9-9-2021

# From Design To Denial- An Environmental Histroy Of The United States Chemical Weapons Program

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# FROM DESIGN TO DENIAL: AN ENVIRONMENTAL HISTORY OF THE UNITED STATES' CHEMICAL WEAPONS PROGRAM

A Thesis

Presented to the

Graduate Faculty of the History Department

and the

Faculty of the Graduate College

University of Nebraska

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

University of Nebraska at Kearney

By

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May 2021

THESIS ACCEPTANCE

Acceptance for the faculty of the Graduate College, University of Nebraska, in partial fulfillment of the requirements for the degree of Master of Arts in History, University of Nebraska at Kearney.

Supervisory Committee

| Name | Department |
| --- | --- |
| | History |
| | History |
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Supervisory Committee Chair

6-14-21
Date

## Abstract

In 1993, the affluent Washington D.C. neighborhood of Spring Valley was unaware of what lurked beneath their carefully manicured lawns and million-dollar homes. Contractors hired by a resident to build an inground pool suddenly found themselves short of breath and half the crew had to be rushed to the hospital suffering respiratory distress, internal blistering of the lungs, and vision problems. The symptoms they exhibited matched all the characteristics of the World War I era blister agent lewisite. This thesis is an environmental study of chemical weapons that aims to contribute to the overall history of these weapons and their disposal by looking beyond diplomacy and development and focusing on how production and disposal of chemical weapons have affected ecosystems, impacting both human and non-human actors in significant ways.

Spring Valley is just one of the more prominent examples of negligent chemical weapons disposal by the military. Numerous other incidents have occurred across the United States since 1993 including a host of chemical agents produced both during and after the Great War including sulfur mustard, chloropicrin, phosgene, and VX gas. By looking at the deep and expansive footprint left by the American chemical weapons program, this study will show how disposal methods used during the twentieth century and continuing through the twenty-first century contributed to the disruption of delicate ecosystems and the continued marginalization of classes of citizens who have been

denied agency in decisions regarding the locations and methods used for destruction of America's aging chemical weapons arsenal.

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“Down at the arsenal they keep the nerve gasses, Guarded day and night by caged white rabbits, Been sitting there for years, I'm gonna have at it, I cut through the fence, run right in and grab it,”

—Dead Kennedys, “Chemical Warfare” (1979)

## Introduction

The story of the United States chemical weapons program is one that has drawn the interest of scholars due to the numerous twists and turns that have marked the program from its inception in 1917 all the way through its official end in 1967. Historians are particularly drawn to this topic and have employed several different disciplinary lenses to elucidate the contours of this controversial topic that has maintained its relevancy especially considering recent terrorist attacks, numerous extensions of the stockpile destruction timeline mandated by the 1997 Chemical Weapons Convention, and suspicions that non-signatory states are amassing their own stockpiles for continuing conflicts in the Middle East and elsewhere.

Generally, the scholarship takes on several forms— histories that explore the key innovators and events that led to the development of an American program, military histories that look at chemical warfare strategies and tactics, diplomatic histories that explore how the program led to legislative framework designed to limit its use in combat, and environmental histories that have added a new layer to an already complicated story by looking at how development, deployment, and destruction of stockpiles have affected ecosystems and impacted human and non-human actors in specific ways. Of these ways in which researchers have approached this topic, environmental histories tend to be the most revealing, yet remain within the minority of the scholarship written on chemical weapons, especially regarding the American Chemical Weapons Program.

To understand the American Chemical Weapons Program and its implications it is important to look at the overall history of chemical warfare at its very root. L.F Haber does

this using a unique perspective in *The Poisonous Cloud*, as a direct descendent of the man responsible for the first use of chemicals in modern combat. Haber, the son of Fritz Haber who is widely considered the "father of chemical warfare," combined archival research and statistical data to what he knew of his father's work in Germany and explores the numerous social, economic, and legislative issues that chemical warfare raised not just in Germany, but in the other countries who employed chemical weapons technology during World War I. Haber's study remains the standard in scholarship surrounding chemical warfare though it is limited to World War I, and despite its coverage of the American chemical weapons program, it is decidedly Eurocentric in nature. [1]

Amos A. Fries, a former chief of the American Chemical Warfare service offers a more nuanced exploration of the American Chemical Weapons Program from the inside that details how the "retaliation in kind" mindset drove American military interest in further development of the program and how it connected to America's burgeoning military-industrial complex. A subsequent article by Fries published in *Current History* was also somewhat revealing of the hubris slowly being adopted by the military regarding its chemical weapons program. However, Fries work must be taken with a grain of salt as he was a known proponent of maintaining the Chemical Warfare Service (CWS) in the face of heavy public criticism of the program by both veterans of the first World War who saw gas as a dishonorable way to achieve victory, and civilians who were just beginning to come to terms with the physical and emotional scars witnessed in soldiers who had been exposed to gas

[1] L.F. Haber, *The Poisonous Cloud: Chemical warfare in the First World War* (Oxford, Oxford University Press, 1986).

during the war.[2] Leo P. Brophy, Wyndham D. Miles and Rexmond C. Cochrane's *The Chemical Warfare Service: From Lab To Field* points out that Fries was so adamant in protecting the CWS from decommissioning that he had convinced those under his command that any calls for chemical disarmament were part of a wider Communist plot against the United States. The authors also show that the criticism Fries faced was both warranted and accurate through their exploration of declassified documents and interdepartmental memos. [3]

Fries' work is not the only history of chemical warfare colored by political or conspiratorial concerns. Robert Harris and Jeremy Paxman, two journalists working for the BBC compiled their own history of chemical warfare, *A Higher Form of Killing: The Secret Story of Chemical and Biological Warfare* claiming both the United States and the Soviet Union were developing chemical and biological weapons in secret undocumented laboratories. While the historical record does validate continued research and development after the United States government's renouncement of chemical warfare in 1967, it is difficult to take this research at face value considering that Harris and Paxman present it with the same sensationalism common to journalistic accounts penned during the Cold War that tend to marginalize the fact that the supposed "secret" laboratories in the United States were limiting their research to defensive capabilities and not mass manufacturing these weapons on the same scale witnessed between 1917 and 1938.[4]

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[2] Amos A. Fries, "The Future of Poison Gas," *Current History 15* (Dec. 1921): 419-422; Amos A Fries and C.J. West, *Chemical Weapons* (New York: McGraw-Hill, 1921).
[3] Leo P. Brophy, Wyndham D. Miles and Rexmond C. Cochrane, *The Chemical Warfare Service: From Lab To Field* (Washington: Center of Military History, 1988).
[4] Robert Harris and Jeremy Paxman, *A Higher Form of Killing: The Secret Story of Chemical and Biological Warfare* (New York: Hill and Wang, 1982).

Recent histories of chemical warfare have proved to be more objective in their treatment of the topic, and less influenced by the reigning geo-political undercurrents of the era. In "Preparing For What Never Came: Chemical and Biological Warfare in World War II," Stephen L. McFarland explored chemical warfare strictly from the defensive perspective and suggested that the significant increase in production of both chemical agents and protective measures such as gas masks, protective suits, and Chemical Agent Identification Sets (CAIS) stemmed from fears that Germany planned on continuing and expanding their chemical weapons program beyond the levels seen during the First World War. Once again, the "retaliation in kind" paradigm played into these fears which caused the United States to grossly overproduce these weapons. By the time military leaders in Washington realized that the Nazis had focused most of their resources on conventional weapons and V-series rocket development and only placed minimal resources towards developing a functional chemical weapons arsenal; thousands of tons of phosgene, sulfur mustard, and VX nerve gas had been produced by American facilities and shipped to strategic locations along the Western Front where they remained undisturbed for years after the end of the second world war.[5]

However, Jonathan B. Tucker's *War of Nerves* points out that Germany did maintain a sizable stockpile of chemical weapons and added new ones, the nerve agents sarin and VX, to their arsenal. Tucker also notes the paradox between extensive Nazi use of zyklon-B to murder thousands of Jews, but their overall hesitance in employing chemicals against belligerents on the battlefield. Interestingly, Tucker also points to the similarities between Germany and the United States in the decision-making process to use chemical weapons

[5] Stephen L. McFarland, "Preparing for What Never Came: Chemical and Biological Warfare in World War II," *Defense Analysis 2,* No. 2 (1986): 107-121.

during the war. Despite having vast stockpiles to use and distinct military divisions trained in their use, neither country was willing to resort to chemical warfare unless the other side employed it first.[6]

Historians are not the only researchers who have contributed to the overall historiography of chemical weapons. In *Dew of Death: The story of Lewisite, America's World War I Weapon of Mass Destruction*, Joel A. Vilensky looked at the development and production of one of America's most notorious chemical weapons, lewisite, using the perspective of a pathologist to trace its history from its initial synthesis at American University, to mass production, and its eventual unsanctioned disposal in large pits underneath what is now the affluent Spring Valley suburb on the outskirts of Washington D.C. Vilensky also applied his extensive knowledge of pathology and cell anatomy to offer compelling yet frightening examples of how this buried non-stockpile material will continue to affect residents in and around the Spring Valley neighborhood for decades to come, despite the remediation efforts of the Environmental Protection Agency and the U.S. Army's Corps of Engineers.[7]

The discovery of what was hiding beneath Spring Valley brought the military's problem into the public sphere as arsenic, a primary byproduct of lewisite decomposition, was discovered in soil and water samples taken from the affected areas. This also brought legislative issues into clear focus as residents sought answers as to why they were never informed about the disposal sites and connected them to the issues surrounding government

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[6] Jonathan B. Tucker, *War of Nerves: Chemical Warfare from World War I to Al-Qaeda* (New York: Anchor Books, 2006).
[7] Joel A. Vilensky, *Dew of Death: The story of Lewisite, America's World War I Weapon of Mass Destruction* (Bloomington: University of Indiana Press, 2005).

oversight and its role in chemical weapons disposal. James W. Moeller explored this facet of chemical weapons in "Arsenic and an Old Base," looking at the legal ramifications for those living in the Spring Valley area and what remedies were offered to residents now forced to face the realities that the toxic legacy of the American Chemical Weapons program is now connected to their own lives. Moeller also discussed the bureaucratic obstacles that agencies had to overcome and compared them to similar legal hurdles residents faced when attempting litigation against the government for health issues related to disposal.[8]

Legal remedies for private citizens were not the only issues raised with the discovery of a chemical weapons burial pit in the heart of the nation. Fears of other similar sites being discovered elsewhere drove legislators to enact a series of laws and protocols designed to limit damages. Jonathan B. Tucker also looked at many of these legislative decisions regarding Spring Valley and other suspected burial sites, but he offered a more candid view of the legal wrangling occurring behind closed doors because of his time spent as an advisor to the Congressional Office of Technology Assessment in "Chemical Weapons: Buried in the Backyard."[9]

Coincidentally, right around the same time that issues in Spring Valley and other Formerly Used Defense Sites (FUDS) began cropping up, the United States along with other countries who had standing chemical weapons stockpiles started to hammer out a treaty that served to prevent the use of chemical weapons in warfare and prevent stockpiles and

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[8] James W. Moeller, "Arsenic and an Old Base: Legal Issues Associated with the Environmental Restoration of Defense Sites in Washington, D.C., Used for the Development and Disposal of World War I Chemical Munitions," *Catholic University Law Review54* (2005):879-959.
[9] Jonathan B. Tucker, "Chemical Weapons: Buried in the Backyard," *Bulletin of the Atomic Scientists 57* (2001): 51-56.

chemical precursors from falling into the hands of terrorists. Under the aegis of the Organization for the Prevention of Chemical Warfare (OPCW), the Chemical Weapons Convention (CWC) entered into force in 1997. The treaty provides for a semi-malleable timeline for complete destruction of stockpiled material, but the OPCW struggled with suggesting disposal methods that were deemed safe and non-harmful to the environment. David Koplow's *By Fire and Ice: Dismantling Chemical Weapons While Preserving The Environment* tackled this conundrum by detailing the methods proposed by the OPCW as well as alternative technologies designed to eliminate these massive stockpiles in a safe and efficient manner. However, Koplow's scholarship was published in the same year that the CWC was entered into force and therefore, unable to account for the long-term environmental effects that occurred at destruction facilities in the intervening years. [10]

As many of these effects are now beginning to manifest themselves touching both ecosystems and people living adjacent to these facilities, this thesis hopes to elucidate the dangers to human and non-human actors. Additionally, a growing body of evidence shows that disposal and destruction are not the only components of the American Chemical Weapons Program that have become problematic. Production, testing, and stockpiling also brought with them a host of environmental issues that J.P. Robinson explores in his eponymous *The Effects of Weapons on Ecosystems.* While somewhat dated, this account does show that researchers were aware of ecological issues stemming from production and testing facilities decades before problems in places such as Spring Valley made headlines.[11]

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[10] David A. Koplow, *By Fire and Ice: Dismantling Chemical Weapons While Preserving the Environment* (Amsterdam: Gordon and Breach Publishers, 1997).
[11] J.P. Robinson, *The Effects of Weapons on Ecosystems* (Oxford: Pergamon, 1979).

Other scholars took note the ecological implications as well, not just regarding the damage done to the environment, but also at the Pentagon's efforts to prevent these issues from becoming public. While presented as a more generalized study looking at the full scale of weapons production both conventional and non-conventional by the American military, Seth Shulman's *The Threat At Home: Confronting The Toxic Legacy of the U.S. Military* offers a striking analysis of the American Chemical Weapons Program though his exploration of every base where testing and stockpiling occurred prior to the CWC and centralization of stockpiles at designated destruction facilities. Susan D. Graham-Lanier's *The Ecology of War: Environmental Impacts of Weapons and Warfare* expands upon the research of Shulman by directly addressing the damage done to the environment itself by military operations and weapons development but does so on a much broader time scale, extending the legacy of ecological damage by the American military back to the American Civil War. While providing valuable information on the most noticeable environmental effects of chemical weapons proliferation, the shortcomings of both Shulman and Graham-Laniers scholarship lies in the fact both authors use such broad periodization that prevent either study from having a nuanced discussion about environmental damage because of chemical weapons proliferation. [12]

Interestingly, one of the few studies that provides a full accounting of environmental damage from chemical warfare material ignores production, storage, and disposal sites and focuses on maritime ecosystems in connection with multiple iterations of America's first attempts to weapons disposal, Operation CHASE. In "Sea-dumped chemical weapons:

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[12] Seth Shulman, *The Threat at Home: Confronting the Toxic Legacy of the U.S. Military* (Boston: Beacon Press, 1992); Susan D. Lanier-Graham, *The Ecology of War: Environmental Impacts of Weapons and Warfare* (New York: Walker, 1993).

environmental risk, occupational hazard," M.J. Greenberg, K.J. Sexton, and D. Vearrier employ several toxicology studies conducted in the Atlantic Ocean and the North Sea to detail how the dumping of thousands of tons of chemical weapons have made a significant impact on aquatic fish populations and how these issues are affecting commercial and recreational fishers both physically and financially.[13]

Indeed, much work has been done on the topic of chemical warfare by researchers, but largely absent from this work is a much-needed environmental history lens that expands beyond the work of political and military historians, by considering the scholarship of toxicologists, biologists, and environmentalists to provide a robust contribution to the field that bridges these gaps, and connects the research done in these distinct fields in important and meaningful ways. This study looks to add a new dimension to this body of research by exploring the agency of citizens who suddenly and without warning were forced to deal with issues from both the chemicals themselves, and the lasting effects they left upon ecosystems. This study offers more of a comprehensive reckoning of the size and scope of the ecological footprint left behind by the American chemical weapons program by compiling archival and secondary research into a singular accessible source in the hopes that it will open further inquiries and pathways for researchers to continue further exploration of this frightening yet fascinating topic.

[13] M.J. Greenberg, K.J. Sexton, and D. Vearrier, "Sea-dumped chemical weapons: environmental risk, occupational hazard," *Clinical Toxicology 54,* no. 2 (2016): 79-91.

## A note on chemical weapons facilities

Chemical weapons proliferation between 1917 and 1997 is not limited to the sites covered within this study, and there are other facilities that are part of the United States chemical weapons program, but often their roles are minimal. The sites covered within this study were chosen due to their prominence, the availability of documents related to the chemical weapons program, and the fact that most of the sites continue to deal with environmental issues and draw the attention of researchers. The sites covered within this study, American University Experimental Station (Washington, D.C.), Blue Grass Army Depot (Richmond, KY), Pueblo Army Depot (Pueblo, CO), Umatilla Army Depot (Hermiston, OR), Pine Bluff Arsenal (White Hall, AR), Edgewood Arsenal (Aberdeen, MD), Anniston Army Depot (Anniston, AL), Newport Army Depot (Newport, IN), Redstone Arsenal (Huntsville, AL), Johnston Atoll (Johnston Island) and Tooele Army Depot (Tooele, UT) comprised the backbone of the United States chemical weapons program and therefore are essential to any history covering America's involvement in chemical weapons proliferation. At Blue Grass Army Depot and Pueblo Army depot, chemical disposal is still ongoing making these two sites a significant part of the emerging history of America's role in global chemical weapons elimination.

## Chapter I- Designed for Disposal: The Beginning of the United States Chemical Weapons Program

Chemical warfare remains an enigma that continues to draw the interest of academic research, even though no major belligerent has used it in combat for decades. The topic itself continues to garner the attention of numerous scholars, examining the phenomenon through the disciplinary lenses of scientific, military, cultural, and diplomatic histories. Environmental historians are just now beginning to explore the nuances of these varied histories to unlock how chemical warfare and ecosystems connect in significant and meaningful ways. Even with the ratification of the Chemical Weapons Convention in 1997 that signaled the end of the chemical warfare era, these outdated weapons remain problematic as the ecological effects of chemical weapons development and proliferation are beginning to fully manifest themselves. However, to fully understand these manifestations the underlying history that led to such massive proliferation by the United States also deserves exploration.

This chapter will offer a brief history of how chemical warfare came to the battlefields of World War I, as well as how the United States became the world's leading producer of chemical weapons, despite the fact they were widely considered to be strategically ineffective. This chapter will also explore how the United States began attempting to dispose of these nearly useless stockpiles by looking at disposal activities at

the American University Experimental Station (AUES) beginning in 1918 that set the precedent for how the United States dealt with these weapons after the war.

**The Chemists War (1914-1918)**

It is widely accepted that the chemical warfare era began during the First World War with the German release of chlorine at Ypres in 1915. While scholars such as Adrienne Mayor, who detailed accounts of early attempts by Greeks and Romans to weaponize nature, or historian Guy Hasegawa who explored similar attempts during the American Civil War to employ chemical compounds in combat, never before had a country's industrial might lent itself to the war effort in such a manner.[1] In the late nineteenth and early twentieth centuries, chemistry served in a fundamental role to generate the highest of the scientific arts as new manufacturing processes and distillation techniques allowed chemists to create a wide array of chemicals in previously unheard-of amounts for application in a wide variety of industries.

For many years prior to World War I, Germany led the world in chemistry due to the significant strides scientists made in chemical research during the first decades of the twentieth century. Rival chemists in Great Britain and the United States struggled to keep up with German chemical innovations and even sent many students to Germany to study at leading universities in Giessen, Göttingen, and Heidelberg. Students such as Lewis M.

[1] For more on chemical and biological weapons use during antiquity see *Adrienne Mayor, Greek Fire, Poison Arrows & Scorpion Bombs: Biological and Chemical Warfare in the Ancient World* (New York: Abrams, 2003), for chemical weapons use during the American Civil War see Guy R. Hasegawa *Villainous Compounds: Chemical Weapons & The American Civil War* (Carbondale: Southern Illinois University Press, 2015).

Norton, Frank H. Thorpe and Warren K. Lewis returned to the United States, forming their own chemistry departments at MIT and Tulane University, applying the knowledge they learned from the German's various industrial processes in the textile and synthetics industries. By the 1890s, chemicals were now being applied with great results by both German and American scientists as manufacturing, agriculture, mining, and textile industries all benefited from these new chemical advances.[2] The sudden marriage of chemicals and industry prompted concerns from several nations that chemicals could be weaponized and used on the battlefield thus providing the impetus for the 1899 Hague treaty, as toxic chemicals which previously had to be painstakingly harvested from natural sources now could be easily produced through industrial processes in vastly greater amounts than previously possible.[3]

The Hague 1899 treaty attempted to put legislation in place governing the laws of war and treatment of prisoners of war. However, Hague dealt specifically with the rising threat of chemical warfare in its second declaration by prohibiting, "poison or poisoned weapons…arms, projectiles or material calculated to cause unnecessary suffering…and projectiles [designed for the] diffusion of asphyxiating or deleterious gases."[4] The treaty was ratified in 1900 by eighteen countries including France, Russia, the United States, Great Britain, and Germany among others. However, there is no way that the framers of

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[2] Nicholas A. Peppas, "The First Century of Chemical Engineering," *Chemical Heritage* 26, no. 3 (Fall 2008): 26.
[3] Kim Coleman, *A History of Chemical Warfare* (London: Palgrave Macmillan, 2005), 9.
[4] International Peace Conference. 1915. *The Hague conventions of 1899 (II) and 1907 (IV) respecting the laws and customs of war on land*.

the Hague treaty could have foreseen the events that would lead up to the beginning of the Great War.

However, in an action that was a portent for future chemical weapons treaties, every signatory of the 1899 treaty who was involved in World War I violated the treaty and continued to use chemical weapons on the battlefield. Initially German leaders, swayed by noted German chemist Fritz Haber's arguments that the release of chlorine from canisters did not constitute a violation of Hague, discovered a loophole that freed them from the restrictions of Hague. Other nations such as France, England, and the United States followed suit and proceeded with developing their own chemical arsenals in earnest pointing towards Germany's use of chlorine at Ypres as justification for their own use of chemical weapons.[5]

The clever interpretation of The Hague treaty, first by Germany and later by England, France, and the United States, served to create dangerous precedent that continued beyond World War I. This is most evident in the United States, as chemical weapons development continued unabated despite the protocols laid out in the Hague treaty. Of all countries who were initially involved in chemical weapons research, only the U.S. increased its investment in development and proliferation of chemical weapons during the first World War, continuing well into the 1980s. Essentially, the first treaty designed to eliminate these weapons from the battlefield had the exact opposite effect.

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[5] L.F. Haber, *The Poisonous Cloud: Chemical Warfare in the First World War* (Oxford: Oxford University Press, 1986), 291.

The Hague treaty proved to be ineffective, and its failure dictated how other developed nations dealt with future policies designed to end the chemical warfare era.[6]

Certainly, there are many compelling reasons against the use of chemical warfare. During World War I and after, many Germans proclaimed to be against the use of chemical weapons to begin with, feeling that it is a dishonorable way to conduct combat. As previously mentioned, Fritz Haber did manage to convince Kaiser Wilhelm into employing chemicals at Ypres in 1915, but key commanders claimed chemical weapons did not produce a definitive tactical advantage. The few who did believe that chemical weapons created an advantage on the battlefield still found their use their use incongruent with the long-held views of the honorable German soldier. Erich Ludendorff and Paul von Hindenburg shared the view of troops under their command who often observed with anger and resentment that the gassers did their job and then left, leaving the infantry to take the damage from those who did survive the initial attack.[7] This sentiment was not held by the Germans alone. Similar criticisms mounted against French and British military leaders that made both countries hesitant to employ chemical weapons on a major scale.

Moral complications surrounding chemical weapons which should have been considered failed to carry similar weight. Even as medics and aid stations scattered along World War I battlefield fronts recorded casualties from chemical attacks, a consensus

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[6] Jonathan B. Tucker, *War Of Nerves: Chemical Warfare From World War I To Al-Qaeda* (New York: Anchor Books, 2006), 17.
[7] L.F. Haber, *The Poisonous Cloud: Chemical Warfare in the First World War*, 276.

emerged among the belligerents that war is unsavory and barbaric, and the casualties caused by chemical weapons represented only a small aspect of that paradigm. In fact, many believed that because chemical weapons are designed to harass and incapacitate, they are more humane than conventional weapons. The morality of chemical weapons use is an issue that would not be dealt with until after the conclusion of the Great War in 1918.

The paradox of proliferation is partially due to strategic failure of the weapons. On the battlefield, chemical weapons killed inconsistently depending upon weather conditions and environments. Dozens of first-hand accounts document shifting winds that blew the gas back to the line of soldiers who launched the attack. Chemical weapons are also subject to moisture, and humid or rainy conditions could quickly render them ineffective. For example, when lewisite, an arsenic based blister agent invented by American researchers, comes into contact with water vapor it immediately breaks down into its constituent components and becomes inert.[8] Other chemicals deemed "battlefield-ready" often suffered similar defects through environmental factors such as heat or light. Even under ideal conditions: a nighttime release with no wind, temperatures between twenty-five and thirty degrees Celsius, and low humidity; most early twentieth century chemical agents lacked persistence and rarely contaminated an area beyond one hour. [9]

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[8] Joel A.Vilensky, *Dew of Death: America's World War I Weapon of Mass Destruction* Bloomington: Indiana University Press 2005), 74.

[9] L.F. Haber did copious testing on several toxic chemical agents in addition to having access to his father's notes from the Kaiser Wilhelm Institute. He discovered that sulfur mustard was an exception to the rule of persistency, which was able to last 48 hours. L.F. Haber, *The Poisonous Cloud: Chemical Warfare in the First World War*, 115.

Considering that conditions on the battlefield such as those witnessed in France and Belgium during World War I, which rarely provided opportunities for an ideal release, failures occurred more often than successes.[10]

Even when conditions were optimal for chemical attacks—dry conditions, low humidity, mild temperatures, and the prevailing wind blowing towards enemy trenches; chemical weapons failed to perform as their designers had intended and successful releases remained elusive. Each time an advance was made with chemical weapons or their deployment, it was quickly overshadowed by a research breakthrough with protective measures such as the gas mask or chemically impregnated protective clothing designed to resist most of the current chemical agents in use.[11] By the time both the Axis and Allied powers began widespread use of chemical weapons, the state of chemical defense had outpaced the effectiveness of most chemical agents. The chemical training soldiers underwent during basic training served them well and aside from isolated instances where discipline failed and soldiers were unable to don protective gear in time, most chemical attacks were nothing but minor annoyances to their victims who were forced to stop firing at the enemy just long enough to employ their gas masks before continuing the battle. In the case of skin irritants such as mustard, soldiers were only concerned with exposed parts of the body which was easily mitigated by thicker clothing and copious decontamination procedures after the battle. These downfalls of chemical

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[10] "Voices of the First World War: Gas Attack At Ypres," Imperial War Museums, accessed May 17,2021, https://www.iwm.org.uk/history/voices-of-the-first-world-war-gas-attack-at-ypres.

[11] For a detailed account of the development of the gas mask and other chemical warfare countermeasures within the context of chemical weapons development see Dietrich Stoltenberg, *Fritz Haber: Chemist, Nobel Laureate, German, Jew: A Biography* (Philadelphia: Chemical Heritage Foundation, 2004).

warfare became exacerbated by logistical issues as well. Having a large arsenal of chemical weapons to use is meaningless without a way to deploy them to the front quickly. German general Erich von Falkenhayn attempted to fix this problem, issuing an order in 1916 for the construction of numerous supply depots adjacent to the German front. However, this also proved to be useless as the supply depots became easy pickings for Allied troops due to their size and visibility. [12]

The logistics issue was also a problem for the Americans as most of its chemical weapons stockpile lay stateside or at depots in England. Instead, American chemical units relied on inadequate French stockpiles of chemical weapons. The Americans quickly learned the lessons the French had learned years earlier: their weapons simply did not have the proper concentration to do anything more than a harass, disorient, and demoralize the enemy. What should have been a potent weapon ended up having little effect on troops already fatigued from several years of the trench warfare stalemate.

The noted failures of chemical warfare did not prevent governments from trying to develop these weapons during the interbellum period. No other country invested as much manpower and resources into this development as did the United States. The Bureau of Mines, which was responsible for U.S. chemical weapon development and deployment during World War I, eventually became the Chemical Warfare Service (CWS), a fully independent unit that operated under the aegis of the U.S. Army.[13]

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[12] L.F. Haber, *The Poisonous Cloud*, 141.
[13] Leo P. Brophy, Wyndham D. Miles, and Rexmond C. Cochrane, *The Chemical Warfare Service: From Lab To Field* (Washington, D.C.: Center of Military History, 1988), 9.

Research and production facilities were set up at Camp Leach, on the campus of American University in Washington D.C. This nexus of chemical warfare development was responsible for a wide array of activities which included, but were not limited to, chemical research and manufacture, submarine gas research, and dirigible deployment.[14]

The Treaty of Versailles, which effectively ended the Great War, ushered in an era where world leaders attempted to regulate rules of combat through legislation, especially chemical weapons. Certainly, the Hague 1899 conference should be included in this regulatory effort, even though it was largely ignored by most powers when it came to the chemical warfare issue. However, *Article 171* of the Treaty of Versailles renewed and expanded the protocols on chemical weapons defined in the 1899 treaty. The new 1919 treaty attempted to remove the loopholes that Germany, Russia, Britain, France, and the US exploited during World War I, although the 1919 treaty and many of its articles specifically targeted Germany. For example, portions of *Article 171* explicitly blamed Germany: "The use of asphyxiating, poisonous or other gases and analogous liquids, materials or devices being prohibited, their manufacture and importation are strictly forbidden in Germany."[15]

However, even this carefully worded article in the Treaty of Versailles treaty did not end the production or development of chemical weapons. Many governments had already committed vast resources to the production of chemical weapons not just in

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[14] [14] Leo P. Brophy, Wyndham D. Miles, and Rexmond C. Cochrane, *The Chemical Warfare Service: From Lab To Field*, 6.
[15] Philander C. Knox, *Treaty of Versailles*. (Washington, D.C.: Government Printing Office, 1919).

Germany, but Britain, France, and the United States as well. Unsubstantiated claims of chemical weapons use by the Russians during the Bolshevik Revolution proved that the stipulations in Versailles were to be interpreted in a manner like the Hague Treaty of 1899.[16] These events prompted the U.S. to propose a new treaty in 1922 to address the continued use of chemical weapons by global powers.

The *Treaty on the Use of Submarines and Noxious Gases in Warfare,* ratified in 1922, provided stricter definitions on chemical warfare to augment chemical warfare restrictions already included in the Versailles treaty. For example Article V states:

> "The use in war of asphyxiating, poisonous or other gases, and all analogous liquids, materials or devices, having been justly condemned by the general opinion of the civilized world and a prohibition of such having been declared in treaties to which a majority of the civilized Powers are parties, The Signatory Powers, to the end that this prohibition shall be universally accepted as a part of international law binding alike the conscience and practice of nations, declare their assent to such prohibition, agree to be bound thereby between themselves and invite all other civilized nations to adhere thereto."[17]

Unfortunately, many in the British Empire including England, Canada, and Australia who played active roles in World War I remained uneasy regarding the prospects of chemical warfare use. The 1922 treaty was never ratified by the League of Nations as France disagreed with the search and seizure provisions regarding submarine warfare.

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[16] For more on chemical weapons use during the Bolshevik Revolution see Stéphane Courtois ed., *The Black Book of Communism: Crimes, Terror, Repression* (Cambridge: Harvard University Press,1999).
[17] "Treaty relating to the Use of Submarines and Noxious Gases in Warfare. Washington, 6 February 1922," Treaties, State Parties and Commentaries, International Committee of the Red Cross. 2012, Accessed Mar. 11, 2020). https://ihl-databases.icrc.org/applic/ihl/ihl.nsf/Treaty.xsp?documentId=7F0E4920E26AB9C2C12563CD002D6907&action=openDocument

The French aversion to the treaty perhaps had little to do with submarines. France had a small fleet of the vessels, but they were not a major component of the navy except for defense of territorial waters. Japanese and Soviet officials claimed that France refused to sign the treaty due to its own complicity in the continuation of chemical weapons research and development, but this conception was disproven in 1925, when as a part of the 1925 Geneva Conference for the Supervision of the International Traffic in Arms, France proposed a treaty to outlaw the use of poisonous gas during combat. The French proposal became the framework for the 1925 Geneva Protocol, which outlawed the use of both chemical and biological weapons during international conflicts.[18] While it took three years for the Geneva Protocol to be entered into force, the steady revisiting of the topic is a testament to the deep fears that all governments had of chemical weapons stemming from their use in World War I and the known fact that both the United States and the Soviet Union were maintaining sizable stockpiles.[19]

The ratification of the 1925 treaty, and the fears that world powers expressed regarding the use of chemical warfare, did nothing to slow down the research, development or use of the weapons. The United States and the Soviet Union continued to produce and stockpile chemical weapons throughout the interbellum years. Japan's infamous Unit 731 employed both chemical and biological attacks during its annexation of Manchuria in 1931, in addition to a medical unit that conducted gruesome experiments

[18] Geneva Protocol. (signed 17 June 1925, entered into force 8 Feb. 1928), *League of Nations Treaty Series*, vol. 94, pp. 66-74.
[19] Lev Aleksandrovich Fedorov, *Chemical Weapons in Russia: History, Ecology, Politics* (Moscow: Center of Ecological Policy of Russia, 1994), https://fas.org/nuke/guide/russia/cbw/jptac008_l94001.htm.

on prisoners with chemical and biological agents.[20] In spite of the strict regulations on chemical weapons set forth in the Treaty of Versailles, Germany was able to continue research under the guise of creating chemicals for use in the agricultural industry.

However, one question that continues to vex researchers is why the United States continued to invest in chemical weapons research and maintenance of its massive stockpiles even though it was deemed a failure as early as 1917. The lessons learned from German failures during World War I dictated American chemical warfare policy throughout the rest of the twentieth century, and the activities of the Chemical Warfare Service showed that the United States was only considering using chemical weapons but was never fully committed to it.

To be sure, production and development continued after the war at a staggering pace even though a distinct tactical advantage remained elusive. Yet at the same time, significant disposal activities occurred at several sites that proved the United States could not get rid of its stockpiles fast enough. The proliferation paradox comes into sharp focus by looking at the disposal activities of the United States Army which started as early as 1918.

**American University Experimental Station**

In the early years of World War I, American University (AU) in Washington, D.C. got involved with the fledgling United States chemical weapons program out of

[20] Nicholas D. Kristof, "Unmasking Horror -- A special report; Japan Confronting Gruesome War Atrocity," *New York Times,* Mar. 17 1995.

financial necessity. Originally intended to be a center of Methodist scholarship vying to compete with the major Roman Catholic universities in the nation's capital, Georgetown and the Catholic University of America, its opening proved it was anything but. By the time AU opened its doors in May of 1914, there were only two buildings on the campus, the completed College of History and McKinley hall that was an empty and incomplete shell. Furthermore, AU's initial graduate studies class consisted of only twenty-eight students, a far cry from the hundreds of scholars the university had anticipated.[21] To make matters worse, nearly one month after its opening, the assassination of Archduke Ferdinand unleashed tensions that had been slowly building in Europe, heralding the beginning of the Great War.

American University's board of trustees, concerned about the war's effects on the American economy and what it meant for the future of the school, scrambled to decide what was to become of the university that was already struggling due to limited financing. To save the university, the trustees granted the United States government the use of ninety-two acres at the rear of the AU campus for the duration of the war in the hopes that their contribution to the war effort would be recognized and attract the attention of patriotic benefactors.

The financial difficulties American University's trustees faced benefitted the U.S. Bureau of Mines, who saw the undeveloped campus as the perfect place to house its chemical division. The empty shell of McKinley Hall could easily be converted into

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[21] Theo Emery, *Hellfire Boys: The Birth Of The U.S. Chemical Warfare Service And The Race For The World's Deadliest Weapons* (New York: Little, Brown and Company, 2017), 56.

laboratories for research, and acreage at the back of the campus could be used as a proving ground, while water and power lines were already in place across the entirety of the campus that would allow for expansion of the facility in case other production areas could not be secured elsewhere.[22] This area of AU's campus became known as the American University Experimental Station (AUES) to civilian contractors and chemists, or Camp Leach to the military personnel eventually stationed there.[23]

At the onset of World War I, researchers worked feverishly to develop and perfect a wide array of chemical agents destined to be used in Europe. Aside from the agents known to be in use by German armies such as chloropicrin, sulfur mustard, and phosgene, which American researchers studied to see if improvements in deployment methods or the agents themselves could be made; researchers at AUES also worked on creating new agents. Of the assumed thousands of chemicals that were tested by researchers, only one showed any promise—lewisite.

While there remains some controversy surrounding the discovery of lewisite, the credit for the achievement is often given to Winford Lee Lewis, a chemist by trade who joined the Army in 1917 as he, like many other young men, were caught up in the wave of patriotism sweeping across the U.S. prior to its entry into the Great War.[24] Upon completing his basic training, Lewis was immediately assigned to the Bureau of Mines

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[22] Theo Emery, *Hellfire Boys: The Birth Of The U.S. Chemical Warfare Service And The Race For The World's Deadliest Weapons*, 59.
[23] United States Army Corps of Engineers, *A Brief History of the American University Experimental Station and U.S. Navy Bomb Disposal School, American University* (Washington, D.C.: U.S. Army Corps of Engineers, 1994), https://www.nab.usace.army.mil/Portals/63/docs/SpringValley/AUES_Report_June_1994.pdf.
[24] Joel A.Vilensky, *Dew of Death: America's World War I Weapon of Mass Destruction,* 7.

and its new outpost located on the campus of American University. At AUES, Lewis' name would become immortalized when the fumes from an arsenic based compound he was working on in the laboratory caused Lewis to faint suddenly. Upon further testing at the Camp Leach proving ground, lewisite was found to be extremely effective at low concentrations, causing blistering if it meets skin, as well as respiratory reactions ranging from coughing at lower concentrations to complete respiratory failure at higher concentrations. But what really put lewisite on the map as far as chemical agents were concerned and garnered the attention of the brass at the Bureau of Mines was the fact that it was thus far the only chemical agent that could easily penetrate protective clothing and the latex being used to in the construction of gas masks. As previously noted, the state of protection research had historically outstripped that of chemical research, but the discovery of lewisite had rendered the state-of-the-art gasmasks nearly obsolete.[25]

**A marriage of research and industry**

Bureau of Mines officials immediately saw the potential of the new agent and ordered that production of lewisite begin at AUES, but the facilities there were only able to produce small batches of the agent, nowhere near the amounts the Bureau thought would be needed by U.S. troops in Europe. However, they had so much faith that lewisite was the weapon that would end the trench stalemate in Europe, they launched a search for a facility that could handle production of lewisite on an industrial scale, finally settling on

[25] "PubChem Compound Summary for CID 5372798, Lewisite," National Center for Biotechnology Information, accessed May 18,2021, https://pubchem.ncbi.nlm.nih.gov/compound/Lewisite.

a plant owned by the Ohio Rubber Company in Willoughby, Ohio.[26] Unfortunately, due to budgetary constraints and the retrofitting of the plant to produce lewisite and not rubber, production at Willoughby did not start until late 1918, right as the European conflict was slowly grinding towards armistice. The facility started producing lewisite in Willoughby right around the time that the Bureau of Mines was reorganized into the Chemical Warfare Service in June 1918. It was only able to produce small amounts of the substance until the plant became fully operational in late October, a few weeks shy of the November 11th armistice. In all, despite its abbreviated run, the Willoughby plant managed to produce around 150 tons of lewisite.[27] Quite a significant amount considering the plant was only at its full functioning capacity for just under one month.

The armistice was met with mixed reactions by those Army personnel stationed at the Willoughby plant. Of course, the men were ecstatic that the bloody European conflict had finally come to an end, however, they also felt that the work they had been doing there for several months was in vain. With the war over, lewisite would never be used in actual combat, its effectiveness only tested in carefully controlled conditions and some soldiers noted with regret that they would never be able to see the fruits of their labors. However, this regret was short-lived as these soldiers, who had been sequestered for the duration of operations at Willoughby could now mingle with the local townsfolk who were more than happy to open up their homes to the troops, which provided a significant boost in morale especially to the soldiers and chemists who had to remain in Willoughby

[26] Joel A.Vilensky, *Dew of Death: America's World War I Weapon of Mass Destruction,* 51.
[27] Vilensky, 52.

for some time after the armistice, as the facility still had several batches of lewisite in various phases of production. These could not just simply be stopped and disposed of but had to complete synthesis to be stable for transport. So, the troops stayed in Willoughby, but were no longer bound by the protocols of secrecy deemed necessary by the CWS.

Eventually, all batch production stopped and closing operations at Willoughby began, but there is some doubt as to what happened to the estimated 150 tons of lewisite produced there. Joel Vilensky has observed that while most accounts verify that 150 tons were produced, much like the rest of the print media produced during this period, reports were often propagandistic in nature overstating not only what was produced, but the overall toxicity of lewisite. He also notes that accounts are conflicting as to the disposition of the lewisite produced at Willoughby. One source suggests that the lewisite was placed in barrels and loaded on a train headed to Edgewood Arsenal, a well-documented site for chemical weapons stockpiling and disposal. From there, the barrels were loaded on to a ship to be dumped only three miles off the coast of Maryland. However, another account claims that despite what news sources claimed about the Willoughby plant and the lewisite there still being in-phase, that the reported 150 tons was already en route to Europe as the details of the armistice were being hammered out and the Americans chose to scuttle the ship carrying the chemical agent once it received word that the armistice had been signed by all parties.[28]

[28] Joel A.Vilensky, *Dew of Death: America's World War I Weapon of Mass Destruction*, 53.

Regardless of the final disposition of Willoughy's 150 tons of lewisite, none of the sources account for toxins left inside the plant: raw materials, chemical pre-cursors, contaminated equipment used during synthesis and transport to other areas of the facility, and assorted waste products. It has been suggested that the majority of this was buried on site, which is consistent with the typical protocols used for disposal of hazardous waste during this time. While there is little in the way of concrete evidence to prove that this was the case at Willoughby, there are numerous anecdotal accounts from people who lived near the plant, as well as stories of discoveries of some of this material from employees of the Ohio Rubber Company, which reassumed control of the factory after the war. [29]

Of course, other facilities had been opened to support the manufacture of the more traditional chemical weapons agents and they ironically shared similar production timelines with the Willoughby plant. The Oldbury Electro-chemical Company in New York was producing chlorine, most of which was actually used in the manufacture of the lewisite pre-cursor arsenic trichloride, Edgewood Arsenal in Maryland was producing phosgene, mustard, and chloropicrin, Dow Chemical in Michigan was producing mustard, and the American Synthetic Color Company in Connecticut was producing chloropicrin.[30] Altogether the combined output of all these plants was an astonishing four-thousand tons of chemical agents per month, all of which occurred in October of 1918. Production ceased at all these facilities shortly after the armistice was signed, but

[29] Joel A. Vilensky, *Dew of Death: America's World War I Weapon of Mass Destruction*, 53.
[30] Theo Emery, *Hellfire Boys: The Birth Of The U.S. Chemical Warfare Service And The Race For The World's Deadliest Weapons*, 320.

within this short time period an estimated six-thousand tons of chemical agents was produced by the wars end as the American chemical weapons program created twice the number of chemical agents of all the other belligerents of World War I combined. [31]

Meanwhile, back at AUES, demilitarization operations began, and the nature of those operations lend a fair amount of credence to the accounts of what may have occurred at Willoughby, as well as the other facilities previously mentioned. With the war over, and the American economy booming from the exigencies of wartime production, American University's board of trustees were not only anxious to reclaim the portion of their campus that had been utilized for chemical weapons research during the war, but to harvest the patriotic glory in attempts to recast the school in its founder's original vision. However, the closing of the AUES remained mired in controversy.

Initially, the Army ordered all chemical agent materials, analogues, and equipment be packed up and shipped to Edgewood Arsenal. This however was a tall order considering the sheer amount of material stored at the facility and the state that much of it was in. Included in the menagerie of barrels, carboys, and dismantled equipment that was relatively safe for transport were discarded and broken equipment, vessels of contaminants that were not safe for transport, and several filled munitions that were slated for testing but never made it to the proving grounds. Following the lead of researchers at Porton Down, England's chemical weapons research facility, the material was simply thrown into a deep pit dug on the AU campus. A caption written on the back

[31] Leo P. Brophy, Wyndham D. Miles, and Rexmond C. Cochrane, *The Chemical Warfare Service: From Lab To Field*, 18.

of an archival photo encapsulated the sentiments of the soldiers tasked with burying these toxic materials, *"*The most feared and respected place on the grounds. The bottles are full of mustard, to be destroyed here. In Death Valley. The hole called Hades*."*[32]

To make matters worse, the grounds surrounding AUES were a veritable chemical weapons graveyard consisting of debris, rotting wooden testing huts, bomb craters, and test trenches.[33] Other facilities such as those owned by Dow Chemical or Oldbury did not suffer the same fate as they were already facilities that produced chemicals and the chemical companies involved simply retrofitted their plants to produce many of the same chemicals they were producing during peacetime.

However, this did not end research at AUES. Shortly after the armistice was signed, then secretary of war Newton D. Baker called for the complete demobilization of the CWS, an order that was superseded by Congress in 1919 who ordered the secretary to retain it for an additional year and shortly thereafter, the CWS became a permanent division of the Army through the National Defense Act of 1920.[34] Research continued at AEUS, though substantially scaled down from its wartime operations. In the meantime, the Army did what it could to remediate the area of the campus that had become a toxic wasteland—filling test trenches and bomb craters, dismantling the contaminated huts, and creating a plan for final deconstruction of the laboratory at McKinley Hall.

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[32] Unknown photographer, *American University- Hades Pit*, 1919, photograph, Washington D.C., Library of Congress.
[33] Theo Emery, *Hellfire Boys: The Birth Of The U.S. Chemical Warfare Service And The Race For The World's Deadliest Weapons,* 341.
[34] Leo P. Brophy, Wyndham D. Miles, and Rexmond C. Cochrane, *The Chemical Warfare Service: From Lab To Field*, 24.

At the height of demilitarization operations, the AU board of trustees saw yet another opportunity in the buildings and infrastructure created by the Army and in 1920 entered into an agreement that allowed AU to keep many of those structures in return for not holding the Army responsible for any damages to the buildings or grounds of the university. [35] Following the terms of that agreement, the Army demolished the buildings that the university did not want, burned the ones that were deemed contaminated, and left the remaining twenty-two structures to the university. The gambit that American University took in 1917 paid off, as by the time the CWS moved remaining AUES operations to Edgewood Arsenal, the university was heralded as one of Washington's top institutions that carried the distinction of being the epicenter of World War I chemical weapons research and development. However, the end of the Great War did not end proliferation, and the activities at AUES and Willoughby would be but merely cornerstones of the ecological footprint constructed by the American chemical weapons program.

[35] James W. Moeller, "Arsenic and an Old Base: Legal Issues Associated with the Environmental Restoration of Defense Sites in Washington, D.C., Used for the Development and Disposal of World War I Chemical Munitions," *Catholic University Law Review 54*, no. 3 (Spring 2005), 884.

## Chapter II- CHASEing Our Troubles Away: Chemical Agent Disposal Before the Chemical Weapons Convention of 1997.

> We do not claim to know where they all are.
> —William Brankowitz, Deputy Project Manager, Army Chemical Materials Agency

World War I, which was supposedly "the war to end all wars," did not live up to those short-sighted expectations and subsequent wars in the twentieth century not only showed how the military-industrial complex became a mainstay in modern combat, but also how countries applied their industrial prowess to create even more destructive weapons and deploy them quickly to any corner of the globe. Meanwhile, as most countries decried the use of chemical weapons on the battlefield, both the United States and the Soviet Union devoted significant resources to maintain substantial stockpiles of weapons that had been proven to be ineffective in combat to maintain the paradigms of mutually assured destruction and retaliation in kind. This greatly changed with the introduction of the atomic bomb, yet both countries still had massive stockpiles of chemical weapons not only stored within their own borders, but also distributed to locations spread across the planet making them difficult to dispose of while posing numerous risks to both military and civilian populations.

This chapter will look at chemical weapons proliferation during the years between the First and Second World Wars and beyond, seeking to account for both the production and distribution of the obsolete weapons of war, while also exploring how both countries all but abandoned their research, and the weapons themselves, after the advent of nuclear weapons as their creators struggled with questions on how they would dispose of these aging stockpiles by looking at disposal activities that began directly after the end of World War I

and continued throughout the twentieth century, culminating with the entry into force of the Chemical Weapons Convention in 1997.

**Preparing for what comes next**

The Chemical Warfare Service (CWS) could not know that the Great War would herald the beginning of an era of global conflicts not an end to them. Yet, the CWS continued to produce chemical agents at astonishing rates. Operations at AUES eventually relocated to Edgewood Arsenal and in 1920 the facility had the capability of producing well over 200,000 filled chemical munitions per day.[1] Additionally, the CWS heavily engaged in recruiting activities to bring new members into its ranks, even as the United States armed forces began to finalize demobilization activities. The CWS had remained successful against numerous demilitarization attempts, constantly citing American gas casualties to justify not only its existence, but its need for continued peacetime investment.

However, the Americans were not the only ones who felt the need to continue research into chemical weapons as both viable and necessary for their country's defense. In England, Porton Down remained in operation as British troops had suffered the most casualties from German chemical weapons use during the war, and experts held fast to the belief that if another conflict arose, gas would certainly be used. British researchers prevented details of their own chemical weapons program from being discovered, undoubtedly assisted by the fact that the research activities at Porton Down did not witness the fanfare and propaganda that surrounded the American program. Other European nations

[1] Robert Harris and Jeremy Paxman, *A Higher Form Of Killing The Secret History of Chemical and Biological Warfare* (New York: Random House. 1982), 35.

did have some knowledge of the British chemical warfare program, and this combined with similar fears of a future conflict where chemicals took center stage prompted France and Italy to conduct their own chemical weapons research. Even in Germany, where the Treaty of Versailles had been most restrictive regarding weapons development and stockpiling, defensive chemical research continued unabated, and this work eventually led to Germany reforming its offensive chemical research arm.

In eastern Europe, the state of chemical warfare was far more complicated during the interbellum years. Still caught within the throes of civil war, the Soviet situation remained volatile with both sides having access to chemical weapons. While evidence that the Red Army used chemical weapons during this conflict remains anecdotal, the British not only supplied the anti-Bolshevik White Army with chemical munitions, but also employed arsenic at the battle of Archangel through aerial bombardment. The British had also considered using chemical weapons on Indian Mahsuds in 1920 as Britain's preeminent expert on chemical warfare, Major-General Charles Foulkes, noted that as the tribesmen did not recognize the Hauge Convention and failed to conform to the most basic rules of combat, that the situation demanded the use of gas.[2] However, the RAF ended the conflict quickly by using conventional bombing raids, not chemical warfare.[3]

The fact that after World War I weaponized gas was rarely used in these smaller conflicts, as well as the lack of a major global war, did not stop the substantial uptick in production by both the United States and its European counterparts. While exact amounts of

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[2] Robert Harris and Jeremy Paxman, *A Higher Form Of Killing The Secret History of Chemical and Biological Warfare,* 45.
[3] Johnathan Glancey, "Out Last Occupation," *Guardian* (London, UK), Apr. 13, 2003.

chemical agent produced by these countries is difficult to come by due to several factors such as the need for secrecy, inaccurate reporting, and chemicals such as chlorine being used as analogues for more potent agents; researchers have only been able to piece together rough estimates for production during the interbellum years. However, the industrial powerhouse of the United States eclipsed anything being produced and stockpiled on the other side of the Atlantic, not just in terms of agent quantity, but also in its distribution of chemical weapon production and stockpiling facilities. Unlike England, France, Italy, and even the Soviet Union, American operations were not centralized and in fact very few areas exist in the United States that do not have at least a peripheral connection to its chemical weapons program. Adding to the ongoing research and production at Edgewood Arsenal, the CWS expanded its operations with new facilities at Redstone Arsenal in Huntsville, Alabama, Dugway Proving Ground in Dugway, Utah, Pine Bluff Arsenal in White Hall, Arkansas, and Rocky Mountain Arsenal in Commerce City, Colorado. Additionally, the CWS forged commercial contracts with several chemical companies, securing contacts for analogues and protective gear to be manufactured at existing facilities in Pennsylvania, New York, Ohio, Missouri, Illinois, California, and Michigan.[4]

In addition to the gases produced during the first World War, this new web of chemical industry began production of adamsite, a vomiting agent, and CS, more commonly known as tear gas. American researchers also standardized Livens projectors and Stokes chemical mortars to increase their dispersion rates and to make them easier to deploy by field units.[5] Consequently, the CWS's infrastructure and bureaucracy grew along with these new

[4] "History of United States' Involvement In Chemical Warfare," DENIX, Department of Defense, accessed October 3,2020, https://denix.osd.mil/rcwmprogram/history
[5] Ibid.

production and research activities, and its sphere of influence within the American military-industrial complex increased accordingly. By the eve of the Second World War, several countries were not only willing to employ chemical weapons, but also had the stockpiles to launch significant attacks over broad areas, and the United States remained by all accounts the leader in global chemical weapons development, in no small part due to the rapid expansion of the CWS.

**Chemical Weapons in World War II**

In many ways, the Second World War should be considered a global conflict of resource management and expanding industrial production. Certainly, strategy and tactics played significant roles in how the war unfolded but overall, the country or coalition of countries able to keep supply lines open and troops properly equipped would emerge victorious. This is the case in how the Barbarossa offensive played out, as German supply lines became stretched too thin leaving German troops poorly equipped deep in the heart of the Soviet Union, or even towards the end of the war as German industrial capacity faltered when Allied forces became able to deny them access to resources through blockades and extensive bombing of German industrial centers.[6]

However, another factor that became indicative of the potential success of belligerents is how the face of chemical weapons proliferation changed during the war. Of all the countries who had turned their chemical industries to the manufacture of chemical weapons, the United States ramped up production of chemical warfare materiel in tandem

[6] Michael Sherry, *The Rise of American Air Power: The Creation of Armageddon* (New Haven: Yale University Press, 1987), 158.

with the amounts of conventional weapons being produced. To be sure, Japan employed chemical warfare against China beginning with its annexation of Manchuria during the Second Sino-Japanese War and continuing through the end of the Second World War. Many of the records of Japan's chemical weapons program were destroyed, but the few surviving documents suggest that Japan engaged in well over two-thousand chemical attacks against China between 1939 and 1945. Further evidence proving that Japan had a robust chemical weapons program is seen in the multitude of weapon caches left behind in China after the end of the war.[7] Japan remains an anomaly as it is the only country that actively employed chemical warfare as a part of its overall strategy, and had it not been for the massive gains as a result of the Sino-Japanese War, it is doubtful that Japan would have had the necessary resources to support such a prolonged chemical warfare campaign.

The Soviet Union, on the other hand did have access to a vast array of natural resources due to its size and produced substantial amounts of lewisite and mustard but did not make chemical weapons an integral part of the Soviet war machine. By 1943, when the Soviets had gained the ability to successfully deploy chemical weapons on a wide scale, the Red Army was already winning the war with conventional weapons.[8] Other known producers of chemical weapons such as France and Italy, who had invested in chemical weapons research during the interbellum years, had all but abandoned that research in favor of conventional weapons. Be that as it may, each of these countries maintained their current

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[7] Organization for the Prohibition of Chemical Weapons, "Japan's Efforts Toward Early Destruction of ACW in China," Report RC-2/NAT.20 at the Second Review Conference, 16 April 2008, accessed September 23, 2020, http://www.opcw.org.

[8] David Hoffman, "Wastes of war: Russia's forgotten chemical weapons," *Washington Post* (August 16, 1998), p. A1.

stockpiles as the retaliation in kind paradigm slowly became the major dictating factor regarding chemical offensive and defensive preparations.

Meanwhile in Britain, Porton Down researchers continued their work on chemical weapons, producing an estimated seven hundred thousand tons of World War I era agents. In fact, Winston Churchill voiced his approval of using chemical weapons against the Nazi's and attempted on numerous occasions to convince both the War Cabinet and the Supreme Headquarters Allied Expeditionary Force (SHAEF) of the advantages of their use. However, much to Churchill's chagrin, experts from both organizations agreed that the number of bomber payloads needed to produce an effective chemical attack against Germany greatly outnumbered what could be attained with conventional bombs.[9] Resources continued to be an important issue as many of them became tied up in maintaining the Royal Navy which had to perform double duty protecting the English Channel while also attempting to defend Atlantic shipping lanes in to maintain a constant supply of much needed resources and war materiel being sent from the United States. In short, practical considerations, not moral ones, prevented Britain from using any of its chemical weapons stockpiles.

Of all the European belligerents, perhaps Germany presents the most interesting case study regarding the state of chemical warfare during World War II. There is no doubt that Germany exercised war under the philosophy of *lebensraum,* what many historians have interpreted as "space and race." Hitler believed that more land for the German people justified the war and the means to create a German hegemony in Europe. However, this only explains part of the reason Germany annexed countries in central Europe such as Poland and

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[9] Robert Harris and Jeremy Paxman, *A Higher Form Of Killing The Secret History of Chemical and Biological Warfare,* 136.

Yugoslavia, as well as embarking on a failed campaign deep into the Soviet Union. What made the *Wehrmacht* so successful in the early years of the war also contributed to its demise. A military so vast required similarly vast amounts of resources, desperately in short supply in Germany. While the United States had the resources available to both supply its military forces and maintain enhanced proliferation of chemical weapons; Germany did not have that luxury, especially in the later years of the war due to the success of the British blockade and Allied carpet bombing. Instead of being able to import what it needed, Germany had to rely upon synthetics, primarily rubber and oil, desperately needed to continue prosecution of the war.[10]

Historians have also suggested that Hitler had an aversion to the use of chemical warfare for reasons that went beyond the practical concerns of resource allocation and management. Hitler's own memoirs claim that while serving as a messenger in the German army, he became the victim of a gas attack during a mission which caused him to temporarily lose his vision and ultimately led to the decision to not employ chemical weapons during World War II.[11] Although, Germany did have stockpiles of both World War I era agents, and newer agents developed in Germany such as soman and tabun, but heavy restrictions put in place by Hitler himself prevented the weapons from ever leaving Germany due to his well-founded fears of the weapons injuring German troops or civilians.[12] An even larger concern stemmed from the fact that if the Germans employed chemical warfare and the Allies found out, Hitler knew they would retaliate in kind and it is doubtful that the U.S. Army

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[10] Albert Speer, *Inside The Third Reich* (New York: Simon and Schuster, 1970), 414.
[11] Adolf Hitler, *Mein Kampf* (Munich, Franz Eher Nachfolger GmbH, 1925), 130.
[12] Jonathan B. Tucker, *War of Nerves: Chemical Warfare From World War I To Al-Qaeda* (New York: Anchor Books, 2006), 61.

successfully maintained a level of secrecy that prevented Germany from being completely unaware of their production levels. However, the retaliation-in-kind paradigm and even Hitler's reluctance to employ chemical weapons did not prevent Germany from continuing its research and development of additional agents for weaponization, and a 1945 investigation into IG Farben's activities during the war revealed the horrifying details of experiments conducted at several Nazi concentration camps to discover the lethal dosages for wide array of potential agents.[13] Thankfully, the Garman's failed to discover any novel agents for weaponization, leaving them lacking the capacity to overcome the retaliation-in-kind threat.

The state of chemical warfare was not much better United States, despite being the leader in global chemical weapons production throughout the 1940s, nothing that came out of the numerous CWS facilities ever appeared on the battlefield during the war. Granted the retaliation in kind paradigm did place numerous restrictions on first use, and the eventual development of the atomic bomb relegated these unpredictable and often ineffective weapons to relics of a bygone era, the United States did consider their possible use during World War II, as an incident at Bari, Italy illustrates.

In 1943 a *Luftwaffe* air raid targeted Bari, Italy, a port that played a significant role in supplying both American and British troops in the Mediterranean. Among the twenty-seven ships destroyed in the raid, most notable is the *SS John Harvey*, an American Liberty ship carrying a secret cargo of mustard gas destined for the Mediterranean theater. The explosion destroyed the vessel, injuring or killing most aboard, but those are only initial casualties. The explosion that sank the *John Harvey* caused several of the mustard shells to rupture, releasing

[13] Tucker, 94.

a massive cloud of mustard gas that blew across the city. Numerous civilians and military personnel became exposed to the blister agent and had to be treated by medical personnel. However, the exact number of civilian casualties is uncertain as many of the victims fled the area and did not report to aid stations or hospitals in Bari. But the story of the incident at Bari does not end here, as the remaining chemical munitions that did not immediately rupture during the attack sank to the ocean floor where they still reside today, yet another piece to the slowly expanding ecological footprint of the United States chemical weapons program.[14]

It is still unclear if the United States knew of Axis backpedaling regarding chemical weapons use during World War II. What is clear is the CWS took no chances that Germany or Japan would use chemical weapons if given the opportunity. The incident at Bari is just one example of how the CWS attempted to hedge its bets by deploying these weapons to Europe. Documented sources are difficult to come by, as much of this information remains classified or in many cases contain inaccurate records, though we can surmise that the vessel destroyed at Bari is not an anomaly, and that additional shipments of chemical warfare materiel were sent to Europe to reinforce the retaliation in kind paradigm.

**The post-World War II fate of the CW stockpile**

The end of World War II brought with it several revelations regarding chemical warfare. After the fall of the Third Reich, the Allied forces discovered that Germany had been developing chemical weapons, with the bulk of their research revolving around nerve agents, dubbed "G-series" agents by American researchers. These included tabun and soman,

[14] "U.S. Merchant Marine In World War II," United States Merchant Marine, accessed October 5, 2020, http://usmm.org/ww2.html

as well as one that American researchers did not become unaware of until after the war—sarin. Previously developed chemical agents are primarily lachrymatory or blister agents such as mustard or lewisite but sarin is an entirely different animal, a highly potent nerve gas that even in low concentrations could kill targets within minutes. However, the amounts of these agents discovered in Germany became more of a curiosity than a concern as researchers claimed while there was an appreciable amount for Germany to have used on the battlefield, the Germans did not have the infrastructure available to get these agents to the front and lacked methods of deploying them effectively.[15] This discovery proved that the fear of retaliation in kind that had driven American chemical weapons development throughout the war turned out to be mostly unfounded.

The Japanese chemical weapons program received a similar assessment. While the activities of Unit 731 became notorious in the aftermath of the second World War, its chemical weapons stockpiles consisted of but a fraction of what American experts had suggested and paled in comparison with that produced by the United States during the war. However, U.S. leaders agreed that all existing stockpiles needed to be removed from these countries, as part of the effort to remove their ability to wage war and avoid the mistakes made at the end of the First World War.

The aftermath of the second World War also produced an innovation that many had thought would be the end of chemical weapons proliferation, at least for the United States. The successful development of the atomic bomb which culminated with the attacks on Hiroshima and Nagasaki ushered in a new era in combat. The CWS, striving to remain

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[15] Stephen L. McFarland, "Preparing For what Never Came: Chemical And Biological Warfare In World War II. *Defense Analysis* 2, no. 2 (1986): 108.

relevant within the nuclear weapons era that promised to make chemical weapons obsolete, designated itself as the U.S. Army Chemical Corps and as part of its mandate now included nuclear defense as well as continuing its role as the de facto experts on both the defensive and offensive applications of chemical and biological warfare. New testing facilities opened at the home base of the Chemical Corps at Fort McClellan, Alabama and Deseret Testing Center at Fort Douglas, Utah in addition to research that had been ongoing since the end of World War I at Edgewood Arsenal.[16] The Chemical Corps had poised itself to become an integral part of the next phase of geopolitical conflict, colloquially known as the Cold War.

**Chemical Weapons and the Cold War**

The Korean War, the conflict that is generally considered the first major conflict of the Cold War, also saw no use of chemical warfare. Certainly, the Soviet-backed North Koreans had access to the Soviet stockpile, yet the few reported instances are anecdotal in nature and conflicting accounts of respiratory and vision problems became attributed to the extensive use of smoke grenades and white phosphorus flares, not chemical weapons. Meanwhile, the United States continued to invest even more resources in chemical weapons as well as advancing their research on atomic weapons. Despite this, there are no documented accounts of the United States using any of their chemical stockpile during the Korean War, and while the discussion of employing chemical weapons in the Korean theater likely took place within the Pentagon, no move was ever made to deploy these

[16] Lee Davidson, "Army Admits Secret Testing," *Deseret News*, July 1, 2003.

weapons to Korea and by the end of the war in 1953, the massive stockpiles remained untouched.

After the end of the Korean War, even though the United States had not deployed any chemical weapons nor had they seriously considered using them, research on these weapons continued during the Vietnam War. DOD officials wanted to study how chemical attacks are dealt with in various arenas of combat. They had plenty of data regarding land-based attacks available from World War I, but naval based attacks remained an uncharted territory. Navy officials were concerned that since their vessels are enclosed and did not offer adequate ventilation, that a chemical attack against one of them would cause serious casualties to those stuck below decks. Beyond that, even if troops followed strict gas discipline, it remained unclear how long it would take before the agent in question dispersed, or decontamination procedures could be completed.

Collectively these tests are known as “Project 112,” a comprehensive DOD program that consisted of chemical and biological warfare vulnerability tests to determine how to protect U.S. service members. Most notable of these is Project SHAD (Shipboard Hazard and Defense), a program designed to test how quickly agents could be cleared from a naval vessel and to see if combatants could detect and identify a chemical attack and react to it without losing combat effectiveness. Declassified DOD documents state that fifty-five such tests scheduled between 1962 and 1973 consisted of joint exercises involving the Deseret Test Center, several Army and Navy vessels, and Marine Corps and Air Force aircraft. Testing took place at numerous locations on both land and sea including undisclosed locations on the open sea in the North Atlantic and the Pacific

Ocean including the Marshall Islands, Hawaii, Baker Island, Puerto Rico, and the California coast. Land-based tests took place in Alaska, Hawaii, Maryland, Florida, Utah, Georgia, and in Panama, Canada, and Great Britain.[17] Interestingly, even with all the tests performed, the DOD marked the trials as inconclusive leaving them unable to make any recommendations based upon the data gathered before the U.S. Congressional Committee on Toxicology shut the project down after an investigation in 1970, declaring the tests inhumane. This not only brought an end to Project 112 but to all government sanctioned forms of chemical weapons testing on humans.[18]

There is still some uncertainty if the United States used chemical weapons during the Vietnam War. It is known the U.S. did employ some chemicals during the war, but the debate stems from whether the substances used could be clearly defined as chemical warfare. Riot control agents (RCA's) such as CS were often used in varying amounts and supplied to the South Vietnamese Army, and U.S. leaders defended their use of RCA's by elucidating the nature of the war in Vietnam.[19] A common tactic used by the Viet-Cong was intermingling with civilians in attempts to hide and prevent attacks against them.[20] RCA's granted U.S. soldiers the ability to incapacitate crowds until enemy

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[17] Department of Defense. Department of the Army. U.S. Army Materiel Command. Deseret Test Center, "Organizational Authority Record, 1962-1973" Records Of The United States Army Materiel Command, Record Group 544, National Archives at College Park, College Park, MD.
[18] Lee Davidson, "Army Admits Secret Testing.," *Deseret News*, July 1, 2003.
[19] CS is a commonly used acronym for tear gas, the letters come from the last names of the chemists who discovered it, Ben Corson and Roger Stoughton, see James W. Hammond, *Poison Gas: The Myths versus Reality* (Westport: Greenwood Publishing Group, 1999).
[20] W.D. Verwey, *Riot Control and Herbicides in War: Their Humanitarian, Toxicological, Ecological, Military, Polemological, and Legal Aspects* (Leyden: A.W. Sijthoff, 1977), 46. See also Arthur W. Galston, "Science And Social Responsibility," *Annals of The New York Academy Of Sciences* 196, vol. 4 (June 1972), 223-235.

combatants could be identified and removed from civilian populations. The Chemical Corps' provided further justification for continued use by pointing out that except in extremely high concentrations, practically unattainable on the battlefield, RCA's are non-lethal.[21]

United States' forces also employed "rainbow" agents in Vietnam to ferret out the enemy. The use of these defoliating agents became necessary due to the nature of the foliage indigenous to Vietnam. The Vietcong forces could easily hide from enemy air attacks in the dense forests, making it impossible to conduct any type of wide scale conventional bombing that had proved successful in previous conflicts. This type of terrain also made it difficult for those involved with search and rescue operations which left many wounded soldiers stranded, often behind enemy lines. These factors provided the impetus for the use of the "rainbow" agents, most notably Agent Orange, during Operation Ranch Hand. The operation had two distinct goals— to remove the cover that made bombing and rescue operations difficult, and to prevent the Vietcong's ability to wage war through the destruction of crops and arable lands used by the Vietcong.[22]

Both goals came under intense scrutiny from those inside the Johnson administration and the American public who saw little difference between defoliation and chemical warfare. This issue also became exacerbated by the American public's general

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[21] "Facts About Riot Control Agents- Interim Document," Centers For Disease Control and Prevention, April 4, 2018, accessed October 5,2020, https://emergency.cdc.gov/agent/riotcontrol/factsheet.asp

[22] United States Institute of Medicine Committee to Review the Health Effects in Vietnam Veterans of Exposure to Herbicides. *Veterans and Agent Orange: Health Effects of Herbicides Used in Vietnam.* Washington, DC: National Academies Press, 1994), 74. See also *Edwin A. Martini, Agent Orange: History, Science, and the Politics of Uncertainty* (Amherst: University of Massachusetts Press, 2013)

disdain for the war that had been growing since 1967 and the feeling that their leaders had violated the national trust by continuing to prosecute it. Noted broadcast journalist Walter Cronkite put a finer point on in a prime-time special report in 1968 where he heavily criticized the war and the American military's ability to win it.[23] Cronkite's editorialization echoed American's refusal to accept the Army's claim that the use of Agent Orange in Vietnam did not constitute chemical warfare and the increasing pressure the public placed upon a government they felt had resorted to an inhumane method to win an unwinnable war.

**CHASEing Our Problems Away**

Several years prior to the end of the Vietnam War, the Chemical Corps realized they had a major issue with their aging stockpiles. Considering the majority of the American stockpile consisted of relics from the first and second World War, many of the ton containers used to store these agents had outlived their lifespan and had started to leak at domestic storage facilities such as Rocky Mountain Arsenal, Redstone Arsenal, and Anniston Chemical Depot, as well as facilities in Hawai'i and Okinawa. This created significant problems for military personnel stationed at these bases, as well as exposing civilian contractors who worked at the facilities.[24] Of course, the stockpiles represented only one facet of the American chemical weapons program causing issues for those outside of the aegis of the military.

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[23] "Who, What, When, Where, Why," Television newscast, Walter Cronkite, CBS News, February 27, 1968.
[24] Central Intelligence Agency, *Memorandum for the Director of Current Intelligence: Nerve Gas Incident in Okinawa,* (official memorandum, Washington D.C.: Central Intelligence Agency, 1969).

In 1968, an incident at the appropriately named Skull Valley in Utah exacerbated issues for the Chemical Corps and their already less than favorable reputation. On March 13th, a plane carrying deadly VX gas had been prepared to release the agent as part of a Chemical Corps' open-air testing demonstration. However, one of the dispensers attached to the plane did not achieve a complete release during the test, and as the pilot gained altitude after the testing run over Deseret Proving Ground, deadly VX leaked from the dispenser killing three-thousand sheep.[25] The Chemical Corps became desperate to find additional outlets for these aging stockpiles before the isolated incidents of accidental exposure to chemical agents became an unmitigated catastrophe measured in both human and non-human casualties as well as the increased potential of environmental damage. This included a substantial number of stockpiled agents and filled munitions consisting of over eight-thousand one-ton containers of mustard, seventeen-hundred mustard projectiles, ten five-hundred-pound cyanogen chloride bombs, four-hundred one-ton containers of various RCA agent, and over twenty-thousand sarin rockets.[26] The Chemical Corps did make attempts to form alliances with the pesticide industry as a potential outlet for its nerve gas stockpile, though this also quickly became mired in controversy.[27] The military's ultimate solution came in the form of Operation CHASE—a bold plan to rid the United States of a sizeable amount of its aging stockpiles. Ensconced within the acronym is the prevailing attitude when it came to the military's

[25] Lee Davidson, "Lethal Breeze," *Deseret News*, June 5, 1994.
[26] David M. Bearden, *U.S. Disposal of Chemical Weapons in the Ocean: Background and Issues for Congress* (Washington D.C.: Congressional Research Service, 1997), 6.
[27] For further information on the Chemical Corps' and pesticides, see Edmund Russell, *War and Nature: Fighting Humans and Insects with Chemicals from World War I to Silent Spring* (Cambridge: Cambridge University Press, 2008).

and in a more general sense the American public's concern towards the environment: Cut Holes And Sink Em'.

However, CHASE did not represent a new and novel plan to reduce American chemical weapons stockpiles, nor was the Chemical Corps unfamiliar with using the ocean as dumping ground. The prevailing philosophy concerning chemical weapons disposal had not changed since World War I when German chemical weapons stockpiles had been unceremoniously dumped into the North Sea— that dumping these chemicals deep into the ocean would have no negative effects on marine environments as the oceans are so vast that such amounts would leave very little long-standing effects on marine ecosystems.[28]

The United States had some qualified experience in this stemming from a disposal operation that dumped an undisclosed amount of lewisite in the Atlantic ocean at an unknown location between the United Kingdom and the United States, and from a subsequent operation in 1919 where the *USS Elinor* dumped 492 tons of an undisclosed chemical agent approximately three-hundred miles off the coast of Virginia.[29] However, this incident would only the be tip of the proverbial iceberg when it came to American predilection for ocean dumping of its toxic weapons.

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[28] David M. Bearden, *U.S. Disposal of Chemical Weapons in the Ocean: Background and Issues for Congress*, 8.
[29] Ian Wilkinson, "Chemical Weapons Munitions Dumped at Sea: An Interactive Map," Middlebury Institute of International Studies at Monterey James Martin Center for Nonproliferation Studies, last modified September 7, 2017, https://nonproliferation.org/chemical-weapon-munitions-dumped-at-sea.

World War II saw several dumping operations by American's that would turn its weapons problem into one of global proportions. Beginning in 1940, the United States increased its ocean dumping operations, conducting at least thirty confirmed disposals that placed these weapons in waters off the coasts of Panama, France, Pakistan, the Philippines, the United Kingdom, Sweden, Denmark, Australia, and Japan. This is in addition to dozens of suspected operations that to date have yet to be confirmed, though researchers have discovered several byproducts of degradation of CW agents including thiodiglycol, a byproduct of sulfur mustard hydrolysis, and arsine oil which is the byproduct of several arsenic based CW agents such as lewisite, adamsite, Clark I and Clark II.[30] One operation that occurred decades prior to Operation CHASE shows that the American belief that ocean dumped weapons are harmless was also shared globally.

In 1946, a joint American-British task force began dumping activities with the alliterative title Operation Davy Jones' Locker— a two-year operation designed to dump the German chemical weapons stockpiles found at the conclusion of World War II. A total of 38 ships were scuttled in the Baltic Sea containing approximately forty thousand tons of chemical agents.[31] Certainly, the Chemical Corps used its previous experience with at-sea disposal to convince the British that the method would not produce any long-term environmental effects. However, through their participation in Operation Davy

[30] M.I. Greenburgh et al, "Sea Dumped Chemical Weapons," *Clinical Toxicology* 54, no. 2 (2016), 84.
[31] Eugeniusz Andrulewicz, "War Gases and Ammunition in the Polish Economic Zone of the Baltic Sea," in *Sea-Dumped Chemical Weapons: Aspects, Problems and Solutions*, ed. Alexander V. Kaffka (Dordrecht: Springer, 2010), 32.

Jones' Locker, the British practically put their own stamp of approval on American dumping operations, both past and future.

CHASE did not become a solution tailor made for chemical weapons disposal alone. In fact, CHASE is overseen by the DOD as a joint operation between the Army and Navy designed for the disposal of chemical weapons as well as outdated munitions in the US arsenal left over from previous wars held by both the Army and Navy that posed significant risks of spontaneous explosion or backfire, if they even worked at all. These consist of bombs, rockets, and standard munitions that had been sitting in military warehouses, many of which from the first World War. Out of the twelve iterations of CHASE conducted between 1964 and 1970, only CHASE 8, CHASE 10, CHASE 11, AND CHASE 12 conducted chemical weapons disposal activities. The other eight operations focused on disposal of an array of bombs, torpedo warheads, naval mines, projectiles, fuzes, detonators, boosters, and missile motors among other conventional weapon detritus.[32]

CHASE 10 in 1970 is the climax of marine chemical weapons disposal, with the joint task force disposing of over three-thousand tons of American nerve agent filled munitions placed in concrete filled vaults and sank off the continental shelf. However, by this time attitudes towards ocean dumping had started to change primarily since Rachel Carson's *Silent Spring* had brought much needed awareness to the myriad of connections between man, the pesticides he used to control his environment, and their effects on

[32] David M. Bearden, *U.S. Disposal of Chemical Weapons in the Ocean: Background and Issues for Congress,* 3-6.

delicate ecosystems. However, part of this newly found awareness can also be attributed to a cultural shift punctuated by Vietnam war protests and the 1969 Woodstock music festival. The Hippie culture remained fervently anti-war and pro-environment, and its members went on to form organizations such as Greenpeace that helped provide the impetus for the first Earth Day in 1970.[33] Eventually, this newfound environmental awareness placed enough pressure on the American government to act. In 1969, prior to the final operations of CHASE, Congress got to work drafting a bill aimed at curbing both the wonton destruction of the environment and the overexploitation of natural resources by the government. On January 1, 1970, President Richard Nixon signed the National Environmental Protection Act (NEPA) into law designed to:

> "…declare a national policy which will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the Nation; and to establish a Council on Environmental Quality."[34]

Suddenly, a nation that had blithely ignored both the environment and the disposition of America's secret chemical weapons history were now acutely aware of both, and the media frenzy that surrounded CHASE 10 supports this assessment. Dozens of reports on CHASE 10 shown on major television networks and several articles published in Time magazine brought widespread attention to the final operations of CHASE.[35]. It had taken almost thirty years, but this extensive media coverage educated

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[33] Adam Rose, "Give Earth A Chance: The Environmental Movement and The Sixties," *Journal Of American History* 90, no 2 (September 2003), 549.
[34] National Environmental Policy Act of 1969, § 2, 42 USC § 4321.
[35] "Armed Forces: GB or Not GB," *Time Magazine* vol. 96, no. 7 (August 17, 1970), 10. "Cut Holes and Sink Em'," *Time Magazine* vol 96, no 8. (August 24, 1970), 9.

the American public on the dangers these stockpiles posed not only in terms of those held at American military outposts, but also what had been disposed of in the ocean since the end of the First World War.

Following this profusion of awareness on the ocean dumping of outdated war materiel, Congress knew it had to go further not only in the spirit of NEPA, but to quell the growing undercurrent of distrust these scathing reports had produced. The solution the American government came up with arrived in 1972 in the form of the Marine Protection and Sanctuaries Act (MPRSA). This act targeted ocean dumping and more specifically, the activities of Operation CHASE and empowered the Environmental Protection Agency (EPA) to determine what could and could not be dumped in the ocean but only if they could determine that the materials being dumped would not harm human health and welfare, or cause irreparable harm to marine environments.[36] While CHASE ended in 1970, two years prior to the passing of MPRSA, the act insured that the American chemical weapons stockpile would not be disposed of in such a manner ever again.

However, thousands of tons of chemical agents still remain on the ocean floor and attempting to track down exactly where the task forces dumped these stockpiles in order to ascertain the type of ecological damage they have caused is highly problematic. In fact, when it comes to nearly all instances of chemical weapons disposal, even those

[36] "Summary of the Marine Protection, Research, and Sanctuaries Act," United States Environmental Protection Agency, last modified December 27, 2018, accessed October 19,2020, https://www.epa.gov/laws-regulations/summary-marine-protection-research-and-sanctuaries-act.

prior to CHASE, both Army and Navy records are difficult to come by as they are incomplete, or in many cases have been destroyed. Several scholars have attempted to look through those records in attempts to piece together where these toxins ended up but can only point to general areas. In the case of those dumped off American shores, researchers have only been able to narrow it down to a three mile zone between the Florida coast and the Bahamas, somewhere within an eight-hundred and ninety-seven nautical mile area stretching from the northern Virginia coast to Nova Scotia, and in a thirteen-hundred square mile area off the coast of California.[37] "We do not claim to know where they all are," notes William Brankowitz deputy project manager in the Army Chemical Materials Agency.[38]Additionally, anecdotal accounts cite that often, troops would engage in dumping ton containers overboard en route to designated disposal sites meaning these suspected dumping areas may be much larger than anticipated. Overall, military leaders were highly critical of ocean dumping operations noting that they had little confidence in those executing them considering sensitive items routinely came up missing or unaccounted for.[39]

Further complicating this is the fact that the ocean is not static—tropical cyclones, shipping activities, and the natural shifting of the ocean through tidal patterns have certainly moved dumped stockpiles from confirmed dumping locations. Some

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[37] Ian Wilkinson, "Chemical Weapons Munitions Dumped at Sea: An Interactive Map," Middlebury Institute of International Studies at Monterey James Martin Center for Nonproliferation Studies, last modified September 7, 2017, https://nonproliferation.org/chemical-weapon-munitions-dumped-at-sea.
[38] John Bull, "Vast Chemical Dumping Found At Sea," *Newport News Daily Press*, October, 30, 2005.
[39] Department of Defense. Department of the Army. U.S. Army Transport Corps "Memorandum to the Office of the Chief of Transportation," October 25, 1945 Records Of The Chemical Warfare Service, Record Group 175, Box 62, National Archives at College Park, College Park, MD.

scholars have even suggested that without comprehensive ocean floor mapping, that pinpointing all the chemical weapons dumping locations is impossible.[40] Regardless, the fact remains that the Chemical Corps race to dispose of these weapons has constructed a vast ecological footprint that spans around the globe.

Of course, it is impossible to lay the blame for all this environmental damage on the United States Chemical Corps, or for that matter any other government that chose to dump its stockpiles in the ocean such as Canada, Britain or the Soviet Union. Up until the mid-1960s, when the environmentalism movement truly began to focus on how these activities affected ecosystems, ocean dumping was still widely considered to be the safest method of disposal for antiquated and obsolete weapons, both conventional and non-conventional. There is also some uncertainty as to why the Chemical Corps began disposing of chemical weapons stockpiles in the final years of World War II despite their ongoing struggle to prove their relevancy to congressional leaders in charge of approving the military's yearly budget. It is clear as early as 1918 that they had no problems attempting to maintain aging and useless stockpiles to prove they were still a necessary arm of the American military. The public backlash stemming from decisions made in Vietnam constituted a threat to the Corps continued existence and several congressmen suggested that if the Chemical Corps could prove it was a good military citizen, it may go a long way to insuring they could maintain their prestige both within the Army, and with politicians chomping at the bit to dismantle unnecessary elements of the American

[40] M.I. Greenburgh et al, "Sea Dumped Chemical Weapons," *Clinical Toxicology* 54, no. 2 (2016), 86.

military in the wake of the Vietnam War.[41] Yet somehow, even with everything stacked against them politically, the Chemical Corps continued to avoid the pitfalls that could lead to decommissioning of the unit.

**Chemicals after the Cold War**

The controversy brought to light by U.S. disposal issues and the overall geopolitical climate after the end of the Vietnam War made the debate over chemical weapons a hallmark of the Cold War as well. Considering the size of U.S. stockpiles, and suspicions that the Soviet Union had similarly large stockpiles, United Nations representatives, primarily French delegate Louis de Guiringand and Sir Colin Crowe of the British delegation, felt that opening a dialogue between the Soviet Union and the United States necessary to prevent further escalation of the conflict. This led to the formation of the Committee of Disarmament (CD), an informal UN committee charged with negotiating present and future multilateral disarmament treaties. While the CD's focus was primarily directed at the reduction of nuclear arms, they also made a point to discuss the state of global chemical and biological weapon stockpiles, the largest being held by the American and the Soviet governments. Members of the CD quickly concluded that representatives from the Soviet Union and the United States remained unwilling to discuss reductions in their perspective nuclear arsenals, especially considering the ongoing conflict between the Soviet Union and the U.S. that caused the

[41] Al Mauroni, "The U.S. Army Chemical Weapons Corps: Past, Present, and Future," National Museum of the U.S. Army, accessed October 19, 2020, https://armyhistory.org/the-u-s-army-chemical-corps-past-present-and-future/.

proxy wars of Korea and Vietnam. Conference chairman Stanislaw Turbanski of Poland correctly assumed that to prevent a protracted legislative stalemate, that focus needed to be shifted to other types of disarmament. They suggested that they should turn to drafting a treaty that prohibited the use of other non-conventional weapons— specifically those of a biological or chemical nature.[42] British representatives submitted a draft to the CD in 1968 that prohibited the development, stockpiling, acquisition and retainment of weapons that are "microbial or other biological agents, or toxins whatever their origin or method of production, of types and in quantities that have no justification for prophylactic, protective or other peaceful purposes" and "weapons, equipment or means of delivery designed to use such agents or toxins for hostile purposes or in armed conflict."[43]

The initial draft might have been ignored had it not been for American support. The British draft had not gained much traction with the CD since other states who supported the measure such as Poland, Bulgaria, and Canada did not wield as much political power, nor did they have substantial amounts of chemical warfare materiel to begin with. However, once the United States pledged its support to the British draft, other members of the CD quickly acceded, and the draft entered into force in 1972 as the Biological Weapons Convention (BWC). While the BWC did mention the banning of toxic agents, it did not specifically target chemical weapons or chemical warfare materiel.

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[42] United Nations, Conference on Disarmament, *Working Paper with suggestions in regard to the draft treaty on non-proliferation of Nuclear Weapons, put forward by the delegation of Sweden at the meeting of the Eighteen-Nation Committee On Disarmament*, ENDC/215 (8 February 1968).
[43] "The Biological Weapons Convention, Article I," Organization for the Prohibition of Biological Weapons, http://www.opbw.org/ (accessed Mar. 17, 2021).

Remarkably, the ban on chemical weapons originally drafted in tandem with the Biological Weapons Convention did not enter into force until 1997, twenty-five years after ratification of the BWC. There are several reasons why such a long gap between ratification of the two treaties exists. The Cold War between the Soviet Union and the United States still simmered, and while both countries agreed in 1972 to cease the use of biological weapons, neither had any interest in limiting their ability to retaliate in kind. Certainly, both sides could accomplish this with nuclear weapons, but they also knew that the effects from retaliation in kind with nuclear weapons could have devastating global environmental ramifications far beyond those reported by the EPA in connection with the military's previous disposal activities.[44]

Another reason that the two powers expressed reluctance agreeing to a chemical weapon ban stemmed from economic concerns. Unlike chemical weapons, biological weapons are often more expensive to develop and stockpile as they required extensive procedures to prevent them from becoming inert or being unleashed through containment failure. As a result, both the United States and the Soviet Union had biological stockpiles that consisted of only a fraction of the amounts of stockpiled chemical weapons. Both powers seemed willing to assume the cost of scuttling their comparatively small biological stockpiles, but not that of their chemical weapons stockpiles. Additionally, the chemical industries in both countries constituted a large portion of their economy. Ceasing production, converting production facilities and dismantling stockpiles came

[44] Joshua Lederberg, "The Dilemma Of curbing Chemical Warfare", *Washington Post*, Sep. 27, 1970.

with the danger that each respective economy would suffer a substantial setback in a global economy already feeling the effects of oil embargoes stemming from the continuing Arab-Israeli conflict.[45]

To complicate matters further, several UN representatives noted the difficulty in framing a comprehensive chemical weapons ban. Certainly, identifying weaponized agents ready for deployment did not pose a significant problem for inspectors, but many chemical weapons are not pre-assembled. Instead, precursors are kept separate until ready for use where they would be mixed shortly before deployment. Additionally, there was the problem of dual-use chemicals. Many chemicals that are weaponized also have other applications. For example, phosgene is instrumental in the synthesis of polyurethane, and chloropicrin is used in a wide array of fungicides, herbicides, and insecticides. Precursors for these lethal chemicals are useful in other various industries such as fertilizer production, synthetic rubber manufacture, and dyes for the textile industry.[46] This served to complicate matters for any verification or inspection committee who would have to decide whether a country had stockpiles of these chemicals for industrial and commercial use or weaponization.

However, the U.S. remained hesitant to completely give up on its chemical weapons program. In 1985, President Ronald Reagan appointed a commission to study the possibility of eliminating all World War era filled unitary munitions and replacing

[45] U.S. Office of Technology Assessment, *The Chemical Weapons Convention: Effects on the U.S. Chemical Industry*, (Washington, D.C.: Government Printing Office, 1993), 56.
[46] Ibid., 14.

them with 155mm binary munitions, and in previous years the president had consistently requested millions of dollars be appropriated for the project.[47] Despite the Reagan Administration's support of a unilateral chemical weapons ban and the continuing issues with its current stockpiles, it appeared that the United States still had interest in development of chemical weapons.

Reports from defectors suggest that the Soviet Union had been dealing with the same problems the United States faced regarding its own aging stockpiles, though sources confirming this remain sparse. Ken Alibek, former head of the Soviet biological weapons program who defected to the U.S. in 1992, acknowledged that at the Soviet Union's main lab in Vladivostok, the state of their chemical stockpiles became somewhat of a running joke, "Not a day went by that we did not hear of some hapless soul who gassed himself."[48] Initially, Alibek commented that he and his staff thought those responsible for handling the agents did not receive adequate training until he took a tour of the facility and saw the storage conditions firsthand. Alibek concluded that the Soviet bureaucracy was to ultimately blame for these failures. In attempts to further distance themselves from the many controversies plaguing the U.S. regarding the Cold War, the Soviets quickly threw their support behind the comprehensive ban on biological and chemical weapons proposed by British UN delegates.

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[47] Wayne Biddle, "New Nerve Gas Weapons Urged For Military," *New York Times,* April 28, 1985.
[48] Ken Alibek, *Biohazard: The Chilling True Story of the Largest Covert Biological Weapons Program in the World, Told from the Inside by the Man who Ran it* (New York: Random House, 1999), 229.

**The long road to CWC ratification**

Looming concerns about the future of chemical weapons stockpiles was not enough to bring about immediate ratification of the CWC by the United States. Before anything could be decided, Congress had to vote on the issue. Several congressional votes taken between 1988 and 1990 showed no clear consensus. Disagreements centered around the concern that another government would use chemical weapons and the U.S. would not be able to retaliate in kind. This issue continued to be debated until 1991, when George H.W. Bush asserted that the U.S. would place an unconditional ban on chemical weapons. This became the groundwork for the Chemical and Biological Weapons Threat Reduction Act, a bill that stipulated the conditions under which the United States government would ratify the CWC.[49] The introduction of this bill launched a lengthy series of congressional sessions, punctuated by the 1992 elections which tabled negotiations on the bill until William J. Clinton took office in 1993. Clinton aimed to push ahead with the issue of CWC ratification initiated by the Bush administration, but soon experienced similar problems regarding the Senate's reluctance to ratification.

The largest of the hurdles to ratification of the Chemical and Biological Weapons Threat Reduction Act were what pundits dubbed "killer amendments,"—that is, amendments intended to prevent its passage. These became the hinge upon which CWC approval turned and negotiations halted as many conservatives felt that without these amendments, the CWC would undermine national security by eliminating the United

[49] Johnathan B. Tucker, *Center for the Study of Weapons of Mass Destruction: Case Study 4* (Washington, D.C.: National Defense University Press, 2011), 28.

States from having the ability to employ chemical weapons while increasing the chance that non-aligned states would get their hands on these weapons once demilitarization began. The first amendment stated that the United States would not become party to the CWC unless states known to sponsor international terrorism such as China, Iraq, Iran, Libya, North Korea, and Syria also ratified the treaty. The United Nations claimed that these rogue states are unlikely to be party to the treaty to begin with.[50] The second "killer amendment" stated that the U.S. would not ratify the treaty unless Russia followed suit, though this concern seemed unfounded considering Russian diplomats had contacted UN representatives regarding the treaty's passage. The third amendment demanded a renegotiation of Articles X and XI by the United States to prevent misuse of the articles by other proliferators.[51] This caused problems with passage since the multilateral negotiations had ended and the treaty was currently open for signatures. The common practice for treaties drafted by the United Nations dictated that after a set time for nations to debate on the content of the treaty, it would be closed to amendment and prepared for the deposit of instruments of accession by signatory nations, and the debate period had already passed. The fourth article involved verification and implied that the president must be able to certify the ability of the intelligence community to detect any significant violation by member states. Members of both the Central Intelligence Agency and the Federal Bureau of Investigation claimed this style of verification unrealistic. Finally, the

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[50] Tucker, *Center for the Study of Weapons of Mass Destruction: Case Study 4*, 32.

[51] Article X of the Chemical Weapons Convention Article X provides for assistance and protection to a State Party if it is attacked or threatened with attack by chemical weapons, and article XI provides international cooperation for the economic and technological development of States Parties. Organization for the Prohibition of Chemical Weapons," The Chemical Weapons Convention," (accessed March 17, 2020). https://www.opcw.org/chemical-weapons-convention/articles

fifth article stated that the United States had the right to refuse inspections from countries designated as state sponsors of terrorism. This article is a testament to the partisan politics involved, for the CWC already allowed for rejection of inspectors on a case-by-case basis.[52]

To appease Republicans against the passage of the bill, *Senate Resolution 75 (SR 75)* was drafted by North Carolina Senator Jessie Helms and sent to the floor for a vote. It kept intact most of the conditions of the Chemical and Biological Weapons Threat Reduction Act but included the five amendments as stand-alone amendments to be voted on individually by the senators. Now Democrats instead of only having to get one vote to go in their favor, needed wins on each of the five free standing votes. Clinton attempted to reach across the aisle to Republicans known to support the resolution, but many Republicans remained undecided, preferring to see which way their senior colleagues voted before pledging their own support.[53]

Surprisingly one of Clinton's biggest political rivals, former Senate Majority Leader Bob Dole, supported *SR 75*. Clinton called upon Dole to be present at another briefing where he hoped to sway Republican support in his favor to help defeat the five "killer amendments." Dole agreed and to the surprise of many Republicans prepared to uphold the five amendments, he appeared at Clinton's side during a press conference in

[52] Tucker, *Center for the Study of Weapons of Mass Destruction: Case Study 4*, 17.
[53] Tucker, *Center for the Study of Weapons of Mass Destruction: Case Study 4*, 29.

1997. This served to claim many of the votes needed for CWC ratification by the United States.[54]

Clinton made further attempts to assure Republicans that the bill had the United States' best interests at heart. His biggest challenge is the third amendment's stipulations regarding Articles X and XI of the CWC. Senators Jesse Helms and Trent Lott argued that these two amendments did not properly address the goal of keeping chemical weapons out of the hands of terrorists. As a sign of good faith, Clinton explained that an independent multinational group under the aegis of the UN, the Australia Group, would handle export controls on dual-use chemicals.[55] In addition, the United States would only provide medical assistance and protective gear to other countries on a case-by-case basis. To further prove the importance of the nation's security, Clinton told Republican leaders that if rogue states did attempt to exploit the two articles in question, then he would consider it to be a situation that jeopardized the United States' interests, and he would be prepared to withdraw the U.S. from the treaty.[56] These capitulations served their intended purpose. As each stand-alone amendment came up for a vote, every one of the five amendments failed to pass, though only by very slim margins. Clinton claimed legislative victory and on April 24, 1997 the United States ratified the treaty four days before it entered into force. During a press conference that immediately followed the final vote,

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[54] Alison Mitchell, "How The Votes Were Won: Clinton's New GOP Tactics," *New York Times,* April 25, 1997.

[55] The Australia group is an independent, multinational group consisting of 54 member nations that assists other countries party to the Chemical Weapons Convention and the Biological Weapons Convention in determining import and export controls to prevent the spread of chemical and biological weapons, see "The Australia Group at a Glance," Arms Control Association, September 2003, www.armscontrol.org/factssheets/australiagroup.asp (accessed Mar. 20, 2016).

[56] Tucker, *Center for the Study of Weapons of Mass Destruction: Case Study 4*, 21.

President Clinton claimed that through the CWC, "We will end a century that began with the horror of chemical weapons in World War I much closer to the elimination of these kinds of weapons."[57]

The Chemical Weapons Convention is unique because its framers attempted to make it a living document, one that could evolve over time as the nature of global chemical weapons stockpiles changed. To this end, the CWC provided many mechanisms that previous treaties had not. In addition to a quinquennial review of the document to avoid the pitfalls that weakened previous chemical weapons bans, the CWC placed prohibitions on the use, transfer, and military preparation of chemicals for war, placed mandates on the destruction of facilities used for production of chemical weapons, and provided for the conversion of current facilities for use in producing chemicals for peaceful purposes. In addition, Article VII extended the provisions of the CWC, making the ban binding not only to member states, but citizens of those member states as well. This meant any private entity or individual in possession of chemical warfare materiel would now be charged under international law. It also provided extensive annexes defining the panoply of chemicals covered by the ban, timelines for destruction of chemical weapons and facilities, and approved disposal methods. Perhaps most importantly, the CWC addressed a major deficiency inherent to all previous chemical weapons treaties— the lack of an enforcing body. Article VIII provided for the establishment of the Organization for the Prohibition of Chemical Weapons (OPCW).

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[57] William J. Clinton, "Remarks By The President After The Vote On Ratification Of The Chemical Weapons Convention," Washington D.C., April 24, 1997. (accessed May 9 2021) https://clinton.presidentiallibraries.us/files/original/071022a66883e63db5b8ac8406bbe97f.pdf.

This multi-lateral committee is responsible for investigating any alleged infractions by member states, on-site inspections, and evaluation of disposal procedures. The CWC *prima facie* seemed to be a document that would be capable of solving any disputes over chemical weapons disposal and use.[58]

**The race against time**

However, cracks immediately began to show in the Chemical Weapons Convention. By and far the largest issue for signatories is the timeline for destruction laid out in the treaty: ten years. Signatories had a decade to eliminate all chemical weapons, manufacturing facilities, and stockpiled agents. The CWC did allow for extensions to be granted on a case-by-case basis, but the treaty is specific that under no circumstances would any state be granted any extension beyond fifteen years after accession. This became a tall order even for countries that did not have as large an arsenal as the United States, consisting of thousands of chemical munitions such as filled shells and chemical missiles, and hundreds of tons of stockpiled chemical agents. The United States chemical arsenal was not just spread out at various military facilities across the country, but also included stockpiles at overseas U.S. bases. This created a complex logistics problem for the Army Chemical Materials Activity (CMA), the unit charged with ensuring U.S. compliance with the Chemical Weapons Convention.[59]

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[58] "Article VIII: The Organization," Organization for the Prevention of Chemical Weapons, accessed May 9, 2021, https://www.opcw.org/chemical-weapons-convention/articles/article-viii-organization.
[59] "The U.S. Army Chemical Materials Activity" http://www.cma.army.mil/ (accessed Mar. 20, 2021).

The CMA needed to find a way to transport stockpiles to a centralized location for destruction. Surprisingly enough, the domestic stockpiles created the largest issues as the majority of overseas stockpiles at U.S. bases in Guam, Panama, Germany, and Japan had already been shipped to Johnston Atoll, where destruction operations had been ongoing since 1990. Stockpiles on U.S. soil presented a more difficult challenge due to the sheer size of it— thirteen large stockpiles that consisted of over one-hundred tons of weapons, with dozens of other facilities in possession of smaller, yet similarly lethal stockpiles.

The CMA chose six military installations that already had sizeable stockpiles: Umatilla Chemical Depot in Washington State, Deseret Chemical Depot in Utah, Pine Bluff Chemical Depot in Arkansas, Anniston Chemical Depot in Alabama, Aberdeen Proving Grounds in Maryland, and Newport Chemical Depot in Indiana. With this infrastructure in place and a United Nations mandate that seemed to close the gaps in previous treaties that had failed to effectively deal with the implications of chemical warfare, the U.S., alongside other global powers, began the arduous process of eliminating global stockpiles of chemical weapons.

However, by the time the United States had committed itself fully to elimination of its chemical weapons stockpiles, the ecological footprint of the military's activities covered well over twenty percent of the globe. Considering that unsanctioned disposal began as early as 1918 and reached its climax in the 1960s anywhere between three to six decades had passed and the effects on the environment were starting to fully manifest themselves, as the following chapters will show.

## Chapter III- Deadly Discoveries: The Military's Problem Enters the Public Sphere

The cultural and intellectual shift in the 1960s that brought enhanced awareness to environmental issues did not occur overnight, nor did it provide a panacea to the numerous issues surrounding how the United States had been dealing with its chemical weapons stockpiles. In fact, this newfound awareness placed the Army under a microscope in terms of its past disposal activities, while also removing several favored avenues of disposal. Exacerbating the already pertinent issues with chemical weapons disposal, was the entry into force of the Chemical Weapons Convention that placed a timeline on destruction of these deadly weapons. As if the Chemical Corps problems could not get any worse, the discovery of forgotten chemical agents disposed of nearly eight decades prior to CWC ratification by civilians became a grim reminder of the toxic legacy created by the military in its efforts to dispose of the American chemical arsenal. This chapter focuses on those discoveries and how decisions made in the early years of the American chemical weapons program came to affect citizens in important, yet detrimental ways. This chapter will also explore how disposed chemical weapons interacted with ecosystems and how improper disposal methods in some ways increased the persistency of the agents in question.

### Denial Through Demilitarization

In the post-World War II era, it is not surprising that chemical weapons found their way into domestic markets. Traditionally, the military built up its holdings in terms

of land and resources in preparation for global conflicts and once resolved, demilitarization operations commenced to bring the amount of natural and human resources back to pre-war levels and available documents show this is certainly the case with both World Wars, the Korean War, and the Vietnam War. This process entailed massive reductions in available war materiel through disposal of obsolete weapons or sale of outmoded but operable war materiel to allied nations, the liquidation of non-weaponized assets through military surplus auctions, and the closure or reduction in size of bases used for the training of an enhanced military force. In most cases land acquired by the military, once deemed clear of all militarily sensitive materials, is returned to the public sector via sale or auction for commercial or residential use unless Congress opted to turn the land over to other federal or municipal government agencies for their use.

By the 1990s, as the United Nations continued to hammer out the details of the Chemical Weapons Convention, the United States started to reconsider the role of its military not only in terms of its capacity in global peacekeeping, but also its impact on the American budget. Several legislators had pointed out that military spending remained at an all-time high even though the United States was not actively involved in a war and the ongoing conflict with the Soviet Union that drove the investment of billions of dollars in military spending during the 1980s had cooled considerably. As a response to criticism from within the government, as well as from US citizens who felt that this money could be better utilized elsewhere, Congress initiated another round of closures, formalized with the Base Realignment and Closure Act (BRAC) of 1990. The act also served as a bulwark against political considerations that often arose when the U.S. government sold

large portions of its property. This of course would not be the first time the American government had attempted to reduce its military spending as previous realignments that had generally occurred following the conclusion of a major conflict such as World War II, the Korean War, or the Vietnam War focused on reductions in personnel or war materiel, not an overall reduction in the military's budget. What made the ones that occurred in the 1990s unique, aside from being formalized by a congressional act, is that it would be the first-time bases or portions of bases where chemical weapons had been developed, tested, and stored would be turned over to the private sector.

Unbeknownst to legislators, and in most cases top military officials, surprises lurking underground at several of these bases brought acute focus to how poorly the Army had done in following approved disposal protocols and in keeping proper records on the disposition of these toxic materials. This is not surprising considering the Chemical Corps legacy of disposal, but to those not directly connected to the Chemical Corps, USACE, or the EPA who had studied previous disposal activities and were aware of the potential risks they posed, these deadly discoveries became unwelcome surprises that hit too close to home.

**Spring Valley, Washington, D.C.**

In 1993 excavation unearthed barrels of lewisite and sulfur mustard, World War I era agents buried decades ago in the Spring Valley neighborhood in the northwestern part of Washington, D.C. In addition, a 1994 report issued by the Edgewood Research and Technology Directorate, the governing arm of the U.S. Army Chemical Corps, claimed

that chlorine, phosgene, and adamsite might also be buried in the vicinity, but they are uncertain about exactly how much had been disposed of in this manner at this location.[1] The most unsettling question that emerged from the discovery of chemical weapons at Spring Valley is how had the Army been so negligent with its stockpiles? Answers were not forthcoming though evidence did emerge from an unlikely source that showed military officials did have knowledge of the chemical weapons buried at Spring Valley and they had acted in concert with American University trustees.

According to a 1921 issue of American University's student newspaper *The American University Courier*, when Army officials started demilitarization operations, representatives met with the university's board of trustees to discuss the munitions at the facility, the same munitions that according to Chemical Warfare Service records had been shipped to Edgewood Arsenal along with the rest of hazardous materials. The university unflinchingly suggested that soldiers dig a hole as deep as possible and bury the weapons at the furthest acres of the campus, confident that the depth of burial and remoteness of the site would prevent the munitions from being disturbed.[2]

When American University sold a portion of the campus to developers seeking to create a high-end residential neighborhood adjacent to the university, but removed from the bustling DC beltway, no one considered the fact that the area had unknown quantities of chemical weapons buried there dating back to 1918. The discovery of the detritus from

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[1] United States Army Chemical and Biological Defense Command, Edgewood Research and Technology Directorate, Herry Salem et. al., "Operation Safe Removal: Spring Valley, Washington, DC. Fact Sheets on Identified World War I Chemical Agents," (ERDEC-TR-206, Aberdeen Proving Ground, Md., 1994), 1.
[2] "Outside Schools On The Campus," *American University Courier* (Washington D.C.), April 1921.

AUES in the form of numerous rusting munitions and barrels of raw agent, as well as contaminated lab equipment cast serious doubt on the Army's continued assurances that all toxic materials had been shipped to Edgewood at the end of World War I.

Spring Valley remains the most controversial and widely known of disposal sites due to a combination of its proximity to the nation's capital and the notoriety of those who owned homes in the area. Spring Valley is an affluent neighborhood in the northeastern section of the District of Columbia, home to several of Washington's political elite and celebrities. Financier Warren Buffet, President Joe Biden, Former Secretary of Defense Donald Rumsfeld, and NBA hall of famer Patrick Ewing have all called Spring Valley home, most of them while these discoveries were ongoing. Considering the list of well-known public figures residing in this neighborhood affected by this revelation, the chemicals buried in Spring Valley garnered not just the attention of the media, but also government officials who have released numerous documents regarding the remediation of the site. However, many of these reports failed to adequately address potential health and exposure risks in Spring Valley or show any significant progress in the cleanup of the disposal site.[3]

Army officials could not offer explanations as to how this chemical warfare materiel ended up being buried on the American University campus despite claims that they relocated it to Edgewood during demilitarization operations. Upon further research

[3] United States Department of Health and Human Services, Agency for Toxic Substances and Disease Registry, Division of Health Assessment and Consultation, *Health Consultation: Spring Valley Chemical Munitions, Washington, District of Columbia, Public Health Evaluation for the Spring Valley Community* (Atlanta: Centers for Disease Control, 1994), 36.

the Army revealed that transit records from the closure of AUES are sparse and, in most cases, non-existent. This lack of documentation seems atypical of standard U.S. military doctrine, which includes forms and protocols for requisitioning everything from eyeglasses to ballistic missiles. Be that as it may, researchers at Edgewood Arsenal's Research and Technology Directorate managed to piece together enough information from AUES lab records to issue a 1994 report outlining what they expected to be buried at the site.[4] They had a significant amount of data on lewisite and sulfur mustard, as much of the U.S. supply was produced there, but the report indicated that adamsite and phosgene may also be buried there. This report, along with the media attention the discoveries garnished, prompted the CMA in conjunction with the U.S. Army Corps of Engineers (USACE) to launch a massive cleanup effort of the area. By 1995, the USACE declared Spring Valley safe, as they claimed the "lost" agents had been recovered and soil tests had shown that the levels of chemical residue, primarily arsenic, all remained well below established EPA standards. However, further incidents proved the assessment incorrect, and stands as a testament to the inefficiency and lack of comprehensive sampling and testing conducted by the Army. In 1996, USACE discovered several vials containing chemical agents, and in 1997 the discovery of two additional disposal pits adjacent to the former AUES site belied Army claims that the site

[4] United States Army Chemical and Biological Defense Command, Edgewood Research and Technology Directorate, Herry Salem et. al., "Operation Safe Removal: Spring Valley, Washington, DC. Fact Sheets on Identified World War I Chemical Agents," (ERDEC-TR-206, Aberdeen Proving Ground, Md., 1994), 2.

did not require further remediation. The only positive news the Army could report is that the pits resided on undeveloped property.[5]

The wide media coverage that led the public to the knowledge of the discoveries in the nation's capital drew public attention away from the Army's realization that the Spring Valley discovery was not an isolated incident. Officials from the CMA became concerned with the status of other sites where the Army had engaged in production and testing of chemical weapons, and if documentation of these sites is as unreliable as that from AUES. However, the intense focus on the Spring Valley community bought the Army valuable time to try to first discover all sites where chemical weapons development had occurred, and then mobilize the proper resources to remediate them. It took nearly ten years and the Army, fearing more public backlash and charges that they failed to act quick enough or in good faith, released to the public an information pamphlet that outlined remediation of the Spring Valley site in coordination with the USACE through their Formerly Used Defensive Sites (FUDS) program, designed to utilize government funding for the assessment and remediation of environmentally hazardous areas previously under military control.[6]

Once fully committed to a widespread remediation campaign, the Army had enough documentation to identify many former defense sites where significant chemical weapons activity occurred such as Edgewood Arsenal or Anniston Chemical Depot, but

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[5] James W. Moeller, "Arsenic and an Old Base: Legal Issues Associated with the Environmental Restoration of Defense Sites in Washington, D.C., Used for the Development and Disposal of World War I Chemical Munitions." Catholic University Law Review 54 (2005), 879

[6] U.S. Army Corps of Engineers, "Recovered Chemical Warfare Materiel (RCWM) Response Process," (Pamphlet 75-1-3, Washington, D.C.: Government Printing Office, 2004).

other areas known for being connected to the American chemical weapons program held further surprises.

**Arsenic in Alabama**

Redstone Arsenal outside of Huntsville, Alabama, is one of the less widely known sites, but the discoveries there are arguably more significant. One area of Redstone, formerly known as the Huntsville Arsenal, became the sister plant to Edgewood for chemical weapons production in 1941 as part of the American effort to mobilize for World War II producing phosgene, lewisite, and mustard gas in significant quantities. It is estimated that the arsenal filled over forty-five million munitions during World War II, but the discoveries a few short decades after the war proved that most of these never left American soil. Since the 1970s, thousands of chemical munitions have been discovered buried in numerous undocumented locations at Redstone Arsenal. Terry de la Paz, current Public Works director for the Arsenal, suggests there may be as many as eighteen sites containing hundreds of tons of buried chemical warfare materiel in the area including over six miles of trenches filled with contaminated materials, as well as a quarry that experts with USACE and the EPA suspect contains barrels filled with chemical warfare agents and hundreds of unidentified munitions.[7]

The contaminated trenches did not surprise researchers as it is well documented that the Army used Redstone for disposal of not only the American chemical munitions

[7] Steve Johnson, "Special Report: What's Hidden Beneath Redstone Arsenal?" WHNT News, CBS, Huntsville, AL, WHNT, July 14, 2014. https://whnt.com/news/hidden-beneath-the-arsenal/.

produced there, but also those shipped back to the United States after World War II from both Germany and Great Britain for disposal.[8] It is difficult to know for sure how much may still be found at Redstone as specific records are scarce, and it has been noted that Army documentation has not been very accurate regarding its chemical weapons program, plus many records have been destroyed or misplaced over the intervening years. Without the benefit of this documentation, it is impossible to approximate the volume or location of these disposal areas, so ongoing remediation operations have become a slow and highly dangerous process.

Redstone Arsenal has received very little of the media attention that caused remediation activities at Spring Valley to occur at a heightened pace, even though the amounts of weapons buried at Redstone dwarf those discovered at Spring Valley. The most current estimates place around 1.7 million mustard filled 105mm rounds, 31,000 mustard filled 155mm rounds, 54,000 mustard filled mortar rounds, and 560,000 M47 100lb. mustard bombs at Redstone in addition to an unknown quantity of ton containers filled with lewisite, and M78 500 lb. phosgene bombs. De la Paz contends that locating and disposing of this dangerous material as well as certifying that soil and groundwater toxins are well within EPA limits could take well over twenty-five years to complete.[9]

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[8] National Research Council. *Remediation of Buried Chemical Warfare Materiel*, (Washington, DC: The National Academies Press, 2012), 66-67.
[9] National Research Council. *Remediation of Buried Chemical Warfare Materiel*, 65.

**“Sniffing” out more issues**

One of the most commons misconceptions when it came to chemical warfare is that it is the penultimate form of combat. Certainly, horror stories of men caught on the battlefield unable to defend themselves against a chemical attack became prevalent once Germany adopted chemical warfare strategies during World War I, yet chemicals never truly coalesced into the next great superweapon. Much of this is due to the rapid development of the gas mask, but also because of specialized training soldiers received once gas became a mainstay in modern warfare. American military training quickly incorporated gas drills, training soldiers to don gas masks quickly and effectively in the heat of battle.

Of course, this training would be useless if soldiers did not understand how to detect the presence of gas. In efforts to familiarize soldiers with the smell of various chemical agents so they could have advance warning if a chemical attack occurred or if an area had already been saturated with chemicals, the Army Chemical Corps created “sniff kits” more formally known as Chemical Agent Identification Sets (CAIS). CAIS contained several glass vials filled with various chemical agents and packed in wooden or metal containers. CAIS contained the most widely used agents: phosgene, lewisite, chloropicrin, and nitrogen mustards, though later iterations of CAIS contained additional agents like adamsite, tabun, and sarin.[10] The Army claims it manufactured 110,000 of these kits and sent them to military installations and select members of civil defense

[10] “Chemical Agent Identification Sets Fact Sheet” United States Army Chemical Materials Activity, http://www.cma.army.mil/fndocumentviewer.aspx?docid=003671048 (accessed January 2, 2021).

networks such as air raid wardens, firefighters, and decontamination workers during World War II. The Army maintains that only twenty-one thousand sets have been recovered, which leaves eighty-nine thousand sets unaccounted for. Others such as former federal toxicologist John R. Cashman estimates that the Army's numbers are conservative and it manufactured and distributed millions of these kits. Cashman's research also suggests that most of the unaccounted CAIS probably ended up improperly disposed of via burial.[11] Army officials maintained that even if this were the case, decades had passed since they manufactured the kits, and any surviving ones did not pose any threat to humans or the environment since the agents would have naturally become inert over time.

However, the discovery of a cache of these kits at the state fairgrounds in Jackson, Mississippi in 1996 severely undermined the Army's claims. Several construction workers using a backhoe to dig a sewer hole suddenly found themselves surrounded by a haze that caused workers to be removed due to respiratory problems. The Mississippi Health Department instructed the workers to cease all work at the site until they could determine what caused the toxic mist. Health Department representatives discovered two intact vials—one that contained pure phosgene and another that contained pure sulfur mustard. They alerted the military, and a response team sent out to the site by the Army unearthed two-hundred and fifty-six intact vials of sulfur mustard, lewisite, and phosgene. Further analysis of the recovered vials confirmed them as CAIS vials from Old

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[11] John R. Cashman, *Emergency Response to Chemical and Biological Agents*, (Boca Raton: CRC Press, 2002), 106.

Jackson Armory, a former National Guard training site that had closed shortly after the end of World War II.[12] The discovery increased the possibility that if kits from that era were still intact, thousands of others produced both during and after the war would be as well.

Of even greater concern is the fact that the two men hospitalized because of the incident proved that the chemicals retained their potency several decades after burial and as CAIS requisition records are sparse, those responsible for locating them had very little knowledge on what bases received kits, or how many sets each facility received. Furthermore, the discovery of these kits at a former National Guard training post signified that the distribution of CAIS is not just limited to the major training facilities, but that they could have ended up practically anywhere where military activities occurred.

These events highlighted the inaccuracy of assertions by the Army that buried chemical weapons materiel posed minimal risk or that it is easy to identify what areas needed remediation and to what degree. Furthermore, discoveries of barrels of chemical agents in places like Spring Valley or the sniff kits in Jackson, Mississippi underscored the fact that the Army had not done a good job of keeping track of these materials and in many cases misplaced or destroyed records vital to locating any other potential hot spots. The Army's arguments of limiting security risks and acting within the interests of

[12] "Formerly Used Defense Sites Program Management Action Plan: Jackson Fairgrounds," United States Army Corps of Engineers, https://fudsportal.usace.army.mil/ems/ems/inventory/map/map?id=55116 (accessed January 5, 2021).

national trust fell terribly short as the health and lives of American citizens were suddenly at stake.

Even sites where the Army had ample documentation on production and closure operations posed significant environmental problems decades after the end of the chemical warfare era. The Dow Chemical plant in Midland, Michigan is a prime example of this. Dow started collaborating with the Army during World War I and the Midland plant is one of the earliest facilities converted to produce mustard gas. Naturally, this collaboration continued throughout successive wars as an integral component of the military-industrial complex. Dow also used the Midland plant to produce Agent Orange, the most prominent rainbow agent used during the Vietnam War, from 1962 to 1971. One of the by-products of Agent Orange production is dioxin, a known carcinogen, and while significant amounts of the compound ended up in the defoliants used in Vietnam causing birth defects among the Vietnamese people and countless instances of cancer among soldiers who fought in the war, the plant also released large amounts of the compound into the nearby Tittabawassee River. In the intervening years, local physicians confirmed the presence of dioxin in the blood of several Midland residents, the majority of which never worked at the plant or served tours of duty in Vietnam, but likely consumed fish taken from the Tittabawassee, or wildlife from the surrounding areas known to feed on fish from the river.[13]

[13] Jack Doyle, Trespass Against Us: Dow Chemical & The Toxic Century (Monroe: Common Courage Press, 2004), 413.

Other known and well-documented sites tend to follow the same pattern seen at Spring Valley. At the former lewisite production facility in Willoughby, Ohio, senior officials with USACE deemed the former production facility safe and free of contaminants in 1984, and even went as far to claim that the pilot plant never produced lewisite. Subsequent reports determined remediation of the site unnecessary yet in 1957, several bottles of lewisite recovered from a filled pit adjacent to the former plant raised questions on the veracity of those reports.[14] Later, a U.S. Institute of Medicine report published in 1993 claimed that the Willoughby plant created over 150 tons of lewisite that was on a ship heading to Europe during the finalization of the 1918 armistice agreement.[15] Still, the Army maintained their position that the Willoughby plant never produced lewisite. However, this did not stop them from earmarking one-hundred thousand dollars for an archival photographic assessment of the site in 2002. Anecdotal accounts also speak to a more varied history as a former Ohio Rubber Company employee claims that several of his coworkers discovered tanks of sulfur mustard during installation of duct work in the elevator shafts.[16]

Of course, these sites and incidents are only but a few of the more prominent examples as USACE's FUDS inventory contains dozens more across the United States, many of which have been unexplored or are in a state of limbo between research being

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[14] Jeffery L. Frischkorn, "Willoughby's war history coming into focus," *Willoughby News-Herald* (Willoughby, OH), Feb. 17,2002.
[15] United States Institute of Medicine. *Veterans at Risk: The Health Effects of Mustard Gas and Lewisite.* (Washington, DC: National Academies Press, 1993), 26.
[16] Don Detore, "Poisonous gas once manufactured at former Ohio Rubber Co. site," *Rubber and Plastics News*, Crain Communications, Apr. 10, 2013, https://www.rubbernews.com/article/20130410/NEWS/130419999/poisonous-gas-once-manufactured-at-former-ohio-rubber-co-site.

incomplete or funding for cleanup being held up by bureaucratic hurdles. Though considering how each of the above examples have played out and the fact that the Superfund list has an extensive backlog of sites still requiring further testing and research, it is doubtful that Americans are finished with the deadly discoveries stemming from the American chemical weapons program.

Meanwhile, as USACE and the CMA maintain that they have gone far in discovery and remediation of numerous sites across the U.S., it is only within the last couple of decades that researchers have started to confront the thousands of tons of chemical agents scattered across the globe. Certainly, the United States is not the only nation complicit in this spread as contamination is not just a byproduct of proliferation and stockpiling. Another stream of chemical weapons that enhanced the ecological footprint is those that left behind by retreating armies between 1917 and 1945. To be sure, most left behind in this manner consisted of German munitions, though research has shown that British and French armies engaged in the practice as well. However, due to programs such as lend/lease, the exigencies of joint allied operations during World War II, and the sheer manufacturing capacity of its production facilities, an overwhelming majority of chemical weapon detritus in Europe is of American manufacture. The chemical weapons left behind after World War II did not get buried like much of the American stockpile but ended up disposed of in European waters. Accordingly, researchers have noted that what lies beneath our oceans has the potential for catastrophic long-term effects.

**Long-term effects of chemical weapons disposal at sea**

Clearly, the discovery of chemical weapons by civilian workers represented one facet of risk associated with how the Army chose to dispose of its chemical arsenal. However, the Army's short-sightedness with regards to disposal manifested itself in other ways and it would only be a matter of time before another facet of risk emerged. At the time the field of ecology, still in its infancy, had yet to fully develop the connections between man and his environment and in fact, much like disposal by burial, the possibility of these chemicals affecting ecosystems and potentially entering the food chain did not garner any concern. In later years, the Army maintained its position that the size of the ocean and the remoteness of disposal areas prevented any chance of humans encountering these toxins. Once again, the conflux of nature and man proved them terribly wrong.

In January 1997 commercial fishermen trawling the Bornholm Basin of the Baltic Sea discovered an unidentifiable chunk of material dredged up by their nets. Thinking the chunk to be dirt or some other harmless debris from the ocean floor, they dumped the mass in a rubbish container once they returned to port, only to discover that the mysterious lump consisted of sulfur mustard when four of the crewmembers developed severe skin lesions and had to be hospitalized the next morning.[17] The discovery was not unexpected considering the sheer amounts of chemical agents dumped in the Baltic Sea

[17] Steve Katona, "Nasty Surprises On The Ocean Floor: Chemical Warfare Agents And Ocean Health," Ocean Health Index, July 24, 2014, http://www.oceanhealthindex.org/news/Nasty_Surprises_on_the_Ocean_Floor.

following the war, however, discovering mustard in lump form initially baffled researchers.

Extensive research on the phenomenon revealed raw sulfur mustard solidifies into a lumpy mass that develops an outer polymer crust when exposed to ocean water. While this does prevent the toxin from spreading further throughout bodies of water, research has indicated that this polymer crust prevents sulfur mustard from dissolving naturally, meaning that much of what lies at the bottom of the ocean still retains its original potency, as the Polish fishermen who discovered it with their trawling nets found out first-hand.[18]

In the case of organoarsenic agents, such as lewisite or adamsite, the rate of degradation depended on the amount of agent dumped. These toxins also tended to clump together like sulfur mustard when exposed to ocean water but do not form the polymer shell that prevents hydrolysis. Organoarsenic agents generally hydrolyze forming tetra-phenyldiarsine as the only toxic byproduct that is quickly absorbed into sediments and can persist for a significant amount time underwater before finally degrading into arsenic that retains its toxic characteristics for nearly a century.[19] This in and of itself created a pathway for these toxins to enter the food chain starting at the lowest levels with filter-feeding organisms such as clams, mussels, and oysters as well as a variety of marine life that subsisted off these organisms. One saving grace that promised to limit the chances of

[18] M.I. Greenberg et. al., "Sea-dumped chemical weapons: environmental risk, occupational hazard," *Clinical Toxicology* 54, no. 2 (2016), 84.
[19] Blaise Baquiche, "Poland, Mustard Gas, &The Rule Of Law: The Battle for Illiberal Democracy," *Byline Times* (London,UK), July 10, 2020.

shellfish being a significant vector of food-borne contamination is that commercial aquaculture rose to prominence during the intervening years and most shellfish consumed by humans globally are not wild-harvested but come from farms that are far removed from polluted areas and impose carefully controlled environments to ensure profitable harvests. This is not the case with many commercial fishing operations as highly profitable species such as cod, squid, and herring are typically caught in deep waters with massive trawling nets to maximize the catch of species that are known to feed on organisms who maintained direct contact with polluted areas such as shellfish and krill. To be sure, the digestive systems of these organisms can filter out toxins such as arsenic to some degree though in areas of heaver pollution, this process becomes increasingly difficult resulting in bioaccumulation of the toxin which in turn is transferred to larger fish and other aquatic species that feed on them. Moving up the food chain, bioamplification occurs carrying increasing levels of arsenic to larger organisms, many of which are eventually consumed by humans.[20]

Larger commercial fishing operations have been wary of these chances, as brought to light not only through Rachel Carson's *Silent Spring*, but also resulting from increasing awareness of the potential for mercury poisoning that threatened to upend the commercial fishing industry. The commercial fishing industry has taken numerous steps to ensure that fish are not harvested from known polluted waters, though smaller local fishing operations and individuals who rely on fishing for sustenance often do not have

[20] M.I. Greenberg et. al., "Sea-dumped chemical weapons: environmental risk, occupational hazard," *Clinical Toxicology* 54, no. 2 (2016), 87.

access to the same amount of data or resources as their larger counterparts, and in most cases are blithely unaware of where governments dumped their hazardous wastes, especially when it comes to chemical weapons of a bygone era. This poses significant risk to these populations as the areas that are not frequented by commercial fisheries due to pollution are the ones that are more commonly used for subsistence fishing.

The long degradation times and the unique characteristics of arsenic-based chemical agents dumped in the ocean present numerous problems. As discussed in the previous chapter, locating the chemical weapons dumped into marine environments remains a monumental task as ocean currents and storms have caused toxins to migrate, meaning that available data from the original disposal programs is not guaranteed to be accurate. Additionally, large underwater construction projects such as transoceanic data cables or the construction of oil and natural gas pipelines threaten to stir up chemicals that have settled at the bottom of the ocean, thus reintroducing them into aquatic environments and increasing the potential for entry into the food chain.

Finally, there is the potential for environmental catastrophes stemming from the tons of filled munitions dumped during the CHASE operations. Most munitions, after being sealed in concrete vaults, ended up at intended dumping sites however, an unknown number of disposed munition sets only had wooden packing crates protecting them underwater.[21] After decades of sitting on the ocean floor, the crates have deteriorated and the shells containing chemical agents have rusted and are now leaking

[21] John Bull, "Vast Chemical Dumping Found At Sea," *Newport News Daily Press,* October, 30, 2005.

into marine ecosystems. The largest risk is not from the shells slowly leaking contaminants into the water where they can dissipate harmlessly, but from munitions that have completely lost structural integrity. In these cases, a massive chemical plume is released stretching hundreds of miles from the original site assisted by naturally occurring ocean currents, or those created within common marine shipping lanes.

Luckily, non-organoarsenical chemical warfare agents dumped into the ocean do not create such issues as they tend to degrade quickly with few toxic byproducts. For example, phosgene, one of the earliest and most widely used chemicals during World War I, hydrolyses into carbon dioxide and hydrochloric acid which degrades rapidly in marine environments thanks to the ocean currents assisting with dilution. Research and ongoing monitoring programs of suspected contaminated areas has indicated that the release of the acid has not produced any significant impacts in marine organisms. Blood agents such as hydrogen cyanide and cyanogen cyanide hydrolyze within a matter of days into chloride and cyanic acid before finally dissolving into ammonia and carbon dioxide, both of which have no deleterious effects on marine organisms and exist naturally within the ocean in varying quantities. The nerve agents tabun and sarin also follow similar patterns of degradation seen with hydrogen cyanide and cyanogen cyanide posing minimal environmental risk or persistence as the breakdown of these agents occurs within the same time frame seen with blood agents.[22]

[22] M.I. Greenberg et. al., "Sea-dumped chemical weapons: environmental risk, occupational hazard," *Clinical Toxicology* 54, no. 2 (2016), 85.

In some cases, ocean dumped munitions do not need to fail to produce substantial risk to both humans and the environment, as one notable incident proved. In coastal areas of the United States, it is common for oyster, clam, and mussel shells to be recycled and used as filler in concrete used to create non-structural items such as driveways and sidewalks. In 2004, a live mustard round was discovered in one such driveway in Bridgeville, Delaware. The homeowner did not sustain any injuries, however, three men with the explosive ordinance team tasked with disarming the munition received severe burns while attempting to neutralize it.[23]

**Long-term effects of buried chemical weapons**

Buried chemical weapons present a different set of challenges for researchers and remediators alike. While buried chemicals are significantly easier to locate as burial sites are most often located at the military bases or near manufacturing facilities where they originated and are largely unaffected by the environmental conditions that make it difficult to locate those disposed at sea, other factors such as terrain type, burial depth, and volume of agent disposed play major roles in how contaminated an area is, as well as what steps are needed for remediation. An analysis of a few of the known chemical weapon burial sites in the United States illustrate both the difficulties of remediation and the extent of environmental effects from these long forgotten chemical weapons.

[23] William C. McMichael and Jeff Montgomery, "Two suspected mustard rounds found at seafood plant," *The News Herald* (Wilmington, DE), January 27, 2015.

The issues surrounding the former AUES facility in Spring Valley have produced a considerable body of research as it is the most widely known site due to its proximity to the nation's capital and the notoriety of its residents, but this did not make the environmental impact any more notable than other sites such as Edgewood Arsenal, Redstone Arsenal, or Rocky Mountain Arsenal. Despite the 2016 USACE claims of Spring Valley being contaminant free, successive years have still witnessed continued monitoring of groundwater supplies for arsenic due to the flat, semi-sandy nature of the soil there and the fact that arsenic absorbs into this type of sediment readily, much like what has been seen with sea-dumped chemical weapons.[24] This also held true at Edgewood Arsenal as there is little marked difference in terrain type considering they are both located adjacent to coastal estuaries.

However, there are a couple of significant differences between these two sites despite their proximity and similar alluvial soils. Unlike Spring Valley, Edgewood Arsenal was the de facto headquarters of the United States chemical weapons program, and therefore outpaced AUES in production, storage, and waste products. Once the U.S. had committed to ending its chemical weapons program, Edgewood Arsenal became as much as a gathering place for America's outdated chemical weapons, as it became its largest disposal grounds.

Key military officials at the facility made the decision that a tract of land towards the southernmost portion of the base be dedicated to house both Edgewood's chemical

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[24] Nancy B. Munro et. al, "The Sources, Fate, and Toxicity of Chemical Warfare Agent Degradation Products, *Environmental Health Perspectives* 107, no. 12 (December 1999), 949.

weapons and waste by-products, as well as those being shipped from other facilities across the country. Of particular interest is an area known as "O Field" where barrels of mustard and adamsite resided—not buried like the agents at Spring Valley or Redstone Arsenal, but thrown into large open-air pits along with other discarded chemical and conventional bombs and shells. A congressional hearing in 1987 on the matter of toxic wastes at U.S. military bases placed particular focus on the activities at Edgewood. Included in this testimony is an excerpt from a 1976 Army report that typified how the Army dealt with its waste products both toxic and non-toxic.

A first-hand account from Dean Dickey, the officer placed in charge of cleanup at O Field in 1949, observed that the field was so congested with pollution that he could walk the entire length of it on discarded munitions without ever touching the ground. Even more startling is the fact that the items had been haphazardly dumped in the field and the only way the soldiers could identify what sort of hazards they faced in any particular area were the markings placed on the items and Dickey noted, "That took some doing for most of the color coding was missing from the munitions body and the munitions were rusty."[25] Dickey's account also mentions several occasions where his team had to quickly evacuate the area due to white phosphorus flare-ups often leading to a chain reaction of live ordinance exploding. Amazingly, considering the sheer amount of chemical munitions housed at O Field, Dickey's account does not mention any instances

[25] United States Congress, House, Subcommittee of the Committee on Government Operations, *Hazardous Waste Problems At Department Of Defense Facilities,* 100th Cong., 2nd sess., 1987, 104.

of he or his team members suffering injuries resulting from the Army's glaring oversights.[26]

Regarding the chemical weapons dumped in O Field, Dickey points to two significant occurrences when he and his team had direct contact with agents. He notes that on one occasion, one of the many white phosphorous flare-ups resulted in mustard gas being released. Luckily, Dickey's quick thinking, no doubt a result of the gas training he had received, recognized the tell-tale odor and warned his team to avoid the area for a few days until the mustard could dissipate.[27]

The other instance is more telling when it came to the Army's myopic view of disposal. One morning, Dickey surveyed a portion of O Field where a massive explosion had been set off by a convoy of tanks passing nearby a few days earlier, he discovered a sulfur mustard leak leading from the field to nearby Watson Creek and Gunpowder River, both of which feed into the Chesapeake Bay. In his report, Dickey suggested that considering the amount of chemical munitions he discovered while working there, there could be no doubt that the soil in and around O Field would be contaminated. Further testing conducted in 1985 by an independent contractor confirmed Dickeys claims, they discovered contaminated soil and groundwater samples, with some toxins being in concentrations of over four-hundred times the EPA's permissible levels.[28]

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[26] According to Dickey's account his team discovered 8151 ton containers of mustard and adamsite, 1700 mustard-filled projectiles, 10 cyanogen chloride bombs, and 21248 sarin rockets.
[27] United States Congress, House, Subcommittee of the Committee on Government Operations, *Hazardous Waste Problems At Department Of Defense Facilities,* 100th Cong., 2nd sess., 1987, 101.
[28] [28] United States Congress, House, Subcommittee of the Committee on Government Operations, *Hazardous Waste Problems At Department Of Defense Facilities,* 100th Cong., 2nd sess., 1987, 407.

A similar situation had also developed at Redstone Arsenal with regards to its own chemical weapons, those shipped from other domestic facilities in attempts to centralize the American chemical weapons stockpile, and a sizable cache of weapons shipped overseas from Germany and Japan following World War II. The Army chose the site due to its previous chemical weapons activities as Redstone churned out hundreds of filled mustard, phosgene, lewisite, and adamsite rounds between 1940 and 1945.[29] Of course, the Army followed the same protocols at Redstone as they did at Edgewood. However, instead of creating yet another O Field, military leaders at Redstone opted to build a series of trenches stretching over six miles to dump the obsolete weapons in and forget they had ever existed. Only after the ratification of the CWC did the American government start to confront the munitions buried at Redstone Arsenal.

However, with Redstone the problem is not simply a matter of digging these trenches up and disposing of what is buried there. Like Edgewood, few accurate records exist for what is buried at each location and according to Jason Watson, one of the program managers overseeing the cleanup at Redstone, chemical munitions are interspersed with other pieces of unexploded ordinance, smoke bombs, and canisters of white phosphorous with the potential to cause a chain reaction release much like Dean Dickey witnessed at Edgewood.[30] In addition to six miles of filled trenches, Watson's team has also discovered several barrels of raw agent, gas masks and lab equipment

[29] National Research Council, *Remediation of Buried Chemical Warfare Materiel*. (Washington, DC: The National Academies Press, 2012), 66.
[30] Chris Colster, "Cleanup efforts restore land for future development," *Redstone Rocket* (Decatur, AL), June 12. 2019.

haphazardly disposed just outside the perimeter of Redstone Arsenal. The prevailing theory is that no one would ever dare to go into the inhospitable swampy land that provided a barrier between the arsenal and the Tennessee River.[31]

Terry de la Paz, Redstone Arsenal project manager, estimates that out of the over three-hundred thousand munitions suspected to be buried there, anywhere between twenty to twenty-five thousand are chemical mentions are still intact, posing incredible challenges for those now responsible for remediation.[32] These also pose significant environmental risk as many of them are suspected to be filled with organoarsenic agents which have been shown to persist in soil and groundwater supplies for many decades. Accordingly, de la Paz notes that full cleanup operations, even with added assistance from USACE will last until the late 2020s, barring any further unexpected discoveries.

An interesting scenario developed at Rocky Mountain Arsenal (RMA) when Army chemical experts selected what they considered a novel method of attempting to dispose of its chemical weapons in a manner that ignored both the danger of these toxins to the environment and the geologic stability of the facility. The arsenal was founded in 1942 as part of the United States mobilizing for World War II after the attack on Pearl Harbor and chosen due to its proximity to Denver's airports as well as unique geological features that made it less likely to suffer an attack. In its span of military operation, RMA produced several different chemical agents including mustard, lewisite, chlorine, and

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[31] David Zucchino, "Deadly chemical weapons, buried and lost, lurk under U.S. soil," *Los Angeles Times* (Los Angeles, CA), March 21, 2014.
[32] David Zucchino, "Deadly chemical weapons, buried and lost, lurk under U.S. soil."

sarin. However, after the war when the Army had made the decision to reduce its chemical production capacity, instead of completely dismantling the facilities at RMA, the Army opted to lease a portion of its chemical production areas to the Shell Chemical Company for pesticide manufacture with the caveat that if needed, the military could use the facility to resume chemical weapons production. However, the portion of the facility not leased out to commercial interests continued to produce chemical weapons until 1968 and pesticides such as chlordane and parathion continued to be produced there until 1982.[33]

Of primary concern at RMA is an area known as Basin F, a ninety-three-acre asphalt lined pit created in 1951 for consolidation of the toxic waste products from chemical weapon and pesticide production and designed to limit the chances that contaminants from the arsenal polluted groundwater supplies. Unfortunately, the Army discovered a flaw in its initial plans to use Basin F to confine the toxic wastes to the facility. In 1957 residents in nearby Commerce City detected migrating contaminants from RMA in local wells. The Army's then decided to build a deep injection well to pump the toxic contents of Basin F, a veritable soup of chemical by-products and stockpiled agents, twelve thousand feet below the Earth's surface.[34] The Army completed the injection well in 1961 and over one-hundred fifty million gallons of Basin F contents were pumped into the well before the Army terminated the project five years later due to

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[33] United States Department of the Interior, United States Department of Fish and Wildlife, *Rocky Mountain Arsenal National Wildlife Refuge Annual Narrative Report Fiscal Year 1998* (Washington, D.C.: Government Printing Office, 2002), 6.
[34] Karen B Wiley and Steven L. Rhodes, "From Weapons To Wildlife: The Transformation of the Rocky Mountain Arsenal," *Environment* 40, no. 5 (June 1998), 7.

a series of atypical earthquakes centered around the arsenal and geologic experts suggested that the injection well is what triggered them.

The first earthquake occurred in January 1966 and measured 5.0 on the Richter scale and immediately prompted Army officials to cease operations. Subsequent earthquakes followed with one in August 1967 that reached 5.3 on the Richter scale, and then another three months later in November that measured 5.2, all of which caused significant damages to homes and businesses in the northern Denver suburbs. Since then, experts have measured fifteen earthquakes of lesser magnitude in the area. What proved that the injection well caused the earthquakes is the fact that records dating back to 1867 show no such seismic activity in this region of Colorado.[35]

Aside from the physical damage caused by yet another misguided attempt to dispose of chemical weapons, to this day continued monitoring of the groundwater supplies in and around the base shows elevated levels of toxins well beyond normal environmental levels.[36] Among the prairie dog towns and bison that roam the arsenal, it is difficult to ignore the presence of hundreds of groundwater testing wells spread out across the former base and there are no clear answers as to when the facility will be completely free of the toxins the Army left here.

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[35] "Colorado Earthquake Information," Colorado Department of Public Safety, Colorado Division Of Homeland Security and Emergency Management, March 11, 2011, http://www.coemergency.com/2010/01/colorado-earthquake-information.html

[36] United States Department of the Army, *Rocky Mountain Arsenal: Annual Summary Report For Groundwater and Surface Water, Fiscal Year 2016* (Washington, D.C.: Department of Defense, 2017), 73.

One notable question that continues to emerge within the available literature is why portions of the Nazi and Japanese chemical stockpiles ended up being shipped to the United States as opposed to being destroyed on-site or held at American bases until a proper disposal method could be discovered, such as the stockpiles in Okinawa that eventually made their way to Johnston Atoll Chemical Disposal System (JACDS) for final neutralization. Unfortunately, the paucity of military records associated with the movements of overseas chemical stockpiles to American facilities have prevented researchers from finding answers to such questions.

Another challenge with these buried stockpiles is that they do not undergo hydrolysis as witnessed with chemical weapons dumped into the ocean. On one hand this is seen as a positive when it comes to contaminants like sulfur mustard that have proven to form a polymer shell protecting the chemicals when exposed to ocean water thus creating a hazard when they are rediscovered. One of the biggest downfalls to the use of mustard as a chemical weapon is that under typical circumstances, it is not an overly persistent agent. While it could contaminate an area for several days, a decent rainstorm or humid conditions rendered it practically ineffective.

On the other hand, organoarsenical agents remained problematic regardless of if they are disposed of in the ocean or on land. As weapons, compounds such as lewisite and adamsite were quickly written off as ineffective under typical battlefield conditions due to their rapid hydrolysis even though the primary hydrolysate – arsenic, remained and is known to persist for several decades. In the case of stockpile burial, the arsenic slowly worked its way into groundwater supplies and its uptake by plants meant that the

possibility of birds and mammals who feed on them brought the same types of bioaccumulation and bioamplification seen in aquatic environments. Researchers have also observed that these discoveries may only be the tip of the iceberg when it comes to the cumulative environmental effects of chemical weapons disposal. It has also been noted that except for the Spring Valley neighborhood, these deadly discoveries have been made in areas with a high minority population, depressed income, and low socioeconomic status, thus creating a crossroads between governmental responsibility, ecological risk, and environmental justice which will be explored in the next chapter.

## Chapter IV- Not In Our Backyard: The Drama Of Chemical Weapons Remediation

The latter half of the twentieth century brought with it a reckoning for the military regarding its chemical weapons legacy, not just due to the increasing amount of accidental discoveries made by civilians that affected both individuals and communities, but also through emerging legislation that sought to make the Army accountable for both its stockpiled material and its previous disposal activities through domestic laws such as the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), and international laws like the Chemical Weapons Convention (CWC). Together, these laws aimed to charge responsible parties with remediation of contamination stemming from proliferation of chemical weapons and eliminate these weapons on a global scale.

However, being the largest producer of such weapons, the United States faced seemingly insurmountable issues between numerous disposal sites located around the globe, the amount of chemical warfare materiel stockpiled at various installations across the country, and how disposal is to be conducted without endangering its citizens or the environment, while maintaining the standards dictated by the Environmental Protection Agency (EPA) and remaining in compliance with the destruction timeline mandated by the CWC. While the Army set forth on the monumental task of finally ending the chemical warfare era and attempting to figure out how to juggle all these competing interests, new problems arose that placed military leaders within the crosshairs of

environmental organizations, local governments, and citizen advocacy groups as issues of environmental justice and agency plagued their efforts at nearly every turn.

This chapter will explore remediation efforts begun after the CWC entered into force in 1997 by looking at the activities and legislative hurdles faced by the United States after it had committed itself to chemical demilitarization while also attempting to mitigate the environmental damage caused due to both the long-term storage of these weapons and their unsanctioned disposal prior to CWC ratification. This chapter also examines public reaction to the construction of facilities designed to destroy chemical agents and munitions quickly and safely in accordance with the CWC, while seeking to discern if members of the surrounding communities were denied agency by the Army. The chapter ends with an exploration of how the United States and Russia diverged in their approaches for stockpile disposal in accordance with the Chemical Weapons Convention.

**CERCLA the Wagons**

By the 1960s the United Sates realized that it had a growing environmental problem not just in terms of the chemical weapons stored at various military facilities, but also increasing streams of solid waste resulting from the rapid industrial and population growth in America following World War II. These growing waste streams in conjunction with the increasing awareness of environmental concerns sparked by Rachel Carson's *Silent Spring* prompted the government to act. In 1976, Congress passed the Solid Waste Disposal Act, a comprehensive plan to deal with solid wastes emanating from federal facilities, manufacturing centers, and urban residential corridors. However, by this time

the nation's environmental watchdog, the Environmental Protection Agency (EPA) did not yet know the full extent of chemical weapons material and waste by-products that already existed at military bases across the country; though the discovery of ocean-dumping programs such as CHASE, and toxic dumping sites such as Edgewood's O Field, and Basin F at Rocky Mountain Arsenal quickly garnered the attention of the EPA who determined further legislation necessary, especially since previous legislation focused on air and water pollution, not buried wastes.[1]

Congress did have the foresight to make the Solid Waste Act a living document, and in 1976 Gerald Ford amended the Solid Waste Act creating the framework for the Resource Conservation and Recovery Act (RCRA), thus charging the EPA with creating a list of all known toxic waste sites and their recommendations for cleanup and disposal of those sites. Furthermore, the act empowered the EPA to dictate a set of requirements to be passed along to the states who were ultimately responsible for following the guidelines and enforcing them. Arguably, the most important provision of RCRA is its strong emphasis of "cradle to grave" responsibility for the producers of toxic wastes, meaning that they were liable not only for the entire life cycle of toxins they produced, but also any detrimental environmental effects that arose from storage, transport, and disposal of their toxic wastes.[2]

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[1] "EPA History: Resource Conservation and Recovery Act," United States Environmental Protection Agency, last modified June 8, 2020, https://www.epa.gov/history/epa-history-resource-conservation-and-recovery-act.

[2] "Resource Conservation and Recovery Act (RCRA) Regulations," United States Environmental Protection Agency, last modified February 25, 2019, https://www.epa.gov/rcra/resource-conservation-and-recovery-act-rcra-regulations#haz.

However, Congress quickly discovered flaws in RCRA, the biggest being that the act only applied to currently operating facilities producing waste, not those that had since ceased operations but had left behind significant amounts of toxic byproducts. Complicating issues further is the fact in many cases, those responsible for contamination are difficult to track down, especially in the case of closed or abandoned facilities typified by environmental disasters such as Love Canal and Valley of the Drums that finally prompted Congress to find solutions for these oversights.[3] Their answer came in 1980 in the form of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), more commonly known as the Superfund.

A primary feature of CERCLA is the establishment of a tax on current producers of toxic waste, with the proceeds from that tax being placed in a trust fund to be used for the cleanup of contaminated sites where a responsible party could not be located, or in cases where a polluter declared bankruptcy. When a responsible party could be located, the CERCLA mandate of "polluter pays principle" attempted to guarantee the sustainability of the Superfund and prevent rapid depletion of the fund by ongoing remediation efforts. Additionally, CERCLA also enacted the of creation of a National Priority List (NPL), a list of sites eligible for CERCLA remediation funds organized by pollution level and ranked by a point-based system designed by the EPA to identify which sites deserved the most immediate attention.[4]

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[3] For further information on the Love Canal and Valley of the Drums sites see Samuel S. Epstein, Lester O. Brown and Carl Pope, *Hazardous Waste in America* (San Francisco: Sierra Club Books, 1982).
[4] "Summary of the Comprehensive Environmental Response, Compensation, and Liability Act (Superfund)," United States Environmental Protection Agency, last modified July 27, 2020,

One of the biggest differences between RCRA and CERCLA is that CERCLA placed cleanup under federal jurisdiction as opposed to the RCRA which provided federal guidelines for cleanup managed by the EPA, but mandated individual states to enforce those laws. This created an interesting legal situation surrounding Colorado's Rocky Mountain Arsenal (RMA) when federal and state actors applied both laws to the former military facility.

These legal issues cropped up long before Congress enacted RCRA or CERCLA and go back to 1975 when the state of Colorado issued several administrative orders requiring that the Army and Shell Oil Company, the two primary polluters of the site, clean up all chemical sources, cease all chemical discharges and begin a thorough groundwater monitoring program at the arsenal. The Army initially complied with the orders, embarking upon a study to determine the extent of contamination at RMA while also taking some immediate steps to control the number of wastes that had been migrating off the facility's property. By 1982, the state of Colorado, the EPA, the Army, and Shell all signed a memorandum of agreement regarding the Army's current and future plans for remediation of the area, just a few short years after CERCLA codification. However, Colorado did not approve the Army's inaction on Basin F and subsequently filed an injunction, claiming that its continued operation constituted a blatant violation of Colorado's environmental laws.[5]

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https://www.epa.gov/laws-regulations/summary-comprehensive-environmental-response-compensation-and-liability-act.

[5] James M. Lenihan, "RCRA versus CERCLA: The Clash of the Titans in Colorado v. United States Dep't of the Army United States Dep't of the Army," *Pace Environmental Law Review* 8, no. 2 (Spring 1991): 624.

The Army sought immediate dismissal of the injunction, claiming that Congress did not waive sovereign immunity at the site and therefore, not required to comply with Colorado's hazardous waste laws. Furthermore, as the site had recently fallen under the purview of CERCLA, that those cleanup efforts superseded any state actions initiated under RCRA, and in fact Colorado's environmental laws hampered cleanup efforts.[6] Initially, the court found the Army's arguments unconvincing and agreed that the state of Colorado had specific rights under RCRA and subsequent legislation could not usurp those rights, nor the State's ability to enforce EPA guidelines set forth in RCRA in accordance with their own environmental laws that the court determined conformed to Federal hazardous waste regulations. The court also charged both the Army and Shell Oil with acting in bad faith towards the state of Colorado by attempting to deny them agency regarding the cleanup efforts.

Of course, the legal battles between the Army and the state of Colorado were only beginning, and the adversarial relationship between Colorado and the Army continued to impede cleanup efforts. However, the litigation surrounding RMA points to deficiencies in both RCRA and CERCLA that create opportunities for selective interpretation of the laws and seemingly endless legal struggles that pit sovereign rights against federal jurisprudence. The Colorado case is archetypical of cases surrounding other former chemical weapons production and storage facilities and clearly points to the deficiencies

[6] James M. Lenihan, "RCRA versus CERCLA: The Clash of the Titans in Colorado v. United States Dep't of the Army United States Dep't of the Army," *Pace Environmental Law Review* 8, no. 2 (Spring 1991): 627.

that are inherent in both RCRA and CERCLA that paradoxically placed the Army in the position of both polluter and responsible party.

The Chemical Weapons Convention of 1997, while not specifically addressing environmental issues, went further than any previous legislation in mitigating the environmental risks commonly associated with chemical weapons proliferation. By mandating a unilateral weapons ban, the CWC altered the "retaliation in kind" paradigm that caused countries to stockpile chemical agents, thus reducing the chance of toxic agents from aging stockpiles being released into the environment. However, implementing the protocols for chemical weapons destruction set forth in the CWC quickly became problematic, especially since previously codified domestic and international laws removed every avenue that the Army favored for disposal—RCRA and CERCLA banned burial, as well as the open-air burning pits and made the Army financially responsible for the cleanup of areas where it had practiced these methods prior to 1970. The Marine Protection Research and Sanctuaries Act of 1972 made offshore disposal illegal, though the United States had ceased ocean dumping shortly prior to its passage, and the strict destruction timelines of the CWC meant the Army's "out of sight, out of mind" approach of storing chemical weapons indefinitely at remote bases was also off the table.[7]

The Army did have some unqualified success at incineration of chemical weapons and considering its favored avenues of disposal had been removed previously by the

[7] Marine Protection, Research, and Sanctuaries Act, 16 USC § 1431 et seq. and 33 USC §1401 et seq. (1988).

Nixon administration and subsequent environmental regulations, incineration remained the Army's best and only option for disposal at the time, though in order gain EPA approval for a wide-scale incineration program, the Army needed to show how they planned on accomplishing this in a safe and environmentally friendly manner.

In 1974, the Army began testing incineration on several different types of munitions such as chemical mines, rockets, and bombs at Deseret Chemical Depot to obtain the data they needed to submit to the EPA, These successful incineration trials evolved into the Chemical Agent Munition Disposal System (CAMDS), a pilot incinerator facility poised to be the blueprint for final destruction of the American chemical weapons stockpile.[8] CAMDS is unique in that it is one of the first instances where robotics were employed to minimize human risk in handling these deadly weapons. First, robots disassemble the munitions in reverse order by removing any volatile components such as fuses and bursters to eliminate the chances of spontaneous explosion, then the toxic agent is drained from the inert munition and sent to a liquid incinerator, and the metal casings from the munition are sent to a separate incinerator to be melted down to ensure destruction of any residual agent, with the metal being recycled by the military or industrial recycling facilities certified to handle such waste. To ensure further compliance with EPA regulations, the exhaust stacks of the incinerators are fitted with carbon filters to assist in removing any additional contaminants.

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[8] Office of the Project Manager Chemical Demilitarization, *Demilitarization Operation of the Chemical Agent Munition Disposal System (CAMDS) at Toole Army Depot, Army Directive A062-499* (Aberdeen Proving Ground, MD: Chemical Agent Disposal System Demilitarization/Disposal Office, 1977), https://apps.dtic.mil/sti/pdfs/ADA062499.pdf.

Overall, CAMDS is a significant achievement for the Army. Despite several early setbacks with the robotic systems improperly draining the munitions, both the EPA and NRC identified CAMDS as the safest way to dispose of these munitions while minimizing further contamination risks. By 1985, over forty-thousand munitions had been disposed of at CAMDS, now renamed the Tooele Chemical Agent Disposal Facility (TOCDF) and the Army started looking towards replicating the system at other storage sites across the United States. Several of the sites considered by the Army were ripe for incinerator placement, as they already housed significant chemical weapons stockpiles with most of the equipment and infrastructure in place to handle these toxic materials and their disposal in a safe manner.

The Army determined Johnston Atoll to be the perfect site to test this theory. Claimed by the U.S. military prior to World War II, Johnston Island essentially served as the eyes and ears of the United States in the Pacific during the war. After the war, the atoll became a testing ground for conventional, biological, chemical, and eventually nuclear weapons in the late 1950s. After nuclear testing ceased here, the Army found Johnston Atoll to be a more than convenient location for its overseas stockpiles of chemical weapons. The Army transported the entirety of the Okinawan stockpile here in 1971, and portions of the U.S. stockpile formerly held in West Germany and the Solomon Islands also made their way to Johnston Island. The island also became a drop point during 1972's Operation Pacer IVY for the thousands of gallons of Agent Orange that

had been all but abandoned in East Asia at the end of the Vietnam War.[9] The number of chemical agents already being stored at Johnston Island, along with the remoteness of the atoll, made it the ideal place for the first full-scale chemical weapons incinerator based upon the TOCDF pilot plant. When the Army broke ground on the Johnston Atoll Chemical Agent Disposal System (JACADS) in 1981, significant contamination issues existed resulting from previous military activities conducted there, so leaking munitions and barrels of raw agent did not draw much concern and the islands only inhabitants consisted of military personnel fully aware of the risks and protocols for handling toxic materials. To be sure, JACADS did not operate as flawlessly as the Army had predicted—the project regularly ran over budget, leaving JACADS operating only half of the time, and several explosions occurred injuring military personnel and releasing chemical agents into the environment.[10] Be that as it may, JACADS managed to complete its mission in 2000 with the Army hailing it as an unparalleled success.

Unfortunately, the remaining ninety-four percent of the American chemical weapons stockpile did not reside at bases ready-made for incinerator construction but scattered across the continental United States at various military installations. The Army's original plan consisted of centralizing the U.S. stockpile at three designated incineration sites with the Army covering the costs of transporting chemicals to these facilities. However, many of the states that the chemicals would be travelling through had

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[9] For more on Operation Pacer IVY, see Edwin A. Martini, *Agent Orange: History, Science, and the Politics of Uncertainty* (Boston: University of Massachusetts Press, 2012).
[10] National Security and Internal Affairs Division, *Chemical Weapons Disposal: Plans for Nonstockpile Chemical Warfare Materiel Can Be Improved*, GAO/NSIAD-95-55 (Washington, D.C.: Government Accountability Office, 1994), 14.

strict hazardous material transportation laws and regulations that made the overall cost of transportation and acquiring the proper permits overwhelming even by government standards. To move all the stockpile and non-stockpile materiel, the Army had to navigate a veritable morass of transportation and safety regulations that changed each time the chemicals crossed a state border.

In 1994, Congress determined the Army's plan to be unrealistic, adding that transportation of chemical weapons across state lines also constituted a significant health risk if any accidents occurred as the materials traveled to disposal facilities. Instead, Congress mandated that the Army must find a way to dispose of the American stockpile both safely and without hauling them across state lines.[11] Interestingly, the Army decided that as much of the continental stockpile already resided at military facilities, that creating destruction facilities at each of these bases would meet that mandate. Instead of the original three sites, the Army chose nine total sites for destruction of the American chemical weapons stockpile: the already active incinerators at JACADS and TOCDF, as well as Pine Bluff Arsenal in Arkansas, Umatilla Chemical Depot in Oregon, Pueblo Chemical Depot in Colorado, Anniston Army Depot in Alabama, Aberdeen Proving Grounds in Maryland, Newport Army Ammunition Plant in Indiana, and Blue Grass Army Depot in Kentucky. However, before any of the required environmental and

[11] To prohibit the Secretary of Defense from transporting across State lines chemical munitions in the chemical weapons stockpile, and for other purposes, H.R. 4346, 103rd Congress, 1st sess., (May 5,1994), https://www.congress.gov/bill/103rd-congress/house-bill/4346?r=27&s=1.

feasibility studies could be completed, the Army once again found itself mired in controversy.

**The NIMBY Principle**

For several decades prior to Chemical Weapons Convention ratification, Americans were blithely unaware of the chemical weapon stockpiles being stored across the United States, and in fact most Americans believed that chemical weapons simply disappeared after the end of the Second World War since the U.S. never used them in combat, and the few accidents where chemical agents had been released proved to be isolated incidents that did not affect Americans writ large. Not to mention how these incidents compared to the dangers from mishaps at nuclear facilities and the threat of nuclear annihilation that became hallmarks of the Cold War. In short, other than the fact that many Americans lived within close vicinity to chemical weapons stockpiles and burial sites, the populace was so far removed from the American chemical weapons program that it never existed at all except as a product of a bygone era.

This ambivalence changed with the revelations at what had been discovered at Spring Valley, a point driven home by the bitter debates surrounding CWC ratification. As Americans watched those debates play out in the media, many began to consider the possibility of chemical weapons being stored in their own communities, and the overall extent of environmental damage from chemical weapons haphazardly buried after the war. The convergence of these factors forced the military into a new age of transparency when it came to these aging stockpiles and how their government intended to dispose of

them. However, this newly found transparency also brought to light the numerous errors the Army had made with TOCDS and JACADS including mismanagement of program funding, lack of rigorous testing on waste byproducts, and a veritable host of mishaps not reported to the EPA. As the Army hailed its pilot incineration plants as a resounding success and prepared to utilize this disposal technology at the other storage facilities, several oversight agencies including the NRC, the EPA, and DHHS became convinced that incineration might not be the best option for disposal.[12]

Two short years after disposal operations had started at JACADS in 1990, Congress, several oversight agencies, and the American public started demanding further research into alternative disposal technologies. For the governmental entities, Public Law 102-484, otherwise known as the National Defense Authorization Act of 1993, forced the military to work with the NRC to identify and implement technologies other than incineration for chemical weapons disposal. Furthermore, the law also mandated that public advocacy commissions be formed for community outreach in areas adjacent to the facilities slated for stockpile destruction.[13] Instead of simply doing what they wanted to at bases they controlled as they had done in the past, now the Army had to include residents living near the facilities in the conversation. Additionally, PL 102-484 also brought with it even more bureaucratic hurdles as the Army now had to deal with several governmental organizations responsible for oversight of the program including the EPA, the

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[12] Michael R. Greenberg, "Public Health, Law, and Local Control: Destruction of the US Chemical Weapons Stockpile," *American Journal of Public Health* 93, no. 8 (August 2003): 1224.
[13] 102nd Congress: National Defense Authorization Act for Fiscal Year 1993, H.R. 5006, 102nd Congress, 1st sess., (October 5, 1992), https://www.govtrack.us/congress/bills/102/hr5006.

Department of Homeland Security, and the CDC among others. Researchers have noted that disagreements between these agencies have not only slowed down the pace of CW destruction, but also created a significant amount of confusion in interpreting all the laws and protocols the Army must follow for destruction of the American stockpile.[14] However, one positive thing that came out of this legislation is the rise of a grassroots citizens advocacy group that would come to dictate the ultimate form that chemical weapons destruction would take as CWC deadlines came into effect.

**Acting globally through acting locally**

When the Army began formulating its plans for destruction of the United States stockpile in the 1990s, it chose existing chemical weapons storage sites. Once the Army made these decisions public, and thanks to newly enacted laws that required the military to provide a public forum regarding any decisions about the disposal of toxic materials, grassroots movements emerged in communities surrounding these bases that clung firmly to the precepts of the NIMBY movement. Ironically, the group that created the biggest impact is one that coalesced around the facility with the smallest stockpile.

Blue Grass Army Depot (BGAD), located just outside of Richmond, Kentucky and originally intended to be one of the Army's incinerator sites, held a mere 1.6% of the total American stockpile consisting of VX, sarin, and mustard munitions. However, Kentucky citizens became immediately concerned that incineration technology posed

[14] Michael R. Greenberg, "Public Health, Law, and Local Control: Destruction of the US Chemical Weapons Stockpile," 1223.

significant health and environmental risks, especially considering the accidental releases and budgetary overruns that had transpired at both JACADS and TOCDS. While Johnston Atoll is mostly uninhabited and the chemical releases there proved to be harmless, this would not be the case if such incidents occurred at BGAD with nearby population centers in Richmond, Berea, and Lexington. However, the seeds of local distrust for the Army and its operations at BGAD were sown several years prior to any of the Army's incinerators coming online.

In August of 1979, a release occurred at BGAD that sent forty-five residents to the hospital complaining of respiratory issues and burning eyes in what became known as the "Smoke Pot Incident." Initially, the Army denied responsibility and stated the cloud did not originate at the depot, but that one of the area's other industrial facilities released the noxious fumes. Once a subsequent investigation proved that none of the other industrial sites in the area had the potential to release fumes causing the symptoms reported by local hospitals, the Army admitted that open pit burning of M4A2 smoke pots—World War II era devices designed to create walls of smoke to confuse the enemy and help conceal troops on the battlefield, caused the release.[15] Still, the Army maintained that no lethal chemical agents had been released during the burn. Toxicology reports from the hospitals confirmed the Army's claim, but the original denial of responsibility for the incident fueled the growing distrust residents had with the Army.

[15] David Zurick, "Grassroots Environmental Opposition to Chemical Weapons Incineration in Central Kentucky: A Success Story," (paper presented at International Conference on Grassroots Environmental Movements in Japan and the United States, Lexington, KY, April 2003), 8.

Opposition to the incinerator focused on two distinct coalitions that formed during numerous public forums where Army officials maintained that the incinerator would be safe, while locals expressed serious doubts to the Army's repeated claims. The "Concerned Citizens of Madison County" and "Common Ground" formed in the late-1980s to provide a more united front against the Army's incinerator plans, though the two groups could not have been more different. Members of the "Concerned Citizens of Madison County," based out of Richmond, consisted mostly of second and third generation descendants of a landed aristocracy and thus tended to be more politically conservative. Their efforts focused on the fact that many of their families had been involved in local politics for decades, and they had several notable connections to state and federal officials and understood working within the political system to affect change from above. On the other hand, Berea Kentucky's "Common Ground" contained members on the liberal end of the political spectrum and therefore, well-versed in grassroots political activism. They also employed experts in biology, chemistry, and ecology from nearby Eastern Kentucky University to host lectures and symposiums on why using incineration technology at BGAD would be harmful to both residents and the environment. By 1990, Common Ground had renamed itself the Kentucky Environmental Foundation (KEF), though their goal of preventing the Army from constructing an incinerator at BGAD remained a top priority.[16] However, later that same year another

[16] David Zurick, "Grassroots Environmental Opposition to Chemical Weapons Incineration in Central Kentucky: A Success Story," 12.

interesting development occurred that ushered in a new era of bipartisan environmentalism.

Both the KEF and "Concerned Citizens of Madison County" realized they shared the same goal but approached it from different perspectives. Being more attuned to the nuances of environmental activism, the KEF reached "across the aisle" to the Concerned Citizens group, as well as numerous other groups fighting similar battles across the country at other proposed incineration sites, knowing that by combining their resources and knowledge as well as broadening their support base to be inclusive of both liberals and conservatives, they stood a much better chance of waging a successful legislative battle against the Army.

Of course, the KEF understood that simply forming an alliance of conservatives and liberals to fight the Army would not immediately spell victory, but in forging connections to these smaller like-minded groups, they discovered others who opposed the Army's incinerators. The act of consolidating those smaller local political groups into a larger, more cohesive unit put the KEF in touch with powerful activist organizations such as Greenpeace and the Sierra Club who shared the KEF's interest in halting incinerator plans. The KEF determined that bringing all these associated entities together in a "Citizens Summit" to discuss these issues and share technical information may prove more successful. The efforts to get all these separate groups on the same page

spearheaded by the KEF quickly evolved into what became known as the Chemical Weapons Working Group. (CWWG).[17]

What made the CWWG different from the activist organizations working to stop incineration at other facilities is their ultimate approach. Certainly, creating a common bipartisan ground gave the CWWG considerable political power, but the CWWG also understood that "fighting fire with fire" was unlikely to succeed. CWWG leaders accepted the fact that many of these facilities held substantial chemical stockpiles and forcing them to shut them down permanently would be impossible. Additionally, laws set forth by NEPA, RCRA, and CERCLA outlawed chemical agents from being transported over state lines proving the core of the NIMBY movement is in most cases, impractical. Instead of attempting to force the Army to remove the weapons entirely, the CWWG decided to place their focus on compromise by suggesting the Army to research and adopt alternative destruction technologies such as chemical neutralization or cryofracture instead of incineration to dispose of these lethal stockpiles.[18]

Meanwhile, the next five years became punctuated by several particularly heated debates at public meetings hosted by the Army. Primarily, the Army maintained its claim that incineration is the safest option, and the other alternative disposal technologies did not offer the safety or cost efficiency provided by incineration. The CWWC countered with the fact that both TOCDS and JACADS ran well over budget, costing taxpayers

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[17] David Zurick, "Grassroots Environmental Opposition to Chemical Weapons Incineration in Central Kentucky: A Success Story," 12.

[18] For additional information on the alternative chemical weapons disposal technologies, see David A. Koplow, *By Fire and Ice: Dismantling Chemical Weapons While Preserving the Environment (*Gordon and Breach Publishers: Amsterdam, 1997*).*

nearly ten times the Army's original cost estimates, and with the 1979 Smoke Pot incident still fresh in their minds, reminded Army officials that neither of those operations ran flawlessly and accidents did happen. Finally, the CWWG concluded that similar mishaps occurring at incineration facilities within close proximity to major population centers and several rural communities would be devastating and wholly irresponsible.[19]

Around the same time that debates over incineration started heating up in Kentucky, Congress faced its own battles with CWC ratification. Democrats led by President Bill Clinton tried to whip up votes to pass the bill, while Republicans for the most part, attempted to delay the vote before it could gain any real traction. However, there were two notable exceptions— former Senate Majority Leader Bob Dole whose appearance at a press conference standing beside President Clinton helped tip the balance in favor of CWC passage, and Kentucky senator Mitch McConnell.

McConnell became acutely aware of the arguments surrounding the CWC through his friendship with Dole, but also from what he heard from his own constituents. The CWWG had reached out to him on several occasions, and he supported the incinerator ban because the issue hit so close to home. So much in fact that in 1996 he introduced a bill to Congress to force the Army to investigate alternative disposal methods and helped bring the CWWG's efforts into the emerging national conversation on chemical weapons disposal. McConnell's bill became part of Public Law 104-208, the Omnibus

[19] David Zurick, "Grassroots Environmental Opposition to Chemical Weapons Incineration in Central Kentucky: A Success Story," 22.

Consolidated Appropriations Act, that authorized the creation of the Assembled Chemical Weapons Assessment (ACWA) program.[20] ACWA in its initial form mandated that the Army must identify and demonstrate a minimum of two alternatives to baseline incineration, and that the program must to be operated independently of the Army's current chemical demilitarization program.[21] The ACWA program did not end the incinerator debates in Kentucky, but it did validate the CWWG as a powerful voice in the overall conversation. By the time the CWC entered into force in 1997, the CWWG had built a framework that included environmental activist groups in Asia, the Pacific, and even Russia, turning what originally started as a local grassroots movement into a significant actor in the Organization for the Prohibition of Chemical Weapons (OPCW), the group charged by the United Nations with ensuring CWC compliance.[22]

However, despite becoming one of the driving forces behind global chemical weapons remediation, their biggest victory did not occur until 2003 when CWWG efforts finally made the Army capitulate and mostly abandon incineration as a disposal technology. Despite the unexpected victory by the CWWC at BGAD, the activities in Kentucky did not produce a ripple effect when it came to the Army's other disposal sites. Certainly, 2003 did represent a change in how the Army chose to destroy chemical weapons at other sites such as Pueblo Chemical Depot, Edgewood Arsenal, and Newport

[20]The Omnibus Consolidated Appropriations Act of 1997, Public Law 104-208, https://www.congress.gov/104/plaws/publ208/PLAW-104publ208.pdf.
[21] "Facts: PEO/ACWA Legislation," Program Executive Office Assembled Chemical Weapons Alternatives, March 12, 2021, https://www.peoacwa.army.mil/2021/03/12/facts-peo-acwa-program-legislation/.
[22] David Zurick, "Grassroots Environmental Opposition to Chemical Weapons Incineration in Central Kentucky: A Success Story," 15.

Chemical Depot where neutralization became the chosen disposal technology, but that still left three other sites using the incinerators the CWWG had fought so hard against. These sites still had the exact same environmental and health risks that had been present at JACADS and TOCDS, and the intervening years did not grant the Army any new insights or experience in making incineration safer.

**A Tale of Three Incinerators**

Anniston, Alabama for many years served as a town extremely proud of its military roots and heritage. Sandwiched between two major installations, Anniston Army Depot (ANAD) and Fort McClellan, Anniston is a prototypical military town where the economy developed and revolved around Army activities. In addition to the array of businesses that served the military community and their families, the town also became home to several large military contractors including BAE Systems and General Dynamics, who worked directly with ANAD in fulfilling its primary role of being one of the only military facilities in the United States where the Army's fleet of tanks are tested, developed, and repaired. Fort McClellan served as a major Army basic training facility and home to the Military Police Corps, as well as the Chemical Corps until its closure in 1995. Thus, it came as no surprise that Anniston also ended up being home to seven percent of the nation's chemical weapons stockpile in the form of filled sarin, VX, and mustard munitions split between Fort McClellan and ANAD, just a short distance away from where a vast majority of Army recruits completed their basic training.

However, once the Army committed itself to destroying the chemical stockpiles, the decision on what disposal technology to use did not follow the same path it had in Kentucky. To be sure, significant opposition to an incinerator being operated at ANAD came from local environmental groups working to force the Army to adopt neutralization technology with assistance from the CWWG, but these plans never came to fruition due to a few important factors. First, many local opposition efforts splintered between opposing the incinerator at ANAD and fighting an ongoing legal battle with the Monsanto Corporation, who had operated a plant in Anniston that produced the carcinogen PCB from 1929 to 1971 and had caused irreparable damage to nearby groundwater and soil.[23] Residents knew the Army had chemical weapons they intended to incinerate at ANAD, but the damage that had been caused by the Monsanto plant garnered more media attention and posed a greater, more visible risk to residents. Furthermore, by the time the CWWG had started stirring up opposition to incineration as a viable disposal technology, construction of the incinerator at ANAD had already been completed and Army officials claimed that waiting any longer to convert it for neutralization technology only increased the chances of an accidental release from a rapidly deteriorating stockpile.[24]

Finally, considering that defense contracts practically built the Anniston community, many residents hesitated on voicing opposition to the ANAD incinerator.

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[23] Sean O'Hagan, "Toxic neighbour: Monsanto and the poisoned town," *The Guardian,* April 20, 2018, https://www.theguardian.com/artanddesign/2018/apr/20/mathieu-asselin-monsanto-deutsche-borse-anniston-alabama.

[24] "Anniston Begins Burning Chemical Weapons," Arms Control Association, last modified September 26, 2003, https://www.armscontrol.org/act/2003-09/anniston-begins-burning-chemical-weapons.

Most still felt the economic effects from the closure of Fort McClellan which hosted nearly ten-thousand troops year-round and provided hundreds of jobs in the civilian sector. Once the base closed in 1995, the added income those soldiers spent at business in Anniston, as well as the jobs that disappeared from the economy seemingly overnight, left a lasting impression upon its citizens who feared another crippling economic blow. To lose another opportunity such as the ANAD incinerator, which had already been providing new jobs in the area due to its construction would be devastating to those who relied upon those jobs.

Of course, the irony lay in the fact that those most affected by McClellan's closure in 1995, are the same socioeconomic group that wielded the least political power and stood to benefit the least from the jobs the incinerator would provide—the lower class. In a sense it created a veritable class war between the wealthy who lived in East Anniston and had made their fortunes as executives for defense contractors and citizens who lived in economically depressed West Anniston who had to choose between the environment or providing for their families. In short, environmental agency took a back seat to the basic needs of West Anniston's residents. The Army and the political elite of East Anniston quickly capitalized upon this and convinced the Alabama Department of Environmental Management (ADEM) to issue the proper permits, allowing incinerator construction to begin at ANAD, "coincidentally" located in West Anniston. The entire ordeal caused problems for ADEM several years after the incinerator began operation including lawsuits, loss of departmental integrity, and general disdain from citizens who felt that the department did not act in the best interests of Alabamans but shared the

Army's complicity in ignoring environmental laws and the needs of its citizens.[25] However, the die was already cast, and the Anniston Chemical Disposal Facility (ANCDF) operated from 2003 until the end of operations in 2011.

The incinerator at Umatilla Chemical Depot (UMCD) in Oregon went into operation in 2004, but the circumstances are vastly different than the controversy that surrounded the incinerator at ANAD. For starters, UMCD is in Northern Oregon, just south of the Washington state border and nearly seven miles away from Hermiston which only held a population of 13,000 residents. Other nearby residential areas such as Umatilla and Irrigon were even more sparsely populated, and the closest major population center, Portland, is well over one-hundred and fifty miles away from the facility. This is not to say that national activist groups such as the CWWC and Oregon-based groups such as the Citizens for Environmental Quality did not take an interest in trying to stop incinerator construction at UMCD, but the arguments successfully used by activists at BGAD did not gain much traction.[26] Furthermore, UMCD had always maintained a wholly positive relationship with its neighbors unlike other facilities in more densely populated areas, so the adversarial relationship and lingering distrust of the Army's activities the CWWG worked so hard to reverse in Kentucky simply did not exist at Umatilla. Residents knew about the chemical weapons stored at UMCD, and spent decades working with the Army to develop contingency plans in case of an accidental

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[25] Stockholm International Peace Research Institute, *SIPRI Yearbook 2001: Armaments, Disarmament, and International Security* (Oxford: Oxford University Press, 2001), 520.
[26] David Zurick, "Grassroots Environmental Opposition to Chemical Weapons Incineration in Central Kentucky: A Success Story," 14.

release. Local emergency personnel understood and are well-versed in emergency protocols, while schools, government buildings and most businesses housed reverse pressure air handling systems designed to prevent airborne toxin exposure. In addition, the Army provided emergency band radios to schools, first responders, and many residents to quickly alert them to any accidental release or mishap.[27]

For the Army's part, once they decided on incineration at UMCD, Army officials used the arguments that fell upon deaf ears in Kentucky—the proven safety record of incineration and the need for expediency in destroying the aging stockpile at Umatilla. Furthermore, the Army pointed out that considering the closest population area lay seven miles away from the incinerator, only a massive release of agent posed a threat. Residents did not consider the economic arguments that drove sentiments at ANAD convincing either, primarily since neither Hermiston, Umatilla, nor Irrigon relied on the facility as part of their economic base, and in fact most of the civilians working at UMCD commuted from Pasco, Kennewick, and Richland, better known as the Tri-Cities, thirty-five miles to the north in Washington state.

Of course, this is not to say that the incinerator operated without controversy, as Oregonians are fully aware of the military's environmental legacy considering the infamous Hanford Nuclear Site lay only fifty miles north of Umatilla.[28] While those living in Umatilla and the surrounding areas did not implicitly trust the Army or their

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[27] John Stang, "Umatilla chemical weapons: end of a nightmare," *Crosscut* (Seattle, WA), October 11, 2011.
[28] For additional information on the Hanford Nuclear Site, see Michele Stenehjem Gerber, *On The Home Front: The Cold War Legacy of the Hanford Nuclear Site* (Lincoln: University of Nebraska Press, 2002).

claims of acting in the best interests of residents, the overall remoteness of UMCD combined with its history of community cooperation and transparency made a bitter pill much easier to swallow.

Pine Bluff Arsenal (PBA) in Arkansas is arguably the most problematic and controversial incinerator site. Situated on the banks of the Arkansas River and home to twelve percent of the nation's chemical weapons stockpile, PBA is bordered by two population centers— White Hall to the west with a population of 5,000 and its namesake Pine Bluff to the south with a population of 55,000, with several smaller communities nestled against PBA's southernmost border. The debates at PBA over incinerator construction became just as heated as those at BGAD, with many of the same actors involved, and mostly under similar circumstances. Metropolitan Pine Bluff represented a mixture of the variables in play at BGAD and ANAD—a site surrounded by both major and minor population centers, both of which had strong and enduring connections with the military and its operations there, and a citizenry concerned with the chemical weapons being held at PBA as well as what any sort of loss in overall military capacity meant for the local economy.

Leading the charge against incinerator construction was the CWWG, the Sierra Club, as well as local activist groups such as Pine Bluff for Safe disposal and the Arkansas Fairness Council[29]. These opposition groups had already been armed with a veritable smoking gun in the form of a scathing 1994 affidavit where Anthony Flippo,

[29] David Zurick, "Grassroots Environmental Opposition to Chemical Weapons Incineration in Central Kentucky: A Success Story," 14.

former branch chief of Dugway Proving Grounds, claimed a vast number of munitions stored at PBA were improperly labeled and stored, meaning that unless the Army could find a safe way to identify the contents and disposition of these munitions, incineration would be exceedingly dangerous.[30] The anti-incineration activists also found themselves with a new powerful ally, the National Association for the Advancement of Colored People (NAACP). Drew into the fray by Pine Bluff's high minority population, the NAACP was no stranger to taking a stand over issues of civil rights and racial justice, but this would be the first time they had stepped into the arena of chemical demilitarization.

Be that as it may, even having the assistance of one of the largest and most widely recognized activist groups did not sway public opinion against the construction of the PBA incinerator. The social and economic realities in Pine Bluff and White Hall are similar to Anniston and for many years after the end of World War II, the overall reduction in force drove unemployment up in the area along with the crime rate. However, during the 1970s, PBA gained the distinction of being the only phosphorus production facility in the Western hemisphere. Pine Bluff Arsenal soon became a hive of activity producing white phosphorous grenades and flares, as well as a wide variety of munitions used not only by American forces, but its overseas allies as well. As demand increased, so did the number of jobs provided by the facility, and while this in and of itself did not drive the crime rate down, it did slow its dramatic increase. This of course

[30] Suzi Parker, "Burning controversy over weapons disposal," *Christian Science Monitor,* March 9, 1999.

left residents with a mostly favorable opinion of PBA and the military activities conducted there.

A 2004 National Research Council (NRC) study offered even more striking impression of how residents saw the base and its desire to build an incinerator once the mandates of the CWC took effect. Many in the community trusted PBA not only with its chemical stockpiles, but also as a long-term employer in the area. One respondent to a survey sent out by the NRC even went as far to claim that, "The Arsenal is us." In short, the local community felt an overwhelming sense of kinship with PBA and treated it like a member of their extended family. This type of loyalty made it difficult for activists to criticize the Army's desire to build an incinerator there, especially when it promised to bring more jobs to the economically depressed area.[31]

The same study also found the residents more concerned about the chemical weapons being destroyed, not what technology the Army used to reach that goal. When faced with alternatives to incineration, the CWWG and its affiliated groups completely failed to frame processes like neutralization or cryofracture into terms Pine Bluff and White Hall residents could understand. One respondent noted that the number of involved agencies, projects, and review processes for alternative disposal methods are confusing, where incineration is a more straightforward concept to understand.[32] Part of this did reflect an inadequately funded education system and the area's historically low literacy

[31] National Research Council, *Assessment of the Army Plan for the Pine Bluff Non-Stockpile Facility*, (Washington, DC: The National Academies Press, 2004), 49.
[32] National Research Council, *Assessment of the Army Plan for the Pine Bluff Non-Stockpile Facility*, 51.

rate, however, observers have noted that for even those well indoctrinated into military and governmental protocols and organizational structure found the web of regulatory agencies involved confusing, and several government reports note that interdepartmental disagreements and the lack of a strong authoritative body is among the main reasons that the United States missed numerous CWC demilitarization deadlines. Those claims are not far off the mark. Just at the national level alone several oversight agencies are involved in demilitarization including the National Research Council (NRC), the Department of Health and Human Services (DHHS), the Centers for Disease Control and Prevention (CDC), the Environmental Protection Agency (EPA), the Council of Environmental Quality (CEQ) and the Occupational Health and Safety Administration (OSHA).[33] This is long before state environmental agencies or any of the Army's various departments got involved.

Thus, it came as no surprise that those with only a peripheral connection to PBA found the entire process overwhelming and did not mind allowing those more involved in the NEPA mandated citizen advisory commissions to make decisions for them. While we can assume that these sentiments echoed those at other potential incinerator sites, they tended to be more prevalent at the informative meetings held by the Army regarding the PBA incinerator. Few residents showed up for the meetings, and those who did attend generally consisted of CWWG-led activists unable to provide any evidence that Pine Bluff or White Hall residents overwhelmingly opposed incinerator construction. Those

[33] Michael R. Greenberg, "Public Health, Law, and Local Control: Destruction of the US Chemical Weapons Stockpile," 1223.

who did show up not connected to CWWG efforts kept going back to the fact that approving incinerator construction meant an immediate shot in the arm for the area's struggling economy in the form of steady employment for hundreds of workers. With arguments that hit so close to home for those living adjacent to PBA, convincing residents simply trying to put food on the table that they should wait several more years until the proper studies on alternative disposal technologies could be completed and hope those technologies held the same promise of jobs the incinerator did seemed impossible. Despite the activist's best efforts, just like in Anniston, economic arguments won out and the PBA incinerator went into operation in 2004.

**Accidents will happen.**

Despite the Army's continued reassurances at citizen's advisory committee meetings proclaiming the safety of incineration, their previous track record proved otherwise. In fact, explosions did occur at nearly every incinerator the Army put into operation, and before chemical weapons disposal began in earnest, the Army had created a legacy of improper handling, mislabeling, and less than favorable disposal methods both on land and at sea. Even in places like Umatilla and Pine Bluff where the Army had seemingly unconditional support, citizens living near these bases worried about the potential for disaster. Fortunately, so did the United States government when they mandated the destruction of the stockpile in 1988 through the passage of Public Law 99-145. The members of congress who drafted that legislation also had the foresight to draft a Memorandum of Understanding into PL 99-145 that provided for such unintended outcomes resulting in the creation of the Chemical Stockpile Emergency Preparedness

Program (CSEPP). CSEPP, managed by the Federal Emergency Management Administration (FEMA) and funded by the U.S. Army, attempted to uphold its primary mission to, "…enhance the existing local, installation, Tribal, State and Federal capabilities to protect the health and safety of the public, workforce, and environment from the effects of a chemical accident or incident involving the Department of the Army's chemical stockpile."[34]

CSEPP mandated FEMA to provide financial and technical support to state and local officials, while enhancing currently existing Army preparedness programs for the entire duration of each facilities disposal program. A Cooperative Agreement remained in effect until all stockpile and non-stockpile items were destroyed, the facilities utilized in the destruction of the stockpiles dismantled, and any toxic waste by-products created as a part of those processes shipped to an approved landfill. They would also assist the Army Corps of Engineers with remediation of the property if the land did not remain under Federal control. The CSEPP mandate also included FEMA providing for public outreach and communication both during and after disposal, annual emergency preparedness exercises, regular training programs for military and non-military first responders, as well as funding for personal protective equipment and the retrofitting of high-pressure air handling systems at public schools and designated emergency shelters in communities surrounding each site regardless of the disposal technology used there.

[34] "What Is CSEPP?," Federal Emergency Management Administration, accessed March 26,2021, https://www.cseppportal.net/SitePages/about-csepp.html.

CSEPP is in many ways a “safety net” for the Army in case anything did go wrong at the disposal facilities and should have been a powerful counterargument to those who opposed incinerator construction. However, as the previous section showed, while safety did remain a primary concern, the debates over the disposal technology to be used often centered on economic concerns, and many felt that the path to safety lay within rapid stockpile destruction, as the weapons existence already constituted a significant risk unmitigated by additional layers of safety.

Some even questioned whether FEMA oversight could provide the necessary safety protocols. The agency did not have a history of being particularly effective when it came to disaster assistance, and prior to CSEPP numerous charges had been levied against them including a lack of effective leadership and poor record keeping. This would be no different when it came to management of the CSEPP program when a 1997 Government Accounting Office (GAO) report handed down a harsh indictment of FEMA and CSEPP. The report found that after nine years of FEMA management and the investment of over four-hundred million in taxpayer dollars that not one of the Army’s chemical weapons storage facilities had the items in place considered critical for mitigation of a chemical release such as gas masks, protective suits, or emergency water supplies in case local supplies became contaminated. Furthermore, the GAO also discovered that FEMA kept inaccurate financial records and could not provide reliable information on its most recent CSEPP related expenditures. To make matters worse, not one of the State agencies interviewed by GAO representatives had anything positive to say about FEMA’s handling of the program. Officials with the Alabama Emergency

Management Agency pointed to their inefficient management of CSEPP funding, claiming that if FEMA effectively managed the program, critical items would already be in place. At PBA, the Arkansas Office of Emergency Services claimed that the federal agency lacked sensitivity to state and local requirements and micromanaged the entire CSEPP budget process. At Umatilla, the Oregon Emergency Management Agency criticized the entire program, claiming that CSEPP lacked good communication, clear priorities, and timely decisions.[35]

In their own defense, FEMA officials argued that many of the issues brought up in the report focused on items already dealt with and overall, their management could be more efficient if there had not been so many disagreements with the Army on emergency protocols and critical equipment that needed to be in place prior to disposal operations. However, it is quite telling that this early in the disposal process, with only JACADS and TOCDS in operation, that significant shortcomings in CSEPP existed. It will be several years before the Army's chemical demilitarization program is complete and a thorough assessment of FEMA's management of CSEPP can be completed, though the criticisms of FEMA's ability to coordinate such an important part of the Army's demilitarization strategy from federal, state, and local actors should not be overlooked.

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[35] National Security and Internal Affairs Division, *Chemical Weapons Stockpile: Changes Needed in the Management of the Emergency Preparedness Program,* GAO/NSIAD-97-91 (Washington, D.C.: Government Accountability Office, 1997), 13.

**Russia: The Greener Superpower?**

Chemical weapons proliferation certainly did not occur within a vacuum, and it has been shown that nearly every developed country at some point maintained an active stockpile, though by the end of the second World War, those held in West Germany, Japan, France, and Great Britain had either been dumped in the world's oceans or shipped back to the United States for research purposes or disposal. This would not be the case with the Soviet Union who shared a long and storied history of chemical weapons development with the United States in many ways. Beginning in 1924, the Soviet Union had been producing the same chemicals that had become mainstays of chemical warfare in the 20th century including mustard, phosgene, lewisite, adamsite, and chloropicrin. By the time the second World War broke out, the Soviet Union had a stockpile that rivaled what the United States held in its arsenal. But much like the other belligerents had discovered, chemical weapons are unreliable under typical battlefield conditions, and it served them better to follow the "retaliation in kind" paradigm adopted by both Axis and Allied powers. Be that as it may, it did not stop the Soviet Union from ramping up production in the 1950s due to emerging conflicts in Korea and Vietnam, though instead of using the traditional retinue of common chemical warfare agents, they focused heavily on nerve agents such as VX and soman, while adding the stockpiles of tabun that had been discovered in East Germany at the end of World War II to their arsenal. Then, in the 1980s, the Soviet Union began developing even more lethal nerve agents, dubbed

Novichok agents.[36] What made the Novichok family of chemicals so deadly is not their method of action, in fact Novichok agents shared the same toxic qualities as other nerve agents like soman and tabun and worked in the exact same manner by inhibiting neurotransmitters. However, Novichok agents overcame the one limitation that had prevented widespread use of chemical weapons to begin with—persistence. Novichok agents are reliably stable with a slow evaporation rate, and it has been suggested that agents within this family can remain toxic for up to fifty years.[37]

Soviet production of Novichok agents continued unabated until the fall of the Soviet Union in 1991. This is not to say that the Russians immediately scrapped their chemical weapons program, but it did falter as the country waited for the dust to settle from the destabilization of the Communist party. Two short years later, Russia entered into the chemical demilitarization pact with the United States that eventually became the Chemical Weapons Convention.

In 1993, when the Russian Federation began attempting to assess how their demilitarization program would operate, they initially determined that centralizing the stockpile at a few key military bases for disposal would be the best option. However, once the Russian government revealed their plan, citizens immediately protested, citing the risks of transporting the toxic chemicals over regional borders. In light of these protests, Russian military leaders determined that destroying the weapons at the facilities

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[36] Lev Aleksandrovich Fedorov, *Chemical Weapons in Russia: History, Ecology, Politics* (Moscow: Center of Ecological Policy of Russia, 1994), https://fas.org/nuke/guide/russia/cbw/jptac008_l94001.htm.
[37] Andrew Griffin, "Novichok remains active long after it is used and people could be poisoned by picking things up, experts warn," *Independent* (London, UK), July 5, 2018.

that housed them to be the best choice. The initial path to destruction of the Russian stockpile followed the decisions the U.S. Army made regarding the American stockpile, though the similarities end here as the destruction timelines of each superpower took strikingly different paths.

The primary difference between Russian chemical munitions and those held in the American stockpile is that the Red Army never designed theirs with explosive components built in, as volatile energetics are kept separate from shells and installed shortly before deployment. This meant that removing toxic chemicals from the munitions did not carry the same risk of detonation that had caused incidents at JACADS and TOCDS. Furthermore, unlike the United States, Russia did not keep strict separation between its military and civilian chemical industries, so when the time came for demilitarization of their stockpile, civilian industrial chemists pointed out that most of the chemicals in their arsenal could be neutralized with the by-products able to be used by the Russian chemical industry. Their research showed that neutralization could produce several types of phosphates for use in fertilizers, and thiodiglycol that is a chemical building block for dyes for the textile industry, ballpoint pen ink, rubberizers, and several types of industrial lubricants. Furthermore, the nature of the Russian military-industrial complex prevented the Russians from having to build additional facilities for demilitarization, as they found their chemical industry both willing and able to convert portions of already existing production facilities for neutralization.[38]

[38] "Chemical Weapons," Federation of American Scientists, accessed March 26, 2021, https://fas.org/nuke/guide/russia/cbw/cw.htm.

In total, Russia operated five dual-use neutralization facilities which went into operation in 2002 and completed disposal operations in 2017. This became a thorn in the side of the United States as Russia became highly critical of the numerous delays in destruction of the American stockpile as well as the fact that the United States has received several extensions to its original 2007 destruction timeline from the OPCW. What did not come to light immediately is the fact that the Russian demilitarization program created an incredible amount of unusable toxic by-products due to the caustic reagents used in the neutralization process. Additionally, Russia also received significant international monetary assistance from the United States, France, Poland, and the United Kingdom in funding its neutralization program even though the Russian chemical industry recouped useful and highly profitable chemicals from the process.[39]

Finally, there is substantial doubt that the Russian claims of complete chemical weapons destruction has occurred, highlighted by recent reports of poisonings using Novichok agents. In March of 2018 Sergei Skripal, a former Russian spy, and his daughter Yulia were poisoned in Salisbury, England and a subsequent medical investigation confirmed that the poison used came from the Novichok agent family.[40] Then in September 2020, Russian opposition leader Alexey Navalny fell ill on a plane travelling from Tomsk to Moscow. Investigators discovered that he too had been

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[39], "Russia Destroys Last Chemical Weapons," Alicia Sanders-Zakre, Arms Control Association, November 2017, https://www.armscontrol.org/act/2017-11/news/russia-destroys-last-chemical-weapons.
[40] "Russian spy: Highly likely Moscow behind attack, says Theresa May," BBC News, March 13, 2018, https://www.bbc.com/news/uk-43377856.com/news/uk-43377856.

poisoned using a Novichok agent like the one that had been used against Skripal.[41] International critics voiced concerns about Russia and its suspected use of a chemical agent that supposedly had been destroyed with the rest of Russia's chemical weapons stockpile in 2017. Both incidents have cast serious doubts on Russian assertions that they no longer possess chemical weapons, or that they are a self-proclaimed leader in chemical weapons demilitarization. Still also in question is what Russia intends to do with the waste by-products from its neutralization program, or if it is environmentally and socially conscious as Russia claimed. It is likely that those questions will still have no answers long after the United States completes its own demilitarization program over the next several years.

These incidents highlight the numerous difficulties that both nations faced in their attempts to comply with the mandates set forth by the CWC. They also outline several shortcomings of the treaty regarding the verification regimes and the OPCW's ability to enforce them. These issues also highlight how the United States and Russia continue to struggle in reducing the ecological footprint of their respective chemical weapons programs and show that despite the differing approaches each country took towards disposal, their social and environmental impact remained the same.

[41] Nadine Schmidt, Gianluca Mezzofiore and Amy Woodyatt, "Russian opposition leader Alexey Navalny was poisoned, Berlin hospital says," CNN, last modified August 24, 2020, https://www.cnn.com/2020/08/24/europe/alexey-navalny-germany-poison-grm-intl/index.html.

## Chapter V- A Lurking Beast: The Detritus of The Chemical Weapons Era

The 21st Century ushered in a new and final era for the American chemical weapons program that saw the near destruction of the bulk of the American stockpile. The controversial incinerators that seemed like a bad idea at the time completed their missions within the first two decades of the century, and most of the neutralization facilities had similarly completed destruction of weapons that haunted the U.S. military almost since the beginning of the 20th century. However, demilitarization did not come without a hefty price tag—billions of dollars were invested in the Army's various programs, as well as remediation of the sites where they were stored. In addition, there remained a cost difficult to quantify in terms of the human lives that were affected, as well as slowly emerging information on how proliferation and demilitarization left its mark on the environment. Even while chemical agent disposal facilities across the United States claimed stockpile destruction a near victory, demilitarization languished at two facilities— Blue Grass Army Depot and Pueblo Chemical Depot. Furthermore, the recovery and destruction of chemical weapons haphazardly buried at military installations across the United States and the failure to confront the thousands of tons of chemical agent they dumped into the world's oceans during the first half of the Twentieth century generated further doubts that America faced an era free from the ecological footprint created by these terrible weapons.

This chapter will look at the current state of chemical weapons disposal by exploring how the demilitarization activities played out at the continental disposal facilities, and what the Army planned to do with the contaminated machinery and the toxic residues that emerged from neutralization facilities. This chapter will also explore the efforts made in remediating chemical weapon dumping sites located in domestic and international waters. Finally, this chapter will discuss where the United States stands in achieving the mandates set forth by the Chemical Weapons Convention and its plans for future remediation efforts.

**The State of Disposal at the Turn of the Century**

Despite the numerous controversies, delays, and mishaps that became a signature of American efforts at chemical weapons stockpile destruction in accordance with CWC deadlines, by 2006 the Army turned a page on those efforts. The incineration facilities started to report entry into the final phase of demilitarization, and looked ahead to dismantling incinerators or potentially turning them over to the civilian sector for use as municipal waste facilities once final decontamination programs completed and the facilities deemed safe for repurposing. This is not the case for neutralization facilities as equipment used in those processes was designed for a singular purpose and the Army struggled to find any commercial entity that able to make use of such equipment. Of course, the Army and its contractors still faced an incredible amount of work ahead of them before any of the disposal facilities were deemed safe, and they still needed to account for several waste by-products including contaminated equipment, hydrolysates from neutralization processes, and old munition casings still considered to be toxic

despite thermal decontamination. What follows is a brief look at the difficulties each facility contended with as demilitarization operations slowly neared completion.

Tooele Chemical Agent Disposal Facility (TOCDF), the Army's original pilot incinerator plant, ended disposal operations in 2012, destroying nearly half of the United States declared chemical weapons stockpile. Despite previous claims by entities such as the Chemical Weapons Working Group that incineration is dangerous and environmentally irresponsible, aside from the mishaps reported while it was still considered a pilot facility, TOCDF recorded no additional incidents and destruction of Tooele's stockpile proceeded without a hitch. Even deconstruction of the incinerator facility, that provided workers with jobs for an additional three years after incineration was complete, caused no adverse health effects in those who worked at the site, and by 2015 TOCDF and the stockpiles it destroyed seemed to never exist to begin with. However, Tooele Army Depot is still in operation with a portion of the former chemical weapons storage area, renamed Tooele Army Depot - South, currently being used for storage of conventional weapons such as short range missiles, mortar rounds, and tank munitions still being used by the Army today.[1] The remaining portion of TOCDF is in the process of being turned over to the Tooele County local reuse authority who envision using the land for commercial and residential development, as well as the creation of a significant municipal green space.[2] As of this writing, the biggest problem the local reuse

[1] Amy Joi O'Donoghue, "Last of chemical weapons to be destroyed in Tooele," *Deseret News,* January 18,2012.
[2] "Weapons of Mass Destruction: Deseret Chemical Depot Tooele, Utah," Globalsecurity.org, accessed April 28,2021, https://www.globalsecurity.org/wmd/facility/deseret.htm.

authority faces is trying to juggle the interests of parties willing to pay to develop on the former military property with those of residents who fear overdevelopment and the potential loss of public land that could be used for parks, bike trails, and playgrounds. As far as the potential for pollutants being left behind, the EPA removed Tooele from the National Priority List (NPL) shortly after demolition of the last building and EPA soil, air, and groundwater testing found that levels of known residues and byproducts of chemical agents were at or below what are considered acceptable safety levels.[3]

Johnston Atoll Chemical Agent Disposal System, the Army's first fully operational incinerator, completed its mission in 2001 and while remaining one of the most controversial Formerly Used Defensive Site (FUDS), it paralleled the success of TOCDF in eliminating not only the stockpile of chemical weapons left over from the Second World War, but also the thousands of gallons of Rainbow agent used for defoliation during the Vietnam War. In fact, the controversy surrounding the atoll is more a product of the nuclear testing done there in the 1950s and 1960s. Of primary concern is an area on the island known as "Pluto Yard," a fenced and capped landfill containing plutonium contaminated missile parts and soil from failed nuclear missile tests in 1962.[4]

The existence of Pluto Yard did not stop the U.S. General Services Administration (GSA) from placing Johnston Island on the auction block in 2005 for anyone with the money and desire to own their own remote island getaway. However, the

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[3] United States Environmental Protection Agency, *Review of Thermal Destruction Technologies for Chemical and Biological Agents Bound on Materials*, Report No. EPA/600/R-15/202 (Research Triangle Park: U.S. Environmental Protection Agency, 2015), B-8.
[4] United States Air Force, *Hazardous Waste Corrective Action Permit Renewal Application For Johnston Atoll Facility*, Report No. FA8903-17-F-238 (Government Printing Office: Washington, D.C., 2018), 381.

listing advised that the only airstrip on the island is one abandoned shortly after disposal operations ended in 2001, and the island also has no power or water lines. Additionally, it also listed numerous land use restrictions that prevented the buyer from using most areas on the island, and there remained substantial doubt that the Army managed to clean up all the plutonium strewn across the island because of the failed nuclear tests in the 1960s. Thus, it came as no surprise when the GSA pulled Johnston Island from its Real Property Utilization & Disposal website and turned control of the island over to the U.S. Fish and Wildlife Service to maintain the island as a refuge for endangered sea turtles and a seabird nesting area. [5]

However, there remain several ecological concerns from the chemical weapons stockpiled at Johnston Island in terms of leaks that occurred with nerve agents and Agent Orange due to deteriorating barrels and spills caused by poor hazardous material handling. Monitoring of fish in the waters surrounding the atoll is ongoing and Johnson Island continues to draw the attention of researchers looking to study the effects of some of the most impactful military activities on marine ecosystems.

Arkansas's Pine Bluff Chemical Agent Disposal Facility (PBCDF) completed its incineration operations in 2010, destroying the twelve percent of the nation's chemical weapons stockpiles held there. However, considering the scope of operations at Pine Bluff, chemical weapons remediation continued as the Army turned to the host of non-stockpile materials stored at the base including over 7100 Chemical Agent Identification

[5] "Wildlife and Habitat," U.S. Fish and Wildlife Service, last modified December 15, 2016, https://www.fws.gov/refuge/Johnston_Atoll/wildlife_and_habitat/index.html.

Sets (CAIS) containing varying amounts and types of toxic agents, and an assortment of other items tested at Pine Bluff's munitions ranges left undisturbed until 2017 when civilian contractors demolishing the PBCDF incinerator discovered a small cache of buried munitions. However, this did not cause any significant issues as by this time, military researchers at Pine Bluff perfected a new system designed to dispose of aging conventional munitions known as the Pine Bluff Explosive Destruction System (PBEDS). While it was only designed to handle traditional bombs and mortars, the researchers discovered that it could also be used on chemical munitions with the only downfall being that the system must be decontaminated after each use. Considering the small number of chemical munitions discovered, this ended up being a much more expedient and cost-effective route than attempting to build another incinerator.[6] As far as the CAIS were concerned, the Army developed a disposal system known as the Single CAIS Access and Neutralization System (SCANS) several years prior that could isolate individual CAIS vials so they could be loaded safely into ton containers approved by the U.S. Department of Transportation for transport to an approved disposal facility for final treatment.[7] In the end, the Army chose to retain areas of Pine Bluff used for chemical storage and incineration, as Pine Bluff remains the sole facility in the Western hemisphere used for production of munitions using white phosphorous, which presents an entirely unique set

[6] United States Army Chemical Materials Activity Recovered Chemical Material Directorate Public Affairs Office, "Recovered Material Directorate Fact Sheet," (Government Printing Office, Washington D.C., 2011).
[7] "Single CAIS Access and Neutralization System (SCANS)," U.S. Army Chemical Materials Activity, accessed April 28,2021, https://www.cma.army.mil/scans/.

of risks that make turning over the land to civilian or commercial interests not feasible from a safety perspective.

Umatilla Chemical Depot's closure is arguably one of the most controversial closures once its incinerator destroyed the twelve percent of the stockpile it held. While observers note that the jobs that left once the facility completed its mission in 2012 never returned, for the most part very few residents living near Umatilla felt the impact of the closure considering that the majority of those employed at the incinerator commuted to the facility from other communities. In fact, Hermiston mayor Dr. David Drotzman claimed in a 2019 interview that many of his constituents have approached him regarding redevelopment of the FUDS, expressing hopes that the site would be purchased by Costco due to their ability to bring new jobs and a greater variety of consumer goods to the area.[8]

The Army chose to retain a portion of the former incinerator as a training facility for the National Guard, but no other plans are currently in the works. Unfortunately, the remainder of the base remains within a legislative gridlock. Aside from the hopes that a Costco will be constructed on the site, residents are interested in the land being used as a nature preserve, much like the green space that is being considered at Tooele. Others think that considering its convenient location at the convergence of Interstates 82 and 84, it could be used as an industrial hub to lure larger corporations to the area, thus increasing revenue and bringing more jobs to the area than the incinerator did. Finally, the

[8] John Notarianni, "Umatilla Chemical Weapons Depot: What next for the 20,000 acre military installation," *Statesman Journal* (Salem, OR), March 11, 2019.

Confederated Tribes of Umatilla Reservation feel that the land should be returned to them as reparations for the Army revoking their usufruct rights through public domain laws to construct the base. Drotzman admits it may be several years before all these competing interests are sorted out and it is unlikely that all the interested parties will get what they want, though it is intriguing that the controversies surrounding Umatilla did not really spring to life until after all the toxic chemical agents were eliminated.[9]

At Anniston Chemical Disposal Facility (ANCDF), where economic concerns drove the decision for incinerator construction, operations concluded in 2013. In what should be considered an extreme case of serendipity, the loss of jobs caused by ANCDF closure and the lingering environmental problems from Monsanto's former PCB plant, combined with the actions of the American Federation of Government Employees finally prompted the United States government to step in to see what could be done about the looming unemployment issues in Anniston. After several years of research and legal wrangling, government officials discovered that Anniston Army Depot, still the center of American tank production and repair, needed skilled workers especially considering many U.S. troops were deployed in the Middle East. To that end, the U.S. government funded a program for workers at ANAD in 2017 that guaranteed jobs at ANAD's Stryker tank facility and offered 100% tuition reimbursement including books and supplies. However, ANAD officials saw no benefit on their end of the bargain as no provision existed that required the workers to remain at ANAD once they completed their

[9] John Notarianni, "Umatilla Chemical Weapons Depot: What's next for the 20,000 acre military installation," *Statesman Journal* (Salem, OR), March 11, 2019.

education. In 2019 ANAD reassessed their position, primarily due to a shrinking military budget, and in an effort to lower operation costs reduced the program to provide for only 75% tuition reimbursement with books and supplies no longer included.[10] Still, many workers stayed at ANAD after completing their degrees and while this did not do anything to address the environmental issues surrounding the ANAD and the former Fort McClellan at the hands of both Monsanto and the Army, it did bring the promise of steady income not just for those who opted into the program, but also to numerous businesses surrounding ANAD on the brink of closure whom had for many years relied on the economic boost the facilities provided.

Following the closure of ANCDF, much like many other disposal sites, the Army intended to retain portions of the base to be used by the National Guard for training purposes, as well as for a field office for the Department of Homeland Security who shifted operations there after the closure of Fort McClellan in 1995. Calhoun county received the rest of the land and is looking into using the land for commercial and residential development, as well as the establishment of a wildlife refuge within the next decade.[11]

However, the Army is currently facing another issue connected to chemical weapons storage and disposal. Prior to the construction of ANCDF, Fort McClellan housed the stockpile, and it sat there only to be shipped to ANAD once the incinerator

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[10] Mark A. Carter, "Anniston Alabama Army Depot And American Federation Of Government Employees, Local 1945,"(official memorandum, Washington, DC, U.S. Federal Labor Relations Authority, 2019), https://www.flra.gov/node/78753.

[11] "Development Zones," McClellan Development Authority, accessed April 29,2021, https://www.exploremcclellan.com/development-zones/.

began operations, as military leaders did not see any reason to move the entire stockpile *em masse* to ANAD. Instead, they only moved the portions that were ready to be fed to the incinerator. The logic behind this is that considering the deteriorated state of the Anniston stockpile, excessive movement greatly increased the chance of a chemical release. The Army did not discover until much later that many of the ton containers developed leaks, which seeped into groundwater supplies and ultimately into the aquifers that fed Fort McClellan's water supplies.[12]

Researchers are uncertain when the leaks began, though it is suspected that they started as early as the 1970s, continuing throughout the end of disposal operations in 2013. The implication here is that the thousands of soldiers who trained there between 1970 and 1995 were exposed not only to the PCB's released by the Monsanto plant, but an untold number of chemical warfare toxins including sarin, VX, Agent Orange, and sulfur mustard. Since McClellan's closure, several veteran's groups have attempted to lobby the U.S. Veteran's Administration (VA) for compensation for illnesses suspected to be caused by exposure to these toxins at the base, but to no avail. The VA position is that there is no substantial evidence that service at McClellan negatively impacted veteran's health and several attempts to push politicians into sponsoring legislation to help establish a health registry languished in the House of Representatives.[13] As is the case with most chemical weapons exposure, especially in the case of organoarsenicals, it

[12] Denise Williams, "Toxic Vets- The Poisonous Legacy of Ft. McClellan," *Chicago Tribune,* August 7, 2013.
[13] Ken Olsen, "The Long Shadow of Fort McClellan," The American Legion, February 20, 2018, https://www.legion.org/magazine/241272/long-shadow-fort-mcclellan.

may be years before the long term effects of activities at Fort McClellan and ANAD fully manifest themselves and the government is forced to take further action. Despite the Army's claims that Anniston's relationship with chemical weapons has ended, many residents still wonder what surprises are lurking in and around the former base.

Newport Chemical Agent Disposal Facility (NECDF) in Indiana, the Army's sole producer of VX nerve agent, completed its disposal operations in 2004 using a neutralization process that ended up being significantly more costly than incineration. While the process is somewhat more environmentally friendly than incineration, the process to eliminate the entire stockpile of 1,270 tons of VX agent created over 1.8 billion gallons of Caustic VX Hydrolysate (CVXH)—a chemical compound that is free of VX agent, but still poses a substantial environmental risk due to its corrosive nature. Unable to dispose of the CVXH at Newport, the Army tried for several years to find a facility willing to accept the CVXH for final disposal. Initially, DuPont was willing to process the VX by-product at its Secure Environmental Treatment Facility in Deepwater, New Jersey, but environmental activists including the CWWG fought a long campaign to prevent CVXH from being shipped there and possibly discharged into the Delaware River. Facing increasing public backlash to the plan, DuPont bowed under the pressure and pulled out of the original agreement.[14]

Then the Army turned to Vieola Environmental Services who agreed to a forty-nine-million-dollar contract to incinerate the CVXH at its Port Arthur, Texas facility.

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[14] Lois R. Ember, "Destroying VX: Army's plan to erase nerve agent stocks in Indiana runs into roadblocks," *Chemical & Engineering News* 82, no. 15 (April, 2004), 29.

Even then, environmental activist groups continued to wage a campaign against the Army's disposal plans, seeking an injunction preventing them from shipping CVXH to Texas for disposal, especially using the disposal technology they fought so hard against the Army using in the first place—incineration. The Army voluntarily halted the shipments until the case brought against them by environmental activist groups played out in court. However, much to the dismay of the CWWG and the other affiliated groups, a federal judge denied the injunction on the grounds that the Army did not violate of any federal or state environmental laws.[15] The shipments continued and by 2008, NECDF eliminated all its chemical weapons stockpiles. As for the CVXH, the Vieola plant in Port Arthur managed to incinerate all 1.8 million gallons of hydrolysate without incident, and the thorn in the side for Texans opposed to the toxic waste being processed in their backyards became a feather in the cap of Vieola as congressional leaders and residents hailed the as a leader in environmentally safe disposal technologies.[16]

Back in Newport, decisions are still pending as to what to do with the land formerly occupied by the NECDF, though like other former chemical weapons disposal facilities, community leaders have a strong desire to use the land for environmentally beneficial purposes. Plans are already in the works to turn portions of the FUDS into a wind farm through a partnership with Duke Energy to provide sustainable power for Newport and the surrounding communities, as well as the creation of a significant amount

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[15] Hayleigh Colombo, "Ridding Newport of deadly VX agent," *Journal and Courier* (Lafayette, IN), March 22, 2014.
[16] Ted Poe (TX), "Vieola Environmental Services," *Congressional Record* 155 (2009), Part 6 p. 7293 (Text from: Congressional Record Permanent Digital Collection); Accessed: April 29, 2021.

of green space in the form of parks, trails, and a nature preserve.[17] Additionally, Newport is also attempting to lure new industries to the area to occupy the former base including railroad giant CSX who expressed interest in creating a industrial transport hub there due to its proximity to Interstate 74 and Interstate 70. Community leaders are excited at the prospects of these plans coming to fruition and the potential that such a hub would bring to a community dealing with a shrinking labor force and high unemployment rates over the last decade. Bill Laubernds, executive director of the Newport Chemical Depot Reuse Authority admits that redevelopment is a slow and long process but remains hopeful that eventually the former Newport Chemical Depot will emerge as a vital recreational and commercial hub for the Newport community.[18]

Edgewood Arsenal in Maryland used neutralization to dispose of most of the chemical agents stored there and their operations ended in 2006, though available sources are not very clear on the success of their mission for several reasons. The disposals prior to CWC ratification at O Field notwithstanding, Edgewood remains a testing and research site for both chemical and biological defense and as such, maintains a limited stockpile of chemical weapons for that purpose. The Army's position is that even though the CWC banned chemical weapons and their use in combat, legislation rarely prevents rogue states from obtaining such weapons, such as the suspected chemical stockpiles held by North Korea, or the potential of terrorist groups getting their hands on chemical weapons

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[17] "RE-Powering America's Land: Evaluating the Feasibility of Siting Renewable Energy Production on Potentially Contaminated Land," U.S. Environmental Protection Agency, accessed April 29,2021, https://www.epa.gov/sites/production/files/2015-07/documents/r05-11-009_newport.pdf.
[18] Hayleigh Colombo, "Ridding Newport of deadly VX agent," *Journal and Courier* (Lafayette, IN), March 22, 2014.

through black market channels like the supply of sarin that was obtained by Aum Shinrikyo used in the 1990 Tokyo subway attack, or the chemical rockets discovered in 2017 held by ISIS that originated from the Russian stockpile.[19] Incidents such as these provide continued justification for Edgewood to maintain the limited stockpile currently held at the Edgewood Chemical and Biological Center (ECBC) under the defensive provisions of the CWC, where research and testing continue on chemical warfare agents, though under strictly controlled and monitored conditions. Their mission is to ensure that both American troops as well as civilian first-responders can access to the latest technologies for protection against chemical agent exposure, early detection technologies, decontamination protocols, toxicology data, and information regarding emerging chemical, biological, and nuclear threats.

The labs at ECBC even offered their research expertise in combating the COVID-19 pandemic by reformulating one of its chemical and biological decontamination solutions into an effective commercial disinfectant.[20] ECBC also initiated a robust community outreach program, partnering with local environmental groups and universities to foster research, as well as sponsoring numerous STEM-based programs throughout the Washington D.C. and Baltimore area that features academic competitions, apprenticeships and fellowships, as well as a host of educational grants and awards

[19]Associated Press, "Chemical weapons found in Mosul in Isis lab, say Iraqi forces," *The Guardian* (London, UK), January 29, 2017.
[20] "DoD Identifies Commercial Decontaminant for Field Use Against COVID-19," U.S Army Combat Capabilities Development Command Chemical Biological Center, last modified June 11, 2020, https://www.cbc.devcom.army.mil/newspost/dod-identifies-commercial-decontaminant-for-field-use-against-covid-19/.

provided through the Department of Defense, the Environmental Protection Agency, and the Federal Bureau of Investigation.[21] Edgewood, despite its past environmental shortcomings, continues to work on turning their former image around. However, considering the discoveries of terrorist organizations in possession of chemical weapons over the past decade, and even more recent incidents of poisonings using Novichok agents in Europe, it remains doubtful that Edgewood will ever be able to fully divorce itself from its own chemical weapons legacy.

**Ending the Chemical Weapons Era**

To date, only two facilities in the United States possess chemical weapons stockpiles still awaiting destruction—Blue Grass Army Depot in Richmond, Kentucky and Pueblo Chemical Depot in Pueblo, Colorado. Both facilities hold only small percentages of the total American stockpile, though considering the sheer amount of chemical munitions the Army produced since 1918, these percentages still represent an incredible amount of weaponized materiel awaiting destruction. However, the fact these two facilities are still engaged in demilitarization activities as the United States managed to complete operations and close its other seven chemical disposal facilities raises interesting questions, especially at BGAD where the fight against incineration of the American stockpile took center stage. Primarily, why is it taking so long for these two facilities to complete disposal operations?

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[21] "STEM and Educational Outreach Program," ," U.S Army Combat Capabilities Development Command Chemical Biological Center, accessed April 29, 2021, https://www.cbc.devcom.army.mil/about-us/stem-and-educational-outreach-program/.

For starters, the entirety of that currently held at BGAD and PCD are munitions as opposed to the ton containers of raw agent stored at the other facilities. With containers of raw agent, while there is a chance of exposure from leakage, the potential of a catastrophic accident is comparatively low since explosive components are not an integral part of the equation. However, considering the state of deterioration the chemical munitions are in, extreme care needed to be taken in both handling and transport, as well as the process of removing energetics from munitions and then draining them of their toxic payload. This process also comes with a significantly higher price tag than the processes than those used at other disposal facilities.

Furthermore, each facility must take different approaches due to the type of chemical fill in the munitions. At PCD, the entirety of the stockpile being processed there is mustard filled munitions and after years of trying to come up with a solution that satisfied the Army, Colorado state environmental laws, and members of the surrounding community, while also attempting to stay within the mandate of the CWC; the Army chose neutralization followed by bioremediation for the Pueblo Chemical Agent-Destruction Pilot Plant (PCAPP). Employing a chemical process that vigorously mixes the agent with hot water and caustic, the mustard drained from munitions is eliminated leaving behind a hydrolysate consisting of water and thiodiglycol. This hydrolysate is pumped into tanks containing microbes commonly used at sewage treatment facilities that consume the thiodiglycol leaving behind water that is filtered to remove the organic

waste left behind by the biomass.[22] The Pueblo facility got the green light for construction in 2002, but the facility did not go online until 2015 and operations are ongoing. According to the Program Executive Office Assembled Chemical Weapons Alternatives (PEOACWA), the facility is working on processing the remaining 28% of its original stockpile.[23]

On the other hand, BGAD houses some mustard munitions, but most of its stockpile consists of VX and sarin filled munitions that cannot be processed in the same manner. However, the mustard filled munitions at BGAD, due to their age and level of deterioration, pose an even larger risk since the chemical fill continues to solidify and turn into a gel-like substance, making it increasingly difficult to properly drain the shells. It was also discovered by Army Chemical Material Activity (CMA) inspectors in 2011 that many munitions were overfilled with mustard, thus making the system being used at Pueblo both impractical and extremely dangerous. Instead, the Blue Grass Chemical Agent-Destruction Pilot Plant (BGCAPP) needed to adapt for these new conditions, thus forcing the designers to essentially start from scratch instead of simply copying the facility already in use at Pueblo. They ended up designing the Static Detonation Chamber (SDC), a system that feeds the entire munition into a chamber heated to 1100 degrees Fahrenheit that detonates the explosive components of the shell while thermally decomposing the sulfur mustard. The gases created during this process are vented

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[22] National Academies of Sciences, Engineering, and Medicine, *Initial Closure Planning for the Blue Grass and Pueblo Chemical Agent Destruction Pilot Plants: Letter Report (2020),* (Washington, DC: The National Academies Press, 2020), 6.

[23] "Pueblo Chemical Agent-Destruction Pilot Plant (PCAPP)," Program Executive Office Assembled Chemical Weapons Alternatives, accessed April, 29 2021, https://www.peoacwa.army.mil/pcapp/.

through a complex system consisting of a thermal oxidizer, air scrubbers, and a carbon filtration system to ensure no toxins are released into the atmosphere.[24] So far, success of the SDC in destroying munitions prompted military officials to construct of a second SDC to expedite the processing of mustard filled munitions.

As for the VX and Sarin filled munitions, BGCAPP wanted to avoid some of the pitfalls that plagued NECDF in relation to the shipping and disposal of toxic hydrolysate. To that end, the Army is employing a three-step process to destroy the weaponized nerve gas. Once energetics like fuzes and bursters are removed and the chemical agent is drained by an automated processing system, the empty shells are sent to a separate incinerator where any residual is burned off and the metal is sent to a scrapper. The agent itself is then treated with an aqueous sodium hydroxide solution that neutralizes it and creates a semi-toxic hydrolysate not unlike the CVXH that was a by-product of neutralization at NECDF. This hydrolysate then undergoes supercritical water oxidization that breaks down the hydrolysate into water, carbon dioxide and inorganic salts.[25] The salts are then filtered from the water, with most the water undergoing additional testing before being reused within the facility for high-pressure spraying of emptied munitions. The brine that is unable to be reused within the process is collected and held in tanks to be shipped off to an EPA approved facility to undergo further treatment.[26] At this time,

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[24] "Static Detonation Chamber," Program Executive Office Assembled Chemical Weapons Alternatives, accessed April 29, 2021, https://www.peoacwa.army.mil/bgcapp/bgcapp-destruction-technologies/static-detonation-chamber/.

[25] For additional information on supercritical water oxidization see M.D Bermejo and M.J. Cocero, "Supercritical water oxidization: A technical review," *AIchE Journal* 52, no. 11 (November 2006), 3933-3951.

[26] "Chemical Weapons Destruction in Richmond, Kentucky," Program Executive Office Assembled Chemical Weapons Alternatives, video, 13:45, https://www.youtube.com/watch?v=7u-ACe1CBfA.

the Army is still waiting for the appropriate federal and state permits to transport this brine off-site for treatment, and while it does retain some level of toxicity, it is not nearly as problematic as the CVXH removed from NECDF. In the intervening years, thanks to a growing need from the commercial chemical industry, disposal sites for brine wastewater from chemical disposal operations are more readily available. Therefore, it is unlikely that the Army will experience the same controversy that surrounded closure operations at NECDF.[27] Currently PEOACWA claims that approximately 23% of the total stockpile held at BGAD is destroyed, though they project those operations may continue well beyond 2023. Within the obstacles that continue to delay disposal operations at BGAD lies the irony that the facility with the smallest stockpile, in the community that precipitated the greatest influence in the Army's decisions regarding alternative disposal technologies, will be the one that takes the longest to move out of the shadow of the chemical weapons era.

**Can A Footprint Be Removed from The Ocean?**

Relatively speaking, the United States is making significant inroads in its efforts to reduce the ecological footprint of the American chemical weapons program, at least in terms of what was held on land. However, there remains a definitive toxic legacy lurking within domestic and international waters. Between seemingly random and haphazard offshore dumping, the numerous iterations of Operation CHASE, and joint American and

[27] National Research Council, *Review of Secondary Waste Disposal Planning for the Blue Grass and Pueblo Chemical Agent Destruction Pilot Plants*, (Washington, DC: The National Academies Press, 2008), 47.

European dumping operations at the end of both World Wars; the American military was both unwilling and unable to contain its toxic footprint within its own borders. Now that the United States is finally beginning to see the light at the end of the tunnel for domestic chemical weapons demilitarization, are there plans to remediate areas outside of those borders? Unfortunately, answers to this question do not come easily and the fact remains that despite numerous advances in ocean mapping technology over the last few decades, researchers failed to come any closer to finding efficient methods to locate the final resting place of the ocean dumped chemical weapons. Furthermore, even if they did manage to pinpoint the numerous dumping locations, several obstacles exist that make military officials hesitant about entering this next chapter of remediation. To begin with, munitions were dumped in waters ranging in depths from 200 feet to over 13000 feet. Those dumped in shallower waters are subjected to disturbance through shifting currents, storms, and underwater development significantly more than those disposed of in deeper waters, thus making them increasingly difficult to pinpoint. Furthermore, underwater recovery operations are costly and marine remediation is always subject to the whims of the environment. Rough seas due to storms or typical ocean currents can put an immediate halt to recovery operations, not to mention how these environmental factors have the potential to create catastrophe if the weather turns while a rusting munition is in the slow process of being brought up from the ocean floor.

Some researchers posit that marine remediation operations may even cause more harm than good, especially in the case of sulfur mustard. Recall that mustard, when introduced to sea water, forms a polymer shell that prevents hydrolysis. To remove it

from the ocean floor safely, the entire "lump" would have to be removed without breaking that crust, a feat that many researchers agree would be impossible considering the sheer amount of mustard dumped into the ocean by the United States. Furthermore, as the sulfur mustard has lain mostly undisturbed for decades, extensive colonies of marine life are well-developed in these areas, meaning that even the smallest release can affect hundreds if not thousands of marine organisms.[28]

Unfortunately, one of the biggest issues preventing concerted efforts in cleaning up the sites where ocean dumping occurred in American waters is lack of a legislative mechanism to force the parties responsible for the environmental damage to act. In fact, the Chemical Weapons Convention's Article III provides a clear exemption for signatory parties from having to remediate marine dumping sites stating:

> The provisions of this Article and the relevant provisions of Part IV of the Verification Annex shall not, at the discretion of a State Party, apply to chemical weapons buried on its territory before 1 January 1977 and which remain buried, or which had been dumped at sea before 1 January 1985.[29]

Considering the bulk of American marine chemical weapons dumping operations ended in the early 1970s after the immense backlash prompted by public discovery of Operation CHASE, the CWC essentially gives the United States a free pass regarding these toxic sites and any detrimental effects caused by disposal operations. However, this does not mean that the American public or its congressional leaders accepted the convenient loophole created by the CWC. In 2015, prompted by the Army's progress in

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[28] M.I. Greenberg et al., "Sea-dumped weapons: environmental risk, occupational hazard," *Clinical Toxicology* 54, no. 2 (2016), 89.
[29] "Article III: Declarations," Organization for the Prevention of Chemical Weapons, accessed April 29, 2021, https://www.opcw.org/chemical-weapons-convention/articles/article-iii-declarations.

chemical stockpile destruction, Congress instructed the Department of Defense (DOD) to embark on a study to determine the extent of pollution caused by ocean dumping, as well as its recommendations for potential remediation. The resulting 2016 report echoed the claims of other researchers— that the weapons are safer being left where they are and that recovering them poses a much greater environmental risk.[30] However, chemical munitions expert James Barton in a subsequent report to the CDC, claims that the DOD is not thorough in their research, and that their conclusions are incorrect. Though in his report, it is interesting that Barton did not add the remediation work being done in the Baltic Sea to his criticisms.

The Baltic Sea practically became a toxic environment seemingly overnight resulting from the chemical weapons dumped there at the end of World War II. While most weapons dumped here were of German or Soviet manufacture, many American made munitions also ended up in the Baltic Sea, though it remains difficult to know the exact quantities and their country of origin due to the amount of deterioration that has occurred over the last six decades, making the marks on the munitions identifying country of origin and chemical fill illegible. Yet, instead of spending time and money attempting to determine who should be financially responsible for the cleanup, several eastern European countries simply acknowledged that there is a problem and started working on solutions. Through a working partnership between the European Union and

[30] Daniel Ross "Government won't remove thousands of tons of potentially toxic chemical weapons dumped off US coasts," International Dialogue on Underwater Munitions, last modified October 3, 2017, https://underwatermunitions.org/2017/10/17/government-wont-remove-thousands-of-tons-of-potentially-toxic-chemical-weapons-dumped-off-us-coasts/.

the Helsinki Commission (HELCOM), the Chemical Munitions Search and Assessment (CHEMSEA) project employed the most advanced underwater mapping techniques to locate the Baltic toxic hot spots, and then collaborated with Europe's leading chemical engineers to devise strategies to remediate those areas of the Baltic Sea. While the CHEMSEA report confirmed the dangers of retrieving munitions from the marine environments, it diverged from the DOD report in that several neutralization methods exist that can greatly reduce the risks to ecosystems and the potential of these toxins from entering the food chain.[31] CHEMSEA not only represents the pinnacle of marine remediation efforts, but also the unique benefits of the collaborative effort of the Russian, Polish, and German military, HELCOM, several prominent European universities, and a litany of other groups including the Stockholm International Peace Research Institute (SIPRI), The Swedish Maritime Administration, and the Polish Academy of Sciences. Conspicuously absent from the parties contributing to CHEMSEA remediation efforts is the United States military who in many ways is just as culpable for Baltic Sea contamination as the Soviet Union or Nazi Germany.

**A final reckoning of the CWC mandate**

Despite a somewhat questionable disposal history, numerous delays and setbacks, and the revising of CWC destruction deadlines, the United States maintains an active role within the Organization for the Prohibition of Chemical Weapons (OPCW) and its support of their efforts in CWC enforcement globally. To date, 90% of the declared U.S.

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[31] Jacek Beldowski et al., *CHEMSEA Findings – Results from the CHEMSEA project (chemical munitions search and assessment)* (Sopot: Institute of Oceanology of the Polish Academy of Sciences, 2014), 74.

stockpile is destroyed with only the remnants at Pueblo Chemical Depot and Blue Grass Army Depot awaiting destruction. Army CMA officials claim that both facilities are slated to begin closing operations as early as 2023, provided that no further incidents at those facilities slow the destruction timeline down.[32] Additionally, the United States continues to play a key role in the destruction of other countries stockpiles. When OPCW inspectors discovered an undeclared stockpile in Albania, American engineers worked closely with their German counterparts to develop a portable disposal system that could be transported through Albania's mountainous terrain. The U.S. was also instrumental in developing the Field-Deployable Hydrolysis System (FDHS) that was used to destroy the mustard and sarin stockpiles held by the Assad regime.[33]

The United States also shows its overall commitment to ensuring CWC compliance by lending its geopolitical power to help the French-led Partnership against Impunity for the Use of Chemical Weapons, which aims to increase political pressure on countries suspected of chemical weapons use. The U.S. also joined Canada and the Netherlands in sponsoring an amendment to Schedule I of the CWC Annex on Chemicals that added Novichok agents in response to suspected Russian use in 2018 and 2020. Furthermore, the U.S. continues its assertion, along with other OPCW member states, that the claims Russia made in 2017 that it destroyed all its stockpiles is inaccurate and suggests that Russia did not declare all of its facilities per the original CWC mandate. To

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[32] "United States," Nuclear Threat Initiative, accessed April 29, 2021, https://www.nti.org/learn/countries/united-states/chemical/.
[33] United States Army DEVCOM Chemical Biological Center, "Official Field Deployable Hydrolysis System (FDHS) animation," YouTube video, 0:48, February 19, 2014, https://www.youtube.com/watch?v=eitQBZTmt80.

that end, the United States maintains sanctions against the country that will not be lifted until the U.S. is satisfied that the Russians are no longer using chemical weapons in violation of international law, provide reliable assurances it will not engage in any such activities in the future, and are willing to allow on-site inspections to ensure compliance.[34]

There remains a considerable amount of debate regarding the overall effectiveness of the CWC to end the chemical weapons era, and in many countries who recently became party to the treaty such as Libya, Afghanistan, and Nicaragua, the mechanisms provided by the CWC for stockpile elimination are only just beginning to take effect. However, the fact that over 71,000 metric tons of globally stockpiled agent is verified as destroyed illustrates the impact of the CWC on global chemical weapons elimination.[35]

Of course, critics will point out that the United States' enduring commitment to the CWC is an effort to deflect attention from its own gross missteps both domestically and on the global stage. From haphazard production, storage, and disposal methods to inaccurate record keeping and, in some cases, willful destruction of important documents, the American military's stewardship of its most toxic weapons is inherently problematic. But none of these activities occurred within a vacuum and the social and environmental lives of these weapons continue to be overlooked by both military officials and political

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[34] Department of State, *Compliance With The Convention On The Prohibition Of The Development, Production, Stockpiling And Use Of Chemical Weapons And On Their Destruction Condition (10) (C) Report* (Washington, D.C.: Department of State, 2021), https://www.state.gov/wp-content/uploads/2021/04/2021-Condition-10-c-Report.pdf.

[35] "OPCW by the Numbers," Organization for the Prohibition of Chemical Weapons, last modified March 31, 2021, https://www.opcw.org/media-centre/opcw-numbers.

leaders. This is not to say that the Army did not make considerable progress in shrinking its environmental footprint through stockpile destruction and remediation efforts, but there is still much work to be done in terms of non-stockpile material and contaminated FUDS, and work needs to begin on unraveling the complex issues of social and environmental justice that became inexorably entwined within the ecological footprint of the American chemical weapons program.

## Conclusion

Nearly twenty years after Chemical Weapons Convention ratification that marked the end of the American chemical weapons program, the wide-ranging effects of it are still being felt both domestically and internationally. Domestically, those who continue to live in areas where chemical weapons proliferation, storage and disposal occurred such as Newport or Umatilla are just trying to find a way to separate themselves from the toxic legacy of these facilities. They worry about things such as residual effects from storage and destruction, asking poignant questions about the safety of drinking water or if their children will be exposed simply by playing outside. Others ask more economic based questions such as, “Now that the destruction facilities are being dismantled, will I still have a job next year?” or “Will my business survive once the military and its contractors leave?”

Expanding the footprint of the American chemical weapons program in less obvious ways carries host of cultural and social issues, many of which will only emerge over time. From the upending of economies in communities surrounding former production, storage, and disposal facilities to low-income areas being chosen as sites for the facilities due to the overall lack of sociopolitical power residents of these areas possessed, weaponized chemicals continue to carry a significant socio-economical footprint. Exacerbating this problem are the disparities in government responses to the social and ecological issues stemming from chemical weapons proliferation as observers have noted the differences of resources dedicated to the cleanup of the affluent Spring Valley community in comparison with the rest of the FUDS.

In places such as Anniston, Alabama where environmental damage caused by the confluence of military and industry is most pronounced, residents, veterans, and their families continue to wonder if the United States government intends to do anything about the environmental problems caused by such facilities, or if the lingering medical issues caused by unintended exposure to military grade toxins will continue to be swept under the proverbial rug. While citizens in these communities seem grateful for the continued military presence and the income it brings to the area, undercurrents of distrust and disillusionment exist that are likely to erupt into anger, resentment, and fear, especially for those groups who have directly suffered because of chemical weapons development and disposal such as the soldiers who trained at Fort McClellan before its closure, or the scores of veterans exposed to Agent Orange during the Vietnam War. Meanwhile, as medical researchers continue to reveal the links between dioxin exposure and cancer, the U.S. government and the Veterans Administration continue to deny those links exist and by proxy, deny responsibility for the health of those veterans. There is bitter irony in the fact that the men and women who swore to protect the United States in peacetime and in war cannot expect the same courtesy from their own government.

For each base or facility, there are numerous complex issues that will continue to emerge as time goes on. Not just at former disposal facilities, but more importantly at sites like Redstone Arsenal where discoveries of non-stockpile material are ongoing, or at the dozens of marine disposal sites surrounding the United States and several European countries that sit much like a jack-in-the-box, just waiting for the right moment to reveal a deadly surprise. These sites in many ways are the most concerning since toxic releases

in this larger environment will greatly disrupt marine and terrestrial ecosystems. Furthermore, as humans continue to find new ways to explore more of the ocean and engage in projects like underwater pipelines, increased trans-oceanic ecotourism, and commercial fishing, the potential for an ecological disaster increases with each passing day. Considering the military's legacy of poor record-keeping regarding sea-dumped chemical weapons, one can assume that is only a matter of time before new and unexpected surprises are revealed as humans continue to expand into these marine environments.

Certainly, there is some merit to the accomplishments and progress made by the United States in reducing the toxic footprint left by its chemical weapons program—Ninety percent of the declared stockpile is destroyed, remediation is still occurring at many domestic sites, and the United States has shown its desire to be a beneficial member of the international community through its continued support of the OPCW and its efforts to eliminate chemical weapons globally. However, even with over twenty years under the CWC mandate, the 1997 treaty still lacks much needed mechanisms to force those responsible for creating toxic environments outside of their own borders to join efforts to remediate them, This shortcoming is highlighted by the fact that while the United States was actively involved in ocean dumping of chemical weapons into the North Sea, it is not actively involved in the CHEMSEA project, nor has the U.S. made any move to join those efforts, despite the fact that the ecological footprint from its chemical weapons program covers three oceans and several countries. Indeed, that footprint may be growing even though the United States is not currently producing

chemical weapons as discoveries of the chemical trenches at Redstone or the continued unearthing by civilians of non-stockpile material such as CAIS or chunks of polymerized sulfur mustard is proof that additional discoveries may only be one trawling net or shovelful of dirt away. Even at sites like Edgewood Arsenal where the Army spent billions of dollars converting the former production facility into a beneficial research hub for chemical defense and educational outreach, a potential ecological time bomb remains. As the Army retained the most problematic areas of the base, including the infamous O Field, environmental testing was not as rigorous as that done at other FUDS.

However, the military has shown that if given the proper incentives, it can convert toxic landscapes into vibrant and beneficial ecosystems. For example, Johnston Island that previously held the distinction of being one of the most polluted sites on the planet between the biological, chemical, and nuclear testing that occurred there now serves as a nesting area for dozens of bird species, a sanctuary for sea-turtles, and hosts numerous researchers interested in observing these organisms in their natural habitat. To be sure, water and soil samples are routinely tested for toxins, but the tests have revealed no significant toxin levels. Furthermore, biologists studying the biota of Johnston Island have not uncovered any evidence of bioaccumulation. The fenced off area known as Pluto Yard notwithstanding, Johnston Atoll shows very little of the Army's toxic legacy.

The same can be said for Rocky Mountain Arsenal National Wildlife Refuge in Colorado. What was once an area considered to be the most polluted in the state between the chemical weapons housed here and the pesticide residues created by Shell, now is a winter nesting area for bald eagles as well as a habitat for a wide array of animals

including bison, ferrets, prairie dogs, and white-tail deer among many others. In fact, the Army in conjunction with U.S. Fish and Wildlife Service created one of the most diverse landscapes in the state of Colorado through their remediation efforts, and like Johnston Atoll serves as proof that full remediation of other sites is attainable but will require a much wider effort than the military can produce alone.

Despite these few success stories, the history of the American chemical weapons disposal is riddled with contradictions, poor decisions, and a general disregard for the long-term environmental and social consequences of chemical weapons development. To make the claim that the CWC ended the chemical weapons era is myopic, considering that the comprehensive chemical weapons treaty fails to address many of these issues or provide guidelines to assist responsible nations on the path to remediation. Perhaps now that U.S. is on the precipice of the end of its own disposal operations, it would be a good time for America to take the lead both domestically and globally in righting the socio-environmental wrongs created by global chemical weapons proliferation by turning its scientific and economic capacity to those ends. Until these issues are properly addressed, the ecological footprint of the American chemical weapons program is only destined to grow, proving that the chemical weapons era is far from over.

# Bibliography

## Primary Sources

### Autobiographies

Hitler, Adolph. *Mein Kampf.* Munich, Franz Eher Nachfolger GmbH, 1925.

Speer, Albert. *Inside The Third Reich.* New York: Simon and Schuster, 1970.

### Government Documents

Central Intelligence Agency. *Memorandum for the Director of Current Intelligence: Nerve Gas Incident in Okinawa.* Official Memorandum. Washington, D.C.: Central Intelligence Agency, 1969.

Marine Protection, Research, and Sanctuaries Act, 16 USC § 1431 et seq. and 33 USC §1401 et seq. (1988).

National Environmental Policy Act of 1969, § 2, 42 USC § 4321.

Office of the Project Manager Chemical Demilitarization. *Demilitarization Operation of the Chemical Agent Munition Disposal System (CAMDS) at Toole Army Depot,* Army Directive A062-499. Aberdeen Proving Ground, MD: Chemical Agent Disposal System Demilitarization/Disposal Office, 1977. https://apps.dtic.mil/sti/pdfs/ADA062499.pdf.

Records Of The Chemical Warfare Service, Record Group 175, Box 62, The National Archives at College Park, College Park, MD.

Records Of The United States Army Materiel Command, Record Group 544 "Organizational Authority Record, 1962-1973." The National Archives at College Park, College Park, MD.

Ted Poe (TX). "Vieola Environmental Services" *Congressional Record* 155:6 (2009), p. 7293. Text from: Congressional Record Permanent Digital Collection; Accessed: April 29, 2021.

United States Congress. House Of Representatives. National Defense Authorization Act for Fiscal Year 1993. H.R. 5006, 102nd Congress, 1st sess. (October 5, 1992), https://www.govtrack.us/congress/bills/102/hr5006.

United States Congress. House of Representatives. Subcommittee of the Committee on Government Operations. *Hazardous Waste Problems At Department Of Defense Facilities,* 100th Cong., 2nd sess., 1987.

United States Congress, House of Representatives. To prohibit the Secretary of Defense from transporting across State lines chemical munitions in the chemical weapons stockpile, and for other purposes. H.R. 4346, 103rd Cong. 1st sess. (May 5,1994). https://www.congress.gov/bill/103rd-congress/house-bill/4346?r=27&s=1.

## Government Publications

Bearden, David M. *U.S. Disposal of Chemical Weapons in the Ocean: Background and Issues for Congress.* Washington D.C.: Congressional Research Service, 1997.

Beldowski, Jacek, Joanna Potrykus, Marta Szubaka, and Jan Fiidler. *CHEMSEA Findings – Results from the CHEMSEA project (chemical munitions search and assessment.* Sopot: Institute of Oceanology of the Polish Academy of Sciences, 2014.

Carter, Mark A, "Anniston Alabama Army Depot And American Federation Of Government Employees, Local 1945," Official memorandum. Washington, DC: U.S. Federal Labor Relations Authority, 2019. https://www.flra.gov/node/78753.

Centers For Disease Control and Prevention, "Facts About Riot Control Agents- Interim Document," April 4, 2018. https://emergency.cdc.gov/agent/riotcontrol/factsheet.asp.

Department of State, *Compliance With The Convention On The Prohibition Of The Development, Production, Stockpiling And Use Of Chemical Weapons And On Their Destruction Condition (10) (C) Report.* Washington, D.C.: Department of State, 2021. https://www.state.gov/wp-content/uploads/2021/04/2021-Condition-10-c-Report.pdf.

National Academies of Sciences, Engineering, and Medicine. *Initial Closure Planning for the Blue Grass and Pueblo Chemical Agent Destruction Pilot Plants: Letter Report (2020).* Washington, DC: The National Academies Press, 2020.

National Research Council. *Assessment of the Army Plan for the Pine Bluff Non-Stockpile Facility.* Washington, DC: The National Academies Press, 2004.

National Research Council. *Remediation of Buried Chemical Warfare Materiel*. Washington, DC: The National Academies Press, 2012.

National Research Council. *Review of Secondary Waste Disposal Planning for the Blue Grass and Pueblo Chemical Agent Destruction Pilot Plants*. Washington, DC: The National Academies Press, 2008.

National Security and Internal Affairs Division. *Chemical Weapons Disposal: Plans for Nonstockpile Chemical Warfare Materiel Can Be Improved.* GAO/NSIAD-95-55. Washington, D.C.: Government Accountability Office.

National Security and Internal Affairs Division. *Chemical Weapons Stockpile: Changes Needed in the Management of the Emergency Preparedness Program.* GAO/NSIAD-97-91. Washington, D.C.: Government Accountability Office, 1997.

Organization for the Prohibition of Chemical Weapons. "Japan's Efforts Toward Early Destruction of ACW in China." Report RC-2/NAT.20 at the Second Review Conference, 16 April 2008. Accessed September 23, 2020. http://www.opcw.org.

Tucker, Johnathan B. *Center for the Study of Weapons of Mass Destruction: Case Study 4.* Washington, D.C.: National Defense University Press, 2011.

U.S. Army Corps of Engineers, "Recovered Chemical Warfare Materiel (RCWM) Response Process." Pamphlet 75-1-3. Washington, D.C.: Government Printing Office, 2004.

United States Air Force. *Hazardous Waste Corrective Action Permit Renewal Application For Johnston Atoll Facility.* Report No. FA8903-17-F-238. Government Printing Office: Washington, D.C., 2018.

United States Army Chemical and Biological Defense Command, Edgewood Research and Technology Directorate. "Operation Safe Removal: Spring Valley, Washington, DC. Fact Sheets on Identified World War I Chemical Agents" ERDEC-TR-206. Aberdeen Proving Ground, Md., 1994.

United States Army Chemical Materials Activity Recovered Chemical Material Directorate Public Affairs Office, "Recovered Material Directorate Fact Sheet," 2011.

United States Army Corps of Engineers. *A Brief History of the American University Experimental Station and U.S. Navy Bomb Disposal School, American University.* Washington, D.C.: U.S. Army Corps of Engineers, 1994, https://www.nab.usace.army.mil/Portals/63/docs/SpringValley/AUES_Report_June_1994.pdf.

United States Department of Health and Human Services, Agency for Toxic Substances and Disease Registry, Division of Health Assessment and Consultation. *Health Consultation: Spring Valley Chemical Munitions, Washington, District of Columbia, Public Health Evaluation for the Spring Valley Community.* Atlanta: Centers for Disease Control, 1994.

United States Department of the Army, *Rocky Mountain Arsenal: Annual Summary Report For Groundwater and Surface Water, Fiscal Year 2016.* Washington, D.C.: Department of Defense, 2017.

United States Department of the Interior, United States Department of Fish and Wildlife, *Rocky Mountain Arsenal National Wildlife Refuge Annual Narrative Report Fiscal Year 1998.* Washington, D.C.: Government Printing Office, 2002.

United States Environmental Protection Agency. *Review of Thermal Destruction Technologies for Chemical and Biological Agents Bound on Materials*. Report No. EPA/600/R-15/202. Research Triangle Park: U.S. Environmental Protection Agency, 2015.

United States Institute of Medicine Committee to Review the Health Effects in Vietnam Veterans of Exposure to Herbicides. *Veterans and Agent Orange: Health Effects of Herbicides Used in Vietnam.* Washington, DC: National Academies Press, 1994.

United States Institute of Medicine. *Veterans at Risk: The Health Effects of Mustard Gas and Lewisite.* Washington, DC: National Academies Press, 1993.

United States Office of Technology Assessment. *The Chemical Weapons Convention: Effects on the U.S. Chemical Industry.* Washington, D.C.: Government Printing Office, 1993.

## Multimedia

Cronkite, Walter. "Who, What, When, Where, Why." *CBS News*. CBS. February 27, 1968.

Johnson, Steve. "Special Report: What's Hidden Beneath Redstone Arsenal?" WHNT News. CBS. Huntsville, AL. WHNT. July 14, 2014. https://whnt.com/news/hidden-beneath-the-arsenal/.

Program Executive Office Assembled Chemical Weapons Alternatives. "Chemical Weapons Destruction in Richmond, Kentucky." Video, 13:45. https://www.youtube.com/watch?v=7u-ACe1CBfA.

United States Army DEVCOM Chemical Biological Center. "Official Field Deployable Hydrolysis System (FDHS) animation." Video, 0:48. February 19, 2014. https://www.youtube.com/watch?v=eitQBZTmt80.

Unknown photographer, *American University- Hades Pit*. Photograph. Washington D.C., Library of Congress, 1919.

Periodicals

"Armed Forces: GB or Not GB." *Time Magazine,* vol. 96, no. 7. August 17, 1970.

"Cut Holes and Sink Em'." *Time Magazine,* vol 96, no 8. August 24, 1970.

"Outside Schools On The Campus." *American University Courier* (Washington D.C.), April 1921.

Associated Press, "Chemical weapons found in Mosul in Isis lab, say Iraqi forces," *The Guardian* (London, UK), January 29, 2017.

Baquiche, Blaise. "Poland, Mustard Gas, & The Rule Of Law: The Battle for Illiberal Democracy." *Byline Times* (London, UK),,July 10, 2020.

Biddle, Wayne. "New Nerve Gas Weapons Urged For Military." *New York Times,* April 28, 1985.

Bull, John. "Vast Chemical Dumping Found At Sea." *Newport News Daily Press.* October, 30, 2005.

Colombo, Hayleigh. "Ridding Newport of deadly VX agent." *Journal and Courier* (Lafayette, IN), March 22, 2014.

Colster, Chris, "Cleanup efforts restore land for future development," *Redstone Rocket* (Decatur, AL), June 12. 2019.

David Zucchino."Deadly chemical weapons, buried and lost, lurk under U.S. soil." *Los Angeles Times* (Los Angeles, CA), March 21, 2014.

Davidson, Lee. "Army Admits Secret Testing." *Deseret News*, July 1, 2003.

———. "Lethal Breeze." *Deseret News,* June 5, 1994.

Detore, Don. "Poisonous gas once manufactures at former Ohio Rubber Co. site." Rubber and Plastics News. Crain Communications, Apr. 10 2013.

Frischkorn, Jeffery L. "Willoughby's war history coming into focus." *Willoughby News-Herald* (Willoughby, OH), February 17, 2002.

Glancey, Johnathan. "Out Last Occupation." *Guardian* (London, UK), Apr. 13, 2003.

Griffin, Andrew. "Novichok remains active long after it is used and people could be poisoned by picking things up, experts warn." *Independent* (London, UK), July 5, 2018.

Hoffman, David. "Wastes of war: Russia's forgotten chemical weapons." Washington Post, August 16, 1998.

Katona, Steve. “Nasty Surprises On The Ocean Floor: Chemical Warfare Agents And Ocean Health.” Ocean Health Index, July 24, 2014.

Kristof, Nicholas D. “Unmasking Horror -- A special report; Japan Confronting Gruesome War Atrocity.” *New York Times,* Mar. 17 1995.

Lederberg, Joshua. “The Dilemma Of curbing Chemical Warfare.” *Washington Post,* Sep. 27, 1970.

McMichael, William C. and Jeff Montgomery, “Two suspected mustard rounds found at seafood plant.” *The News Herald* (Wilmington, DE), January 27, 2015.

Mitchell, Alison. “How The Votes Were Won: Clinton’s New GOP Tactics.” New York Times, April 25, 1997.

Notarianni, John “Umatilla Chemical Weapons Depot: What’s next for the 20,000 acre military installation.” *Statesman Journal* (Salem, OR), March 11, 2019.

O’ Hagan, Sean. “Toxic neighbour: Monsanto and the poisoned town.” *Guardian,* April 20, 2018, https://www.theguardian.com/artanddesign/2018/apr/20/mathieu-asselin-monsanto-deutsche-borse-anniston-alabama.

O’Donoghue, Amy Joi. “Last of chemical weapons to be destroyed in Tooele.” *Deseret News,* January 18,2012.

Olsen, Ken “The Long Shadow of Fort McClellan.” The American Legion, February 20, 2018. https://www.legion.org/magazine/241272/long-shadow-fort-mcclellan.

Parker, Suzi. “Burning controversy over weapons disposal.” *Christian Science Monitor,* March 9, 1999.

Stang, John. “Umatilla chemical weapons: end of a nightmare.” *Crosscut* (Seattle, WA), October 11, 2011.

Williams, Denise. “Toxic Vets- The Poisonous Legacy of Ft. McClellan.” *Chicago Tribune,* August 7, 2013.

## Press Conferences

Clinton, William J. “Remarks By The President After The Vote On Ratification Of The Chemical Weapons Convention.” Washington D.C., April 24, 1997. Accessed May 9 2021. https://clinton.presidentiallibraries.us/files/original/071022a66883e63db5b8ac8406bbe97f.pdf.

## Treaties

"Treaty relating to the Use of Submarines and Noxious Gases in Warfare. Washington, 6 February 1922.” Treaties, State Parties and Commentaries, International Committee of the Red Cross. 2012. Accessed Mar. 11, 2020. https://ihl-databases.icrc.org/applic/ihl/ihl.nsf/Treaty.xsp?documentId=7F0E4920E26AB9C2C12563CD002D6907&action=openDocument.

Geneva Protocol. *League of Nations Treaty Series*, vol. 94, pp. 66-74.

International Peace Conference. 1915. *The Hague conventions of 1899 (II) and 1907 (IV) respecting the laws and customs of war on land*.

Knox, Philander C *Treaty of Versailles*. Washington, D.C.: Government Printing Office, 1919.

Organization for the Prohibition of Chemical Weapons.” The Chemical Weapons Convention.” Accessed March 17, 2020. https://www.opcw.org/chemical-weapons-convention/articles.

United Nations, Conference on Disarmament. *Working Paper with suggestions in regard to the draft treaty on non-proliferation of Nuclear Weapons, put forward by the delegation of Sweden at the meeting of the Eighteen-Nation Committee On Disarmament*, ENDC/215 (8 February 1968).

## Websites

Sanders-Zakre, Alicia. “Russia Destroys Last Chemical Weapons.” Arms Control Association. Accessed November 22, 2020. https://www.armscontrol.org/act/2017-11/news/russia-destroys-last-chemical-weapons.

Arms Control Association. "The Australia Group at a Glance." Accessed March 20, 2021. https://www.armscontrol.org/factssheets/australiagroup.asp.

———. “Anniston Begins Burning Chemical Weapons.” Last modified September 26, 2003. https://www.armscontrol.org/act/2003-09/anniston-begins-burning-chemical-weapons.

BBC News. “Russian spy: Highly likely Moscow behind attack, says Theresa May.” Accessed March 13, 2018. https://www.bbc.com/news/uk-43377856.com/news/uk-43377856.

Colorado Department of Public Safety, Colorado Division Of Homeland Security and Emergency Management. “Colorado Earthquake Information.” Accessed March 11, 2011, http://www.coemergency.com/2010/01/colorado-earthquake-information.html.

Department of Defense. “History of United States’ Involvement In Chemical Warfare.” Accessed October 3,2020. https://denix.osd.mil/rcwmprogram/history.

Federal Emergency Management Administration. “What Is CSEPP?” Accessed March 26,2021. https://www.cseppportal.net/SitePages/about-csepp.html.

GlobalSecurity.org. “Weapons of Mass Destruction: Deseret Chemical Depot Tooele, Utah.” Accessed April 28,2021. https://www.globalsecurity.org/wmd/facility/deseret.htm.

Imperial War Museum. “Voices of the First World War: Gas Attack At Ypres.” Imperial War Museums. Accessed May 17,2021. https://www.iwm.org.uk/history/voices-of-the-first-world-war-gas-attack-at-ypres.

Mauroni, Al. “The U.S. Army Chemical Weapons Corps: Past, Present, and Future.” National Museum of the U.S. Army. Accessed October 19, 2020. https://armyhistory.org/the-u-s-army-chemical-corps-past-present-and-future/.

National Center for Biotechnology Information. “PubChem Compound Summary for CID 5372798, Lewisite.” Accessed May 18,2021. https://pubchem.ncbi.nlm.nih.gov/compound/Lewisite.

Nuclear Threat Initiative. “United States.”Accessed April 29, 2021, https://www.nti.org/learn/countries/united-states/chemical/.

Organization for the Prohibition of Biological Weapons., "The Biological Weapons Convention, Article I. Accessed March 17, 2021. http://www.opbw.org/.

———. “OPCW by the Numbers.” Last modified March 31, 2021. https://www.opcw.org/media-centre/opcw-numbers.

Program Executive Office Assembled Chemical Weapons Alternatives. “Facts: PEO/ACWA Legislation.” Accessed March 12, 2021. https://www.peoacwa.army.mil/2021/03/12/facts-peo-acwa-program-legislation/.

———. “Pueblo Chemical Agent-Destruction Pilot Plant (PCAPP),” Accessed April 29, 2021, https://www.peoacwa.army.mil/pcapp/.

———. “Static Detonation Chamber.” Accessed April 29, 2021. https://www.peoacwa.army.mil/bgcapp/bgcapp-destruction-technologies/static-detonation-chamber/.

Ross, Daniel. “Government won’t remove thousands of tons of potentially toxic chemical weapons dumped off US coasts,” International Dialogue on Underwater Munitions. Last modified October 3, 2017. https://underwatermunitions.org/2017/10/17/government-wont-remove-thousands-of-tons-of-potentially-toxic-chemical-weapons-dumped-off-us-coasts/.

Schmidt, Nadine, Gianluca Mezzofiore and Amy Woodyatt. “Russian opposition leader Alexey Navalny was poisoned, Berlin hospital says.” CNN. Last modified August 24, 2020. https://www.cnn.com/2020/08/24/europe/alexey-navalny-germany-poison-grm-intl/index.html.

United States Army Chemical Materials Activity. “Chemical Agent Identification Sets Fact Sheet.” Accessed January 2, 2021. http://www.cma.army.mil/fndocumentviewer.aspx?docid=003671048.

———. “Single CAIS Access and Neutralization System (SCANS).” Accessed April 28,2021. https://www.cma.army.mil/scans/.

———. “The U.S. Army Chemical Materials Activity.” Accessed March 20, 2021. http://www.cma.army.mil/.

United States Army Corps of Engineers, “Formerly Used Defense Sites Program Management Action Plan: Jackson Fairgrounds. Accessed January 5, 2021. https://fudsportal.usace.army.mil/ems/ems/inventory/map/map?id=55116.

United States Army Combat Capabilities Development Command Chemical Biological Center. “DoD Identifies Commercial Decontaminant for Field Use Against COVID-19.”Last modified June 11, 2020. https://www.cbc.devcom.army.mil/newspost/dod-identifies-commercial-decontaminant-for-field-use-against-covid-19/.

———. “STEM and Educational Outreach Program.” Accessed April 29, 2021, https://www.cbc.devcom.army.mil/about-us/stem-and-educational-outreach-program/.

United States Environmental Protection Agency “RE-Powering America’s Land: Evaluating the Feasibility of Siting Renewable Energy Production on Potentially Contaminated Land.” Accessed April 29,2021. https://www.epa.gov/sites/production/files/2015-07/documents/r05-11-009_newport.pdf.

———, “EPA History: Resource Conservation and Recovery Act.” Last modified June 8, 2020. https://www.epa.gov/history/epa-history-resource-conservation-and-recovery-act.

———, “Summary of the Comprehensive Environmental Response, Compensation, and Liability Act (Superfund),” Last modified July 27, 2020. https://www.epa.gov/laws-regulations/summary-comprehensive-environmental-response-compensation-and-liability-act.

———. “Resource Conservation and Recovery Act (RCRA) Regulations.” Last modified February 25, 2019, https://www.epa.gov/rcra/resource-conservation-and-recovery-act-rcra-regulations#haz.

———. “Summary of the Marine Protection, Research, and Sanctuaries Act.” Last modified December 27, 2018. https://www.epa.gov/laws-regulations/summary-marine-protection-research-and-sanctuaries-act.

United States Fish and Wildlife Service. “Wildlife and Habitat.” Last modified December 15, 2016. https://www.fws.gov/refuge/Johnston_Atoll/wildlife_and_habitat/index.html.

United States Merchant Marine. “U.S. Merchant Marine In World War II.” Accessed October 5, 2020. http://usmm.org/ww2.html

## Secondary Sources

### Books

Alibek, Ken. *Biohazard: The Chilling True Story of the Largest Covert Biological Weapons Program in the World, Told from the Inside by the Man who Ran it.* New York: Random House, 1999.

Andrulewicz, Eugeniusz. "War Gases and Ammunition in the Polish Economic Zone of the Baltic Sea." in *Sea-Dumped Chemical Weapons: Aspects, Problems and Solutions*. Edited by Alexander V. Kaffka. Dordrecht: Springer, 2010.

Brophy, Leo P., Wyndham D. Miles and Rexmond C. Cochrane. *The Chemical Warfare Service: From Lab To Field.* Washington: Center of Military History, 1988.

Carson, Rachel. *Silent Spring.* Boston: Houghton Mifflin, 1962.

Cashman, John R. *Emergency Response to Chemical and Biological Agents*. Boca Raton: CRC Press, 2002.

Coleman, Kim. *A History of Chemical Warfare* (London: Palgrave Macmillan, 2005.

Courtois, Stéphane, Nicholad Werth, Jean-Louis Panné, Andrzej Paczkowski, Karel Baetosek, and Jean-Louis Margolin. *The Black Book of Communism: Crimes, Terror, Repression.* Edited by Stéphane Courtois. Cambridge: Harvard University Press,1999.

Doyle, Jack. *Trespass Against Us: Dow Chemical & The Toxic Century*. Monroe: Common Courage Press, 2004.

Edmund Russell, Edmund. *War and Nature: Fighting Humans and Insects with Chemicals from World War I to Silent Spring.* Cambridge: Cambridge University Press, 2008.

Emery, Theo. *Hellfire Boys: The Birth Of The U.S. Chemical Warfare Service And The Race For The World's Deadliest Weapons*. New York: Little, Brown and Company, 2017.

Epstein, Samuel S., Lester O. Brown and Carl Pope. *Hazardous Waste in America.* San Francisco: Sierra Club Books, 1982.

Fedorov, Lev Aleksandrovich. *Chemical Weapons in Russia: History, Ecology, Politics.* Moscow: Center of Ecological Policy of Russia, 1994. https://fas.org/nuke/guide/russia/cbw/jptac008_l94001.htm.

Fries, Amos A. and C.J. West. *Chemical Weapons.* New York: McGraw-Hill, 1921.

Gerber, Michele Stenehjem. *On The Home Front: The Cold War Legacy of the Hanford Nuclear Site*. Lincoln: University of Nebraska Press, 2002.

Haber, L.F. *The Poisonous Cloud: Chemical warfare in the First World War*. Oxford: Oxford University Press, 1986.

Harris, Robert and Jeremy Paxman. *A Higher Form of Killing: The Secret Story of Chemical and Biological Warfare.* New York: Hill and Wang, 1982.

Hasegawa, Guy R. *Villainous Compounds: Chemical Weapons & The American Civil War*. Carbondale: Southern Illinois University Press, 2015.

James W. Hammond, *Poison Gas: The Myths versus Reality* (Westport: Greenwood Publishing Group, 1999).

Koplow, David A. *By Fire and Ice: Dismantling Chemical Weapons While Preserving the Environment.* Amsterdam: Gordon and Breach Publishers, 1997.

Lanier-Graham, Susan D. *The Ecology of War: Environmental Impacts of Weapons and Warfare.* New York: Walker, 1993.

Martini, Edwin A. *Agent Orange: History, Science, and the Politics of Uncertainty*. Boston: University of Massachusetts Press, 2012.

Mayor, Adrienne. *Greek Fire, Poison Arrows & Scorpion Bombs: Biological and Chemical Warfare in the Ancient World.* New York: Abrams, 2003,

Robinson, J.P. *The Effects of Weapons on Ecosystems.* Oxford: Pergamon, 1979.

Sherry, Michael. *The Rise of American Air Power: The Creation of Armageddon.* New Haven: Yale University Press, 1987.

Shulman, Seth. *The Threat at Home: Confronting the Toxic Legacy of the U.S. Military*. Boston: Beacon Press, 1992.

Stockholm International Peace Research Institute. *SIPRI Yearbook 2001: Armaments, Disarmament, and International Security.* Oxford: Oxford University Press, 2001.

Stoltzenberg, Dietrich. *Fritz Haber: Chemist, Nobel Laureate, German, Jew: A Biography.* Philadelphia: Chemical Heritage Foundation, 2004.

Tucker, Jonathan B. *War of Nerves: Chemical Warfare from World War I to Al-Qaeda.* New York: Anchor Books, 2006.

Verwey, W.D. *Riot Control and Herbicides in War: Their Humanitarian, Toxicological, Ecological, Military, Polemological, and Legal Aspects.* Leyden: A.W. Sijthoff, 1977.

Vilensky, Joel A. *Dew of Death: The story of Lewisite, America's World War I Weapon of Mass Destruction.* Bloomington: University of Indiana Press, 2005.

Journal Articles

Bermejo, M.D. and M.J. Cocero. "Supercritical water oxidization: A technical review." *AIchE Journal* 52, no. 11 (November 2006), 3933-3951.

Ember, Lois R. "Destroying VX: Army's plan to erase nerve agent stocks in Indiana runs into roadblocks." *Chemical & Engineering News* 82, no. 15 (April 2004): 28-29.

Fries, Amos A. "The Future of Poison Gas." *Current History 15* (Dec. 1921): 419-422.

Galston, Arthur W. "Science And Social Responsibility." *Annals of The New York Academy Of Sciences* 196, vol. 4 (June 1972): 223-235.

Greenberg, Michael R. "Public Health, Law, and Local Control: Destruction of the US Chemical Weapons Stockpile." *American Journal of Public Health* 93, no. 8 (August 2003): 1222-1226.

Lenihan, James M. "RCRA versus CERCLA: The Clash of the Titans in Colorado v. United States Dep't of the Army United States Dep't of the Army," *Pace Environmental Law Review* 8, no. 2 (Spring 1991): 621-646.

M.J. Greenberg, M.J., K.J. Sexton, and D. Vearrier. "Sea-dumped chemical weapons: environmental risk, occupational hazard." *Clinical Toxicology 54,* no. 2 (2016): 79-91.

McFarland, Stephen L. "Preparing for What Never Came: Chemical and Biological Warfare in World War II." *Defense Analysis 2,* No. 2 (1986): 107-121.

Moeller, James W. "Arsenic and an Old Base: Legal Issues Associated with the Environmental Restoration of Defense Sites in Washington, D.C., Used for the Development and Disposal of World War I Chemical Munitions." *Catholic University Law Review54* (2005):879-959.

Munro, Nancy B., S.S. Talmage, G.D. Griffin, L.C. Waters, A.P. Watson, and J.F. King. "The Sources, Fate, and Toxicity of Chemical Warfare Agent Degradation Products." *Environmental Health Perspectives* 107, no. 12 (December 1999): 933-974.

Nicholas A. Peppas, "The First Century of Chemical Engineering," *Chemical Heritage* 26, no. 3 (Fall 2008): 26-28.

Rose, Adam. “Give Earth A Chance: The Environmental Movement and The Sixties.” *Journal Of American History* 90, no 2 (September 2003): 525-554.

Tucker, Jonathan B. “Chemical Weapons: Buried in the Backyard.” *Bulletin of the Atomic Scientists 57* (2001): 51-56.

Wiley, Karen B. and Steven L. Rhodes, “From Weapons To Wildlife: The Transformation of the Rocky Mountain Arsenal,” *Environment* 40, no. 5 (June 1998): 4-11.

Conference Papers

Zurick, David “Grassroots Environmental Opposition to Chemical Weapons Incineration in Central Kentucky: A Success Story.” Paper presented at International Conference on Grassroots Environmental Movements in Japan and the United States, Lexington, KY, April 2003.

Websites

Wilkinson, Ian “Chemical Weapons Munitions Dumped at Sea: An Interactive Map,” Middlebury Institute of International Studies at Monterey James Martin Center for Nonproliferation Studies, last modified September 7, 2017, https://nonproliferation.org/chemical-weapon-munitions-dumped-at-sea.

Federation of American Scientists. “Chemical Weapons.” Accessed March 26, 2021. https://fas.org/nuke/guide/russia/cbw/cw.htm.

McClellan Development Authority. “Development Zones.” Accessed April 29,2021, https://www.exploremcclellan.com/development-zones/.