

LEGAL STANDARDS FOR CLEANUP

What Does the Law Say?

Washington State's Model Toxics Control Act (MTCA), and the federal Comprehensive Environmental Response, Compensation and Liability Act (CERCLA, also known as Superfund), require cleanup levels to be based on the highest beneficial use of groundwater.

The protection of subterranean water from pollution or degradation is of great concern.

RCW 36.36.010

It is the intent of the legislature to work closely with the executive branch, Indian tribes, local government, and interested parties to ensure that water resources of the state are wisely managed.

RCW 90.54.010

Any well which is unusable, abandoned, or whose use has been permanently discontinued, or which is in such disrepair that its continued use is impractical or is an environmental, safety or public health hazard shall be decommissioned.

WAC 173-160-381

HANFORD CLEANUP LINE

1-800-321-2008



DEPARTMENT OF
ECOLOGY
State of Washington

www.ecy.wa.gov/programs/nwp

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If you need this publication in an alternate format, please call the Nuclear Waste Program at 509-372-7950. Persons with hearing loss can call 711 for Washington Relay Service. Persons with a speech disability can call 877-833-634.

REMAINING CONCERNS

DOE is not putting sufficient funding into exploration of different or new technology.

Current technologies to treat groundwater and the vadose zone are inadequate.

We need more data to fully understand groundwater problems.

Additional contamination may move toward the Columbia River.

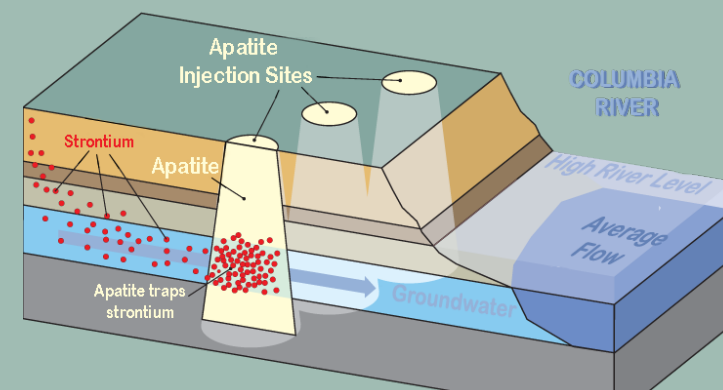
Groundwater and deep vadose zone cleanup is very expensive and funding is limited.

FOCUS ON APATITE

Apatite is a type of calcium phosphate that attracts strontium. In the 100 Area, apatite was pumped into the ground and the water table near the shoreline.

The strontium concentrations are highest within several feet of the water table. When the river rises, the groundwater also rises, allowing the apatite to capture more strontium.

This method of cleaning groundwater is very promising.



CLEANING HANFORD'S GROUNDWATER

HANFORD'S NUCLEAR LEGACY

The race to build the atomic bomb and win World War II - and later the Cold War - required a monumental effort. The U.S. government spent huge sums of money, and supported amazing scientific ingenuity. However, in their hurry, scientists created what is considered by many to be the most polluted spot in the western hemisphere.

More than 1.7 trillion gallons of liquid waste, radionuclides and hazardous chemicals were released to the ground at the Hanford Site in southeastern Washington State. Some of these contaminants are held in the soil above the water table (the vadose zone), some have reached the groundwater, and others have reached the Columbia River via the groundwater. The river remains safe for all uses, however, work is underway to stop or reduce further contamination.

The Washington State Department of Ecology's Nuclear Waste Program oversees the cleanup of groundwater at Hanford along with the U.S. Environmental Protection Agency. The U.S. Department of Energy and its contractors perform the actual cleanup work. The three agencies work through a cooperative agreement that sets deadlines and targets for cleanup. It is called the Tri-Party Agreement.

UNDERSTANDING GROUNDWATER ISSUES AT HANFORD

At Hanford, the geology below the ground's surface is very complicated. There are places where groundwater flows vertically and horizontally through sand and gravel deposited by the ice age floods.

Groundwater is replaced or "recharged" from the surface, or from nearby rivers, lakes, or streams. Groundwater may recharge quickly or slowly. If too much water is pumped from wells, recharge by natural precipitation or from surface water may not maintain the groundwater level. Groundwater can also build up, or mound, in areas where water used for industry or irrigation is discharged to the ground.

GROUNDWATER GLOSSARY

Groundwater is water filling in the cracks or pores between rocks or grains of sand at varying depths below ground surface.

An **aquifer** is an area where water moves easily, and its pores are completely saturated, much like a sponge full of water.

Confined aquifers are areas where the aquifer is contained between impervious (solid) layers.

Unconfined aquifers are where groundwater moves through saturated layers in the ground, slowly working its way in or out of the earth. Depending on the geologic make-up of an area, groundwater may rise to the surface through springs; flow laterally into nearby rivers, streams, or ponds; or sink deeper into the earth.

A **water table** is the top of an aquifer.

The **vadose zone** is the area between ground surface and the water table.

Ecology Publication #08-05-001

SOURCES OF GROUNDWATER CONTAMINATION AT HANFORD

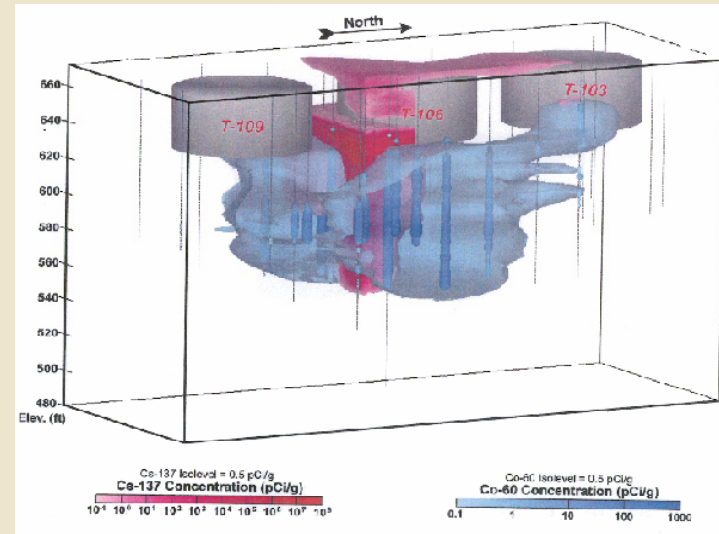
GROUNDWATER FACTS

About 80 square miles of Hanford's groundwater has contamination levels above federal and state drinking water standards.

Some of that contamination has reached the Columbia River, though the river is still safe for all uses.

The major **chemical contaminants** are nitrate, chromium, and carbon tetrachloride.

Major **radioactive contaminants** are uranium, technetium-99, tritium, strontium-90, and iodine-129.



This image from a three-dimensional model shows Cesium-137 (red) and Cobalt-60 (blue) contamination under the T series tanks.

Reverse Wells

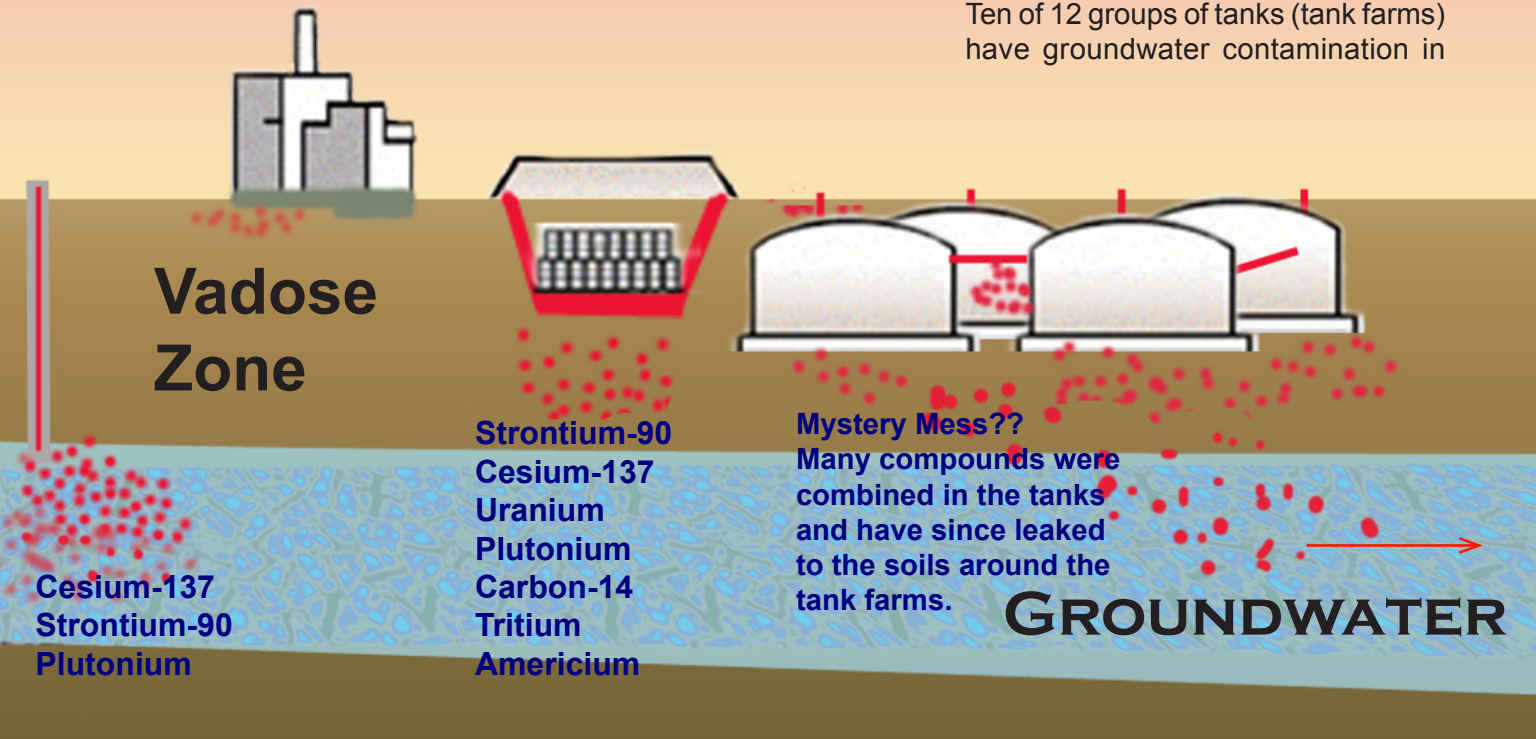
Also known as injection wells, reverse wells served as disposal areas for liquid contaminants by pumping them directly back into

Pits, Burial Trenches & Landfills

Solid and liquid wastes in barrels were buried in trenches, pits, and unlined landfills. As the containers break down, contaminants

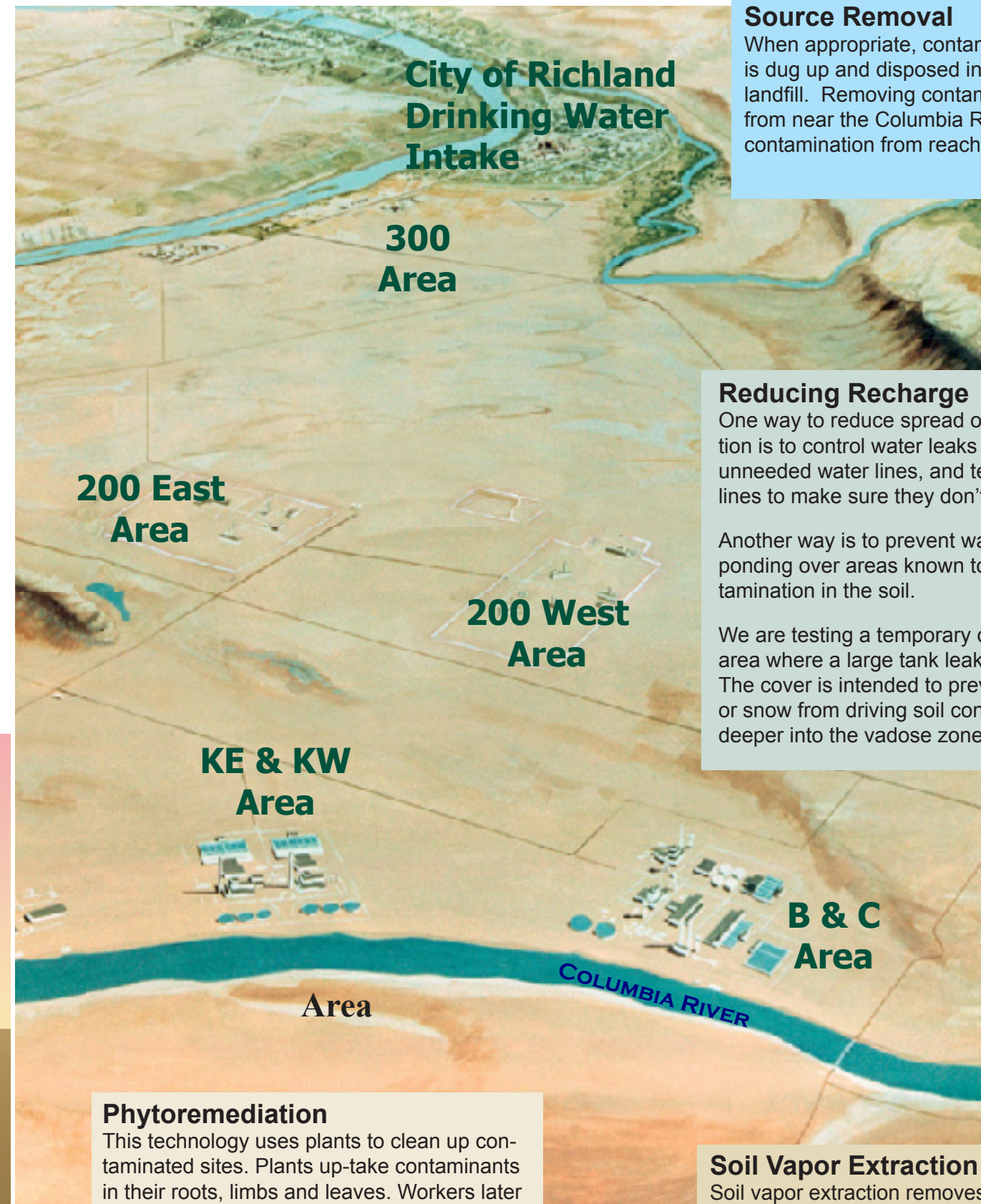
Underground Storage Tanks

There are 149 Single-Shell Tanks (SST's), and 28 Double-Shell Tanks (DST's) at Hanford. They store more than 53 million gallons of radioactive and chemical waste. About 1 million gallons have leaked from 67 SST's. Ten of 12 groups of tanks (tank farms) have groundwater contamination in



Source Removal

When appropriate, contaminated soil is dug up and disposed in a Hanford landfill. Removing contaminated soils from near the Columbia River prevents contamination from reaching the river.



Reducing Recharge

One way to reduce spread of contamination is to control water leaks by removing unneeded water lines, and testing other lines to make sure they don't leak.

Another way is to prevent water from ponding over areas known to have contamination in the soil.

We are testing a temporary cover over an area where a large tank leak occurred. The cover is intended to prevent rain or snow from driving soil contamination deeper into the vadose zone and into

Phytoremediation

This technology uses plants to clean up contaminated sites. Plants up-take contaminants in their roots, limbs and leaves. Workers later remove and dispose of the plants in a landfill.

We are presently testing phytoremediation using coyote willows to determine whether they will effectively remove strontium-90.

Soil Vapor Extraction

Soil vapor extraction removes harmful chemicals from the soil above the water table. Vapors are the gases that form when the chemicals evaporate. This method vacuums the vapors out of the soil.

In-Situ Redox Manipulation (ISRM)

ISRM is a treatment method that uses chemicals to immobilize groundwater contaminants below ground surface.

ISRM creates a permeable barrier that captures hexavalent chromium from groundwater.

The ISRM project in the 100 D Area at Hanford has successfully created a 2,230-foot treatment barrier for hexavalent chromium. As chromium crosses the barrier it changes into a non-hazardous form.

Natural Attenuation

Natural attenuation is a wait and watch approach. Some chemicals and radionuclides will degrade or stabilize on their own, over time. If a technology is unavailable to treat contamination, we will continue monitoring the groundwater and look for a treatment method.

Bio-Stimulation

Encouraging soil microbes to help in the cleanup process by feeding them is a technology new to Hanford.

Recently we used molasses to feed the microbes. Their use of oxygen as they multiply will change the chromium to a less toxic form. We plan to test vegetable oil as another way to encourage microbial activity in the future.

CLEANING GROUNDWATER TO PROTECT THE COLUMBIA RIVER



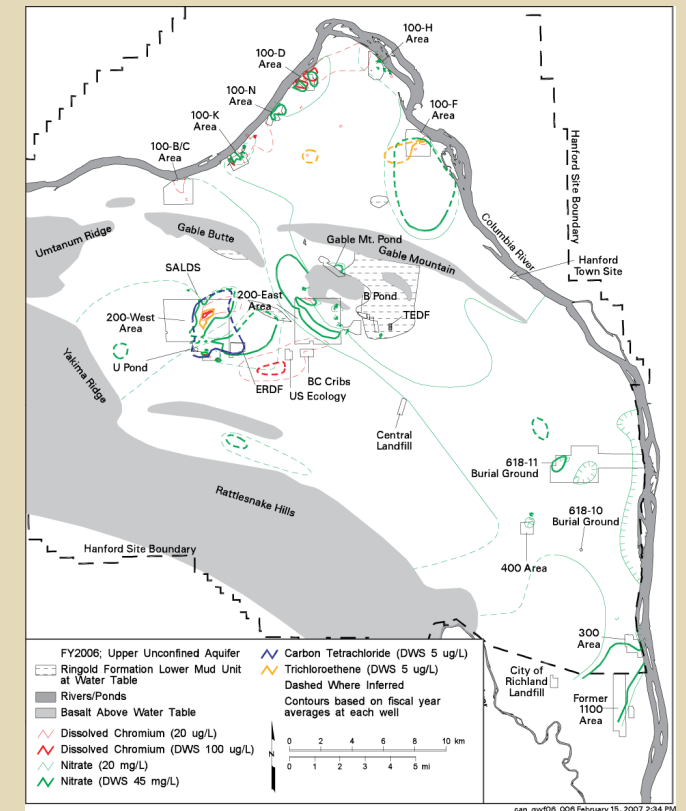
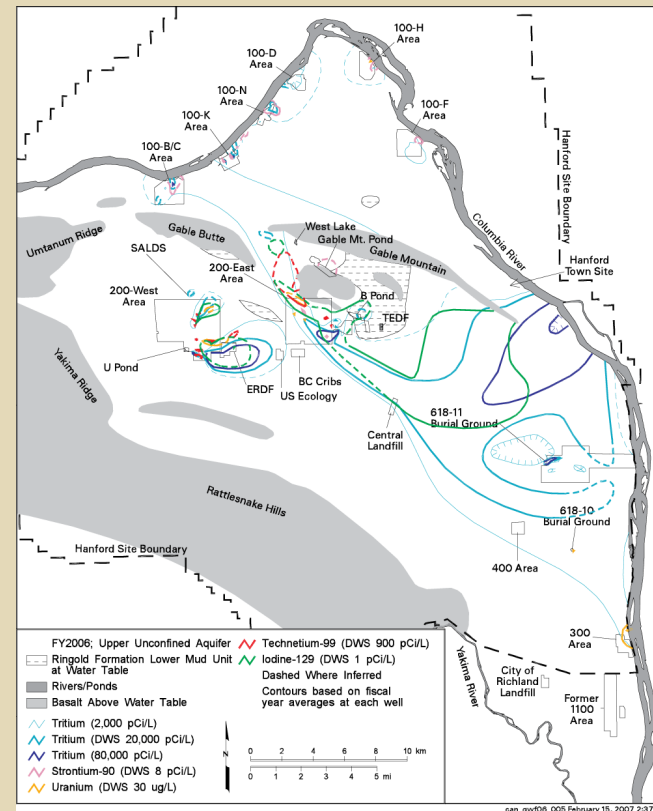
Pump & Treat

A pump and treat system pumps contaminated groundwater out of the ground, removes the contaminants, and injects the clean water back into the ground.

In most cases, pump and treat is time consuming and costly, and only addresses certain contaminants. However, there are cases where it is an appropriate interim solution. Pump and treat technology creates a secondary waste form which is safely disposed at a burial ground.

Calcium-phosphate Barrier

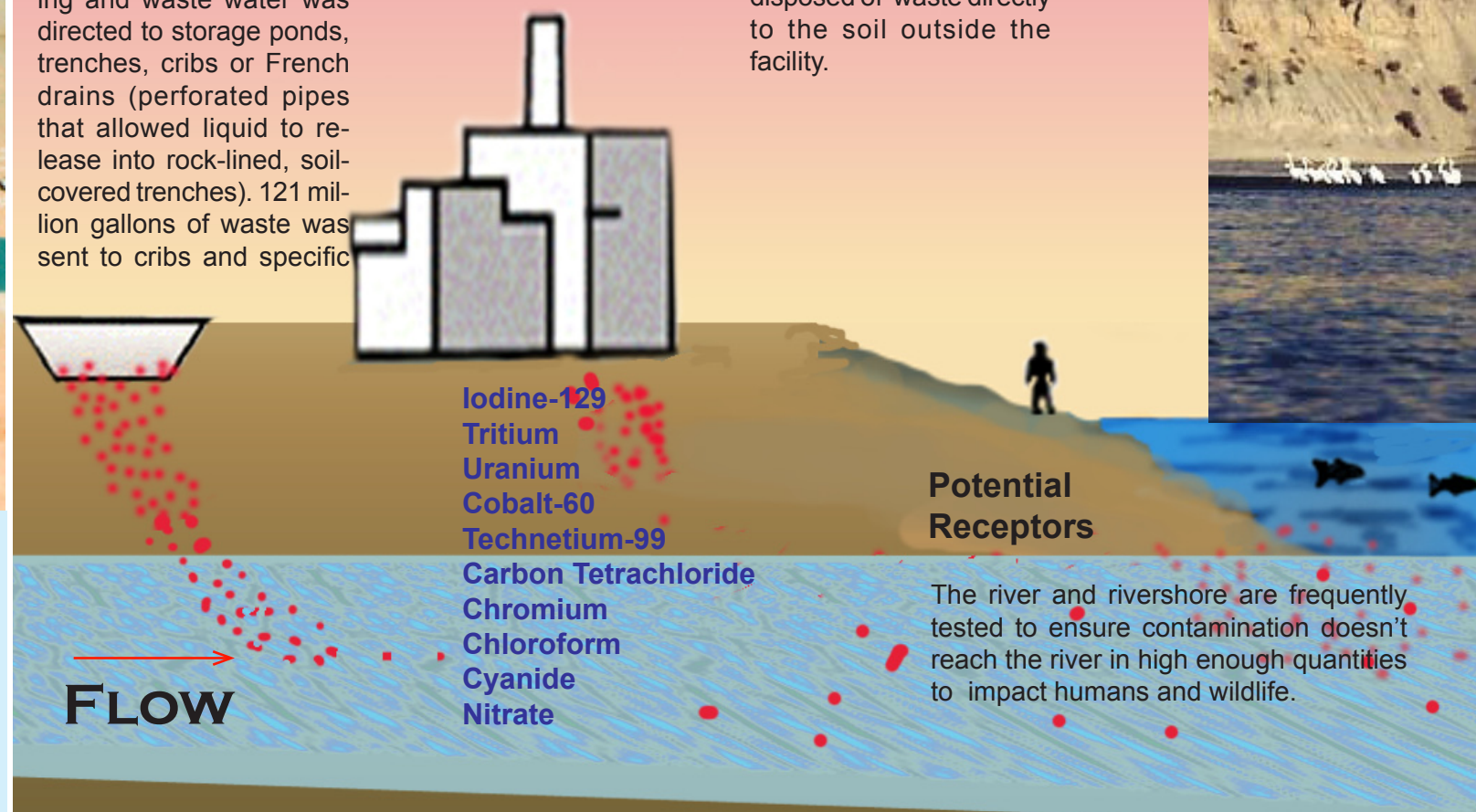
Also called "apatite," calcium phosphate is pumped into the ground where it forms an underground barrier by trapping radioactive strontium. The strontium binds to the phosphate creating a sort of "wall." The wall keeps more strontium from reaching the Columbia River.



These maps show various radioactive, and chemical contaminant plume concentrations at Hanford.

Cribs, Ponds, Trenches & French Drains

During production, cooling and waste water was directed to storage ponds, trenches, cribs or French drains (perforated pipes that allowed liquid to release into rock-lined, soil-covered trenches). 121 million gallons of waste was sent to cribs and specific



Plant Waste Discharge

Some facilities at Hanford disposed of waste directly to the soil outside the facility.



Potential Receptors

The river and rivershore are frequently tested to ensure contamination doesn't reach the river in high enough quantities to impact humans and wildlife.

TRACKING GROUNDWATER CONTAMINATION

Groundwater Monitoring

Groundwater at Hanford generally flows from west to east, or toward the Columbia River. Hanford had several areas where groundwater “mounded” or built up, as facilities discharged water to the ground.

As production ended, liquid discharge stopped. Groundwater mounds diminished, lowering water tables. Recently, water tables across the site have dropped, changing groundwater flow in some places or leaving monitoring wells high and dry. Some wells have been replaced with deeper wells.

At Hanford, about 650 wells are sampled each year to detect the extent and type of groundwater contamination. Monitoring data shows about 170 square miles of groundwater contamination. About 80 square miles of groundwater at Hanford is contaminated beyond safe drinking water levels.

More wells need to be installed in those areas for contaminant detection and assessment, and to meet the required regulations. The agencies are working to meet this goal.



Water is sampled across the site, as well as in the river shore, and river bottom.

HOW ARE CHEMICALS MEASURED?

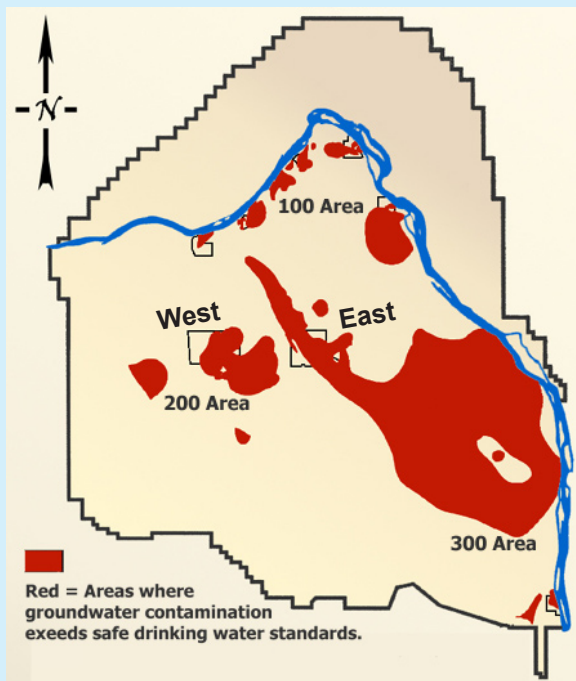
Organic and inorganic chemicals are measured in parts per million (ppm), or billion (ppb) in a liter of water. Sometimes ppm is used interchangeably with milligrams per liter (mg/L).

Vadose Zone Monitoring

The vadose zone is the area between the ground surface and the top of the groundwater table. The agencies monitor the vadose zone at many waste disposal and storage facilities. Sampling reveals contamination in the vadose zone in some places, especially under the waste tanks and waste disposal facilities in Central Hanford.

Columbia River Monitoring

In the early years at the Hanford Site, some contaminants were discharged directly to the river. While that practice has ended, some contaminants still enter the river from the groundwater. The river and plant community are monitored on a regular basis to determine the impact of contamination. River shore soil, river water, river bottom sediment, plants, aquatic biota and wildlife are all sampled. The samples are then analyzed for radionuclides and hazardous chemicals. Although reported results are well within surface water quality standards, Ecology remains vigilant and looks for ways to limit Hanford’s impact to the river.



MAJOR TYPES OF GROUNDWATER CONTAMINATION



Biostimulation to control chromium plume spread.

Carbon Tetrachloride

Carbon tetrachloride, an organic chemical, is found in the central part of Hanford. It contaminates about 6.8 square miles of groundwater reaching levels beyond the drinking water standard of 5 ppb. Carbon tetrachloride hasn’t been found in wells near the Columbia River. However, studies indicate contaminants may reach the river eventually. Soil vapor extraction to control plume expansion of carbon tetrachloride is underway.

Chromium

Chromium, an inorganic chemical, contaminates one square mile of groundwater near the river shore. Hanford is pursuing a more stringent cleanup than required by the drinking water standard, to protect aquatic animals. Chromium has entered the Columbia River. Remediation of chromium has successfully reduced toxicity and is slowing chromium contamination from entering the river.

WHAT’S pCi/L?

A Pico Curie is equivalent to the radioactivity present in one trillionth of one gram of pure radium.

Iodine-129

In the 200 East area, iodine-129 contaminates about 42 square miles of groundwater. The drinking water standard is 1 pCi/L. Remediation technology is not currently available.

Nitrates

Nitrates are an inorganic contaminant. About 25 square miles of Hanford groundwater are contaminated with nitrates. The drinking water standard for nitrates is 45 ppm, or as nitrogen is 10 ppm. Nitrate contamination has reached the Columbia River. Average contamination is slightly above drinking water standards. Large scale remediation of nitrate from groundwater is impractical.

Strontium-90

Radioactive strontium, polutes about one and a half square-miles of groundwater, mostly near the N and 200 East Areas. Strontium-90 has entered the Columbia River. The drinking water standard is 8 pCi/L. Remediation is underway and has reduced the strontium-90 entering the river.

Technetium-99

Technetium-99 is a long-lived radionuclide. In the 200 West Area, technetium-99 contaminates about one and a half square-miles. The drinking water standard is 900 pCi/L. Studies show that technetium-99 may reach the Columbia River. Remediation is underway to control contaminant plume expansion.

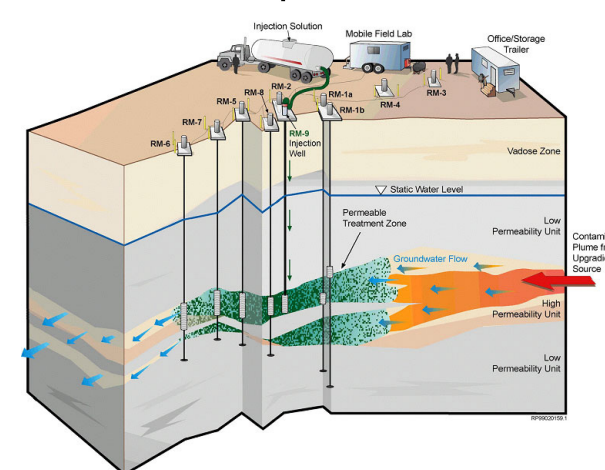
Tritium

The largest tritium plume is in the 200 East Area, but it is found throughout Hanford groundwater. About 84 square miles are contaminated, and it has entered the Columbia River. The drinking water standard for tritium is 20,000 pCi/L. Remediation technology is not currently available. However, tritium has a short half-life, so natural decay will play a major role in reducing contamination over time.

Uranium

Uranium contaminates about one square mile of groundwater in the 200 West Area and 300 Area. The 300 Area plume has entered the Columbia River. The drinking water standard is 30 pCi/L. Interim remediation to remove uranium is being conducted in the 200 West Area. In the 300 Area, natural attenuation for uranium (waiting for it to decrease on its own) has been unsuccessful. The agencies are still looking for a potential treatment method.

In Situ Redox Manipulation



Permeable treatment barriers treat water below ground by forming chemical ‘curtains.’