FUSRAP at Fifty: From Investigation to Remediation and Long-Term Stewardship – 24617

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ABSTRACT

The Formerly Utilized Sites Remedial Action Program (FUSRAP) will have its 50th anniversary in June 2024. The US Atomic Energy Commission (AEC) initiated the program in response to concerns about residual contamination at privately owned industrial facilities that had performed work for the Manhattan Engineer District (MED) and AEC. The MED and AEC had utilized several hundred private contractors to conduct research and work with uranium and thorium in the 1940s and 1950s. The work included refining uranium and thorium ores and casting and machining uranium metal. The MED and early AEC work was conducted without licensing to ensure that industrial hygiene practices were being utilized. The facilities ranged in size from small machine shops to major chemical factories. The facilities were usually decontaminated to then-current industrial standards at the completion of their contracts.

This paper chronicles the transformations of FUSRAP's mission over the last 50 years and describes programmatic strategies for protecting human health and the environment. These transformations included identifying sites for cleanup, establishing a remediation program, transferring remediation responsibilities, and becoming a stewardship-focused organization. During these transformations, the US Department of Energy (DOE) and its predecessor organizations developed practices to meet their nationwide mission amid larger changes in the regulatory landscape.

In the 1970s, public awareness was being raised about the dangers of exposure to radium and radon from contaminated sites. AEC began to take notice of potential contamination at its formerly utilized sites when the Borough of Middlesex, New Jersey, encountered radioactive contamination in its landfill during a civil defense drill. At the request of the last AEC chairperson, Dixy Lee Ray, a search was initiated for the formerly utilized sites that were potentially contaminated. On June 4, 1974, the AEC Division of Operational Safety was assigned responsibility for planning, budgeting, and directing a program for conducting radiological surveys of previously utilized sites that were no longer under AEC control. During the initial records review, FUSRAP personnel assessed the radiological conditions at more than 600 sites that were potentially involved in early atomic weapons and energy activities. Forty-six sites were identified for cleanup. Since 1974, nearly 1000 sites have been reviewed for potential inclusion into FUSRAP. The approach for cleanup was to reduce exposure to contamination using the best available strategies at the time despite many constraining factors. As such, properties with minimal contamination were decontaminated, waste on private residential properties was excavated, and interim storage facilities were created and later remediated.

By 1997, DOE had remediated 25 of the 46 sites, and 13 were undergoing remediation. More than 200 vicinity properties had been remediated. DOE recognized issues that needed to be addressed and reported these to Congress. Congress acted on these issues by transferring responsibility for FUSRAP investigations and remedial actions to the US Army Corps of Engineers (USACE). DOE transferred 21 sites to USACE for cleanup. Congress directed USACE to use the guidelines of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Contingency Plan to conduct the cleanups.

Furthermore, USACE classified the FUSRAP wastes as byproduct material, which simplified options for waste disposal. USACE and DOE developed the March 1999 Memorandum of Understanding and two letters of agreement to determine the protocols for sharing FUSRAP responsibilities.

There are currently 34 completed FUSRAP sites under long-term stewardship by the DOE Office of Legacy Management (LM) and 21 active sites being remediated by USACE, for a total of 55 sites. Six of the sites were added by Congress.

USACE may complete the final Record of Decision under FUSRAP in 2024 for the former Joslyn Manufacturing and Supply Company site in Fort Wayne, Indiana. FUSRAP remedial investigations are essentially completed unless new sites are added to the program, which marks a major milestone. In total, 10 sites have been transferred back to LM for long-term stewardship. LM anticipates that all USACE remedial actions will be completed before 2040, by which time FUSRAP will change from a cleanup program to a long-term stewardship program.

LM's stewardship responsibilities are long-term. LM anticipates operating two remediation systems, one at the Lockport, New York, Site, and one at the Hicksville, New York, Site. There will be groundwater monitoring programs at up to 10 sites, as well as institutional controls to manage and CERCLA-mandated Five-Year Reviews. Stewardship challenges include coordinating long-term stewardship activities and disseminating site information to hundreds of property owners and other stakeholders.

LM is meeting these challenges by developing a wide range of innovative tools and collaborative strategies to ensure the effective execution of the current mission.

INTRODUCTION

The Formerly Utilized Sites Remedial Action Program (FUSRAP) has changed significantly over time and will continue to change in the future. Over the last half century, FUSRAP has evolved from identifying potentially contaminated sites to cleaning up contaminated sites and performing long term stewardship of completed sites. Roughly a quarter of a century ago, the program evolved into an interagency partnership between the US Department of Energy (DOE) and the US Army Corps of Engineers (USACE). In the coming decades, it will continue to evolve, eventually becoming primarily a long-term stewardship program, once remediation of sites has been completed.

In the race to develop nuclear weapons during World War II, the Manhattan Engineer District (MED) relied on more than 10 prime contractors and several hundred subcontractors for research and development as well as for processing and production of uranium and thorium [1]. Activities conducted at these contracted sites included milling, sampling, and assaying uranium and thorium ores; refining uranium compounds; producing uranium metal; machining uranium metal; and researching and developing new processes. The products of these facilities were ultimately used as feedstock for the uranium enrichment plants and plutonium production reactors. The uses of the FUSRAP sites are shown in Figure 1.

Responding to concerns about residual contamination at privately owned industrial facilities that had performed work for the MED and its descendent, the US Atomic Energy Commission (AEC), on June 4, 1974, AEC established what would become FUSRAP [2].

During an initial records review, FUSRAP personnel assessed the radiological conditions at more than 600 sites. A descendent of the MED and AEC, DOE began cleanup of FUSRAP sites in 1979 and completed cleanup at 25 sites by 1997.

That year, Congress transferred the responsibility for FUSRAP investigations and remedial actions to USACE. Between 1997 and 2023, 10 sites were remediated by USACE and transferred into DOE's long-term stewardship program [3].

Abbreviation: LM = Office of Legacy Management

Figure 1. Uses of the FUSRAP Sites.

Within the next 2 decades, FUSRAP will likely progress from primarily a cleanup program to primarily a long-term stewardship program. DOE anticipates that all USACE remedial actions will be completed by 2040 [4].

BACKGROUND

Work performed at privately owned facilities in support of the MED and early AEC was conducted before the practice of licensing to ensure that industrial hygiene practices were in place. Facilities were typically decontaminated to industrial standards at the completion of their federal contracts [5]. To provide cleanup guidance, in 1954 AEC issued *Decontamination of Buildings Used for Processing Alpha Emitters* [6]. The guidance was designed to remediate surface contamination so that the maximum occupational absorbed dose would be less than 3 millisieverts (mSv) (300 millirem [mrem]) per week, which is approximately equivalent to 150 mSv per year (yr) (15 rem/yr), the then-current dose limit. Through the years, the federal limits for radiation exposure have decreased, and cleanup guidance has been revised in response. Before 1949, the occupational limit was 300 mSv/yr (30 rem/yr); in 1949, it was lowered to 150 mSv/yr (15 rem/yr); and in 1958, the occupational limit was lowered to 50 mSv/yr (5 rem/yr) [7]. Annual dose limits for members of the public have also been lowered significantly over the same period, as shown in Figure 2 [8].

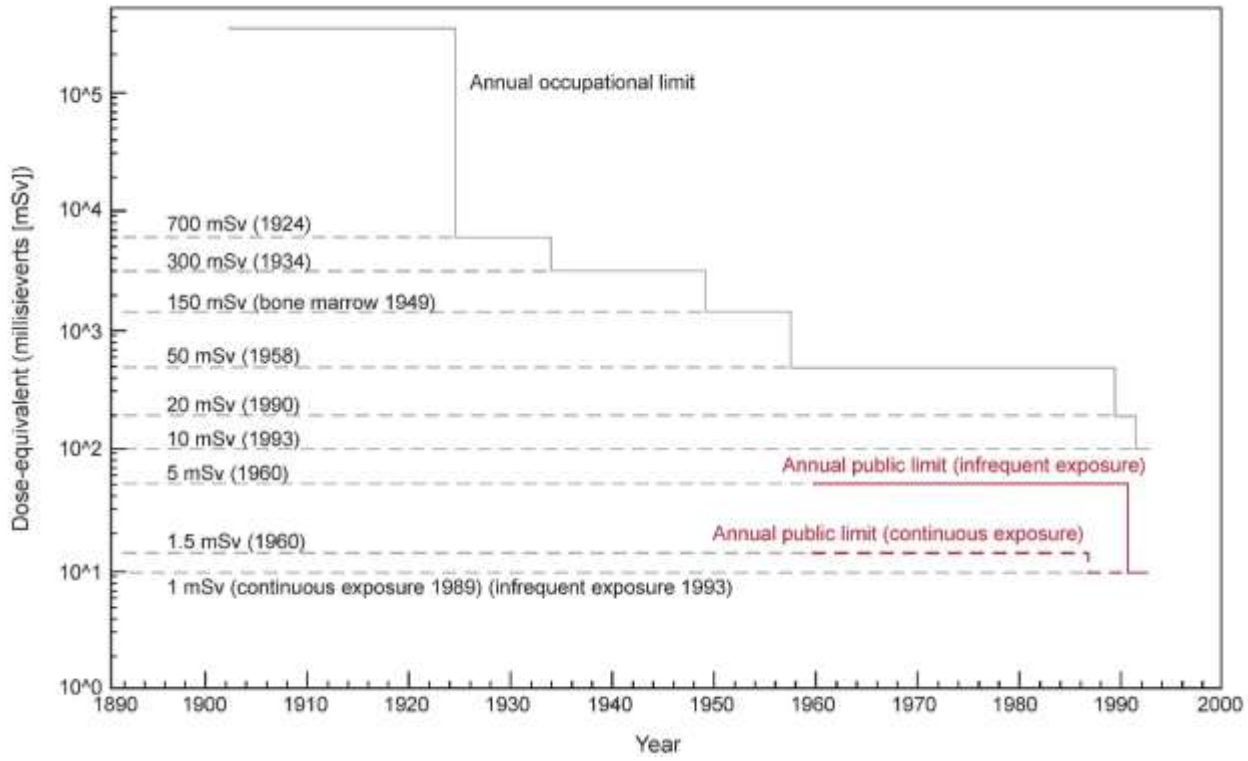

Figure 2. Recommended Dose Limits Over Time [8].

Formerly utilized facilities included storage sites and sampling plants, laboratories, machine shops, and chemical factories. For example, large plants like the Mallinckrodt Chemical Works in St. Louis, Missouri, refined uranium through several steps to produce natural uranium metal. Meanwhile, multiple machine shops in the midwestern United States machined uranium metal rods into slugs to fuel the plutonium-producing reactors at Hanford, Washington, and Oak Ridge, Tennessee.

Other factories, such as DuPont Chambers Works in Deepwater, New Jersey, refined uranium compounds to ultimately produce uranium hexafluoride. Uranium hexafluoride was the feedstock for the gaseous diffusion process that produced highly enriched uranium. The quantities and complexities of material processing at these sites varied, and so did the management of the cleanup of materials [5].

By the early 1970s, public concerns about the hazards posed by radium and radon from contaminated sites began to increase and the AEC responded. There had been earlier issues about residual contamination at formerly used sites, such as Lake Ontario Ordinance Works in New York and the Kellex Laboratory in Jersey City, New Jersey, but they had not caused further concern at the time. Eventually, a landfill in New Jersey planted the seeds for what would become FUSRAP.

In 1960, a civil defense exercise had detected elevated radiation levels in the municipal landfill in Middlesex, New Jersey. AEC determined that waste material from the nearby Middlesex Sampling Plant had been disposed in the landfill. AEC excavated 500 cubic meters (650 cubic yards) of near-surface contaminated material and covered the area with soil. An estimated 4600 cubic meters (6000 cubic yards) of contaminated material remained in the landfill. Recognizing that the remaining waste could create radon emissions similar to the mill tailings emissions in Grand Junction, Colorado, AEC placed institutional controls on the landfill [9]. However, AEC took notice when the Borough of Middlesex initiated plans to redevelop its municipal landfill in 1973.

INVESTIGATIONS OF FORMER MED/AEC SITES

Responding to the waste found in the Middlesex landfill, the last AEC chairperson, Dixy Lee Ray, directed the commission in 1973 to research formerly utilized sites that might be of concern if reexamined in the light of the newer, more rigorous, standards [2]. AEC directed its field offices to identify all past cleanup efforts resulting from the transfer or release of real property for unconditional or restricted use. Field offices determined the availability of records addressing the radiological conditions of properties at the time MED or AEC control ceased. They also identified, where available, any more recent data relating to the radiological conditions of the properties, as well as their present owners, current use, and exact locations.

On June 4, 1974, AEC assigned its Division of Operational Safety with the responsibility for planning, budgeting, and directing a program for conducting radiological surveys of FUSRAP sites [10]. These surveys were to target properties where available data were insufficient to establish that the environment and public health and safety were protected.

During the initial records review, FUSRAP personnel assessed the radiological conditions at more than 600 sites. The assessment of site conditions and eligibility for FUSRAP relied upon the availability of historical contract and operational records. Two factors impeded the search: Manhattan Project and early AEC work was classified, and government contracting records were regularly purged in accordance with records schedules, typically 7 years after contract expiration [11]. Many of the records documenting the extent of decontamination were incomplete. Additionally, many of the sites had changed ownership or use. In some cases, buildings were modified or demolished, and the MED and AEC utilized facilities were no longer present. For example, the site where the world's first self-sustaining nuclear reactor went critical in 1942, the University of Chicago's Stagg Field, had been demolished in the late 1950s.

AEC completed its initial review in December 1974, identifying 104 sites that had been previously used for radiological work and were no longer under AEC control. Adequate records were found for 54 sites to satisfactorily indicate that they had no residual radiological contamination of concern.

The remaining 50 sites were found to have insufficient records to make a determination. AEC developed a plan for surveying the 50 remaining sites. The Oak Ridge Operations Office administered the program, contracting with the Oak Ridge National Laboratory to conduct the surveys [12].

FUSRAP CLEANUPS UNDER DOE

In the "Department of Energy Act of 1978—Civilian Applications," Congress expressed the opinion that DOE should seek additional authority to conduct cleanups once the work of historical research and radiological surveys had been completed [13].

DOE recognized three issues that would need to be addressed:

(1) *Specific authority from Congress would be needed for cleanups of private sites.* At the time DOE was conducting cleanups using only the implied authority of the Atomic Energy Act, yet annual budgets were beginning to exceed $50 million. DOE considered that it had authority to perform cleanups of federally owned sites but not cleanups of privately owned sites.
(2) *Radiological cleanup criteria needed to be developed.* At the beginning of FUSRAP, there were AEC surface contamination guidelines but no soil cleanup guidelines.
(3) *Disposal sites needed to be identified that would accept FUSRAP wastes* [1].

In 1979, DOE divided FUSRAP into two parts. FUSRAP cleanups were assigned to the assistant secretary for nuclear energy, while the responsibility for identifying FUSRAP sites and certifying their cleanups was assigned to the assistant secretary for environment [14]. FUSRAP thus became an intra-agency shared program.

By 1980, 70 sites had undergone onsite investigations by Oak Ridge National Laboratory. Eighteen were identified for remedial action, and an additional 13 sites were anticipated to require cleanup [1]. Three years later, in 1983, Congress directed DOE to conduct four additional cleanups; the Hazelwood, Missouri; Colonie, New York; and Maywood and Wayne, New Jersey, Sites. By 1987, 29 sites had been designated for remedial action.

Until the early 1980s, when the first FUSRAP cleanup was completed at the former Kellex Laboratory site in Jersey City, New Jersey, the criteria used to release sites were developed on a case-by-case basis. DOE began to develop generic guidance for release of surface contaminated materials and soil. FUSRAP cleanup limits included US Nuclear Regulatory Commission (NRC) guidance for license termination, dose limits established by the International Commission on Radiological Protection, and the surgeon general's recommendations for structures affected by uranium mill tailings. In 1983, the US Environmental Protection Agency promulgated Title 40 *Code of Federal Regulations* Part 192, "Standards for Remedial Actions at Inactive Uranium Processing Sites" [15], and DOE published its *Radiological Guidelines for Application to DOE's Formerly Utilized Sites Remedial Action Program* [16]. The initial DOE guidelines were superseded two yours later in 1985 by the *U.S. Department of Energy Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites* (FUSRAP Guidelines). The FUSRAP Guidelines were revised in 1987 to reflect a revision of the public dose limit from 5 mSv/yr (500 mrem/yr) to 1 mSv/yr (100 mrem/yr) [17] (see Figure 2).

To better define cleanup criteria, DOE organized a working group that included representatives of the national laboratories, DOE operations offices, the US Environmental Protection Agency, and NRC. The working group advised against developing nationwide cleanup standards in favor of site-specific goals based on dose.

In 1988, DOE developed a manual to provide information for implementing residual radioactive material guidelines. As a companion to that manual, Argonne National Laboratory developed the RESRAD computer code, "RESRAD" being short for "residual radiation." The manual and RESRAD code were to be used to derive site-specific cleanup levels at FUSRAP sites and remote sites identified by the Surplus Facilities Management Program (SFMP) [18,19]. DOE had established the SFMP in 1978 to address residual contamination at DOE facilities that were no longer needed, similar to how FUSRAP addressed residual contamination at privately owned sites [20].

When DOE Order 5400.5, *Radiation Protection of the Public and the Environment* [21] in 1990, it contained the same cleanup limits that were established in the FUSRAP Guidelines [22].

FUSRAP BECOMES AN INTERAGENCY PROGRAM

In 1997, Congress transferred the responsibility for FUSRAP remedial actions to USACE. At the time, DOE transferred 21 active FUSRAP sites to USACE. The following year in 1998, Congress directed USACE to use the guidelines of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Contingency Plan to conduct cleanups [23]. USACE classified FUSRAP wastes as byproduct material, as defined in the Uranium Mill Tailings Radiation Control Act of 1978, which greatly simplified options and reduced costs for waste disposal [24]. To help clarify roles and responsibilities, USACE and DOE established the March 1999 Memorandum of Understanding (MOU) regarding program administration and execution [25]. The March 1999 MOU was followed by an exchange of two letters of agreement between USACE and DOE in 2001 and 2002, clarifying procedures for adding new sites to the program and for transferring completed sites into long-term stewardship [25].

In 2003, DOE established the Office of Legacy Management (LM) to provide long-term stewardship for DOE's remediated facilities, including the sites in FUSRAP [26]. USACE and LM have forged a close partnership in managing FUSRAP. The two organizations routinely communicate. They hold information exchanges on a quarterly basis, and, since 2015, they participate in annual joint meetings to improve programmatic strategies.

LM ACTIVITIES

There are currently 34 completed FUSRAP sites under long-term stewardship by LM and 21 active sites being remediated by USACE for a total of 55 sites. Figure 3 shows the completed sites along with the years they were designated for FUSRAP and the years they were transferred to DOE for long-term stewardship.

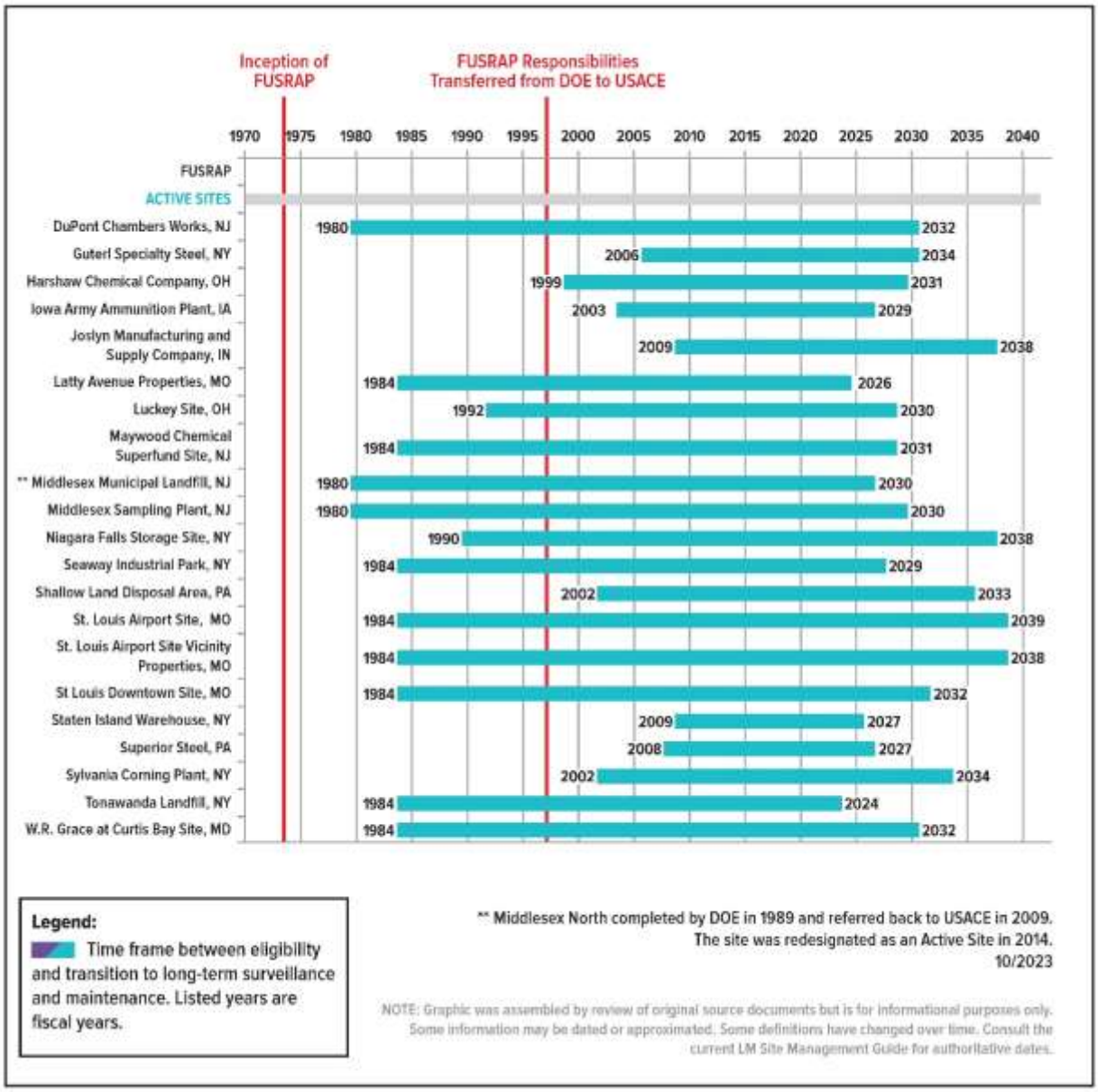

Figure *4* shows the active sites currently being remediated by USACE along with their years of designation for FUSRAP and estimated years they are set to be transferred to LM for long-term stewardship. Six of the sites were designated for the program by Congress. Four of the sites are owned by the US government, two of which were purchased by the government for the purpose of cleanup. Nine of the sites were added to the US Environmental Protections Agency's National Priorities List (the "Superfund List"), and two have been subsequently delisted. To date, 10 sites have been transferred back to DOE for long-term stewardship [4].

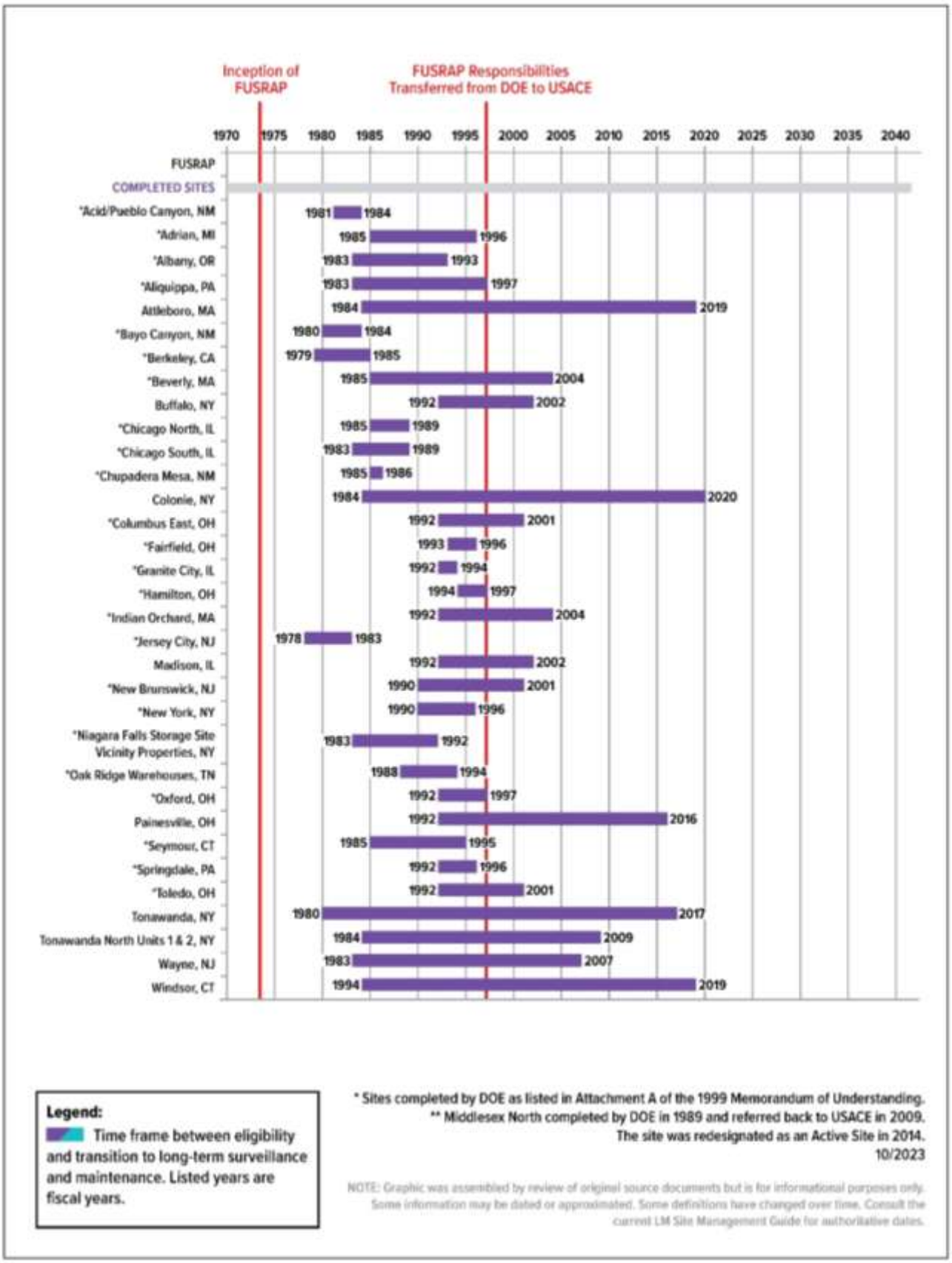

Figure 3. Timeline of the 34 Completed FUSRAP Sites.

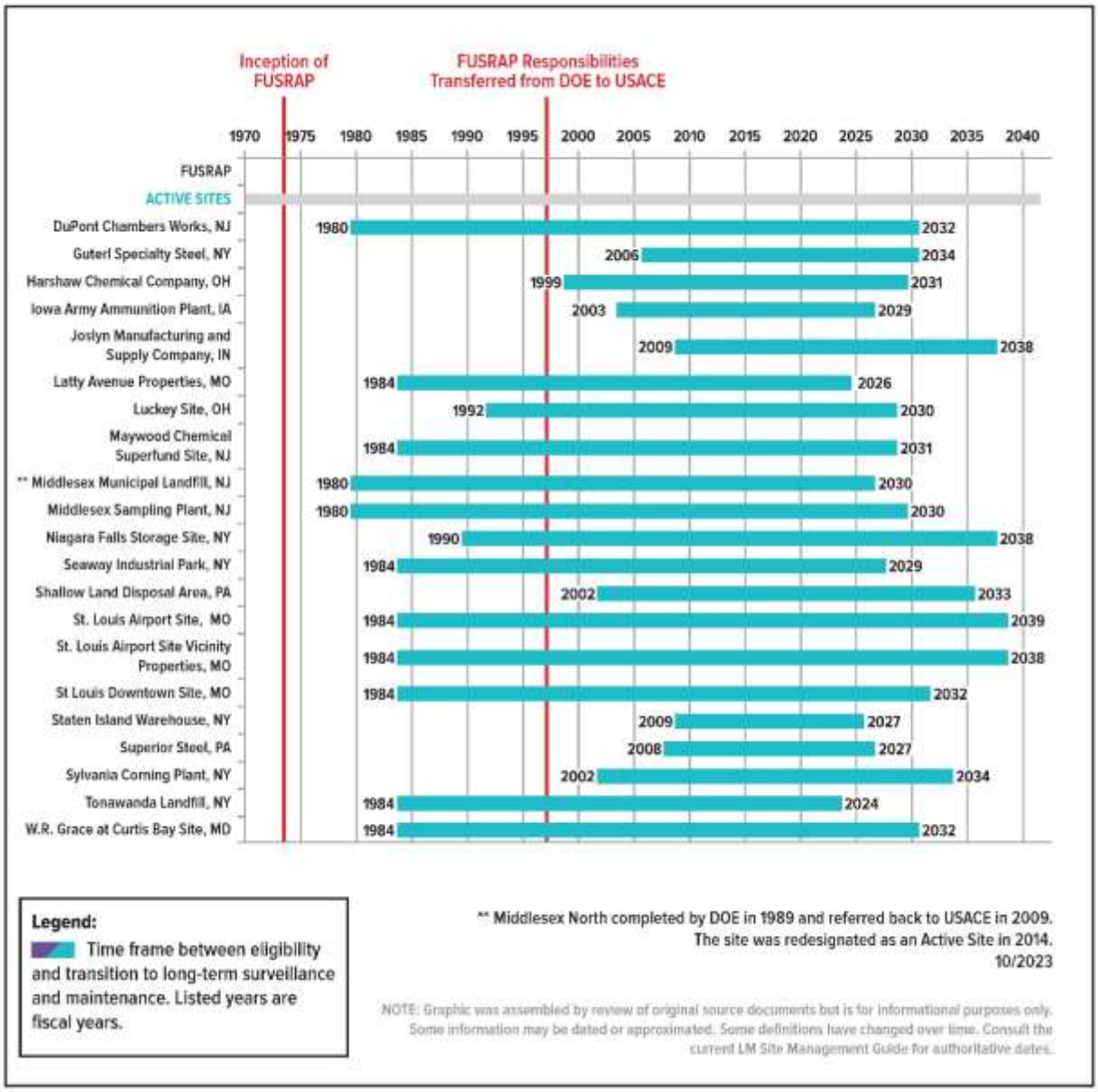

Figure 4. Timeline of the 21 Active FUSRAP Sites.

One of the goals of LM is to sustainably manage and optimize the use of land and assets [27]. Working toward this goal, LM properties that no longer serve the mission are made available for beneficial reuse. In 2006, LM transferred the Wayne, New Jersey, Site to Wayne Township for park and recreational use under the National Park Service's Lands to Parks program. The township has constructed a public playground and dog park on the site. In 2018, the Borough of Middlesex, New Jersey, proposed acquiring the former Middlesex Sampling Plant site for use as two local government facilities and a new road. The new road was competed in 2022 and has allowed the development of a warehouse that will provide increased tax revenue and jobs for the community. A recent Finding of Suitability for Early Transfer completed in 2023 will allow the borough to acquire the site for its municipal emergency response building. Also in 2023, LM engaged the US General Services Administration (GSA) to make the FUSRAP Colonie site available to the public. GSA sold the site at public auction to a developer.

Another significant LM initiative is the development of the Master Sites List. Begun in 2014, it involved a comprehensive review of sites potentially eligible for LM programs, including FUSRAP. The list contains information on sites that had been considered under FUSRAP as well as sites evaluated by DOE, or its predecessor agencies, for inclusion in other DOE cleanup programs. The Master Sites List allows LM to compare the names of sites among multiple source lists and identify duplicate or redundant names associated with individual sites. For a variety of reasons, site names have changed over time, and names commonly differ between source lists. LM updates the Master Sites List annually [11]. In 2014, the Master Sites List contained 677 sites. After the 2023 update, the Master Sites List had expanded to 989 sites. Most of the nearly 300 sites added after 2014 were never considered potentially eligible for FUSRAP and had not undergone FUSRAP eligibility determinations. However, they are included in the Master Sites List to assist in answering potential questions from stakeholders.

USACE ACTIVITIES

When executing FUSRAP, USACE follows the framework of CERCLA, as amended, and the National Contingency Plan. Sites may have multiple operable units in different phases of the CERCLA process. Six USACE districts across three USACE divisions are currently working on active FUSRAP projects: the Buffalo and Pittsburgh Districts from the Great Lakes and Ohio River Division; the St. Louis District from the Mississippi Valley Division; and the Baltimore, New York, and Philadelphia Districts from the North Atlantic Division. The USACE Environmental and Munitions Center of Expertise and the Kansas City District also provide technical assistance.

Since USACE began administering FUSRAP, their program funding has ranged from $99.9 million to $225 million a year. The USACE FUSRAP budget for fiscal year 2024 is $200 million.

THE FUTURE

Given the anticipated completion date of the Record of Decision for the former Joslyn Manufacturing and Supply Company site in Fort Wayne, Indiana, USACE may complete the final Record of Decision under FUSRAP as early as 2024 [28]. Unless new sites are added to the program, FUSRAP remedial investigations are essentially completed. DOE anticipates that all USACE remedial actions will be completed by 2040, by which time FUSRAP will have progressed from a cleanup program to a long-term stewardship program [4].

LM's stewardship responsibilities for FUSRAP sites are enduring. LM anticipates operating two remediation systems, one at Guterl Specialty Steel (the Lockport, New York, Site) and one at Sylvania Corning Plant (the Hicksville, New York, Site). Currently there is only one completed site with a groundwater monitoring program. In the future, groundwater monitoring programs may be implemented at up to 10 sites. Some FUSRAP sites require managing institutional controls and CERCLA-mandated Five-Year Reviews. Long-term stewardship activities will include identifying opportunities for beneficial reuse and disseminating site information to hundreds of community members, property owners, and other stakeholders.

USACE's FUSRAP environmental liability estimate for the remaining remediation projects was $2.6 billion in 2022. LM's FUSRAP environmental liability estimate is approximately $216 million over the next 75 years. Approximately half of the estimated future cost over the next 75 years would be for operation and maintenance of the planned Lockport and Hicksville remediation systems, as shown in Figure 5. These USACE and LM estimates are anticipated to change as remedy decisions are made for the remaining sites.

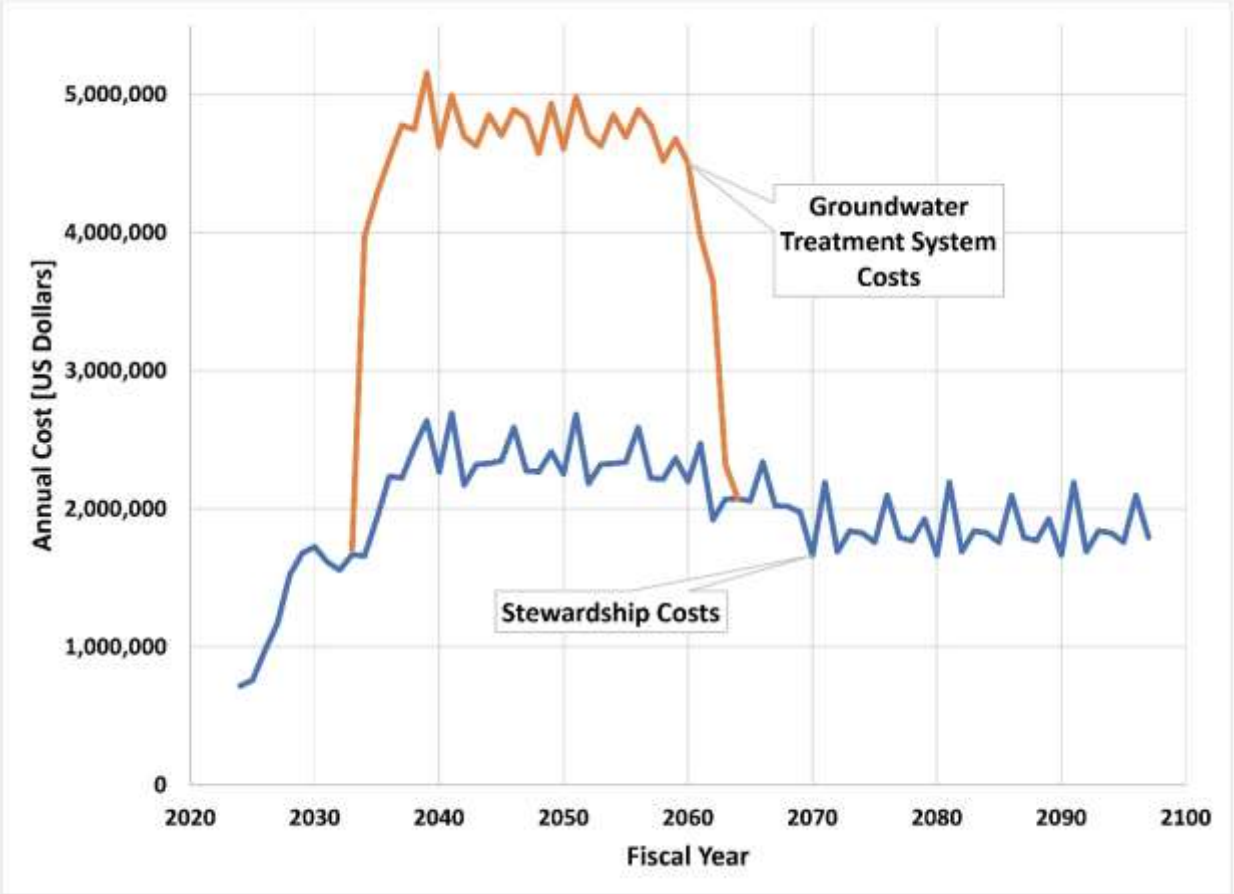

Figure 5: LM FUSRAP Environmental Liability Estimate Based on 2022 Data

Important site information, including administrative records and other key documents, is made available to the public on LM's webpages. Sampling data are recorded automatically into web-connected devices and stored in a single environmental database. An interactive web interface of site information for both the active sites and completed sites is maintained as an internal reference tool. LM continues to identify strategies to centralize and expand site information in support of its long-term stewardship mission.

CONCLUSIONS

Over the course of the last half century, FUSRAP has been a dynamic and evolving program. FUSRAP grew out of a 1974 AEC initiative to identify formerly utilized sites that might not have met contemporary cleanup standards. AEC and descendent agencies conducted exhaustive research, reviewing nearly 1000 sites for eligibility for FUSRAP cleanup. While there were cleanup standards for equipment and building surfaces at the time these sites were utilized, until the 1970s, there were no cleanup standards for soil. DOE formed a working group to address this issue. In 1988, as a member of that working group, Argonne National Laboratory developed the RESRAD code to perform site-specific dose assessments. DOE separated the cleanup responsibilities of FUSRAP into a separate division in 1979. In 1997, Congress transferred the responsibility for FUSRAP cleanups to USACE. USACE accelerated cleanups and developed new strategies for disposing of waste.

USACE may complete the final FUSRAP Record of Decision in 2024, and FUSRAP remedial actions may be completed by 2040, by which time FUSRAP will have transitioned from a cleanup program to a long-term stewardship program. LM is committed to continuous improvement in protecting human health and the environment at FUSRAP sites over the next half century and beyond.

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