HANFORD: CLEANING UP THE MOST CONTAMINATED PLACE IN THE UNITED STATES

Gerald F. Hess*

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* Professor of Law, Gonzaga University School of Law. The author thanks Mr. Paul Kube and Professors Mary Pat Treuthart and Jim Vaché whose review of earlier drafts improved this article. The author is also indebted to Mr. David Parker for his diligent research assistance and Ms. Paula Prather for her careful editing. Finally, the author thanks the editors and staff of the *Arizona Law Review*, whose competence improved this article and whose professionalism was outstanding.

INTRODUCTION

From 1943 to 1988, the United States government produced plutonium for nuclear weapons at the Hanford Site[1] in south-central Washington. The production of plutonium was an immense, complicated undertaking of vital national importance. From 1988 to the present, the challenge at Hanford has been to clean up the millions of tons of waste at the Site. The Hanford cleanup is as huge, complex, and important as Hanford's production mission. The government's nuclear weapons program is not limited to Hanford. The United States Department of Energy (USDOE) is responsible for cleanup of more than 100 contaminated nuclear installations in thirty-six states.[2] The Hanford cleanup is not only the largest single environmental cleanup challenge in the United States, it is the model of environmental restoration for USDOE's Nuclear Weapons Complex[3].

This article, a historical and legal analysis of Hanford, has six main sections. Section I describes Hanford's role in the production of nuclear weapons, the Site's physical environment, and an overview of the Nuclear Weapons Complex. Section II details the contamination released at Hanford and other Nuclear Weapons Complex facilities for the past fifty years and the waste that needs to be dealt with today and in the future. Section III analyzes the major federal and state statutory schemes that apply to the cleanup of the Nuclear Weapons Complex in general and Hanford in particular. Section IV describes the "Tri-Party Agreement" among USDOE, the United States Environmental Protection Agency (EPA), and the Washington Department of Ecology (Ecology), which provides a legal, technical, and political framework for much of the Hanford restoration. Section V examines the waste management and environmental remediation programs that constitute the Hanford cleanup. Finally, Section VI explores the critical legal issues that must be addressed for the Hanford cleanup to succeed.

I. HANFORD'S HISTORIC MISSION AND PHYSICAL ENVIRONMENT

A. Hanford's Nuclear Production Mission

In June 1942, in the midst of World War II, President Franklin D. Roosevelt charged the Army Corps of Engineers with constructing industrial plants to produce uranium–235 and plutonium–239, the fuels for nuclear bombs. Leslie R. Groves was selected to lead this effort, the Manhattan Project.

1. The Hanford Site has had many names. In 1943, the War Department called it the Gable Project and then the Hanford Project. The Army Corps of Engineers renamed it the Hanford Engineer Works. In 1947, the Atomic Energy Commission assumed control of the Site and named it the Hanford Works. In 1975, the Energy Research and Development Administration renamed it the Hanford Reservation. Since 1977, under the United States Department of Energy, it has been known as the Hanford Site. MICHELE S. GERBER, U. S. DEP'T OF ENERGY, LEGEND AND LEGACY: FIFTY YEARS OF DEFENSE PRODUCTION AT THE HANFORD SITE, at vi (1992) (Revision 2).

2. I U.S. DEP'T OF ENERGY, ENVIRONMENTAL RESTORATION AND WASTE MANAGEMENT FIVE YEAR PLAN: FISCAL YEARS 1994–1998, I8–9, app. D (1993) [hereinafter DOE FIVE-YEAR PLAN].

3. GERBER, *supra* note 1, at v.

Groves developed the criteria for the plutonium production site. The ideal location would be a large, remote tract of land, with room for a plutonium production area of at least twelve miles by sixteen miles, no towns of over 1000 people within twenty miles of the production rectangle, and no main highway or railroad within ten miles of it. In addition, the Site needed an abundant clean water supply and a large electric power supply.[4]

In December 1942, Groves dispatched Colonel Frank Matthias to search for such a site in the western United States. He found what he was looking for near the confluence of the Columbia, Snake, and Yakima Rivers in south-central Washington (see Figure 1). Matthias located a half-million-acre tract of desert surrounding the tiny towns of Richland, White Bluffs, and Hanford, which had a combined population of 1500.[5] The Columbia River rushed through the site at the rate of five million gallons per minute and to the north the Grand Coulee Dam could produce ample electric power for the project.[6]

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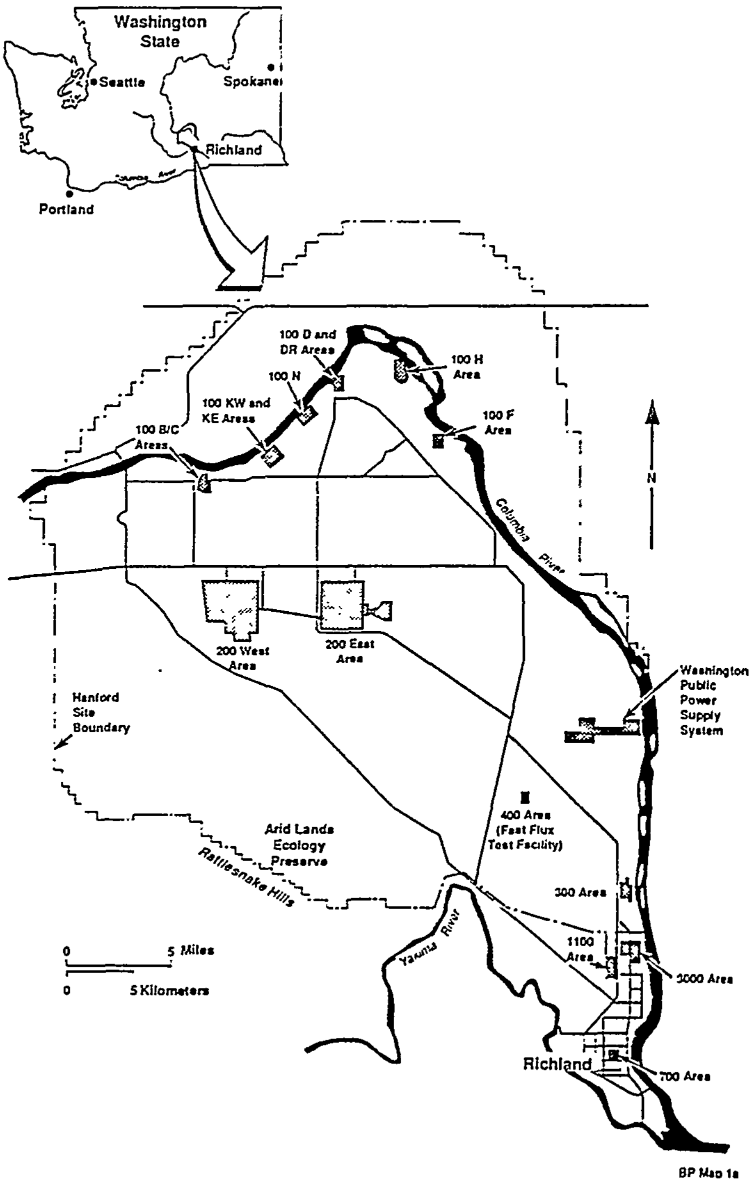
4. *Id.* at 5–6.

5. MICHAEL D'ANTONIO, ATOMIC HARVEST: HANFORD AND THE LETHAL TOLL OF AMERICA'S NUCLEAR ARSENAL 13–14 (1993); GERBER, *supra* note 1, at iv, 5–6.

6. D'ANTONIO, *supra* note 5, at 13–14.

FIGURE 1 HANFORD SITE LOCATION AND MAP[7]



7. GERBER, *supra* note 1, at iv.

In March 1943, residents of the towns of White Bluffs and Hanford, as well as local farmers, received notice to vacate within thirty days so their land could be used for a war-related project. Government agents told Indian tribes that they could no longer fish and forage on the Columbia Reach. The farmers, villagers, and Indians left, for the good of the war effort. Within a few months, livestock was sold, houses were boarded up, and crops and orchards withered and died. By the end of the summer of 1943, 400,000 acres of land became the Hanford Site.[8]

Wartime construction proceeded at a furious pace. Workers came from around the country, drawn by notices posted in union halls and community centers which promised hard work and good pay.[9] Potential recruits were not told the precise nature of the work, only that they would be "doing important war work."[10] Hanford Camp, the temporary town for construction workers, eventually contained over 1000 wooden buildings (barracks, shops, mess halls, taverns, etc.) and housed 50,000 workers. The Army also built a permanent settlement in Richland for the managers and scientists who would operate the secret project. The population of Richland grew from 200 in 1943 to over 15,000 in 1945.[11]

Construction directly related to plutonium production resulted in 554 buildings by the end of the war in August 1945. With the exception of a few top engineers, the construction managers and workers did not know what they were building. The most prominent buildings constructed during this period included B, D, and F reactors and T, B, and U plutonium separations facilities.[12] The original three reactors are spaced six miles apart along the Columbia River. The reactor buildings look like concrete blockhouse factories, seven stories high. Each contains a cube-shaped reactor, the size of a three-story house, made of graphite bricks. The plutonium separations facilities are 800 feet long, sixty-five feet wide, and ten stories tall. Designers called them "canyons"; workers renamed them "Queen Marys."[13] To handle the high-level nuclear waste that was generated during production, workers constructed sixty-four single-shell underground storage tanks;[14] some of the tanks are as small as 55,000 gallons, but most have capacities of 500,000 or 1,000,000 gallons.[15]

After construction, most of the workers were involved in the production of plutonium. Long rods containing uranium were pushed into the graphite reactor core until spontaneous fission took place. The nuclear reaction created new elements, including plutonium. The irradiated slugs from the reactors were taken to the canyons where a thirty-step process was used to chemically separate the plutonium from the slugs.[16] Because exposure to even tiny amounts of plutonium could be lethal in a short time, workers handled the plutonium by remote control behind thick glass and concrete walls. The rooms where

8. D'ANTONIO, *supra* note 5, at 14.
9. *Id.* at 15.
10. GERBER, *supra* note 1, at 7.
11. D'ANTONIO, *supra* note 5, at 14–15.
12. GERBER, *supra* note 1, at 6.
13. D'ANTONIO, *supra* note 5, at 15–16.
14. GERBER, *supra* note 1, at 6, 47.
15. U.S. DEP'T OF ENERGY, OVERVIEW OF THE HANFORD CLEANUP FIVE-YEAR PLAN 9 [hereinafter OVERVIEW].
16. D'ANTONIO, *supra* note 5, at 15.

plutonium was handled were filled with inert gas to prevent the plutonium from igniting, and the rooms were kept under negative pressure so that if a leak developed contamination would not flow out.[17] It took one ton of irradiated uranium slugs to produce one-tenth of a gram of plutonium.[18]

Manhattan Project leaders thought that they were racing the Germans and Japanese to produce the first atomic bomb, so Hanford designers and craftsmen operated under impossible deadlines. However, plutonium production at Hanford presented awesome technical obstacles. Most of the facilities were the first of their kind. Pipefitters, carpenters, masons, and welders were required to make things work even as designs were being changed.[19] Engineering tolerances were minuscule; for example, measurements in graphite reactor cores were permitted to deviate only by thousandths or ten-thousandths of an inch. In addition, the workers did not know what they were producing—uranium was called "base metal" and plutonium was "product."[20] Another immense challenge was to protect workers, nearby residents, and the environment from exposure to radiation and hazardous chemicals. Some of the wastes would remain toxic for tens of thousands of years.[21]

Despite these daunting challenges, Hanford workers produced ten kilograms of plutonium by July of 1945. Five kilograms fueled the Trinity test—the first atomic explosion in history. The other five kilograms went into the bomb dropped on Nagasaki.[22]

World War II ended on August 14, 1945, five days after the bomb was dropped on Nagasaki. A few days earlier, Hanford employees had learned for the first time the nature of the project they had worked on for two years. Hanford workers expressed great pride in the role they had played in ending the war. They received praise and admiration from a grateful nation. Each Hanford worker was awarded the Army–Navy "E" Award, the highest civilian production commendation.[23]

The end of World War II meant big changes at Hanford. On January 1, 1947, the Atomic Energy Commission assumed control of the U.S. atomic complex, including Hanford. However, the end of World War II did not cease plutonium production at Hanford. Instead, the dawning of the Cold War led to massive expansion of Hanford's defense nuclear production capacity.[24]

The Cold War expansion at Hanford included the construction of five more production reactors (C, DR, H, KE, and KW) along the Columbia River by 1955. N-Reactor, the last plutonium production reactor built at Hanford, began operations in 1963. To process the output from the additional reactors,

17. OFFICE OF ENVIRONMENTAL MANAGEMENT, U.S. DEP'T OF ENERGY, CLOSING THE CIRCLE ON THE SPLITTING OF THE ATOM: THE ENVIRONMENTAL LEGACY OF NUCLEAR WEAPONS PRODUCTION IN THE UNITED STATES AND WHAT THE DEPARTMENT OF ENERGY IS DOING ABOUT IT 19, 40 (1995) [hereinafter CLOSING THE CIRCLE].

18. GERBER, *supra* note 1, at 11–12.

19. D'ANTONIO, *supra* note 5, at 16-18.

20. GERBER, *supra* note 1, at 6–7, 11.

21. D'ANTONIO, *supra* note 5, at 17.

22. *Id.* at 19. The Hiroshima bomb was fueled by uranium produced in Oak Ridge, Tennessee, another Manhattan Project facility that is now part of the USDOE Nuclear Weapons Complex in need of cleanup.

23. GERBER, *supra* note 1, at 17.

24. *Id.* at 18–23.

huge new production facilities were constructed, including the Plutonium Finishing Plant (PFP), the Reduction Oxidation Processing Plant (REDOX), and the Plutonium–Uranium Plant (PUREX).[25] U-Plant, a processing canyon built during World War II, was retrofitted as the Metal Recovery Plant to recover uranium from the high-level waste stored in Hanford's underground storage tanks. To provide research and development, numerous laboratory and testing facilities were built. Increased production meant increased high-level radioactive waste, so eighty-five more single-shell underground storage tanks were built by 1964 and twenty-eight double-shell tanks were constructed by 1986. In addition, evaporators were built in the 1950s and 1970s to boil off low-level waste and reduce the volume of the high-level waste.[26]

The 1950s and 1960s were also a time of exploration of the peaceful use of the atom. N-Reactor was used both for producing plutonium and for generating electric power. Hanford pursued non-defense research and development programs, including the search for alternative nuclear fuels at the Plutonium Fuels Pilot Plant, the Plutonium Recycle Test Reactor, and the 318 High Temperature Lattice Test Reactor.[27] In 1970, the Fast Flux Test Facility, a prototype light metal breeder reactor, was built. Portions of the Hanford Site are leased for commercial nuclear production. In the 1970s, the Washington Public Power Supply System began constructing three commercial nuclear power plants at Hanford. One of the reactors was completed and produces power today; the other two were never completed. Another portion of the Site is leased to the State of Washington and operated by U.S. Ecology, a private company, as a low-level radioactive waste disposal site.[28]

B. Hanford's Physical Environment Today

Today, more than fifty years after Colonel Franklin Matthias flew over the south-central Washington desert near the tiny town of Richland, the Hanford Site is a complicated place. Hanford's 560 square miles[29] contain extensive diversity of human and natural landscapes, including nuclear research and production facilities that employ highly sophisticated science and technology, waste storage for some of the most toxic materials on the earth, and wildlife reserves supporting diverse species of plants and animals.

The Hanford Site is home to a tremendous variety of plants and animals. Although the dominant plants are sagebrush and cheatgrass, nearly 600 plant species have been identified on the Site. It also supports more than 300 species of insects and twelve species of amphibians and reptiles. Over thirty varieties of birds live at Hanford, including herons, hawks, pheasants, geese, and many

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25. *Id.* at 21, 25–26. PFP converted the output of the processing canyons, plutonium nitrate, a wet paste, into hockey puck-shaped plutonium metal. REDOX and PUREX used different processes to extract plutonium and uranium from the reactors' irradiated fuel rods. *Id.* at 21.

26. *Id.* at 26, 39–41, 46.

27. *Id.* at 31, 40.

28. STEVE M. BLUSH & THOMAS H. HEITMAN, TRAIN WRECK ALONG THE RIVER OF MONEY: AN EVALUATION OF THE HANFORD CLEANUP 1–2, 1–4 (1995).

29. PACIFIC NORTHWEST LABORATORY, U.S. DEP'T OF ENERGY, PNL–6415 REV. 5, HANFORD SITE NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) CHARACTERIZATION 4.1 (C.E. Cushing ed., 1992).

types of songbirds. Nearly forty species of mammals are found on the Site, ranging from mice and bats to bobcats and elk.[30]

The major areas of the Hanford Site, according to the USDOE designations, are as follows (see Figure 1).

1. 100 Area

This area takes up twenty-seven square miles along the south bank of the Columbia River. It contains eight plutonium production reactors retired in the 1960s and N-Reactor, which was shut down in 1991.[31] The 100 Area encompasses dozens of buildings near the reactors. For example, N-Reactor is surrounded by approximately 100 buildings, including office buildings, warehouses, shops, pump houses, and fuel storage facilities.[32] The land between the reactors and surrounding buildings also contains Native American burial sites and the White Bluffs Townsite.[33]

2. 200 Area

This area consists of nine square miles on a plateau in the center of the Hanford Site. The 200 Area has been used primarily for plutonium processing and high-level radioactive waste storage.[34] All major nuclear fuel processing facilities (the "canyons", PFP, REDOX, and PUREX), none of which still operates, are located here. Hanford's 177 underground storage tanks for high-level waste and the evaporators are also in the 200 Area. An additional 100 or so buildings (laboratories, office buildings, warehouses, shops, and other facilities) accompany the processing facilities and tank farms.[35] Finally, this area includes the land leased to the State of Washington for a low-level radioactive waste disposal facility.[36]

3. 300 Area

Located along the Columbia River in the southeast corner of the Site, this area of less than one square mile houses more than 130 facilities for fuel fabrication, research, and development.[37]

4. 400 Area

This area of one square mile is located in the southeastern part of the Site. It contains the Fast Flux Test Facility and more than fifty support facilities.[38]

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30. *Id.* at 4.59–4.72.
31. HANFORD FUTURE SITE USES WORKING GROUP, THE FUTURE FOR HANFORD: USES AND CLEANUP 59 (Dec. 1992).
32. Hanford Site Maps (Feb. 1986) (on file with the author).
33. HANFORD FUTURE SITE USES WORKING GROUP, *supra* note 31, at 59.
34. *Id.* at 73.
35. Hanford Site Maps, *supra* note 32.
36. HANFORD FUTURE SITE USES WORKING GROUP, *supra* note 31, at 73–75.
37. Jim Lynch & Karen D. Steele, *The Nuclear Mess at Hanford*, SPOKESMAN–REV. (Spokane), Nov. 13, 1994, at H4; Hanford Site Maps, *supra* note 32.
38. Lynch & Steele, supra note 37, at H4; Hanford Site Maps, *supra* note 32.

5. 1100 Area

This area of less than one square mile is in the southeast corner of the Site. Its fifteen buildings contain the main warehouses, shops, and vehicle maintenance and fuel storage facilities.[39]

6. Arid Lands Ecology Reserve (ALER)

The ALER comprises 120 square miles in the southwest portion of the Site. It was established in 1967 and is currently managed by Battelle Pacific Northwest Laboratories as a habitat and wildlife reserve and a nature research center. Rattlesnake Ridge, which rises 3,600 feet above the rest of the Reserve, contains a former Army missile site and is a religious site for Native Americans. Public access to the ALER has been limited since 1943, so the shrub-steppe land is mostly undisturbed.[40]

7. North of the River

The 140 square miles of the Site north of the Columbia River are managed in part by the Washington Department of Wildlife as the Wahluke Slope Wildlife Recreation Area and in part by the U.S. Fish and Wildlife Service as the Saddle Mountain National Wildlife Refuge. The ecosystem includes relatively undisturbed shrub-steppe habitat. This area also includes a former missile site and Native American religious and burial sites.[41]

8. Other Land Areas

The southeast corner of the Site contains the 700 Area (primarily federal office buildings and records storage), the 3000 Area (approximately twenty-five office buildings, shops, and warehouses),[42] the Pacific Northwest Laboratories (a lab complex operated by Battelle), and the Washington Public Power Supply commercial nuclear power plants (one operating and two unfinished and mothballed).[43] The remaining 250-plus square miles of the Site not otherwise designated are the 600 Area.[44] The 600 Area contains large parcels of undeveloped land and Native American religious and burial sites.[45]

9. Columbia River

Fifty-one miles of the Columbia River flow through or border the Site. This segment of the river, known as the Hanford Reach, is the last free-flowing stretch of the Columbia in the United States. The river, its banks, and islands provide recreation for local residents[46] and habitat for grouse, pelicans, bald eagles, golden eagles, blue herons, steelhead, sturgeon, and salmon.[47] The riverbanks and islands are also the traditional fishing, food gathering, and burial grounds for the Native American tribes (Yakama, Nez Perce, and the

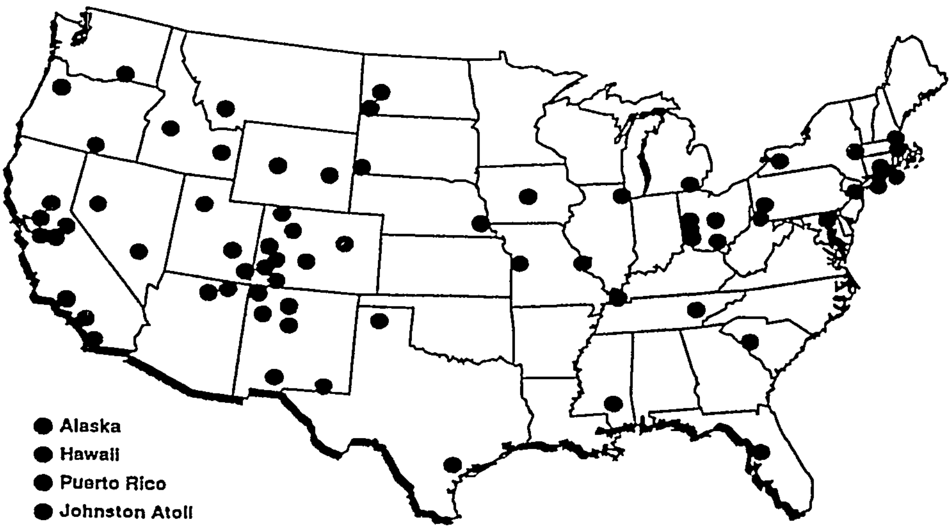
39. Lynch & Steele, supra note 37, at H4; Hanford Site Maps, *supra* note 32.
40. HANFORD FUTURE SITE USES WORKING GROUP, *supra* note 31, at 24.
41. *Id.* at 37–38.
42. Hanford Site Maps, *supra* note 32.
43. BLUSH & HEITMAN, *supra* note 28, at 1–2 to 1–4.
44. Lynch & Steele, *supra* note 37, at H4.
45. HANFORD FUTURE SITE USES WORKING GROUP, *supra* note 31, at 89.
46. *Id.* at 48.
47. GERBER, *supra* note 1, at 37.

Confederated Tribes of the Umatilla Indian Reservation) who once lived at the site. Further, river water is used downstream by Washington and Oregon residents for drinking water, agriculture, industry, and recreation.[48]

C. *Nuclear Weapons Complex History and Mission*

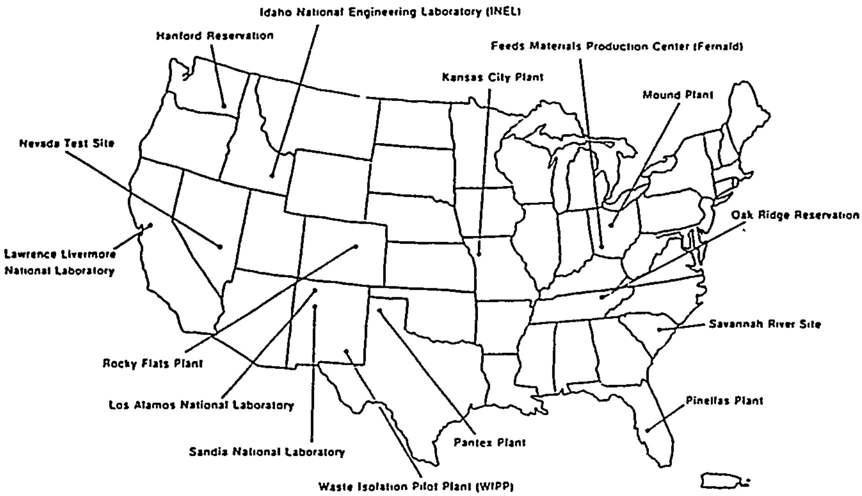
Hanford is part of USDOE's Nuclear Weapons Complex, which encompasses over 100 contaminated facilities in thirty-six states and territories (see Figure 2).[49] The core of the Complex consists of fifteen facilities in twelve states (see Figure 3), covering 3,350 square miles and employing more than 100,000 people. The Complex contains nuclear reactors, enormous factories, laboratories, support buildings, and waste storage structures. For the past fifty years, these facilities conducted research, produced nuclear materials, irradiated them in nuclear reactors, reprocessed them to separate weapons-grade materials, manufactured and finished weapons components, assembled and tested nuclear weapons, and recycled parts when weapons were retired.[50]

Figure 2 USDOE Nuclear Weapons Complex—Contaminated Sites[51]



48. BLUSH & HEITMAN, *supra* note 28, at 1–1; HANFORD FUTURE SITE USES WORKING GROUP, *supra* note 31, at 48.
49. DOE FIVE-YEAR PLAN, *supra* note 2, at I–8.
50. OFFICE OF TECH. ASSESSMENT, U.S. CONGRESS, COMPLEX CLEANUP: THE ENVIRONMENTAL LEGACY OF NUCLEAR WEAPONS PRODUCTION 15, 17 (1991) [hereinafter COMPLEX CLEANUP].
51. DOE FIVE-YEAR PLAN, *supra* note 2, at I–8.

Figure 3 USDOE Nuclear Weapons Complex—Major Facilities[52]



The Nuclear Weapons Complex began during World War II as part of the Manhattan Project and expanded during the 1950s.[53] Between 1953 and 1990, the Complex produced nearly 70,000 nuclear warheads, more than 50,000 of which have now been retired and disassembled.[54] The tasks performed at the major Complex facilities to produce those warheads fall into four categories: (1) weapons research and design; (2) nuclear materials (plutonium, uranium, tritium) production and processing; (3) warhead manufacturing; and (4) weapons testing.[55]

Weapons research and design took place at three facilities: National Laboratories at Los Alamos, Sandia, and Lawrence Livermore.[56] The Los Alamos National Laboratory was established in 1943, on forty-three square miles northwest of Santa Fe, New Mexico. Its original mission was to develop the world's first nuclear bombs. Its continuing mission includes research and development in nuclear weapons, environmental sciences, fusion, physics,

52. COMPLEX CLEANUP, *supra* note 50, at 16.
53. *Id.* at 15.
54. Michael B. Gerrard, *Fear and Loathing in the Siting of Hazardous and Radioactive Waste Facilities: A Comprehensive Approach to a Misperceived Crisis*, 68 TUL. L. REV. 1047, 1085 (1994).
55. COMPLEX CLEANUP, *supra* note 50, at 15, 17.
56. *Id.*

chemistry, and medicine.[57] The Sandia National Laboratory–New Mexico was created in 1949 on sixty-two square miles in Albuquerque. Its primary mission is the development of arming, fusing, and firing systems for nuclear bombs. Other projects include nuclear reactor safety, transport and storage systems for uranium and plutonium, and radioactive waste disposal techniques.[58] The Lawrence Livermore National Laboratory is a one-square-mile facility near San Francisco, California. It was established in 1952 to perform research, development, and testing on all aspects of the nuclear weapons cycle. It also does biomedical, environmental, and fusion research.[59]

The production of weapons-grade plutonium, uranium, and tritium took place at three facilities in addition to Hanford: Savannah River Site, Fernald, and Idaho National Engineering Laboratory (INEL).[60] The Savannah River Site is located on 325 square miles in south-central South Carolina. The site contains five reactors, two chemical separations facilities, one reactor fuel manufacturing facility, and numerous support buildings. Its mission is to produce plutonium and tritium.[61] The Fernald Environmental Management Project was constructed in 1952 on 1050 acres near Cincinnati, Ohio. Before production was ended in 1989, Fernald's mission was to produce uranium ingots.[62] INEL comprises 890 square miles in southern Idaho. It was established in 1949 to produce enriched uranium. INEL has operated nuclear reactors as well as fuel processing plants and support facilities. INEL's mission now includes research in nuclear safety, waste management, and space technology.[63]

Warhead manufacturing occurred at six facilities: Rocky Flats Plant, Oak Ridge Reservation, Mound Plant, Pinellas Plant, Kansas City Plant, and Pantex Plant.[64] Rocky Flats is located on eleven square miles near Denver, Colorado. The plant opened in 1952 and produced plutonium components for weapons until 1992.[65] The Oak Ridge Reservation occupies fifty-eight square miles in Tennessee. It opened in 1943 and its historic mission was to produce enriched uranium and warhead components. Its current mission includes reactor and accelerator development and operation, environmental and health research, and dismantling nuclear weapons.[66] The Mound Plant is located on 306 acres in southwestern Ohio. Since 1948, it has produced non-nuclear components for nuclear weapons.[67] The Pinellas Plant is on ninety-nine acres near Tampa, Florida. It has produced electronic and ceramic nuclear weapons components

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57. DOE FIVE-YEAR PLAN, *supra* note 2, at II–22; II U.S. DEP'T OF ENERGY, NATIONAL SUMMARY REPORT OF DRAFT SITE TREATMENT PLANS (FINAL DRAFT) 101 (1994) [hereinafter SITE TREATMENT PLANS].

58. COMPLEX CLEANUP, *supra* note 50, at 7; SITE TREATMENT PLANS, *supra* note 57, at 105.

59. DOE FIVE-YEAR PLAN, *supra* note 2, at II–220; SITE TREATMENT PLANS, *supra* note 57, at 15.

60. COMPLEX CLEANUP, *supra* note 50, at 15, 17.

61. DOE FIVE-YEAR PLAN, *supra* note 2, at II–241.

62. *Id.* at II–110; SITE TREATMENT PLANS, *supra* note 57, at 131.

63. COMPLEX CLEANUP, *supra* note 50, at 17; DOE FIVE-YEAR PLAN, *supra* note 2, at II–115; SITE TREATMENT PLANS, *supra* note 57, at 45.

64. COMPLEX CLEANUP, *supra* note 50, at 17.

65. DOE FIVE-YEAR PLAN, *supra* note 2, at II–198; SITE TREATMENT PLANS, *supra* note 57, at 27.

66. COMPLEX CLEANUP, *supra* note 50, at 17; DOE FIVE-YEAR PLAN, *supra* note 2, at II–164; SITE TREATMENT PLANS, *supra* note 57, at 159.

67. DOE FIVE-YEAR PLAN, *supra* note 2, at II–30; SITE TREATMENT PLANS, *supra* note 57, at 135.

since 1957.[68] The Kansas City Plant is in 3.2 million square feet of office space. Beginning in 1949, it produced electronic, plastic, and metal components.[69] The Pantex Plant is near Amarillo, Texas, on 16,000 acres. Since 1950, its mission has been assembly and disassembly of nuclear weapons.[70]

Warhead testing has been conducted both above and below ground since the early 1950s at the Nevada Test Site. The site is located on 1,350 square miles in south-central Nevada. Approximately 720 nuclear explosions were detonated at the Nevada Test Site. USDOE also manages eight other sites in Alaska, Colorado, Mississippi, Nevada, and New Mexico, where nuclear explosives were tested from 1961 to 1973 to study the peaceful use of the atom.[71]

USDOE succeeded in its massive effort to unlock the power of the atom and produce nuclear weapons. However, nuclear weapons production resulted in the release of vast quantities of hazardous chemicals and radioactive particles into the environment. Consequently, the legacy of the Nuclear Weapons Complex includes widespread environmental contamination.[72]

II. PAST RELEASES AND PRESENT CONTAMINATION

A frightening amount of toxic materials was released into the environment at Hanford during the past fifty years. Radioactive and chemical wastes totaling billions of gallons of liquids and billions of cubic meters of gases were released. The business of producing nuclear bombs spread millions of curies of radioactivity into the Columbia River and into the soil and air of the Columbia basin.[73] In comparison, during the 1979 accident at the Three Mile Island nuclear reactor, less than thirty curies escaped.[74]

The current contamination at Hanford is located in 1377 sites. Of those, 158 contain chemical hazardous waste, 100 contain solely radioactive waste, 996 contain mixed chemical and radioactive waste, and 123 contain non-hazardous waste. The total volume of waste at these sites is not yet known, but at least 1.2 million cubic yards (enough to cover a football field 700 feet deep) of waste contain radioactivity. The amount of soil contamination is also unknown. It is known, however, that approximately 200 square miles of ground water are contaminated.[75]

The past releases and current contamination at Hanford are indicative of the releases and environmental problems of the entire Nuclear Weapons Complex. Contamination of the ground water, surface water, and soil is

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68. DOE FIVE-YEAR PLAN, *supra* note 2, at II–43; SITE TREATMENT PLANS, *supra* note 57, at 37.

69. DOE FIVE-YEAR PLAN, *supra* note 2, at II–15; SITE TREATMENT PLANS, *supra* note 57, at 75.

70. DOE FIVE-YEAR PLAN, *supra* note 2, at II–37; TREATMENT PLANS, *supra* note 57, at 165.

71. DOE FIVE-YEAR PLAN, *supra* note 2, at I–161, II–130, II–135; SITE TREATMENT PLANS, *supra* note 57, at 87.

72. COMPLEX CLEANUP, *supra* note 50, at 15, 23.

73. MICHELE S. GERBER, ON THE HOME FRONT: THE COLD WAR LEGACY OF THE HANFORD NUCLEAR SITE 3 (1992). Curies measure radioactive decay over time; one curie is 37 billion atoms decaying per second. *Id.* at 298.

74. SETH SHULMAN, THE THREAT AT HOME: CONFRONTING THE TOXIC LEGACY OF THE U.S. MILITARY 95 (1992); D'ANTONIO, *supra* note 5, at 270.

75. OVERVIEW, *supra* note 15, at 7–8.

widespread throughout the Nuclear Weapons Complex.[76] The release of millions of tons of radioactive and hazardous chemical polluted approximately 9000 sites.[77]

A. Hanford's Releases Into Air, Water, and Soil

1. Releases into Air

Most of the airborne emissions of radioactive waste from Hanford occurred between 1944 and 1955. Radioiodine, radioxenon, radioruthenium, and plutonium were released from the stacks of the facilities that separated plutonium from irradiated uranium fuel rods. Iodine-131 was the radioisotope emitted into the air in the greatest amounts; by 1955, more than 500,000 curies had entered the atmosphere from the Hanford stacks.[78]

In 1988, USDOE began the Hanford Environmental Dose Reconstruction Project (HEDRP) to estimate radiation exposure to the public from Hanford. The HEDRP's 1990 report found significant exposure for people who drank milk from cows that grazed on grasses contaminated by iodine-131 downwind from Hanford. Approximately 13,500 "downwinders" accumulated doses in excess of thirty-three rads.[79] Children accumulated the highest doses; about 1200 children received over 650 rads. To put these numbers in context, the current EPA standard for airborne radiation is .025 rads per year. Workers in nuclear power plants are limited to five rads per year of exposure to their entire bodies. When iodine-131 is absorbed into the human body it often is deposited in the thyroid. The radioactivity damages the thyroid, possibly leading to hypothyroidism or cancer.[80]

2. Releases into Water

Most of Hanford's toxic waste that entered the Columbia River came from the eight "single-pass" reactors built along the river between 1944 and 1955. The single-pass design pumped river water into the reactor cores for cooling. As the water passed through the reactors, it picked up heavy metals and sixty different radionuclides along with chemicals used to cleanse the reactors. The spent cooling water was held in basins, generally for thirty minutes to four hours, to allow the shortest-lived radionuclides to decay. The spent cooling water was then pumped back into the Columbia River. Unfortunately, the short stay in the retention basins had no effect on the longer-lived radionuclides, including radioactive isotopes of phosphorous, arsenic, zinc, chromium, and neptunium which decays into plutonium. By 1963, millions of gallons of spent cooling water containing an average of 14,500 curies of radioactivity were being released into the Columbia River *each day*.[81]

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76. COMPLEX CLEANUP, *supra* note 50, at 23.
77. Kyle Bettigole, Comment, *Defending Against Defense: Civil Resistance, Necessity and the United States Military's Toxic Legacy*, 21 B.C. ENVTL. AFF. L. REV. 667, 669 n.14 (1994).
78. GERBER, *supra* note 73, at 77–78.
79. SHULMAN, *supra* note 74, at 97–98; Michele Stenehjem, *Indecent Exposure*, NAT. HIST., Sept. 1990, at 10, 20. A rad is a unit of measure of the absorbed dose of radiation. GERBER, *supra* note 73, at 301.
80. SHULMAN, *supra* note 74, at 97–98; Stenehjem, *supra* note 79, at 10, 20.
81. GERBER, *supra* note 73, at 115, 125; Stenehjem, *supra* note 79, at 6, 8.

The radioactivity was absorbed by and concentrated in organisms that lived in the Columbia River. From 1947 to 1967, concentrations of radioactive phosphorous in algae, plankton, crustaceans, and fish ranged from 5000 to 170,000 times the concentration in river water. In 1959, radiation in significant amounts was detected in oysters off the Oregon coast in water contaminated by the Columbia. Humans were exposed to radiation in the Columbia River by eating fish from the river, eating vegetables irrigated by river water, and drinking water that the municipal water supply systems in the cities of Pasco and Kennewick drew from the river.[82]

All of Hanford's single-pass reactors were shut down between 1964 and 1967. As the reactors closed, the concentration of radionuclides in the Columbia River dropped dramatically. By 1973, the level of radioactivity in the river water was essentially undetectable. However, thousands of curies of radioactivity remain in the river sediments.[83]

3. Releases into Soil

Much of the waste generated at Hanford was released into the soil. Radioactive waste was released into Hanford's soil from three primary sources: (1) high-level radioactive waste[84] leaking from underground storage tanks, (2) low-level radioactive waste[85] from plutonium processing facilities, and (3) solid waste.

High-level radioactive waste is stored in huge underground storage tanks, 149 single-shell and 28 double-shell.[86] The single-shell tanks were designed to store waste for only twenty years but many have been used for nearly twice that long.[87] As many as sixty-six of the tanks may have leaked a total of approximately 750,000 gallons of high-level waste into the ground.[88] The largest known tank leak, 115,000 gallons, occurred in 1973 from 106-T.[89] It is quite a story.

> In April 1973 tank 106T contained high-level radioactive waste from the Purex fuel reprocessing plant—about 1.5 million litres of it, mostly liquid. [Towards the end of] April tank 106T sprang a leak.
>
> The employees of the Atlantic Richfield Hanford Company (ARHCO), AEC contractors responsible for the facility, went about their business. From [April 4 to 24] a fresh installment of hot liquid was pumped into tank 106T. Every week or so after pumping ended someone read the gauge indicating the level of the radioactive liquid in tank 106T, and jotted it down in a log. Every week the day shift supervisor left it to someone else to review the data. Apparently nobody did. On [May 8] the monthly reading of radioactivity in Well 299–W–10–51, a test hole next to tank 106T, showed nothing unusual. On [May 31], when next the radiation detector was lowered into the well, it went off scale. The

82. GERBER, *supra* note 73, at 118–41; Stenehjem, *supra* note 79, at 8–21.
83. GERBER, *supra* note 73, at 140–41.
84. High-level radioactive waste contains more than one ten-thousandth (1/10,000) of a curie of radioactivity per milliliter of waste. *Id.* at 144, 298–99.
85. Low-level radioactive waste contains less than 5/10,000,000,000 of a curie of radioactivity per milliliter of waste. *Id.* at 300.
86. OVERVIEW, *supra* note 15, at 9, 11.
87. Michael W. Grainey, *Nuclear Weapons Waste: Recent Federal Legislation and the Cleanup Effort,* 30 WILLAMETTE L. REV. 765, 769 (1994).
88. OVERVIEW, *supra* note 15, at 9.
89. GERBER, *supra* note 1, at 47.

> monitoring operator told the day shift supervisor, who asked him to check this well daily, but did nothing further. The next day, using a less sensitive Geiger-Mueller probe, the monitoring operator got a reading of 300,000 counts per minute. The radiation data was placed on the desk of the supervisor, who did not review it. This went on daily until, in a leisurely fashion, by means of a casual exchange of telephone calls on [June 7], the idea occurred to someone that perhaps all was not entirely in order under tank 106T. On the morning of [June 8] the supervisor confirmed that there did indeed seem to be a leak in the tank....
>
> Between [April 20 and June 8] tank 106T leaked approximately 435,000 litres of highly radioactive liquid into the earth, containing approximately 40,000 curies of caesium–137, 14,000 curies of strontium–90, and 4 curies of plutonium....[90]

Although high-level radioactive waste from tanks accidentally leaked into the soil, USDOE and its contractors intentionally released most of the other waste that ended up in soil. The facilities in the 200 Area that processed irradiated uranium fuel rods to extract plutonium produced a tremendous amount of low-level liquid radioactive waste. In 1944, the liquid waste was simply poured into low spots in the ground. By the beginning of 1945, radiation levels on the surface of the disposal site created concern. From 1945 to 1947, the liquid waste was put into deep "reverse wells"—dry shafts with holes in the bottom. However, the reverse wells were also problematic because they discharged the waste close to ground water.[91] By 1948, most of the low-level liquid waste in the 200 Area was pumped into "cribs"—shallow pits in the ground with gravel bottoms and a plastic cover. Cribs were designed to allow Hanford's soil to filter and trap radioactive particles.[92] By 1970, about 120 billion gallons of low-level liquid radioactive waste had been dumped into the ground at Hanford. Approximately 3.2 million curies of radioactive isotopes had been disposed, along with 280,000 grams of plutonium and 120,000,000 grams of uranium.[93] Although the volume of low-level liquid waste gradually declined after 1970, fourteen of Hanford's 124 cribs continued to receive waste in the 1990s.[94] The land disposal of low-level liquid radioactive waste over the past fifty years has contaminated one trillion gallons of ground water and a vast but unknown volume of soil.[95]

Throughout Hanford's operations, solid objects contaminated with radioactive and chemical wastes were buried at various places across the Site. Bulldozers simply interred containers filled with contaminated equipment and clothing. In 1956, a 500-foot tunnel was dug at the end of a railroad spur near PUREX. Apparatus too heavy to be hauled away for burial were rolled into the tunnel. In 1964, a 1,688-foot tunnel for solid waste was constructed. After 1970, some of the solid waste was placed in retrievable storage. To date, over 10,000,000 cubic feet of solid radioactive waste has been buried or stored at Hanford.[96]

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90. WALTER C. PATTERSON, NUCLEAR POWER, 110–11 (1980).
91. GERBER, *supra* note 73, at 147–49.
92. *Id.* at 148–49; OVERVIEW, *supra* note 15, at 14.
93. GERBER, *supra* note 73, at 162.
94. OVERVIEW, *supra* note 15, at 14.
95. BLUSH & HEITMAN, *supra* note 28, at 2–17, 2–20.
96. GERBER, *supra* note 73, at 168–69.

4. Health Effects of Releases

Although the disposal of radioactive waste into Hanford's soil and ground water probably did not result in significant exposure to humans off the Site, the discharges into the Columbia River and the air emissions certainly did.[97] Beginning in 1943, Hanford scientists conducted numerous extensive studies that documented the extent of the radiation releases, the exposure to humans, and the human health effects from exposure to radiation. Hanford officials were aware that thousands of people living in the vicinity of the Site were in danger of developing cancer or other serious health problems from exposure to Hanford's radiation releases.[98] Nevertheless, for forty years Hanford officials not only kept secret the public health risk from Hanford, they assured local residents that Hanford's emissions were so slight as to be innocuous. The public did not learn of the extent of the radiation and the danger to which they had been exposed until the USDOE released 19,000 pages of documents on the history of the Hanford Site in 1986.[99]

B. Present Contamination at Hanford

The scope of the current contamination at Hanford is so vast that it is hard to develop a big picture. The present contamination and the associated risks to humans are summarized in nine categories: high-level radioactive waste, spent nuclear fuel, cesium and strontium capsules, plutonium stockpiles, contaminated facilities, contaminated ground water, contaminated soil, and solid waste.

1. High-Level Radioactive Waste

Over 60 million gallons of high-level nuclear waste are stored in Hanford's 177 underground storage tanks in the 200 Area. Most of the high-level waste was generated during the extraction of plutonium from fuel rods. Even though plutonium extraction is no longer performed at Hanford, high-level waste continues to be added to the tanks. The new waste is generated by programs to deactivate surplus facilities and to stabilize tank waste. Unfortunately, no one knows exactly what is stored in each tank because transfers between tanks were not always recorded, and some of the waste changed form through chemical reactions.[100]

Although the precise makeup of the tank waste is uncertain, its toxicity is clear. The tanks contain approximately 446,000,000 curies of radiation;[101] direct contact would kill people. The high-level radioactive waste will remain dangerous for thousands of years. While many of the tanks are currently leaking, direct human contact with the waste is unlikely because the tanks are covered with six to ten feet of soil.[102] However, significant concerns have been raised about the potential that the presence of flammable gas in the tanks would

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97. *See supra* text accompanying notes 78, 81.

98. D'ANTONIO, *supra* note 5, at 277–80; GERBER, *supra* note 73, at 77–193; Stenehjem, *supra* note 79, at 8–21.

99. GERBER, *supra* note 73, at 201. The USDOE released the documents in response to a Freedom of Information Act request by Karen Dorn Steele, a reporter for the *The Spokesman-Review*. D'ANTONIO, *supra* note 5, at 58, 116–17.

100. BLUSH & HEITMAN, *supra* note 28, at 2–5.

101. COMPLEX CLEANUP, *supra* note 50, at 49.

102. OVERVIEW, *supra* note 15, at 7–9.

ignite and cause an explosion. Although USDOE has taken steps to mitigate the threat of an explosion,[103] the possibility is not merely theoretical. In 1957 near Kyshtym, Russia, an above-ground tank containing 80,000 gallons of high-level nuclear waste exploded and spread radioactive contamination over an area 800 miles long and 100 miles wide. Although the Hanford tanks are underground, which would reduce the impact of an explosion, most are five to ten times the size of the Russian tank, so an explosion could be equally catastrophic.[104]

2. Spent Nuclear Fuel

Hanford has 2300 tons of irradiated nuclear fuel. Ninety-eight percent of it, in the form of 90,000 highly radioactive fuel rods, is stored underwater in two basins (K-East Basin and K-West Basin) in the 100K Area. The K-Basins were built in 1950 and were expected to last twenty years. The remaining irradiated fuel is scattered across the Site. Nuclear fuel from the decommissioned Shippingport Nuclear Power Plant is stored in a pool in the T-Plant canyon. The Fast Flux Test Facility has fuel in the reactor and in storage. PUREX contains fuel in a pool and partially dissolved on the floor. Irradiated fuel is also stored in four buildings in the 300 Area.[105]

The fuel in the K-East Basin is the main safety concern. The fuel is stored in open-top containers, and the uranium has contaminated the 1,000,000 gallons of water that covers them and has created 2300 cubic feet of sludge on the bottom of the basin. K-East Basin leaked in 1973 (15 million gallons) and in 1993. K-West Basin is of less immediate worry because the fuel rods are sealed. However, there is some concern that the canisters are building up explosive hydrogen gas. Finally, since the K-Basins are 1000 feet from the Columbia River, scientists are concerned that an earthquake could cause a catastrophic radiation release.[106]

3. Cesium and Strontium Waste

Approximately 1100 capsules of cesium and 600 capsules of strontium are stored in pools in the Waste Encapsulation and Storage Facility (WESF) adjoining B-Plant in the 200 Area. These capsules contain 90 million curies of radioactivity. They were manufactured at Hanford from tank waste and many were leased to private companies, which used them commercially to provide food or industrial irradiation services. USDOE began a capsule return program after a capsule failed in 1989. Returns will continue for several years. The returned capsules are stored in the 300 Area in Building 324. The same building contains thirty-two highly radioactive canisters of vitrified cesium waste. A large spill occurred during the glassification process, severely contaminating the floor.[107]

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103. WASHINGTON STATE DEP'T OF ECOLOGY & U.S. DEP'T OF ENERGY, IMPLEMENTATION PLAN FOR THE SAFE INTERIM STORAGE OF HANFORD TANK WASTES ENVIRONMENTAL IMPACT STATEMENT 1–6 to 1–7 (1994) [hereinafter TANK WASTE EIS].

104. Grainey, *supra* note 87, at 770.

105. BLUSH & HEITMAN, *supra* note 28, at 2–8; Jim Lynch & Karen D. Steele, *Environmental Threat: K Basins*, SPOKESMAN-REV. (Spokane), Nov. 15, 1994, at A9.

106. BLUSH & HEITMAN, *supra* note 28, at 2–8, 3–5, 3–6; Lynch & Steele, *supra* note 105, at A9.

107. BLUSH & HEITMAN, *supra* note 28, at 2–10, 3–6.

The storage of cesium capsules at WESF may be Hanford's next major contamination problem. The capsules were designed to remain sealed for hundreds of years. USDOE investigated the 1989 capsule failure and learned that other capsules stored at WESF are susceptible to breaching. The failure of a single capsule would severely contaminate the storage pool and generate up to 500,000 gallons of highly contaminated water.[108]

4. Plutonium Stockpiles

Hanford has plutonium at the Plutonium Finishing Plant, PUREX, and a dozen or so other buildings in the 200 and 300 Areas. Over ninety-three percent of the plutonium is stored in the Z-Vaults at the PFP.[109] Surrounded by armed troops, behind concrete walls, inside steel safes, in an electronically monitored room, sit 22,400 pounds of weapons-grade plutonium.[110]

In 1994, USDOE examined safety issues associated with plutonium throughout the nuclear weapons complex. USDOE listed 2000 of the PFP containers of plutonium among its most serious safety issues. However, the main problem relative to plutonium is the lack of a national policy on whether Hanford's plutonium is an asset to be stored for future use or a waste to be disposed.[111]

5. Contaminated Facilities

The Hanford Site contains dozens of facilities contaminated with radioactive and hazardous materials. Major facilities in need of decontamination and decommissioning include reactors (FFTF, N-Reactor, the eight production reactors along the Columbia River) and processing plants (PUREX, PFP, REDOX, B-Plant, T-Plant, U-Plant).[112]

Decontamination of the reactors presents formidable challenges. The FFTF contains 347 irradiated fuel elements, 260,000 gallons of contaminated liquid sodium that were used to cool the reactor, and the reactor vessel. N-Reactor contamination includes water and sludge in the N fuel basin, two silos of highly radioactive metal spacers that were used to keep the fuel rods in place in the reactor, the reactor itself, and ancillary equipment.[113] Each of the eight production reactor buildings contains a reactor block, a control room, a fuel storage basin, ducts for ventilation and gas recirculation, water cooling systems, and supporting offices, shops, and labs. A typical reactor building is made of concrete and is over 200 feet long, 200 feet wide, and nearly 100 feet tall. The fuel basins currently store low-level radioactive sludge and rubble except for the K-Basins which store spent fuel. The reactor blocks (a base, graphite stack, thermal shield, and biological shield) weigh from 8100 to 11,000 tons and are approximately forty feet on all three sides. A typical reactor block contains a stack of 80,000 graphite blocks, a thermal shield of 3200 cast-iron blocks, and a biological shield, four feet thick made of steel and masonite or concrete. The

108. *Id.* at 3–6, 3–7.
109. *Id.* at 2–12.
110. Jim Lynch & Karen D. Steele, *Environmental Threat: Plutonium Finishing Plant*, SPOKESMAN-REV. (Spokane), Nov. 16, 1994, at A–7.
111. BLUSH & HEITMAN, *supra* note 28, at 2–12, 2–13.
112. *Id.* at 2–13 to 2–15, 2–21, 2–22, 3–43, 3–44.
113. *Id.* at 2–14, 2–15, A–54, A–55, A–68 to A–71.

production reactors are contaminated with hundreds of thousands of curies of radioactivity.[114]

The major processing facilities are also seriously contaminated. PUREX is to be the model for deactivating and decommissioning Hanford's major plutonium processing facilities. PUREX is a huge (900-foot long) facility with massive concrete shield walls surrounding plutonium processing canyons. Radiation levels inside the canyons are deadly. Spent nuclear fuel has been left in the canyons since the facility was shut down in 1990. In addition, 6000 gallons of plutonium-uranium solution are still in the plant and 200,000 gallons of plutonium-contaminated nitric acid are located in storage tanks. Finally, the canyon walls, the ventilation system, and thousands of feet of piping are severely contaminated.[115] Similar radioactive contamination exists at the other major processing facilities and at smaller buildings throughout the Site.[116]

6. Contaminated Ground Water

Ground water contamination was caused by liquid effluent discharges throughout Hanford's history. Radioactive and chemical contamination was a result of reactor operations (100 Area), irradiated fuel processing (200 Area), fuels fabrication (300 Area), and equipment and maintenance (1100 Area). Over one trillion gallons of Hanford's ground water are polluted.[117]

Tritium is the most widely dispersed pollutant. It has been detected above drinking water standards in all parts of the Site except the 300 Area. A plume of tritium-contaminated ground water extends from the 200 Area in two directions all the way to the Columbia River, more than five miles away. A plume of carbon tetrachloride covers four square miles in the 200 Area. Nitrate has been measured above the drinking water standards in all parts of the Site except the 400 Area. Other ground-water contaminants include cobalt–60, strontium–90, cesium–137, uranium, plutonium, trichloroethylene, chromium, and cyanide.[118]

Ground water contaminated with tritium and strontium continues to seep into the Columbia River in about forty locations.[119] However, the seeps are so small compared to the volume of the Columbia that they do not create a serious health hazard. The level of strontium in the Columbia is in compliance with drinking water standards and the level of tritium is comparable to the naturally occurring levels in Oregon and Washington.[120]

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114. U.S. DEP'T OF ENERGY, ADDENDUM (FINAL ENVIRONMENTAL IMPACT STATEMENT) DECOMMISSIONING OF EIGHT SURPLUS PRODUCTION REACTORS AT THE HANFORD SITE, RICHLAND, WASHINGTON 1.4, 1.6, 1.7 (Dec. 1992) [hereinafter DECOMMISSIONING EIS].

115. BLUSH & HEITMAN, *supra* note 28, at 2–14, A–51 to A–53; Jim Lynch & Karen D. Steele, *Environmental Threat: PUREX*, SPOKESMAN-REV. (Spokane), Nov. 17, 1994, at A10.

116. BLUSH & HEITMAN, *supra* note 28, at 2–15, A–56 to A–59.

117. *Id.* at 2–17; HANFORD FUTURE SITE USES WORKING GROUP, *supra* note 31, at app. C, p. 9.

118. BLUSH & HEITMAN, *supra* note 28, at 2–17, A–77; HANFORD FUTURE SITE USES WORKING GROUP, *supra* note 31, at app. C, p. 10.

119. HANFORD FUTURE SITE USES WORKING GROUP, *supra* note 31, at app. C, p. 10.

120. BLUSH & HEITMAN, *supra* note 28, at 1–30, 1–31; OVERVIEW, *supra* note 15, at 14.

7. *Contaminated Soils*

The same liquid effluent discharges that contaminated Hanford's ground water also polluted the soil. Soil is contaminated in 139 surface sites (ponds, ditches, trenches), 239 sub-surface sites (reverse wells, cribs, burial grounds, landfills), and about 240 places where waste was spilled. The precise amount of contaminated soil is unknown,[121] but has been estimated at 1.4 billion cubic meters.[122]

8. *Solid Waste*

Radioactive, hazardous, and mixed solid waste exists in a wide variety of forms and locations at Hanford. Large pieces of contaminated equipment are stored in tunnels.[123] In addition, Hanford has over seventy-five waste burial grounds. Before 1970, packaged wastes contaminated with hazardous chemicals, plutonium, or low-level radioactivity went into burial trenches. The packages include drums, wooden boxes, cardboard boxes, and bags.[124] After 1970, the plutonium-contaminated solid waste was packaged in steel drums or boxes of concrete, steel, fiberglass, or plywood and buried in soil trenches, concrete-lined trenches, and in underground concrete or metal cylinders. Many of the containers may have deteriorated extensively. Since 1987, hazardous and mixed waste has been stored in buildings. More than 1300 pieces of contaminated equipment over twelve feet long are stored in the high-level waste tanks. Finally, Hanford continues to receive solid waste generated off-site, such as U.S. Navy submarine reactor compartments.[125]

C. Nuclear Weapons Complex Contamination

Forty-five years of warhead production in the Nuclear Weapons Complex resulted in the release of vast quantities of hazardous and radioactive pollutants into the environment.[126] Factors that contributed to the extensive pollution include manufacturing processes that are inherently waste producing, an emphasis on urgent weapons production for national security, the neglect of health and environmental considerations, and decades of self-regulation without independent oversight or public scrutiny.[127] In 1989, Secretary of Energy James D. Watkins commented that USDOE's environmental problems "resulted from a 40-year culture cloaked in secrecy and imbued with a dedication to the production of nuclear weapons without a real sensitivity for protecting the environment."[128]

Most of the facilities in the Complex have contaminated ground water and surface water. In addition, substantial quantities of radioactive and mixed waste are buried throughout the Complex, much without records of its location or composition. Contaminated soil and sediments are estimated to total billions of cubic meters. USDOE is currently in the process of discovering and

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121. OVERVIEW, *supra* note 15, at 14.
122. Elaine Hiruo, *DOE Cleanup Program at Threshold of Several Far-Reaching Changes*, NUCLEAR FUEL (WASTE MANAGEMENT), Sept. 16, 1991, at 12.
123. *See supra* note 96 and accompanying text.
124. OVERVIEW, *supra* note 15, at 13.
125. BLUSH & HEITMAN, *supra* note 28, at 2–37, A–83, A–86, A–87.
126. *See* COMPLEX CLEANUP, *supra* note 50, at 23.
127. *See id.* at 15.
128. *See id.*

characterizing the waste and contamination in the Complex facilities.[129] However, enough is known about the contamination at nine of the major Complex facilities to earn them places on the EPA's National Priorities List for cleanup under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA): Fernald, Hanford (four areas), INEL, Lawrence Livermore (two areas), Mound, Oak Ridge, Pantex, Rocky Flats, and Savannah River.[130]

Besides dealing with the contaminated soil, ground water, and surface water from past releases, USDOE must manage its stockpile of plutonium and the tremendous amount of radioactive waste currently stored at the Nuclear Weapons Complex facilities. Those wastes fall into five categories: spent nuclear fuel, high-level waste, transuranic waste, low-level waste, and contaminated buildings.

1. Spent Nuclear Fuel

The Complex has about 100 types of highly radioactive spent nuclear fuel totaling approximately 3000 tons.[131] Most of it is stored at Hanford (2300 tons), INEL, and Savannah River.[132] Much of USDOE's spent fuel was designed to be reprocessed, so its outer layer was not designed for long-term storage. Consequently, some of the stored fuel has corroded, creating safety problems. Further, USDOE's spent fuel contains highly enriched uranium, which can fuel bombs, raising security concerns.[133]

2. High-Level Waste

High-level waste is comprised of the highly radioactive liquids, sludges, and solids that result from the reprocessing of spent nuclear fuel to recover uranium and plutonium. All of the high-level waste (385,000 cubic yards, 1.2 billion curies) generated by the Complex is in giant underground storage tanks at Hanford (244,000 cubic yards, 446 million curies, 177 tanks), Savannah River (128,000 cubic yards, 661 million curies, 51 tanks), and INEL (11,000 cubic yards, 67 million curies, 11 tanks plus underground steel bins). Leaks have occurred in over sixty of the Hanford tanks and ten of the Savannah River tanks. Due to serious concerns that some of the Hanford tanks could explode, USDOE is investigating tank safety at all three sites.[134]

3. Transuranic Waste

Transuranic waste is contaminated by radionuclides with an atomic number greater than uranium, such as plutonium. Although it is much less

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129. *See id.* at 23.

130. 40 C.F.R. pt. 300, app. B, tbl. 2 (1994).

131. DOE FIVE-YEAR PLAN, *supra* note 2, at I–113; U.S. DEP'T OF ENERGY, PROGRAMMATIC SPENT NUCLEAR FUEL MANAGEMENT AND IDAHO NATIONAL ENGINEERING LABORATORY ENVIRONMENTAL RESTORATION AND WASTE MANAGEMENT PROGRAMS FINAL ENVIRONMENTAL IMPACT STATEMENT 1–7, 1–9 (Apr. 1995) [hereinafter SPENT FUEL PEIS].

132. *See supra* text accompanying note 105; DOE FIVE-YEAR PLAN, *supra* note 2, at I–113.

133. CLOSING THE CIRCLE, *supra* note 17, at 26–27.

134. COMPLEX CLEANUP, *supra* note 50 at 44–47; DOE FIVE-YEAR PLAN, *supra* note 2, at I–110 to I–115.

radioactive than spent fuel or high-level waste, it is long-lived and very toxic.[135] Transuranic waste includes everything from liquids used in plutonium processing to air filters, gloves, tools, piping, and contaminated soil.[136] Prior to 1970, transuranic waste was buried, but since 1970 it has been packaged in metal drums and metal and wooden boxes, and stored in earth berms, culverts, and on concrete pads. USDOE manages approximately 251,000 cubic meters of transuranic waste (containing five million curies of radiation), of which 61,000 cubic meters are in retrievable storage. Over sixty percent of the retrievably stored transuranic waste is at INEL; the rest is at Hanford, Lawrence Livermore, Savannah River, Oak Ridge, Nevada Test Site, and Mound. USDOE estimates that twenty to thirty percent of the steel drums containing transuranic waste have holes.[137]

4. Low-Level Waste

Low-level radioactive waste includes waste not classified as high-level, transuranic, spent nuclear fuel, or uranium mill tailings. Most of USDOE's low-level waste is mixed with non-radioactive hazardous waste and is in the form of liquids, sludges, soil, and debris (clothing, rags, tools). Approximately 2.5 million cubic meters of low-level waste have been buried at the Complex facilities. Currently, USDOE low-level radioactive waste is generated at thirty sites and disposed at Hanford, INEL, Los Alamos, Nevada Test Site, Oak Ridge, and Savannah River.[138] Cleanup operations will produce more radioactive waste in the form of clothing, tools, and dismantled machinery and buildings.[139]

5. Contaminated Buildings

The end of the Cold War in the late 1980s and early 1990s caused USDOE to downsize its nuclear weapons facilities. Inactive and surplus facilities contaminated with radioactive and hazardous waste pose a risk to health and safety.[140] USDOE currently maintains over 20,000 buildings and structures that will need decontamination and decommissioning. Those buildings contain some highly radioactive areas. For example, Rocky Flats has over twenty rooms contaminated with plutonium; they are called "infinity rooms" because the radiation is too high for standard monitoring equipment to measure. Stabilization and decontamination of USDOE's surplus facilities are necessary to save large maintenance costs and to protect workers and the public.[141]

6. Plutonium Stockpiles

The Nuclear Weapons Complex produced over 100 tons of plutonium during the Cold War. The plutonium is currently in warheads or stored in Complex facilities. USDOE's plutonium stockpile causes contamination

135. DOE FIVE-YEAR PLAN, *supra* note 2, at 116; Gerrard, *supra* note 54, at 1079.
136. CLOSING THE CIRCLE, *supra* note 17, at 44.
137. COMPLEX CLEANUP, *supra* note 50, at 47; DOE FIVE-YEAR PLAN, *supra* note 2, at I-116, I-117.
138. COMPLEX CLEANUP, *supra* note 50, at 23-24; DOE FIVE-YEAR PLAN, *supra* note 2, at I-122, I-123; SITE TREATMENT PLANS, *supra* note 57, at 23, 54.
139. CLOSING THE CIRCLE, *supra* note 17, at 49.
140. DOE FIVE-YEAR PLAN, *supra* note 2, at I-175, I-194.
141. CLOSING THE CIRCLE, *supra* note 17, at 65, 79-80.

concerns because it is so toxic and some storage containers have deteriorated over time. In addition, weapons-grade plutonium presents a serious security problem. However, the most fundamental issue facing USDOE is whether its plutonium is an asset or a waste. Scientists, engineers, policymakers, arms-control specialists, and economists are debating the fate of USDOE's surplus plutonium. Some argue that USDOE should recover some of the billions of dollars it spent producing plutonium by using it to fuel power reactors. Others believe that USDOE should vitrify the plutonium and dispose of it deep in the ground or in the sea bed.[142]

7. Effects on Health from Nuclear Weapons Complex Releases and Waste

Many of the contaminants the Complex released into the environment over the past fifty years and much of the waste currently managed by USDOE represent a clear danger to public health if people are exposed to sufficient doses. For example, radionuclides such as cesium, strontium, uranium, and plutonium are all carcinogens. USDOE has just begun to gather data regarding exposure to off-site populations from past, present, and future operations of the Nuclear Weapons Complex. Nevertheless, USDOE maintains that the contamination poses no immediate or near-term health risks and is relying on site-specific health studies to disprove the threat from chronic exposure.[143] The Office of Technology Assessment has concluded that the possible health effects have not been adequately investigated:

> Off-site health impacts are an unproven but plausible consequence of environmental contamination from the Nuclear Weapons Complex. Published reports and available data can neither demonstrate nor rule out the possibility that adverse health effects have occurred or will occur as a result of weapons site production. Investigations beyond those already completed will be necessary to pursue questions about the occurrence of off-site health effects and to produce the information required to identify the most pressing cleanup priorities.[144]

III. MAJOR STATUTORY SCHEMES GOVERNING THE HANFORD CLEANUP

The cleanup at Hanford and the rest of the Nuclear Weapons Complex is taking place in a legal environment that is as complicated and challenging as the contamination and waste described above. Many federal and state statutory and regulatory schemes govern the Hanford cleanup. The applicability and operation of three categories of schemes are analyzed: (1) planning and preservation, (2) regulation of radioactive materials and waste, and (3) regulation and cleanup of hazardous and mixed waste.

A. Planning and Preservation

Three types of planning and preservation statutes apply to the Hanford cleanup. First, the National Defense Authorization Act for Fiscal Years 1992 and 1993 requires USDOE to develop five-year plans to guide the cleanup of

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142. *Id.* at 42–43.
143. COMPLEX CLEANUP, *supra* note 50, at 77, 117.
144. *Id.* at 117.

the Nuclear Weapons Complex.[145] Second, the Environmental Policy Act (NEPA)[146] and its Washington equivalent, the State Environmental Policy Act (SEPA),[147] address the environmental effects of government action. Third, the National Historic Preservation Act (NHPA),[148] the Archaeological Resources Protection Act (ARPA),[149] and their Washington counterparts[150] are concerned with historic buildings and archaeological sites.

1. Five-Year Plans—National Defense Authorization Act

At the national level, the primary vehicle for Complex-wide planning and public participation has been the USDOE's Five-Year Plans for Environmental Restoration and Waste Management.[151] USDOE issued its first five-year plan in 1989 covering fiscal years 1991–1995.[152] Congress requires that USDOE update the plan each year and that the plan be designed to complete environmental restoration at USDOE facilities by 2019.[153]

The five-year plan discusses the objectives, accomplishments, and issues for the environmental restoration and waste management programs.[154] The mission of the USDOE's environmental restoration program for the Nuclear Weapons Complex is to ensure that risks to the environment, human health, and safety from contaminated inactive waste sites and surplus facilities are either eliminated or reduced to safe levels by 2019. The environmental restoration program consists of two main types of activities: (1) remedial actions for inactive sites where contaminants were released, and (2) decontamination and decommissioning of surplus nuclear facilities.[155] The mission of the waste management program is to treat, store, and dispose of USDOE's Nuclear Weapons Complex waste to protect human health, safety, and the environment.[156]

The five-year plan also contains sections that summarize the environmental restoration and waste management activities for each Nuclear

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145. National Defense Authorization Act for Fiscal Years 1992 and 1993 § 3135, 42 U.S.C. § 7274g(a)(1) (Supp. V 1993) [hereinafter NDAA], which provides:

> Not later than September 1 of each year, the Secretary of Energy shall issue a plan for environmental restoration and waste management activities to be conducted during the five-year period beginning on October 1 of the next calendar year, at (A) defense nuclear facilities and (B) all other facilities owned or operated by the Department of Energy. The plan also shall contain a description of environmental restoration and waste management activities conducted during the fiscal year in which the plan is submitted and of such activities to be conducted during the fiscal year beginning on October 1 of the same calendar year. Such five-year plan shall be designed to complete environmental restoration at all Department of Energy facilities not later than the year 2019.

146. 42 U.S.C. §§ 4321–4370d (1988 & Supp. V 1993).

147. WASH. REV. CODE ch. 43.21C (1994).

148. Pub. L. No. 89–665, 80 Stat. 915 (1966) (codified as amended at 16 U.S.C. §§ 470–470x–6 (1995)).

149. Pub. L. No. 96–95, 93 Stat. 721(1979) (codified as amended at 16 U.S.C. § 470aa–470mm (1995)).

150. WASH. REV. CODE chs. 27.34 & 27.53 (1994).

151. DOE FIVE-YEAR PLAN, *supra* note 2, at I–3.

152. COMPLEX CLEANUP, *supra* note 50, at 26.

153. NDAA, *supra* note 145.

154. *See* DOE FIVE-YEAR PLAN, *supra* note 2, at I–3, I–4.

155. DOE FIVE-YEAR PLAN, *supra* note 2, at I–141, I–143.

156. *Id.* at I–103.

Weapons Complex installation, including Hanford. These site-specific plans set out the long-term cleanup goals, five-year objectives, and specific annual milestones for each installation.[157]

USDOE allows for significant public participation in the planning process. USDOE convenes groups to review drafts of the national five-year plan; the groups include representatives from states, Indian tribes, Congress, federal agencies, trade unions, industry, and environmental and public interest groups.[158] In addition, USDOE solicits and receives public comments on the plan.[159] Moreover, the USDOE has public reading rooms at twenty sites around the country to make information about the Nuclear Weapons Complex more accessible to the public.[160] Finally, each USDOE Field Office developed Public Participation Action Plans designed to increase the quantity and quality of public involvement in the site-specific five-year planning process.[161] As a result, each Complex site has created a variety of ways to improve public participation, such as advisory groups, newsletters, public meetings, and opportunities to comment on proposed actions.[162]

2. Environmental Effects of Government Action—NEPA and SEPA

NEPA declares a broad national commitment to protect and promote environmental quality.[163] To effectuate its broad policy goals, NEPA mandates that before engaging in major federal actions that significantly affect the environment, federal agencies analyze the environmental impacts of and alternatives to their actions.[164] The purposes of NEPA's requirement for an environmental impact statement (EIS) are to enable the agency to carefully consider environmental impacts in reaching its decision and to provide the relevant information to other agencies and the public who may participate in the decisionmaking process.[165]

USDOE is engaging in planning and public participation through four programmatic environmental impact statements (PEIS) that focus on the Nuclear Weapons Complex. In 1990, USDOE began a PEIS for its environmental restoration and waste management programs. The purpose of that PEIS is to provide a broad analysis of the environmental and human health effects of those programs. In 1990 and 1991, USDOE held twenty-three public meetings on the scope of the PEIS and received 20,000 pages of comments. In 1992, USDOE created a PEIS advisory group which includes representatives from local and state government, Indian tribes, regulatory agencies, labor, industry, academia, environmental groups, and interest groups from the locations of USDOE installations. The PEIS is not yet complete. USDOE is preparing three other programmatic environmental impact statements related to the Nuclear Weapons Complex: (1) the Defense Programs Nuclear Weapons

157. *Id.* at II-3 to II-249.
158. *Id.* at app. J-1.
159. *Id.* at I-55.
160. *Id.* at app. E.
161. *Id.* at I-53.
162. *Id.* at I-53 to I-58.
163. Robertson v. Methow Valley Citizens Council, 490 U.S. 332, 348 (1989) (citing 42 U.S.C. § 4331 (1988)).
164. 42 U.S.C. § 4332(C) (1988).
165. *Robertson*, 490 U.S. at 349.

Complex Reconfiguration PEIS will analyze future uses of Complex sites;[166] (2) the Storage and Disposition of Weapons-Usable Fissile Materials PEIS will cover alternatives for managing the nation's stockpile of enriched uranium and plutonium;[167] and (3) the Spent Nuclear Fuel PEIS will analyze options for the safe storage of spent fuel pending its ultimate disposition.[168]

Numerous environmental impact statements directly address the Hanford cleanup. Four EISs were completed between 1984 and 1994. In 1984, the U.S. Navy completed an EIS on the disposal of submarine reactor cores at Hanford.[169] In 1987, USDOE finished an EIS on disposal of Hanford's high-level and transuranic waste.[170] In 1992, USDOE completed an EIS on the decommissioning of eight surplus reactors.[171] Two years later, the National Park Service finalized an EIS on the designation of the North Slope as a National Wildlife Refuge and the Hanford Reach as a Wild and Scenic River.[172] The USDOE currently is preparing five more EISs on aspects of the Hanford cleanup: (1) the Hanford environmental restoration program, (2) disposition of spent nuclear fuel, (3) decontamination of the Plutonium Finishing Plant, (4) safe interim storage of tank waste, and (5) long-term storage and disposition of tank waste. All of these Hanford EISs and the PEISs on the Nuclear Weapons Complex will affect the scope, schedule, and cost of the Hanford cleanup.[173]

Washington's SEPA is modeled on NEPA. SEPA policies and purposes are similar to NEPA,[174] and SEPA requires EISs for major state actions.[175] The regulations implementing SEPA allow a state agency to adopt an EIS prepared under NEPA in lieu of preparing a separate SEPA EIS.[176] At Hanford, the Washington Department of Ecology (Ecology) and USDOE decided to prepare a joint EIS on a proposal to construct new high-level waste storage tanks.[177]

One significant difference between SEPA and NEPA has the potential to affect the Hanford cleanup. The Supreme Court has decided that NEPA is procedural, not substantive; if an agency adequately identifies and evaluates the environmental impacts of proposed action, NEPA does not require the agency to reject or modify the proposal due to environmental concerns.[178] However, the Washington Supreme Court and Ecology's SEPA rules agree that SEPA has substance—SEPA gives an agency the authority, and the responsibility in some instances, to reject a proposed action on the basis of its adverse environmental

166. DOE FIVE-YEAR PLAN, *supra* note 2, at I-25, I-49, I-55, I-56.
167. U.S. DEP'T OF ENERGY, IMPLEMENTATION PLAN: HANFORD REMEDIAL ACTION ENVIRONMENTAL IMPACT STATEMENT RICHLAND, WASH. 1-10 (June 1995) [hereinafter IMPLEMENTATION PLAN].
168. SPENT FUEL PEIS, *supra* note 131, at 1-1.
169. BLUSH & HEITMAN, *supra* note 28, at 1-58.
170. *Id.*; IMPLEMENTATION PLAN, *supra* note 167, at 1-10 to 1-11.
171. BLUSH & HEITMAN, *supra* note 28, at 1-58; IMPLEMENTATION PLAN, *supra* note 167, at 1-11.
172. BLUSH & HEITMAN, *supra* note 28, at 1-58; IMPLEMENTATION PLAN, *supra* note 167, at 1-12.
173. BLUSH & HEITMAN, *supra* note 28, at 1-58 to 1-59; IMPLEMENTATION PLAN, *supra* note 167, at 1-8 to 1-11.
174. WASH. REV. CODE §§ 43.21C.010, .020 (1994).
175. *Id.* § 43.21C.030(2)(c).
176. WASH. ADMIN. CODE § 197-11-610 (1995).
177. TANK WASTE EIS, *supra* note 103, at 1-12.
178. Robertson v. Methow Valley Citizens Council, 490 U.S. 332, 350 (1989).

impacts.[179] However, it appears that Ecology has not yet asserted SEPA's substantive aspect at Hanford.

3. Historic and Archaeological Preservation—NHPA and ARPA

The broad purpose of the National Historic Preservation Act (NHPA) is to preserve for future generations the cultural and historical foundations of the United States.[180] The NHPA authorizes the Secretary of the Department of the Interior to maintain and expand a National Register of Historic Places composed of buildings, sites, and districts significant in American history, archaeology, engineering, and culture.[181] Before it expends federal funds or issues a license, a federal agency must consider the effects of its actions on any building, site, or district that is included or eligible to be included in the National Register.[182] For property owned or controlled by a federal agency, the agency must identify properties eligible for the National Register and manage the eligible property in a way that considers the preservation of its historic, archaeological, and cultural values.[183] Further, if federal agency action or assistance will result in the substantial alteration or destruction of a historic property, the agency must make appropriate records of the property.[184]

The Archaeological Resources Protection Act (ARPA) is designed to protect archaeological resources located on public and Indian lands.[185] Archaeological resources include graves, human skeletal remains, weapons, tools, structures, paintings, and carvings, if the item is at least 100 years old.[186] The ARPA prohibits excavation, damage, sale, and exchange of archaeological resources without a permit.[187]

The USDOE, its contractors, and the Washington Office of Archaeology and Historic Preservation are expending considerable effort to comply with the requirements of the NHPA and the ARPA. Currently, Hanford is being inventoried for buildings, sites, and districts that may qualify for protection. So far, B-Reactor has been listed on the National Register, and twelve other buildings or groups of buildings have been determined to be eligible for the Register. Many more buildings will likely be determined to be eligible for the National Register in the future. Since most of the buildings will eventually be destroyed as part of the Hanford cleanup, extensive documentary and photographic records will be prepared. In addition, forty-eight archaeological sites have been listed on the National Register and 106 more sites are eligible for listing.[188]

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179. *See* State v. Lake Lawrence Pub. Lands Protection Ass'n, 601 P.2d 494 (Wash. 1979); Polygon Corp. v. City of Seattle, 578 P.2d 1309 (Wash. 1978); WASH. ADMIN. CODE § 197-11-660 (1995).

180. 16 U.S.C. § 470(b) (1994).

181. *Id.* § 470a(1)(A).

182. *Id.* § 470f.

183. *Id.* § 470h-2(a)(2).

184. *Id.* § 470h-2(b).

185. *Id.* § 470aa(b).

186. *Id.* § 470bb(1).

187. *Id.* § 470ee.

188. Telephone conversation with David Harvey, Historian/Archaeological Historian, Battelle Memorial-Pacific Northwest Laboratories, in Richland, Wash. (July 1995).

B. Regulation of Radioactive Material and Waste

Many statutory and regulatory schemes apply to the radioactive material and waste at Hanford. The Atomic Energy Act and USDOE's implementing regulations apply to some aspects of Hanford's operations and cleanup.[189] Federal statutes mandating disposal facilities for high-level radioactive waste, transuranic waste, and low-level radioactive waste affect the Hanford cleanup.[190] Further, one federal statute specifically addresses the dangers from high-level waste stored in tanks at Hanford.[191] Finally, federal and state air pollution statutes and regulations apply to the air emissions of radionuclides at Hanford.[192]

1. Atomic Energy Act

The Atomic Energy Act of 1954, as amended (AEA),[193] authorized the Atomic Energy Commission (AEC) to produce plutonium and enriched uranium in its own facilities,[194] to conduct research and development on the military use of atomic energy,[195] and to produce atomic weapons.[196] The AEA also gave the AEC the power to regulate the civilian medical, industrial, and commercial applications of atomic energy.[197] The AEA required the AEC to promulgate rules that set forth minimum health and safety criteria for licensing the civilian uses of atomic energy and nuclear materials.[198] However, the AEA exempted its own nuclear weapons facilities and operations from the licensing requirements.[199] Instead, the AEA granted the AEC general authority to establish regulations or orders to protect health, life, or property from its own activities.[200]

The Energy Reorganization Act of 1974[201] abolished the AEC and transferred its duties to two new agencies.[202] The Energy Research and Development Administration (ERDA) took over the nuclear weapons program.[203] The Nuclear Regulatory Commission (NRC) assumed the AEC's licensing and regulatory authority.[204] However, the NRC was not given regulatory and licensing authority over the nuclear weapons program, except for long-term storage facilities for high-level nuclear waste.[205] The Department of Energy Organization Act[206] subsequently transferred all of ERDA's nuclear

189. *See infra* notes 193–219 and accompanying text.
190. *See infra* notes 220–39 and accompanying text.
191. *See infra* notes 240–43 and accompanying text.
192. *See infra* notes 244–49 and accompanying text.
193. 42 U.S.C. §§ 2011 to 2297g-4 (1988 & Supp. V 1993).
194. *Id.* §§ 2061(b) and 2014(aa).
195. *Id.* § 2121(a)(1).
196. *Id.* § 2121(a)(2).
197. *See, e.g., id.* §§ 2013 (1988), 2131–40.
198. *See, e.g., id.* §§ 2073(b), 2093(b), 2134.
199. *Id.* § 2140.
200. *Id.* §§ 2201(b), 2201(i)(3).
201. Pub. L. No. 93–438, 88 Stat. 1233 (1974) (codified as amended at 42 U.S.C. §§ 5801–91 (1988)).
202. 42 U.S.C. § 5814 (1988 & Supp. V 1993).
203. *Id.* § 5801(b).
204. *Id.* § 5841(f).
205. *Id.* § 5842(4).
206. Pub. L. No. 95–91, 91 Stat. 565 (1977) (codified as amended at 42 U.S.C. §§ 7101–7381(e) (1988 & Supp. V 1993)).

weapons functions to the USDOE.[207] The Act gave USDOE responsibility over the management, treatment, storage, and disposal of nuclear waste.[208]

The NRC has promulgated extensive rules to effectuate its licensing and regulatory responsibilities over civilian uses of nuclear energy. For example, NRC rules govern occupational radiation dose limits,[209] radiation dose limits for members of the public,[210] waste disposal,[211] and licensing for nuclear material and production facilities.[212] Thus, NRC rules govern the low-level radioactive waste disposal facility operated by U.S. Ecology on land leased to the State of Washington at the Hanford Site.[213]

However, the NRC rules generally do not apply to USDOE activities at nuclear weapons facilities, including Hanford.[214] Instead, the USDOE regulates itself. In sharp contrast to the extensive NRC rules, the USDOE has not enacted rules governing nuclear materials or wastes for its nuclear weapons facilities, with the sole exception of occupational radiation dose limits.[215] Rather, USDOE regulates its own management of radioactive materials and waste through internal orders to the heads of field offices. The internal orders give significant discretion to the field offices and are not as detailed or stringent as the NRC rules.[216]

One other part of the AEA applies to Hanford. In 1988, Congress created the Defense Nuclear Facilities Safety Board.[217] The Board is to evaluate the standards relating to design, construction, operation, and decommissioning of USDOE's nuclear facilities and to recommend specific measures to protect public health and safety.[218] In 1994, the Board issued recommendation letters to the Secretary of USDOE which covered topics that apply to Hanford, including safety standards for low-level disposal sites and stabilization of plutonium and spent nuclear fuel.[219]

2. *Statutes Governing Disposal Facilities for Radioactive Waste and Spent Fuel*

Congress has enacted statutes to spur development of facilities to treat, store, and dispose of the three categories of radioactive waste generated by the Nuclear Weapons Complex: (1) high-level radioactive waste and spent nuclear fuel; (2) transuranic waste; and (3) low-level radioactive waste.

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207. 42 U.S.C. §§ 7112(18) (1988 & Supp. II 1990), 7151(a) (1988).
208. *Id.* § 7133(a)(8).
209. 10 C.F.R. §§ 20.1201–08 (1995).
210. *Id.* §§ 20.1301–02.
211. *Id.* §§ 20.2001–07, 61.1–61.84.
212. *See, e.g., id.* pts. 30, 40, 50.
213. *See id.* pt. 61. *See supra* text accompanying note 28.
214. *See, e.g., id.* § 20.1002 (the occupational radiation dose limits, public radiation dose limits, and the waste disposal rules apply only to persons "licensed by the Commission...").
215. *Id.* pt. 835.
216. Barbara A. Finamore, *Regulating Hazardous and Mixed Waste at Department of Energy Nuclear Weapons Facilities: Reversing Decades of Environmental Neglect*, 9 HARV. ENVTL. L. REV. 83, 98–100 (1985). This article contains a good discussion of the applicability to USDOE Nuclear Weapons Complex facilities of the AEA, the Energy Reorganization Act of 1974, and the Department of Energy Reorganization Act.
217. Pub. L. No. 100–456, Div. A, tit. XIV § 1441(a)(1), 102 Stat. 2076 (codified as amended at 42 U.S.C. § 2286 (1988 & Supp. IV 1992)).
218. 42 U.S.C. § 2286a(a)(1) (1988 & Supp. III 1991).
219. BLUSH & HEITMAN, *supra* note 28, at 1–72.

a. High-Level Radioactive Waste and Spent Nuclear Fuel

The Nuclear Waste Policy Act of 1982 directed USDOE to develop a deep geologic repository for disposal of high-level radioactive waste and spent nuclear fuel.[220] Although Congress initially told USDOE to nominate and study three candidate sites,[221] in 1987 Congress directed the USDOE to study only Yucca Mountain, Nevada,[222] which is located near the Nevada Test Site.[223] The repository is not expected to open until sometime between 2010 and 2020.[224] Both the NRC and EPA have rules that govern radiation exposure from materials sent to the repository.[225]

High-level radioactive waste must be a durable, stable solid before transfer to the repository. Consequently, USDOE plans to glassify its high-level waste, currently in storage tanks at Hanford and Savannah River, at vitrification facilities to be built at those sites. The vitrification process will produce 21,000 stainless steel canisters each filled with approximately two tons of high-level waste. USDOE has yet to decide what treatment process it will use for the high-level waste at INEL. Finally, USDOE is searching for technologies to package its spent nuclear fuel for disposal at the repository.[226]

b. Transuranic Waste

In 1979, Congress authorized the development of a Waste Isolation Pilot Plant (WIPP) as a disposal facility for transuranic waste.[227] In the early 1980s, the first rooms were mined in salt formations 2150 feet underground in New Mexico. Technical problems and legal challenges have delayed WIPP's opening, which is now not expected before 1998.[228]

USDOE plans to dispose of all of its retrievably stored transuranic waste, including Hanford's, at WIPP.[229] USDOE is developing Waste Acceptance Criteria to ensure public safety during both the transportation to WIPP and the 10,000-year isolation. USDOE plans to treat the transuranic waste to meet those criteria at seven locations: Hanford, Oak Ridge, INEL, Rocky Flats, Nevada Test Site, and Argonne National Laboratories in Idaho and Illinois.[230] Once WIPP opens, USDOE plans to ship the waste in fifty-five-gallon drums, forty-two drums per truck, twenty-three trucks per week, for twenty to thirty years.[231]

Unfortunately, eighty percent of USDOE's transuranic waste is not destined for WIPP. Instead, it lies in shallow burial grounds at Nuclear

220. 42 U.S.C. §§ 10131–10145 (1988).
221. *Id.* § 10132(b)(1)(B).
222. *Id.* §§ 10172–72a.
223. Gerrard, *supra* note 54, at 1077.
224. *Id.* at 1077–78.
225. 10 C.F.R. pt. 60 (1995) (NRC); 40 C.F.R. pt. 191 (1994) (EPA).
226. DOE FIVE-YEAR PLAN, *supra* note 2, at I-111 to I-113.
227. U.S. Department of Energy National Security and Military Applications of Nuclear Energy Authorization Act of 1980, Pub. L. No. 96–164, § 213, 93 Stat. 1259, 1265 (1979).
228. Gerrard, *supra* note 54, at 1079–1080.
229. COMPLEX CLEANUP, *supra* note 50, at 50.
230. SITE TREATMENT PLANS, *supra* note 57, at 53–57.
231. COMPLEX CLEANUP, *supra* note 50, at 50–51.

Weapons Complex sites around the country. The USDOE has no clear plans for the final disposal of its non-retrievably stored transuranic waste.[232]

c. Low-Level Radioactive Waste

In the Low-Level Radioactive Waste Policy Amendments Act of 1985,[233] Congress provided that the federal government was responsible for the disposal of low-level radioactive waste generated by the Department of Energy.[234] However, if USDOE handles its low-level waste at a facility operated exclusively for USDOE waste, the facility is not subject to the Low-Level Waste Policy Amendments[235] nor to the NRC's rules on low-level waste disposal.[236] Currently, USDOE disposes low-level waste at six Complex facilities. USDOE plans to treat or dispose of most of the low-level and mixed waste at the site where it is generated, but is considering off-site disposal for some waste.[237] For example, USDOE plans to dispose of all of Hanford's low-level waste on site and to dispose of low-level waste from some other nuclear weapons complex facilities at Hanford as well.[238]

USDOE is exploring a variety of treatment technologies for low-level radioactive waste and mixed waste (low-level radioactive waste mixed with nonradioactive hazardous waste) including filtration, vitrification, cementation, incineration, and chemical treatment. However, one of the most serious challenges low-level and mixed waste disposal poses is the lack of public confidence that USDOE can treat and dispose of the waste in a safe and environmentally acceptable manner.[239]

3. Federal Statute Concerning Hanford Waste Tanks

As part of the National Defense Authorization Act of 1991, Congress enacted section 3137, entitled "Safety Measures for Waste Tanks at Hanford Nuclear Reservation."[240] Section 3137 addressed high-level nuclear waste tanks at Hanford that "may have a serious potential for release of high-level waste due to uncontrolled increases in temperature or pressure."[241] Congress directed USDOE to identify the tanks with the potential for explosive release, to monitor the tanks (if monitoring will not increase the danger of an explosion), and to develop action plans to deal with the problem tanks.[242] In response, USDOE identified fifty-one tanks, established increased monitoring, took interim

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232. Gerrard, *supra* note 54, at 1080.
233. Pub. L. No. 96–573, 99 Stat. 1842–59 (1986) (codified as amended at 42 U.S.C. §§ 2021b–2021j (1988)).
234. 42 U.S.C. § 2021c(b)(1)(A) (1988).
235. *Id.* § 2021d(b)(2).
236. 10 C.F.R. §§ 61.2, .3 (1995) (definition of "person" excludes USDOE for most purposes).
237. DOE FIVE-YEAR PLAN, *supra* note 2, at I–122 to I–123; SITE TREATMENT PLANS, *supra* note 57, at 23–52.
238. SITE TREATMENT PLANS, *supra* note 57, at 173–74.
239. DOE FIVE-YEAR PLAN, *supra* note 2, at I–122, I–123, I–127; SITE TREATMENT PLANS, *supra* note 57, at 23–52.
240. Pub L. No. 101–510, § 3137, 104 Stat. 1485, 1833–34 (1990).
241. *Id.*
242. *Id.*

measures to address the primary safety concerns, and prepared an EIS on its plans for safe interim storage of Hanford's high-level nuclear waste tanks.[243]

4. Federal and State Air Pollution Statutes and Regulations

The federal Clean Air Act requires the EPA to establish emission limits for sources of radionuclides.[244] EPA rules applicable to USDOE facilities limit radionuclide emissions[245] and require monitoring of point sources of those emissions.[246] In 1994 USDOE and EPA entered an agreement to bring Hanford into compliance with the monitoring requirements.[247]

The Washington Department of Social and Health Services administers state regulations of airborne radionuclide emissions from Hanford.[248] The regulations require USDOE to register its sources of radionuclide emissions, obtain permits to operate the sources, monitor the emissions from those sources, and construct a new source or modify an existing source only after giving a notice of construction which is approved by the Department.[249]

C. Regulation of Hazardous and Mixed Waste

The federal and state statutes and regulations with the greatest applicability to Hanford deal with hazardous and mixed waste. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)[250] and EPA's implementing regulations[251] focus on the cleanup of releases of hazardous substances into the environment and liability for the cleanup. The Resource Conservation and Recovery Act (RCRA),[252] EPA's implementing regulations,[253] Washington's Hazardous Waste Management Act,[254] and the Washington Department of Ecology's regulations[255] govern the generation, transportation, treatment, storage, disposal, and cleanup of solid and hazardous waste. This discussion provides an overview of those laws and the overlap between them.[256] Section IV addresses the application of those statutory and regulatory schemes to the Hanford cleanup.

243. TANK WASTE EIS, *supra* note 103, at 1–6, 1–7. USDOE mitigated the most serious risk, the build up of hydrogen gas in tank 101–SY, by installing a mixer pump. USDOE may install mixer pumps in other tanks as a short-term safety measure. USDOE has identified retrieval and dilution of the tank waste as the method to assure safe storage of the waste until its ultimate treatment and disposal. *Id.* at 2–1.

244. 42 U.S.C. § 7412(b)–(d) (1988 & Supp. II 1990).

245. 40 C.F.R. § 61.92 (1994).

246. *Id.* § 61.93.

247. BLUSH & HEITMAN, *supra* note 28, at 1–70, 1–71.

248. WASH. ADMIN. CODE ch. 246–47 (1995).

249. *Id.* §§ 246–47, 060, 075, 080.

250. Pub. L. No. 96–510, 94 Stat. 2767 (1980) (codified as amended at 42 U.S.C. §§ 9601–75 (1988 & Supp. V 1993)).

251. 40 C.F.R. pt. 300 (1994).

252. 42 U.S.C. §§ 6901–92k (1988 & Supp. V 1993).

253. 40 C.F.R. pts. 260–82 (1994).

254. WASH. REV. CODE ch. 70.105 (1994).

255. WASH. ADMIN. CODE chs. 173–303 (1995).

256. This overview is limited to the provisions that apply to the Hanford cleanup. For an excellent, detailed overview of RCRA and CERCLA in the context of federal lands, see Robert L. Glicksman, *Pollution on the Federal Lands III: Regulation of Solid and Hazardous Waste Management,* 13 STAN. ENVTL. L.J. 3 (1994) [hereinafter FEDERAL LANDS III], and Robert L. Glicksman, *Pollution on the Federal Lands IV: Liability for Hazardous Waste Disposal,* 12 UCLA J. ENVTL. L. & POL'Y 233 (1994) [hereinafter FEDERAL LANDS IV].

1. Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

a. CERCLA's Scope

The scope and coverage of the liability and cleanup provisions of CERCLA are controlled by the concepts of "release" and "hazardous substance."[257] CERCLA defines "hazardous substance" by incorporating substances identified as hazardous under other federal environmental laws, including RCRA, the Clean Water Act, and the Clean Air Act.[258] For example, radionuclides are hazardous air pollutants under section 112 of the Clean Air Act so they are also hazardous substances under CERCLA. Since CERCLA is not media-specific, radionuclides are hazardous substances whether they are released into the air, water, or soil.[259] The term "release" is broadly defined to cover nearly any manner in which a substance could enter the environment, including leaking, spilling, discharging, and disposing.[260] Congress also provided that CERCLA applies to the United States and its agencies in the same manner it applies to private parties.[261]

b. CERCLA's Regulatory Provisions—Reporting and Responding to Releases

If a release of hazardous substances occurs in an amount that EPA determines to be reportable,[262] CERCLA requires the person in charge of the facility to notify the National Response Center.[263] The Center must then notify all appropriate governmental agencies and the governors of affected states.[264] The reporting requirements apply to all federal agencies.[265] However, the reporting requirements do not apply to federally permitted releases,[266] which include releases of hazardous substances in compliance with a permit under RCRA or the Clean Air Act, and releases of nuclear materials in compliance with a "legally enforceable license, permit, regulation, or order issued pursuant to the Atomic Energy Act of 1954."[267]

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257. *See, e.g.,* 42 U.S.C. § 9607(a) (1988) (liability) and *id.* § 9604(a) (1988) (cleanup).
258. *Id.* § 9601(14).
259. Steven R. Miller, *The Applicability of CERCLA and SARA to Releases of Radioactive Materials,* 17 ENVTL. L. REP. 10071, 10071 (1987).
260. 42 U.S.C. § 9601(22) (1988). Congress excluded from the definition of "release" radioactive material and waste in two circumstances. Section 9601(22) excludes from CERCLA releases of nuclear material under the AEA if the release is subject to financial protection requirements under 42 U.S.C. § 2210, or if the nuclear material is released from a processing site under 42 U.S.C. § 7912(a)(1) or 7942(a). The financial protection requirements apply to NRC licensees, not to USDOE, and the processing sites concern uranium mill tailings. Therefore, neither exclusion applies to USDOE Nuclear Weapons Complex facilities.
261. 42 U.S.C. § 9620(a) (1988).
262. *Id.* § 9602 and 40 C.F.R. §§ 302.4–302.5 (1994) govern reportable amounts of hazardous substances.
263. 42 U.S.C. § 9603(a) (1988).
264. *Id.*
265. 40 C.F.R. § 300.170(c) (1994).
266. 42 U.S.C. § 9603(a), (b) (1988).
267. *Id.* § 9601(10).

To deal with releases of hazardous substances, Congress authorized the EPA to provide a removal or remedial action.[268] Removals are relatively short-term actions designed to prevent, minimize, or mitigate damage to public health or welfare or the environment.[269] Remedial actions are relatively long-term, permanent remedies to prevent or minimize the release so that it does not migrate to cause substantial danger to the public health or welfare or the environment.[270] Further, whenever the EPA has authority to respond to a release, it also may undertake monitoring, testing, and investigations in support of the response action.[271] Finally, the EPA can enter a cooperative agreement with a state or Indian tribe to exercise its response authority.[272]

Response actions must be consistent with the National Contingency Plan (NCP).[273] The NCP was originally developed under the Clean Water Act to respond to discharges of oil and hazardous substances into surface water.[274] In CERCLA, Congress directed EPA to revise the NCP to address releases of hazardous substances in all media.[275] The revised NCP is to include methods for discovery and investigation of releases, criteria for removal and remedial actions, and means to assure that remedial actions are cost effective. Congress also required EPA to set out criteria to determine priorities for response actions to known releases based on the relative threat to health or the environment. Finally, Congress mandated that EPA create and revise the National Priorities List (NPL) of sites most in need of cleanup.[276] As of May 1994, 150 federal facilities were on the NPL.[277]

Congress provided numerous criteria EPA is to employ in selecting cleanup standards and remedies.[278] Remedial actions are to be cost effective and consistent with the NCP.[279] Remedial actions in which treatment permanently and significantly reduces the volume, toxicity, and mobility of hazardous substances are preferred.[280] Off-site transportation and disposal of hazardous substances without treatment is the least favored remedy.[281] In assessing alternative remedies, the decisionmaker is to weigh seven statutory criteria.[282] Ultimately, the remedy selected must protect human health and the environment.[283] If hazardous substances are to remain on site, the remedy must attain a level of cleanup in compliance with standards established in federal and state laws that are legally applicable or relevant and appropriate.[284] For example, if a release of carbon tetrachloride contaminates ground water, the

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268. *Id.* § 9604(a). EPA is also authorized to respond to a threat of release of a hazardous substance, or to a release or substantial threat of release of a pollutant or contaminant which may present an imminent and substantial danger to the public health or welfare.
269. *Id.* § 9601(23).
270. *Id.* § 9601(24).
271. *Id.* § 9604(b).
272. *Id.* § 9604(d).
273. *Id.* § 9604(a)(1).
274. 33 U.S.C. § 1321(d) (1988).
275. 42 U.S.C. § 9605(a) (1988).
276. *Id.* § 9605(a)(8)(B).
277. 40 C.F.R. pt. 300, app. B, tbl. 2 (1994).
278. *See* 42 U.S.C. § 9621 (1988).
279. *Id.* § 9621(a).
280. *Id.* § 9621(b)(1).
281. *Id.*
282. *Id.* § 9621(b)(1)(A)-(G).
283. *Id.* § 9621(b)(1).
284. *Id.* § 9621(d).

CERCLA remedy must reduce the level of carbon tetrachloride to the maximum contaminant level established in the Safe Drinking Water Act.[285]

Congress also mandated significant opportunities for public participation in decisions concerning response actions to releases of hazardous substances. The selection of removal and remedial actions must be based on an administrative record that is available to the public.[286] Before decisions are made on a removal or remedial action, the public must have the opportunity to submit comments and attend a public meeting on the proposed action.[287] To enhance public participation, Congress authorized the President to make grants of up to $50,000 to any group of individuals which may be affected by a release to obtain technical assistance regarding the nature of the hazard, removal action, remedial investigation, feasibility study, record of decision, remedial design, and remedial action.[288]

EPA has enacted detailed regulations to govern response actions.[289] For removal actions, EPA established requirements for a removal site evaluation (to determine the nature, source, magnitude, and threat to public health of the release)[290] and for the removal itself, including criteria to determine whether to do a removal, types of appropriate removal actions, and public participation.[291] EPA's rules for remedial actions set out an extensive process: preliminary assessment,[292] site inspection,[293] remedial investigation,[294] feasibility study,[295] remedy selection,[296] and remedial design/remedial action.[297]

Response actions for releases of hazardous substances at federal facilities have some special features. Executive Order 12580 gives response authority to USDOE for releases at its facilities.[298] CERCLA requires the agency which owns or operates the facility to commence a remedial investigation and feasibility study within six months after the facility is placed on the NPL.[299] Within 180 days of the completion of the remedial investigation and feasibility study, the agency must enter an interagency agreement with EPA to govern the remedial action.[300] The agency and EPA must allow relevant state and local officials the opportunity to participate in the planning and selection of the

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285. *See* 42 U.S.C. § 9621 (d)(2)(A) (Supp. V 1993).
286. *Id.* § 9613(k)(1).
287. *Id.* §§ 9613(k)(2), 9617(a).
288. *Id.* § 9617(e).
289. 40 C.F.R. §§ 300.400–440 (1994).
290. *Id.* § 300.410.
291. *Id.* § 300.415.
292. *Id.* § 300.420(b) (a review of existing information about a release to determine whether a removal action or a remedial site inspection should occur).
293. *Id.* § 300.420(c) (gather additional data, including field testing, to evaluate the release and decide whether further removal or remedial action is appropriate).
294. *Id.* § 300.430(d) (data collection, field studies, risk assessment, and treatability studies to characterize the site).
295. *Id.* § 300.430(e) (development and evaluation of alternative remedies based on nine criteria set forth at § 300.400(e)(9)(iii)(A)–(I)).
296. *Id.* § 300.430(f) (criteria for remedy selection, public participation, record of decision).
297. *Id.* § 300.435 (design of the remedy, public participation, and implementation of the remedy).
298. 52 Fed. Reg. 2923 § (2)(d) (1987).
299. 42 U.S.C. § 9620(e)(1) (1988).
300. *Id.* § 9620(e)(2).

remedy.[301] Within fifteen months after the completion of the remedial investigation and feasibility study, substantial remedial action must commence.[302] However, to protect national security interests, the President can issue orders exempting USDOE facilities from CERCLA.[303]

c. CERCLA's Liability Provisions—Paying for the Cleanup

In addition to its provisions for cleanup of releases of hazardous substances, CERCLA creates a liability scheme. CERCLA creates monetary liability for four categories of costs and damages: (1) response costs incurred by the United States, a state, or an Indian tribe, not inconsistent with the NCP; (2) response costs incurred by others, consistent with the NCP; (3) damages for injuries to or destruction of natural resources; and (4) the cost of health assessments carried out under section 104(i) of CERCLA.[304] Section 104(i) requires the Agency for Toxic Substances and Disease Registry to assess the potential risk to human health from releases at each facility on the NPL.[305] CERCLA designates four categories of parties liable for costs and damages from releases of hazardous substances: (1) the current owner and operator of the facility; (2) the owner or operator of the facility at the time hazardous substances were disposed; (3) any person who arranged for disposal or treatment of hazardous substances at a facility owned by someone else; and (4) any person who accepted hazardous substances for transport to treatment or disposal facilities.[306] CERCLA's defenses to liability are limited. A party is not liable: (1) if the release and damages were caused solely by an act of God, act of War, or the act or omission of a third party;[307] (2) if the release is a federally permitted release;[308] or (3) if the statute of limitations has run.[309]

Federal agencies are subject to CERCLA to the same extent as nongovernmental entities.[310] Moreover, CERCLA imposes liability on categories of "persons,"[311] which includes the United States Government.[312] Consequently, federal agencies are subject to CERCLA liability. In addition, federal agencies must fund cleanups out of their own budgets because the Superfund generally cannot be used for remedial actions at federal facilities.[313]

d. CERCLA Enforcement

CERCLA contains several enforcement mechanisms. When the President determines that the release or threat of release of hazardous substances may cause imminent and substantial endangerment to public health or welfare or the

301. *Id.* § 9620(f).
302. *Id.* § 9620(e)(2).
303. *Id.* § 9620(j)(1).
304. *Id.* § 9607(a)(4)(A)–(D).
305. *Id.* § 9604(i)(6).
306. *Id.* § 9607(a)(1)–(4). A "facility" includes any site where a hazardous substance comes to be located. 42 U.S.C. § 9601(9) (1988).
307. 42 U.S.C. § 9607(b) (1988).
308. *Id.* § 9607(j) (1988). *See supra* notes 266–67 and accompanying text for a discussion of the term "federally permitted release."
309. *Id.* § 9613(g).
310. *Id.* § 9620(a)(1).
311. *Id.* § 9607(a).
312. *Id.* § 9601(21).
313. *Id.* § 9611(c),(e)(3).

environment, the U.S. Attorney General is authorized to bring an action to abate the release and the President is authorized to issue any order to protect public health or welfare or the environment.[314] Any person who without sufficient cause fails to comply with the President's order is subject to fines of up to $25,000 per day[315] and may be liable for punitive damages in the amount of treble response costs.[316] Moreover, violations of various CERCLA provisions, including the failure to comply with interagency agreements at federal facilities, are subject to administrative and civil penalties of up to $75,000 per day.[317] Further, CERCLA provides for judicial review of response actions; however, that review has severe limitations. Review of the adequacy of a response action usually must wait until the response is complete, the review is limited to the administrative record, and the action can be overturned only if the court finds it to be arbitrary and capricious.[318] Finally, any person can bring a citizen suit against any person (including federal agencies) for violations of CERCLA (including the provisions of interagency agreements at federal facilities) and against the United States for failure to perform a nondiscretionary duty, including duties CERCLA places on federal facilities.[319]

EPA's ability to enforce CERCLA at federal facilities is constrained in one respect. Under the "unitary executive theory," the Justice Department has taken the position that EPA cannot sue another federal agency.[320] The Justice Department believes that there may not be a justiciable controversy in a suit between federal agencies and that suits and orders by one agency against another would interfere with the President's management of the executive branch. Consequently, to facilitate enforcement of CERCLA, EPA has entered compliance agreements with federal agencies responsible for contaminated sites. Those agreements set milestones for cleanup tasks, authorize citizen suits to enforce the milestones, and stipulate penalties for failure to comply with the terms of the agreement.[321]

2. *Resource Conservation and Recovery Act (RCRA) and Washington's Hazardous Waste Management Act (HWMA)*

RCRA attempts to protect human health and the environment by minimizing the generation of waste, safely managing waste, and preventing land pollution.[322] Although RCRA addresses solid waste[323] and underground storage

314. *Id.* § 9606(a).
315. *Id.* § 9606(b)(1).
316. *Id.* § 9607(c)(3).
317. *Id.* § 9609.
318. *Id.* § 9613(h), (j).
319. *Id.* § 9659(a).
320. FEDERAL LANDS IV, *supra* note 256, at 295–96 (citing Robert C. Davis & R. Timothy McCrum, *Environmental Liability for Federal Lands and Facilities*, 6 NAT. RESOURCES & ENV'T 31, 66–67 (1991)).
321. *Id.*
322. *See* 42 U.S.C. §§ 6901, 6902 (1988).
323. *Id.* §§ 6941–49a. RCRA Subtitle D's requirements for nonhazardous solid waste emphasize state solid waste management planning. *Id.* Subtitle D is intended to encourage resource conservation, resource recovery, and environmentally sound disposal practices for solid waste by providing states with financial and technical assistance for comprehensive planning. *Id.* § 6941. RCRA does not require any state to develop a solid waste management plan; however, states are eligible for financial assistance if they create a plan that EPA approves. *Id.* § 6947. Congress established minimum criteria for state plans including the requirements that the plan provide for state regulatory power to implement the plan, provide for the closure of all

tanks,[324] its primary focus is hazardous waste.[325] Congress intended RCRA to (1) minimize the generation of hazardous waste by encouraging process substitution and recycling, and (2) comprehensively regulate the generation, transportation, treatment, storage, and disposal of hazardous waste.[326]

a. RCRA's Scope

The scope and nature of RCRA's regulatory schemes depend on the definitions of "solid waste," "hazardous waste," and "mixed waste." Solid waste includes "garbage, refuse, sludge...and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities...."[327] However, one of the exceptions to the solid waste definition is "source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954...."[328] Congress defined hazardous waste as a subset of solid waste that may cause an increase in mortality or serious illness or pose a substantial threat to human health or the environment if not properly managed.[329] EPA's complex regulations define hazardous waste to include solid waste that EPA has listed as a hazardous waste or that displays the characteristics of a hazardous waste (ignitability, corrosivity, reactivity, toxicity).[330] Congress defines mixed waste as "waste that contains both hazardous waste and source, special nuclear, or by-product material subject to the Atomic Energy Act of 1954...."[331]

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open dumps, and require that solid waste be used for resource recovery or be disposed of in sanitary landfills. *Id.* § 6943(a). At Congress' direction, EPA has promulgated guidelines for development of state solid waste management plans, criteria for land disposal of solid wastes, criteria for solid waste disposal facilities, and criteria for municipal solid waste landfills. *Id.* §§ 6907, 6942; 40 C.F.R. pts. 241, 256–58 (1995). Washington statutes and rules address solid waste in great detail, including solid waste management planning, disposal facility siting, disposal facility permitting, and enforcement. *See, e.g.*, WASH. REV. CODE ch. 70.95 (1994); WASH. ADMIN. CODE ch. 173–304 (1995).

324. 42 U.S.C. §§ 6991–91(i) (1988 & Supp. V 1993). RCRA has a separate regulatory scheme for underground storage tanks (USTs) that contain petroleum and hazardous substances not subject to Subtitle C. *Id.;* 40 C.F.R. pt. 280 (1994). Tank owners are required to notify state or local agencies of the age, size, type, location, and uses of their tanks (42 U.S.C. § 6991a (1988); 40 C.F.R. § 280.22 (1995)); comply with performance standards for new tanks (42 U.S.C. § 6991b(e) (1988); 40 C.F.R. § 280.20 (1995)); maintain a leak detection system (42 U.S.C. § 6991b(c)(1) (1988); 40 C.F.R. §§ 280.40–.45 (1995)); report releases (42 U.S.C. § 6991b(c)(3) (1988); 40 C.F.R. §§ 280.50–.53 (1995)); take corrective action when releases occur (42 U.S.C. § 6991b(c)(4) (1988); 40 C.F.R. §§ 280.60–.67 (1995)); prevent releases when tanks are closed (42 U.S.C. § 6991b(c)(5) (1988); 40 C.F.R. §§ 280.70–.74 (1995)); and comply with financial responsibility requirements (42 U.S.C. § 6991b(c)(6), (d)(1988); 40 C.F.R. §§ 280.90–.116 (1995)). If a release of petroleum from an UST creates a threat to health or the environment, EPA can undertake corrective action and recover its response costs from the owner or operator of the tank. 42 U.S.C. § 6991h (1988). EPA can enforce the UST program through administrative orders and civil penalties. 42 U.S.C. § 6991e (1988).

325. 42 U.S.C. §§ 6921–39e (1988 & Supp. V 1993).

326. 42 U.S.C. § 6902 (1988).

327. *Id.* § 6903(27). EPA's detailed definition of "solid waste" is at 40 C.F.R. § 261.2 (1995).

328. 42 U.S.C. § 6903(27).

329. *Id.* § 6903(5).

330. 40 C.F.R. § 261.3 (1994) contains EPA's definition of hazardous waste; 40 C.F.R. §§ 261.20–.24 define the four characteristics of hazardous waste; 40 C.F.R. §§ 261.30–.33 lists hundreds of hazardous wastes.

331. 42 U.S.C. § 6903(41) (Supp. V 1993).

RCRA does not apply to nuclear material governed by the Atomic Energy Act (AEA) because those radioactive materials are exempt from the definition of solid and, therefore, hazardous waste.[332] However, RCRA's comprehensive regulatory scheme for hazardous waste does apply to mixed radioactive and hazardous waste. In 1986, EPA issued a notice that it interpreted RCRA to apply to the hazardous components of radioactive mixed wastes.[333] The D.C. Circuit upheld EPA's interpretation[334] and USDOE concurred in its rules.[335] In the Federal Facility Compliance Act of 1992, Congress made clear that RCRA applied to mixed radioactive and hazardous waste at USDOE facilities.[336]

b. RCRA and HWMA—Regulatory Scheme for Hazardous Waste

Subtitle C of RCRA[337] and EPA's implementing regulations[338] constitute a comprehensive regulatory scheme for hazardous waste. Congress allowed states to create, administer, and enforce a hazardous waste program in lieu of all or part of the federal program if the state program is authorized by EPA.[339] Washington exercised this authority in the Hazardous Waste Management Act [340] and the Dangerous Waste Regulations.[341] Consequently, RCRA Subtitle C, EPA's regulations, and Washington statutes and regulations all control the generation, transportation, treatment, storage, and disposal of hazardous wastes.

Generators are persons who produce hazardous waste.[342] Generators must obtain an EPA identification number[343] and keep records that identify the quantities and chemical composition of the hazardous wastes they generate.[344] Additional rules govern the types of containers suitable for hazardous waste and the labeling of the containers.[345] Further, for hazardous waste that the generator is sending to an off-site treatment, storage, or disposal (TSD) facility, the generator must comply with a manifest system designed to ensure that the waste ends up at a permitted TSD facility.[346] On the manifest, the generator must certify that "the generator of the hazardous waste has a program in place to reduce the volume or quantity and toxicity of such waste to the degree determined by the generator to be economically practicable."[347] Finally, generators are required to report to EPA or a state with an approved program the amounts and nature of hazardous waste generated, the disposition of the

332. 42 U.S.C. §§ 6903(5), (27) (1988).
333. 51 Fed. Reg. 24,504 (1986).
334. New Mexico v. Watkins, 969 F.2d 1122, 1130–32 (D.C. Cir. 1992).
335. 10 C.F.R. § 962.3 (1995).
336. Pub. L. No. 102–386, 106 Stat. 1505 (1992).
337. 42 U.S.C. §§ 6921–6939e (1988 & Supp. V 1993).
338. 40 C.F.R. pts. 260–72 (1995).
339. 42 U.S.C. § 6926 (1988).
340. WASH. REV. CODE ch. 70.105 (1994).
341. WASH. ADMIN. CODE chs. 173–303 (1995).
342. 40 C.F.R. § 260.10 (1995); WASH. ADMIN. CODE § 173–303–170(1) (1995).
343. 40 C.F.R. § 262.12 (1995); WASH. ADMIN. CODE § 173–303–170(2) (1995).
344. 42 U.S.C. § 6922(a) (1988); 40 C.F.R. § 262.40 (1995); WASH. ADMIN. CODE § 173–303–210 (1995).
345. 42 U.S.C. § 6922(a)(2)–(3) (1988); 40 C.F.R. §§ 262.30–.31(1995); WASH. ADMIN. CODE § 173–303–190 (1995).
346. 42 U.S.C. § 6922(a) (1988); 40 C.F.R. §§ 262.20–.23 (1995); WASH. ADMIN. CODE § 173–303–180 (1995).
347. 42 U.S.C. § 6922(b)(1) (1988).

waste, the efforts to reduce the volume and toxicity of waste generated, and the results of those efforts.[348]

Similar rules govern transporters of hazardous wastes. Transporters must obtain an identification number[349] and keep records of the source and delivery points of the hazardous waste.[350] Transporters can accept hazardous waste only if it is properly labeled and accompanied by a manifest.[351] Transporters must comply with the manifest system and transport the waste only to the next transporter, a permitted TSD facility, or a place outside of the United States designated by the generator.[352] If hazardous waste is discharged during transport, the transporter must notify national and local officials and take immediate action to protect human health and the environment.[353]

Rules governing facilities for treatment,[354] storage,[355] or disposal[356] of hazardous waste are comprehensive and complex. At Congress' direction, EPA and states with approved programs have enacted detailed regulations on numerous issues related to TSD facilities including: recordkeeping regarding the wastes treated, stored, or disposed at the facility;[357] inspection;[358] compliance with the manifest system;[359] reporting;[360] contingency plans;[361] personnel training;[362] financial responsibility;[363] location, design and

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348. *Id.* § 6922(a)(6); 40 C.F.R. § 262.41 (1995); WASH. ADMIN. CODE § 173–303–210 (1995).

349. 40 C.F.R. § 263.11 (1995); WASH. ADMIN. CODE § 173–303–240 (1995).

350. 42 U.S.C. § 6923(a)(1) (1988); 40 C.F.R. § 263.22 (1995); WASH. ADMIN. CODE § 173–303–260 (1995).

351. 42 U.S.C. § 6923(a)(2)–(3) (1988); 40 C.F.R. § 263.20 (1995); WASH. ADMIN. CODE § 173–303–250 (1995).

352. 42 U.S.C. § 6923(a)(3)–(4) (1988); 40 C.F.R. § 263.21 (1995); WASH. ADMIN. CODE § 173–303–250(5) (1995).

353. 40 C.F.R. §§ 263.30–.31 (1995); WASH. ADMIN. CODE § 173–303–145 to –270 (1995).

354. Treatment means "any method...designed to change the physical, chemical, or biological character or composition of any hazardous waste so as to neutralize such waste or so as to render such waste nonhazardous, safer for transport, amendable [sic] for recovery, amenable for storage, or reduced in volume." 42 U.S.C. § 6903(34) (1988).

355. Storage means "the containment of hazardous waste, either on a temporary basis or for a period of years, in such a manner as not to constitute disposal of such hazardous waste." *Id.* § 6903(33).

356. Disposal means "the discharge, deposit, injection, dumping, spilling, leaking, or placing of any solid waste or hazardous waste into or on any land or water so that such solid waste or hazardous waste or any constituent thereof may enter the environment...." *Id.* § 6903(3).

357. 42 U.S.C. § 6924(a)(1) (1988); 40 C.F.R. § 264.73 (1995); WASH. ADMIN. CODE § 173–303–380 (1995).

358. 42 U.S.C. § 6924(a)(2); 40 C.F.R. § 264.15; WASH. ADMIN. CODE § 173–303–320.

359. 42 U.S.C. § 6924(a)(2); 40 C.F.R. §§ 264.71–.72; WASH. ADMIN. CODE § 173–303–370.

360. 42 U.S.C. § 6924(a)(2); 40 C.F.R. §§ 264.75–.77; WASH. ADMIN. CODE. § 173–303–390.

361. 42 U.S.C. § 6924(a)(5); 40 C.F.R. §§ 264.50–.56; WASH. ADMIN. CODE § 173–303–350.

362. 42 U.S.C. § 6924(a)(6); 40 C.F.R. § 264.16; WASH. ADMIN. CODE § 173–303–330.

363. 42 U.S.C. § 6924(a)(6), (t); 40 C.F.R. §§ 264.140–.151; WASH. ADMIN. CODE § 173–303–620.

operation;[364] ground-water monitoring and protection;[365] and closure and post-closure.[366] The regulations provide more specific requirements for certain types of TSD facilities, including tank systems,[367] surface impoundments,[368] waste piles,[369] landfills,[370] and incinerators.[371] RCRA and the regulations generally restrict the land disposal of untreated hazardous wastes.[372]

Each TSD facility must have a permit which applies the detailed TSD regulations to the specific facility,[373] but certain TSD facilities are allowed to operate on interim status pending final action on their permit applications.[374] Although the permits focus on current management of hazardous waste, two important provisions deal with past releases: (1) the applicant must undertake "corrective action for all releases of hazardous waste or constituents from any solid waste management unit at a treatment, storage, or disposal facility seeking a permit...regardless of the time at which waste was placed in such unit",[375] and (2) "corrective action [must] be taken beyond the facility boundary where necessary to protect human health and the environment...."[376] Finally, RCRA contains "omnibus" authority for permit regulators: "Each permit issued under this section shall contain such terms and conditions as the Administrator (or the State) determines necessary to protect human health and the environment."[377]

c. RCRA and HWMA Enforcement of Hazardous Waste Regulations

RCRA provides four primary types of enforcement of the requirements of Subtitle C. First, the Congress authorizes federal enforcement of RCRA, even in states that are administering Subtitle C under EPA approval.[378] Federal enforcement can include administrative compliance orders, administrative monetary penalties, civil penalties, and criminal penalties.[379] Second, RCRA's citizen suit provision allows any person to bring three types of civil actions: (1) against any person alleged to be in violation of a RCRA permit, regulation, or requirement; (2) against any past or present generator, transporter, owner, or operator of a TSD facility whose handling, transportation, storage, treatment, or disposal of hazardous waste may present an imminent and substantial

364. 42 U.S.C. § 6924(a)(4); 40 C.F.R. §§ 264.18, 264.31; WASH. ADMIN. CODE § 173-303-282.
365. 42 U.S.C. § 6924(p); 40 C.F.R. §§ 264.90-.101; WASH. ADMIN. CODE § 173-303-645.
366. 40 C.F.R. §§ 264.110-.120; WASH. ADMIN. CODE § 173-303-610.
367. 40 C.F.R §§ 264.190-.199; WASH. ADMIN. CODE § 173-303-640.
368. 40 C.F.R. §§ 264.220-.231; WASH. ADMIN. CODE § 173-303-650.
369. 40 C.F.R. §§ 264.250-.259; WASH. ADMIN. CODE § 173-303-660.
370. 40 C.F.R. §§ 264.300-.317; WASH. ADMIN. CODE § 173-303-665.
371. 40 C.F.R. §§ 264.340-.351; WASH. ADMIN. CODE § 173-303-670.
372. 42 U.S.C. § 6924(d)-(g), (m); 40 C.F.R. pt. 268 (1995); WASH. ADMIN. CODE § 173-303-140.
373. 42 U.S.C. § 6925(a) (1988); 40 C.F.R. pt. 270 (1995); WASH. ADMIN. CODE §§ 173-303-800 to 173-303-830.
374. 42 U.S.C. § 6925(e); 40 C.F.R. pt. 265 (1995); WASH. ADMIN. CODE § 173-303-805.
375. 42 U.S.C. § 6924(u).
376. *Id.* § 6924(v). Regulations governing corrective action under 42 U.S.C. § 6924(u) and (v) are at 40 C.F.R. §§ 264.101, .552, .553 and WASH. ADMIN. CODE 173-303-645(11)-(12).
377. 42 U.S.C. § 6925(c)(3).
378. *Id.* § 6928(a).
379. *Id.* § 6928. Washington's Hazardous Waste Management Act provides the state with similar enforcement authority.

endangerment to health or the environment; and (3) against the Administrator of the EPA for failure to perform a nondiscretionary duty.[380] Third, EPA may issue orders against any past or present generator, transporter, owner, or operator of a TSD facility whose handling, transportation, storage, treatment, or disposal of hazardous waste may present an imminent and substantial endangerment to health or the environment.[381] EPA can use this "imminent hazard" authority to sue for injunctions and to recover its costs of responding to the hazard.[382] Fourth, RCRA provides for judicial review of EPA's regulations and decisions regarding permits.[383]

d. RCRA and HWMA Applicability to Federal Facilities

Section 6001 of RCRA subjects federal agencies to federal, state, and local regulation of hazardous waste, although the President may exempt federal facilities "in the paramount interest of the United States...."[384] However, two cases and subsequent Congressional action illustrate the complexity in this area. In *United States Department of Energy v. Ohio*, the Supreme Court held that RCRA section 6001 waived sovereign immunity and subjected USDOE to coercive fines to get the agency to comply with court orders, but that USDOE was not subject to punitive fines for past statutory and regulatory violations.[385] In *Sierra Club v. United States Department of Energy*, the court held that Subtitle C applied to mixed radioactive and hazardous waste at USDOE's Rocky Flats facility and ordered USDOE to obtain a TSD permit.[386]

Congress reacted to these decisions in the Federal Facility Compliance Act of 1992 (FFCA).[387] The FFCA overturned *USDOE v. Ohio* and amended RCRA by waiving sovereign immunity for "Federal, State, interstate, and local substantive and procedural requirements" including "all administrative orders and all civil and administrative penalties and fines, regardless of whether such penalties or fines are punitive or coercive in nature...."[388]

The FFCA also addressed the applicability of RCRA to mixed waste. As to the storage of mixed radioactive and hazardous waste, the FFCA generally deferred the applicability of the sovereign immunity waiver for three years.[389] The FFCA also required USDOE to report to EPA and the governors of applicable states a national inventory of USDOE's mixed waste and an inventory of mixed waste treatment capacity and technology.[390] Further, each USDOE facility that generates or stores mixed waste is required to develop a plan for treatment of all of the facility's mixed waste.[391] As long as USDOE complies with the plan, sovereign immunity for violations of RCRA section

380. *Id.* § 6972(a).
381. *Id.* § 6973(a).
382. *See id.* § 6973(a); United States v. Northeastern Pharmaceutical & Chem. Co., 810 F.2d 726 (8th Cir. 1986).
383. 42 U.S.C. § 6976 (1988).
384. *Id.* § 6961(a).
385. United States Dep't of Energy v. Ohio, 503 U.S. 607 (1992).
386. Sierra Club v. United States Dep't of Energy, 770 F. Supp. 578 (D. Colo. 1991).
387. Pub. L. No. 102-386, 106 Stat. 1505 (1992).
388. 42 U.S.C. § 6961(a) (Supp. IV 1992).
389. *Id.* § 6961 note (Effective Date for Certain Mixed Waste).
390. *Id.* § 6939c(a).
391. *Id.* § 6939c(b).

3004(j) concerning storage of mixed waste is not waived.[392] However, neither the requirement for a plan nor the delay in the waiver of sovereign immunity applies to USDOE facilities that have entered compliance agreements governing the treatment of mixed waste.[393] Thus, if USDOE enters a compliance agreement regarding the treatment of mixed waste, it need not prepare a plan, but violations of RCRA will be subject to administrative, civil, and criminal enforcement.

3. Overlap Between CERCLA and RCRA

CERCLA is directed at the cleanup of past releases of hazardous substances[394] while RCRA's primary focus is the management of solid and hazardous waste to prevent future releases.[395] Nevertheless, there is significant overlap between the two statutory schemes. Since CERCLA's definition of "hazardous substance" includes hazardous wastes under RCRA,[396] both statutes could apply to a hazardous waste. Moreover, one important requirement of a RCRA permit is corrective action of all past releases of hazardous substances from a solid waste management unit at the TSD facility seeking the permit.[397] Therefore, if a facility with past releases of hazardous substances is on the National Priorities List and the facility intends to continue operating as a TSD facility, both RCRA's corrective action requirements[398] and CERCLA's remedial action provisions[399] would apply. Further, if the state is authorized to administer the RCRA permit program,[400] the permit applicant would need to deal with two regulators—the state for RCRA and the EPA for CERCLA.

There are important similarities between RCRA corrective actions and CERCLA remedial actions. RCRA corrective actions are modeled on the CERCLA remedial action process. Their parallel requirements are: (1) CERCLA Preliminary Assessment/Site Investigation—RCRA Facility Assessment; (2) CERCLA Remedial Investigation—RCRA Facility Investigation; (3) CERCLA Feasibility Study—RCRA Corrective Measures Study; (4) CERCLA Proposed Plan—RCRA Draft Permit; (5) CERCLA Record of Decision—RCRA Permit; and (6) CERCLA Remedial Design/Remedial Action—RCRA Corrective Measures Implementation.[401]

Significant differences between RCRA and CERCLA cleanup actions include: (1) cleanup standards—RCRA's statutory requirement is to protect human health and the environment while CERCLA cleanups must comply with applicable or relevant and appropriate standards from state and federal environmental laws; (2) judicial review—RCRA corrective action decisions can

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392. *Id.* § 6961 note (Application of Waiver to Agreements and Orders).
393. *Id.* §§ 6939c(b)(1), 6961 note (Effective Date for Certain Mixed Waste).
394. *See supra* notes 257–321 and accompanying text.
395. *See supra* notes 322–93 and accompanying text.
396. 42 U.S.C. § 9601(14) (1988).
397. *Id.* § 6924(u), (v).
398. *See supra* notes 375–77 and accompanying text.
399. *See supra* notes 268–303 and accompanying text.
400. *See* 42 U.S.C. 6926 (1988).
401. *See* J. Stanton Curry et al., *The Tug-of-War Between RCRA and CERCLA at Contaminated Hazardous Waste Facilities,* 23 ARIZ. ST. L.J. 359, 375–78 (1991); Hanford Federal Facility Agreement and Consent Order, In the Matter of: U.S. Dep't of Energy, Richland Operations Office, Richland, Wash., (EPA No. 1089-03-04-120) (Ecology No. 89-54), Fourth Amendment, Attachment 2, § 7.2 (Jan. 1994).

be appealed as part of the judicial review of a permit, but CERCLA remedial action decisions generally are not reviewable prior to completion of the action; (3) regulator—although states and EPA have roles in cleanups under both statutes, states with approved programs control RCRA corrective actions through the permit process while EPA has primary authority over CERCLA remedial actions; (4) scope—CERCLA is broader because it applies to hazardous substances, which includes more than RCRA hazardous wastes, and because CERCLA applies to threatened as well as actual releases; (5) liability—CERCLA not only imposes liability on more parties than RCRA, CERCLA provides for wider cost recovery and for natural resources damages.[402]

United States v. Colorado[403] illustrates the RCRA/CERCLA overlap in the context of the cleanup of a federal facility. The U.S. Army operated the Rocky Mountain Arsenal (Arsenal) since 1942 in metropolitan Denver, Colorado. The court characterized the Arsenal as "one of the worst hazardous waste pollution sites in the country."[404] The case focused on Basin-F, a 92.7-acre basin where millions of gallons of hazardous waste had been disposed. In the early 1980s, the Army applied to EPA under RCRA for a TSD permit, which included a closure plan for Basin-F. In 1984, EPA rejected the Army's application based in part on the inadequacy of the closure plan. The Army then began a Remedial Investigation/ Feasibility Study under CERCLA. Later in 1984, EPA authorized Colorado to carry out the Colorado Hazardous Waste Management Act (CHWMA) in lieu of RCRA. The Army resubmitted its RCRA permit application, which Colorado found deficient because of the Basin-F closure plan. In 1986 Colorado issued a revised Basin-F closure plan and requested that the Army immediately implement the plan. In 1987, the Army withdrew its RCRA permit application claiming that it intended to remediate Basin F under CERCLA. The Army subsequently began an interim response action under CERCLA. In 1989, Colorado issued a compliance order to the Army under CHWMA directing that the Army submit an amended Basin-F closure plan and that the Army not implement any closure plan without Colorado's approval.[405]

The Army sued for a declaratory judgment that Colorado's compliance order was void because CERCLA's response and enforcement provisions preempted state RCRA enforcement actions. The Tenth Circuit held that CERCLA did not bar an enforcement action by a state authorized by EPA to enforce its hazardous waste laws in lieu of RCRA.[406] The court relied primarily on three provisions of CERCLA.[407] First, CERCLA's savings provisions state in part: "Nothing in this chapter shall affect or modify in any way the obligations or liabilities of any person under other Federal or State law...with respect to releases of hazardous substances...."[408] Second, CERCLA also provides: "Nothing in this chapter shall be construed or interpreted as preempting any State from imposing any additional liability or requirements

402. Curry, *supra* note 401, at 382–94.
403. 990 F.2d 1565 (10th Cir. 1993).
404. *Id.* at 1569 (quoting Daigle v. Shell Oil Co., 972 F.2d 1527, 1531 (10th Cir. 1992)).
405. 990 F.2d at 1571–73.
406. *Id.* at 1578–79.
407. *Id.* at 1575–76, 1580.
408. 42 U.S.C. § 9652(d) (1988).

with respect to the release of hazardous substances...."[409] Third, CERCLA's federal facility section provides in part: "Nothing in this section shall affect or impair the obligation of any department...of the United States to comply with any requirement of [RCRA] (including corrective action requirements)."[410] The Court also relied on RCRA's waiver of sovereign immunity for federal agencies.[411] Thus, the Tenth Circuit's opinion gives states a significant role under RCRA in the cleanup of federal facilities, even if the facility is also subject to remedial action under CERCLA.

IV. HANFORD CLEANUP—TRI-PARTY AGREEMENT

The numerous federal and state statutory and regulatory schemes described in Section III above apply to the Hanford cleanup. Moreover, that complex web of legal requirements is administered by regulators at both the federal and state levels. The regulation of USDOE's remediation and waste disposal activities at Hanford is coordinated through a federal facility compliance agreement between USDOE, EPA, and the Washington State Department of Ecology (Ecology).

A. Introduction to the Tri-Party Agreement

The framework for the Hanford cleanup is provided by the Hanford Federal Facility Agreement and Consent Order, among the USDOE, EPA, and Ecology,[412] commonly called the Tri-Party Agreement (TPA). The TPA was the first cleanup agreement for a Nuclear Weapons Complex facility among USDOE, EPA, and a state.[413] The TPA was signed in 1989 and has been amended five times since.[414]

The TPA has ambitious goals: (1) ensure that the environmental impacts of past and present activities at Hanford are thoroughly investigated and that appropriate response action is taken to protect public health and welfare and the environment; (2) provide a framework for TSD units to comply with RCRA and Washington HWMA requirements for permits, closure, and post-closure; (3) establish a framework and schedule for developing, prioritizing, implementing, and monitoring response actions in compliance with CERCLA and corrective actions in accordance with RCRA; (4) facilitate cooperation and avoid litigation between the parties to the agreement; and (5) minimize duplication of analysis and documentation.[415]

The TPA consists of three main documents. First, the Hanford Federal Facility Agreement and Consent Order establishes the regulatory framework for the cleanup and clarifies the roles of the three parties.[416] Second, the Action

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409. *Id.* § 9614(a).
410. *Id.* § 9620(i).
411. 990 F.2d at 1576 (citing 42 U.S.C. § 6961).
412. Hanford Federal Facility Agreement and Consent Order, In the Matter of: U.S. Dep't of Energy, Richland Operations Office, Richland, Wash., (EPA No. 1089-03-04-120) (Ecology No. 89-54) (1989) [hereinafter Tri-Party Agreement].
413. COMPLEX CLEANUP, *supra* note 50, at 33.
414. Tri-Party Agreement, *supra* note 412, First Amendment (Aug. 1990); Second and Third Amendments (Sept. 1992); Fourth Amendment (Jan. 1994); Fifth Amendment (July 1995).
415. Tri-Party Agreement, *supra* note 412, Fourth Amendment, art. III (Jan. 1994).
416. *Id.* at arts. I-LI.

Plan sets out detailed procedures to ensure that the Hanford cleanup complies with RCRA, CERCLA, and the Washington HWMA.[417] Third, a Work Schedule attached to the Action Plan contains milestones to govern the cleanup.[418] Each main document of the TPA will be addressed in a separate section below.

B. Hanford Federal Facility Agreement and Consent Order (FFACO)

The FFACO has five parts. Part One contains agreements among the parties regarding the law governing the cleanup. Part One notes that four areas (100, 200, 300, and 1100) of the Hanford Site have been placed on the NPL, so CERCLA applies.[419] The parties agree that RCRA applies as well. Further, Part One recognizes that EPA authorized the State of Washington to regulate the generation, treatment, storage, and disposal of hazardous waste and that Ecology implements that program; however, EPA retains authority over RCRA corrective action. USDOE acknowledges that it is subject to CERCLA, RCRA, Washington's HWMA, and the terms of the TPA, as long as they are not inconsistent with the Atomic Energy Act. Finally, the parties agree to integrate the legal requirements applicable to CERCLA response actions and RCRA corrective actions so that any cleanup action satisfies the requirements of both statutes, including the requirement that the action protect human health and the environment and achieve compliance with applicable or relevant and appropriate requirements under section 121 of CERCLA.[420]

Part Two deals with permitting and closure of TSD facilities under RCRA and Washington's HWMA. USDOE admits that it is a generator, transporter, owner, and operator of a treatment, storage, and disposal facility for hazardous wastes at Hanford and, therefore, is subject to RCRA and HWMA. The parties acknowledge that USDOE is operating Hanford under interim status and is pursuing RCRA/HWMA permits.[421] USDOE agrees to perform RCRA/HWMA permitting and closure according to the Action Plan and the cleanup milestones.[422] Part Two also contains enforcement provisions including a dispute resolution process[423] and stipulated penalties for violations of Part Two of the TPA or the milestones.[424] However, Ecology reserves the right to pursue enforcement under HWMA and to initiate citizen suits under RCRA.[425]

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417. *Id.* at Attachment 2.

418. *Id.* at app. D. Attachments to the Action Plan also include tables that provide information on each TSD or past-practices unit. One table lists all of Hanford's TSDs, organizes them into TSD units, and indicates whether the unit will be subject to an operating or closure permit. *Id.* at app. B. Another table lists all of the past-practices units, organizes them into operable units, lists the operable units in order of cleanup priority, and indicates whether EPA or Ecology is the lead regulatory agency. *Id.* at app. C.

419. Tri-Party Agreement, *supra* note 412, Fourth Amendment, at art. I (Jan. 1994). The federal facilities portion of the NPL is at 40 C.F.R. pt. 300, app. B, tbl. 2 (1994).

420. Tri-Party Agreement, *supra* note 412, Fourth Amendment, arts. I, IV (Jan. 1994).

421. *Id.* at art. VI.

422. *Id.* at art. VII.

423. *Id.* at art. VIII.

424. *Id.* at art. IX.

425. *Id.* at arts. I and X.

Part Three of the FFACO concerns CERCLA remedial actions and RCRA corrective actions. For purposes of CERCLA and RCRA, USDOE admits that Hanford is a facility, that hazardous substances have been released at Hanford, that USDOE is the owner of the facility, and that USDOE is a responsible party.[426] USDOE agrees to carry out interim and final remedial and corrective actions in accordance with the Action Plan,[427] and the parties agree that the cleanup schedule set out in the milestones satisfies CERCLA.[428] As to enforcement, Part Three contains provisions similar to Part Two: dispute resolution procedures, stipulated penalties, citizen suits, and the penalty provisions of RCRA and CERCLA.[429] However, the parties note that they currently dispute the issue of USDOE liability for reimbursement of EPA's costs.[430]

Part Four establishes a framework for EPA and Ecology to coordinate their regulatory responsibilities at Hanford. The parties recognize that there is the potential for EPA and Ecology to impose conflicting obligations on USDOE because of the complexity of the Hanford Site and the overlap between CERCLA and RCRA. Either EPA or Ecology will be the lead agency for each of the many units needing corrective or remedial action.[431]

Part Five of the FFACO addresses common provisions that apply to Parts Two, Three, and Four. Those provisions include quality assurance, recordkeeping, inspection, and reporting.[432] Two provisions are of particular note. First, USDOE agrees to pay fees to Ecology which would be payable by any other person managing hazardous and mixed waste under Washington law and to reimburse Ecology for its costs of implementing the TPA.[433] Second, the parties agree that actions taken under the TPA will comply with the public participation provisions of CERCLA, RCRA, and HWMA, including the requirement that USDOE develop and implement a Community Relations Plan.[434]

C. Action Plan

The primary purposes of the Action Plan are to implement the terms of the FFACO by establishing procedures and plans for (1) hazardous waste permitting, closure, and post-closure under RCRA and Washington's HWMA, and (2) the cleanup of the Hanford Site according to the remedial and corrective action provisions of CERCLA and RCRA.[435] The Action Plan achieves its purposes through seven major types of provisions: classification of waste units, prioritization of waste units, integration of regulatory programs,

426. *Id.* at art. XIII.
427. *Id.* at art. XIV.
428. *Id.* at art. XVII.
429. *Id.* at art. XVI, XX–XXI.
430. *Id.* at art. XIX.
431. *Id.* at art. XXIII. EPA and Ecology will attempt to agree on each lead agency designation and the appropriate regulatory process for the cleanup; however, in the event that they cannot agree, they reserve the right to impose requirements directly on USDOE and to seek judicial review of remedial or corrective actions. *Id.* at art. XXVIII.
432. *Id.* at art. XXXI, XXXVI, XXXVII, XLVIII.
433. *Id.* at art. XXIX.
434. *Id.* at art. XLII.
435. Tri-Party Agreement, *supra* note 412, Fourth Amendment, Attachment 2 at § 1.1 (Jan. 1994) [hereinafter ACTION PLAN].

process for TSD units, process for past-practices units, facility decommissioning process, and public participation.

The Action Plan classifies a number of waste units for purposes of organizing the Hanford cleanup. The broadest classification is "waste management unit" which is any location that may require action to mitigate an environmental impact, including waste disposal units, unplanned release units, inactive contaminated structures, and RCRA treatment and storage units.[436] Waste disposal units are of two types: first, treatment, storage, and disposal units, which will be permitted for operation or closure under RCRA and HWMA; second, past-practice units, which are places where waste has been disposed that are not subject to regulation as TSD units.[437] Hanford contains more than 120 TSD units, which are organized into over 50 TSD groups for purposes of permitting.[438] Hanford's approximately 1000 past-practice units[439] are subdivided into RCRA past-practice units and CERCLA past-practice units, depending upon which statutory scheme is most applicable to the release.[440] Finally, the past-practice units are organized into groups of operable units, primarily by geographic area, for purposes of investigation, remediation, and prioritization of the cleanup work. Some TSD units, primarily land disposal units, will be investigated and managed in conjunction with appropriate operable units. There are approximately seventy-five operable units at Hanford.[441]

The Action Plan articulates criteria to establish priorities for permitting of TSDs and cleanup of operable units. Priority for operable units and TSDs associated with operable units is based on the magnitude of the potential risk, the availability of technology to investigate or remediate the unit, and operational considerations such as the timing of other cleanup activities. The criteria for evaluating risk potential include the type, volume, concentration, toxicity, and potential for migration of the hazardous substance.[442] Priority for permits for TSD units not associated with past-practice units is based on several factors. The risk to public health and the environment is the most important consideration. Further, the parties agreed to comply with the waste management priorities, listed in order, in the HWMA: waste reduction, recycling, treatment, stabilization, and land disposal.[443]

The Action Plan deals with the CERCLA/RCRA overlap and the potential for EPA and Ecology to impose conflicting requirements on USDOE. To insure that only one past-practice process is followed for each operable unit, all units are classified either as RCRA past-practice units or CERCLA past-practice units. CERCLA authority generally will be used if the operable unit contains primarily past-practice units (no TSD units or insignificant TSD units), while RCRA authority generally will apply to operable units that contain significant

436. *Id.* § 3.1.
437. *Id.* §§ 3.2–3.3.
438. *Id.* § 3.2 and app. B.
439. *Id.* at Summary, p. 2.
440. *Id.* § 5.2.
441. *Id.* § 3.3.
442. *Id.* § 3.4.1. Appendix C of the Action Plan contains a list of all of Hanford's operable units in order of priority.
443. *Id.* § 3.4.2 (citing WASH. REV. CODE § 70.105.150).

TSDs.[444] In addition, for each operable unit, either Ecology or EPA will be designated the lead regulatory agency, responsible for ensuring that applicable requirements are met at the unit. Generally, EPA will be the lead agency for operable units regulated under CERCLA and Ecology will be the lead agency for units governed by RCRA.[445]

The Action Plan outlines the permitting process for TSD units. For purposes of the HWMA and RCRA, the Hanford Site is a single facility, even though it contains many TSD units. Since all of the TSD groups cannot be permitted simultaneously, EPA and Ecology will issue an initial permit for less than the entire facility. Additional TSD groups will be added as modifications to the permit, until the permit covers all TSD groups at the Site.[446] The Action Plan also sets out the closure process for TSD units. TSDs can achieve clean closure if all hazardous wastes are removed. If clean closure cannot be achieved, the TSD unit will be closed as a land disposal unit, which requires a post-closure permit. Post-closure permits will cover maintenance, inspection, ground-water monitoring, and corrective actions if necessary.[447]

The Action Plan defines the cleanup processes under CERCLA and RCRA for the approximately 1000 past-practice units at Hanford. Although separate processes are described for CERCLA and RCRA, the parties intend them to be functionally equivalent.[448] If at any time the lead regulatory agency finds an imminent and substantial endangerment to the public health or welfare or the environment because of an actual or threatened release of a hazardous substance, hazardous waste, or a solid waste at an operable unit, the agency may direct USDOE to take immediate action to abate the threat. The Action Plan also authorizes the lead agency to require USDOE to conduct an interim response to prevent the development of an imminent hazard or to address a single past-practice unit with a high priority for cleanup even though it is part of an operable unit with low priority.[449] The final cleanup process is quite detailed under either RCRA or CERCLA, including procedures to identify releases needing further investigation; to characterize the nature, extent, and rate of the release; to evaluate alternatives and identify the preferred remedy; to authorize the selected remedy; and to design and implement the remedy.[450] All operable units, whether addressed under CERCLA or RCRA, will attain the CERCLA cleanup standard—compliance with applicable or relevant and appropriate requirements for the hazardous substance.[451]

Recent changes to the TPA added facility decommissioning to the Action Plan.[452] The decommissioning process applies to key facilities not fully addressed in the TSD or past-practice processes. The parties agreed that the decommissioning process will apply to PUREX, UO3, FFTF, and other major

444. *Id.* § 5.4.
445. *Id.* § 5.6.
446. *Id.* § 6.2.
447. *Id.* § 6.3. For TSD units containing mixed waste, the closure will include the radioactive waste to avoid duplication with CERCLA.
448. *Id.* § 7.1.
449. *Id.* § 7.2.
450. *Id.* §§ 7.2–7.4.
451. *Id.* § 7.5.
452. Tri-Party Agreement, *supra* note 412, Fifth Amendment, Attachment, §§14.1–14.9 (July 1995).

facilities to be identified in the future.[453] Decommissioning will take place in three phases: (1) transition, (2) surveillance and maintenance, and (3) disposition. During the transition phase, the facility will need to comply with criteria regarding documentation of the facility's structural integrity, stabilization, and remaining hazardous and radioactive material.[454] The surveillance and maintenance phase is to ensure that remaining contaminants are contained, to maintain the facility to avoid significant risk to human health or the environment, and to provide physical safety and security.[455] Final disposition of the facility will achieve closure criteria developed by the parties with public input and in compliance with CERCLA, RCRA, and HWMA.[456]

Opportunities for the public to get information and participate in decisions on the Hanford cleanup are described in the Action Plan[457] and the Community Relations Plan (CRP)[458] it incorporates by reference. The Community Relations Plan commits the parties to public involvement and notes its benefits. It enhances the credibility of the cleanup, leads to better decisions, and increases community support which aids continued funding for the cleanup.[459]

The CRP describes many ways for the public to keep informed about the Hanford cleanup. For example, the CRP provides names, addresses, and phone numbers for contact persons at each of the three parties; the parties maintain mailing lists to send publications to interested persons; the parties publish a quarterly newsletter and many fact and focus sheets that provide information on current issues, cleanup activities, and opportunities for participation; and the parties hold quarterly public meetings and annual public update meetings. In addition, the parties created information repositories in four locations that contain copies of the most important documents related to the TPA and the cleanup. The parties maintain an administrative record file containing all documents that the agencies considered in arriving at a record of decision for an operable unit or in the issuance of a permit or modification for a TSD group. Finally, the parties make special efforts to provide information to Indian tribes affected by the cleanup.[460]

The Action Plan and CRP also describe many opportunities for public participation in the decisionmaking process. The parties welcome public comments on the major documents governing the cleanup, such as significant changes to the TPA, key phases in the past-practices process, and permits related to TSD units.[461] The parties also solicit public comments at public meetings.[462] To get public input on a regular basis, the parties created an advisory committee made up of representatives of local governments, public

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453. *Id.* § 14.1.
454. *Id.* § 14.5.
455. *Id.* § 14.6.
456. *Id.* §§ 14.7–14.8.
457. *Id.* §§ 10.1–10.11.
458. U.S. DEP'T OF ENERGY, U.S. ENVIRONMENTAL PROTECTION AGENCY, WASHINGTON STATE DEP'T OF ECOLOGY, COMMUNITY RELATIONS PLAN FOR THE HANFORD FEDERAL FACILITY AGREEMENT AND CONSENT ORDER (June 1993) [hereinafter COMMUNITY RELATIONS PLAN].
459. *Id.* at 1.
460. *Id.* at 14–18, 22–23.
461. ACTION PLAN, *supra* note 435, § 10.6.
462. *Id.* § 10.5.

interest groups, Indian tribes, interested citizens, and federal and state agencies.[463] Moreover, the CRP provides information on federal and state grants of up to $50,000 to facilitate informed and active participation by public interest groups.[464]

D. Tables and Milestones

The Action Plan also contains a Work Schedule with major and interim milestones. The milestones identify steps in the cleanup process and assign due dates to each step. There are dozens of major and hundreds of interim milestones.[465] The milestones fall into four categories: disposal of tank waste, cleanup of past-practice units, TSD operating requirements, and facility decommissioning. The tank waste milestones address the closure of Hanford's single-shell storage tanks and the final disposition of the wastes stored in the single- and double-shell tanks.[466] Major milestones include characterization of the contents of the storage tanks by 1999, resolution of tank safety issues by 2001, closure of single-shell tanks by 2024, and vitrification of the tank wastes by 2028.[467] The past-practice milestones deal with the investigation and cleanup of the operable units.[468] Major milestones include completion of the CERCLA Remedial Investigation and Feasibility Study or RCRA Facility Investigation and Corrective Measures Study for all operable units by 2008 and the completion of remedial or corrective actions for all operable units by 2018.[469] The TSD milestones concern the permitting of TSD units for closure or operation under RCRA and HWMA.[470] Major milestones include the treatment of Phase II liquid effluent by 1997; completion of new facilities to treat, store, and dispose of mixed and solid waste by 1999; and completion of all RCRA/HWMA permits by 2000.[471] Facility decommissioning milestones address the transition from operation to closure of Hanford's key facilities. Major milestones include decommissioning of PUREX, FFTF, UO3, and PFP.[472]

V. HANFORD CLEANUP PROGRAMS

The Nuclear Weapons Complex stopped producing highly enriched uranium in 1964 and plutonium in 1988, and has not manufactured a nuclear warhead since 1990.[473] USDOE has begun the enormous tasks of safe, permanent waste disposal and environmental restoration of contaminated sites throughout the Complex. In 1989, Energy Secretary Watkins outlined his vision

463. COMMUNITY RELATIONS PLAN, *supra* note 458, at 23.
464. *Id.* at 21–22. *See also supra* note 288 and accompanying text.
465. ACTION PLAN, *supra* note 435, at app. D.
466. *Id.* §§ 2.1–2.2.
467. *Id.* at app. D (Milestones M-40-00, M-44-00, M-45-00, M-51-00, M-60-00).
468. *Id.* § 2.3.
469. *Id.* at app. D (Milestones M-15-00, M-16-00); Federal Facility Agreement and Consent Order Change Control Form, at 3 (No. M-15-94-09) (May 1, 1995).
470. *Id.* § 2.4.
471. *Id.* at app. D (Milestones M-17-00A, M-17-00B, M-18-00, M-19-00, M-20-00, M-33-00, M-70-00); Federal Facility Agreement and Consent Order Change Control Form, at 3 (No. M-20-94-05) (Sept. 29, 1994).
472. Tri-Party Agreement, *supra* note 412, Fifth Amendment, at 73-85 (July 1995) (Milestones M-80-00, M-81-00 and M-83-00).
473. Gerrard, *supra* note 54, at 1084.

for a new USDOE culture of environmental responsibility, public involvement, openness, and accountability.[474] USDOE identified its mission for environmental restoration and waste management as (1) safely managing the generation, treatment, storage, transportation, and disposal of USDOE waste and (2) ensuring that risks to human health and the environment from inactive and surplus sites and facilities would be eliminated or reduced to safe levels. USDOE committed to achieving its mission in a cost effective manner.[475]

The cleanup of the Hanford Site is not merely a piece of the remediation of USDOE's Nuclear Weapons Complex. USDOE has designated Hanford as the "flagship" of its waste remediation efforts.[476] The Hanford cleanup has been characterized as the biggest waste remediation program undertaken in human history[477] as well as the largest public works project ever in the United States.[478]

Most of the major elements of the Hanford cleanup are covered by the TPA, although some important aspects of the cleanup not governed by RCRA or CERCLA take place outside of that agreement. USDOE operates programs that include cleanup elements both inside and outside of the TPA. The following programs constitute the bulk of the Hanford cleanup: Tank Waste Remediation System, Spent Nuclear Fuel, Solid Waste, Liquid Effluent, Facility Transition, and Environmental Restoration.[479]

A. Tank Waste Remediation System

The largest single program at Hanford is the Tank Waste Remediation System (TWRS). The focus of the TWRS is on the radioactive waste contained in 177 underground storage tanks. The program also deals with the 1100 cesium and 600 strontium capsules stored in pools.[480]

One set of elements of the TWRS is concerned with the safe storage of tank waste until disposal is complete in 2028. The first priority of the TWRS is to identify and resolve tank safety issues, such as the threat of explosion. Since USDOE does not know the precise physical and chemical properties of the waste in all of the tanks, an essential element of safe storage and eventual disposal is the characterization of the waste. Further, safe storage until 2028 requires upgrades in the tank system. Upgrades will include replacement of the tank infrastructure (ducts, alarms, electrical connections, pumps, pipes), construction of a pipeline to transfer tank waste from the 200 East Area to 200 West, and possibly the construction of up to six new double-shell tanks, each with a capacity of one million gallons.[481] The safe interim storage elements of

474. DOE FIVE-YEAR PLAN, *supra* note 2, at I–8.
475. *Id.* at I–8 to I–11.
476. GERBER, *supra* note 1, at v.
477. *Id.*
478. BLUSH & HEITMAN, *supra* note 28, at 1–1.
479. *See id.* at app. A; J.M. PETERSON, U.S. DEP'T OF ENERGY, THE HANFORD SITE FOCUS 15–39 (Mar. 1994).
480. BLUSH & HEITMAN, *supra* note 28, at 2–10, A–1; PETERSON, *supra* note 479, at 15–16.
481. BLUSH & HEITMAN, *supra* note 28, at A–1 to A–19; PETERSON, *supra* note 479, at 15–16.

the TWRS will be analyzed in, and may be affected by, the Safe Interim Storage of Tank Wastes EIS, which USDOE is preparing.[482]

The other major elements of the TWRS deal with the retrieval, treatment, and disposal of the tank waste and the closure of the single-shell tanks. The tank waste from the 149 single-shell tanks and the twenty-eight double-shell tanks will be transported to a pretreatment facility. Pretreatment will separate the tank waste into high-level radioactive and low-level radioactive waste and will prepare the waste for vitrification. Low-level waste will be vitrified and placed in shallow burial grounds so that it can be retrieved if off-site disposal or better treatment technology is developed in the future. The high-level waste will be vitrified, placed in containers suitable for deep geologic disposal, and stored at Hanford until the geologic repository opens. USDOE is exploring ways to reduce the volume of high-level waste through evaporation or pretreatment because the disposal fee for each canister of vitrified high-level waste is estimated to be $300,000 and as many as 40,000 canisters may be produced. When all of the waste is removed from the single-shell tanks, they will be closed.[483] USDOE is addressing its alternatives for the treatment, long-term storage, and disposal of tank wastes in the Tank Waste Remediation System EIS, which may be completed in 1996.[484]

B. Spent Nuclear Fuel

The Spent Nuclear Fuel Program is concerned with the 2300 tons of irradiated nuclear fuel at Hanford. Most of that fuel is stored in huge pools in the K-Basins, but spent fuel is also located in various facilities in the 200, 300, and 400 Areas. The Spent Nuclear Fuel Program is also responsible for the million gallons of radioactive water and 2300 cubic feet of radioactive sludge in the K-East Basin.[485]

The first priority of the Spent Nuclear Fuel Program is to restore essential safety systems, including earthquake protection, to the K-Basins. Then the fuel and sludge in the K-Basins will be characterized, since USDOE is unsure of their physical, chemical, and radiological properties. The fuel and the sludge in K-Basins will be retrieved and the water in K-East Basin will be treated. The sludge and spent fuel will be transported to a new storage facility, probably in the 200 Area. There, another new facility will stabilize the fuel so that it is suitable for long-term storage until its ultimate disposition at the deep geologic repository.[486]

The Spent Nuclear Fuel Program will continue to evolve. USDOE recently completed a programmatic EIS on spent nuclear fuel for the entire Nuclear Weapons Complex.[487] In its programmatic EIS, USDOE analyzed alternatives that ranged from decentralization (keeping spent fuel dispersed at sites around the Nuclear Weapons Complex) to centralization (transferring all of USDOE's spent fuel to one site). USDOE identified its preferred alternative,

482. IMPLEMENTATION PLAN, *supra* note 167, at 1–11.
483. BLUSH & HEITMAN, *supra* note 28, at A–22 to A–36; PETERSON, *supra* note 479, at 15–16.
484. IMPLEMENTATION PLAN, *supra* note 167, at 1–11.
485. BLUSH & HEITMAN, *supra* note 28, at 2–8 to 2–10, A–44 to A–45; *see supra* notes 105–06 and accompanying text.
486. BLUSH & HEITMAN, *supra* note 28, at A–41 to A–45.
487. *See supra* note 131.

in which Hanford would continue to store its defense spent fuel and would transport its non-defense spent fuel to INEL.[488] In addition, USDOE is preparing a site-specific EIS on spent nuclear fuel at Hanford, which will analyze how to retrieve, stabilize, and store spent fuel.[489]

C. Solid Waste

The Solid Waste Program deals with several categories of waste: transuranic, low-level radioactive, low-level mixed, and nonradioactive hazardous. Program elements include waste retrieval, storage, processing, and disposal. The Solid Waste Program will operate a number of new facilities.[490]

Retrieval will focus on transuranic waste in containers buried in twenty-five trenches. The waste will be dug up and brought to two new retrieval facilities where existing containers will be inspected and the waste repacked in new containers if necessary. Irradiated fuel pieces and other material which were sealed in paint cans and stored in underground cylindrical tanks will also be retrieved.[491]

The Solid Waste Program operates more than fifteen buildings for storage of hazardous and mixed waste and one building for transuranic waste. A new complex of ten buildings will be constructed for waste storage. These new buildings will provide temporary storage to support retrieval and processing and long-term storage of waste for which processing or disposal is years away.[492]

Two types of waste processing facilities will be constructed at Hanford. The first type of new facility will characterize the transuranic waste in containers that have been retrieved and will package the waste for eventual disposal. Two new facilities of this first type will allow workers to handle the waste in glove boxes or by remote handling to protect workers from radiation exposure. The second type of new facility will process low-level mixed waste to prepare it for land disposal in compliance with RCRA. This waste will be placed in 55-gallon steel drums and solidified with concrete or polymer.[493]

The types of disposal depend on the nature of the waste. Transuranic waste will be transported to WIPP for disposal, if and when it opens.[494] Mixed waste will be placed in two new disposal trenches. Each trench is 450 feet long, 350 feet wide, and 30 feet deep, double-lined, and equipped with a leachate collection system. Low-level radioactive waste will be treated or put in containers and disposed in six burial grounds. To protect against ground-water contamination and human penetration of the waste, the low-level waste burial grounds will be capped with a "Hanford barrier", designed to afford protection for 1000 years. The "Hanford barrier" consists of the following levels, from top to bottom: three feet of soil/gravel mix, three feet of soil, a six-inch sand filter, a one-foot gravel filter, five feet of fractured basalt, another one-foot

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488. 1 SPENT FUEL PEIS, *supra* note 131, at 3–1, 3–27 to 3–31.
489. *Id.* at app. A at 2–10 to 2–17.
490. BLUSH & HEITMAN, *supra* note 28, at A–80 to A–82; PETERSON, *supra* note 479, at 17–18.
491. BLUSH & HEITMAN, *supra* note 28, at A–84 to A–86.
492. *Id.* at A–87 to A–90.
493. *Id.* at A–91 to A–96.
494. *See supra* notes 227–31 and accompanying text.

gravel layer, six inches of asphalt, and a compacted soil foundation. The barrier will be surrounded by warning markers both above and below ground.[495]

D. Liquid Effluent

The mission of the Liquid Effluent Program is to discontinue unpermitted discharges of liquid waste into the soil and to manage all effluent for the duration of the cleanup.[496] In 1988, Hanford had thirty-three liquid effluent streams that were discharged into the soil in cribs, ponds, or ditches. Those effluents included condensate from evaporators of high-level waste, B-Plant, and PUREX; cooling water from B-Plant, FFTF, and PUREX; and wastewater from T-Plant and U-Plant.[497]

In 1992, USDOE constructed three basins, 6.5 million gallons each, to hold condensate from evaporators until it could be treated in the new 200 Area Effluent Treatment Facility. After treatment, the water will be discharged in the soil 6.5 miles from the Columbia River, where it will enter the groundwater and migrate to the Columbia River in more than 100 years, when it will comply with drinking water standards.[498] Another new facility, the 200 Area Treated Effluent Disposal Facility, will collect treated effluent and dispose of it in a five-acre pond.[499] Finally, the new 300 Area Treated Effluent Disposal Facility will collect effluent in the 300 Area, treat the effluent, and discharge it into the Columbia River in compliance with a permit from EPA under the Clean Water Act.[500]

E. Facility Transition

The Facility Transition Program was created to address the increasing number of facilities that no longer have production or research missions. This program's focus is deactivation of a facility as it moves from operation mode to decommissioning and decontamination, which are covered by the Environmental Restoration Program. The Facility Transition Program currently includes three major facilities: Plutonium Uranium Extraction facility (PUREX), the Fast Flux Test Facility (FFTF), and the Plutonium Finishing Plant (PFP).[501]

USDOE is using PUREX as the model for major facility transition cleanout and stabilization. PUREX last operated in 1990 and began the transition phase in 1993. Deactivation of PUREX consists of transferring liquids containing plutonium and uranium to the high-level waste tanks; packaging low-level radioactive and transuranic waste and transporting it to the

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495. BLUSH & HEITMAN, *supra* note 28, at 2–30 to 2–34, A–96 to A–101. The surface markers are to be large monolithic stone obelisks which will contain a message to warn potential intruders about the nature and hazards of the waste buried at the disposal site. They are patterned after ancient surface markers such as Stonehenge. The subsurface markers will be placed throughout the barrier to provide a redundant warning system to the surface markers. *Id.* at 2–32.

496. *Id.* at A–102; PETERSON, *supra* note 479, at 19.

497. Tri-Party Agreement, *supra* note 412, Fourth Amendment, app. D (Jan. 1994) (Milestones M–17–00A, M–17–00B, M–17–08B).

498. BLUSH & HEITMAN, *supra* note 28, at A–102 to A–106.

499. *Id.* at A–107.

500. *Id.* at A–108 to A–109.

501. *Id.* at A–50.

Solid Waste Program for disposal and storage; transferring spent fuel to the K-Basins; and documenting the hazardous waste remaining in the facility.[502]

FFTF is a sodium-cooled reactor that last operated in 1992. Deactivation will include the removal and safe storage of 347 irradiated and fifty-six unirradiated fuel elements. The other major deactivation project is the removal and storage of 260,000 gallons of contaminated liquid sodium, which will be placed in a new storage facility. Final cleaning and disposing of the reactor vessel and core will await decontamination and decommissioning.[503]

The deactivation of PFP is more complex. The production part of PFP needs stabilization and cleanup while another part of the facility has an ongoing mission to store weapons-grade plutonium. Further, the transition of PFP will be shaped by two unfinished EISs. USDOE's programmatic EIS on fissile material will guide decisions on how much plutonium and uranium should be stored at Hanford, for how long, and in what form. Following the record of decision from the programmatic EIS, USDOE will prepare a site-specific EIS for PFP.[504]

F. Environmental Restoration

The Environmental Restoration Program is responsible for remediating Hanford's contaminated buildings, ground water, and soil. Its activities are closely tied to the Tri-Party Agreement milestones.[505] The 1989 TPA focused on remediating all of Hanford's past-practice waste sites within thirty years. However, the 1995 Fifth Amendment to the TPA refocused the Environmental Restoration Program by adding the decommissioning and decontamination of facilities to the TPA and by giving first priority to the cleanup of soil, ground water, and buildings near the Columbia River.[506]

As contaminated structures at Hanford no longer have a production, treatment, storage, or research mission, they will undergo decommissioning and decontamination (D&D). As the cleanup progresses, D&D will apply to Hanford's reactors, processing factories, laboratories, waste treatment and storage facilities, and many support buildings.[507] The cleanup plans for the nine reactors along the Columbia River illustrate the challenges facing USDOE in its D&D activities.

N-Reactor is part of a pilot project which integrates the D&D of the reactor and support buildings with the remediation of associated past-practice units. The past-practice units are two liquid effluent disposal cribs adjacent to the N-Reactor. The discharge of radioactive liquids in the cribs contaminated the soil and the ground water which flows into the Columbia River. The remediation of the soil and ground water will be part of an expedited response action. The D&D of N-Reactor will include three major activities. First, contaminated water and sediment will be removed from the N spent fuel basin and sent to the 200 Area Effluent Treatment Facility. Second, USDOE must deal with two silos that contain 70,000 highly radioactive metal slugs that were

502. *Id.* at A–51 to A–53.
503. *Id.* at A–54 to A–55.
504. *Id.* at A–56 to A–57.
505. *Id.* at A–60; PETERSON, *supra* note 479, at 33–34.
506. BLUSH & HEITMAN, *supra* note 28, at A–60 to A–61.
507. *Id.* at A–60 to A–63; *see supra* notes 112–16 and accompanying text.

used to keep fuel rods in place inside the reactor core. Third, USDOE will prepare an EIS on the D&D of the reactor building.[508]

B-Reactor has been placed on the National Register of Historic Places. Consequently, USDOE will take actions to mitigate the impact of D&D on the historic preservation of the reactor. Those actions may include extensive records via photographs, drawings, models, exhibits, and written histories but may also include preservation of the reactor itself.[509]

The D&D for the other seven surplus production reactors along the Columbia River were the subject of a 1992 EIS.[510] In the EIS, USDOE looked at several alternatives, including entombing the reactors in place; however, USDOE decided to remove the reactors to the 200 Area after a period of safe storage.[511] The D&D plan for removal is remarkable:

- Design four transporters, 110 feet wide, 160 feet long, 60 feet high, and capable of carrying 16,400 tons each;
- Demolish the reactor building and fuel basin;
- Excavate four acres around the reactor to provide access to the concrete base of the reactor, twenty-five feet below grade;
- Build a cage out of steel plates around the reactor block (the reactor core, cast iron thermal shield, four-foot-thick concrete shield, concrete base) to maintain its structural integrity;
- Drill tunnels laterally through the base, insert lifting beams, and grout them in place;
- Saw through the bottom of the base;
- Lift the block onto the transporter;
- Drive the transporter to the 200 Area on a new haul road, which will be 150 feet wide, capable of supporting 16,000 tons, not exceeding four percent grade (the road will need to be twenty-five miles long to accommodate the elevation change between the 100 and 200 Areas);
- Dispose of the reactor block in a new disposal trench, 1000 feet long, 600 feet wide, and 110 feet deep;
- Transport the contaminated equipment from the reactor building, any contaminated soil around the reactor or fuel basin, and all contaminated rubble from the reactor and fuel basin to the 200 Area for disposal;
- Backfill, regrade, and vegetate the reactor site.[512]

USDOE estimates that the removal of each reactor would take two and one-half years.[513]

Ground-water remediation is in the test phase. USDOE is conducting tests in the 100 and 200 Areas to measure the scope of the ground-water contamination, to determine whether the contaminants will be in the water when it is pumped from the ground, and, if so, to determine the appropriate

508. *Id.* at 1–29 to 1–33, A–68 to A–72.
509. DECOMMISSIONING EIS, *supra* note 114, at 1.17–1.18.
510. *Id.* at 1.1.
511. *Id.* at 1.3–1.17.
512. BLUSH & HEITMAN, *supra* note 28, at A–63 to A–67.
513. DECOMMISSIONING EIS, *supra* note 114, at 1.9.

treatment technology. Based on the test results, USDOE will propose a groundwater remediation strategy.[514]

Most of the operable units at Hanford contain contaminated soil.[515] Before remediation can begin, the soil at each waste site must be sampled and tested to determine the nature of the contamination. While that testing is going on, USDOE is operating a pilot soil washing project designed to reduce the total amount of soil that will need to be dug up and disposed.[516] Further, USDOE contemplates that some operable units with contaminated soil will be capped in place with a Hanford barrier.[517]

The contaminated material removed from past-practice units and decommissioned buildings will be disposed at the Environmental Restoration Disposal Facility (ERDF). This new landfill will occupy 1.5 square miles in the 200 Area and will be able to contain 30 million cubic yards of contaminated material. ERDF will have a double liner and a leachate collection and treatment system. It will be capped with a Hanford barrier when it closes.[518]

VI. Critical Issues for the Success of the Hanford Cleanup

USDOE, EPA, Ecology, Congress, and the public all have important roles to play in the future of Hanford, the "flagship" cleanup in the Nuclear Weapons Complex. Whether the Hanford cleanup will be a success from the perspective of any of those parties is yet to be determined. Numerous critical issues must be resolved as the remediation progresses. Those issues fall into three categories: (1) the fundamental uncertainties concerning the nature, scope, level, cost, and time of the cleanup; (2) the coordination of regulatory requirements; and (3) the quantity and quality of public participation.

A. Fundamental Cleanup Uncertainties

Five of the most basic questions about the Hanford cleanup have yet to be answered: (1) What future use will be made of the Hanford Site? (2) What level of cleanup will be achieved? Or, stated negatively, how much contamination will be left on site? (3) What technology will be used for treatment and disposal of Hanford's waste? (4) How much will the cleanup cost? (5) When will the cleanup be complete? Unfortunately, these basic questions are unanswered for the cleanup of the entire Nuclear Weapons Complex as well.[519]

1. Future Use

Although the five questions are interrelated and the answers to each affect the answers to others, perhaps the most basic issue is the future use of the Hanford Site. In 1992, USDOE, EPA, and Ecology convened a Working Group to address this issue. The Working Group consisted of representatives from

514. BLUSH & HEITMAN, *supra* note 28, at A–75 to A–77.
515. *Id.* at 2–20.
516. *Id.* at 2–20, 2–22, A–74 to A–75.
517. *Id.* at 2–30 to 2–31; *see also supra* note 495 and accompanying text.
518. BLUSH & HEITMAN, *supra* note 28, at A–77 to A–78; U.S. DEP'T OF ENERGY, U.S. ENVIRONMENTAL PROTECTION AGENCY, WASHINGTON STATE DEP'T OF ECOLOGY, ERDF THE ENVIRONMENTAL RESTORATION DISPOSAL FACILITY (1994).
519. CLOSING THE CIRCLE, *supra* note 17, at 7, 70–71, 90.

government (federal, state, and local), Indian tribes, business, labor, agriculture, environmental groups, and public interest groups.[520] The Working Group studied the suitability of each of Hanford's areas[521] for agriculture, wildlife, industry, waste management, research, recreation, commercial, and Native American uses. For each area, the Working Group identified a range of potential future uses.[522]

The Working Group provided valuable information to USDOE and its regulators about the types of potential future uses favored by various stakeholders. More information about Hanford's future role will be forthcoming as USDOE completes programmatic EISs on the redesign of the Nuclear Weapons Complex.[523] However, the primary vehicle for USDOE to identify future land uses for Hanford is the Hanford Remedial Action EIS which is now underway.[524]

The Hanford Remedial Action EIS will establish future land-use objectives for all areas of Hanford, except the Arid Lands Ecology Reserve and the North of the River areas for which remediation is complete. USDOE, EPA, and Ecology will use the future land-use objectives as a basis to develop a cost effective, technically sound remediation strategy for Hanford so that land-use decisions will not need to be made on a case-by-case basis for each operable unit. The EIS will analyze three future land-use alternatives: (1) unrestricted—allow all types of future human uses; (2) restricted—allow limited human use due to residual contamination; and (3) exclusive—use for management and disposal of hazardous or radioactive materials, with control of the area maintained by USDOE. The Record of Decision is anticipated in October of 1996.[525]

2. Levels of Cleanup

Once the parties decide the future use for each of Hanford's areas, they must establish cleanup levels for each operable unit and TSD group; that is, the parties need to decide how much contamination, if any, can remain consistent with the proposed use. Obviously, every molecule of contamination will not be treated or removed. Instead, the parties will establish the cleanup levels through the past-practices process and TSD process set out in the Tri-Party Agreement Action Plan.[526] The process of setting cleanup levels for over fifty TSD units and over seventy operable units will be a formidable undertaking.[527]

3. Treatment and Disposal Technology

The methods for treatment or disposal of much of Hanford's waste are uncertain. This uncertainty hinders most of USDOE's major cleanup programs.

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520. HANFORD FUTURE SITE USES WORKING GROUP, *supra*, note 31, at ii–iii, 3.
521. See *supra* notes 31–48 and accompanying text for a description of the areas of Hanford.
522. HANFORD FUTURE SITE USES WORKING GROUP, *supra* note 31, at 17–23.
523. *See* IMPLEMENTATION PLAN, *supra* note 167, at 1–2, 1–4.
524. *Id.* at 3–1.
525. *Id.* at 1–4, 2–1, 3–1 to 3–6, 5–1.
526. *See supra* notes 446–51 and accompanying text.
527. *See supra* notes 437–41 and accompanying text.

The Tank Waste Remediation System is confronted by a number of unknowns. First, USDOE is unsure of the properties of the tank waste, so it currently is sampling, testing, and characterizing the waste. Further, although USDOE has identified treatment methods for the waste contained in the 149 single-shell tanks, it has not addressed how the tanks will be closed when they are empty. Nor has USDOE decided how it will handle the 1100 cesium and 600 strontium capsules until their ultimate disposition in a geologic repository. Moreover, the vitrification plant for low-level radioactive tank waste will be the first of its kind in the world.[528] Finally, although USDOE plans to transport vitrified high-level tank waste and the cesium and strontium capsules to the geologic repository, technical problems and litigation have already delayed the opening of the repository to an unknown point after 2010.[529] USDOE currently is studying many of the issues related to tank waste remediation in two EISs.[530]

Hanford's Spent Nuclear Fuel Program is in a state of flux. Which portions of Hanford's spent fuel will be processed and stored on site is addressed in USDOE's recent programmatic EIS on spent fuel for the Nuclear Weapons Complex.[531] The manner of processing and storing spent fuel at Hanford is the subject of another EIS that USDOE is preparing.[532] And, since USDOE plans to dispose of Hanford's spent fuel in the geologic repository, the uncertainty of when the depository will open complicates USDOE's task.[533]

USDOE faces similar uncertainties in dealing with transuranic waste in its Solid Waste Program. Much of Hanford's transuranic waste is buried in deteriorating containers, and USDOE is in the process of conducting a pilot project to identify appropriate retrieval methods.[534] After USDOE retrieves the waste, it will need to process and store the waste until its ultimate disposal at the WIPP.[535] But litigation and technical problems continue to delay WIPP's opening.[536]

The Facility Transition Program is engaged in two projects that should help the parties with the decommissioning and decontamination of other major facilities in the future. First, the cleanout and stabilization of PUREX are being used as a model for major facility transition. Second, transition of the PFP is the subject of an ongoing EIS.[537]

Several uncertainties plague important aspects of Hanford's Environmental Restoration Program. First, USDOE has not decided what it will do with the 70,000 radioactive fuel spacers in silos next to N-Reactor.[538] Second, USDOE is conducting tests on treatment technology for Hanford's one trillion gallons of contaminated ground water. USDOE has not yet determined whether a cost effective ground water treatment technology exists.[539] Third, no reliable estimates exist on the amount of contaminated soil at Hanford. USDOE,

528. BLUSH & HEITMAN, *supra* note 28, at A–8, A–9, A–23, A–24, A–33, A–49.
529. *See supra* note 224 and accompanying text.
530. *See supra* notes 482, 484 and accompanying text.
531. *See supra* notes 488–90 and accompanying text.
532. *See supra* note 489 and accompanying text.
533. *See supra* notes 486, 224 and accompanying text.
534. BLUSH & HEITMAN, *supra* note 28, at A–84 to A–86.
535. *See supra* notes 493–94 and accompanying text.
536. *See supra* note 228 and accompanying text.
537. *See supra* note 504 and accompanying text.
538. BLUSH & HEITMAN, *supra* note 28, at A–71.
539. *Id.* at 2–17, 2–20, A–75 to A–77.

EPA, and Ecology will use the CERCLA and RCRA past-practice processes to identify the amount of the contamination and the appropriate disposal or treatment technology, if any.[540]

4. Cost

The first five years of the Hanford cleanup cost $7.5 billion, nearly $5 million per day.[541] In 1994, USDOE estimated the cost of the Tank Waste Remediation System alone at $40 billion, and that estimate did not include the disposition of the tanks themselves, the soil around them, contaminated equipment, or the D&D of the new facilities built to retrieve, treat, and process the waste.[542] The estimated cost of the Environmental Remediation Program is $20 billion, and the Solid Waste Program is $10.5 billion.[543] The total cost of the cleanup has been estimated at $100 billion.[544]

The reliability of the $100 billion estimate of total cleanup costs is questionable. The cost of the cleanup will depend in large part on the resolution of the critical issues discussed above: the future land use for Hanford, the level of cleanup, and the technological uncertainties. Until those issues are resolved, no one—not USDOE, EPA, Ecology, Congress, or the public—can accurately predict the ultimate cost of the Hanford cleanup.

The uncertainty of the cost of the Hanford cleanup is indicative of the problem USDOE has estimating the cost of the cleanup of the entire Nuclear Weapons Complex. The cost will be high because of the enormity of the contamination, the toxicity of the wastes, the variability of the sites, the sophistication of the remediation technology, and the requirements of NEPA, CERCLA, and RCRA. How high? In 1988, USDOE estimated the twenty-year cleanup cost at $71 billion to $111 billion. In 1990, the General Accounting Office estimated the cost of cleanup and modernization at $125 billion to $155 billion.[545] More recent estimates of the cleanup costs exceed $300 billion.[546] USDOE has been reluctant to publish overall cost estimates of the cleanup since 1988 because of uncertainty about the extent of the contamination and the type of remediation that will lead to acceptable results.[547]

5. Time

When USDOE, EPA, and Ecology entered the Tri-Party Agreement in 1989, they envisioned a thirty-year cleanup for Hanford, so the TPA included milestones to complete the cleanup by 2018. None of the parties believes any longer that the Hanford remediation will be completed anytime near 2018. The current milestone to complete processing tank waste is 2028. The Environmental Restoration Program has work scheduled through 2047. EPA and Ecology are using 2055 as the deadline for removing all reactor blocks from the 100 Area and 2118 as the date when the 100 Area can be released for

540. *Id.* at 2–20, 2–22, A–74, A–75.
541. Jim Lynch & Karen D. Steele, *River of Money*, SPOKESMAN-REV. (Spokane), Nov. 13, 1994, at H1–H2.
542. BLUSH & HEITMAN, *supra* note 28, at A–2, A–4.
543. *Id.* at A–62, A–81.
544. *Id.* at 2–50; Lynch & Steele, *supra* note 541, at H2.
545. COMPLEX CLEANUP, *supra* note 50, at 55–59.
546. BLUSH & HEITMAN, *supra* note 28, at 2–50.
547. COMPLEX CLEANUP, *supra* note 50, at 56.

unrestricted use. Even these estimates, 100 years longer than the original TPA envisioned, are based on assumptions that technological problems will be resolved and Congress will continue to fund the cleanup at the rate the parties deem necessary.[548] Given the substantial revisions in the schedule during the first five years of the Hanford cleanup, one must question the accuracy and efficacy of a cleanup schedule 35, 50, or 100 years in the future.

B. Coordination of Regulatory Requirements

The Hanford cleanup is a management nightmare. USDOE must comply with numerous federal and state environmental statutes and regulations, which are administered by multiple state and federal agencies, while incorporating input from diverse citizen and government advisors, at a huge site with hundreds of contaminated places.

The statutes and implementing regulations that apply to the Hanford cleanup are a veritable "Who's Who" of environmental law. CERCLA governs the releases of hazardous substances at Hanford[549] and RCRA deals with releases of hazardous waste.[550] RCRA and Washington's HWMA control USDOE's generation, transportation, treatment, storage, and disposal of solid, hazardous, and mixed waste.[551] At many of Hanford's contaminated sites, both RCRA and CERCLA govern the cleanup.[552] The Clean Air Act applies to Hanford's air emissions, the Clean Water Act regulates discharges into the Columbia River, and RCRA and HWMA control disposal on land.[553] The Atomic Energy Act applies to Hanford's plutonium, uranium, and other nuclear material,[554] and several federal statutes address disposal of radioactive waste.[555] Finally, NEPA and SEPA mandate analysis of major cleanup activities,[556] and federal and state historical and archaeological preservation statutes try to ensure that Hanford's buildings and sites are not lost for future generations.[557]

USDOE must satisfy several regulators and listen to various advisors. EPA is the primary regulator at Hanford for CERCLA remedial action and RCRA corrective action.[558] Ecology regulates USDOE's generation, transportation, treatment, storage, and disposal of hazardous waste under the HWMA.[559] The Washington Department of Social and Health Services oversees the radionuclide emissions at Hanford.[560] USDOE receives oversight and input on its cleanup activities not only from its regulators but from a variety of citizen and government groups as well, including the Hanford Advisory Board, several Indian tribes, the Defense Nuclear Facilities Safety Board, and the General Accounting Office.[561]

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548. BLUSH & HEITMAN, *supra* note 28, at 2–42 to 2–49.
549. *See supra* notes 257–321 and accompanying text.
550. *See supra* note 329–30 and accompanying text.
551. *See supra* notes 322–93 and accompanying text.
552. *See supra* notes 394–401 and accompanying text.
553. *See supra* notes 244–46 (air), 498–500 (water), 322 (land) and accompanying text.
554. *See supra* notes 193–219 and accompanying text.
555. *See supra* notes 220–39 and accompanying text.
556. *See supra* notes 163–79 and accompanying text.
557. *See supra* notes 180–88 and accompanying text.
558. *See supra* notes 420, 445 and accompanying text.
559. *See supra* notes 420, 445 and accompanying text.
560. *See supra* notes 248–49 and accompanying text.
561. BLUSH & HEITMAN, *supra* note 28, at 2–41 to 2–42.

The complexity of the Hanford Site itself contributes to the management problems. It has more than 120 treatment, storage, and disposal units for which USDOE must obtain operating or closure permits. Hanford also contains more than 1000 contaminated sites.[562]

The Tri-Party Agreement is the primary organizational tool that USDOE, EPA, and Ecology are using to address the challenges posed by the numerous statutory schemes administered by multiple agencies at the complex Hanford Site.[563] The TPA attempts to deal with the challenges in several ways. First, the TPA reduces the regulatory burden on USDOE, EPA, and Ecology by organizing Hanford's TSDs into fifty-six groups for purposes of permitting and by combining Hanford's more than 1000 contaminated sites into seventy-eight operable units for the CERCLA and RCRA investigation and remediation processes.[564] Second, the TPA addresses the CERCLA/RCRA overlap problem by making the CERCLA and RCRA cleanup processes functionally equivalent and through the lead agency process, in which either EPA or Ecology has primary responsibility for each operable unit.[565] Third, the TPA coordinates most of the legal and technical requirements that make up the Hanford cleanup in hundreds of milestones with target dates.[566]

The TPA looks great on paper. But how does it work in real life? The answer is not clear. On one hand, critics of the TPA raise serious concerns about its effectiveness. Critics assert that (1) six years after the TPA was signed very little cleanup work has been done; (2) the past-practice process that applies separately to each operable unit increases cost and delays the cleanup; (3) the milestones give the illusion of progress but have no meaning because they were set before essential decisions were made, such as the identification of future land uses and cleanup technology that is technically and economically feasible; (4) the milestones lead USDOE to take actions that later analysis shows to be of questionable value, and (5) the parties have already amended the TPA five times in a futile attempt to provide a sound framework of priorities for the cleanup.[567]

The high-level radioactive waste vitrification plant is an example of the problems with the TPA. The 1989 TPA set milestones for the initiation of construction (1992) and operation (1999) of the facility.[568] In 1991, the parties characterized the vitrification facility as "one of the cornerstones of Hanford cleanup" and stated that "the credibility of the cleanup hinges on making sure this project proceeds as scheduled."[569] Nevertheless, safety problems in single-shell tanks and pretreatment needs made the schedule unattainable, so in 1993 the parties renegotiated the TPA to delay the start of construction and operation of the vitrification plant by ten years.[570]

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562. *See supra* notes 437–40 and accompanying text.
563. *See supra* notes 412–72 and accompanying text.
564. *See supra* notes 438–41 and accompanying text.
565. *See supra* notes 431, 444–45, 448–53 and accompanying text.
566. *See supra* notes 465–72 and accompanying text.
567. BLUSH & HEITMAN, *supra* note 28, at ES1, 1–23 to 1–29, 1–84 to 1–91.
568. Tri-Party Agreement, *supra* note 412, Fourth Amendment, app. D (Milestones M–03–00, M–03–01).
569. *Vitrification Plant Construction to Begin in April 1992*, HANFORD UPDATE (Washington Dep't of Ecology, Olympia, Wash.), Oct. 1991, at 1.
570. BLUSH & HEITMAN, *supra* note 28, at A–34 to A–35; Tri-Party Agreement, *supra* note 412, Fourth Amendment, app. D (Milestone M–53–03–T03).

On the other hand, the critics' assertions can be viewed as strengths of the TPA or challenges that the TPA can meet. Most of the $7.5 billion spent at Hanford in the last six years went toward safely managing Hanford's radioactive and toxic materials, complying with the numerous statutory and regulatory requirements, investigating contamination at the Site, and developing and testing cleanup technology.[571] These appear to be appropriate activities for the early stages of a long-term cleanup effort. Further, it is certainly true that the TPA milestones drive the Hanford cleanup; as of January 1994, USDOE had completed or renegotiated 293 of 294 milestones on schedule.[572] Moreover, the amendments significantly changed the TPA by (1) creating the Hanford Past-Practices Strategy to reduce the cost and time spent on analysis of contaminated sites and show tangible cleanup progress; (2) giving higher priority to cleanup along the Columbia River; (3) changing the treatment technology for low-level radioactive tank waste; and (4) adding D&D of major facilities to the TPA. These amendments were based on experience the parties accumulated as the cleanup progressed and input on cleanup priorities from the public.[573] It remains to be seen whether the parties through the TPA will successfully identify future land uses, develop appropriate cleanup technology, and achieve the proper balance between analysis and action.

C. Public Participation

In 1993, Secretary of Energy Hazel O'Leary announced a new "openness initiative" for USDOE. "The Department of Energy is removing the cloak of Cold War secrecy that has shrouded its nuclear weapons program for 50 years.... In the old days we decided, announced, and then defended policy. In the new days, we must engage the public, debate, decide, announce and then go forward...."[574]

USDOE has implemented the openness policy at Hanford with gusto, at least with respect to providing the opportunity for public participation. The Tri-Party Agreement Community Relations Plan (CRP) describes numerous methods by which USDOE tries to keep the public informed about the Hanford cleanup, such as a toll-free number, publications, public meetings, and document repositories. The CRP also details the parties' efforts to solicit public input on key documents and decisions through written comments, oral comments at public meetings, the Hanford Advisory Board, and grants to public interest groups.[575] USDOE is putting its money where its mouth is; it spent over $2 million in 1994 on public participation.[576]

A tremendous amount of public participation is taking place through the NEPA process related to Hanford. USDOE is preparing three programmatic EISs on aspects of the Nuclear Weapons Complex. USDOE has prepared four EISs on portions of the Hanford cleanup, is in the process of completing five

571. *See* BLUSH & HEITMAN, *supra* note 28, at ES1, A–1 to A–125.
572. PETERSON, *supra* note 479, at 7.
573. BLUSH & HEITMAN, *supra* note 28, at 1–18 to 1–29, A–30 to A–31, A–50 to A–51.
574. CLOSING THE CIRCLE, *supra* note 17, at 83.
575. *See supra* notes 460–64 and accompanying text.
576. BLUSH & HEITMAN, *supra* note 28, at A–123 to A–124.

more, and undoubtedly will complete more in the future. Eventually, every major aspect of the Hanford cleanup will have been the subject of an EIS.[577]

Public input has been a significant factor in the parties' decisions on major elements of the Hanford cleanup. Plans for disposal of low-level radioactive waste, remediation priority for the Columbia River, and removal of the production reactors are all examples of the power of public participation.

The 1987 Record of Decision for the Hanford Defense Waste EIS established that USDOE would mix low-level radioactive tank waste with grout (cement) and dispose of it in underground concrete vaults. Pursuant to this EIS, USDOE constructed a grout facility and vaults and began operating the facility. A citizen task force recommended that USDOE close the grout facility and replace it with a vitrification plant which would reduce the volume of the waste and allow the vitrified product to be retrieved if better treatment or disposal options appeared in the future. The parties incorporated the citizens' recommendation in the Fourth Amendment to the TPA.[578]

The 1989 TPA focused on the remediation of past-practice sites, many of which are in the 200 Area. The original TPA did not address D&D of contaminated facilities or the soil under them, nor did it emphasize cleanup along the Columbia River. In 1994, the parties negotiated the Fifth Amendment to the TPA, which adds milestones for D&D and focuses the Environmental Restoration program on the cleanup of facilities and sites along the Columbia River.[579] The negotiations and the Amendment reflected input from the public, Indian tribes, the Tank Waste Task Force, and the Future Site Uses Working Group.[580]

In a 1992 EIS, USDOE analyzed five alternatives for decommissioning the eight surplus production reactors along the Columbia River. The EIS did not find significant environmental or human health differences between the alternatives. Based in part on public comments, USDOE decided to remove the reactors from the river to the 200 Area rather than entombing them in place.[581]

Although it is clear that public participation opportunities abound at Hanford and that public input has affected major cleanup decisions, critics raise two concerns. First, does the public input lead to good decisions? Critics charge that the plan to remove the reactors to the 200 Area and the N Pilot Project (part of the refocusing of remediation on the Columbia River) are poor decisions that will increase the cost of the cleanup with no benefit to health or the environment.[582] Second, critics assert that much of the public participation in the NEPA process occurs after the key decisions have been made. For example, the TPA sets out milestones for the major elements of the Tank Waste Remediation System (pretreatment facility, vitrification facilities for low-level

577. *See supra* notes 173, 482, 484, 488, 504, 508 and accompanying text.
578. BLUSH & HEITMAN, *supra* note 28, at A–29 to A–31.
579. *Id.* at A–60 to A–61.
580. U.S. DEP'T OF ENERGY, ENVIRONMENTAL PROTECTION AGENCY, WASHINGTON STATE DEP'T OF ECOLOGY, TENTATIVE AGREEMENT ON ENVIRONMENTAL RESTORATION REFOCUSING TRI-PARTY AGREEMENT NEGOTIATIONS 13 (1994).
581. BLUSH & HEITMAN, *supra* note 28, at A–62 to A–65; DECOMMISSIONING EIS, *supra* note 114, at 1.14–.17.
582. BLUSH & HEITMAN, *supra* note 28, at 1–29 to 1–32, A–62 to A–74.

and high-level radioactive waste) even though EISs on the TWRS are currently underway.[583]

CONCLUSION

In 1995, Secretary of Energy Hazel O'Leary wrote about the challenges of the Manhattan Project and the cleanup of the Nuclear Weapons Complex:

> The United States built the world's first atomic bomb to help win World War II and developed a nuclear arsenal to fight the Cold War. How we unleashed the fundamental power of the universe is one of the great stories of our era. It is a story of extraordinary challenges brilliantly met, a story of genius, teamwork, industry, and courage.
>
> We are now embarked on another great challenge and a new national priority: refocusing the commitment that built the most powerful weapons on Earth towards the widespread environmental and safety problems at thousands of contaminated sites across the land. We have a moral obligation to do no less....[584]

Hanford played a critical role in the production of nuclear weapons. Now Hanford is the "flagship" of USDOE's environmental restoration of the Nuclear Weapons Complex. Lessons learned in the Hanford cleanup will be applied across the Complex. Whether the USDOE meets the challenge to remediate its Nuclear Weapons Complex depends in large part on the success of the Hanford cleanup.

USDOE, its contractors, EPA, Ecology, Congress, and the public share responsibility to ensure the success of the Hanford cleanup. We owe it to the people who gave up their homes and lands to create the Hanford Site. We owe it to the thousands who worked at Hanford, to those who lived in its shadow, and to those who suffered from its effects. Ultimately, we owe it to ourselves.

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583. *Id.* at 1–34 to 1–35.
584. CLOSING THE CIRCLE, *supra* note 17, at vii.