Chapter 3

Fernald Site

History and Mission

The Feed Materials Production Center, located outside of Fernald, Ohio, began operations in 1951. "Fernald had primary responsibility for converting depleted uranium and low-enriched uranium into metal."[1] The metal uranium was then fabricated into target elements for use in plutonium production reactors at the Savannah River Site, Oak Ridge, and Hanford. Fernald was also responsible for converting solid UO_3 from Hanford into solid UF_4 (green salt) that was converted at the gaseous diffusion plants into uranium hexafluoride. The site produced more than 227,000 metric tons of high-purity uranium products.[2] Operations ceased in 1989 and the site officially closed in 1991, when the name of the site was changed to the Fernald Environmental Management Project (FEMP).[3]

Declared as a Superfund site, Fernald was placed on the National Priorities List in 1989. The current mission of the site includes:

- Environmental Remediation;
- Site Restoration;
- Decontamination and Decommissioning Activities.

Location and Land

Within 3 miles of the site are the towns of Fernald, Ross, New Baltimore, and New Haven, Ohio. (See Figure 1.) Fernald is approximately 17 miles northwest of Cincinnati (population 331,000). The site is situated on 1.66 square miles (1,050 acres) of land in what was once a relatively rural area, but now has increasing numbers of suburban homes.

The site is divided into two areas: production and storage. The majority of the facilities on-site are located in the production area. This originally included 9 plants and 70 individual buildings. Some of the plants in this area have been dismantled.[4] Six waste pits, four silos, drum storage pads, and scrap piles comprise the waste storage area.[5] Fernald is owned by the Department of Energy and operated by Fluor Fernald.

Number of people living within 50 miles of Fernald: Approximately 635,000 [6]

Employees at Fernald: Approximately 1,800 as of 2003 [7]

The soil beneath the site consists of a clay layer that contains silty sand and gravel and a perched water system, the groundwater of which is not used for drinking water. (See Figure 2.) Beneath the perched water is a layer of clay, below which is thick sand and gravel that contains the Great Miami Aquifer.[8] This aquifer provides abundant water and is one reason this site was selected for a nuclear weapons factory back in 1951. The Great Miami River, which recharges the Great Miami Aquifer, is located approximately 0.8 miles east of the site and flows in a southerly direction. The Great Miami River joins the Ohio River 24 miles downstream.

Wastes from production were sent to the pits, silos, scrap piles, and contaminated effluent was directly released, via a buried pipeline, to the Great Miami River.

FEMP was divided into Operable Units to expedite remediation of major contamination problems.

Operable Unit 1. This area contains 6 waste storage pits. Two of the pits are lined with plastic[9], the remaining four are lined with clay. There is also a burn pit and a clearwell (a pit containing water runoff from other waste pits), where solid and slurried wastes from on-site processing are located.[10] Over 11 million pounds of uranium, smaller amounts of thorium, radium, and the chemical tributyl-n-phosphate were dumped into these pits. Contamination has the potential to move directly into the aquifer from the waste pits, either seeping out laterally through permeable strata or, in the cases where clay is present, overflowing the side of the pits and flowing into Paddy's Run Creek and then into the Great Miami Aquifer.[11]

Operable Unit 2. This area contains a sanitary landfill, lime sludge ponds and onsite disposal facility.[12]

Operable Unit 3. This area contains 9 production plants and associated facilities and equipment.

Operable Unit 4. This area consists of 4 large concrete waste storage silos. Located at the western edge of the site, these silos contain over 9,000 tons of uranium and radium contaminated waste. Silos 1 and 2, also known as the K-65 silos, contain highly radioactive residues from the Manhattan Project, the project that created the first atomic bomb.[13] These silos are a major source of hazardous radon gas. Silo 3 contains thorium burn residues, while Silo 4 is empty.[14]

Operable Unit 5. This area consists of groundwater, surface water, soil, and other environmental media around the site.

Water Sources

Surface Water

The Great Miami River is located approximately 0.8 miles east of Fernald. The river flows at a rate of 2,693 cubic feet per second.[15] For all the years the plant was in operation, contaminated effluent containing a total of 82 metric tons of uranium[16] was released via a buried pipeline to the Great Miami River.

Surface water on-site includes Paddy's Run Creek. Paddy's Run Creek flows intermittently in a southerly direction along the western boundary of the site, typically during the winter months.[17] The creek flows immediately adjacent to the site's 6 waste pits.

Another source of water on-site is the Storm Sewer Outfall Ditch. This ditch originates just south of the former uranium production plant area and flows in a southerly direction to meet up with Paddy's Run in the southern section of the site. Near the southern border of the site, Paddy's Run Creek travels underground carrying a portion of the contaminants with it into the subsurface. Overflow from the Sewer Outfall Ditch and contaminated storm water runoff draining the site flow into Paddy's Run. One mile downstream Paddy's Run joins the Great Miami River.

Another drainage ditch also carries contaminants away from the site. Located in the southwest corner of the Former Production Area, near the Old Pilot Plant, it is smaller than the Sewer Outfall Ditch and is known as the Pilot Plant Drainage Ditch. Previously, contaminated runoff from this ditch flowed toward Paddy's Run. It was the source for the underlying Pilot Plant Drainage Ditch Plume in the Great Miami Aquifer. In all, approximately 17 tons of uranium were released to Paddy's Run.[18]

A sump was installed near the ditch in 1996 with the purpose of collecting contaminated runoff and pumping it for treatment, thereby minimizing this source of contamination. As of 2001, the sump continues to pump. It is scheduled to remain in operation until the contaminated areas draining into it are remediated.[19]

Aquifer

The Great Miami Aquifer flows continually and is the sole-source aquifer for the surrounding areas and Cincinnati. Its water is used by water supply companies and in privately owned wells. This aquifer flows beneath the entire site and covers a substantial portion of southwestern Ohio. As one of the nation's largest drinking water aquifers, it contains almost 10 trillion gallons of water.[20] The Great Miami Aquifer and the Ohio River provide the majority of Cincinnati's drinking water.[21]

The city of Cincinnati is located in Hamilton County. Cincinnati Water Works supplies water to Cincinnati and the majority of Hamilton County through two treatment plants. The Charles M. Bolton Treatment Plant is located north of Cincinnati and is 1 mile northeast of Fernald,[22] and serves almost 100,000 customers, mainly in towns north of Cincinnati. The Richard Miller Treatment Plant is located south of Cincinnati on the Ohio River. It is the primary water supply for the Cincinnati and is not affected by Fernald.[23]

Thus, though the city of Cincinnati is 17 miles away from Fernald, some of the utilities providing water to the city are uncomfortably close.

In addition to the Cincinnati Water Works' Bolton Plant, the Southwest Ohio Water Company has a well field located 1 mile directly East of the plant.[24]

It should be noted (see box below) that groundwater flow from the plant moves in a southeasterly direction, with the ability to carry contaminants at a very rapid rate.

Groundwater flow: Southeasterly at a rate of 33 to 83 feet per year for the majority of the site and in the southern portion of the site, the flow is southerly[25]

Average Annual Precipitation: approximately 41 inches per year[26]

Seventeen extraction wells, with four more extraction wells coming online in spring of 2003, are actively pumping contaminated groundwater out of the Great Miami Aquifer for remediation.

Contamination

Contamination at the site has reached both the Great Miami River and the Great Miami Aquifer. Contamination from all areas of Fernald has contributed to the pollution of the surface water, the subsurface, and the groundwater, though recent releases to the Great Miami River are within EPA's 30 parts per billion drinking water standard.

Great Miami River

Contamination is carried to the Great Miami River via several routes. Storm water overflow, a buried pipeline, and surface drainage of contaminants adhering to the soil into Paddy's Run, which in turns dumps into the river. "During periods of heavy, sequential rainfall events, untreated storm water, which exceeds the capacity of Fernald treatment systems, is bypassed directly to the Great Miami River."[27] In addition, contaminants travel underground via sandy and silty strata to both Paddy's Creek and to the Great Miami River aquifer.

Manhole-175 was the last point for monitoring discharges of effluent water to the Great Miami River from Fernald. Manhole-175 was located within the former Sewage Treatment Plant compound on the eastern edge of the site property. Between the years 1952 through 1988, 74 metric tons of uranium passed through Manhole-175 en route to the Great Miami River via an underground pipeline.[28] Radioactive waste from each of Fernald's nine plants was sent to the General Sump, a central facility that treated all remaining radioactive effluents from individual plants with lime. Then a complex series of processes produced filter cake (solid, wet radioactive waste) and various contaminated effluents.[29] Effluents were then discharged through the pipeline to the Great Miami River.

Manhole-175 was taken out of service when a new outfall line was installed in 1995. Site effluent is currently sampled where the effluent enters the new outfall line. Through discharge permits, the US EPA sets off-site standards for this effluent; these standards were recently changed to allow 30 ppb rather than the previous 20 ppb. Recent releases have been within these standards.

Groundwater

As the primary material processed at Fernald, uranium is the primary contaminant in the groundwater. (See Figures 3 and 4.) Substantial amounts of liquid and solid wastes were created at each step of the process of making uranium compounds. During the plant's operation 550,000 tons of filter cake, and 620,000,000 gallons of contaminated water were produced. This vast amount of produced waste has led Fernald to become the third largest radioactive waste storage site in the country by volume, after Hanford and Savannah River.[30]

Airborne Releases

Airborne releases of uranium were enormous. There is considerable controversy regarding the magnitude of these releases, with estimates ranging from 135 metric tons to 1,400 metric tons. The lower estimates were generated by National Lead and Westinghouse, former contractors at the site, and the higher estimate is by the Radiological Assessment Corporation.[31] The measure of the releases is extremely important because all of the uranium released to the air eventually deposited itself on the ground where it was available to migrate via soil, surface streams, drainage ditches and groundwater into the Great Miami Aquifer.[32]

The mobility of the uranium released on site was increased because much of this material was contaminated with the chemical tributyl-n-phosphate. This chemical enhances the solubility of uranium.

Contamination has entered the groundwater through Paddy's Run, the Storm Sewer Outfall Ditch, and the Pilot Plant Drainage Ditch.[33] Six waste pits and airborne releases have also contributed to this contamination in the aquifer.

A large area of the Great Miami Aquifer has become contaminated: about 176 acres. Prior to the OU 5 ROD change in 2001 to accommodate the 30 ppb uranium safe drinking water act mcl, the total acreage was approximately 220 (based on the proposed mcl of 20 ppb). Of the current 176 acres, approximately 50 acres are off property, in the South Plume portion of the GMA.

Three principal plumes of groundwater contamination have been identified in this aquifer. Uranium is the principal contaminant of concern in each of these plumes.

Plumes of Contamination

The contamination of the GMA is separated into 4 distinct areas: (1) south plume off property, (2) south field and storm sewer outfall ditch area, (3) pilot plant drainage ditch area and (4) waste storage area. The Fernald facility is actively remediating 3 of the 4 areas. The South Plume, South Field and Storm Sewer Outfall Ditch areas represent the largest portion of the contaminated GMA, at approximately 145 acres, and represents one contiguous area of contamination.

There is a large plume associated with the Pilot Plant Drainage Ditch. This plume is located within the waste storage area. The Pilot Plant Drainage Ditch plume resulted from uranium contaminated surface waters flowing through the ditch from the Pilot Plant to enter the aquifer through the lower reaches of the ditch, which are in direct contact with the upper sands of the Great Miami Aquifer and Paddy's Run.

Another major plume is associated with the South Field area. This uranium plume, similar to the waste storage area plume, resulted, in part, from uranium-laden surface water flowing down the Storm Sewer Outfall Ditch and entering the aquifer in the lower reaches of the Outfall Ditch, which are in contact with the Great Miami Aquifer. Additionally, the South Field uranium plume also resulted from the disposal practices associated with the practice of dumping contaminated materials into South Field area, mostly in the Inactive Fly-ash Pile area and the South Field area itself.

The final principal component of Great Miami Aquifer contamination was discovered first and is called the South Plume. This plume resulted entirely from the flow of contaminated surface waters to either Paddy's Run Stream or the Storm Sewage Outfall Ditch.

A potential contributor to the contamination may have arisen from the 6 waste pits located within hundreds of feet of Paddy's Run. These waste pits vary between each other in depth and size. Over the years, some of these pits have been covered with unmounded, permeable sod. Sometimes the sod sank down into the supposedly "closed" pits and rainwater got access to the poisonous wastes.[34] Four of these pits have clay liners and two are lined with elastomeric membrane.

Currently all of the pits are covered: 4 are covered with clay (with a synthetic cap) or topsoil, one is wet, and pit 6 is open and 75% full. These waste pits are located in close proximity or adjacent to the aquifer,[35] but DOE is in the process of removing the pit contents and transporting it to the Envirocare facility in Utah.

The role the 6 waste pits played in the origins of contamination at Fernald are controversial. The contention of some public interest groups is that the main source of contamination to the groundwater has been due to leaching of contaminated materials from the waste pits. Although much of the uranium waste has been sent to Envirocare, the groundwater uranium concentrations have decreased but still do not meet drinking water standards.

In a detailed analysis, the Radioactive Waste Campaign, a non-profit research and public education group, identified three main forms of migration. The first type of migration involved underground, lateral migration via permeable strata directly into the aquifer. The second involved, the "bathtub effect." This effect results from the location of some of the pits in impermeable clay strata. As liquid waste products and rainwater enter the pits, the water levels inside the pits rise and eventually overflow the sides of the pits. This surface contamination then discharges into Paddy's Run. The third route for contamination is through the first 4-9 inches of surficial till, with toxins discharging into Paddy's Run.[36]

The government and its contractors believe that surface water, *not* underground lateral migration, is the primary contributor to groundwater contamination. In the 2000 Integrated Site Report issued by DOE contractor, Fluor Fernald, groundwater contamination was attributed to the infiltration of contaminated surface water through the streambed of Paddy's Run, the Storm Sewer Outfall Ditch, and the Pilot Plant Drainage Ditch. "In these areas, the glacial overburden is eroded, and the sand and gravel of the aquifer are in direct contact with uranium-contaminated surface water from the FEMP."

However, the DOE contractor also admitted to some contamination from the sides of the waste pits and saying that, "to a lesser degree, groundwater contamination also resulted where past excavations, such as the waste pits, removed some of the protective clay contained in the glacial overburden and exposed the aquifer to contamination."[37] Sources of uranium, such as the waste pits, are being removed and uranium concentrations in the Great Miami Aquifer have declined as a result.

Thus far, 5.8 billion gallons of water have been removed from the aquifer and 3,600 lbs of uranium have been removed with ion exchange resins.

Contaminants of Potential Concern:
Polychlorinated bi-phenyls, chlorides, fluorides, nitrates, and sulfates
Volatile Organic Compounds:
Perchloroethylene, trichloroethane
Metals:
Barium, chromium
Radionuclides:
Actinium[38], cesium[39], lead, neptunium, potassium, plutonium, radon[40], radium, ruthenium, strontium, technetium, thorium, uranium[41]

Other sources of contamination at Fernald include thousands of drums containing radioactive material, presumably thorium, produced at other sites. This material had been shipped to Fernald for temporary storage and has contributed to further leakage.[42]

Manhattan Project radioactive waste has been stored in Silos 1 and 2 since the 1950s. Silos 1 and 2, also known as the K-65 silos, contain an estimated 1,650 curies of radium that, in turn, generates a dangerous radioactive gas, radon.[43] Over the 50-plus years radium has been stored significant quantities of this gas have been released to the surrounding environment.

Radon releases from the K-65 silos were greatly reduced in the early 1990s with the introduction of bentonite into Silos 1 and 2. In recent years, however, concentrations of radon are increasing as radon diffuses through the clay bentonite into the silos' head space and from there into the environment. Silo 3 contains cold metal oxide and thorium waste.[44]

Fernald requires remediation that is extensive and complete. Partial decontamination and decommissioning will not suffice, as the contaminants will continue to spread. This is of particular concern because of the threat to the sole-source aquifer, the Great Miami Aquifer, which is critical to the surrounding areas.

Remediation

The Department of Energy's expected date for the completion of remediation of Fernald is December 2006; after which long-term stewardship, including monitoring and maintenance is supposed to continue indefinitely.[45]

The water treatment facilities remove uranium, which is the primary contaminant on-site. Uranium has contaminated both the surface water and the groundwater. Pump-and-treat operations began in 1993 and this method of remediation is currently in place at Fernald. A report published in 2002 stated that over 2,300 pounds of uranium have been removed from the Great Miami Aquifer.[46] In 2003 this figure has grown to 3,600 pounds. Contaminated groundwater withdrawn from the wells is sent to the on-site wastewater treatment plant. After treatment, the water is discharged to surface waters or re-injected back into the Great Miami Aquifer to speed the cleanup.[47]

Excavation of contaminated materials and soils is also occurring on-site. The waste pits are in the process of being excavated and will require the removal of approximately one million tons of waste.[48] The surrounding soils will also need to be excavated. During 2000, 94,537 metric tons of contaminated waste was excavated and shipped offsite from the waste pit area. These materials were transported to Envirocare, a commercial disposal facility in Utah.[49] As of October 2001, 292,400 tons of material has been shipped offsite and the shipments will continue until early 2005. All facilities on-site will be decontaminated and dismantled.[50]

The site will not be fully returned to its original condition. An assessment must be made regarding the amount of uranium left in the soil to determine if it meets the established standard for drinking water, which is the eventual goal. Certainly the removal of the source of contamination will aid the cleanup of groundwater. However, groundwater remediation and long-term maintenance will take many years. The state of groundwater will remain a key issue at the site. Due to the long life of radionuclides at Fernald, they will pose a continual threat to the environment for many years to come.

Challenges

Smaller communities surrounding the site could be greatly affected by the contamination. Wells were installed at the Fernald site for plant use but a major draw are the nearby the Bolton Plant well field of the Greater Cincinnati Water Works, and the Southwest Water Treatment Plant that services the outlying communities. The offsite and plant wells created a groundwater divide. But now that the plant has ceased operation, it bears watching to see whether the offsite wells draw contaminated water from the site. Given the importance of the Great Miami Aquifer as a water source for Cincinnati and other towns, a full assessment of the degree of contamination of this important aquifer is necessary.

Challenges facing Fernald

- Restrict the movement of radionuclides from entering into the wells used by water supply companies;
- Characterization of radionuclides deposited in sediments in the Great Miami River and Paddy's Run Creek;
- Maintaining required funding for the accelerated cleanup and long-term stewardship; and
- Maintaining proper site management practices through remediation and during post closure care and maintenance.[51]

Initially, construction of DOE sites did not focus on the longevity or concern for contaminated materials. Concrete silos, used for the storage of radium-contaminated wastes, were not designed to last for the periods of time this hazardous, long-lived material will be around. Radium has a half-life of 1600 years. Radium's decay product, radon gas, can be carried over distances by wind. Then, because radon gas has the unusual characteristic of converting back to particulates, such as radioactive polonium, it can be deposited on soil and in surface water.

The attempted remediation of the radon problem has not been completely solved by the use of bentonite. Removal of the contents from the silos would effectively eliminate the source of this hazardous gas. In addition, until the contents are completely removed, maintenance on the concrete silos must be continued, virtually forever.

As a remediation goal, the site must be returned as close as possible to its original state, despite the cost and time constraints. Maintaining the health and safety of the employees and community must be a priority during the cleanup of the site.

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[1] Makhijani et al. *Nuclear Wastelands*. 2000: 207.
[2] US DOE. "NDAA Report to Congress on Longterm Stewardship", January 2001: 11.
[3] ITRC. "Determining Cleanup Goals at Radioactively Contaminated Sites: Case Studies", April 2002: 34.
[4] Fluor Fernald, Inc. *2000 Integrated Site Report* May 2001: 9.
[5] Coyle et al. *Deadly Defense: Military Radioactive Landfills*, 1988: 115.
[6] Estimated from the US Census 2000. http://factfinder.census.gov/servlet/BasicFactsServlet.
[7] Communication with L Crawford, FRESH, April 2003.
[8] US DOE. Charting the Course: The Future Use Report", April 1996, 33, <http://www.em.US DOE.gov/www/stake/future.pdf>.
[9] Pits 5 and 6 have an elastomeric membrane.
[10] Pike, J. "US Nuclear Forces", July 27,2000, <http://www.fas.org/nuke/guide/usa/facility/fernald.htm>.
[11] Coyle et al. *Deadly Defense: Military Radioactive Landfills*, 1988: 120-1.
[12] Fluor Fernald, Inc. "About Fernald", <http://www.fernald.gov/aboutfernald/aboutf.htm>.
[13] Makhijani et al. *Nuclear Wastelands*. 1995: 214.
[14] Pike, J. "US Nuclear Forces", July 27,2000, <http://www.fas.org/nuke/guide/usa/facility/fernald.htm>.
[15] Fluor Fernald, Inc. *2000 Integrated Site Report,* May 2001: 11.
[16] Radiological Assessments Corporation, "The Fernald Dosimetry Reconstruction Project, Tasks 2 and 3," prepared on behalf of CDC, June 1995, p. L-49.
[17] US DOE. "Vadose Zone Fact Sheet: Fernald Environmental Management Project", September 2000.
[18] RAC, p. L-49.

[19] Lisa Crawford of Fernald Residents for Environmental Safety and Health, Inc. Facsimile. October, 2001.
[20] US DOE. "Charting the Course: The Future Use Report", April 1996, 33, <http://www.em.US DOE.gov/www/stake/future.pdf>.
[21] Coyle et al. *Deadly Defense: Military Radioactive Landfills*, 1988: 117.
[22] Ibid, 116
[23] GCWW. "Where does my water come from?", <http://www.rcc.org/cww/source.html>.
[24] Coyle et al. "Deadly Defense: Military Radioactive Landfills," 1988:116
[25] US DOE. "Groundwater Fact Sheet: Fernald Environmental Management Project", September 2000.
[26] US DOE. "Vadose Zone Fact Sheet: Fernald Environmental Management Project", September 2000.
[27] Fluor Fernald, Inc. *2000 Integrated Site Report,* May 2001: 67.
[28] ATSDR. "Public Health Assessment for FEMP", CERCLIS No. OH6890008976 June 30, 2000: 57.
[29] Coyle et al. *Deadly Defense: Military Radioactive Landfills*, 1988: 116-7.
[30] Coyle et al. *Deadly Defense: Military Radioactive Landfills*, 1988: 117.
[31] Makhijani et al. *Nuclear Wastelands*, 1995:214
[32] Makhijani et al. *Nuclear Wastelands*, 1995: 214-215.
[33] Fluor Fernald, Inc. *2000 Integrated Site Report*, May 2001: 43
[34] Coyle et al. *Deadly Defense: Military Radioactive Landfills*. 1988: 118
[35] ITRC. "Determining Cleanup Goals at Radioactively Contaminated Sites: Case Studies", April 2002: 35.
[36] Coyle et al. *Deadly Defense: Military Radioactive Landfills*, 1988: 120.
[37] Fluor Fernald, Inc. *2000 Integrated Site Report,* May 2001: 43.
[38] Actinium and thorium all due to the processing of thorium materials.
[39] Cesium, lead, neptunium, plutonium, ruthenium, strontium, technetium all due to the processing of recycled uranium, primarily from Hanford.
[40] Contaminant in air only.
[41] US Congress, OTA. *Complex Cleanup: The Environmental Legacy of Nuclear Weapons Production*, February 1991: 150.
[42] US DOE. "Record of Decision: Operable Unit 3", EPA/ROD/RO5-94-269 July 22, 1994: 5.1.
[43] Makhijani et al. *Nuclear Wastelands*, 1995: 214.
[44] ATSDR. "Public Health Assessment for FEMP", CERCLIS No. OH6890008976 June 30, 2000: 3.
[45] US DOE. "NDAA Report to Congress on Longterm Stewardship", January 2001: 11.
[46] Fluor Fernald, Inc. "Cleanup Project", <http://www.fernald.gov/CleanupProj/Aquifer.htm>.
[47] US DOE OTA. *Complex Cleanup: The Environmental Legacy of Nuclear Weapons Production*, February 1991, 149.
[48] ITRC. "Determining Cleanup Goals at Radioactively Contaminated Sites: Case Studies", April 2002: 36.
[49] Pike, J. "US Nuclear Forces", July 27,2000, <http://www.fas.org/nuke/guide/usa/facility/fernald.htm>.
[50] ITRC. "Determining Cleanup Goals at Radioactively Contaminated Sites: Case Studies", April 2002: 36.
[51] Pike, J. "US Nuclear Forces", July 27,2000, <http://www.fas.org/nuke/guide/usa/facility/fernald.htm>.

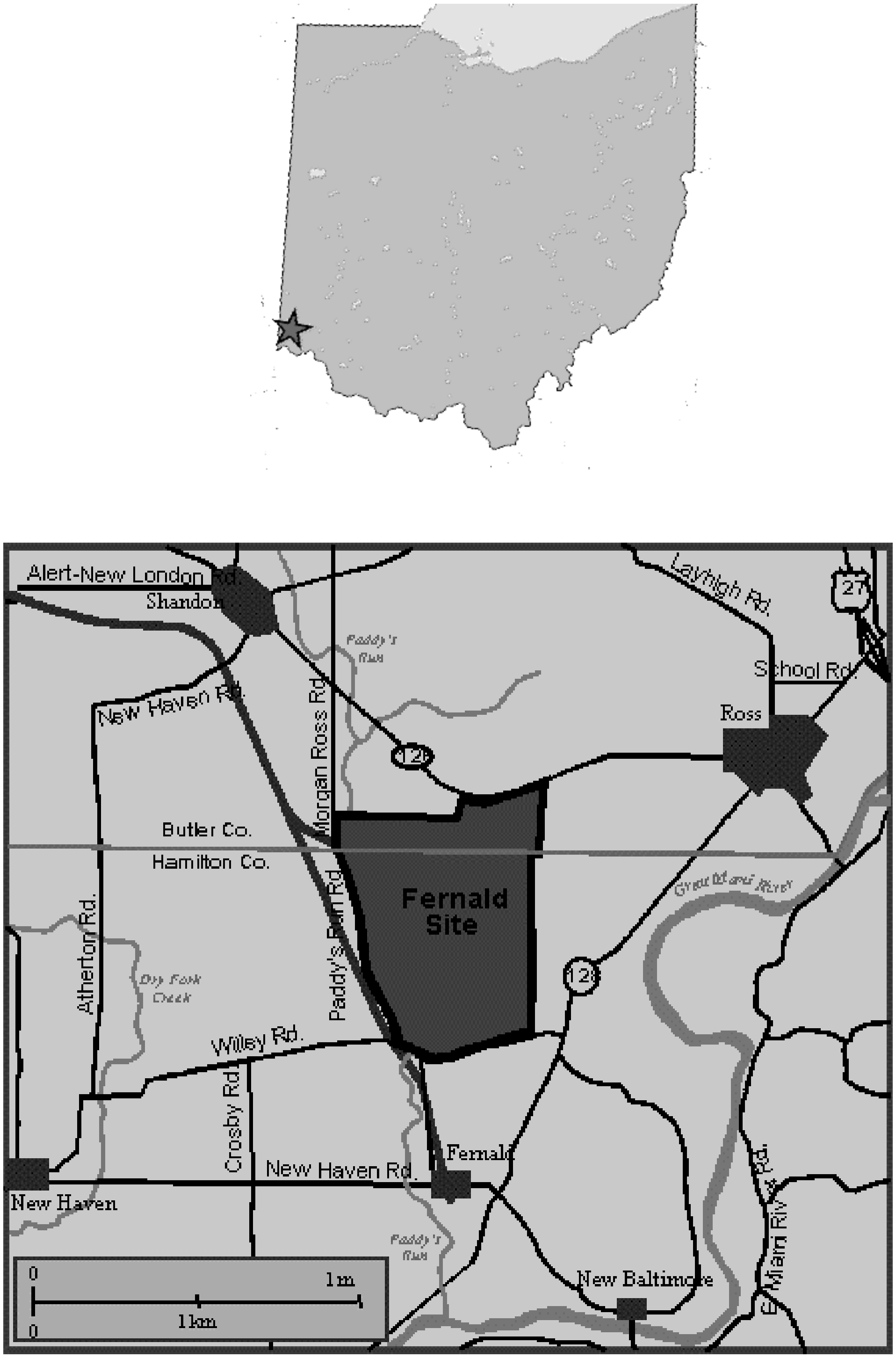

Figure 1: Location of Fernald Site

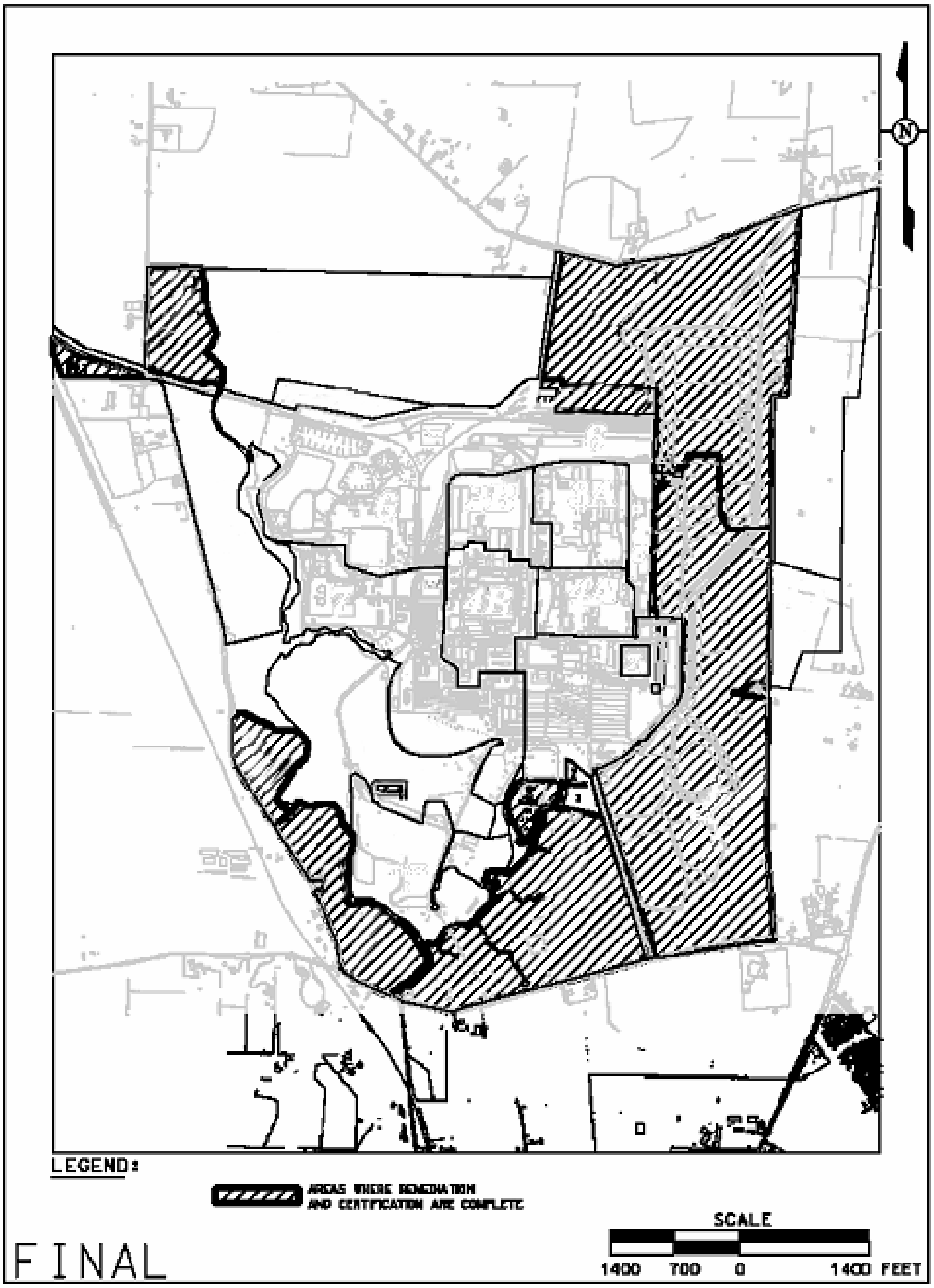

Figure 2: Fernald Soil Remediation Areas.
Source: http://www.fernald.gov/newsupdate/5-yrReview/Sec-6.pdf

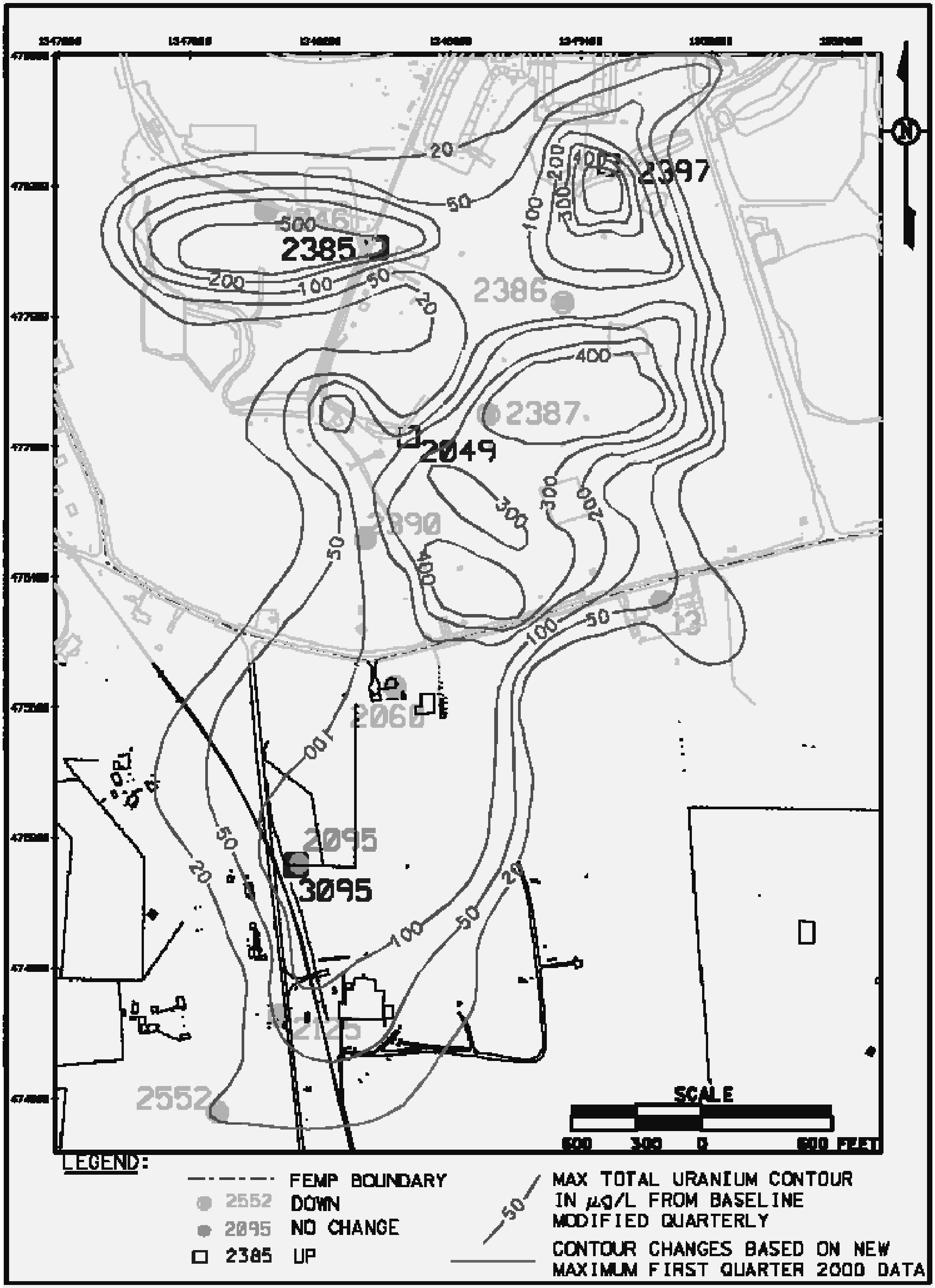

Figure 3: Uranium Groundwater Concentrations: May 2001

Source: http://www.fernald.gov/newsupdate/5-yrReview/Sec-6.pdf

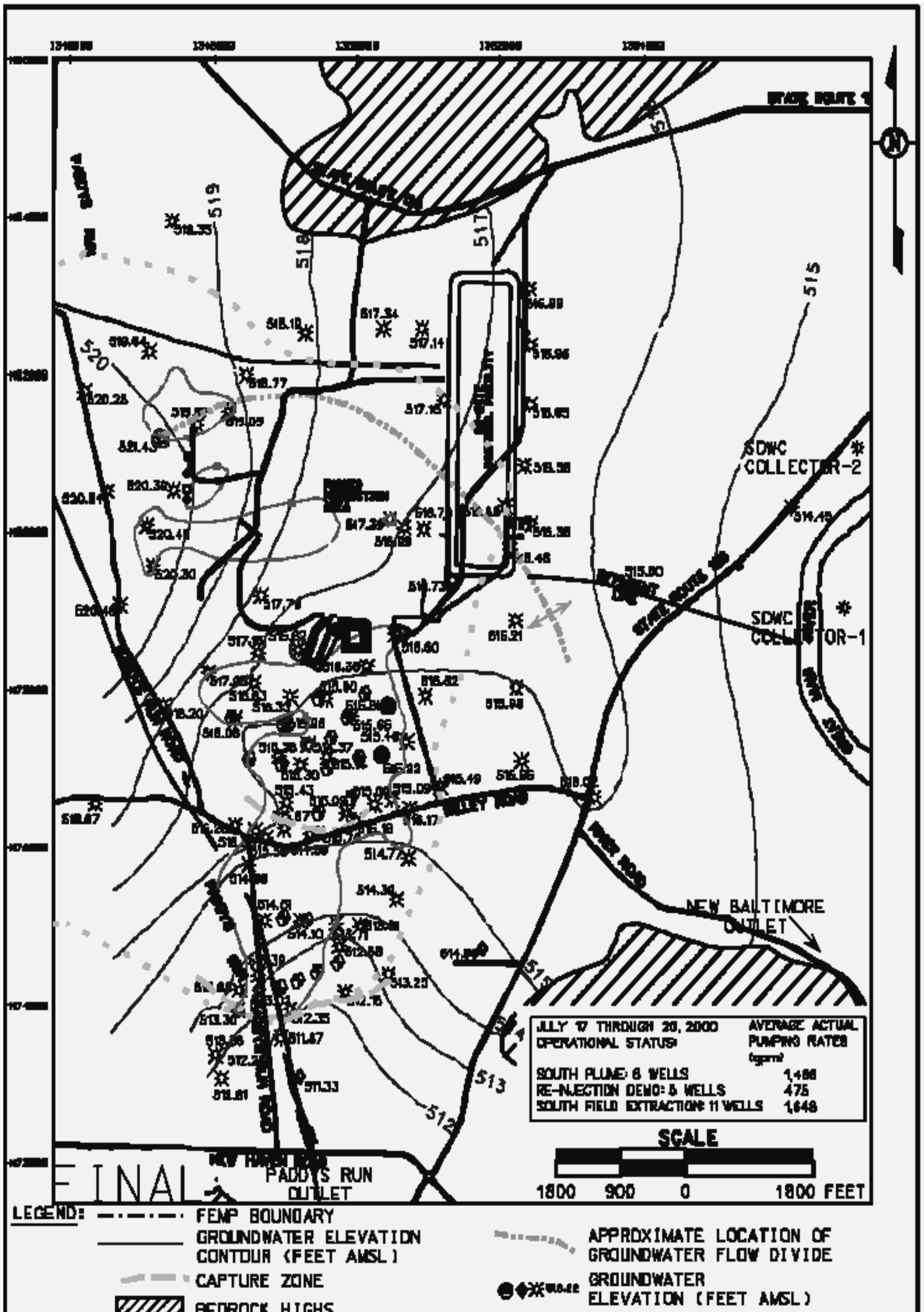

Figure 4: Groundwater Elevation Contours
Source: http://www.fernald.gov/newsupdate/5-yrReview/Sec-6.pdf