentrations of carbon tetrachloride would increase over several decades.

Contaminants of Interest	*Radioactive Waste Management Complex*	
Organic contaminants	*Maximum Concentration **	*MCL*
carbon tetrachloride (CCl4)	8 g/L	5 g/L

* (Fiscal Year 2003 Environmental Monitoring Report for the Radioactive Waste Management Complex)

What's being done to clean up the aquifer?

A vapor vacuum extraction and treatment system is pulling organic vapors to the surface and destroying them. Since operations began in 1996, the system has removed and destroyed approximately 169,000 pounds of contaminants, including more than 101,000 pounds of carbon tetrachloride. An evaluation is ongoing to determine if additional action is necessary.

info *Why isn't plutonium listed as an aquifer contaminant at the INEEL?*

The discussion in this factsheet focuses on the contaminants that consistently exceed drinking water standards, posing a potential unacceptable risk to the aquifer.

Though there is a perception that plutonium poses a significant risk, levels have been so low as to be almost undetectable and well below the drinking water standards. Because there have been isolated and inconsistent trace detections of plutonium in sedimentary interbeds and in the aquifer, researchers are working on gaining a greater understanding of how plutonium behaves in the environment.

INEEL Site-Wide Cumulative Groundwater Risk Study in Progress

One of the tasks described in the Federal Facility Agreement and Consent Order, the agreement governing CERCLA remediation of the INEEL, was to assess the cumulative, site-wide risk from contamination. The agencies have determined that there are no unacceptable cumulative risks aboveground. However, because contaminants released by activities at the INEEL have entered the aquifer and potentially pose an unacceptable risk to water users, this risk requires further examination.

One aspect of the assessment of cumulative risks to the aquifer from INEEL activities is the development of a new INEEL-wide groundwater model that will integrate the results of previous modeling work across the INEEL. The new model, originally scheduled to be completed in 2010, is now expected to be completed and in use by 2007. It will be used to evaluate how any cumulative risk from contaminant plumes could affect public health and safety and the environment.

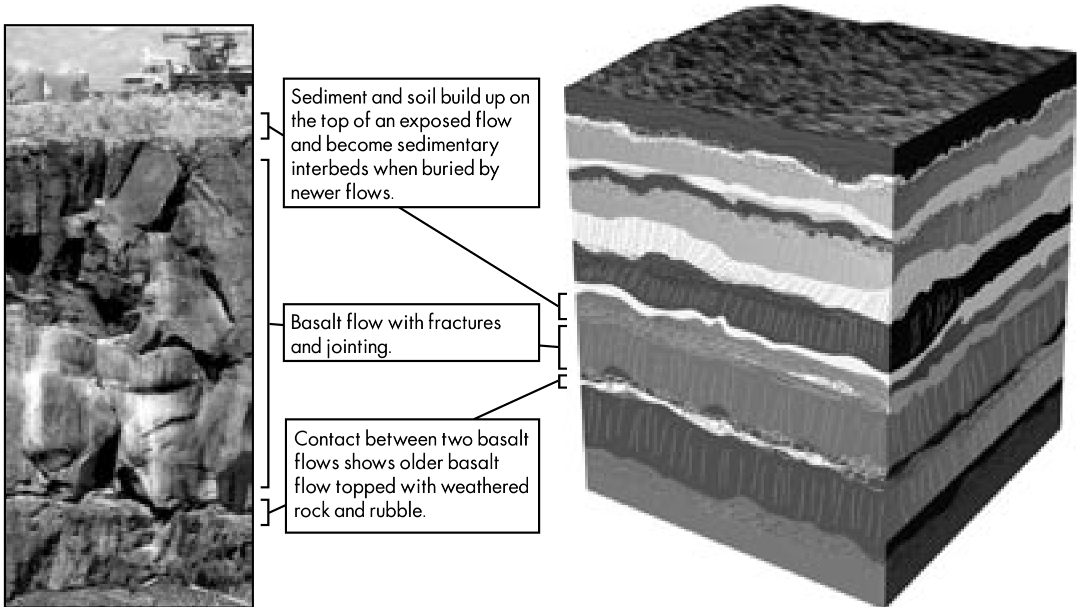
The cumulative, INEEL-wide risk assessment is referred to as Operable Unit 10-08. Results of the assessment are scheduled to be reported to the public in 2008. Updates on the status of activities will be provided at least yearly.

Geology of the Snake River Plain Aquifer

The Snake River Plain primarily consists of layered basalt flows that resulted from cycles of ancient volcanic activity. During periods of inactivity, soils and sediments were deposited on the basalt flows. Over several million years, the sequence of basalt flows and sedimentary interbeds became thousands of feet thick. Beneath the INEEL, individual basalt flows typically range in thickness from 5-50 ft. and may cover tens of square miles.

The Snake River Plain Aquifer is contained within this sequence of layered basalts. The depth to the surface of the aquifer (known as the water table) is about 200 ft. at the INEEL's northern border and increases gradually to about 900 ft. at the INEEL's southern border.

The Snake River Plain Aquifer is very productive, which is a result of its geological character. Water in the aquifer primarily moves within zones where older basalt flows were covered by new flows. When they are connected by fractures to similar zones, groundwater can move relatively quickly through the resulting network. Groundwater flow is also influenced by other features, such as volcanic dikes, buried vents, and sedimentary interbeds.



Over time, multiple basalt flows covered the Snake River Plain, forming a layercake of basalt beds separated by sedimentary interbeds and buried rubble zones.

The aquifer's productivity also is the result of a plentiful supply of recharge water. Vast amounts of moisture are trapped and stored as snow in the highlands of the Yellowstone Plateau and surrounding mountains. As this moisture is carried from the highlands by rivers, streams, and canals, some of it infiltrates into the ground to recharge the aquifer below. Irrigation and rainwater infiltration also contributes to recharge.

Most water flowing beneath the INEEL enters the aquifer at its northeastern end and moves through it in a southwesterly direction. Groundwater moves through the aquifer at velocities of 0.5-20 ft. per day, much faster than aquifers in general (where groundwater often moves a few feet per year). Scientists estimate that groundwater takes 50 to 100 years to travel from the southern boundary of the INEEL to the Snake River near Twin Falls, 100 miles away.

Glossary

acre-feet
The amount of water needed to cover one acre to a depth of one foot. The term is the basic measure of agricultural water use. One acre-foot of water (equivalent to 325,850 gallons) can irrigate an acre of alfalfa in the arid west for 10 days during the summer.

aquifer
An underground geologic formation through which water flows in a quantity useful to people.

attenuation
The physical, chemical, and biological processes that act without human intervention to reduce the mass, toxicity, mobility, concentration, or volume of contaminants in groundwater. Also referred to as "natural" attenuation.

contaminant plume
An area of groundwater contamination that usually stretches along the aquifer flow direction.

dispersion
The phenomenon by which a contaminant may be carried by water in a direction other than that of the groundwater flow. Dispersion is caused by both differences in the velocity that the water travels at the pore level and differences in flow paths through different strata.

drinking water standards (MCLs)
Also known as maximum contaminant levels (MCLs), these federal Safe Drinking Water Act standards establish the maximum levels of contaminants permitted in water delivered to any user of a public water system. These levels are established to protect public health.

groundwater
Water that soaks into the ground and percolates downward through rock or soil pores until it is stopped by an impermeable layer.

inorganic chemicals
Chemicals that include metals, and nitrates and nitrites. While many metals are essential to life, practically all are toxic in excessive quantities. Some metals, such as lead, are toxic in very small quantities.

Metals in the environment are commonly absorbed and concentrated by plants and animals. This can be dangerous for humans if they eat the plants and animals.

Nitrates and nitrites are simple compounds of oxygen and nitrogen. They also occur as a major part of animal waste, many commercial fertilizers, and byproducts of many industrial processes and form as an end-breakdown product for many nitrogen-containing chemicals.

In situ bioremediation
A cleanup method in which a nutrient is injected into a highly contaminated area to stimulate naturally occurring bacteria to break down volatile organic compounds into other harmless compounds.

monitoring wells
Wells that are used to collect groundwater samples from various depths, and are not used to supply drinking water. Groundwater samples, however, can also be collected from drinking water wells.

organic chemicals
Chemicals containing carbon. All known life forms are based on organic chemicals. Common products containing organic chemicals include gasoline and alcohol.

Many organic chemicals are readily absorbed by the body. Because the liver is the body's major site for chemical breakdown, some organic chemicals can cause liver damage and increase the likelihood of liver cancer.

Many organic chemicals are almost completely insoluble in water; they will either float or sink depending upon their density relative to water. For example, gasoline floats on the surface of water in a thin film; trichloroethene sinks.

perched water
Water that collects above a layer of relatively impermeable material, such as clay, and then slowly moves downward to the aquifer. Perched water zones are often present beneath reservoirs and industrial facilities, but disappear when the surface water source is eliminated.

radionuclides
Radioactive forms of elements. For example, iodine-129 is a radioactive form of iodine. Tritium is a radioactive form of hydrogen that is usually found as a component of water. Radionuclides are a special case of inorganic chemicals and are easier to detect in minute quantities due to their radioactive properties.

Radionuclides decay (emit radioactivity) at predictable rates called half-lives—the time it takes for half of the atoms in a quantity of a radionuclide to decay. After the passage of one half-life, half of the atoms originally present have decayed (50 percent remains undecayed). After the passage of another half-life, half of the remaining atoms have decayed (25 percent of the initial amount remains undecayed), and so forth. After seven half-lives, less than 1 percent of the radionuclide remains in its original form. The decayed form can be either another radionuclide or a non-radioactive substance.

Radionuclides, like all contaminants, can be inhaled as dust or ingested in food and water. Though some studies indicate low doses of radiation can have beneficial effects, radionuclides can damage the genetic material in cells and overexposure to radiation may lead to cancer.

Water containing tritium is almost identical to ordinary water except that it is radioactive and slightly heavier. Though there is no practical cleanup method to separate tritium-containing water from ordinary water, a quantity of tritium-containing water will contain less than 1 percent of its original radioactivity after an 86-year period (seven half-lives).

vadose zone
The region between the land surface and underlying aquifer.

DEPARTMENT OF ENERGY • UNITED STATES OF AMERICA

Information

- Specific documents, speakers, briefings, tours, public meetings, and comment periods, call (800) 708-2680.

1 800
708-2680

- Environmental topics: (208) 526-0075
- INEEL's website: **http://www.inel.gov**
- Idaho Completion Project website: **http://cleanup.inel.gov**
- INEEL Administrative Record (documents and source materials): **http://ar.inel.gov** and at the following locations:

INEEL Technical Library
DOE Public Reading Room
1776 Science Center Drive
Idaho Falls, ID 83415
208-526-1185

Albertsons Library
Boise State University
1910 University Drive
Boise, ID 83725
208-385-1621

More Resources

- The U.S. Geological Service (USGS), Water Resources Division, Idaho District: http://id.water.usgs/gov/
- The U.S. Environmental Protection Agency (EPA) Office of Groundwater and Drinking Water: 800-498-9198 or http://www.epa/gov/ebtpages/water.html
- The INEEL Oversight Program, which independently monitors activities at the INEEL on behalf of Idaho's citizens: 800-232-4635 or http://www.oversight.state.id.us

Publications

- *Summary of the Snake River Plain Regional Aquifer-System Analysis in Idaho and Eastern Oregon.* 1993. G. F. Lindholm, U.S. Geological Survey (USGS) Open-File Report 91-98, Boise, Idaho.
- *Upper Snake River Basin Study.* 1997. Idaho Department of Water Resources, 1301 N. Orchard St., Boise, Idaho.
- *Risk Assessment in Superfund: A Primer,* an EPA guide to risk assessment, available in Binder 300 of the Information Repositories, or by calling the EPA at 206-553-6901.

Idaho Completion Project

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