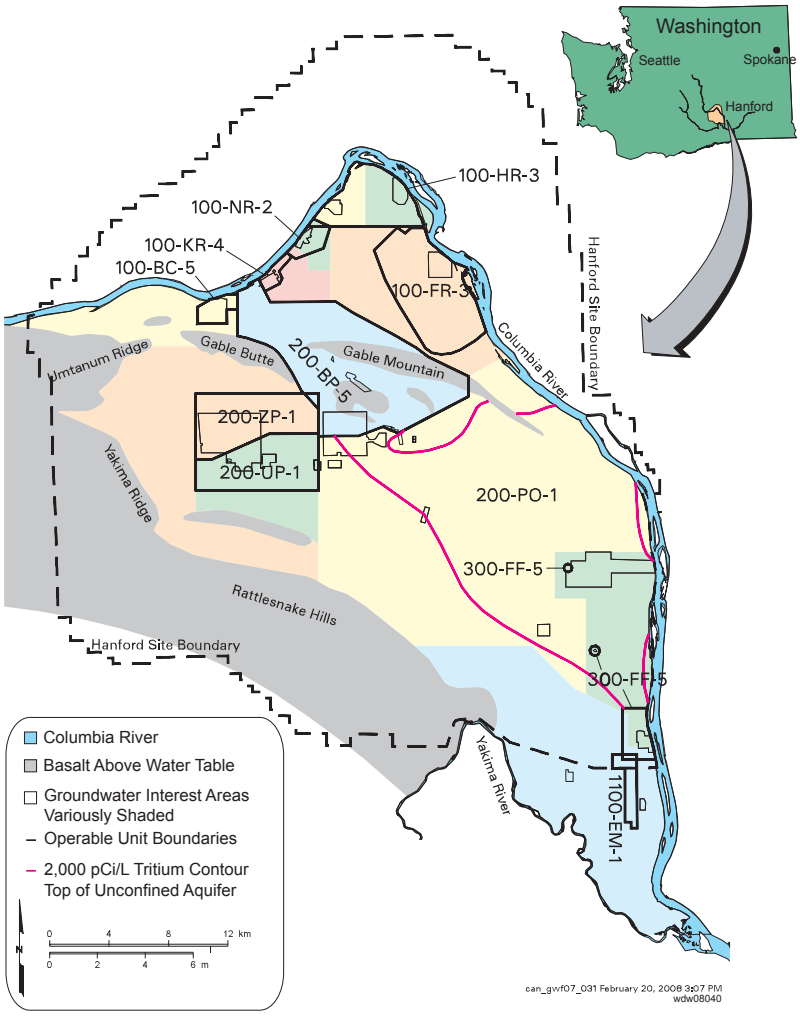
# Summary

## Introduction

The Hanford Site, part of the U.S. Department of Energy's (DOE) nuclear weapons complex, encompasses ~1,500 square kilometers in southeast Washington State. The Columbia River flows through the site. The federal government acquired the Hanford Site in 1943, and until the 1980s used it to produce plutonium for national defense. Management of waste associated with plutonium production has been a major activity throughout Hanford's history and continues today at a much reduced scale. Beginning in the 1990s, DOE has focused on cleaning up the site.

DOE is committed to protecting the Columbia River, human health, and the environment from Hanford's contaminated groundwater. As part of this commitment, DOE updated their groundwater management plan in 2007. The plan lays out steps for addressing groundwater and vadose zone contamination.

***The Hanford Site Groundwater Strategy focuses on three key areas: groundwater protection, groundwater monitoring, and remediation of contaminated groundwater.***




***Hanford Site groundwater monitoring is organized by areas of interest, which are informally named after the groundwater operable units. The areas of interest are useful for planning and scheduling groundwater monitoring and interpreting data.***

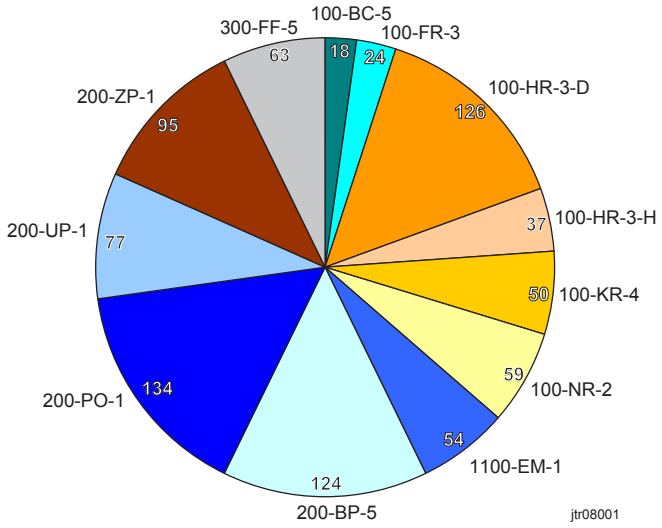
DOE monitors groundwater at the Hanford Site to fulfill a variety of state and federal regulations, including the *Atomic Energy Act* (AEA), the *Resource Conservation and Recovery Act* (RCRA), the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA), and *Washington Administrative Code* (WAC).

DOE Order 450.1, "Environmental Protection Program," implements requirements of the AEA. This Order requires environmental monitoring to detect, characterize, and respond to releases from DOE activities, assess impacts, and characterize exposure pathways. The Order recommends implementing a site-wide approach for groundwater protection. The Order requires compliance with other applicable environmental protection requirements.

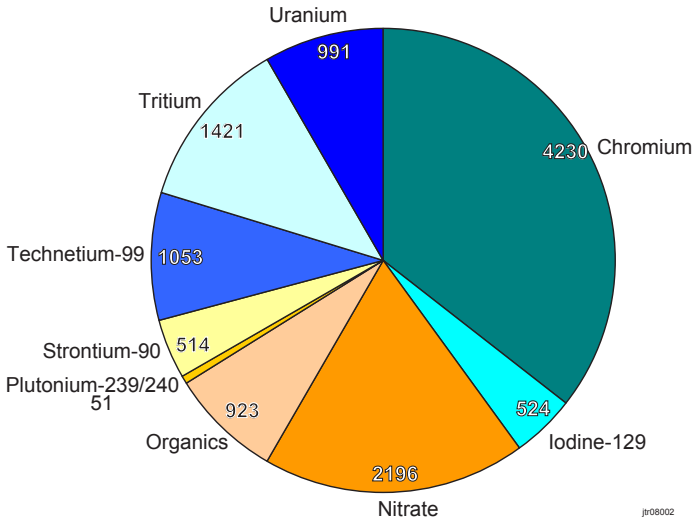
***DOE sampled 861 wells during FY 2007. Chromium, nitrate, and tritium are constituents most frequently analyzed.***

The Hanford Site has been divided into 56 operable units, or groupings of similar waste units within a geographic area, so that the CERCLA process can be efficiently implemented. Forty-six are source operable units and eleven are groundwater operable units. The concept of the groundwater operable unit was adopted to allow separate characterization of the waste sites and the groundwater. Separate characterization recognizes differences between localized contaminants in the soil column at the sources and the more wide spread, mingled contamination in groundwater. Monitoring wells are located and sampled in accordance with remedial investigation/feasibility study work plans to define the nature and extent of the contaminant plumes. Groundwater also is monitored under CERCLA to assess the effectiveness of groundwater remediation.

The groundwater monitoring requirements for Hanford's RCRA units fall into one of two categories: interim status or final status. A permitted RCRA unit requires final status monitoring as specified in WAC 173-303-645. RCRA units that have not yet been incorporated into permits require interim-status monitoring as specified in WAC 173-303-400, which invokes 40 CFR 265.




***This chart shows the number of wells sampled in each groundwater interest area in FY 2007.***




***The groundwater project requests specific laboratory analyses based on the wells location, historical contaminant trends, and regulatory requirements. This graph shows the number of analyses for the most common constituents during FY 2007.***

RCRA groundwater monitoring is conducted under one of three possible phases:

- **Indicator Parameter** (or final status detection). Initially, a detection program uses groundwater data to determine and monitor the impact, if any, of the facility on groundwater.
- **Assessment** (or final status compliance). If the detection monitoring results indicate a statistically significant change in chemistry, then an assessment or compliance phase of monitoring begins.
- **Corrective Action** (via administrative order for interim status sites or during final status). If the source of the contamination is determined to be the RCRA unit and the concentration exceeds applicable limits, then Washington State Department of Ecology (Ecology) may require corrective action. Groundwater is monitored to determine if the corrective action is effective.

***The analysis of groundwater samples provides data that help characterize the nature, potential fate, and transport of contaminants in the environment.***

Some contaminants reached the Columbia River by moving downward from waste sites, through the vadose zone, into the groundwater, and then into the river. Sampling groundwater helps determine how the contaminants move through the environment. DOE works with regulatory agencies such as the Environmental Protection Agency (EPA) and Ecology to make cleanup decisions based on sound technical information.

In fiscal year (FY) 2007, workers sampled 861 monitoring wells and 202 shoreline aquifer tubes to determine the distribution and movement of contaminants. This was an increase from the previous fiscal year of more than 84 wells. Many of the wells were sampled multiple times during the year.

A total of 4,230 samples of Hanford groundwater were analyzed for chromium, 2,196 for nitrate, and 1,421 for tritium. Other constituents frequently analyzed include technetium-99 (1,053), uranium (991), and carbon tetrachloride (923). These totals include results for routinely sampled groundwater wells, pump-and-treat operational samples, and aquifer tube samples.

## Emerging Items of Interest

This section briefly describes some of the high-priority groundwater topics for FY 2007. The groundwater chapter (2.0) of the full report contains additional details.

***Integrating Hanford's Groundwater and Vadose Zone Activities***. DOE has instituted a series of business processes to enhance integration across the projects engaged in groundwater and vadose zone activities at Hanford. Integrated Project Teams have been formed to ensure effective coordination of field investigations and timely communication of emerging data.

***DOE is focusing remediation efforts on activities that protect the Columbia River.***

***CERCLA Five-Year Review.*** In November 2006, DOE published the second five-year review of records of decision for remedial actions. The purpose of the review was to evaluate whether the remedies protect human health and the environment. The review recommended several actions relating to groundwater and DOE began to work on these in FY 2007, as discussed in the body of this report. More information on the five-year review is available at: http://www.hanford.gov, "CERCLA Five-Year Review."

***KW Reactor Chromium Plume.*** In 1998, chromium concentrations in groundwater near the KW Reactor began to rise. A new pump-and-treat system began to operate in FY 2007 and removed 15.8 kilograms of chromium from groundwater.

*A new treatment system in the 100-N Area, apatite sequestration, is immobilizing strontium-90 in the aquifer.*

***100-N Apatite Barrier.*** Workers injected apatite-forming chemicals into a line of wells along the 100-N Area shoreline in spring and summer 2007. Strontium-90 concentrations initially increased in many wells, but then declined to levels below those observed before treatment began.

***100-HR-3 Characterization and Testing.*** DOE installed 26 wells in the 100-HR-3 Operable Unit in FY 2007. The objectives of this work were to (a) characterize the chromium plume between 100-D and 100-H Areas; (b) locate the source of the chromium plume in south 100-D Area; (c) characterize deep chromium contamination, (d) test biostimulation, an in situ remediation method for chromium; (e) test micron-size iron injection, a method to increase effectiveness of the redox barrier in 100-D Area; and (f) test electrocoagulation, a water-treatment process.

***200-ZP-1 Pump-and-Treat Expansion.*** DOE issued a draft feasibility study and proposed plan for groundwater remediation in September 2007. The goal is to design a remediation system to remove carbon tetrachloride throughout the vertical extent of the aquifer. The expanded system will affect groundwater flow and contaminant movement through much of the operable unit.

***Treatability Test for Technetium-99 in 200-ZP-1 Extraction Wells.*** Groundwater in two of the carbon tetrachloride extraction wells west of Waste Management Area TX-TY have increasing technetium-99 concentrations. In FY 2007, DOE ran a treatability test to remove technetium-99 prior to carbon tetrachloride treatment so the radionuclide would not contaminate the groundwater around injection wells. The treatability test ran through October 2007, and results will be used to determine further actions.

***Technetium-99 Extraction at Waste Management Area T.*** Two wells downgradient (east) of Waste Management Area T, in the 200 West Area, were converted to extraction wells in May 2007. The wells are screened at the top of the aquifer and technetium-99 concentrations were over 22,000 pCi/L in one of the wells in FY 2007.

***200-UP-1 Pump-and-Treat.*** DOE restarted the pump-and-treat system for technetium-99 and uranium after a 2-year hiatus. Although concentrations had not risen to levels above current remedial action goals, DOE anticipated the cleanup goal for uranium changing to a lower concentration.

***300-FF-5 Studies.*** Scientists continued an aggressive campaign to investigate the uranium plume in the 300 Area in FY 2007. They updated computer simulations of groundwater flow and uranium transport, conducted a limited field investigation involving multiple characterization boreholes, updated the human health and ecological risk assessment, and assessed potential remedial action technologies for the uranium plume. DOE also continued to investigate the distribution of organic contaminants in groundwater beneath the 300 Area.

***EM-22 Technology Proposals.*** In FY 2006, the U.S. Congress authorized 10 million dollars for "...analyzing contaminant migration to the Columbia River, and for the introduction of new technology approaches to solving contamination migration issues." DOE's Office of Environmental Management (EM-22) administers these funds. Fluor Hanford, Inc. is leading the research on the following studies, which are summarized in this document:

- 100-D Area south chromium plume
  - – Inject micron-size iron into the deteriorating portions of the redox barrier.
  - – Refine location of the chromium source.
- 100-D Area north chromium plume
  - – Field test electrocoagulation for accelerated cleanup.

Pacific Northwest National Laboratory is leading the research on other EM-22 projects:

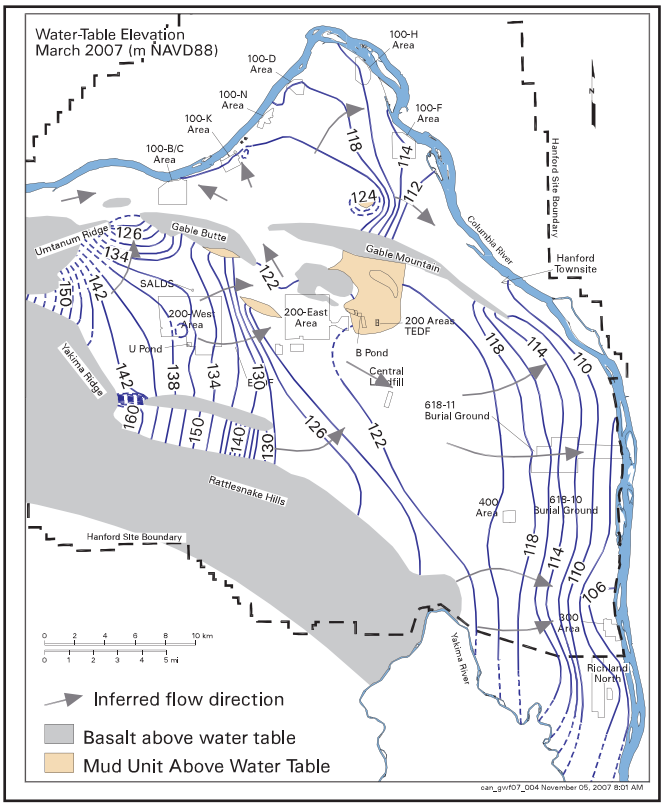
- Characterize chromium geochemistry in 100 Areas vadose zone sediment.
- Test biostimulation for remediation of chromium in 100-D Area.
- Investigate phytoremediation for strontium-90 in 100-N Area.
- Treat vadose zone strontium-90 in 100-N Area with surface infiltration of apatite.
- Study carbon tetrachloride and chloroform attenuation parameters.
- Stabilize uranium plume in 300 Area using polyphosphate.

More information on the EM-22 projects is available at http://www.hanford.gov/cp/ gpp/science/em21.cfm.

## Groundwater Flow

General directions of groundwater flow are illustrated on the water-table map for March 2007. The direction of groundwater flow is inferred from water-table elevations, barriers to flow (e.g., basalt or mud units at the water table), and the distribution of contaminants. Groundwater enters the unconfined aquifer from recharge areas to the west and eventually discharges to the Columbia River. Additional water infiltrates through the vadose zone beneath the Hanford Site. Hydrologists estimate that the total discharge of groundwater from the Hanford Site aquifer to the Columbia River is in the range 1.1 to 2.5 cubic meters/second. This rate of discharge is very small compared to the average flow of the river, ~3,400 cubic meters/second.

In the part of the site north of Gable Mountain and Gable Butte, unconfined groundwater flows generally toward the river. The water table beneath the 200 East Area is relatively flat because of the presence of highly permeable sediment of the Hanford formation at the water table. Groundwater enters the vicinity of the 200 East Area from the west and divides, with some migrating to the north through a gap between Gable Butte and Gable Mountain (Gable Gap) and some moving southeast toward the central part of the site. This groundwater divide is located near the




***This map shows the water table and inferred flow directions in March 2007. Areas shaded in gray or tan show where the unconfined aquifer is absent.***

northwest 200 East Area, but its precise location is not known. Ongoing studies will help determine the direction of groundwater flow in this region. In the south part of the Hanford Site, groundwater enters the 300 Area from the northwest, west, and southwest.

The natural pattern of groundwater flow was altered during the Hanford Site's operating years by water-table mounds. The mounds were created by the discharge of large volumes of waste water to the ground and were present in each reactor area and beneath the 200 Areas. Since effluent disposal decreased significantly in the 1990s, these mounds have dissipated in the reactor areas and have declined considerably in the 200 Areas. Currently, waste water is discharged to the ground at the State-Approved Land Disposal Site, north of the 200 West Area, affecting groundwater flow locally.

Groundwater flow in the unconfined aquifer is currently altered where extraction or injection wells are used for pump-and-treat systems. Extraction wells in the 100-K, 100-D, 100-H, and 200 West Areas capture contaminated water from the surrounding areas. Water flows away from injection wells, which are located upgradient of the contaminant plumes, so the injection increases the hydraulic gradient toward the extraction wells.

A confined aquifer occurs within sand and gravel of the lowest sedimentary unit of the Ringold Formation. It is confined below by basalt and above by the lower mud unit. East of the 200 East Area, where the water-table map is shaded tan, there is no unconfined aquifer, and groundwater in the Ringold Formation confined aquifer is still influenced by a residual recharge mound. Several wells north and east of the 200 East Area have shown evidence of intercommunication between the unconfined and confined aquifers. The intercommunication has been attributed to erosion of the upper Saddle Mountains Basalt and a downward hydraulic gradient. An upward gradient exists elsewhere in the 200 East Area/Gable Gap region, so it is expected that the upper basalt-confined aquifer discharges to the overlying unconfined aquifer, especially within Gable Gap where the Elephant Mountain Basalt was removed by erosion.

***DOE's cleanup plan includes the following elements: (a) remediate high risk waste sites, (b) shrink the contaminated area, (c) reduce recharge, (d) remediate groundwater, and (e) monitor groundwater.***

## Groundwater Monitoring and Remediation

DOE has developed a plan that lays out steps for cleaning up groundwater and the vadose zone. Key elements include:

- Continue to implement remedies that are working.
- Gather characterization data to help make informed decisions.
- Address emerging problems.
- Work with regulatory agencies to make remediation decisions.
- Identify new cleanup technologies.
- Continue to monitor groundwater to detect emerging problems and determine how well remedies are working.

The maps on pages xviii and xix show the distribution of nine principal groundwater contaminant plumes. Of the radionuclide plumes, tritium and iodine-129 have the largest areas with concentrations above drinking water standards. The dominant plumes had sources in the 200 East Area and extend toward the east and southeast. Less extensive tritium and iodine-129 plumes are also present in 200 West Area. Technetium-99 exceeds standards in plumes within both the 200 East and 200

West Areas. One technetium-99 plume extends northward from the 200 East Area. Uranium is less mobile than tritium, iodine-129, or technetium-99; plumes containing uranium are found in the 200 East, 200 West, and 300 Areas. Strontium-90 exceeds standards in the 100 Areas, 200 East Area, and beneath the former Gable Mountain Pond. Cesium-137, cobalt-60, and plutonium exceed drinking water standards in only a few wells in the 200 East Area.

**Area of Contaminant Plumes at Levels Above Drinking Water Standards (square kilometers)**

| Constituent (drinking water standard) | Fiscal Year 2000 | Fiscal Year 2006 | Fiscal Year 2007 |
|---|---|---|---|
| Carbon tetrachloride (5 µg/L) | 9.8 | 9.8 | 10.1 |
| Chromium (100 µg/L) | 2.8 | 2.0 | 2.2 |
| Iodine-129 (1 pCi/L) | 90 | 67 | 64 |
| Nitrate (45 mg/L) | 36 | 40 [(a)] | 37.3[(a)] |
| Strontium-90 (8 pCi/L) | 2.8 | 2.4 | 2.3 |
| Technetium-99 (900 pCi/L) | 2.3 | 3.9[(b)] | 2.3[(b)] |
| Trichloroethene (5 µg/L) | 4.2 | 3.0 | 2.6 |
| Tritium (20,000 pCi/L) | 180 | 120 | 127 |
| Uranium (20/30 µg/L)[(c)] | 2.0 | 1.6 | 1.4 |
| Combined Plumes[(d)] | 230 | 190[(a)] | 183[(a)] |

(a) Excludes 1100-EM-1 plume from offsite sources.
(b) Change is the result of changing interpretation of plume in 200-BP-5 interest area due to data from a new well.
(c) Area of uranium plume based on 20-µg/L standard in 2000 and 30-µg/L standard in subsequent years.
(d) Area with one or more constituents above drinking water standards.

Nitrate is a widespread chemical contaminant in Hanford Site groundwater; plumes originate from the 100 and 200 Areas and from offsite industry and agriculture. Carbon tetrachloride, the most widespread organic contaminant on the Hanford Site, forms a large plume beneath the 200 West Area. Other organic contaminants include chloroform, found in 200 West Area, and trichloroethene. Trichloroethene plumes that exceed the drinking water standard are found in the 100-F and 200 West Areas; a single well exceeded the standard in the 100-K Area. Wells completed at depth in the aquifer in the 300 Area also detected trichloroethene at levels above the drinking water standard. Chromium at levels above the 100-µg/L drinking water standard underlies portions of the 100-K and 100-D Areas, and the 600 Area west of 100-H Area. Chromium exceeds the state's aquatic standard (10 µg/L) in these areas and portions of the 100-B/C, 100-H, 100-F, and 600 Areas. Local plumes of chromium contamination also are present in the 200 Areas, particularly the north part of 200 West Area.

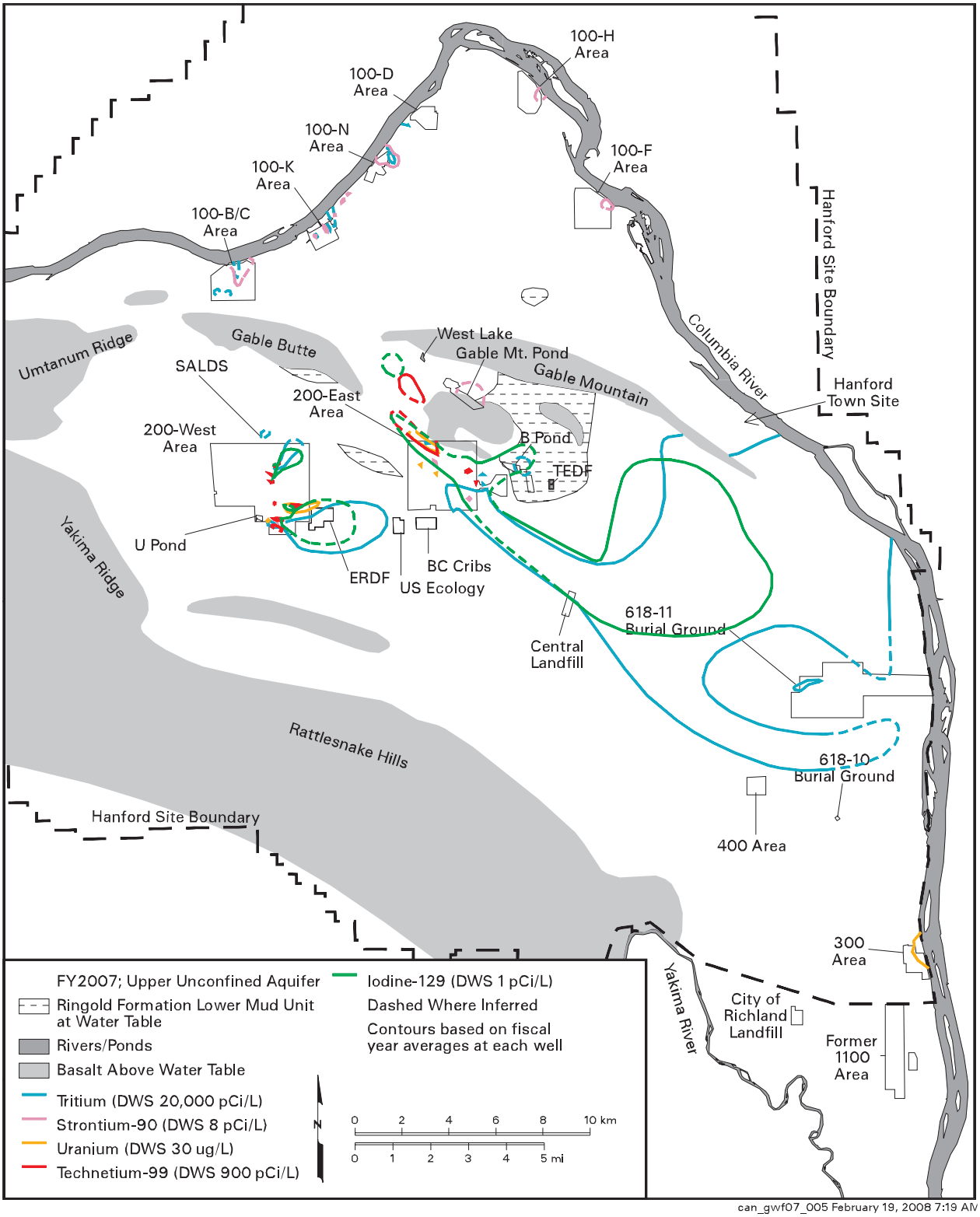
The following text discusses groundwater contamination, monitoring, and remediation for each of the 11 groundwater operable units and in the confined aquifers.

## 100-BC-5 Operable Unit

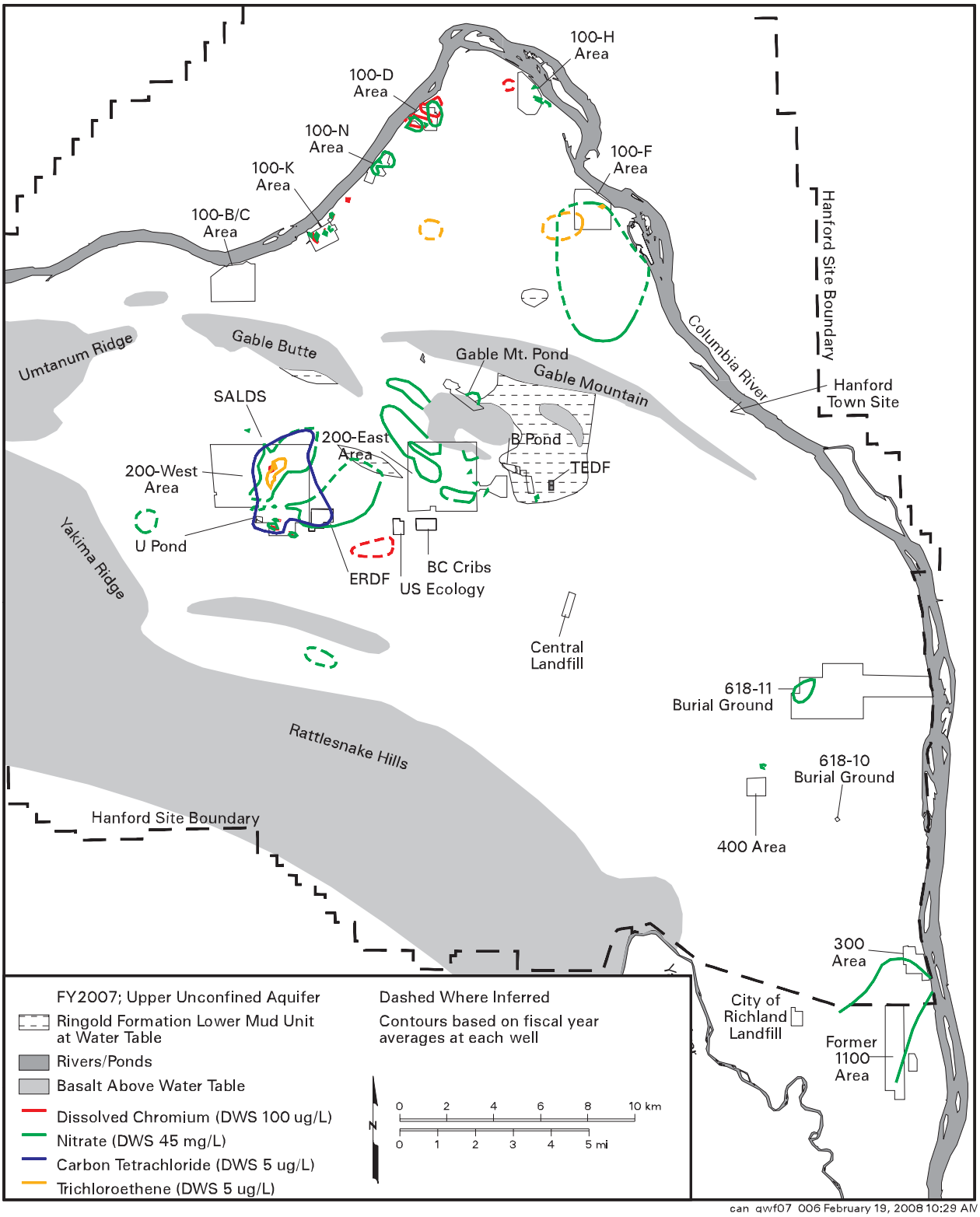
A complete discussion of the 100-BC-5 Operable Unit can be found in Section 2.2. Most of the groundwater contamination is found in the north portion of the area, beneath former waste trenches and retention basins. Tritium and strontium-90 exceeded drinking water standards in several wells. Tritium concentrations in two new wells in the south 100-B/C Area were unexpectedly high, exceeding the drinking water standard in one well. Nitrate and chromium continued to be below drinking water standards in recent years in the 100-B/C Area, but chromium exceeds the 10-µg/L aquatic standard.

***Two new wells in the south 100-B/C Area had elevated levels of tritium but low levels of chromium.***

A record of decision has not yet been developed for the 100-BC-5 Operable Unit, and no active remediation of groundwater is underway. Groundwater monitoring has continued since the initial remedial investigation and while waste site remedial actions are being conducted.

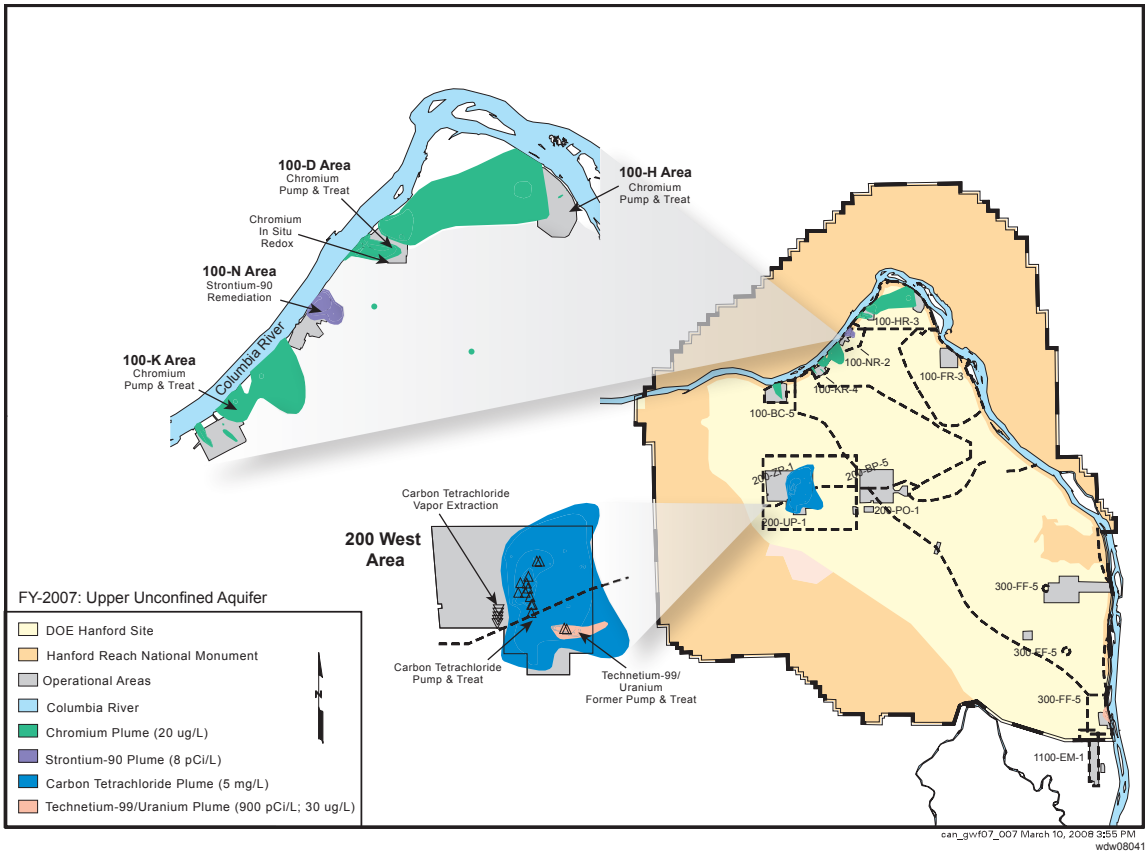



***This map shows the distribution of radionuclides in groundwater at concentrations above drinking water standards during FY 2007 in the upper part of the unconfined aquifer.***

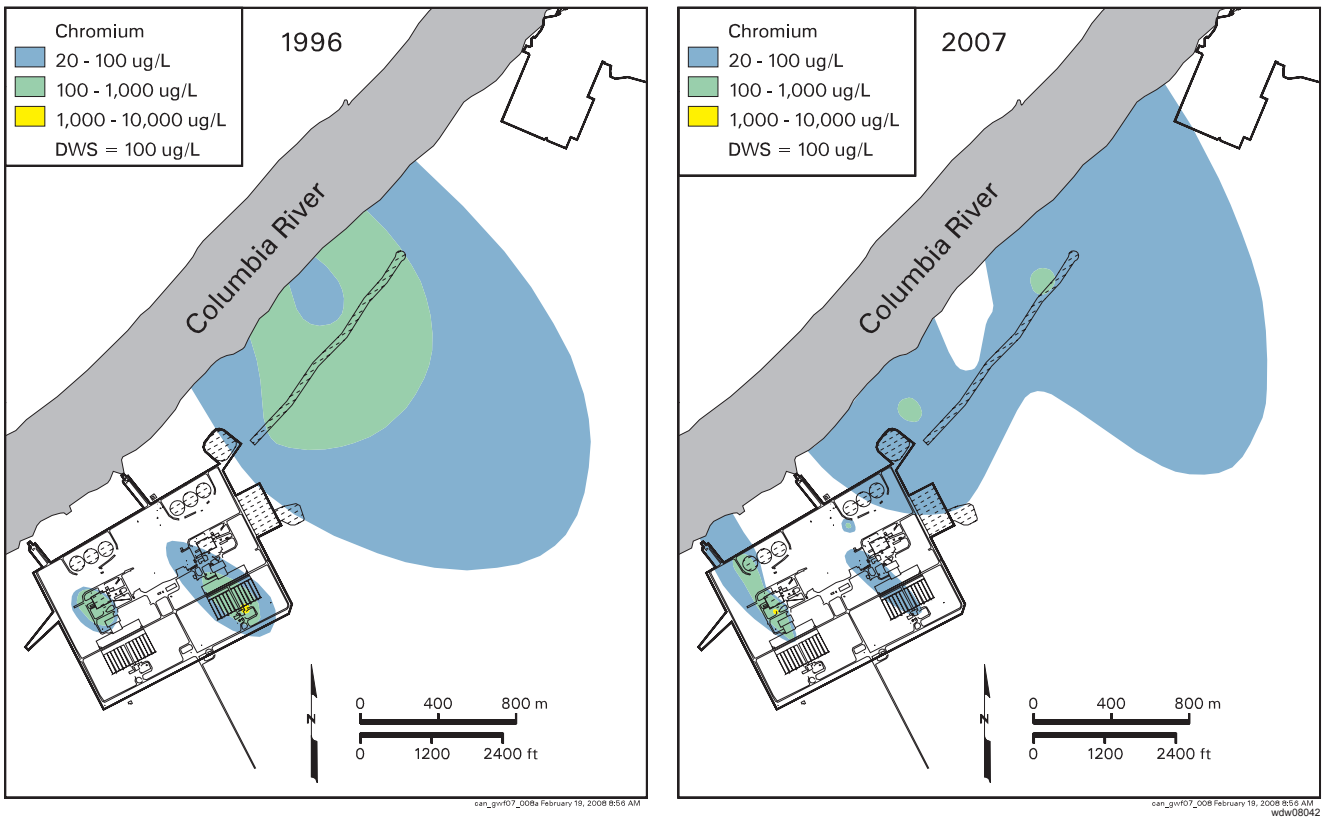



***This map shows the distribution of hazardous chemicals in groundwater at concentrations above drinking water standards during FY 2007 in the upper part of the unconfined aquifer.***

| Groundwater Remediation | | |
|---|---|---|
| Remedial Action Site | Startup Date | Progress From Startup to September 2007 |
| 100-K Area – 100-KR-4 Pump-and-Treat | 1997 | Decreases chromium to river; 328 kilograms removed. |
| 100-N Area – 100-NR-2 Pump-and-Treat | 1995 | 1.8 curies of strontium-90 removed. Extraction ceased March 2006. Injected apatite-forming chemicals to create permeable barrier in aquifer near shore. |
| 100-D Area – 100-HR-3 Pump-and-Treat | 1997 | Decreases chromium to river; 264 kilograms removed. |
| 100-D Area – DR-5 Pump-and-Treat | 2004 | Decreases chromium to river; 160 kilograms removed. |
| 100-D Area – 100-HR-3 In Situ Redox | 1999 | Decreases chromium concentrations downgradient of barrier. |
| 100-H Area – 100-HR-3 Pump-and-Treat | 1997 | Decreases chromium to river; 49 kilograms removed. |
| 200 West Area – 200-ZP-1 Pump-and-Treat | 1994 | Prevents high-concentration portion of carbon tetrachloride plume from spreading; 10,980 kilograms removed. |
| 200 West Area – Soil-Vapor Extraction | 1992 | Reduces carbon tetrachloride movement to groundwater; 79,200 kilograms removed. |
| 200 West Area – 200-UP-1 Pump-and-Treat | 1994 | System restarted January 2007. Decreases lateral migration of contaminants; 119 grams technetium-99 (2.02 curies) and 213 kilograms uranium removed. |
| Waste Management Area S-SX – Well 299-W23-19 Pump-and-Treat | 2003 | Decreased technetium-99 concentrations; 0.31 grams (0.0053 curie) of technetium-99 removed. |
| 300 Area – 300-FF-5 Natural Attenuation | Not applicable | Average trichloroethene concentrations below target level in wells; uranium concentrations above target level. |
| 1100-EM-1 – Natural Attenuation | Not applicable | Average trichloroethene concentrations below 5 µg/L since 2001. |




***DOE operates groundwater and vadose zone remediation systems to remove contaminants and limit their movement in groundwater and the vadose zone.***




***These maps show chromium in the upper part of the unconfined aquifer in the 100-K Area. Two pump-and-treat systems reduce the amount of chromium entering the Columbia River.***

## 100-KR-4 Operable Unit

A complete discussion of the 100-KR-4 Operable Unit can be found in Section 2.3. The principal groundwater issues in this operable unit include (a) cleaning up of chromium in groundwater; (b) tracking plumes from past-practices sites; and (c) monitoring groundwater near the KE and KW Basins. Interim remedial action involves two pump-and-treat systems that remove chromium from groundwater.

***Interim Remedial Action***. A pump-and-treat system is being used to remove hexavalent chromium from the aquifer beneath the 116-K-2 infiltration trench. Approximately 312 kilograms of chromium have been removed since startup in 1997. Although the mapped extent of contamination has remained fairly constant during the past 10 years, the area of highest concentrations (>100 µg/L) has decreased markedly. The concentration goal for the interim remedial action is 22 µg/L in groundwater near the Columbia River.

***The 100-K Area pump-and-treat systems now address a region near the KW Reactor and a region near the 116-K-2 trench.***

In 1998, chromium concentrations in groundwater near the KW Reactor began to rise. One new monitoring well had chromium concentrations >2,000 µg/L, higher than other wells in the area. In FY 2007, DOE began operating a new pump-and-treat system to clean up the KW plume. The system removed 15.8 kilograms of chromium during the year.

***Monitoring Past-Practice Waste Sites***. Other contaminants of potential concern in the operable unit are carbon-14, nitrate, strontium-90, trichloroethene, and tritium. Levels remain above drinking water standards, and decisions regarding groundwater remedial actions have been deferred until remedial actions of source areas are complete.

***Strontium-90 levels rose sharply in some of the 100-N Area aquifer tubes in August 2007. The increase was likely caused by side effects of apatite injections in nearby wells. Levels are expected to decline.***

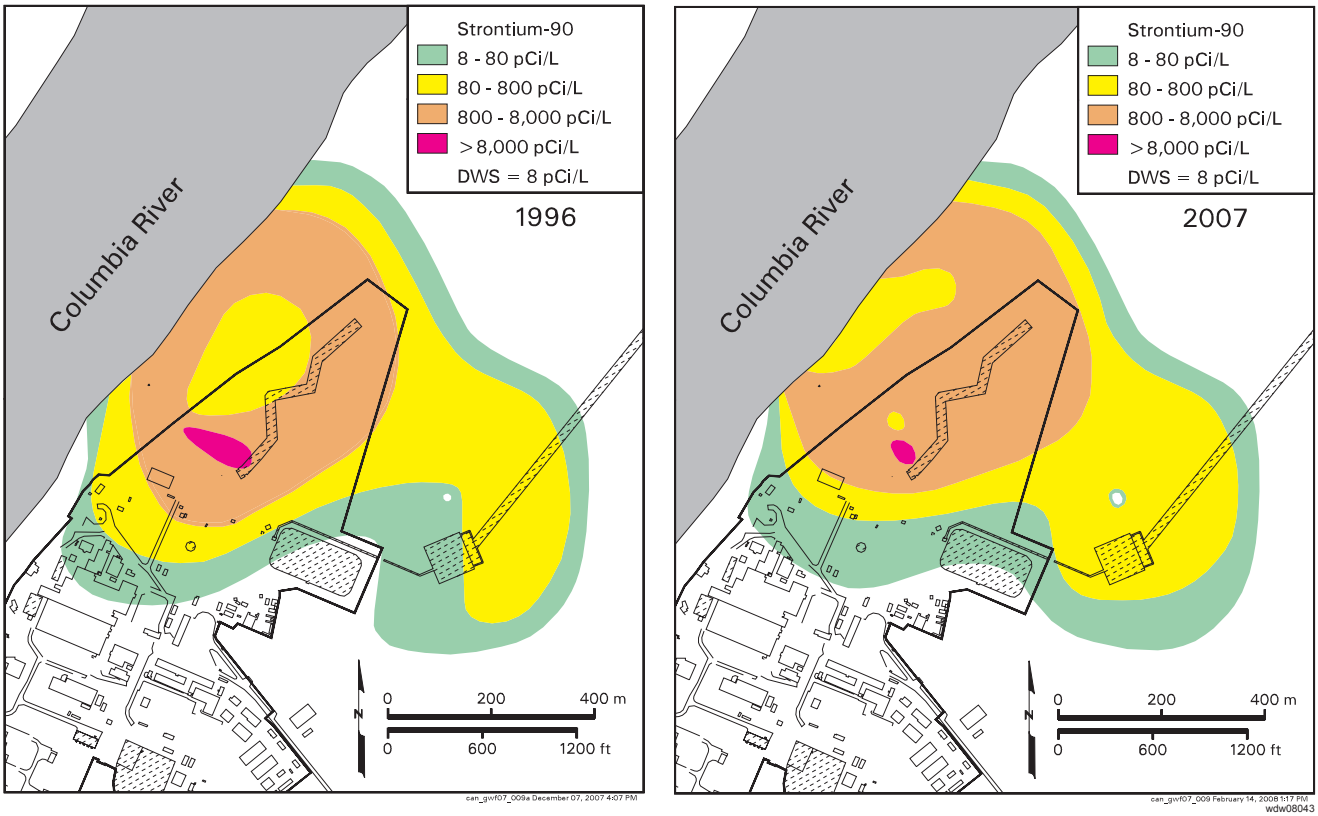
***K Basins***. The KE and KW Basins are integral parts of each reactor building. From the late 1970s to 2004, they were used to store irradiated fuel from the last run of N Reactor, as well as miscellaneous fuel fragments recovered from cleanup at other reactor areas. The basins still contain contaminated water, which DOE will remove in coming years. In FY 2007, monitoring of water levels in the basins and groundwater in downgradient wells indicated no new leaks.

## 100-NR-2 Operable Unit

A complete discussion of activities in the 100-NR-2 Operable Unit can be found in Section 2.4. The primary groundwater contaminant plume in the 100-N Area is strontium-90, which originated at two liquid waste disposal cribs. Tritium, nitrate, sulfate, and petroleum hydrocarbons also are present in 100-N Area groundwater.

***Interim Remedial Action***. DOE is applying an in situ technology to immobilize strontium-90 in the aquifer to prevent it from entering the Columbia River. Apatite-forming chemicals were injected into a line of wells along the river shore in FY 2007. The goal is to create a permeable, reactive barrier that will capture strontium-90 as groundwater flows through it to the river. Monitoring shows strontium-90 concentrations declined below baseline levels within the barrier and in downgradient monitoring wells. However, strontium-90 concentrations increased to new maxima in aquifer tubes downgradient of the barrier.

***116-N-1, 116-N-3, 120-N-1, and 120-N-2 (1301-N, 1325-N, 1324-N/NA) Facilities.*** Four RCRA units are located in the 100-N Area. During FY 2007, the sites remained in detection monitoring programs. AEA and CERCLA monitoring continued to track strontium-90 and tritium plumes from the 116-N-1 and 116-N-3 facilities and sulfate from the 120-N-1 pond.



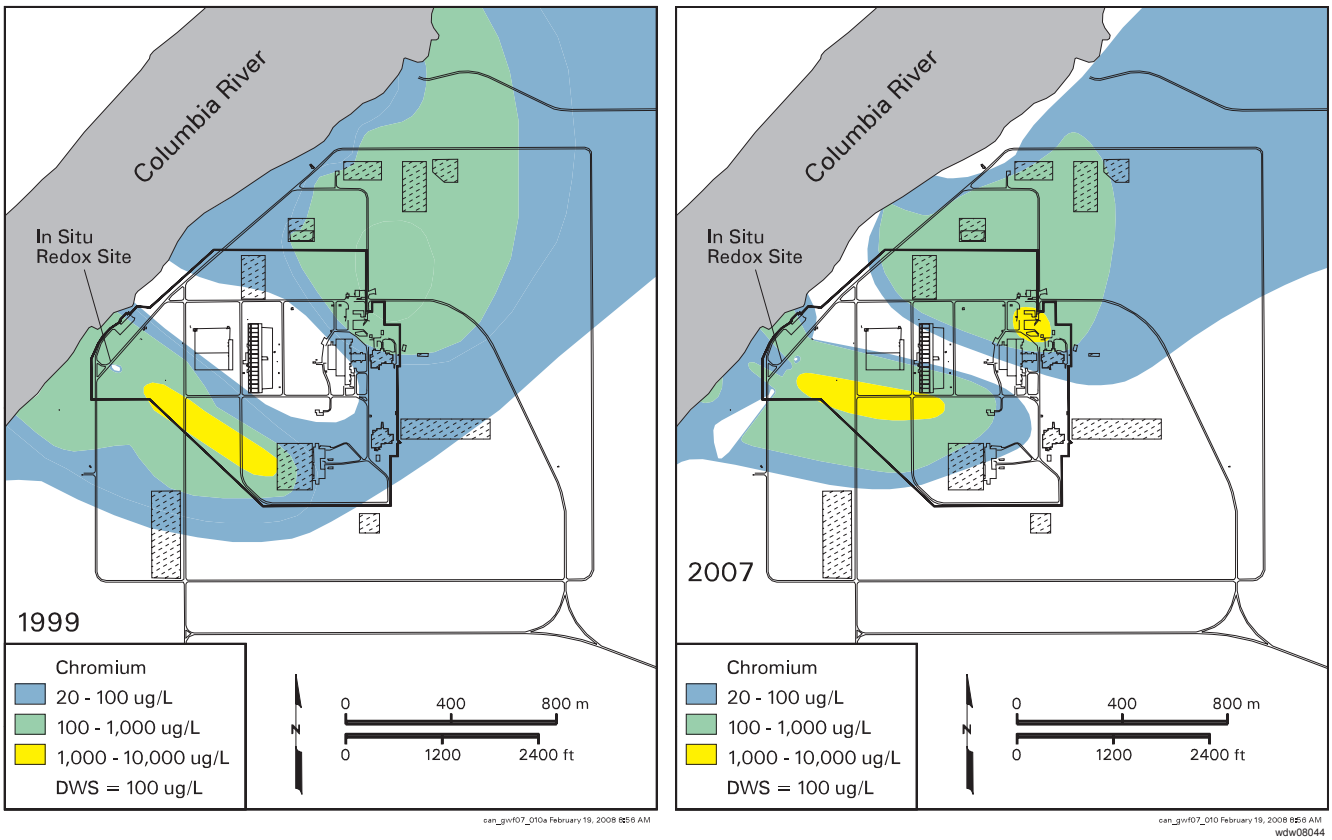

***The overall shape of the 100-N strontium-90 plume at the 8-pCi/L level has not changed in many years, despite the operation of the pump-and-treat system from 1995 until March 2006.***

## 100-HR-3-D Operable Unit

The 100-HR-3 Operable Unit underlies the 100-D and 100-H Areas and the region between. Hexavalent chromium is the primary contaminant of concern in groundwater beneath the 100-D Area, which comprises the west part of the operable unit (100-HR-3-D; described in Section 2.5). A principal cause for this contamination was the routine disposal of reactor coolant, which contained sodium dichromate as a corrosion inhibitor. A second cause was periodic spillage and leakage of sodium dichromate stock solution to the ground. Chromium is distributed in north and southwest plumes. Other contaminant plumes include tritium and nitrate.

***Three remediation systems in the 100-D Area operate to reduce the amount of chromium reaching the Columbia River. Data from new wells help characterize chromium in the vadose zone and east of the 100-D Area.***

***Interim Remedial Actions.*** The north chromium plume is the target of a pump-and-treat system, which is designed to reduce the amount of chromium entering the Columbia River. A second pump-and-treat system intercepts groundwater in the central 100-D Area near the shoreline. FY 2007, chromium concentrations remained above the remediation goal (22 µg/L) in compliance wells. The two extraction systems have removed 424 kilograms of chromium from the aquifer since 1997. The southwest chromium plume is being remediated with a permeable barrier that immobilizes chromium in the aquifer. Data from recent years indicate that chromium is breaking through the barrier. At the end of FY 2007, concentrations in barrier wells ranged from below detection limits to 880 µg/L, with concentrations in ~69% of the wells below the remedial action goal of 20 µg/L. Most of the elevated concentrations are in the northeast half of the barrier. Downgradient of the barrier, the 20-µg/L goal was met at two of the seven compliance wells.



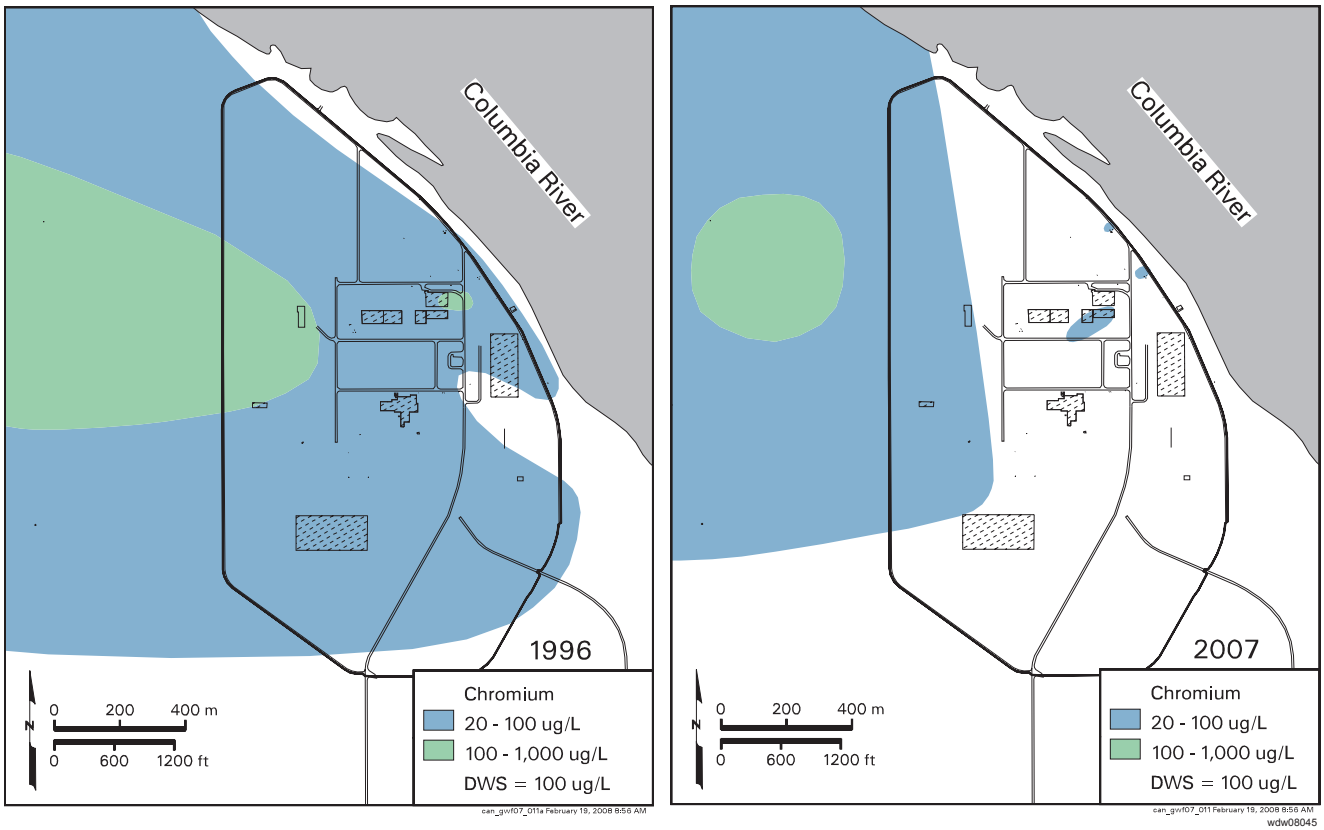

***These maps show chromium plumes in the upper part of the aquifer in the 100-D Area. To reduce the amount of chromium entering the Columbia River, DOE operates two pump-and-treat systems in the north and an in situ treatment system in the south.***

***Five-Year Review Actions.*** DOE has begun several investigations in the 100-HR-3 Operable Unit that address items identified in a November 2006 CERCLA review:

- *Chromium Source Investigation.* DOE installed wells to obtain samples from the vadose zone and to monitor groundwater near suspected sources in the south 100-D Area. Chromium levels in some of the wells were the highest ever observed in Hanford groundwater.
- *Chromium Plume in the Horn.* DOE installed wells and aquifer tubes to define the plume between 100-D and 100-H Areas, the region known as the "horn" of the Hanford Site. Data show that concentrations >20 µg/L extend across the horn.
- *Micron-Size Iron Injection.* Scientists think that injecting tiny particles of iron into redox barrier wells will help "repair" the barrier where chromium has been breaking through. A contractor conducted laboratory tests in FY 2007 to support this effort.

## 100-HR-3-H Operable Unit

A complete discussion of the east part of the 100-HR-3 Operable Unit (100-HR-3-H), which underlies the 100-H Area, can be found in Section 2.6. Hexavalent chromium is the primary contaminant of concern in this area, but the plume is smaller and concentrations are lower than in the 100-D Area. Nitrate levels also are above background, but have declined from their peak historical levels.




***A pump-and-treat system in the 100-H Area has reduced the amount of chromium entering the Columbia River. Between 1996 and 2007, concentrations decreased through most of the plume.***

Strontium-90 exceeds the drinking water standard (8 pCi/L) beneath former retention basins. Technetium-99 and uranium concentrations are detected in a small area but did not exceed drinking water standards in FY 2007.

***Chromium concentrations in 100-H Area have declined due to remediation and natural processes.***

***Interim Remedial Action.*** The chromium plume in the 100-H Area is the target of a pump-and-treat system. The remediation of the plume has removed 49 kilograms of hexavalent chromium from the aquifer since 1997. Hexavalent chromium concentrations in compliance wells were mostly below the 22-µg/L remedial action goal in FY 2007.

***Five-Year Review Action.*** DOE installed three wells as part of additional characterization of a deeper aquifer within the Ringold Formation upper mud unit.

***116-H-6 (183-H) Evaporation Basins.*** These former basins comprise the only RCRA site in the 100-H Area. Leakage from the basins contaminated groundwater with chromium, nitrate, technetium-99, and uranium. The site is monitored during the post-closure period to track contaminant trends during the operation of the CERCLA interim action for chromium.

### 100-FR-3 Operable Unit

A complete discussion of the 100-FR-3 Operable Unit can be found in Section 2.7. Nitrate concentrations in groundwater exceed the drinking water standard beneath much of the 100-F Area and the downgradient region. Other groundwater contaminants include strontium-90 and trichloroethene. Chromium exceeds the 10-µg/L aquatic standard in some wells.

A record of decision has not yet been developed for the 100-FR-3 Operable Unit and no active remediation of groundwater is underway. Monitoring contaminant conditions has continued since the initial remedial investigation and while waste site remedial actions are conducted.

### 200-ZP-1 Operable Unit

A complete discussion of the 200-ZP-1 Operable Unit can be found in Section 2.8. This operable unit encompasses the north portion of the 200 West Area. The primary contaminant of concern is carbon tetrachloride. Other contaminants include tritium, nitrate, chloroform, chromium, fluoride, iodine-129, technetium-99, trichloroethene, and uranium.

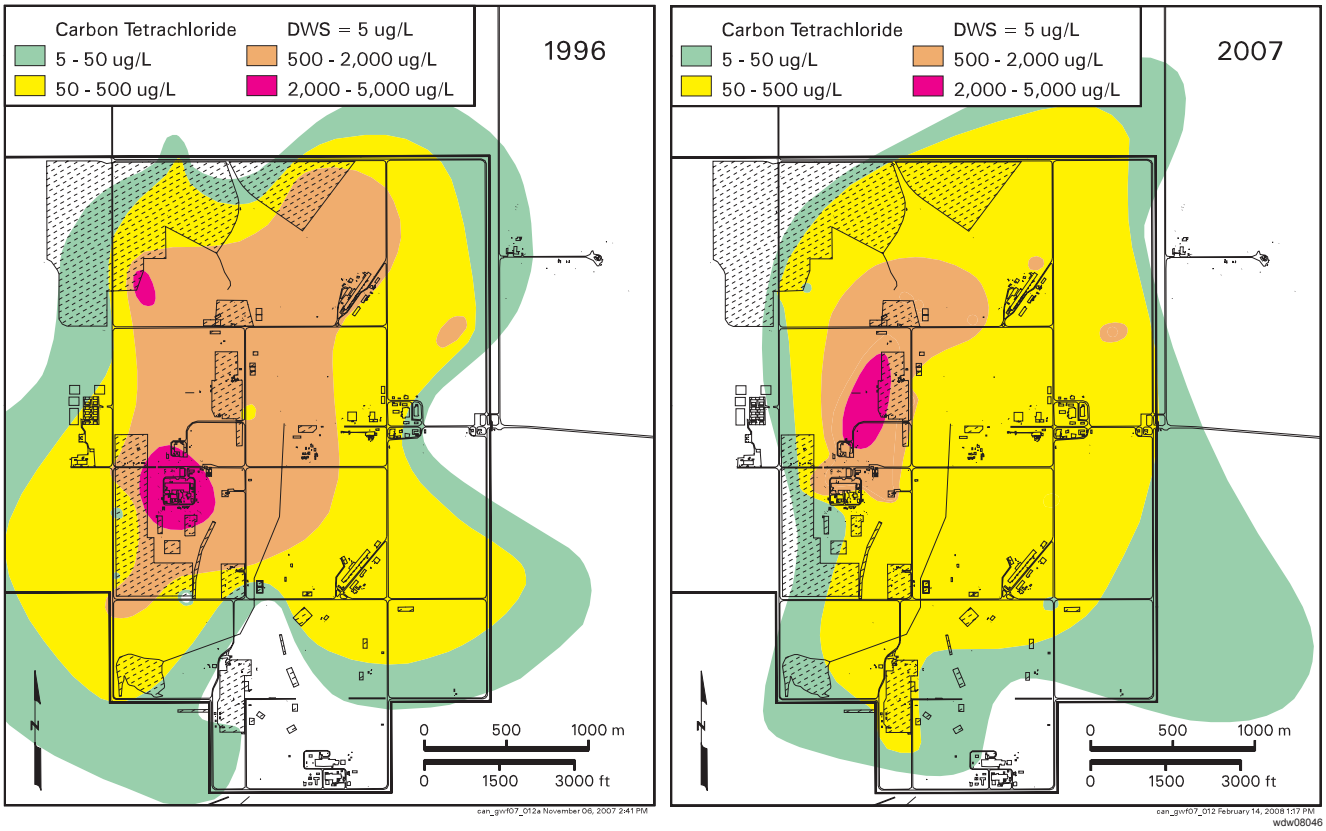
Work on the feasibility study for the 200-ZP-1 Groundwater Operable Unit is ongoing. DOE published the remedial investigation report in October 2006 and a draft of the feasibility study/proposed plan in September 2007. DOE installed four new monitoring wells in this operable unit in FY 2007.

***Carbon tetrachloride contamination varies with depth in the aquifer.***

The distribution of carbon tetrachloride is complex because it can migrate as a dense, non-aqueous phase liquid, as a gas, and dissolved in water. The contamination occurs at increasing depth to the east (downgradient) of the known source areas. In this area natural and artificial recharge may have led to reduced carbon tetrachloride concentrations in the upper portion of the aquifer. Contamination in wells screened deeper in the aquifer indicates that a greater mass is present in the unconfined aquifer than previously calculated.

The 200-ZP-1 interest area contains one CERCLA interim action for groundwater, one remediation system for the vadose zone, four facilities monitored under RCRA (in conjunction with CERCLA and AEA), and one state-permitted unit.

***Interim Remedial Action.*** Since 1994, DOE has operated an interim action pump-and-treat system to prevent carbon tetrachloride in the upper part of the aquifer




***These maps show the carbon tetrachloride plume beneath the 200 West Area in the upper part of the unconfined aquifer. Since 1996, a pump-and-treat system in the 200-ZP-1 Operable Unit is helping prevent further spreading of the core of the plume.***

***Groundwater and vadose zone remediation systems have removed over 90,000 kilograms of carbon tetrachloride from the subsurface.***

from spreading. The system has removed ~11,000 kilograms of carbon tetrachloride from groundwater.

***Soil-Vapor Extraction***. Soil vapor is extracted from the vadose zone and treated to remove carbon tetrachloride. The system has removed ~79,200 kilograms of carbon tetrachloride from the vadose zone since operations started in 1991.

***Low-Level Burial Grounds Waste Management Areas 3 and 4***. RCRA groundwater monitoring continued under interim status requirements in FY 2007. The groundwater flow direction changed after liquid effluent discharges in 200 West Area ceased. The change left Low-Level Waste Management Area 3 without any upgradient wells. Until new upgradient wells are installed and background conditions are established, statistical evaluations have been suspended.

***Waste Management Area T.*** RCRA assessment monitoring continued in FY 2007. The waste management area has introduced technetium-99 and other tank waste contaminants to the uppermost aquifer in the area. In September 2007, two downgradient wells on the east side of the tank farms were converted to extraction wells to remove technetium-99 from the aquifer.

***Waste Management Area TX-TY.*** RCRA assessment monitoring continued in FY 2007. Sources in the waste management area have contaminated groundwater with chromium, technetium-99, and other tank waste constituents. Groundwater flow beneath Waste Management Area TX-TY is changing due to the operation of the 200-ZP-1 pump-and-treat remediation system. Extraction wells operate south

and west of the waste management area. Because of the change in flow direction, the monitoring network no longer performs as originally designed.

***State-Approved Land Disposal Site***. This active disposal facility is regulated under a state waste discharge permit. Groundwater is monitored for tritium and 15 other constituents. Concentrations of all constituents considered in the permit did not exceed enforcement limits during FY 2007.

## 200-UP-1 Operable Unit

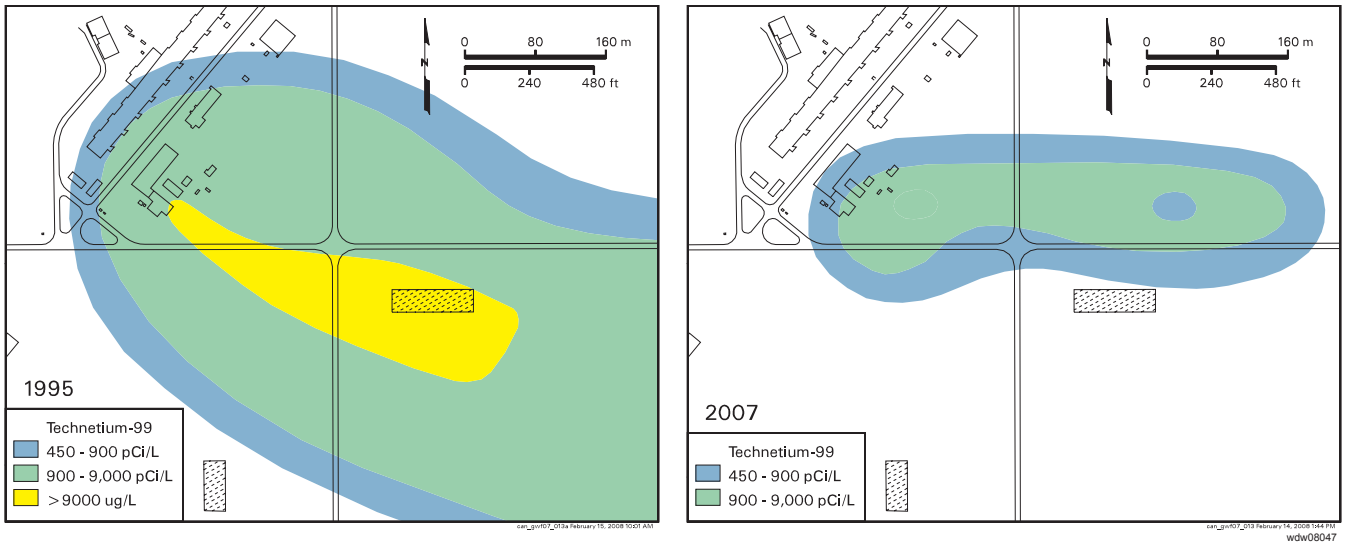
A complete discussion of the 200-UP-1 Operable Unit can be found in Section 2.9. This operable unit underlies the south portion of 200 West Area. The primary contaminants of concern are technetium-99 and uranium. Tritium, chromium, iodine-129, and nitrate plumes also have sources in this operable unit. Carbon tetrachloride in the 200-UP-1 Operable Unit originated from sources in the 200-ZP-1 Operable Unit. One new monitoring well was drilled in this operable unit in FY 2007.

***DOE resumed operation of a pump-and-treat system near U Plant to contain the technetium-99 and uranium plumes there.***

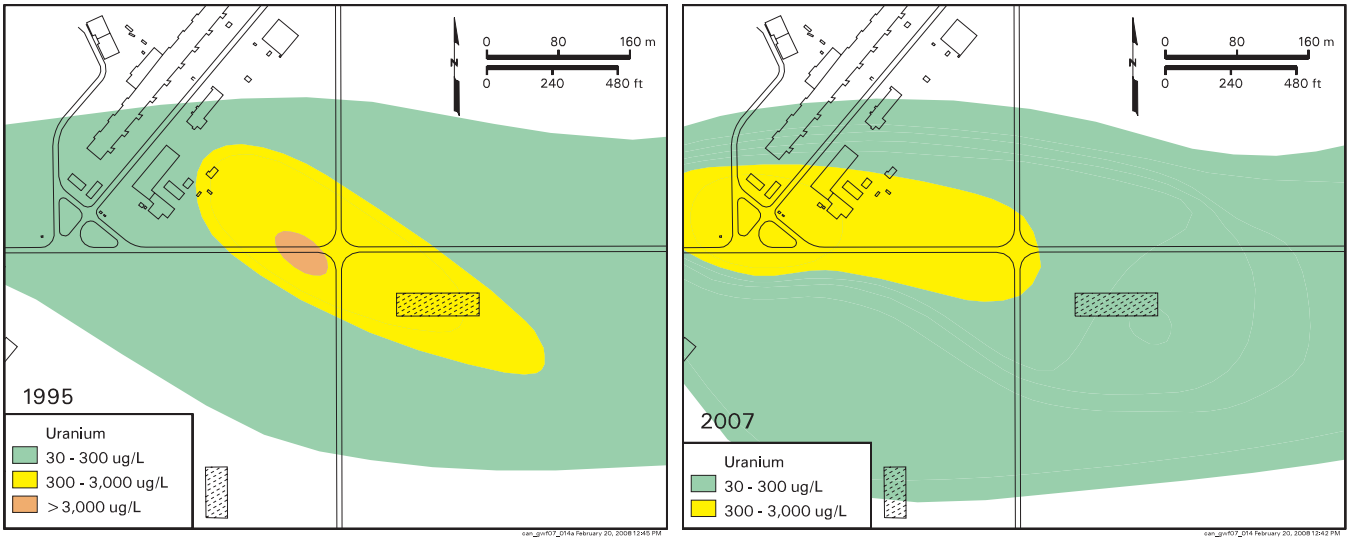
The 200-UP-1 Operable Unit contains four facilities monitored under RCRA (in conjunction with CERCLA and AEA), one CERCLA interim action, and one CERCLA disposal site.

***Interim Remedial Action.*** DOE operated an interim remedial action pump-and-treat system for technetium-99 and uranium from 1994 until early 2005. The effort successfully reduced contaminant concentrations below remedial action goals. DOE shut down the system in January 2005 and conducted a rebound study. The remedial action goal for uranium was ten times the Washington State *Model Toxics Control Act* cleanup standard at the time the record of decision was issued, which was 48 µg/L. Since that time, EPA established a drinking water standard of 30 µg/L. In expectation that the remedial action goal will be revised to 300 µg/L (ten times the current standard), DOE resumed groundwater extraction in April 2007. Restarting the pump-and-treat system was a response to an action identified in the November 2006 CERCLA five-year review.

***Waste Management Area S-SX.*** RCRA assessment monitoring continued in FY 2007. Groundwater beneath this waste management area is contaminated with tank waste constituents, which include nitrate, chromium, and technetium-99




***A pump-and-treat system at the 200-UP-1 Operable Unit (200 West Area) has decreased the size of the technetium-99 plume in the upper part of the aquifer. The system began to operate in fall 1995.***




***Uranium contamination in the 200-UP-1 Operable Unit (200 West Area), although now below the remedial action goal, did not respond to the pump-and-treat system as quickly as the technetium-99. Unlike technetium-99, uranium interacts with sediment grains, slowing its movement and response to remediation.***

attributed to two general source areas within the waste management area. In the north plume, concentrations of the mobile tank waste constituents increased in FY 2007. Both plumes continued to expand in a downgradient direction.

***The 216-U-12 Crib has been reclassified as a RCRA past-practice unit.***

***Waste Management Area U.*** RCRA assessment monitoring continued in FY 2007. The waste management area has been identified as the source of groundwater contamination that is limited to the downgradient (east) side of the site. Plume constituents of interest include nitrate and technetium-99. One monitoring well went dry during FY 2007.

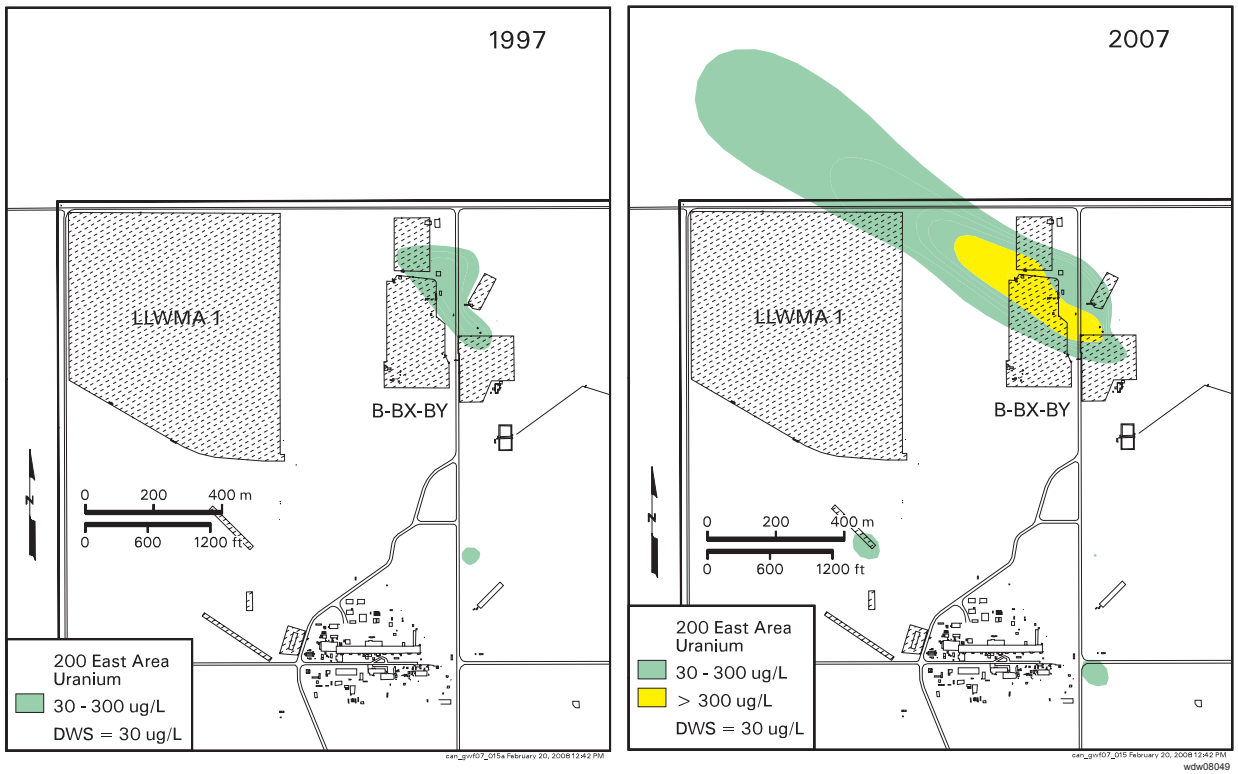
***216-U-12 Crib.*** RCRA assessment monitoring continued in FY 2007. The crib is one of several sources that have contributed to a nitrate plume in the area. In June 2007, the Tri-Parties approved two Tri-Party Agreement change requests reclassifying the crib from a RCRA treatment, storage, or disposal unit to a RCRA past-practice unit. Based on this approval, RCRA groundwater monitoring will be discontinued for FY 2008. DOE will continue to monitor groundwater near the crib under CERCLA.

***216-S-10 Pond and Ditch.*** The 216-S-10 facility continued to be monitored under a RCRA interim status detection program in FY 2007. The current RCRA monitoring network consists of only two shallow downgradient wells and one deeper downgradient well, because other wells have gone dry. Three new wells are planned for installation in 2008.

***Environmental Restoration Disposal Facility.*** This facility is a low-level, mixed waste facility where waste from surface remedial actions and other activities on the Hanford Site is disposed. The site was built under CERCLA and is designed to meet all hazardous landfill standards. Results of groundwater monitoring continued to indicate that the facility has not adversely impacted groundwater quality.

## 200-BP-5 Operable Unit

A complete discussion of the 200-BP-5 Operable Unit can be found in Section 2.10. This operable unit includes groundwater beneath the north 200 East Area. The water table is flat in this portion of the Hanford Site, so it is not possible




***A uranium plume has developed in the northwest corner of the 200 East Area. The plume appears to have sources in Waste Management Area B-BX-BY.***

to determine groundwater flow directions from water-table data alone. One of the primary objectives of the remedial investigation in the 200-BP-5 Operable Unit is to define contaminant migration.

Technetium-99 and tritium plumes extend northward between Gable Mountain and Gable Butte. Uranium forms a narrow plume that extends northwest of the 200 East Area. Nitrate forms a plume that extends to the north and probably originated from multiple sources within the 200 East Area. Other contaminants include cesium-137, cobalt-60, cyanide, iodine-129, nitrate, plutonium, strontium-90, sulfate, and uranium.

***DOE continued to characterize the vadose zone and aquifer in the 200-BP-5 Operable Unit.***

In FY 2007, DOE continued to work on the 200-BP-5 Operable Unit remedial investigation/feasibility study. An aggressive characterization program will support decisions during this process. DOE released a data quality objectives summary report and a draft work plan. Drillers installed three new wells in FY 2007 and will add ten more in FY 2008. Scientists continued to characterize the vadose zone and groundwater in the operable unit through sampling, geophysics, and aquifer tests.

Six facilities in the 200-BP-5 Operable Unit are monitored under RCRA in conjunction with CERCLA and AEA.

***Waste Management Area B-BX-BY.*** RCRA assessment monitoring continued at this site in FY 2007. Contaminants include uranium, technetium-99, and nitrate. Concentrations of these contaminants continued to increase in FY 2007.

***Waste Management Area C.*** This site continued to be monitored under an interim status RCRA detection program in FY 2007, but is sampled quarterly at Ecology's request. RCRA indicator parameters did not exceed critical mean values. However, nitrate, technetium-99, and sulfate are elevated in wells monitoring the waste management area.

***216-B-63 Trench.*** This RCRA site continued to be monitored under an interim status detection monitoring program.

***Low-Level Waste Management Area 1.*** This site continued to be monitored under RCRA interim status requirements. Specific conductance continued to exceed its critical mean value but exceedances were reported previously and do not appear to indicate contamination from the waste management area.

***Low-Level Waste Management Area 2***. This site continued to be monitored under RCRA interim status requirements.

***Liquid Effluent Retention Facility.*** The water table has dropped below the top of basalt in all but two monitoring wells. DOE and Ecology are pursuing an agreement for environmental monitoring. Two new wells are planned that will explore the possibility of monitoring the basalt flow-top and weathered zone.

## 200-PO-1 Operable Unit

A complete discussion of the 200-PO-1 Operable Unit can be found in Section 2.11. This operable unit encompasses the south portion of the 200 East Area and a large region to the east and southeast that is contaminated with plumes of tritium and iodine-129. Concentrations of tritium continued to decline as the plume attenuates naturally due to radioactive decay and dispersion. Nitrate forms a large plume but mostly at levels below the drinking water standard. Other contaminants include nitrate, strontium-90 and technetium-99, but these are limited to smaller areas.

***The PUREX cribs contributed to plumes of iodine-129, nitrate, and tritium. Nitrate and tritium concentrations are generally declining.***

During FY 2007, DOE published a data quality objectives report for groundwater remediation and started to develop a work plan for a 2-year groundwater site characterization study.

Groundwater is monitored at eight regulated units in the 200-PO-1 Operable Unit. Water supply wells in the 400 Area, which falls within the footprint of the 200-PO-1 Operable Unit, also are monitored.

***Integrated Disposal Facility.*** This facility will be an expandable, lined, RCRA-compliant landfill. The facility is scheduled to receive its first waste in 2010. Until the facility begins to operate, results from semi-annual monitoring will be added to the background data set.

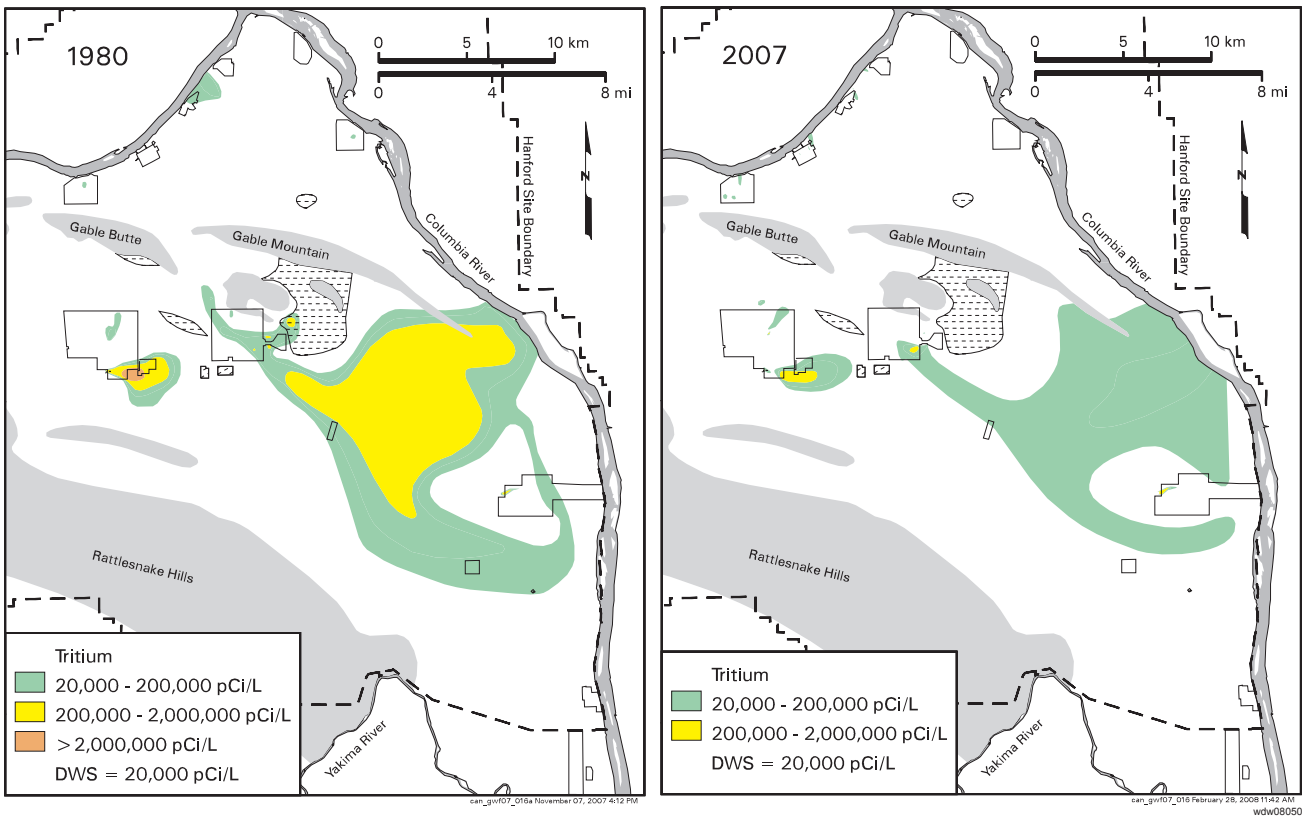
***PUREX Cribs.*** Three cribs (216-A-10, 216-A-36B, and 216-A-37-1) are monitored jointly under a RCRA interim status assessment program, CERCLA, and AEA. The cribs have contributed to widespread contaminant plumes in the area, including nitrate, tritium, and iodine-129. The nitrate and tritium plumes are generally attenuating throughout most of their area.

***Waste Management Area A-AX.*** RCRA assessment monitoring continued in FY 2007. Technetium-99 concentrations exceeded the drinking water standard (900 pCi/L) in two wells, but levels decreased in FY 2007.

***216-A-29 Ditch.*** The groundwater beneath this site continued to be monitored as required by RCRA interim status detection regulations. Groundwater quality beneath the ditch closely resembles regional patterns.

***216-B-3 Pond.*** The groundwater beneath this site continued to be monitored as required by RCRA interim status detection regulations.

***200 Area Treated Effluent Disposal Facility.*** A state waste discharge permit governs groundwater sampling and analysis in the three monitoring wells at this facility. No permit criteria for constituents in groundwater were exceeded in FY 2007.




***These maps show site-wide tritium plumes in the upper part of the unconfined aquifer in 1980 and 2007. Concentrations in the core of the plume have decreased over the years and the south margin is no longer spreading.***

Because no unconfined aquifer exists beneath the facility, groundwater monitoring wells are installed in the locally confined aquifer below the Ringold Formation lower mud unit. Thus, groundwater beneath the facility is isolated from the effects of the effluent.

***Nonradioactive Dangerous Waste Landfill.*** This RCRA site is located in the 600 Area, within the footprint of the 200-PO-1 regional plume. Interim status detection monitoring continued FY 2007.

***600 Area Central Landfill.*** This facility is adjacent to the Nonradioactive Dangerous Waste Landfill and is regulated under state solid waste regulations. As in previous years, some downgradient wells showed higher chemical oxygen demand, chloride, coliform bacteria, specific conductance, and sulfate, and lower pH than upgradient wells. Some of these constituents may be related to past disposal of sewage materials to the 600 Area Central Landfill.

***400 Area Water Supply Wells.*** Three water supply wells provide drinking water and emergency supply water for the 400 Area. Because the 400 Area lies in the path of the site-wide tritium plume, the wells are routinely monitored for tritium. Tritium concentrations in all samples were below the drinking water standard in FY 2007.

## 300-FF-5 Operable Unit

A complete discussion of the 300-FF-5 Operable Unit can be found in Section 2.12. This operable unit includes three geographic regions: the 300 Area, the 618-11 burial ground region, and the 316-4 cribs/618-10 burial ground region. The operable unit


***The uranium plume in the 300 Area, at the 30-μg/L level, is attenuating slowly. DOE is investigating alternatives for more rapid remediation.***

***In the 300 Area, trichloroethene concentrations exceed drinking water standards in a fine-grained layer of sediments. Concentrations in the shallower, more permeable part of the aquifer are below the standard.***

is currently regulated under an interim record of decision that calls for groundwater monitoring and institutional controls on the use of groundwater. In FY 2007, DOE installed 16 new wells for a uranium treatability test or aquifer characterization.

Contaminants of concern in 300 Area groundwater are uranium, trichloroethene, and cis-1,2-dichloroethene. Monitoring and plume characterization activities indicate relatively constant or gradually decreasing levels for these contaminants. Uranium is the primary contaminant of concern and remains above the drinking water standard (30 μg/L) beneath part of the 300 Area.

Trichloroethene continued to be below the 5-μg/L drinking water standard in wells monitoring the top of the unconfined aquifer. However, characterization samples collected in FY 2006 detected higher concentrations from a fine-grained unit within the upper portion of the Ringold Formation. Wells subsequently completed to monitor this unit showed only low levels of trichloroethene (<1 μg/L). This suggests contamination in a relatively small area.

Groundwater downgradient of the 618-11 burial ground is contaminated by a high-concentration tritium plume whose origin is believed to be irradiated material in the burial ground. Concentrations at a well adjacent to the burial ground have decreased from >8 million pCi/L in 2000 to 850,000 pCi/L in September 2007.

During excavation of the 618-2 burial ground in 2006, plutonium and other radiological contamination was detected unexpectedly. To investigate this occurrence, workers drilled three boreholes within the excavated burial ground. No plutonium was detected in groundwater.

***300-FF-5 Operable Unit Phase III Feasibility Study.*** Because the uranium plume beneath the 300 Area has not decreased in concentration as rapidly as predicted

by earlier remedial investigations, DOE continued a detailed investigation of the natural processes that cause the plume to persist and the residual sources that may supply uranium to the plume. During FY 2007, DOE prepared a report describing the screening of potential remedial action technologies. The most promising technologies are those that use in situ methods to reduce the mobility of uranium in the environment

In FY 2007, scientists continued a comprehensive program of simulation, laboratory, and field research tasks to support the 300-FF-5 feasibility study. The project's objective is to improve conceptual and transport-simulation models for uranium movement.

***DOE is investigating remediation methods for uranium in the 300 Area.***

A treatability test to immobilize uranium in the aquifer continued during FY 2007. The test involved injecting polyphosphate into the aquifer. Preliminary information indicates that the timing of injections relative to seasonal conditions is very important in the implementation of this technology.

***316-5 Process Trenches.*** This former liquid waste disposal site was the last in the 300 Area to receive uranium-bearing effluent, with discharges ending in the early 1990s. The site, which has been remediated, is regulated under RCRA in conjunction with CERCLA and AEA. Uranium currently exceeds the drinking water standard in wells downgradient from the waste site, although concentrations appear to be decreasing with time. Cis-1,2,dichloroethene concentrations exceed the standard at only one downgradient well that is completed near the bottom of the aquifer.

## 1100-EM-1 Operable Unit

A complete discussion of the 1100-EM-1 Operable Unit, located in the south part of the Hanford Site, can be found in Section 2.13. Trichloroethene was the primary contaminant of concern. Contaminants also flow into the area from off-site sources (e.g., nitrate from agriculture and industry).

The final remedy selected for 1100-EM-1 Operable Unit groundwater is monitored natural attenuation of volatile organic compounds. Concentrations of trichloroethene have remained below the drinking water standard since FY 2001.

Wells in the city of Richland well field are monitored frequently to detect any changes in Hanford contaminants near these wells. The tritium plume originating from sources in the 200 East Area has not been detected in these wells. Low levels of tritium, similar to those detected in Columbia River water, continued to be detected.

***In the 1100-EM-1 Operable Unit, trichloroethene concentrations continued to be below the cleanup level. Groundwater monitoring was reduced to annual sampling of three wells.***

Uranium concentrations in wells downgradient of DOE's inactive Horn Rapids Landfill have been increasing since 1996, but remained below the 30-µg/L drinking water standard in FY 2007.

DOE reduced groundwater monitoring for the 1100-EM-1 Operable Unit in response to an action item identified by the CERCLA five-year review published in November 2006. A Tri-Party Agreement change notice, approved in June 2007, specifies annual monitoring of three wells.

## Confined Aquifers

A complete discussion of the confined aquifers can be found in Section 2.14. Although most of Hanford's groundwater contamination is in the unconfined aquifer, DOE monitors wells in deeper aquifers because of the potential for downward migration of contamination and the potential migration of contamination offsite through the basalt confined aquifer. No evidence of offsite migration via the confined aquifer has been detected.

***Cyanide, nitrate, and technetium-99 were elevated in only one basalt-confined well. Contaminant migration via the well bore during well construction is suspected.***

The Ringold Formation confined aquifer occurs within fluvial sand and gravel comprising the lowest sedimentary unit of the Ringold Formation. It is confined below by basalt and above by the lower mud unit. Groundwater in this aquifer flows generally west to east in the vicinity of the 200 West Area. In the central portion of the aquifer, flow appears to converge into the 200 East Area from the west, south, and east. Groundwater likely discharges from the confined aquifer to the overlying unconfined aquifer where the confining mud unit has been removed by erosion.

While effluent disposal was occurring at the B Pond system, mounding within the unconfined aquifer in this area led to downward migration of groundwater into the Ringold Formation confined aquifer. During FY 2007, eighteen wells were sampled that are completed in the Ringold Formation confined aquifer. Tritium in a single well near the former B Pond was the only contaminant present at concentrations above the drinking water standard.

Within the upper basalt-confined aquifer system, groundwater occurs within basalt fractures and joints, interflow contacts, and sedimentary interbeds. Groundwater in the upper basalt-confined aquifer generally flows from west to east across the Hanford Site, up through fractures or other pathways in the confining layers, into the unconfined aquifer, and into the Columbia River. Vertical gradients between the basalt-confined aquifer and the unconfined aquifer are upward on most of the Hanford Site. Downward gradients are measured in the west portion of the Hanford Site, near B Pond, and north and east of the Columbia River.

Tritium continued to be detected at low levels in some basalt-confined wells. One elevated tritium concentration near the 200 East Area is associated with intercommunication between the upper basalt-confined aquifer and the overlying unconfined aquifer (see Section 2.14). Iodine-129, strontium-90, gamma-emitting isotopes, and uranium isotopes were not detected above the minimum detection limits in the upper basalt-confined aquifer. Cyanide, nitrate, and technetium-99 were elevated in an upper basalt-confined aquifer well in the northwest part of the 200 East Area. Migration of high-salt waste from the vadose zone or unconfined aquifer via the well bore during well construction is responsible for this contamination.

## Shoreline Monitoring

DOE monitors groundwater near the Columbia River via aquifer tubes, which are small diameter, flexible tubes that are implanted in the shallow aquifer and natural seepage points or springs. Results are discussed in the following paragraphs and along with other groundwater monitoring data in the applicable sections of this report.

Concentrations of strontium-90 continued to exceed the 8-pCi/L drinking water standard in aquifer tubes in the 100-BC-5 and 100-NR-2 interest areas. Levels exceed the 1,000-pCi/L derived concentration guide in 100-N Area tubes, reaching 15,000 pCi/L in one tube in August 2007.

Tritium concentrations exceeded the 20,000-pCi/L drinking water standard in one tube at the upstream end of 100-D Area. The source is believed to be the 100-N Area plume. Tritium also exceeded the standard in springs at the Hanford town site, but were below the standard in aquifer tube samples.

Uranium concentrations exceed the 30-µg/L drinking water standard in aquifer tubes and springs in the 300 Area.

Hexavalent chromium concentrations exceeded the 100-µg/L drinking water standard in 100-D Area aquifer tubes. Concentrations in aquifer tubes or springs exceeded the 10-µg/L aquatic standard in the 100-B/C, 100-K, 100-D, 100-H, and 100-F Areas.

Nitrate concentrations were all below the 45-mg/L drinking water standard in aquifer tubes in FY 2007. Levels have exceeded the standard in the 100-F, 100-H, and 300 Areas in the past.

Trichloroethene is detected in several aquifer tubes in the 300 Area. Concentrations are highest in deep tubes. The maximum in FY 2007 was 290 µg/L in tube AT-3-3-D. The value is under review to see if it is representative. The next highest result was 57 µg/L in tube AT-3-7-D.

## Well Installation, Maintenance, and Decommissioning

A complete discussion of the well installation, maintenance, and decommissioning can be found in Chapter 4. DOE installs new wells when needed for monitoring or characterization, maintains wells to repair problems, and decommissions wells that are no longer needed. Ecology, EPA, and DOE worked together to develop a prioritized list of new wells needed to meet requirements of various groundwater monitoring regulations. Fifty-seven new wells were installed during FY 2007.

During FY 2007, a number of temporary characterization boreholes were installed around the Hanford Site to support various projects. The temporary boreholes are installed to characterize subsurface contamination or determine hydrogeologic properties (e.g., moisture, grain-size distribution). In FY 2007, 100 temporary boreholes were installed. Four borings were drilled to groundwater, the remainder extended no farther than the vadose zone.

Approximately 8,836 unique well identification numbers have been identified within the Hanford Site. These include all wells, characterization boreholes, aquifer tubes, soil gas probes, piezometers, or other subsurface installations. To date, 3,948 of these, or ~45% of the total, have been either administratively removed from the well inventory or decommissioned (sealed with grout). Wells are decommissioned when they are no longer needed; are in poor condition; are in the path of intended remediation or construction activities; or pose an environmental, safety, or public health hazard. DOE maintains a list of wells that are candidates for decommissioning. All candidate wells must be reviewed and approved by potential well users prior to decommissioning. During FY 2007, a total of 3,085 unique well identification numbers were documented as "in use." This number includes 2,310 wells, 129 piezometers within host wells, 354 aquifer tubes, and 292 soil gas boreholes. A total of 91 wells were physically decommissioned during FY 2007 and a 623 temporary boreholes and subsurface installations were administratively decommissioned by records management.

**Wells Installed in 2007**

| Interest Area or RCRA Site | Number of New Wells FY 2007 |
|---|---|
| 100-BC-5 | 2 |
| 100-KR-4 | 4 |
| 100-NR-2 | 0 |
| 100-HR-3-D | 20 |
| 100-HR-3-H | 0 |
| 100-HR-3 Horn chromium investigation | 6 |
| 200-PO-1 | 1 |
| 200-BP-5 | 3 |
| 200-ZP-1 | 4 |
| 200-UP-1 | 1 |
| 300-FF-5 | 16 |
| **Total** | **57** |

Staff performed maintenance on 186 wells in FY 2007. Surface tasks include labeling wells, fixing or replacing

| Dry Monitoring Wells | | | | |
|---|---|---|---|---|
| Some wells that were formerly sampled for the groundwater project have gone dry as the water table declined. Most of the wells are in the 200 Areas. | | | | |
| Fiscal Year | 200 West | 200 East | Other Areas | Total |
| 1999 | 12 | 1 | 1 | 14 |
| 2000 | 8 | 2 | 1 | 11 |
| 2001 | 11 | 0 | 2 | 13 |
| 2002 | 9 | 2 | 1 | 12 |
| 2003 | 9 | 1 | 3 | 13 |
| 2004 | 6 | 1 | 2 | 9 |
| 2005 | 3 | 5 | 0 | 9 |
| 2006 | 4 | 0 | 0 | 4 |
| 2007 | 3 | 0 | 6 | 9 |
| **Total** | **65** | **12** | **16** | **93** |

locking well caps, repairing casing, repairing or replacing sampling pumps, and performing camera surveys.

## Vadose Zone

Vadose zone activities in FY 2007 included leachate monitoring, soil-vapor extraction and monitoring, surface geophysics, and borehole geophysical logging. The complete discussion of these activities can be found in Chapter 3.

***Leachate Monitoring at Environmental Restoration Disposal Facility.*** This facility is used for disposal of radioactive and mixed waste generated during waste management and remediation activities at the Hanford Site. Leachate is collected and sent to the Effluent Treatment Facility. Composite leachate samples contained detectable concentration of common metals, anions, and mobile radionuclides. Constituents that were generally increasing in concentration include chromium, specific conductance, bromide, nitrate, gross alpha, and uranium. The facility is lined, and there is no evidence of impacts to groundwater.

***Leachate and Soil-Gas Monitoring at Solid Waste Landfill.*** Leachate is sampled and tested quarterly. Concentrations in the past year were similar to previous concentrations and did not identify any areas of concern. Soil gas is monitored quarterly to determine concentrations of oxygen, carbon dioxide, methane, and several key volatile organic compounds. Results were consistent with previous years. Contaminants of concern were near or below detection limits.

***During FY 2007, 91 unneeded wells were physically decommissioned and filled with grout; 3,085 wells remain in use.***

***Soil-Vapor Extraction.*** This remedial action is being used to remove carbon tetrachloride from the vadose zone in the 200 West Area. Three new vapor extraction wells were installed in FY 2007. As of September 2007, ~79,200 kilograms of carbon tetrachloride have been removed from the vadose zone since extraction operations started in 1991.

***Direct Push Boreholes and Sampling.*** The hydraulic hammer unit was deployed in B, T, and U Tank Farms during FY 2007 to evaluate subsurface contamination in the vadose zone. A hydraulic hammer is a modern type of pile driver that can be used to collect samples or place monitoring equipment into the vadose zone.

***Surface Geophysical Exploration.*** Surface geophysical exploration, a combination of surface deployed geophysical techniques, was applied in Waste Management Area B-BX-BY during FY 2007. The analyses point to several regions worthy of further characterization using more conventional approaches such as drilling. The analysis of the surface geophysical exploration data is being used to direct the locations of several groundwater monitoring wells to be drilled during FY 2008 and beyond.

***Geophysical Logging.*** Radiation measurements have been taken in boreholes since the early days of the Hanford Site to detect manmade radionuclides in the subsurface. Geophysical logging at Waste Management Area B-BX-BY in FY 2007 indicated an increase of uranium-235 in the deep vadose zone.

***Deep Vadose Zone Treatability Test Plan.*** In FY 2007, DOE began work on a treatability test plan for investigating remediation of technetium-99 and uranium in the deep vadose zone beneath the 200 Areas. The objective of this plan is to provide a strategy to evaluate specific technologies including the appropriate laboratory, modeling, and field tests for deep vadose zone remediation.

***Geophysical logging at Waste Management Area B-BX-BY indicated an increase of uranium-235 in the deep vadose zone.***

## Continued Monitoring

DOE will continue to monitor groundwater to meet the requirements of AEA, CERCLA, RCRA, and DOE Orders. During ongoing groundwater remediation, the groundwater project will monitor, assess, and report on activities at groundwater operable units. Both the unconfined and upper-confined aquifers are monitored and data are maintained and managed in a centralized database. Monitoring well locations, frequencies, and analytical constituents will continue to be documented each year. Water-level monitoring will continue to be performed to characterize groundwater flow and to determine the impact of Hanford Site operations on the flow system.

Groundwater monitoring remains a part of the Hanford Site baseline throughout the cleanup mission and will remain a component of long-term stewardship after remediation is completed.

Details about the Hanford Site Groundwater Remediation Project can be found online at http://www.hanford.gov/cp/gpp/.