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A MARTIAL ENVIRONMENT: THE ROCKY MOUNTAIN ARSENAL AND ECOLOGICAL CHANGE, 1942-2010

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Abstract

This thesis examines the military-industrial complex and ecological change in the American West during and after the Cold War. By specifically examining one munitions factory—the Rocky Mountain Arsenal—this thesis demonstrates two things. First, it shows that the environmental consequences of warfare are not limited to combat areas. Second, it contends that the military-industrial complex continued to dominate the land after the Cold War ended. These arguments work together to demonstrate that the military-industrial complex dominated the Front Range's environs through its weapons, waste, and its unilateral control over remediation. In both polluting the land and cleaning it up, the military-industrial complex demonstrated the extent of its control over the environment.

Introduction

From 1942 through 1982, a factory ten miles northeast of Denver, Colorado, significantly altered the region's environment. This facility, the Rocky Mountain Arsenal, was a physical manifestation of the military-industrial complex. There the U.S. Army manufactured a wide assortment of chemical weapons, while large private businesses, such as the Shell Oil Company, produced pesticides. This military-industrial complex dominated the land. Throughout the Cold War, the Arsenal's wares and waste accumulated in the soil, traveled in the groundwater, poisoned wildlife, and even generated earthquakes. The Arsenal's borders did not confine these environmental changes. Toxins flowed from the Arsenal into nearby neighborhoods and waterways, poisoned animals migrated throughout the region, and Arsenal-induced seismic activity rocked the greater Denver area.[1] While the material transformations caused by warfare often invoke images of Sherman's march through Georgia and the Carolinas, the trenches of Ypres, and the streets of Fallujah, the history of the Rocky Mountain Arsenal demonstrates that the environmental consequences of warfare are not limited to combat areas.

To understand the Rocky Mountain Arsenal is to recognize it as an example of the military-industrial complex's hold on the American West in the twentieth century. In simple terms, the military-industrial complex is a shorthand for the close relationship between the military and large private firms. President Dwight D. Eisenhower coined the term in his 1961 farewell address to describe the "conjunction of an immense military establishment and a large arms industry" whose "total influence—economic,

[1] For another study of how the military-industrial complex contaminated local lands and harmed nearby animals see Leisl Carr Childers, *The Size of the Risk: Histories of Multiple Use in the Great Basin* (Norman: University of Oklahoma Press, 2015).

political, even spiritual—is felt in every city, every State house, every office of the Federal government." This definition came with a warning. Worried about its power, Eisenhower implored the American people to "never let the weight of this combination endanger our liberties or democratic processes."[2] *Time* magazine offered a more complete explanation of the concept in 1969:

> The complex is not a well-organized, centrally directed entity. It is a vast, amorphous conglomeration that goes far beyond the Pentagon and the large manufacturers of weapons. It includes legislators that benefit from job-generating military activity in their constituencies, workers in defense plants, the unions to which they belong, university scientists and research organizations that receive Pentagon grants. It even extends to the stores where payrolls are spent, and the landlords, grocers and car salesmen who cater to customers from military bases.[3]

The military-industrial complex was a machine as large as the nation. Tax dollars, subsidies, legislation, labor, natural resources, and warfare provided its energy. It manufactured weapons, chemicals, machinery, automobiles, airplanes, ships, and thousands of other products. More broadly, this machine created international power, national security, and economic prosperity which, in turn, allowed Americans to have larger families. Like other machines, the military-industrial complex also generated environmental change.

By the time Eisenhower counseled the nation to keep this machine in check, it had already taken hold of the West's economy and environs. The military-industrial complex did not form during Eisenhower's presidency, or even during the Second World War. As the historian Kurt Hackemer notes, the military-industrial complex idea "has been around for quite some time, even before President Eisenhower popularized it

[2] Dwight D. Eisenhower, "Military-Industrial Complex Speech, 1961," in Edward K. Eckert, ed., *In War and Peace: An American Military History Anthology* (Belmont, California: Wadsworth, 1990), 339-342.
[3] "Nation: What is the Military-Industrial Complex?" *Time*, 11 April 1969.

in 1961."[4] In 1979, the historian Benjamin Cooling looked to the relationship between the United States Navy and Carnegie Steel in the 1880s as the origin of the military-industrial complex.[5] Later, in 2001, Hackemer argued that the antecedents of military-industrial complex predated the Civil War, beginning with the Navy's relationship with private steam-technology firms in the 1850s.[6] Yet, the scale of the complex before the Civil War was small in comparison to the national machine that produced American prosperity and environmental change in the twentieth century.

The key parts of the machine, the Army and large industries, have long histories in the American West. Countless books document the Army's wars and massacres against Native Americans in the nineteenth-century West.[7] However, the Army was not solely an agent of destruction. Military forts, outposts, and supply depots provided Euro-Americans and some Native Americans with access to income and goods.[8] In regards to industry, William Robbins's *Colony and Empire* synthesizes much of the historical scholarship on the how eastern firms dominated and transformed the American West in the nineteenth century. According to Robbins, capitalism plundered the West's environs and made westerners economically dependent on the East.[9] In his groundbreaking 1985 work, *The American West Transformed*, the historian Gerald Nash

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[4] Kurt Hackemer, *The U.S. Navy and the Origins of the Military-Industrial Complex, 1847-1883* (Annapolis, Maryland: Naval Institute Press, 2001), 2.
[5] Benjamin Frank Cooling, *Gray Steel and Blue Water Navy: The Formative Years of America's Military-Industrial Complex, 1881-1917* (Hamden, Connecticut: Archon Books, 1979).
[6] Hackemer, *U.S. Navy and the Origins.*
[7] For a small sampling see Gary Clayton Anderson, *Ethnic Cleansing and the Indian: The Crime That Should Haunt America* (Norman: University of Oklahoma Press, 2014); Richard White, *"It's Your Misfortune and None of My Own": A New History of the American West* (Norman: University of Oklahoma Press, 1993); Patricia Nelson Limerick, *The Legacy of Conquest: The Unbroken Past of the American West* (W.W Norton and Company, 1987); Robert M. Utley, *Frontier Regulars: The United States Army and the Indian, 1866-1891* (Bison Books, 1984).
[8] Gerald D. Nash, *The Federal Landscape: An Economic History of the Twentieth-Century West* (Tucson: University of Arizona Press, 1999), 50.
[9] William G. Robbins, *Colony and Empire: The Capitalist Transformation of the American West* (University Press of Kansas, 1994).

contends that World War II was a watershed moment in the history of the American West. For Nash, the war "matured" the West and allowed it to "shed its colonial status" by diversifying its economy and ethnic population. Yet, as Nash readily admits, his text was "suggestive rather than exhaustive."[10] He left for future historians the task of identifying just how the war transformed the lives of female westerners and the environment. In 1989, the historian Donald Worster echoed the need for historians to study the war's effects on the environment. Additionally, Worster pointed out that Nash only documented the positive effects the war had on the region. For Worster, perhaps the most important legacies of World War II in the West is how it made the region economically dependent on the military-industrial complex and poisoned the land with military waste.[11]

Nash's later work, *The Federal Landscape*, is perhaps the best overview of the economic impact that the military-industrial complex had on the West in the twentieth century. By focusing on economics and regional development, Nash argues that the twentieth-century West was "the creature of the federal government." It was the federal government, Nash says, "that determined the pattern of farms in the humid regions, built the major roads and highways, and fostered growth of the principal cities of the West." Furthermore, the federal government built dams, diverted rivers, forced Native Americans onto reservations, controlled vast stretches of land, and, most pertinent to this thesis "determined the shape of the large military reservations and their environs." According to Nash, the military-industrial complex was the West's biggest business

[10] Gerald D. Nash, *The American West Transformed: The Impact of the Second World War*, reprint (Lincoln and London: University of Nebraska Press, 1990), vii, viii, ix.
[11] Donald Worster, *Under Western Skies: Nature and History in the American West* (Oxford University Press, 1992), 10-11.

during the Cold War. This combination of large subsidized firms and the Department of Defense constructed factories, military bases, shipyards, radar stations, and arsenals across the region. From a distance, Nash explains, the military-industrial complex seemed to be "a conspiracy foisted on an unwilling populace." However, this was not the case. In reality, "it was a product of what westerners, and Americans, wanted."[12] The machine brought economic prosperity to the region.

Over the past thirty years or so, other historians have focused on specific manifestations of the military-industrial complex in the West, including Hanford, Los Alamos, and the region's uranium mines.[13] Richard White's *The Organic Machine* offers an excellent analysis of how one manifestation of the military-industrial complex transformed the Columbia River. White examines the river as an organic machine, an energy system comprised of water, salmon, human labor, and the Grand Coulee Dam.[14] The military-industrial complex harnessed the energy of this machine to manufacture plutonium at the nearby Hanford Nuclear Complex. This thesis borrows and augments White's machine concept. The Columbia River may have been a machine in itself but, like the Rocky Mountain Arsenal, it also was a significant cog in a much larger machine—the military-industrial complex.

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[12] Nash, *The Federal Landscape,* 161, x, 78, 99.

[13]Most of the works on the military-industrial complex in the West focus on social, cultural, political, and technological transformations. Few focus on the environmental implications of the complex. Those that do investigate the complex examine its nuclear footprints, not its chemical ones. For a good sample of literature on the militarized West see Kate Brown, *Plutopia: Nuclear Families, Atomic Cities, and the Great Soviet and American Plutonium Disasters* (Oxford University Press, 2015); John Findlay and Bruce Hevly, *Atomic Frontier Days: Hanford and the American West* (University of Washington Press, 2011); Michele Stenehjem Gerber, *On the Home Front: The Cold War Legacy of the Hanford Nuclear Site* (Bison Books, 2007); Gretchen Heefner, *The Missile Next Door: The Minutemen in the American Heartland* (Harvard University Press, 2012); Jon Hunner, *Inventing Los Alamos: The Growth of an Atomic Community* (Norman: University of Oklahoma Press, 2004); Traci Brynne Voyles, *Wastelanding: Legacies of Uranium Mining in Navajo Country* (University of Minnesota Press, 2015); Sarah Alisabeth Fox, *Downwind: A People's History of the Nuclear West* (Bison Books, 2014).

[14] Richard White, *The Organic Machine: The Remaking of the Columbia River* (New York: Hill and Wang, 1995), ix.

White suggests that the military-industrial complex did not "kill" or "rape" the Columbia River, it only altered it. Although dams significantly changed the river by controlling what happened to its energy and by decimating its salmon population, the river continued to exist. Control of natural resources is an important characteristic of the military-industrial complex in the West. Nature is often unpredictable, and even though humans cannot fully master it, the military-industrial complex did exercise a tremendous degree of control, or domination over nature in the American West. The dams on the Columbia River, the manufacturing of plutonium, and the splitting of the Atom emblemized the military-industrial complex's degree of technological domination over nature. Land and facility-ownership also constituted domination. While the military-industrial complex did not own the Columbia River, it did control the dams and the nearby Hanford plutonium plant. By controlling these installations, the military-industrial complex determined their environmental consequences. Local residents, such as the Yakima bands and Euro-American fishermen, did not have the power to direct these facilities or their environmental repercussions. Their pleas for the protection of salmon went largely unheard.[15] In the case of the Rocky Mountain Arsenal, the military-industrial complex dominated the land through its wares and waste. Local residents did not have the power to direct how these facilities operated or interacted with nature.

Few historians have investigated the military-industrial complex along the Front Range. The influence that the military had on Denver was not lost on Nash. Ever focused on population, economics, and development, Nash noted that "like the silver rushes of the 1870s, war mobilization provided extraordinary stimulus for Denver's

[15] White, *The Organic Machine,* 59, 91-97.

economy." The construction of new military camps, factories, and other facilities brought 100,000 new people to the metropolis, and forced the city to expand horizontally. This expansion in population, infrastructure, and services, helped cement Denver as "the 'capital' of a region 1,500 miles wide and 1,700 miles tall—sometimes known as the Rocky Mountain Empire."[16] The Denver historians Stephen Leonard and Thomas Noel also examine the growth of the Braggart City during World War II in one chapter of their exhaustive tome, *Denver.* They too recorded that the war was a boon to the city, bringing it new military installations and servicemen with dollars to spend. They also recognize that the war brought new problems as well. More than 1,300 servicemen from the Front Range died in combat. Shortages, price controls, and gasoline restrictions also hit the city during the war. Nash and Noel and Leonard provide excellent assessments of Denver's economy, population, infrastructure, and influence during the Second World War. Yet, one of the most important legacies that the new military facilities left in the city was their toxic footprints.

During the Cold War, the American West—the Front Range included—continued on the path that it began during World War II. The military-industrial complex continued to supply jobs to westerners, especially Coloradans, western cities continued to expand, and western lands continued to transform under the burdens of military pollutants. One of the few scholarly historical studies of the military-industrial complex on the Front Range during the Cold War is Len Ackland's monograph on Rocky Flats. This facility was located ten miles northwest of Denver, occupying roughly the same line of latitude as the Rocky Mountain Arsenal. At Rocky Flats, the Dow Chemical Company and the U.S. Atomic Energy Commission, and later Rockwell

[16] Nash, *The American West Transformed,* 82, 83, 56.

International and the Department of Energy, constructed the explosive plutonium cores for most of the United States's 70,000 nuclear weapons from 1952 to 1992. The history of Rocky Flats, Ackland argues, is a story about the federal government and private firms making the most destructive weapons in history and, in turn, creating environmental and health risks.[17] Like Ackland's work, this thesis hopes to elucidate how in pursuit of profit and the means of destruction, the military-industrial complex at the Rocky Mountain Arsenal significantly harmed the Front Range's environs.

Other historians have briefly investigated the military-industrial complex in Colorado Springs, another city along the Front Range. Ann Markusen and her coauthors examined Colorado Springs in chapter eight of their volume, *The Rise of the Gunbelt.* Colorado Springs's history is extraordinary. At the end of the 1930s, the resort town had fewer than 35,000 residents. By 1985, it was home to numerous computer companies and 306,000 people. This transformation, according to the authors, was a result of the military-industrial complex moving into the city. During World War, the military directly invested in the city by building the Army's Fort Carson and Peterson Air Force Base there. During the Cold War, the military selected Colorado Springs to be home of the Air Force Academy, as well as the Air Defense Command (ADC). Later reorganized into the North American Aerospace Defense Command (NORAD), the ADC monitored American air defenses and oversaw air-based assaults in the event of nuclear war. Perhaps most fascinating, the ADC operated from within the heart of Cheyenne Mountain. The military excavated and built inside Cheyenne Mountain to

[17] Len Ackland, *Making a Real Killing: Rocky Flats and the Nuclear West* (University of New Mexico Press, 2002), 3; For a memoir on one woman's experience growing up near Rocky Flats see Kristen Iversen, *Full Body Burden: Growing Up in the Nuclear Shadow of Rocky Flats* (New York: Broadway Books, 2013).

provide the shelter the ADC needed to weather a nuclear blast. The Cold War also brought major technology companies to Colorado Springs, including Hewlett-Packard and Kaman Sciences. Markusen and her coauthors argue that even though these technology firms did not choose to come to Colorado Springs because of military contracts, they were nevertheless attracted to the city because of the economic and population boom that accompanied the military's presence.[18] This argument is important because it demonstrates that the military and large private corporations did not always coordinate or plan their symbiotic relationship. Rather, in the case of Colorado Springs, the U.S. military inadvertently pulled large technological firms in its direction.

However, Gerald Nash reminds us that sometimes the military-industrial complex did, indeed, work in a centralized manner. The history of Colorado Springs in the 1980s is one example of this. Important to Ronald Reagan's so-called "Star Wars" initiative, the federal government made Colorado Springs a center for space defense by awarding the Consolidated Space Operation Center, the U.S. Space Command, and the Strategic Defense Initiative National Test Bed Facility to the city. To construct these facilities, the federal government awarded contracts to "at least thirty" large technological firms, including IBM, Hughes Aircraft, Ford Aerospace, and Honeywell. These contracts totaled $186 million in 1986 alone, and created an additional 36,200 nonmilitary jobs between 1980 and 1985.[19] Undoubtingly the military-industrial complex economically benefitted Colorado Springs.

[18] Ann Markusen, Peter Hall, Scott Campbell, and Sabina Deitrick, *The Rise of the Gunbelt: The Military Remapping of Industrial America* (Oxford University Press, 1991), 176, 179, 187.
[19] Nash, *The Federal Landscape,* 92.

The military-industrial complex was not just an agent of economic change, it was also a force of environmental change. While Nash focuses on the economic history of the military-industrial complex, this thesis examines the environmental history of the Rocky Mountain Arsenal. The history of the Rocky Mountain Arsenal is an enviro-military history. Even though military historians have long considered environment in their analyses, they have done so from the perspective of logistics rather than ecological issues. On the other hand, the comparatively young field of environmental history only has turned to the intersection of war and the environment relatively recently. In 2001, the environmental historian Edmund Russell published *War and Nature*. Briefly using the history of the Rocky Mountain Arsenal to frame his work, Russel argues that the paths of chemical warfare and pest control intersected and coevolved repeatedly throughout the twentieth century. Essentially, his argument rests on the ideological, technological, and organizational intersections between the military and large industries. Russell prompts historians to "rethink the relationship between war, nature, and human history" by recognizing the two-way interactions between humanity's control of nature and warfare.[20]

Russell followed this line of thinking in his next work, *Natural Enemy, Natural Ally*, a volume he edited with the historian Richard Tucker. Each essay in their collection demonstrates that war is a force of environmental change, and that the environment is a force in shaping war.[21] These essays, much like *War and Nature*, challenge historians to evaluate interactions between war and the environment.

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[20] Edmund Russell, *War and Nature: Fighting Humans and Insects with Chemicals from World War I to Silent Spring*, Studies in Environment and History (Cambridge University Press, 2001), 3, 2. Richard P. Tucker and Edmund Russell, eds., *Natural Enemy, Natural Ally: Toward an Environmental History of Warfare*, (Corvallis: Oregon State University Press, 2004).
[21] Tucker and Russell, eds., *Natural Enemy, Natural Ally*.

Following Russell's lead, other environmental historians examine dual interactions between the environment and armed conflict. Their writings founded a new subfield known as enviro-military history. This thesis continues their tradition, but also fills a significant vacancy in the historiography. Almost all enviro-military histories to date examine two-way interactions between war and nature on battlefields, areas of resource extraction, and zones of nervous détente. Few of them examine sites of arms manufacture and storage.[22]

The historian J.R. McNeill wrote a handful of chapters on the relationship between military-industrial complexes and the environment. These chapters are scattered throughout various edited volumes. Two of McNeill's chapters have profoundly influenced this thesis. In his afterword to *Nation-States and the Global Environment,* McNeill explains why the modern international system is not currently able to effectively combat global environmental problems. According to McNeill, the lack of global solidarity and will to make shared sacrifices makes international environmental problems unwieldy. For example, the global community has yet to combat climate change in a unified, comprehensive manner. This is partially because of "an essentially anarchic international system composed of numerous states." In short, the current global order of nation-states makes it different for humanity to tackle

[22] For major works in the field of enviro-military history see Kathryn Shively Meier, *Nature's Civil War: Common Soldiers and the Environment in 1862 Virginia* (The University of North Carolina Press, 2015); J. R. McNeill and Corinna R. Unger, eds., *Environmental Histories of the Cold War* (Cambridge University Press, 2013); Megan Kate Nelson, *Ruin Nation: Destruction and the American Civil War* (Athens: University of Georgia Press, 2012); Lisa M. Brady, *War upon the Land: Military Strategy and the Transformation of Southern Landscapes during the American Civil War* (Athens: University of Georgia Press, 2012); David Zierler, *The Invention of Ecocide: Agent Orange, Vietnam, and the Scientists Who Changed the Way We Think About the Environment* (Athens: University of Georgia Press, 2011); Charles Edwin Closmann, ed., *War and the Environment: Military Destruction in the Modern Age* (College Station: Texas A&M University Press, 2009); Lisa M. Brady, "Life in the DMZ: Turning a Diplomatic Failure into an Environmental Success," *Diplomatic History* 32, no. 4 (September 2008): 585–611.

transnational environmental problems. More pertinent to this thesis, McNeill also explains that "states often create environmental problems by pursuing their routine priorities." He writes that "for the past two centuries, the foremost goals of most states have been security and economic growth. So they have built military-industrial complexes and nuclear weapons, at the cost of untold pollution." Thus, in pursuit of their individual goals, nation-states created military-industrial complexes which, in turn, "sometimes knowingly, often unwittingly" created environmental problems.[23] The Rocky Mountain Arsenal is an example of this scenario.

The chapter J.R. McNeill wrote with David Painter for the edited volume *War and the Environment* also provides a good foundation for this thesis. In that chapter, McNeill and Painter examine the global environmental footprint of the U.S. military from the birth of the American republic to early twentieth-first century. Before 1890, McNeill and Painter contend, the U.S. military brought "widespread ecological change" to North American through frontier expansion, infrastructure construction, and by stimulating metallurgical industries through purchasing weaponry. After the United States acquired an external empire in the 1890s, the U.S. military's ecological footprint expanded overseas. Even though many enviro-military historians investigated areas of combat, McNeill and Painter argue that the U.S. military's environmental footprint after 1941 was mainly "associated with military bases at home and abroad, with their infrastructure, with their chemical and nuclear wastes, and with their disruptions caused

[23] J.R. McNeill, "Afterword: International Systems and Their Discontents," in Erika Marie Bsumek, David Kinkela, and Mark Atwood Lawrence, eds., *Nation-States and the Global Environment* (Oxford University Press, 2013), 276.

by training and maneuvers."[24] This thesis tests McNeill and Painter's argument using the Rocky Mountain Arsenal.

The Rocky Mountain Arsenal's history is not solely a story of environmental declension. Recognizing the land's toxicity, the federal government designated the Rocky Mountain Arsenal as a Superfund site in 1987. When remediation workers spotted bald eagles roosting at the Arsenal, some local environmentalists and politicians called for the land's transformation into a national wildlife refuge. The Arsenal's transition from Superfund site to refuge became law in 1992. United States Code 2705 directed the remediation of the land to be a collaborative effort between community members and the federal government. However, the forces who implemented remediation, the U.S. Army, Shell Oil Company, and the U.S. Fish and Wildlife Service, ignored most of the concerns and recommendations that the locals offered. Instead of being a celebration of local-federal cooperation, the Rocky Mountain Arsenal's transformation from Superfund site to Wildlife Refuge was another expression of the dominance of the military-industrial complex. The U.S. Army and Shell continued to rule the land.

The historiography of the Rocky Mountain Arsenal is limited. Visitors to the Rocky Mountain Arsenal National Wildlife Refuge's gift shop will find that John Hoffecker's *Twenty-Seven Square Miles* is the only book about the Arsenal on the shelves. Hoffecker, an excellent archaeologist at the University of Colorado Boulder, composed and published that brief monograph with the help of the Remediation Venture Office—an organization comprised of representatives from the Army, Shell,

[24] J.R. McNeill and David S. Painter, "The Global Environmental Footprint of the U.S. Military, 1789-2003," in Charles E. Closmann, ed., *War and the Environment: Military Destruction in the Modern Age* (College Station: Texas A&M University Press, 2009), 13, 15-20, 28.

and the Fish and Wildlife Service.[25] As a publication approved by the military-industrial complex, *Twenty-Seven Square Miles* offers a good chronology of the Arsenal's history but serves more as a booster piece than a work of scholarship. Indeed, Hoffecker either downplays or fails to mention the more controversial aspects of the Arsenal's remediation.

One historian who did write about the Rocky Mountain Arsenal was William Cronon. In his edited volume, *Uncommon Ground*, Cronon offers a brief commentary on the Arsenal during its early years of rehabilitation. Promotional material for the Arsenal and a few newspaper reports follow his remarks. The Rocky Mountain Arsenal appears in *Uncommon Ground*, however, in the volume's introduction as well as in a brief album, or as an interlude, between essays. Cronon did not intend to offer a complete or historical analysis. Rather, he constructed his commentary and the album of facsimiles to encourage readers to consider nature and all its complexities differently. For him, "the ability to blur the boundaries between 'natural' and 'unnatural' is precisely what makes the Rocky Mountain Arsenal…so useful for encouraging us to question our assumptions about what nature means and how we should relate to it."[26] Although thinking about how wildlife were attracted to a toxic landscape does lead us to question what constitutes nature, this thesis leaves that discussion in the capable hands of Cronon. Instead, this thesis focuses on the military-industrial complex's domination of the land and how its wares and waste created biological and geological changes at the Rocky Mountain Arsenal.

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[25] John F. Hoffecker, *Twenty-Seven Square Miles: Landscape and History at Rocky Mountain Arsenal National Wildlife Refuge* (Walden, Colorado: Walden Press, 2014), 8-9.
[26] William Cronon, ed., *Uncommon Ground: Rethinking the Human Place in Nature*, (W. W. Norton and Company, 1996), 35-44, 28.

Despite limited coverage, especially compared to other topics in enviro-military history, the Rocky Mountain Arsenal does appear in a few legal and historical studies. Professor of Law Stephen Dycus touched on the remediation of the Rocky Mountain Arsenal in his 1996 work, *National Defense and the Environment.* In it, Dycus examines the intersection of national defense and the environment from a legal standpoint in order to "present a framework for determining when environmental sacrifices are necessary to protect us from sovereign aggression or terrorism." To do this, Dycus presents twenty-seven case studies that highlight the defense industry's environmental footprint. One of these case studies focuses on a Rocky Mountain Arsenal's waste reservoir, Basin F, whose toxic contents killed migratory birds who landed there. Dycus uses the history of Basin F to examine if a state, in this case Colorado, can "carve out a significant role for itself" in the cleanup of federal sites. While the State of Colorado wanted to oversee remediation of the site under the Resource Conservation Recovery Act (RCRA), the Army dominated the cleanup under the auspices of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as the Superfund law. In short, the issue here was jurisdiction. Dycus recounts that the 10th Circuit Court resolved this issue when it ruled that the State of Colorado could "carry out its own independent RCRA closure plan concurrently with the Army's ongoing CERCLA response."[27] Yet, because Dycus published his work in 1996, fourteen years before remediation concluded, he was unable to evaluate if the State of Colorado did indeed end up playing a role in the cleanup. This thesis demonstrates that although the State of Colorado was certainly

[27] Stephen Dycus, *National Defense and the Environment* (Hanover and London: University Press of New England, 1996) xiv, 91, 92.

interested in remediation, ultimately the Army, Shell, and the Fish and Wildlife Service dominated the process.

Historians also have used the Rocky Mountain Arsenal to investigate how the military's relationship with the environment changed over time. In a 2011 article, the historian Peter Coates and others examine the tensions between militaries and environmentalists, as well as the rise of military environmentalism in the United States, Great Britain, and France. While using the Rocky Mountain Arsenal as one of their case studies, the authors also direct the reader to consider areas off the battlefield as militarized environments. Overall, the authors argue that militaries have become more aware of their environmental impacts over time. Some militaries, such as Great Britain's, even worked with concerned citizens to lessen their ecological footprints at military-training sites.[28] However, the authors do not examine the relationship between the U.S. Department of Defense and the Denver community. This work differs from my own in focus and categorization. These authors are concerned with how militaries changed their relationship with the environment over time; this thesis evaluates the material and biological consequences of creating and storing weapons of war. It also stresses that although the U.S. Army became more environmentally-aware over time, its firm hold on the western landscape did not loosen.

Rachael Salcido, a scholar of environmental and natural resources law, also wrote about the Rocky Mountain Arsenal. Salcido published an article on the Arsenal in *The John Marshall Law Review* in 2014. In it, Salcido sees the restoration of the Rocky Mountain Refuge as a "work-in-progress" despite the fact that the Army, Shell, and the

[28] Peter Coates et al., "Defending Nation, Defending Nature? Militarized Landscapes and Military Environmentalism in Britain, France, and the United States," *Environmental History* 16, no. 3 (July 1, 2011): 456–91, 476.

Fish and Wildlife Service declared remediation complete four years earlier. To Salcido, in order for remediation to be complete the Army, Shell, and the Fish and Wildlife Service must convince the community to accept the Refuge despite its history of toxicity and the shortcomings of remediation. To do this, Salcido suggests that the Army, Shell, and the Fish and Wildlife Service move away from "simply burying the past and marketing the fabulous new open space" and adopt a new, transparent approach that communicates both the successes "of the [Rocky Mountain Arsenal] Refuge restoration and the short-sighted mistakes and past failures to protect the environment." Salcido's article also examines what legally and ecologically constituted restoration of the Arsenal. She examines several federal laws, such as CERCLA and the Federal Facilities Agreement, as well as if remediation was committed to "historical [ecological] fidelity." Salcido's work differs from this thesis. Salcido scrutinizes the Army's "emphasis on image control" and provides insight to the legal and ecological aspects of remediation.[29] This thesis takes a broader approach. It emphasizes that the Arsenal's remediation revealed that the military-industrial complex refused to cede control of this landscape after the Cold War.

Although this study draws on newspapers, scientific journals, and government reports, the Freedom of Information Act (FOIA) proved the most essential resource. Even though this thesis incorporates many military archival materials gathered via (FOIA) requests, much of the Arsenal's history remains shrouded in secrecy. For example, this study was unable to unearth the medical profiles of the men and women who worked at the Rocky Mountain Arsenal both during the Cold War and remediation.

[29] Rachael Salcido, "The Rocky Mountain Arsenal National Wildlife Refuge: On a Rocky Road to Creating a Community Asset," *The John Marshall Law Review* 47, issue 4 (summer 2014): 1403, 1404, 1424, 1437.

Therefore, it is unable to fully assess how the chemicals and weapons manufactured at the Rocky Mountain Arsenal interacted with the biology and physiology of the laborers. A few sources do exist, however, that show that some workers were poisoned by sarin gas while on the job at the Arsenal.

Chapter one, "The Arsenal and the Environment," describes the global and local environmental consequences of the Rocky Mountain Arsenal. Specifically, it examines the history of the facility from its creation in World War II and its operations during the greater Cold War. It also investigates how the incendiary bombs manufactured at the Arsenal destroyed three major cities across the globe during the Second World War. Chapter two, "A Military-Industrial Cleanup," challenges the idea that the remediation of the Rocky Mountain Arsenal was a collaborative effort between locals and the federal government. Instead, it shows that the Army, Shell, and the U.S. Fish and Wildlife Service dominated the remediation of the land and ignored local concerns. Finally, the conclusion briefly examines worker health using the few documents available on the subject. In all, the history of the Rocky Mountain Arsenal demonstrates that the military-industrial complex dominated the Front Range's environment through its weapons, waste, and its unilateral control over remediation.

Chapter 1: The Arsenal and the Environment

The military-industrial complex came to Denver, Colorado, and changed the land. International conflict spurred this transformation. In September 1939, Nazi Germany invaded Poland. Nine months later, the Germans took France and began plotting to invade the Soviet Union. U.S. President Franklin D. Roosevelt responded to this global crisis with a variety of tools. While the Cash and Carry and Lend-Lease programs bolstered the defenses of American allies, Roosevelt also understood the need to strengthen the security of the United States.[30] In 1939, FDR called for the modernization of the nation's military. "Without modern weapons and without adequate training," Roosevelt explained, "[we] would be hopelessly handicapped if we were attacked." Throughout 1939, 1940, and 1941 the president courted Congress to increase the National Defense Budget. Congress repeatedly obliged, providing the War Department with the fiscal means to modernize and develop new military installations around the country.[31] With this massive program underway, the United States of America entered World War II in December 1941.

[30] For more on Cash and Carry and Lend-Lease see Edward R. Stettinius Jr., *Lend-Lease: Weapon for Victory* (New York: The Macmillian Company, 1944); Warren F. Kimball, *The Most Unsordid Act: Lend-Lease, 1939-1941* (Baltimore: Johns Hopkins Press, 1969).
[31] "Text of Defense Message Asking For 552 Million," *Chicago Daily Tribune*, 13 January 1939; Franklin D. Roosevelt, "Message to Congress on Appropriations for National Defense," 16 May 1940, The American Presidency Project, http://www.presidency.ucsb.edu/ws/?pid=15954; Franklin D. Roosevelt, "Message of President Roosevelt to the Congress," 31 May 1940, U.S. Department of State, *Peace and War: United States Foreign Policy, 1931-1941* (Washington, D.C.: Government Printing Office, 1943), 542-543.

Table 1: National Defense Spending, 1937-1947.[32]

Fiscal Year	Total government spending in billions $	National defense spending in billions $	Percentage of total budget allocated to defense in billions $
1937	7.6	1.0	13.1%
1938	6.8	1.1	16.2%
1939	9.1	1.0	11.0%
1940	9.5	1.7	17.9%
1941	13.7	6.4	46.7%
1942	35.1	25.7	73.2%
1943	78.6	66.7	84.9%
1944	91.3	79.1	86.6%
1945	92.7	83.0	89.5%
1946	55.2	42.7	77.4%
1947	34.5	12.8	37.1%

In the 1940s, the War Department militarized the Colorado Front Range by constructing factories, camps, air bases, radar stations, and even a practice bombing range in the region. One of the new installations on the Front Range was the Rocky Mountain Arsenal. Located ten miles northeast of Denver, Colorado, the Rocky Mountain Arsenal produced a wide variety of weaponry for the U.S. Army during

[32] U.S. Office of Management and Budget, *Historical Tables: Fiscal Year 2012, Budget of the U.S. Government* (Washington D.C.: Government Printing Office, 2010), 21, 47; J. David Singer, Melvin Small, and Inter-university Consortium for Political and Social Research, *National Material Capabilities Data, 1816-1985* (Ann Arbor, Michigan: Inter-university Consortium for Political and Social Research, 1993), http://dx.doi.org/10.3886/ICPSR09903.

World War II and the subsequent Cold War. The history of the Rocky Mountain Arsenal is just one part of an incredibly large and complex story of how the U.S. military transformed environments around the globe in the twentieth century.[33] Above all, it demonstrates that military's environmental footprint was not limited to battlefields, areas of resource extraction, or soldiers' bodies. Through the manufacturing of war materials and chemicals, the military-industrial complex degraded Denver's environment.

Although many people outside of the Denver metropolitan area have never heard of the Rocky Mountain Arsenal, its history is not solely a local story. During World War II, the Chemical Warfare Service (CWS), a specialized branch of the Army that oversaw all aspects of chemical warfare and defense, fashioned numerous chemical weapons at the Arsenal. Its production orders included the M-69 and M-74 incendiary bombs, or "firebombs." From 1943 through 1945, the CWS assembled 48,000 M-69 and 30,000 M-74 bombs per day just north of Denver.[34] These munitions destroyed sixty-nine cities across the globe, including Hamburg and Dresden in Germany, and Tokyo, the capital of Japan.[35]

During the Cold War, the Rocky Mountain Arsenal's effect on Denver's environs became well known. In the late 1940s, when demand for war materials was low, the CWS leased a portion of the Arsenal to chemical manufacturers. Housing both

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[33] For a brief overview of the U.S. military's global environmental footprint see J.R. McNeill and David S. Painter, "The Global Environmental Footprint of the U.S. Military, 1789-2003," in Charles E. Closmann, ed., *War and the Environment: Military Destruction in the Modern Age* (College Station: Texas A&M University Press, 2009).

[34] Army Service Forces Chemical Warfare Service, *History of Rocky Mountain Arsenal Volume 1, Part 1, 1945*, Manuscript, 16-17, Rocky Mountain Arsenal Joint Administrative Record and Document Facility Physical Archives (hereafter cited as JARDF Physical Archives).

[35] Stephen J. Leonard and Thomas J. Noel, *Denver: Mining Camp to Metropolis* (University Press of Colorado, 1990), 223-224.

the CWS and private industries, the Rocky Mountain Arsenal was a physical manifestation of the military-industrial complex. Among the chemicals manufactured at the Arsenal were the pesticides dichlorodiphenyltrichloroethane (DDT), aldrin, dieldrin, and endrin. These dangerous compounds found their way into the bodies of birds and small mammals that lived on and near the Arsenal grounds, accumulating in their livers and brains, reducing the quality of their lives, and sometimes ending them altogether. Wildlife mortality was not the Arsenal's only environment consequence. In the 1960s, the facility suffered from an abundance of waste and an absence of long-term waste management solutions. To solve these problems, the Army began pressure-injecting its liquid refuse deep into the Earth. Earthquakes, previous rarities in the Denver region, became frequent nuisances six weeks after the military began this practice. Scientists quickly investigated the possible connection between the injection well and the new seismic activity. The majority of them concluded that the injection well induced the earthquakes. Thus, the military-industrial complex not only left an environmental footprint on the Earth's surface, but on its innards as well.

Before the War Department constructed the Rocky Mountain Arsenal, it first had to select a desirable location to house the facility. The task of selecting the site fell to the Missouri River Division of the United States Army Corps of Engineers (MRD).[36] Interested in the Denver region, the MRD examined the land ten miles northeast of the city. There it found small homesteaders who grew corn and alfalfa.[37] Unfortunately for these farmers, when the MRD examined the land that comprised their homestead and other nearby farms, it found the model environment to house a modern munitions plant.

[36]Army Service Forces Chemical Warfare Service, *History of Rocky Mountain Arsenal Volume 1, Part 1, 1945,* 26.
[37] Jeremy P. Meyer, "Evicted by War, Restored by Peace," *Denver Post,* 22 October 2006.

The first and most important factor that the MRD investigated was the area's geography, specifically the proposed site's distance from international borders. In order for the arsenal to be safe from external attack and enemy reconnaissance, it needed to be located deep in the interior of the United States. The MRD concluded that Denver was "nearly one hundred per cent safe" because of its distance from international boundaries. The fact that the Colorado metropolis also hugged the Rocky Mountains perhaps gave it a fortress-like quality in the minds of military engineers. Geography provided the security the site required.[38]

Just as Denver's physical distance from international borders was a boon to city in the minds of military planners, the city's connections to the rest of the country via railways made it strategically and logistically ideal. Denver was the "isothermal axis," or the location where the Atlantic World met the Pacific.[39] First settled by Euro-Americans in 1858 as a mining camp, by the end of the century Denver was the "capital" of the so-called "Rocky Mountain Empire."[40] Denver's ascension was complex, and largely due to the innovation, business acumen, and community ethos held by its local entrepreneurs. Businessmen such as Jerome Chaffee, David Moffat, and John Evans reached for and created hinterlands for the city in order to expand their own personal wealth and benefit their community. In doing so, they led the charge to remove the Southern Cheyenne and Arapaho Indians from the region, created booster programs to attract farmers, invested in the local mines, enforced laws when they were

[38] Army Service Forces Chemical Warfare Service, *History of Rocky Mountain Arsenal Volume 1, Part 1, 1945*, 10.
[39] William G. Robbins, *Colony and Empire: The Capitalist Transformation of the American West* (University Press of Kansas, 1994), 175.
[40] Gerald D. Nash, *The American West Transformed: The Impact of the Second World War* (Lincoln and London: University of Nebraska Press, 1990), 56.

advantageous to their community, and established banks and railroads. Their efforts transformed Denver into a hub of market activity that directed "people, resources, information, and capital into and out of the region."[41] The city physically occupied a small portion of the Front Range, but its economic, political, cultural, and social reach was pervasive.[42] Although the financial health of the city ebbed and flowed with the mining industry, its connections to the rest of the nation via railways stood firm. This system, a "spiderweb of steel," both transformed the mining camp into a regional metropolis in the nineteenth century and attracted military development in the twentieth.[43]

Accompanying these attractive features was the city's willingness to provide the military with the water it needed. Manufacturing chemical weapons, especially nerve gasses, required millions of gallons of water each day. In 1942, the City of Denver, wanting to attract military investment, agreed to provide the CWS with twenty million gallons of potable water per day.[44] In a region known for aridity, this was no small request. The history of water allocation in Colorado is a controversial one. Because the South Platte River did not contain enough water to support the metropolis, the Denver

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[41] Kathleen A. Brosnan, *Uniting Mountain and Plain: Cities, Law, and Environmental Change along the Front Range* (Albuquerque: University of New Mexico Press, 2002), 8.
[42] Robbins, *Colony and Empire*, 182.
[43] Leonard and Noel, *Denver*, 39. For the importance of railways to the MRD see Army Service Forces Chemical Warfare Service, *History of Rocky Mountain Arsenal Volume 1, Part 1, 1945*, 10; Although the War Department created new communities for their top-secret projects in 1940s (such as Hanford, Washington, and Los Alamos, New Mexico), these endeavors were costly. The War Department much preferred to utilize previously established communities for less secret facilities; For a work on Hanford see John M. Findlay and Bruce Hevly, *Atomic Frontier Days: Hanford and the American West,* (Seattle and London: The Center for the Study of the Pacific Northwest, in association with the University of Washington Press, 2011); For works on Los Alamos see John Hunner, *Inventing Los Alamos: The Growth of an Atomic Community,* (Norman: University of Oklahoma Press, 2004) and Lillian Hoddeson et al, *Critical Assembly: A Technical History of Los Alamos during the Oppenheimer Years, 1943-1945,* (Cambridge University Press, 1993).
[44] Army Service Forces Chemical Warfare Service, *History of Rocky Mountain Arsenal Volume 1, Part 1, 1945,* 13.

Water Department began redirecting water from the Western Slope to the Front Range in the 1930s.[45] Boosted by Public Works Administration money, in 1936, the Denver Water Department successfully completed its first trans-mountain diversion, channeling water from the Fraser River to a tunnel that bisected the mountains. Three years later, it completed its second trans-mountain diversion when it redirected the Williams Fork River via another tunnel towards the Front Range.[46] Although the Denver Water Department did not plan these engineering feats with the War Department in mind, its accomplishments later made it possible for the military to consider the Front Range as a site for the mass production of chemical weapons.

Along with a sufficient water supply, the arsenal needed sinks that could accommodate 16,500,000 gallons of sewage per day.[47] One of the leading historians of urban sanitation systems, Joel Tarr, explains the concept in *The Search for the Ultimate Sink.* Tarr writes that "the creation of wastes from any process, be it a natural, consumer, or production process, requires location of a place of deposit, or a 'sink.' Much of the history of industrial waste disposal . . . involves the search for a sink in which wastes could be disposed of in the cheapest and most convenient manner possible."[48] Just as Tarr observed, the MRD looked for cost-effective and opportune sinks in the Denver region. They found the natural reservoirs near the farmland

[45] Leonard and Noel, *Denver,* 459-460; The MRD also obtained water from an irrigation canal that previously served the farms northeast of the city. See Army Service Chemical Warfare Service, *History of Rocky Mountain Arsenal Volume 1, Part 1, 1945,* 11-12.
[46] Patricia Nelson Limerick, *A Ditch in Time: The City, the West, and Water* (Golden, Colorado: Fulcrum, 2012), 106, 116-120.
[47] Army Service Forces Chemical Warfare Service, *History of Rocky Mountain Arsenal Volume 1, Part 1, 1945,* 32.
[48] Joel A. Tarr, *The Search for the Ultimate Sink: Urban Pollution in Historical Perspective* (Akron, Ohio: University of Akron Press, 1996), 385.

northeast of Denver "adequate [for] waste disposal."[49] These reservoirs consisted of half-a-dozen depressions in the land about a hundred acres in size. Scientists later in the twentieth century surmised that bison carved these basins centuries ago by rolling in the dirt.[50] Aside from the excavation of a few dikes and the construction of treatment facilities, these natural sinks required little military investment. The CWS simply had to direct its refuse to these basins and presumably allow it to evaporate over time. The MRD concluded that these basins did not "constitute a safety hazard to the streams and potable water supply in the vicinity."[51]

The MRD also examined, and was pleased with, the geology of the Front Range. The surface strata, consisting of wind-blown sands, clays, and humus top soil, were ideal for both water removal and construction. The "sandy nature" of the surface stratum and the rolling-prairie topography quickly drained water into nearby creeks and, ultimately, the South Platte River. The region's surface strata also made extraction and earth-moving operations comparatively easy year-round.[52] Below the surface strata was the Laramie Formation, which consisted of fossilized sandbanks and silt that geologists, today, categorize as sandstone, clay, and coal. This geologic structure, resting approximately thirty-five feet below the surface, resulted from the recession of the

[49] Army Service Forces Chemical Warfare Service, *History of Rocky Mountain Arsenal Volume 1, Part 1, 1945,* 12.
[50] "Rocky Mountain Arsenal as a National Wildlife Refuge," narrated by David Baron, *All Things Considered*, National Public Radio, 18 March 1997, transcript, SITE Database Number 2321-28, Document Number 00004740, 2, Rocky Mountain Arsenal Joint Administrative Record and Document Facility Digital Archives (hereafter cited as JARDF).
[51]Army Service Forces Chemical Warfare Service, *History of Rocky Mountain Arsenal Volume 1, Part 1, 1945,* 12.
[52]Ibid., 35-36.

Western Interior Seaway during the Late Cretaceous period.[53] The Laramie Formation provided a solid foundation on which the military could build large warehouses and industrial machinery.

Finally, the MRD assessed Denver's climate. It found that Denver was overall "one of the best health areas in the country." The area's "pleasant weather conditions," the engineers reported, would "contribute to better morale and higher operating efficiency among the personnel." Planners defined "pleasant weather conditions" by the absence of meteorological hazards such as hurricanes, high winds, and abundant snowfall. The Front Range's low humidity, according to the MRD, also made the area "especially suited to the manufacture of Chemical Warfare gases as well as smokes, incendiaries, and other material" whose handling and loading usually required extensive air conditioning to keep them dry.[54]

Based on the MRD's positive report, on May 12, 1942, the Under-Secretary of War Robert P. Patterson authorized the construction of the Rocky Mountain Arsenal on the 19,883 acres of farmland northeast of Denver. Before the CWS could break ground, however, it needed to force farmers off the land to make room for its facilities.[55] In the summer of 1942, two hundred families received eviction notices and vacated their small homesteads in what the *Denver Post* called a "mass exodus." Almost a dozen families left their homes before the required deadline of August 2, 1942. Others slowly packed their belongings as the clock ran out on them.[56]

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[53] Arnold Hague and S.F. Emmons, *Descriptive Geology,* (Washington D.C.: Government Printing Office, 1877) chapter 1; Steven M. Stanley, *Earth System History*, (New York: W.H. Freeman and Company, 1999) 487-489.
[54] Army Service Forces Chemical Warfare Service, *History of Rocky Mountain Arsenal Volume 1, Part 1, 1945*,13, 12, 12-13.
[55] Ibid., 4-5.
[56] "Mass Exodus is Being Started by Farmers on Arsenal Land," *Denver Post*, 29 July 1942.

In 1993, Ray Telfer remembered when the military dispossessed his family from their farm in the 1942. The Telfer family homesteaded their land beginning in 1912. They grew corn and wheat. A child at the time, Telfer remembered that his family's eviction emotionally and economically devastated his parents. "Visualize this:" Telfer explained, "you don't have a penny in your pocket, you're deep in debt, and you're told you've got 60 days to get out of your house and find a place to live. You have farm machinery. What are you going to do with it? You don't have any place to put your animals, so you sell 'em at whatever price you can get." Although the government provided compensation for the loss of their crops, Telfer related that the money simply was not enough to cover the costs of relocation. Resigned to their fate, Telfer remembered that his family "tearfully accepted what was offered." The process was especially painful for his parents. "Those of us who were young, our sight were set beyond the arsenal. But for our parents, who knew nothing else but dirt farming, it was a trauma. They had developed the farms as their place until death." Yet, despite the trauma of land dispossession, Telfer looked back on the situation without bitterness. "As hard as it was to leave, it was the patriotic thing to do. Nowadays you hear this expression: 'grief therapy.' In our day, that concept was unknown even to Freud. The expression we heard was 'T.S.' Tough Shit."[57]

Unable to stop their eviction, many families quietly relocated to southeastern Colorado and the Western Slope.[58] After the homesteaders vacated the land, the CWS

[57] Alan Katz, "Arsenal Pushed Homesteader to a Patriotic Sacrifice of Land," *Denver Post,* 24 October 1993.
[58] Ibid.

immediately began construction. By 1943, the Rocky Mountain Arsenal was fully functional, assembling 48,000 M-69 and 30,000 M-74 incendiary bombs per day.[59]

Figure 1: Aerial photograph of the Rocky Mountain Arsenal South Plants in 1945. Behind the Arsenal, to the southwest, are downtown Denver and the Rocky Mountains. Photograph by the U.S. Army. Courtesy of the Library of Congress.

The Rocky Mountain Arsenal was not the only military installation near the Queen City of the Plains. Although many Denverites were vocal isolationists in the late 1930s, the city welcomed the jobs and dollars the defense industries brought. In certain cases, Denver's leaders actively worked to attract the military. For example, in 1938, the city floated $750,000 in bonds to purchase 880 acres of property. After adding

[59]Army Service Forces Chemical Warfare Service, *History of Rocky Mountain Arsenal Volume 1, Part 1, 1945,* 16-17.

another 960 acres to this plot, the city donated the land to the Army, along with 100 square miles southeast of the city. There, the military constructed Lowry Air Base, a station comprised of more than 600 buildings and a practice bombing range. Other military installations quickly followed, including Buckley Field, Fort Logan, the Denver Ordnance Plant, Fitzsimons Army Hospital, Camp George West, and Camp Carson.[60]

Richard White's *"It's Your Misfortune and None of My Own"* helps explain why the military-industrial complex invested and built in the West. According to White, defense contractors feared labor unions because of their ability to strike and cripple production. Thus, defense contractors "preferred the West and South, with their antiunion, right-to-work laws, over the East." Despite the growth of the military-industrial complex in the West during World War II, White points out that the region still depended on its old extractive economy. "In the late 1940s," White writes, "lumber, food processing, paper, transportation, and primary metals accounted for 80 percent of the region's industrial output." The oil booms in Texas and Oklahoma also kept those western states entrenched in resource extraction. Adding a global component, White recognizes that both extractive companies and defense contractors based in the American West expanded their reach outside of the United States. Western oil companies set up refineries in places like Venezuela, Saudi Arabia, and across the Persian Gulf. Meanwhile, western defense contractor constructed military bases across the Pacific.[61]

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[60] Leonard and Noel, *Denver*, 220-222; Carl Abbott, Stephen J. Leonard, and David McComb, *Colorado: A History of the Centennial State*, revised edition (Boulder, Colorado: Colorado Associated University Press, 1982), 280.
[61] White, *"It's Your Misfortune and None of My Own,"*516, 517, 516.

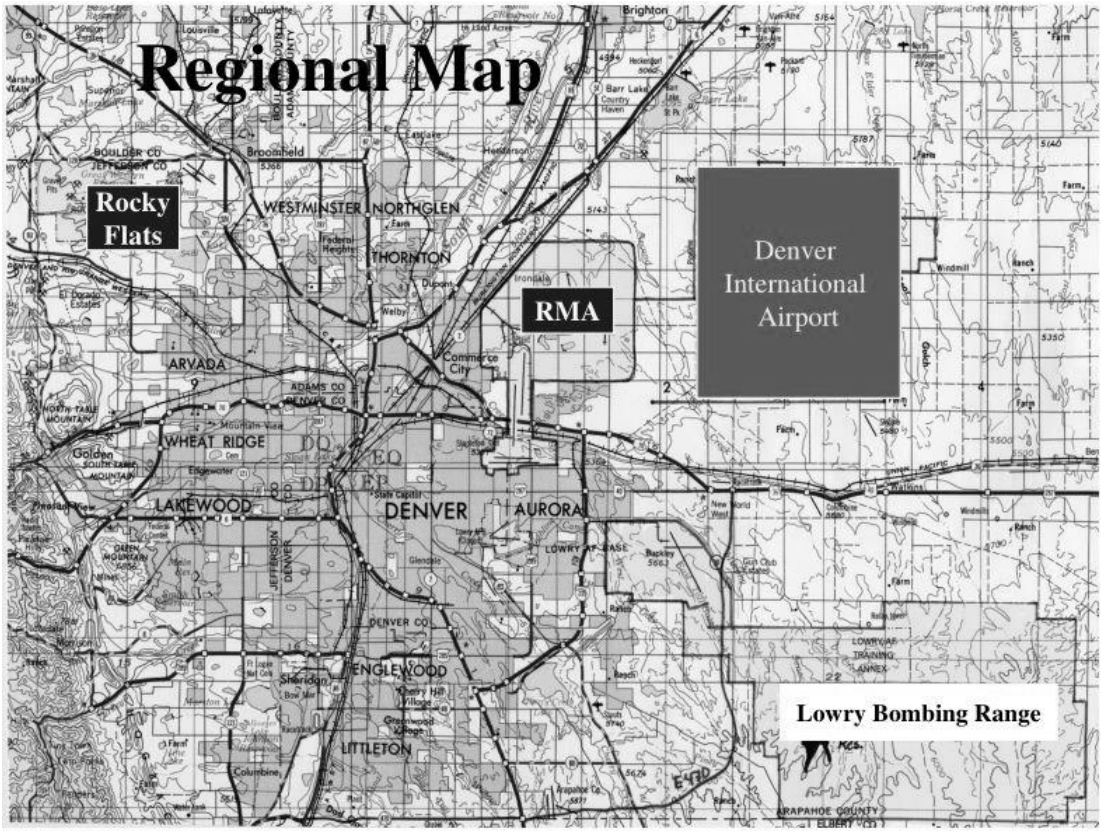

Figure 2: The Denver Metropolitan Area, circa 2007. This map identifies the major military installations near the city, including the Rocky Mountain Arsenal (RMA), Rocky Flats, and Lowry Bombing Range. The locations of these facilities remained static throughout the Cold War. Map by and courtesy of the Colorado Department of Public Health and Environment.[62]

Even though much of the West continued to rely on extractive industries during World War II, Denver embraced the military-industrial complex. The military-industrial complex brought to the Braggart City thousands of federal dollars and servicemen looking to spend. During the war, Denver's population increased by approximately twenty percent or 100,000 people, not including the workforce who lived on military

[62] The U.S. Atomic Energy Commission, and later the Department of Energy, manufactured plutonium triggers for nuclear weapons at the Rocky Flats plant beginning from 1952 to 1992. For a good history of Rocky Flats see Len Ackland, *Making a Real Killing: Rocky Flats and the Nuclear West* (University of New Mexico Press, 2002).

bases outside of the city.[63] This influx of military personnel, the historian Lyle Dorsett notes, was comparable to the flood of miners who descended on the city during the gold rush days.[64] As the Denver historians Stephen Leonard and Thomas Noel so aptly put, "War was hell on the fighting front, but on the home front it brought prosperity."[65]

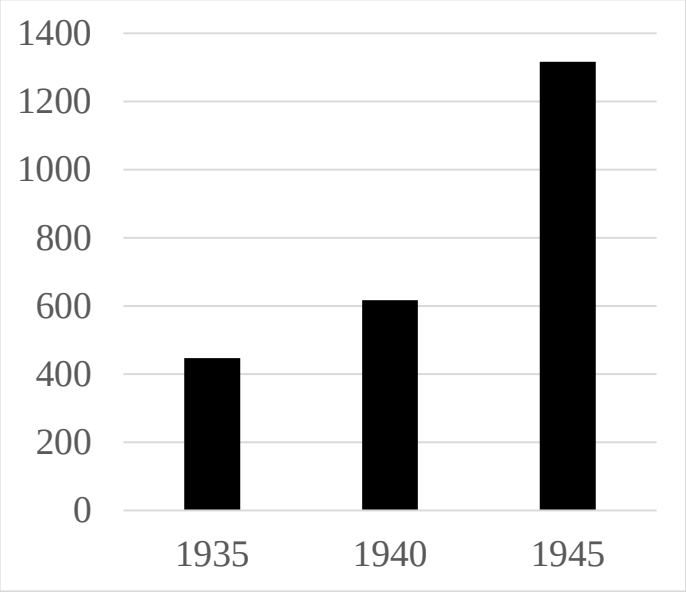

Figure 3: Total Income in the State of Colorado in Millions of Dollars from 1935 to 1945. While income between 1935 and 1940 increased by $170 million, during the Second World War income rose by $700 million in just five years. This was largely due to the growth of the military-industrial complex in the region.[66]

Incendiaries, not nerve gasses, were the chemical weapons of choice during World War II. The use of nerve gasses during the First World War prompted the League of Nations to create a protocol in 1925 prohibiting the use of chemical and biological weapons in combat. The treaty held up during the Second World War. The United States never joined the League and did not ratify the protocol. Nonetheless, Roosevelt

[63] Lyle W. Dorsett, *The Queen City: A History of Denver* (Boulder, Colorado: Pruett Publishing Company, 1977), 238; Michael P. Malone and Richard W. Etulain, *The American West: A Twentieth-Century History* (Lincoln and London: University of Nebraska Press, 1989), 115.
[64] Dorsett, *The Queen City*, 238.
[65] Leonard and Noel, *Denver*, 225.
[66] Data from Dorsett, *The Queen City*, 237.

abided by its principles and refused to use nerve gasses "unless they are first used by our enemies."[67] FDR's refusal to initiate the use of nerve gasses during World War II is just one example of how the president attempted to wage a "moral war." Indeed, Roosevelt based both his domestic and foreign policies on the principle that the Presidency "is preeminently a place of moral leadership."[68] Thus, the United States stockpiled nerve agents, including mustard gas and lewisite, at the Rocky Mountain Arsenal during the Second World War, but refrained from using them. Incendiaries were another matter.

While humans first weaponized gas in the late nineteenth century, the history of incendiary weapons began in antiquity. As the story goes, sometime between 1400-1000 BCE, the biblical Samson tied firebrands to the tails of three hundred foxes and set them loose against his Philistine enemies. Hundreds of years later, the Assyrians fought with flaming arrows and pots filled with fire. The Greeks too experienced the power of fire in warfare. In the midst of the Peloponnesian War in 412 BCE, the Syracusans filled an old merchant ship with wood, set it aflame, and positioned the vessel so that the wind would drift it down towards the Athenian fleet. While the Syracusans hoped that the flames would spread to the enemy ships, the Athenians avoided the disaster by putting out the blaze as the boat drew near them.[69]

In 1943 CE, the CWS at the Rocky Mountain Arsenal drew on a long history of weaponizing fire when they mass-produced the M-69 and M-74 incendiary bombs.

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[67] Franklin D. Roosevelt, "Statement Warning the Axis Against Using Poison Gas," 8 June 1943, The American Presidency Project, http://www.presidency.ucsb.edu/ws/?pid=16407.
[68] Anne O'Hare McCormick, "Roosevelt's View of the Big Job," *The New York Times*, 11 September 1932.
[69] Robert M. Neer, *Napalm: An American Biography* (Cambridge, Massachusetts and London, England: The Belknap Press of Harvard University Press, 2013), 17-18; Thucydides, *The History of the Peloponnesian War, Book VII, Chapter XXIII,* trans. Richard Crawley (Project Gutenberg, 2009), http://www.gutenberg.org/files/7142/7142-h/7142-h.htm.

These weapons were far more sophisticated than Samson's fire-foxes, the Assyrians' fire-tipped arrows, and the Syracusan's flaming ship. The active agent in the M-69 and M-74 was jellied gasoline, also known as napalm. This substance looked "like mashed potatoes well soaked with butter," had a sticky, rubber cement-like consistency, and erupted in flames when ignited.[70] The M-74 was far more deadly than the M-69. It contained pyrogel, a mixture of napalm and magnesium that made it impervious to water when lit. Even members of the CWS did not know how to snuff-out the concoction once it ignited. The jelly simply needed to burn itself out. The CWS designed the M-69 and the M-74's delivery methods using the grapeshot principle. This meant that workers at the Rocky Mountain Arsenal filled small bomblets with napalm and pyrogel, which they then loaded into larger cluster bomb containers. When these canisters fell from the sky, they cracked open and scattered dozens of individual bomblets on the earth below. After impact, each bomblet spewed its flaming jelly up to 100 feet in different directions, starting numerous fires.[71]

[70] Volta Torrey, "How we Fight Japan with Fire," *Popular Science*, May 1945, 100-104.
[71] Torrey, "How we Fight Japan with Fire," 100-104; Stewart Halsey Ross, *Strategic Bombing by the United States in World War II: The Myths and Facts* (McFarland, 2002), 107-108; F.J. Bradley, *No Strategic Targets Left* (Nashville, Tennessee: Turner Publishing Company, 1999), 33-35; Office of Scientific Research and Development and National Defense Research Committee, Summary Technical Report of Division 11, National Defense Research Committee, *Fire Warfare: Incendiaries and Flame Throwers* (Washington D.C.: Government Printing Office, 1946), 1-28.

Figure 2: The Rocky Mountain Arsenal's Napalm and Incendiary Bomb Warehouse and Filling Station in 1943. Pictured are cluster bomb containers. Photograph by the U.S. Army. Courtesy of the Library of Congress.

The Rocky Mountain Arsenal shipped environmental destruction abroad in the bodies of the bomblets. Because the U.S. Army Air Force (USAAF) dropped bomblets on strategic targets—namely cities—these firebombs primarily destroyed built environments and ended human lives. When the laborers finished assembling a batch of M-69 or M-74 cluster bombs, the CWS transported the completed weapons via the railroads, such as the previously mentioned Union Pacific, to military ports. There, servicemen carefully loaded them onto carriers that transported them into the European and Pacific Theaters.

During the Second World War, the United States dropped 38,000 tons of incendiary bombs on Germany, many of which came from the Rocky Mountain Arsenal.[72] The Allied forces used two types of bombing strategies against the Germans. The United States followed the "precision" strategy throughout the balance of the conflict. Another expression of Roosevelt's "moral war," the precision strategy targeted power plants, sewer lines, and industries instead of civilian homes and city streets.[73] Along with being a more humane strategy, precision bombing was, according to senior military commanders Hap Arnold and Ira Eaker, a "more economical way of reducing a large city to the point of surrender."[74]

The British, on the other hand, used the "area" bombing strategy against the Germans. Believing that Germany's bombing of London in August 1940 had freed Britain to "take the gloves off," Sir Charles Portal, then the Chief of the Air Staff of the British Royal Air Force (RAF), advocated for a devastating, exhaustive strategic bombing program. According to national security policy scholar Tami Biddle, "Churchill's thinking ran along the same lines." In fact, Churchill initially suggested to Portal that the RAF spread its attacks over as many German cities as possible. In February 1942, Air Chief Marshal Sir Arthur Harris took control of the RAF's Bomber Command. Harris believed that area bombing would both psychologically and materially devastate Germany, and would quickly end the war entirely on its own. Furthermore, according to Biddle, "Harris believed that all the resources—material and human—fueling a state's capacity to wage war were legitimate targets of attack. He did

[72] John F. Hoffecker, *Twenty-Seven Square Miles: Landscape and History at Rocky Mountain Arsenal National Wildlife Refuge* (Walden, Colorado: Walden Press Inc., 2014), 63; This thesis was unable to uncover the specific number of Arsenal cluster bombs used during the war.
[73] Neer, *Napalm*, 61-62.
[74] Henry H. Arnold and Ira C. Eaker, *Winged Warfare* (Harper & Brothers, 1941), 133-134.

not feel compelled to shroud his work in a guise designed to make it more palatable for the public." Thus, under Harris's leadership, the RAF indiscriminately bombed major German urban centers.[75] When the USAAF and the RAF worked together, as they often did, their combination of the "precision" and "area" strategies effectively destroyed Germany's built environments and killed thousands of people.

One of the cities targeted by the USAAF and RAF was Hamburg. Founded by Charlemagne in 810 CE, Hamburg was one of the oldest cities in northern Europe. During the Second World War, it was the second largest city in Germany, with a documented population of 1,150,000 people. Hamburg contained a world-renowned zoo, opera, theater, and a series of planned parks and lakes that testified to generous city planning. Along with being a cultural center, the city housed countless industries, the foreign exchange, insurance companies, custom houses, and banks. Additionally, the metropolis was Germany's largest port, containing twenty-two miles of quays, 110 miles of docks and landings, as well as four shipbuilding yards.[76] Hamburg was an important transportation hub for the Third Reich. The city's networks of canals connected to the Elbe River which "flow[ed] to all rivers and corners of Germany."[77] Overland transportation networks also routed through Hamburg. Like Denver, Hamburg was an important war city. Among other items, it manufactured one-quarter of Germany's submarines during the World War II.[78]

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[75] Tami Davis Biddle, *Rhetoric and Reality in Air Warfare: The Evolution of British and American Ideas about Strategic Bombing, 1914-1945* (Princeton University Press, 2002), 188, 199, 201, 219. It is worth noting that by the war's end, Churchill became uneasy with the area bombing campaign. See Biddle, 256.
[76] Hiram Blauvelt, "Nazi Morale Badly Shaken by Hamburg Destruction," *The Washington Post,* August 8, 1943; "2,300 Tons on Hamburg," *The Manchester Guardian,* 26 July 1943.
[77] Blauvelt, "Nazi Morale Badly Shaken by Hamburg Destruction," 26 July 1943.
[78] "2,300 Tons on Hamburg," 26 July 1943.

On the night of July 24, 1943, the USAAF and RAF launched Operation Gomorrah against Hamburg. This joint operation called for alternating USAAF and RAF bombing raids. Using the area strategy, in the early hours of July 25, the RAF dropped 2,300 tons of bombs on the city in what the *Chicago Tribune* called the "heaviest air attack the world has known."[79] The payload included 350,412 individual incendiary devices.[80] The ensuing fires across the cityscape burned so high and bright that British crews in Ruhr, approximately 200 miles away, stopped in awe of the distant hellscape.[81] As the historian Keith Lowe recounts, fires across the city that night "were so numerous that they sparked off a number of unusual meteorological events."[82] Like a self-sustaining generator, the flames created strong winds that fed the fire and carried it throughout the city's built environment. When the bombing ceased that morning, a German radio reporter surveyed the damages, noting that the opera house, the state library, the theater, and two of Hamburg's oldest churches, Nikolai and St. George's, had fallen to the flames.[83] Later that day, 1,200 U.S. Superfortresses, with the Rocky Mountain Arsenal's wares in tow, dropped incendiaries on the city in "the heaviest daylight raid in history."[84] Using the precision strategy, the B-17s bombed Hamburg's southern harbor district. Specifically, the USAAF aimed for the Blohm & Voss shipyards and the Klöckner air-engine factory. Despite the USAAF's emphasis on precision bombing, the smoke hanging over the ruined city made exact targeting

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[79] "U.S. Forts Make Second Heavy Raid on Hamburg," *Chicago Daily Tribune,* 27 July 1943.
[80] Keith Lowe, *Inferno: The Fiery Destruction of Hamburg, 1941* (New York, London, Toronto, and Sydney: Scribner, 2007), 91; While the USAAF used the Rocky Mountain Arsenal's incendiaries during World War II, it is unclear if any of the incendiaries used by the RAF originated at the Rocky Mountain Arsenal. The RAF might have used a combination of incendiaries manufactured in the United Kingdom, as well as American incendiaries procured through the Cash and Carry program.
[81] "2,300 Tons on Hamburg," 26 July 1943.
[82] Lowe, *Inferno,* 112.
[83] "Nazi Reporter Tells Havoc of Hamburg Raid," *The Associated Press,* 26 July 1943.
[84] "U.S. Forts Make Second Heavy Raid on Hamburg," *Chicago Daily Tribune,* 27 July 1943.

impossible. Only 60 percent of the B-17s bombed near their intended targets. The USAAF took to the skies again on July 26, hoping to add greater precision to its earlier efforts. Their targets were the same as the day before, Blohm & Voss, as well as Klöckner. Amidst the lingering smoke, the Superfortresses somehow found their marks and successfully destroyed the shipyard and the engine works.[85] From July 27 through August 3, the RAF returned to pummel the city. When the fires finally burned themselves out, the German authorities reported that 10,000 people had perished.[86] The fires destroyed the biological components—the nature—that made up human bodies. According to the literary scholar Sven Lindqvist, the "British air attacks on Hamburg killed more people than all German air attacks against English cities put together."[87]

The damage to Hamburg's built environment was extensive. Whole streets, post offices, schools, police stations, and stores turned to ash. The city's great gothic churches crumbled. The Hagenbeck Zoo also succumbed to the flames. More than one hundred large animals died during the blaze, while dozens of others escaped into the ruins of the metropolis.[88] Bombings crippled transportation and communication systems. The fires melted the city's telephone system, train stations, railways, and bridges. One of Hamburg's distinctive transportation ways—the Elbe Canal Tunnel, which connected the wharfs to the city proper—flooded with seawater after a direct hit.[89]

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[85] Lowe, *Inferno,* 117-118, 151-155.
[86] "Hamburg 'Ceases to be Organised City," *The Observer*, 1 August 1943.
[87] Sven Lindqvist, *A History of Bombing,* trans. Linda Haverty Rugg (New York: The New Press, 2001), 95.
[88] Lowe, *Inferno,* 114, 166.
[89] "Hamburg Wiped Out; 10,000 Reported Dead," *Los Angeles Times*, 1 August 1943.

Figure 3: The ruins of Hamburg, July 1943. Photograph courtesy of Keystone Images/Getty Images.

Along with destroying the city's built environment, Operation Gomorrah generated a refugee crisis. Thousands of German, Danish, and Swedish men, women, and children fled from the northern port city to the nearby Danish border seeking sanctuary. On August 1, the Danish Radio reported that "on all the roads leading out of Hamburg thousands of evacuees can be seen on foot, cycling, or pushing carts and wheelbarrows." Many left without documents, money, and their personal possessions. The refugees brought with them stories of the "inferno." Some shared how the bombing not only flattened the city, but caused a social upheaval. "Hamburg has ceased to exist as an organized city," recalled one refugee. Some debated over how many buildings

remained standing. One eyewitness counted fifty, while another said that taking inventory of the "maul[ing]" was "impossible."[90]

Weeks after the attack on Hamburg, the *Washington Post* explained to the American people the significance of the raid. "Besides the tremendous material devastation visited on the city and its environs," the reporter Hiram Blauvelt wrote, "[the] combined British and American air power has dealt a devastating blow to German morale at home and Nazi prestige abroad." By selecting Hamburg's built environment for "total pulverization" the "Allied High Command gained far beyond the concrete returns normally to be achieved by bombings."[91] Indeed, the destruction of the city had a psychological effect on the German people and Nazi leadership. In his personal journal, the Nazi Propaganda Chief Joseph Goebbels recorded that the bombing of Hamburg created "problems that are almost impossible of solution." The Nazi leader strained to find food, clothing, and shelter for "this population of a million."[92] Rapt with stress over what he called the "greatest crisis of the war," Goebbels ordered the partial evacuation of Berlin as a precautionary measure.[93]

The Rocky Mountain Arsenal's incendiaries also fell on the German city of Dresden in February 1945. The capital of Saxony, Dresden was a cultural mecca known for its "artistic treasures."[94] Some regarded the city as the "German Florence," others the "Athens of Germany," while a few settled for simply calling it the "most beautiful

[90] "Hamburg 'Ceases to be Organised City," 1 August 1943.
[91] Blauvelt, "Nazi Morale Badly Shaken by Hamburg Destruction," 26 July 1943.
[92] Joseph Goebbels, *The Goebbels Diaries,* trans. and ed. Louis P. Lochner (London: Doubleday, 1948), 333-334.
[93] Frederick Taylor, *Dresden: Tuesday, February 13, 1945* (Harper Collins Publishers, 2004), 134.
[94] Gladwin Hill, "Rail City Blasted," *New York Times,* 16 February 1945.

city in Europe."[95] Dresden was home to distinctive theaters, beautiful architecture, dozens of historical buildings, and quaint parks. Although often solely remembered for its cultural value, Dresden was also a military city.[96] During World War II, the metropolis served as an administrative and communications depot for the Eastern Front, a refuge for Germans fleeing from the Red Army, and home to several war industries.[97] It boasted of an inland harbor, numerous railway maintenance shops, large marshalling yards, an iron foundry, engineering and armament industries, chemical and explosive factories, and several electronic motor plants. In January 1945, the Red Army was quickly closing in on the heartland of Germany, pushing the Eastern Front closer and closer to Berlin. At the Yalta Conference in early February, the Allied forces agreed that they must stop the Germans from reinforcing the Eastern Front. To accomplish this, the USAAF and RAF set their sights on Dresden, the gateway to the East.[98]

On February 13, 1945, as the Dresden Frauenkirche's clock struck 10:09 P.M., "hell broke loose" in the city.[99] The RAF bombers screamed across the night sky, dropping nearly 650,000 incendiaries over the metropolis.[100] Following the night-and-day bombing pattern they used years before in Hamburg, the USAAF razed the city the next day with the Rocky Mountain Arsenal's incendiaries. As it had in Hamburg, the

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[95] Joseph P. Tustin, *Why Dresden Was Bombed: A Review of the Reasons and Reactions* (United States Air Forces in Europe, 1954), 2; Gladwin Hill, "U.S. Army Disliked in Ruined Dresden," *New York Times*, 3 January 1946.

[96] Nazi Propaganda Minister Joseph Goebbels was responsible for molding the way the international community remembered the firebombing. On March 4, he published "The Death of Dresden, a Beacon of Resistance" in a German weekly newspaper. Reprinted countless times, this article recounts how the Allies committed "mass-murder" against civilians and a city void of military value. By insisting that Dresden was solely an innocent cultural Eden, Goebbels created a narrative of Allied brutality that others, including American author Kurt Vonnegut, repeated throughout history. As the historian Frederick Taylor put best, this propaganda campaign was Goebbel's "final, dark masterpiece." See Taylor, *Dresden*, 372.

[97] Sebastian Cox, "The Dresden Raids: Why and How," in Paul Anderson and Jeremy A. Crang, eds. *Firestorm: The Bombing of Dresden 1945* (Chicago: Ivan R. Dee Press, 2006), 53.

[98] Tustin, *Why Dresden Was Bombed*, 9, 6-7.

[99] Tustin, *Why Dresden Was Bombed*, 10.

[100] "Triple Raid on Dresden," *The Manchester Guardian*, 15 February 1945.

USAAF struggled to implement its precision strategy because of the smoke that hung over the city. While the first wave of Superfortresses did indeed hit their target, the marshalling yards, subsequent groups scattered their payloads all over the city.[101] The temperature of the ensuing inferno exceeded 1,000º C. The fires claimed many Dresdeners. Some fled into cellars only to be crushed by falling debris or suffocated by smoke. Others jumped into the city's water tanks, hoping to prevent their immolation. They too perished when the water around them boiled and evaporated.[102]

By the time the assault ended on February 15, 1945, the incendiaries had destroyed Dresden's built environment. The fires claimed six square miles of the inner city, one-third of the city's apartments (approximately 75,000 units), 27,000 houses, and 7,000 public buildings. Hospitals and schools collapsed, the city's water system failed, and public transportation came to a halt. Out of Dresden's thirty historic and culturally significant buildings, eleven crumbled in ruin, and seventeen more sustained damage.[103] Among the buildings damaged were Dresden's ornate city hall and the Zwinger Museum. The baroque Catholic Hofkirche lost it roof in the raid. Consequently, the interior of the cathedral filled with shrapnel and falling ash. The sixteenth-century Residenz Castle lost everything but its outside walls to the flames. The Opera House where Richard Strauss debuted the majority of his operettas also suffered severe

[101] Cox, "The Dresden Raids: Why and How," 50.
[102] Anthony Clayton, "Dresden, 1919-1945," in Anthony Clayton and Alan Russell, eds., *Dresden: A City Reborn* (Oxford & New York: Berg Press, 1999), 40-41.
[103] Sönke Neitzel, "The City under Attack," in Paul Addison and Jeremy A. Crang, eds., *Firestorm: The Bombing of Dresden 1945* (Chicago: Ivan R. Dee Press, 2006), 74; Tustin, *Why Dresden Was Bombed,* 47.

damage. The Allies also destroyed their intended targets—Dresden's industrial centers and transportation nodes.[104]

Figure 4: A view from the tower of city hall, Dresden, February 13, 1945. Photograph courtesy of Walter Hahn/AFP/Getty Images.

The human cost of the Dresden firebombing is historically controversial. After the inferno swept through the city, Dresdeners spent months searching through the debris for loved ones. Because the city was in complete disarray, it was nearly impossible to identify and take inventory of the deceased. The exact death toll of the Dresden firebombing has shifted over time. Immediately after the raids, some Dresdeners claimed the fires took 150,000 people.[105] The records of the Dresden Chief of Police contain conflicting information. One police report lists 18,375 dead. However,

[104] Hill, "U.S. Army Disliked in Ruined Dresden," 3 January 1946; Nicola Lambourne, "The Reconstruction of the City's Historic Monuments," in Paul Addison and Jeremy A. Crang, eds. *Firestorm: The Bombing of Dresden 1945* (Chicago: Ivan R. Dee Press, 2006), 145.
[105] Taylor, *Dresden,* 371.

another police report records that 21,271 people were buried and cremated after the firebombing.[106] Today, there is still a debate about the numbers. More conservative historians estimate that the fires ended 25,000 lives.[107]

Firebombings were not unique to the European Theater. On the other side of the world, the Japanese implemented a similar strategy in their conflict with China. Japan and China had competed with each other for East Asian hegemony intermittently for hundreds of years. In some cases, these competitions took the form of large-scale "world wars," such as the First Great East Asian War of 1592-1598.[108] Running concurrently with the Second World War, the Second Sino-Japanese War of 1937-1945 was the latest struggle between Japan and China for regional dominance. Hoping to finally break Chinese morale and end Chinese resistance, the Japanese indiscriminately bombed urban centers, such as Chongqing, China's wartime capital. This campaign included the use of incendiary weapons. Between 1938 and 1943, Japanese aircraft dropped 21,600 bombs on Chongqing.[109] This bombardment destroyed approximately 10,000 homes and killed over 10,000 civilians.[110] "No apparent distinction was made between civilian or military targets," writes historian Edna Tow, "both fell victim to Japan's bombers."[111] An eyewitness reported to the *Times* that "the bombing was the worst exhibition of cold-blooded mass murder that the Japanese have so far been able to

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[106] Cox, "The Dresden Raids: Why and How," 51.
[107] Paul Addison and Jeremy A. Crang, eds., *Firestorm: The Bombing of Dresden 1945* (Chicago: Ivan R. Dee Press, 2006), ix.
[108] Kenneth M. Swope, *A Dragon's Head and a Serpent's Tail: Ming China and the First Great East Asian War, 1592-1598* (Norman: University of Oklahoma Press, 2009), 5.
[109] Edna Tow, "The Great Bombing of Chongqing and the Anti-Japanese War, 1937-1945," in Mark Peattie, Edward J. Drea, and Hans van de Ven, eds., *The Battle for China: Essays on the Military History of the Sino-Japanese War of 1937-1945* (Stanford University Press, 2011), 257.
[110] Hagiwara Misuru, "The Japanese Air Campaigns in China, 1937-1945," in Mark Peattie, Edward J. Drea, and Hans van de Ven, eds., *The Battle for China: Essays on the Military History of the Sino-Japanese War of 1937-1945* (Stanford University Press, 2011), 248-249.
[111] Tow, "Great Bombing of Chongqing," 261.

perpetrate. . . . The areas infected were raging infernos. I never saw anything like it."[112] By 1943, the Japanese bombers had transformed the entire city into rubble. Despite the scale of this destruction, the bombings did not achieve their main objective. China did not surrender, nor concede to Japanese demands. Instead of breaking the will of the people, the air raids unified the Chinese in Chongqing. They gave civilians and state officials a shared sense of hardship and purpose.[113]

While the Japanese were busy dropping firebombs on China, the Americans were preparing to drop their own incendiaries on Japan. Departing from the precision strategy, throughout the spring and summer of 1945 the United States indiscriminately dropped the Rocky Mountain Arsenal's M-69s and M-74s on Tokyo. In the 2003 documentary *The Fog of War,* former Secretary of Defense Robert S. McNamara illuminated just how the USAAF came to embrace the area bombing strategy in the Pacific Theater. As part of the USAAF's Office of Statistical Control, McNamara—then a captain in the USAAF—analyzed the efficiency and effectiveness of the B-29 Pacific bombing campaigns commanded by Major General Curtis LeMay. "LeMay was focused on only one thing: target destruction," McNamara related. "Most Air Force generals could tell you how many planes they had, how many tons of bombs they dropped . . . but he was the only person I knew in the Senior Commanding Air Force that focused solely on the loss of his crews per unit of target destruction." Guided by this emphasis, McNamara wrote a report which outlined how flying B-29s at 10,000 feet reduced their accuracy and made their operations "inefficient." In light of this and other reports from the Office of Statistical Control, LeMay decided to "drastically

[112] Lindqvist, *History of Bombing,* 75.
[113] Tow, "Great Bombing of Chongqing," 275, 281.

change" his operations. He began flying his B-29s at 5,000 feet and bomb using incendiaries to maximize their efficiency—their destructive power. Without a doubt, this strategy contained moral conundrums. As McNamara related, the alternative to firebombing was a protracted invasion and the loss of American lives. There was not an international rule or law against firebombing, and it indeed was an efficient way to destroy enemy infrastructure. Still, LeMay and McNamara both recognized that the firebombings were immoral. "LeMay said that if we would have lost the war we all would have been prosecuted as war criminals," McNamara related. "And I think he's right . . . we were behaving as war criminals. . . . But what makes it immoral if you lose and not immoral if you win?"[114]

While Tokyo weathered firebombing throughout 1945, the air raids on March 9 and 10, dubbed Operation Meetinghouse by the USAAF, were particularly devestating. Years after the bombing, the Tokyo native Tomio Yoshida provided a detailed ground-level perspective of the destruction. On the night of March 9, in less than one hour, the USAAF dropped 690,000 pounds of firebombs on Tokyo. When the teenager Tomio and his young sister first heard the air raid alarms sound, they quickly gathered a few valuables and fled to the streets. The two hoped to reach the open areas in their neighborhood—namely Sarue Park or the lumberyard operated by the Ministry of Forestry—believing that the bombers would have no cause to destroy those spaces. Shortly after Tomio and his sister took to the streets, they heard "the horrifying roar of the low-flying B-29s and the sound of incendiary bombs falling." As they ran through the streets they saw "the oily contents of the bombs ooz[ing] out, carrying flames to

[114] *The Fog of War,* directed by Errol Morris (2003; Sony Pictures Home Entertainment, 2004), DVD, 34:00-42:00.

everything they touched." Firefighters tried combatting the fires with water, but because "water was no good," the firefighters "threw aside their buckets and began trying to suffocate the flames with clothes and quilts." Despite the firefighters' best efforts to quell the flames, nothing worked. The fires raged on, spurred by the strong gales. People aflame frantically doused themselves with buckets of water, not realizing that water only fed the flames. After dodging the flames while racing through the streets, the Yoshida siblings reached their destination—the park district. However, they were unable to enter into the park. "A ring of burning shops" barricaded their entry. Quickly reassessing their situation, the children made way for their backup refuge—the lumberyard. However, the lumberyard was also engrossed with flames. Not knowing where to hide, the children finally took refuge near a stone wall of a canal.[115]

When dawn came and the fires burned out, the Yoshida children left the safety of the stone wall and made their way home. This task was nearly impossible. Tokyo had become unrecognizable. Wandering through ashes and rubble for "a long time" the Yoshida siblings could not find their home. "The neighborhood was a wasteland," Tomio explained. "Not a house remained in the formerly densely built-up region." While searching for their home, and their parents, the children saw dead bodies that "littered the streets" charred beyond recognition. The Rocky Mountain Arsenal's incendiaries—militarized fossils fuels—burned and transformed the biological elements—the nature—that made up human bodies. Eventually, the children "found the place where our house should have been." Nothing but ashes remained. Afraid and alone, the Yoshida children "squatted in the ruins" of their home "with no place to

[115] The Youth Division of Soka Gakkai, comp., *Cries for Peace: Experiences of Japanese Victims in World War II* (Japanese Times, 1978), 101-103.

go."[116] That night 87,793 people perished in the flames, 40,918 were injured, and more than one million became homeless.[117]

Figure 5: Tokyo's industrial Nihonbashi District after the firebombing on March 10, 1945. Photograph by and courtesy of the U.S. Army.

Operation Meetinghouse devastated Tokyo's built environment. American incendiaries turned fifteen square miles of the city into dust.[118] In an interview on March 11, LeMay said that Operation Meetinghouse "left nothing but twisted, tumbled down rubble in its path." Eight industrial facilities laid in ruins, including the Ueno railroad station, the Rising Sun petroleum terminal, the Ogura Oil Company, the Japan Machine Industry, and the Maranouchi telephone exchange. Furthermore, the fires destroyed hundreds of small businesses, administration buildings, and homes. "There

[116] The Youth Division of Soka Gakkai, comp., *Cries for Peace: Experiences of Japanese Victims in World War II* (Japanese Times, 1978), 101-103.
[117] Neer, *Napalm*, 81.
[118] Neer, *Napalm*, 81.

were acres and acres of smoke and flames [across Tokyo]," one B-29 pilot said. "The town was burning like hell—and I mean hell." Another pilot likened Operation Meetinghouse to "throwing matches on a floor covered with dry sawdust."[119] A reporter with the Boston Globe, Martin Sheridan, recorded that the smoke over Tokyo was so thick that it left soot on underside of the fuselage of his plane. The smoke carried with it the stench of burning bodies. "I not only saw Tokyo burning," Sheridan wrote, "I smelled it."[120]

The Rocky Mountain Arsenal's firebombs continued to rain down on Tokyo throughout the spring of 1945. In May, the USAAF dropped 3,258 tons of napalm on the undamaged parts of the city. As Lindqvist aptly observes, "no one counted the human cost anymore; damage was measured in surface area, square miles." The air raids had destroyed 178 square miles of Japan in five months.[121]

The Germans and the Japanese were not the only victims of the Rocky Mountain Arsenal's wares during World War II. In the pursuit of producing and exporting destruction, the CWS unintentionally harmed its own facilities and workers. While the explosions of June 6, 1945, killed and maimed American workers, the fires of June 25, 1945 and July 27, 1947, torched the Arsenal's built environment.

At 6p.m. on June 6, 1945, two M-74 incendiary bomblets reached the end of their assembly lines and exploded. Their flaming contents splattered on the bodies of workers nearby. Women made up 70 percent of the Rocky Mountain Arsenal's

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[119] "15 Sq. Miles of Tokyo Laid Waste in Raid," *Chicago Daily Tribune,* 11 March 1945.
[120] Martin Sheridan, "Eyewitness Tells of 'Hot Foot' Given to Tokyo," *Los Angeles Times,* 11 March 1945; It is unclear if the military used the Arsenal's stockpile of war materials in Korea or Vietnam. Newspaper reports on American incendiary use in both Korea and Vietnam link those materials to Japanese arsenals.
[121] Lindqvist, *History of Bombing,* 109.

workforce, and thus, it was statistically not surprising that women suffered from the Arsenal's fires and explosions. Although there is no data on what percentage of the workers were Hispanic, several women that the fires and explosions harmed had names suggesting Hispanic heritage. One woman, the 21-year-old Nora Ruiz, died from the fatal burns she received from the incendiaries. Three other women, Jean Mangledorf, Jewel Phillips, and Lila Baca, were seriously injured. Workers quickly rushed to smother the flames the best they could and attempted to save the lives of their coworkers. Emergency crews quickly transported the injured women to the Fitzsimons General Hospital for treatment. It was there that their historical record ends. Two other women, Elvira Jacobs and Anne Chavez, received minor burns from the explosions and quickly returned to work. The CWS never revealed what triggered the explosions. The official statement of the CWS, made by Brigadier General Alexander Wilson, the commandant of the Rocky Mountain Arsenal, did not offer any clues as to what caused the bomblets to explode.[122] The press made no further inquiries. The explosions of June 6, 1945, like their victims, faded away in the historical record.

Nineteen days later, on June 25, 1945, a fire broke out at the Rocky Mountain Arsenal. The inferno began in an unidentified building. The flames, fanned by high winds, quickly spread towards the main incendiary bomb plant just 200 feet away. Thankfully, the Denver Fire Department and the Arsenal's firefighters were able to keep the blaze from triggering a larger chemical explosion. To do this, the coalition of firemen quickly rearranged the Arsenal's built environment by moving freight cars on the Arsenal's railway to create a fire-break. The firefighters moved six empty freight

[122]"Girl Killed, 5 Women Hurt in Denver Munitions Blast," *Chicago Daily Tribune,* 7 June 1945; "Denver Arsenal Blast Kills One and Injures Five," *Denver Post,* 6 June 1945; "Women Holding 70% of Jobs at Denver arsenal." *Denver Post,* 11 May 1945.

cars to the north side of the burning structure, placing them between the fire and the chemical weapons plant. After an hour and a half, the firemen brought the blaze to heel. By the fire's end, the blaze had ruined approximately $75,000 worth of materials. Thankfully, this fire did not claim any lives. The CWS again did not definitively identify the origins of the blaze. They offered two explanations to the press. The first explanation detailed that the fire began because of a short circuit in the building's wiring. The second explanation stated that the fire was the result of spontaneous combustion.[123] Again, just like with the explosions of June 6, reporters did not press the issue. The next day, newspapers resumed their coverage of the war in Europe and Asia, quietly ending the story of the June 25 inferno.

Two years later, the Rocky Mountain Arsenal again burst into flames. On the night of July 27, 1947, the coal storage area of the Arsenal erupted into a blaze. The fire rapidly spread throughout the plants, destroying $150,000 in valuable machinery. By the time the Denver Fire Department arrived at the scene, the conflagration neared the poisonous chlorine gas tanks. The flames burned so high and bright that they were visible from many different spots across the Denver metropolitan area. In fact, residents of the Denver area pulled their cars over to watch the inferno light up the night sky. The resulting traffic jam took Denver police and state highway patrolmen more than an hour to untangle. Back at the Arsenal, firefighters worked on the blaze for more than an hour before it was contained. No one was injured or killed. When interviewed the next day about the cause of the fire, Colonel Ralph Johnson, the then acting commander of the

[123] "Blaze at Denver Arsenal Causes $75,000 Damage," *Denver Post,* 26 June 1945.

Arsenal, attributed the flames to "spontaneous combustion." [124] Once again, the press quickly forgot about this issue. The Rocky Mountain Arsenal had a way of avoiding scrutiny during the Second World War. After all, its weapons helped make the American victory possible.

As World War II dovetailed into the Cold War, the military-industrial complex also expanded into other front-range cities. Eighty-four miles south of Denver, in Colorado Springs, the Air Force burrowed into Cheyenne Mountain. There, it established the Air Defense Command (later known as the Aerospace Defense Command and the North American Air Defense Command). From its control centers deep in the mountain, the Air Force monitored North American airspace for missiles and enemy aircraft. It also prepared to coordinate the launch of America's ICBM cache in the event of nuclear war. In short, the Air Defense Command controlled all measures of air defense. [125] Indeed, during the Cold War the military-industrial complex brought much to the Front Range.

The Cold War not only changed the Front Range, it transformed the American West. As the economist Roger Bolton explains, "changes in the 1950's had important repercussions for regional growth simply because they were large enough to amount to significant shifts in demand, and because defense activity is an important source of income for certain areas." International tensions, including the Korean War and the threat of nuclear war with the U.S.S.R., spurred a greater demand for missiles, ships, and aircraft located along the West Coast of the United States. As a result, defense

[124] "Fire in Denver Arsenal Threatens Chlorine Tanks," *Chicago Daily Tribune*, 28 July 1947; "Blasts Averted During Arsenal Blaze, Damage Totals $150,000" *Denver Post*, 28 July 1947.
[125] For more on the Air Defense Command see Ann Markusen, Peter Hall, Scott Campbell, and Sabina Deitrick, *The Rise of the Gunbelt: The Military Remapping of Industrial America* (Oxford University Press, 1991), chapter 174.

businesses "fell off" the Old Northwest and Middle Atlantic states and traveled to the West.[126] Nuclear facilities, shipyards, aircraft manufacturers, and rocket researchers all congregated along the Rocky Mountains and the Pacific Ocean.[127] They brought with them regional growth.[128]

Sunbelt states across the South and the Southwest, such as Georgia and Arizona, also attracted large industries and experienced an economic boom during the Cold War. Sunbelt boosters and politicians, such as Arizona's Barry Goldwater, harnessed government power to create business-friendly environments. These environments consisted of low taxes, minimal regulations, and anti-union legislation. "The rise of the Sunbelt," the historian Elizabeth Shermer claims, "makes clear the extent of which America's New Deal moment proved but a transitory and contested episode in the construction of late twentieth-century capitalism." While Shermer's argument is a bit simplistic, there is little doubt that Sunbelt cities such as Phoenix, Arizona, attracted large electronics and aerospace firms because local boosters and the Phoenix Chamber of Commerce "perfected an anti-New Deal growth politics" that empowered businessmen. In short, Sunbelt boosters "redrew the boundaries of American capitalism and reoriented American politics toward the idea that the chief purpose of government, on both the local and the national level, was to sustain and advance businesses interests and those who presided over America's great corporations." Of course, in addition to

[126] Roger E. Bolton, *Defense Purchases and Regional Growth* (Washington D.C.: The Brookings Institution, 1966), 1.
[127] White, *"It's Your Misfortune and None of My Own,"* 515.
[128] Bolton, *Defense Purchases and Regional Growth*, 12.

their attractive politics, Sunbelt boosters advertised warm weather and an abundance of sunshine.[129]

Even though Denver could not boast of having consistently warm weather, it could brag about being "the West's greatest federal nerve center."[130] Testifying to the city's importance, after the Soviet Union detonated its first atomic bomb in 1949, the U.S. federal government designated Denver as an alternative capital of the United States in the event of nuclear warfare.[131] The Cold War increased the presence of the military-industrial complex in Denver. For example, in 1956 the Martin Marietta Aerospace Corporation (later Lockheed Martin) constructed a plant to manufacture Titan I missiles south of Littleton, a suburb of Denver. The Titan I missile program was important to both the greater Cold War and the Denver region. After Marietta finished constructing the ICBMs, they found their way into missile silos just southeast of the city at Lowry Air Force Base. There they waited for the Cold War to become hot. Along with Marietta, other large subsidized aerospace and avionic firms opened facilities near Denver, including IBM, Honeywell, Sundstrand, Ball Brothers Research, and Beech Aircraft.[132] The Atomic Energy Commission also took up residence ten miles northwest of downtown Denver at the Rocky Flats plant. There it worked alongside the Dow Chemical Company to manufacture plutonium triggers for America's entire nuclear

[129] Elizabeth Tandy Shermer, "Sunbelt Boosterism: Industrial Recruitment, Economic Development, and Growth Politics in the Developing Sunbelt," in Michelle Nickerson and Darren Dochuck, eds., *Sunbelt Rising: The Politics of Place, Space, and Region* (Philadelphia: University of Pennsylvania Press, 2011), 33, 34, 44, 57, 44.
[130] María E. Montoya, "Landscapes of the Cold War West," in Kevin J. Fernlund, ed., *The Cold War American West, 1945-1989* (University of New Mexico Press, 1998), 18.
[131] Ibid., 17-18; Malone and Etulain, *The American West,* 224.
[132] Abbott, Leonard, and McComb, *Colorado,* 281-283.

cache.[133] By 1980, Denver could boast that it had more than thirty-three thousand federal employees—more than any other city in the nation except Washington D.C.[134]

Yet when the Second World War ended, so did the mass production of weaponry at the Rocky Mountain Arsenal. The CWS, then reorganized into the Chemical Corps, placed the Rocky Mountain Arsenal on standby. The military-industrial complex simply no longer needed to mass-produce incendiary weapons and nerve gasses. It would contain communism using other means, including economic, political, and psychological pressures, as well as the threat of mutual assured destruction.[135] No longer needing all of its facilities, the CWS leased a portion of the Rocky Mountain Arsenal to two private chemical and pesticide manufacturers: the Colorado Fuel & Iron Corporation and the Julius Hyman & Company. These leases transformed the Arsenal into a physical manifestation of the military-industrial complex. In 1950, Julius Hyman & Company assumed Colorado Fuel & Iron's lease. Then, in 1951, Shell Chemical Company (later Shell Oil Company) bought out Julius Hyman and consolidated pesticide manufacturing at the Rocky Mountain Arsenal. Shell manufactured pesticides there until 1982.[136]

In her monumental work, *Silent Spring*, Rachel Carson addressed the dangers pesticides posed to American society and touched-off a new environmental

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[133] For more on Rocky Flats see Ackland, *Making a Real Killing.*
[134] Malone and Etulain, *The American West,* 224.
[135] For more on containment strategies see John Lewis Gaddis, *Strategies of Containment: A Critical Appraisal of American National Security Policy During the Cold War,* revised and expanded edition (Oxford University Press, 2005), John Lewis Gaddis, *George F. Kennan: An American Life* (New York: The Penguin Press, 2011), and Campbell Craig, *Destroying the Village: Eisenhower and Thermonuclear War* (Columbia University Press, 1998).
[136] Department of the Army, U.S. Army Munitions Command, Rocky Mountain Arsenal, *Summary History of Rocky Mountain Arsenal Denver, Colorado, 1942-1967,* 1967, Manuscript, 4, Database Number 505041, Document Number B6700172, JARDF; Jeffery T. Edson, James V. Holmes, John E. Elliot, and Christine A. Bishop, "The Rocky Mountain Arsenal: From Environmental Catastrophe to Urban Wildlife Refuge," in John E. Elliot, Christine A. Bishop, and Christy Morrissey, eds., *Wildlife Ecotoxicology: Forensic Approaches* (New York: Springer, 2011), 100.

consciousness in the United States. Hoping to explain what had "silenced the voices of spring in countless towns in America," Carson explored environments across the United States that were falling silent to pesticides—and one her examples was the Rocky Mountain Arsenal.[137] In a few short pages, the patron saint of environmentalism described how a wide assortment of chemicals, including chlorides, chlorates, fluorides, and arsenic flowed from the Rocky Mountain Arsenal's waste basins and into the region's groundwater. From there, according to Carson, it sickened livestock, damaged crops, and perhaps even harmed humans.[138]

Flawed waste management caused the Arsenal's wide assortment of chemicals to interact with the flora and fauna in the region. The story of waste management at the Rocky Mountain Arsenal is a long one. From 1942 to 1946, the Army treated its liquid waste, which included industrial chemicals and nerve gas byproducts, with sodium hydroxide to dissolve grease, oils, and protein-based liquids. The Army then stored the remaining liquid refuse in one of the natural reservoirs on site, which they dubbed Basin A. This basin was a depression in the earth approximately 100 acres in size. The idea behind this method of storage was that as the liquid waste pooled in the basin, it would slowly evaporate over time.[139] However, the military produced waste much faster than the refuse could vaporize. When Basin A began to overflow in 1946, the military directed its liquid refuse into another reservoir, Basin B. When Shell joined the Army at the Arsenal in 1951, it also stored its liquid waste in the basins. As the years went on, the military designated more natural waste basins to keep up with the high amount of

[137] Rachel Carson, *Silent Spring* (Boston: Houghton Mifflin Company, 1962), 3.
[138] Carson, *Silent Spring*, 43.

waste both it and Shell generated. In 1956, the Chemical Corps and Shell had moved to their sixth waste reservoir, Basin F.[140]

Figure 6: Aerial View of Basin A circa 1970. Photograph by the U.S. Army. Courtesy of the Library of Congress.

The basin method, however, failed to confine liquid refuse. Pollutants leached into the sandy soil, and quickly dispersed throughout the region. Throughout Shell's tenure at the Rocky Mountain Arsenal, the company released an estimated 136,000 tons of contaminants into the surrounding environment. Four of the many pesticides that leached out of the basins were DDT, dieldrin, aldrin, and endrin. These organochlorine chemicals work by attacking the nervous system of insects and mammals, causing

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[139] Foster Wheeler Environmental Corporation, *Record of Decision for the On-Post Operable Unit*, volume 1, sections 1-11, version 3.1 (June 1996), 1-2, 1-3.
[140] U.S. Department of the Interior, U.S. Environmental Protection Agency, *Fact Sheet Rocky Mountain Arsenal*, June 2004, SITE Database Number 13165-1, Document Number 00037631, 2, JARDF.

"disorientation, emaciation, and eventually death."[141] When these substances traveled through the soil, they found their way into the bodies of rodents and other small animals. Once there, they not only transformed the bodies and lives of these creatures—they also entered the food chain.

The waste basins were not the only lakes on the Arsenal grounds. Workers at the Arsenal dammed three other reservoirs to create the Upper Derby, Lower Derby, and Ladora lakes. [142] These lakes collected run-off and irrigation water from the area which Shell then pumped and recycled through its chemical plants to cool machinery. During the winter months, each of these lakes attracted migratory waterfowl to their shores.[143]

Responding to local complaints that the Arsenal was harming the region's wildlife, in May 1952 the biologist George M. Sciple of the Wildlife Research Laboratory in Denver conducted a field epidemiological survey of avian mortality on the grounds of the Rocky Mountain Arsenal. While walking through the land, Sciple and his team found "many dead and dying birds on the water and along the shorelines" of the Upper Derby, Lower Derby, and Ladora lakes. They also found "many more carcasses . . . far out in the surrounding grasslands and fields." When they looked up into the sky, they saw birds overhead "go into convulsions and fall while in flight." In their report, the surveyors recorded the characteristics of the sickened birds:

> The individual duck would sit quietly on the bank when approached closely by the observer. Its only movements would be an unusual repetitive "feeding" tremor of the mandibles and a coarse tremor of the head and neck. Depending upon the severity of the symptoms, the bird would either allow itself to be

[141] Edson et al., "The Rocky Mountain Arsenal: From Environmental Catastrophe to Urban Wildlife Refuge," 100, 93.
[142] To distinguish between the waste basins and the Upper Derby, Lower Derby, and Ladora lakes, I will refer to the waste basins strictly as "basins" for the remainder of this thesis.
[143] Robert B. Finley, Jr., *Investigations of Waterfowl Mortality at the Rocky Mountain Arsenal* (U.S. Department of the Interior, U.S. Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, Denver Wildlife Research Center, 1959), 4.

> picked up without a struggle or would suddenly become alert as the observer came within a few feet of it. In the first situation, the duck seemed unable to coordinate muscular activity and could not escape. In the second situation, the bird apparently had a greatly reduced sensorium and was unable to respond except to the strongest stimuli. These latter birds, once they became alerted, would fly up strongly as the observer approached within 4-5 feet of them. They would rise sharply, but as an altitude of perhaps 50-75 feet was gained, the ducks would go into violent convulsions and fall back into the water.

At the conclusion of the study, Sciple and his team estimated that 1,200 ducks died during the few months the biologists surveyed the area.[144] On May 28, 1952, Sciple submitted his study to the Julius Hyman Company, the Colorado Department of Game and Fish, the U.S. Food and Drug Administration, and the Commanding Officer of the Rocky Mountain Arsenal.[145] In his conclusion, Sciple noted that "it seems indicated that the avian mortality occurring on Upper Derby, Lower Derby, and Ladora Lakes is related etiologically to a surface-borne agent, or agents, toxic to the central nervous system." He continued, "Though not yet proven, it is believed probable that this surface agent is contained in an oily scum which entered the lakes through a process-water drain from the plant area."[146]

In 1955, other biologists associated with the Wildlife Research Laboratory trekked through the fields and brush around the Rocky Mountain Arsenal. They took field notes as well as collected tissue samples from the dead animals they encountered. They then sent this data to the Communicable Disease Center (CDC) in Savannah, Georgia, for analysis. Out of all the tests conducted by the CDC, one troubled the scientists more than the rest. After carefully dissecting and testing the fatty tissue and

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[144] George A. Sciple, "Study of Avian Mortality on Three Lakes at the Rocky Mountain Arsenal, Derby, Colorado," *History of Pollution Sources and Hazards at RMA,* Database Number 508914, Document Number B8000080, 1E-2, 2E-3, 1E-2, JARDF.
[145] Finley, *Investigations of Waterfowl Mortality at the Rocky Mountain Arsenal,* 1-2.
[146] Sciple, "Study of Avian Mortality on Three Lakes at the Rocky Mountain Arsenal, Derby, Colorado," E-7.

liver of a dead duck, the CDC found that it contained "large amounts of dieldrin," a pesticide manufactured at the Rocky Mountain Arsenal.[147]

In April 1959, Robert B. Finley, Jr., a research biologist with the Wildlife Research Laboratory, followed up on these studies. Finley and his team scoured the grounds surrounding the Rocky Mountain Arsenal, made field observations, as well as collected samples of water, mud, vegetation, and dead birds. Finley's group was primarily interested in waterfowl mortality around the Upper Derby, Lower Derby, and Ladora lakes. However, waterfowl were not the only animals dying in suspicious numbers. Both scientists and workers at the Rocky Mountain Arsenal recorded seeing dead pheasants, songbirds, muskrats, rabbits, and frogs around the shorelines of the lakes. While walking along the Ladora shore on April 17, 1959, Finley and his group found "a total of 119 dead birds and animals." They included "94 ducks of 9 species, 6 coots, 2 pheasants, 7 muskrats, 4 rabbits, and 6 frogs." Finley hypothesized that "if the 94 ducks all died within the preceding week, and if this mortality rate was typical for a 4-month period, January-April, the losses for this period would be approximately 1,500 ducks around Ladora Lake alone." While the Finley group trudged through the Arsenal grounds, they crossed paths with a Shell employee who was assigned to "periodically" gather up dead ducks around the property and bury them. With a gunny sack filled with dead ducks in his hands, the man disclosed to the researchers that during the first three months of 1959 he had collected "20 gunny sack of ducks, 25 birds to a sack, or a total of 500 ducks." Based off this information, Finley made a "conservative estimate" that 2,000 ducks per year might have died from the "toxic contamination of these three lakes." However, Finley also recognized that calculating the number of waterfowl killed

[147] Finley, *Investigations of Waterfowl Mortality at the Rocky Mountain Arsenal,* 2.

was “difficult to estimate because of the transient and constantly changing nature of the migratory duck population.” In other words, birds could have acquired toxins from the Arsenal and flown elsewhere to sicken and die. “Therefore,” Finley wrote, “counts of birds found dead around the three lakes represent the minimum losses and provide a basis for rough estimates of additional mortality.”[148]

After observing that the Upper Derby, Lower Derby, and Ladora lakes lacked the amphibian populations common in the Denver area—leopard and chorus frogs—Finley and his associates conducted simple bioassay experiments in their laboratory to determine if the lakes’ toxicity was to blame. This experiment consisted of raising tadpoles in four distinctive aquaria environments. One aquarium served as a control, the other three as tests. Each aquarium held both leopard and chorus frog tadpoles. The scientists filled the first aquarium with uncontaminated pond water and algae, as well as added mud they collected from Upper Derby Lake. Eleven days later, all twenty-five tadpoles in the first aquarium were dead.” The scientists left mud out of the second aquarium, filled it with uncontaminated pond water, and fed the tadpoles algae from Upper Derby Lake. Twelve days later, all forty-two tadpoles in the second aquarium were dead. The scientists also left mud out of the third aquarium, filled it with water collected from the Upper Derby Lake and fed the tadpoles uncontaminated algae. Forty-nine days later, all fifty tadpoles in the third aquarium were dead. The control aquarium held sixty-six tadpoles, uncontaminated pond water, and uncontaminated algae. Fifty-one days later, all of the control tadpoles were dead. Although the control bioassay was “crude,” Finley still maintained that this bioassay “showed that the survival of tadpoles in water alone from Upper Derby Lake was almost as good as survival in the control

[148] Ibid., 2, 3, 4, 3.

water." However, the algae and mud from Upper Derby Lake were toxic enough to kill tadpoles within 2 weeks.[149] The problem with Upper Derby Lake, then, was not in the water but in the soil.

Because the solubility of aldrin and dieldrin is low, they are readily absorbed and held in soil. As Finley explained, mud "acts as a great reservoir holding large quantities of insecticides for long periods." Along with the tadpole experiment, Finley's group analyzed mud taken from the inlet canal that fed into the Upper Derby Lake. They found that it was "very heavily loaded with dieldrin" containing 440 parts-per-million (ppm) of the chemical. Smaller concentrations of insecticides were also present in the mud taken from the outlets of the Upper Derby and Lower Derby Lakes. "It seems clear," Finley recorded, "that the mud deposits of the three lakes have become charged with [aldrin and dieldrin] brought into the lakes by the effluent canal from the chemical plant and that the mud, over a long period of time, releases small amount of toxicants to the water and living organism."[150]

Next, Finley and his group conducted a series of chemical analyses on three of the dead ducks they found at Ladora Lake. They found that each duck carcass held dieldrin.[151] To contextualize this finding, Finley noted a few studies that linked aldrin and dieldrin to duck mortality. In 1952, the Bureau of Entomology and Plant Quarantine, the United States Department of Agriculture, and the Wyoming Department of Agriculture attempted to control the grasshopper population by spraying 300,000 acres of Wyoming range land with aldrin, two ounces to the acre. The day before

[149] Ibid., 6, 7.
[150] Ibid., 8, 9.
[151] Finley explains that "absence of detectable amount of aldrin in the bird samples is not unusual because most of the aldrin entering animal tissues is converted and retained in the form of dieldrin." See Finley, *Investigations of Waterfowl Mortality at the Rocky Mountain Arsenal*, 7.

dusters sprayed the reservoir with aldrin, researchers saw a merganser and recorded that it "appeared to be healthy." Two days after spraying, researchers found the merganser lying dead near the reservoir. When scientists analyzed its carcass, they found that its brain contained 31ppm of aldrin, it kidney 24, and its liver 4ppm.[152] The other study that Finley consulted was a 1956 report titled *Pesticides: Their Use and Toxicity in Relation to Wildlife* by the zoologists Robert L. Rudd and Richard E. Genelly of the University of California, Davis. In that study, Rudd and Genelly investigated and recorded "the high toxicity of some chemicals" that the American people routinely used as pesticides. Four of the chemicals included in their report were aldrin, dieldrin, endrin, and DDT. Pertinent to Finley's research, Rudd and Genelly noted that mourning doves could not detect aldrin in their food and that ingesting 12.5ppm of the chemical resulted in their mortality. Additionally, in their bobwhite quail report, the scientists recorded that "all quail fed 0.001 percent aldrin . . . died within eight days."[153] Using these studies along with his own bioassays, Finley ended his report by "support[ing] the conclusion that [the Arsenal's ducks] were killed by aldrin or dieldrin or both."[154]

As the years went on, pesticides continued to poison the area's wildlife. Reports of dead ducks, fish, and birds continued throughout the 1960s, 1970s, and 1980s. Along with waterfowl, birds of prey seemed to be the most susceptible to the toxins. When hawks, for example, ingested prairie dogs or other small animals who lived in contaminated soil, they accumulated toxins in their bodies.[155] In 1983, workers at the

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[152] George Post, "The Effects of Aldrin on Birds," *The Journal of Wildlife Management* 16, no. 4 (October 1952): 492, 494-495.
[153] Robert L. Rudd and Richard E. Genelly, *Pesticides: Their Use of Toxicity in Relation to Wildlife* (State of California, Department of Fish and Game, Game Management Branch, 1956), 5, 52, 62, 85, 92, 54.
[154] Finley, *Investigations of Waterfowl Mortality at the Rocky Mountain Arsenal,* 10.
[155] Jane Diehl, "Not Fit for Man Nor Beast," *Up the Creek,* 29 January 1993, Database Number 14769-10, Document Number 00041405, JARDF.

Rocky Mountain Arsenal collected twelve ill birds. After the birds succumbed to death, scientists dissected their bodies searching for contamination clues. Their brains contained pesticide organochlorine residues, including dieldrin and endrin.[156] The next year, the Army's Division of Wildlife examined the carcasses of numerous animals at the Rocky Mountain Arsenal looking for more signs of contamination. Out of the fifteen pheasant corpses they examined, seven contained dieldrin and two endrin. When they examined the bodies of fifteen ducks, they found that ten held dieldrin, one endrin, one DDT, and six DDE.[157] The breast meat of eight mourning doves also contained dieldrin, one held endrin, and one DDT.[158]

Birds were not the only ones affected by the organochlorines. Mammals and fish also fell to poisoning. In 1984, the Army's Division of Wildlife found that out of the fifteen cottontail rabbit carcasses they studied, five held dieldrin. Walking along the shorelines of the Arsenal's lakes, workers gathered 117 dead fish, including catfish, bluegill, bass, pike, and bullhead. Nearly all of them contained one or more of the previously mentioned toxins.[159] Autopsies of a dead coyote and a dead badger in 1989, revealed that their livers contained "an elevated concentration of the pesticide dieldrin."[160]

The mortality caused by the Arsenal's pesticides was extensive, yet the Arsenal's environmental consequences were not confined to the biological world. According to the *Denver Post*, on August 7, 1971, at 11:22 P.M., Mrs. Wendt of 1725

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[156] *Organochlorine Chemical Residues in Brains of Birds and One Mammal Found Dead on the Rocky Mountain Arsenal, 1982*, 1983, Database Number 50998-2, Document Number B9710602, JARDF.
[157] DDE is a compound formed by the degeneration of DDT.
[158] Thomas G. James, "A Report on the Chemical Monitoring of Fish and Game Animals at RMA," 2 October 1985, Database Number 551374-1, Document Number G9501139, JARDF.
[159] James, "Chemical Monitoring."
[160] Diehl, "Not Fit for Man Nor Beast," 29 January 1993.

Williams Street, Denver, watched in horror as her "kitchen floor just rolled" beneath her. Quickly examining the room around her, Mrs. Wendt saw the kitchen table shake and braced herself, fearing that the walls would fall down on her. Six miles to her northeast, at 3040 West Virginia Avenue, the shaking earth threw Jesse Herrera out of his bed. Minutes later the police department switchboards all across the metropolitan area—from Westminster, Northglenn, and Commerce City to Arvada and Thornton—lit up with calls from concerned citizens. That night, an earthquake measuring 4.25 on the Richter scale rocked the region.[161]

Historically, Colorado had only recorded a handful of earthquakes prior to the 1960s. The first known earthquake to hit Colorado happened on December 7, 1870. Later, in 1882, an earthquake measuring 6.6 on the Richter scale, the largest in the city's history, shook Denver. Other quakes struck the state in 1901, 1944, 1955, and 1960.[162] The earthquake that shook the city on the night of August 7, 1971, was different from these quakes. The source of this quake, according to scientists, was the Rocky Mountain Arsenal.[163]

Responding to complaints of animal mortality, and realizing that the basin method did not offer a long-term solution to waste management, the Chemical Corps drilled a deep waste well into the Earth in 1961. The idea here was to pump hazardous liquid refuse deep into the Earth, which would prevent it from contaminating flora and fauna, as well as eliminate the need for more basins.[164] The hole cut through

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[161] "Area Shaken by Quake; Damage Light," *Denver Post,* 8 August 1971.
[162] U.S. Department of the Interior, U.S. Geological Survey, "Colorado Earthquake History," *Earthquake Hazards Program,* http://earthquake.usgs.gov/earthquakes/states/colorado/history.php.
[163] J.D.J. Bott and I.G. Wong, "What's Been Happening at the Rocky Mountain Arsenal?" *Seismological Research Letters* 67, no. 2 (1996): 61.
[164] David G. Havlick, "Bombs Away: New Geographies of Military-to-Wildlife Conversions in the United States" (dissertation, Chapel Hill: University of North Carolina, 2006), 134.

approximately 11,936 feet of horizontal sedimentary rocks in the Denver basin and emptied into Precambrian crystalline rocks, approximately 12,044 feet in the earth.[165] As the drill made its way through the Precambrian rocks, it burrowed through a layer of "bright green weathered schist" that occupied the space 11,950 to 11,970 feet below the surface, and emptied into a "highly fractured hornblende granite gneiss containing pegmatite intrusions" from 11,970 feet to the bottom of the hole.[166] It was this layer of fractured rock that bore the burden of holding the injected waste, and gave way as pressure grew overtime.

The Chemical Corps began injecting chemical waste into the fractured gneiss beginning on March 8, 1962.[167] This process would prove the wisdom offered by Joel Tarr to be true: some substances placed in sinks interact "with other substances to produce serious nuisance."[168] Six weeks after injection began, on April 24, 1962, seismographs at the Colorado School of Mines at Bergen Park, and at Regis College in Denver, recorded earthquake activity northeast of the city.[169] For the next three years, the Chemical Corps pumped waste into the earth, the seismographs documented movement, and the greater Denver metropolitan area shook.[170]

It did not take long for scientists on the Front Range to investigate the new seismic activity. Father Joseph V. Downey, a Jesuit Priest and the director of Regis College Seismological Observatory, was the first to suggest that the earthquakes were

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[165] J.H. Healy, W.W. Rubey, D.T. Griggs, and C.B. Raleigh, "The Denver Earthquakes," *Science* New Series 161, no. 3848 (September 27, 1968): 1301.
[166] David M. Evans, "Man-made Earthquakes in Denver," *Geotimes* 10, no. 9 (May-June 1966): 12.
[167] Healy et al., "The Denver Earthquakes," 1301.
[168] Tarr, *The Search for the Ultimate Sink,* 385.
[169] Evans, "Man-made earthquakes in Denver," 14; Healy et al., "The Denver Earthquakes," 1301.
[170] Healy et al., "The Denver Earthquakes," 1301.

possibly related to the Arsenal's waste well.[171] Other scientists developed different explanations. A graduate student at the Colorado School of Mines, Yung-Liang Wang, compiled all of the recent seismographic data for the Denver region in his doctorate dissertation in 1965. He found that many of the earthquake hypocenters clustered near Derby, a suburb on the western border of the Rocky Mountain Arsenal, and were located within the Precambrian layer of the Earth's crust.[172] Instead of linking the earthquakes with the injection well, Wang suspected that "normal faulting" in fractured Precambrian earth "may be the main cause of these Derby earthquakes."[173] Furthermore, Wang concluded that this "faulting process is compatible with the proposition that the Laramide Orogeny," the historical process that raised the Rocky Mountains, "is still continuing."[174]

While Wang was still in the process of completing his dissertation, the independent geologist David M. Evans began theorizing that earthquakes plaguing the Denver area were human induced. In November 1965, Evans presented his theory that the Rocky Mountain Arsenal injection well generated seismic activity to several local geological societies. While the majority of his audience questioned his theory, a few convinced him to broadcast his ideas to the public. By early 1966, Denverites could see

[171] Ibid., 1301.
[172] Yung-Liang Wang, "Local Hypocenter Determinations in Linearly Varying Layers Applied to Earthquakes in the Denver Area*"* (dissertation, Golden, Colorado: Colorado School of Mines, 1965), 140.
[173] For "normal faulting" see Wang, "Local Hypocenter Determinations in Linearly Varying Layers Applied to Earthquakes in the Denver Area,*"* iv; For "may be…" see Wang, "Local Hypocenter Determinations in Linearly Varying Layers Applied to Earthquakes in the Denver Area,*"* 141.
[174] Wang, "Local Hypocenter Determinations in Linearly Varying Layers Applied to Earthquakes in the Denver Area,*"* iv; Fascinatingly, Wang used information gathered at the Rocky Mountain Arsenal's well to demonstrate that the Precambrian layer was "highly fractured." See Wang, "Local Hypocenter Determinations in Linearly Varying Layers Applied to Earthquakes in the Denver Area,*"* 141.

Evans on their local news programs, hear him on the radio, and read him in newspapers.[175]

Responding to the public stir Evans created, the U.S. Army Corps of Engineers along with the U.S. Geological Survey (USGS) launched an "investigation to calculate Evans theory."[176] In December 1965, the USGS, in conjunction with the Colorado School of Mines, Regis College in Denver, and the University of Colorado, set up a "very dense network" of seismograph stations near the Rocky Mountain Arsenal to locate the epicenters of the earthquakes.[177] This consisted of eight small arrays near the injection well. Each array "consisted of six vertical seismometers at half-kilometer intervals, arranged in an L-shaped pattern, and two horizontal seismometers located at one of the vertical-seismometer positions." In January and February of 1966 these seismometers documented "between one and five earthquakes large enough to be located" each day. Their findings placed sixty-two of the quakes in an ellipsoidal zone around the Rocky Mountain Arsenal's injection well.[178]

The USGS concluded that "the pumping of waste fluids into a deep disposal well at the Rocky Mountain Arsenal near Denver appears to be a significant cause of a series of minor earthquakes that have occurred just north of Denver since the spring of 1962."[179] Recognizing the geological consequences of injecting liquid waste into the earth, the Chemical Corps slowly culled the volume and pressure of waste injected into

[175] Ben M. Parker, "Geology and the Citizen," *Geotimes* 10, no. 9 (May-June 1966): 18.
[176] For the public stir see Parker, "Geology and the Citizen," 18; For "investigation" see Healy et al., "The Denver Earthquakes," 1301.
[177] Evans, "Man-made Earthquakes in Denver," 11; Healy et al., "The Denver Earthquakes," 1301.
[178] Healy et al., "The Denver Earthquakes," 1302.
[179] Evans, "Man-made Earthquakes in Denver," 11.

the well. Then, on February 20, 1966, it permanently shut the well down and returned to the basin method.[180]

Later that year, the Rocky Mountain Arsenal was the topic of two articles published in scholarly journal *The Mountain Geologist.* The more significant of the two was the study published by Evans. In his article, Evans presented data that showed that the amount of waste the Arsenal injected into the earth correlated with the frequency of the earthquakes. When the Arsenal temporarily paused injections from October 1963 through August 1964, Evans's data showed that seismic activity in the region dropped. Additionally, the figures that Evans compiled placed the epicenters of "the majority of these earthquakes . . . within a five-mile radius of the Arsenal well."[181] In the second article, George E. Bardwell, a scholar from the University of Denver, ran a statistical analysis of the relationship between the Rocky Mountain Arsenal well and the frequency of earthquakes in the Denver area. He determined that the probability of seismic activity increasing due to "random fluctuation is about 1 in 1,000."[182]

The official monthly publication of the American Geological Institute, *Geotimes,* also published some of Evans's findings in 1966.[183] In "Man-made Earthquakes in Denver," Evans explained how the liquid waste induced the quakes. "As fluid was injected into the Precambrian reservoir," Evans wrote, "the fluid pressure adjacent to the well bore rose, and the frictional resistance along the fracture planes was thereby reduced. When, finally, enough fluid pressure exerted over enough area,

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[180] "Seismology: Instant Earthquake," *Time,* 1 April 1966.
[181] David M. Evans, "The Denver Area Earthquakes and the Rocky Mountain Arsenal Disposal Well," *The Mountain Geologist* 3 (1966): 31-32, 27, 23.
[182] George E. Bardwell, "Some Statistical Features of the Relationship Between Rocky Mountain Arsenal Waste Disposal and Frequency of Earthquakes," *The Mountain Geologist* 3 (1996): 41.
[183] In the same issue of *Geotimes,* the geologist Ben Parker thanked Evans for doing "more to bring geology and geologists into favorable focus in the public eye than has been accomplished by any planned program of public relations." See Parker, "Geology and the Citizen," 18.

movement occurred. The elastic energy released was recorded as an earthquake."[184] For Evans, then, the liquid waste accumulated in fractures of the Precambrian rocks until the built-up pressure necessitated movement.

The notion that human activity induced earthquakes shook up the scientific community. In 1968, *Science* published an article titled, "The Denver Earthquakes," written by the earth scientists J.H. Healy, W.W. Rubey, D.T. Griggs, and C.B. Raleigh. In it, the authors analyzed the data collected by the Colorado schools, Evans, and the USGS, as well as offered their own conclusions. After careful inspection, the scientists "consider[ed] the possibility of a coincidental occurrence of earthquakes with the onset of fluid injection at Denver to be remote." They also suggested that "it might be possible to reduce the size and number of the earthquakes by removing substantial quantities of fluid from the reservoir." Yet, Healy and his coauthors realized that testing their hypothesis "may prove prohibitively expensive." Considering cost, they hypothesized that "given sufficient time, the pore pressure in the focal zone will dissipate naturally, and it is hoped that, as the zone of high pressure spreads outward from the well, the maximum pressures in the reservoir will fall below the level required to trigger seismic activity." However, the authors did not know how much time the dissipation process would require. Thus, despite the high costs, Healy and his group ultimately recommended that the military drill a second well to remove the fluid from the earth in order to prevent future earthquakes.[185] The military, however, did not follow this suggestion.

[184] Evans, "Man-made Earthquakes in Denver," 16.
[185] Healy et al., "The Denver Earthquakes," 1309, 1310.

Despite the conclusions drawn by Evans, the USGS, and Healy's group, one scientist at the Colorado School of Mines, Ruth B. Simon, insisted that the earthquakes had nothing to do with the Arsenal. In writing her 1969 *Science* article, "Seismicity of Colorado," Simon borrowed tools from the history discipline by collecting nineteenth-century newspapers from the Denver area that documented earthquake activity. By doing so, she found that "earthquakes had occurred in the same regions of western Colorado, the Arkansas and Platte River valleys, for nearly one hundred years despite the increasing cultural effects of mining, highway construction, reservoir building, and loading." Drawing on these historical supports, Simon argued that "it appears unnecessary to explain the Denver earthquakes in terms of pressure induced by the introduction of waste fluid." Instead, Simon put forth that the earthquakes that shook Denver in the 1960s demonstrated that the area contained preexisting tectonic strains that had gone unnoticed for decades.[186]

A year later, the geologist Edwin Karp of New York University took issue with Simon's conclusion. Writing in *Science,* Karp argued Simon's work of being "extremely misleading." While Karp yielded to Simon that the "present-day broad patterns of seismicity in Colorado agree with those deduced from historical records," he also recognized that Simon's data "also indicate[d] that very numerous . . . earthquakes in the Denver area *began* at the time waste fluid was first injected at the Arsenal well." In short, Karp used the historical evidence Simon gathered against her. By juxtaposing Simon's evidence with the contemporary quakes he concluded that the "frequency of seismic events and the resultant concentration of energy release are not in accord with

[186] Ruth B. Simon, "Seismicity of Colorado: Consistency of Recent Earthquakes with Those of Historical Record," *Science* New Series 165, no. 3896 (August 29, 1969): 897.

historical records." Going further, Karp maintained that Simon's data did not discredit Evans and Healy's findings. Rather, he claimed that Simon "substantiate[d]" their work by showing how "waste fluid pressures appear[ed] to have been a *necessary* element in the initiation of the Denver earthquakes."[187]

Simon responded to Karp's argument with three points that she believed distanced the earthquakes from the injection well. First, she turned against the historical records that provided her initial position. Challenging the idea that the high frequency of earthquakes was a new phenomenon, she argued that since there were no seismograph stations with "sensitive, matched, short-period instruments" near Denver between 1882 and 1962, there was no way of knowing the frequency of seismic activity during that period. Second, Simon pointed out that only "smaller earthquakes" were located near the injection wellhead. The larger ones had documented epicenters south of the well and therefore, Simon concluded, were not associated with it. Simon ended her rebuttal with her strongest point: although the military stopped injecting waste in 1966, the earthquakes continued. Data collected from seismographs and newspaper reports from around the Front Range collaborated this point.[188]

[187] Edwin Karp and Ruth B. Simon, "Denver Earthquakes," *Science* New Series 167, no. 3924 (March 13, 1970): 1518 (Karp's emphasis), 1519.
[188] Ibid., 1519; Simon's emphasis.

Table 2: Magnitude and Quantity of Earthquakes in the Denver Area, 1959-1967 [189]

	Magnitude								
Year	1.5-1.9	2.0-2.4	2.5-2.9	3.0-3.4	3.5-3.9	4.0-4.4	4.5-4.9	5.0-5.4	Total
1959									0
1960									0
1961									0
1962	72	29	4	2	1	1			189
1963	89	34	9	3	1	1			284
1964	26	8	3						72
1965	168	64	25	6	4				550
1966	61	18	3	2	1				186
1967	62	29	15	4	4	2		3	306
Total	478	182	62	17	11	4		3	1584

Earthquakes continued to haunt the Denver area for decades to come.[190] Even though Simon insisted that this meant the injection well was not to blame, other scientists did not rule out injection as their source. Evans, as well as Healy and his coauthors, identified that seismic activity would lag behind the operation of the well.[191]

[189] Healy et al., "The Denver Earthquakes," 1302; M. L. Morgan, V. Matthews, and L. Heerschap, *Colorado Earthquake Map Server,* 2012, http://dnrwebcomapg.state.co.us/CGSOnline/
[190] Bott and Wong. "What's Been Happening at the Rocky Mountain Arsenal?"
[191] Evans, "Man-made Earthquakes in Denver," 16; Healy et.al, "The Denver Earthquakes," 1310.

In short: shutting down the well did not remove the 165,000,000 gallons of liquid waste that still pressurized the Precambrian gneiss.

This pressure continued to be released over time in the form of earthquakes. On April 10, 1967, a quake measuring 5.0 on the Richter scale shattered 118 windowpanes at the Rocky Mountain Arsenal and cracked parking lots and roads as far west as Boulder. Fearing for the safety of their students, the Boulder schools dismissed classes for the day. Back in Denver, legislators in the Capitol Building rushed away from tremoring chandeliers, fearing that they would come tumbling down onto them. Seventeen days later, a 4.4 quake broke walls and ceiling tiles in Boulder. On August 9, 1967, a 5.3 earthquake drummed through the city. The damage was widespread but not devastating. In the suburb of Northglenn, the quake rattled a church, breaking twenty windows and cracking concrete pillars. Light fixtures fell from nearby school ceilings. Around the suburb, homeowners reported cracks in their walls, ceilings, floors, patios, and sidewalks. The USGS recorded more earthquakes on November 14, 15, and 25, 1967. A 5.2 earthquake boomed through the earth on November 26, 1967. People as far north as Laramie, Wyoming, east as Goodland, Kansas, and as far south as Pueblo, Colorado, felt the earth shake underfoot. Earthquakes continued to rock the greater Denver area until seismic activity slowed down in 1981.[192]

This history of the Rocky Mountain Arsenal during World War II and the Cold War provides two important lessons. First, although many outside of Denver have never heard of the facility, it exported destruction around the globe. Second and most important, the Rocky Mountain Arsenal reminds us that the military-industrial

[192] U.S. Department of the Interior, U.S. Geological Survey, "Colorado Earthquake History"; Bott and Wong, "What's Been Happening at the Rocky Mountain Arsenal?"

complex's ecological footprint was not limited to battlefields. When the military-industrial complex came to Denver it brought with it economic prosperity and environmental degradation. The Rocky Mountain Arsenal's pesticides poisoned wildlife northeast of Denver, and its search for the ultimate sink generated earthquakes that rocked the greater Denver metropolitan area. During the latter years of the Cold War, the Chemical Corps phased out weapon production at the Rocky Mountain Arsenal in favor of demilitarization.[193] By 1982, both weapon and pesticide production at the Rocky Mountain Arsenal had ended.[194] However, the military-industrial complex continued to dominate Denver's environment after the Arsenal closed. That story is the subject of the next chapter.

[193] U.S. Department of the Interior, U.S. Environmental Protection Agency, *Superfund Record of Decision: Rocky Mountain Arsenal,* 3 June 1990, 2, accessed January 8, 2016, nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=91000T94.TXT.
[194] John F. Hoffecker, *Twenty-Seven Square Miles: Landscape and History at Rocky Mountain Arsenal National Wildlife Refuge* (Walden, Colorado: Walden Press Inc., 2014), 79-80.

Chapter 2: A Military-Industrial Cleanup

On Friday, October 9, 1992, President George H.W. Bush addressed his usual cadre of journalists and photographers in the White House. In front of the commander-in-chief sat a stack of papers and a line of pens. With his back slightly hunched forward, President Bush dryly, yet gladly addressed the nation: "I am pleased to sign into law H.R. 1435, the 'Rocky Mountain Arsenal National Wildlife Refuge Act of 1992.' This Act provides for the future establishment of a national wildlife refuge at the Rocky Mountain Arsenal immediately outside of Denver, Colorado." Less than a month before the American people voted him out of office, President Bush signed into law a bipartisan plan to transform a polluted landscape into a national treasure.[195]

After decades of manufacturing pesticides and munitions, the Arsenal's primary mission changed to demilitarizing war materials under the Nixon Administration in 1971. Later, in 1982, both the Army and Shell ended all production at the Rocky Mountain Arsenal.[196] That same year, the Army, Shell, the U.S. Environmental Protection Agency (EPA), and the Colorado Department of Health began investigating the effects military pollutants and industrial pesticides had on the land.[197] Under the Superfund Act of 1984, Army personnel traversed the Arsenal lands wearing "moon suits" and collected samples for laboratory analysis.[198] In November 1986, eight months before the federal government designated the Arsenal as a Superfund site, workers

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[195] George H.W. Bush, "Statement on Signing the Rocky Mountain Arsenal National Wildlife Refuge Act of 1992," 9 October 1992, The American Presidency Project, http://www.presidency.ucsb.edu/ws/?pid=21600.
[196] John F. Hoffecker, *Twenty-Seven Square Miles: Landscape and History at Rocky Mountain Arsenal National Wildlife Refuge* (Walden, Colorado: Walden Press Inc., 2014), 79-80; "Army About Ready to Destroy Old Gas," *Denver Post,* 21 July 1971.
[197] Kevin M. Kostelnik and James H. Clarke, "Managing Residual Contaminants—Reuse and Isolation Case Studies," *Remediation Journal* 18, no. 2 (spring 2008): 84.
[198] James Coates, "Arsenal May Be Turned Into Wildlife Refuge," *Chicago Tribune,* 1 March 1992.

spotted twenty bald eagles roosting on Arsenal land.[199] These birds of prey would prove the wisdom that the historian Lisa Brady offered in her monograph, *War upon the Land,* to be true. Nature is "more than mere victim, nature is an active force in human affairs."[200]

The presence of the eagles spurred several groups to action. In 1989, the U.S. Fish and Wildlife Service moved quickly to establish a substation at the Arsenal to aid in protecting the eagles and the 130 other species of wildlife on the land.[201] That same year, the photographers Wendy Shattil and Bob Rozinski journeyed onto the grounds of the military complex to see the bald eagles for themselves.[202] To their surprise, they found a variety of animals inhabiting the environment. They snapped photographs documenting the presence of deer, prairie dogs, and a wide assortment of birds, including bald eagles. The ensuing newspaper articles and photograph collections excited both local residents and environmentalists across the nation.[203] "When I first came out here," Shattil told the *New York Times*, "I half expected to find birds that glowed in the dark." Instead, she found a "diversity and quantity of wildlife" that, in her

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[199] Dorothy Rorex, "The Arsenal's Natural Lease," *E: the Environmental Magazine* 23, (July/August 1997): 23; The Rocky Mountain Arsenal was placed on the National Priorities List of Superfund sites on in July 1987.

[200] Lisa M. Brady, *War upon the Land: Military Strategy and the Transformation of Southern Landscapes during the American Civil War* (Athens: University of Georgia Press, 2012), 3.

[201] Rorex, "The Arsenal's Natural Lease," 23; Coates, "Arsenal May Be Turned Into Wildlife Refuge," 1 March 1992.

[202] It is worth noting that the photographers treaded in the safer portions of the Arsenal. As the *New York Times* quickly pointed out, in 1989 parts of the Arsenal were "so dangerous" that field workers could not "enter the area without donning protective suits and breathing apparatuses." See William E. Schmidt, "Nature Sows Life Where Man Brewed Death," *The New York Times,* 12 March 1989.

[203] The most well-known published collection of these photographs is Wendy Shattil, Bob Rozinki, and Chris Madson, *When Nature Heals: The Greening of the Rocky Mountain Arsenal* (Roberts Rinehart, Inc. Publishers, 1990); For examples of the influential weight these photographs carried see Schmidt, "Nature Sows Life Where Man Brewed Death," 12 March 1989; The environmental historians William Cronon and Richard White and other scholars were also intrigued by the photographs of wildlife on the Arsenal. For their brief analysis see William Cronon, ed., *Uncommon Ground: Rethinking the Human Place in Nature,* (W. W. Norton & Company, 1996) 35-44.

words, rivaled "Yellowstone National Park."[204] Shattil and Rozinski's pictures of bald eagles roosting on the Arsenal's trees, a western meadowlark perched on top of a sign reading "U.S. ARMY MILITARY RESERVATION NO TRESPASSING," and a group of mule deer taking shelter in an abandoned Army shed, sparked hope that "nature" would "heal."[205] They also inspired humans to try their hand at transforming "the most polluted square mile on Earth" into the "Central Park of the West."[206]

The Arsenal's remediation from Superfund site to National Wildlife Refuge became law on October 9, 1992, when President Bush's signature transformed H.R. 1435 into Public Law No. 102-402.[207] The law assigned the Secretary of the Army to remediate the portions of the Arsenal grounds that suffered from contamination. As sections of the land completed remediation, the law directed the War Department to transfer them to the Department of the Interior. Finally, the law assigned the Department of the Interior to establish a national wildlife refuge on the property it received.[208]

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[204] Schmidt, "Nature Sows Life Where Man Brewed Death," 12 March 1989.
[205] Shattil et al., *When Nature Heals,* cover.
[206] For "most polluted…" see Hoffecker, *Twenty-Seven Square Miles,* 86, 84; For "Central Park…" see Coates, "Arsenal May Be Turned Into Wildlife Refuge," 1 March 1992.
[207] According to the historian Otis L. Graham, Jr., Bush made gestures towards environmentalists, but ultimately did not have the ambition to pursue meaningful environmental programs. "Bush," Graham writes, "showed no interest in many trouble zones—climate change, strip mining, the endangered bald eagle and other waning critters, crowing and pollution in national parks." Nevertheless, while some might be surprised that Public Law No. 102-402 began under the auspices of Bush's administration, it was in keeping with his leadership style and national goals. The first President Bush, according to the scholars Ryan Barilleaux and Mark Rozell, "saw leadership as a collection of small actions that one at a time add up to something significant in the nation's history." Although he did not author H.R. 1435, the renovation of the Rocky Mountain Arsenal served as an example of President Bush's incremental approach to national improvement. While transforming the Rocky Mountain Arsenal was no small monetary task, it was a rather small geographical assignment. Aside from the environmental benefits of remediation, the site's value to the nation was prudent. See Otis L. Graham, Jr., *Presidents and the American Environment* (University Press of Kansas, 2015), 308, 307; Ryan J.Barilleaux and Mark J. Rozell, *Power and Prudence: The Presidency of George H.W. Bush* (College Station: Texas A&M University Press, 2004), 3-4.
[208] U.S. Congress, *The Rocky Mountain Arsenal National Wildlife Refuge Act of 1992,* H.R. 1435, 102nd Cong., 2nd sess. (October 9, 1992): https://www.govtrack.us/congress/bills/102/hr1435/text.

As part of the remediation process, the Army established the Rocky Mountain Arsenal Restoration Advisory Board (RAB) in 1994. This organization was an extension of the Department of Defense's Technical Review Committee (TRC) concept. United States Code 2705 provided for the creation of TRCs or site-specific RABs "to review and comment on Department of Defense actions and proposed actions with respect to releases or threatened releases of hazardous substances at installations." TRC and RAB membership was to consist of at least one representative from the Department of Defense, the EPA, State and local authorities, and the public.[209] Accordingly, the Rocky Mountain Arsenal's RAB was comprised of residents from Denver's northern suburbs, including, Brighton, Commerce City, and Montbello, as well as representatives from the Remediation Venture Office (RVO). The RVO was a manifestation of the military-industrial complex. It consisted of officials from the U.S. Army, Shell Oil Company (Shell Chemical's successor), and the U.S. Fish and Wildlife Service.[210]

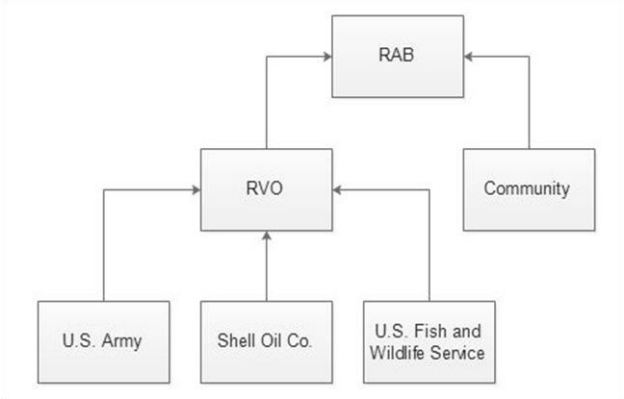

Figure 7: RAB and RVO membership. Figure by the author.

[209] *Notice of Environmental Restoration Activities, U.S. Code 10* (1994), § 2705, http://law.justia.com/codes/us/1994/title10/subtitlea/partiv/chap160/sec2705;
U.S. Department of Defense and U.S. Environmental Protection Agency, "Restoration Advisory Board (RAB) Implementation Guidelines," 27 September 1994, http://www.epa.gov/fedfac/restoration-advisory-board-rab-implementation-guidelines.
[210] Ray Rausch, "Refuge Views," *Wild News*, Summer/Fall 1997, SITE Database Number 2272-8, Document Number 00002905, JARDF.

While the RVO planned and implemented remediation, the RAB was to monitor and provide input to guide the process.[211] Throughout remediation, local actors and environmentalists who sat on the RAB took their role seriously, and presented their concerns that remediation was not going far enough. Chiefly, these locals were worried about the presence of diisopropyl methylphoshonate (DIMP) in the region's groundwater. They believed that this chemical caused them physical harm and that the RVO's methods of treating DIMP pollution did not thoroughly address the plume that had traveled off-site and towards the South Platte River. In the end, the RVO listened to these concerns, but it did not heed them. In effect, the RAB was a sham. The input from residents did not guide the course of remediation. Just as it had during the Cold War, the military-industrial complex dominated this land. The history of remediating the Rocky Mountain Arsenal is not a story of locals working with the federal government to redeem the land. It is a story of a military-industrial cleanup.

The Rocky Mountain Arsenal's RAB was not the only citizen advisory board to monitor military Superfund sites in the American West. Jennifer Ohayon examines the RABs associated with two Superfund sites in California—Hunters Point Naval Shipyard and Fort Ord—in her publication "Addressing Environmental Risks and Mobilizing Democracy?" She concludes that RABs were not "meaningful vehicles for public participation," and were "not necessarily democratic." In the case of Hunters Point, some members of the San Francisco community disagreed with the course of

[211] Rocky Mountain Arsenal Remediation Venture Office, *Milestones*, Spring 2005, SITE Database Number 14067-1, Document Number 00039554, 4, The Rocky Mountain Arsenal Joint Administrative Record Document Facility Digital Archives (hereafter cited as JARDF); The specific responsibilities of the RAB are outlined by the Department of Defense and the EPA. See "Restoration Advisory Board (RAB) Implementation Guidelines," 27 September 1994, http://www.epa.gov/fedfac/restoration-advisory-board-rab-implementation-guidelines

remediation implemented by the Navy. Tensions ran so high that environmentalists, anglers, and members of the RAB sued the Navy in 1994 "for nineteen thousand violations of the Clean Water Act." Members of Fort Ord's RAB also sued the Army for burying lead-contaminated soil in an on-site landfill, and later filed another lawsuit against the Army for violating CERCLA standards. The military disbanded the RABs at both Hunters Point and Fort Ord after their monthly meetings turned hostile.[212] Thus, the failure of the Rocky Mountain Arsenal's RAB to effect change was not exceptional.

The Cold War left a "toxic cocktail" in the soil at the Rocky Mountain Arsenal. DIMP was just one of the 666 chemicals that the military-industrial complex left in the land.[213] DIMP is a chemical byproduct of sarin nerve gas.[214] From 1953 to 1957 the Army manufactured sarin at the Rocky Mountain Arsenal, and from 1973 to 1975 it demilitarized the nerve gas. The Army produced DIMP in both manufacturing and demilitarizing sarin. When the Army pooled DIMP, along with the rest of its liquid waste, in earthen reservoirs on site, it failed to take the necessary precautions to prevent DIMP to seep into the saturated alluvium soil and begin moving downslope towards the South Platte River with the flow of the region's groundwater.[215]

The Army initially detected DIMP in the Arsenal's groundwater in 1974. It first identified the chemical in surface water draining from a marshy bog on the northern

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[212] Liss Ohayon, "Addressing Environmental Risks and Mobilizing Democracy?: Policy on Public Participation in U.S. Military Superfund Sites," in Edwin A. Martini, ed., *Proving Grounds: Militarized Landscapes, Weapons Testing, and the Environmental Impact of U.S. Bases* (University of Washington Press, 2015), 176, 175, 183, 184, 189.

[213] "Toxic cocktail" was the term John Yelenick, a prominent environmentalist in the Denver area, used to describe the hundreds chemicals that the Rocky Mountain Arsenal used or produced. See John J. Yelenick to Laura Williams, 19 December 1996, SITE Database Number 2410-16, Document Number 00005122, JARDF.

[214] U.S. Department of the Interior, U.S. Geological Survey, *Model Study of Diisopropyl Methylphosphonate (DIMP) Contamination, Rocky Mountain Arsenal Near Denver, Colorado Progress Report—Phase I,* by S.G. Robson (February 1976), 1.

[215] U.S. Department of the Interior, U.S. Geological Survey, *Phase I,* 1-2.

boundary of the Arsenal, far from the waste reservoirs. To stop this water from traveling beyond the Arsenal's borders, the Army began pumping water from the bog into the only waste reservoir lined with asphalt, Basin F.[216] The idea behind this measure was that the asphalt lining of Basin F would prevent the chemical from entering the soil and mixing with the groundwater. Following DIMP's trail from the bog, the Army found that the chemical had traveled downslope as far away as seven miles northwest of the disposal ponds, past the Arsenal's borders, and was within one mile of two wells in "the city of Brighton's municipal well field."[217] Later that year, the Colorado Department of Health detected DIMP nearly three miles downstream from the Arsenal in a well near the City of Brighton.[218] Although the concentration of DIMP in this well was comparatively small, 0.57 parts-per-billion (ppb), it nonetheless troubled the State.[219] In response to these findings, the Colorado Department of Health issued a Cease and Desist Order against the Rocky Mountain Arsenal and Shell on April 7, 1975. These orders directed the Arsenal and Shell to "immediately stop the off-post discharge of DIMP," submit a plan of action to "preclude such future off-post discharge," and develop and follow a surveillance plan to verify these actions.[220]

To fulfill these obligations, the Army contacted the U.S. Geological Survey (USGS) to evaluate the presence and trajectory of DIMP in the Arsenal's soil. USGS determined that DIMP had entered into the groundwater from the waste basins between

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[216] John W. Reynolds, *Rocky Mountain Arsenal Offpost Contamination Control Plan,* 30 May 1975, Database Number 507122-1, Document Number B7500085, 1-4, 4-1, JARDF.
[217] U.S. Department of the Interior, U.S. Geological Survey, *Phase I,* 2.
[218] Reynolds, *Rocky Mountain Arsenal Offpost Contamination Control Plan*, 1-4; *Technical Report 7508 Problem Definitions Studies on Potential Environmental Pollutants, Toxicology and Ecological Hazards,* December 1975, Database Number 507229-1, Document Number B7500057, 33, JARDF.
[219] Reynolds, *Rocky Mountain Arsenal Offpost Contamination Control Plan,* 1-6.
[220] U.S. Department of the Interior, U.S. Geological Survey, *Phase I,* 2.

1952 and 1956.[221] A later study conducted by the Army concluded that one of the earthen waste reservoirs—Basin A—and corroded sewer lines were the most likely sources of the contaminants.[222] According to the USGS, once DIMP entered the soil it spread "in excess of 28 square miles between 1952 and 1975." The groundwater at the Arsenal moved downslope southeast to northwest until it ultimately discharged into the South Platte River or First Creek. Using the available data on the groundwater's flow, the USGS determined that the contaminated groundwater could move "as much as 15 feet per day" to the northwest and "about 1 foot per day" to the north. The water that moved north entered First Creek and from there either entered Barr Lake or returned to the aquifer between First Creek and Barr Lake, "thus affecting the ground-water quality between the arsenal and the city of Brighton." The USGS did not provide insight as to what happened to the DIMP that traveled underfoot northwest into the South Platte River. Presumably, dispersal and dilution via the river was the solution to pollution. The USGS did recognize, however, that "model simulations of DIMP movement in the aquifer indicate that the contaminated ground water readily moves from the area of the disposal ponds to the northwest and begins discharging into the South Platte River about 4 years after the first introduction of the contaminant to the aquifer."[223] This meant that DIMP, at least in the simulation, had reached the South Platte as early as 1956.

[221] U.S. Department of the Interior, U.S. Geological Survey, *Digital Model Study of Diisopropyl Methylphosphonate (DIMP) Groundwater Contamination Rocky Mountain Arsenal Near Denver, Colorado, Final Report,* by S.G. Robson (June 1977), 1.
[222] Reynolds, *Rocky Mountain Arsenal Offpost Contamination Control Plan,* 3-1.
[223] U.S. Department of Interior, U.S. Geological Survey, *Final Report,* 1, 49, 2, 50.

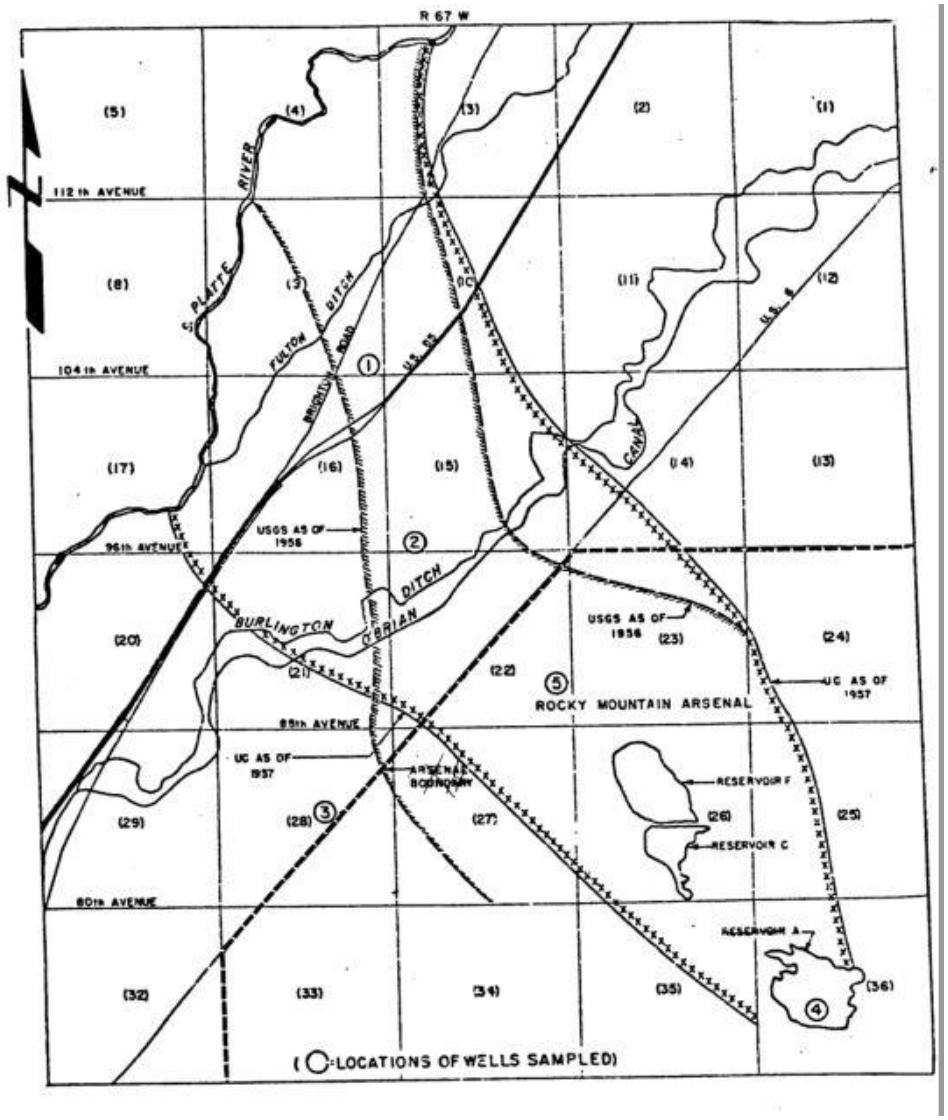

Figure 8: The Suspected Area of DIMP Groundwater Contamination, 1956-1957. The estimated boundaries of the plume are noted via a series of hash-marks. Note how the plume begins at Basin A, in the lower right corner of the map, and flows northwest towards the South Platte. This map is based on both the data gathered from testing five area wells, as well as the USGS simulation. Map courtesy of the USGS.[224]

While the USGS investigated the spread of DIMP, the Army also hired a private firm, Aerojet Ordnance and Manufacturing Company, to study the impacts of the chemical. From June 1975 through July 1977, the Aerojet scientists, led by P.A.

[224] Reynolds, *Rocky Mountain Arsenal Offpost Contamination Control Plan,* 1-5.

O'Donovan and J.E. Woodward, performed several tests to determine DIMP's toxicity to plants, if and where it concentrates in vegetation, and the movement of the chemical once it entered the soil. [225]

In order to uncover how DIMP interacted with plants, O'Donovan and Woodward's group treated a variety of vegetation with DIMP using two methods: bathing the plants with water containing DIMP, and culturing the vegetation in DIMP-contaminated soil. In their hydroponic bath study, the company grew ten species of plants while "constantly" bathing their roots with "0, 1, 10, 100, and 1000 ppm levels" of DIMP.[226] This study revealed that plants flooded with DIMP at a concentration between 10 and 100ppm suffered from stunted growth, leaf tip burn, and necrosis. Additionally, the plants flooded with 100ppm or higher concentrations of DIMP exhibited "severe tissue damage." In their soil study, the company planted carrot, wheat, alfalfa, sugar beet, and bean seeds in soil. They then irrigated these seeds with "0, 1, 8 and 20 ppm" of the chemical. In another greenhouse, the company repeated the soil study but increased the DIMP concentrations to "0, 50, 100, 300, 500, 700, and 1000ppm." The results of the soil study closely matched those of the hydroponic bath experiment. Plants treated with 50ppm of DIMP showed "marginal symptoms of phytotoxicity." Additionally, the company noted that all of the plants tested in both the hydroponic and soil studies, except for the junipers, took up the contaminant and concentrated it in their tissues, especially their leaves. Because it was the leaves that stored the majority of the DIMP, not the roots that were exposed to the chemical, the

[225] P.A. O'Donovan and J.E. Woodward, *Investigations of the Environmental Fate and Phytotoxicity of DIMP and DCPD* (Downey, California: Aerojet Ordnance Co., 1977), ii.
[226] The ten species of plants they grew were: "corn, bean, radish, wheat, tomato, carrot, sugar beet, meadow fescue, rose, and juniper." See O'Donovan and Woodward, *Investigations of the Environmental Fate and Phytotoxicity of DIMP and DCPD,* ii.

company presumed that DIMP followed "the general water movement in the plant" and was "somehow trapped in the leaves and accumulates there as the water is lost through the various transpiration mechanisms." The scientists concluded that since DIMP "display[ed] little tendency" to accumulate in the portions of plants consumed by humans, such as radish, carrot, and bean roots, it "would not function as concentrators in the human food chain." However, the animal food chain was another matter. The scientists noted that since farmers sometimes use wheat, fescue, beet and corn leaves as animal fodder, DIMP could potentially find its way into the food chain via animal feed.[227]

Finally, the Aerojet scientists attempted to determine how DIMP moved through "various types of soil" after it encountered water. They applied DIMP to five different soil plots via two methods. The first method consisted of placing 20ppm of DIMP on the surface of the soils and allowing it to absorb and filter down through the plot. The second method consisted of mixing the DIMP with the top foot of each soil plot and then irrigating it with clean water. 320 days later, the scientists tested each soil sample. They found that DIMP diluted and traveled throughout each type of soil in the first experiment, with higher concentrations of the chemical located on the soils' surface. As for the second experiment, the scientists found that DIMP traveled more broadly throughout each of the soils. Both studies led O'Donovan and Woodward's group to conclude that irrigation water could wash "a single DIMP contamination" throughout "a

[227] O'Donovan and Woodward, *Investigations of the Environmental Fate and Phytotoxicity of DIMP and DCPD,* ii, iii, 106; O'Donovan and Woodward replicated their results when they tested another group of sugar beet, bean, wheat, alfalfa, and carrot seeds in contaminated soil and irrigated them with various levels of DIMP water, up to 1000ppm. Seven to ten days after the seeds sprouted, the scientists recorded that each plant began to experience leaf curl and necrosis. See O'Donovan and Woodward, *Investigations of the Environmental Fate and Phytotoxicity of DIMP and DCPD,* iii.

given soil matrix." They also found that DIMP "when mixed with wet or dry soils, is not lost to the atmosphere by vaporization to an appreciable degree." Although the scientists did not rule out the possibility that DIMP could evaporate in "relatively small amounts," their studies did not point to evaporation as a significant way to disseminate the chemical.[228] Dilution, extraction, or containment appeared to be the only ways to combat the chemical.

Based on these findings, the Army established several measures to better contain and monitor DIMP. Primarily, the Army redirected as much of its liquid waste as it could to Basin F. With the cooperation of the Colorado Department of Health and Shell, the Army also developed two water monitoring programs to screen both on-post and off-post wells.[229] To combat DIMP already in the soil, in 1978, the Army constructed a pilot groundwater containment and treatment system on the northern boundary of the Arsenal that intercepted a 1,500-foot section of the land.[230]

With these measures in place, the Army, the EPA, and the State of Colorado turned to science to understand DIMP's toxicity to mammals. Two scientific studies yielded conflicting results. In 1979, the scientist R.J. Aulerich and his group studied DIMP's toxicity to American mink (*Neovision vison*). They found that feeding female mink 11, 37, and 95ppm of DIMP for 12 months increased their morality in comparison

[228] O'Donovan and Woodward, *Investigations of the Environmental Fate and Phytotoxicity of DIMP and DCPD,* iv, v, 107. The five types of soil used in this study were Chino (sandy clay loam), Brawley (silty clay), Ventura (clay loam), Fullerton (sandy loam), and Walnut (clay loam). See O'Donovan and Woodward, *Investigations of the Environmental Fate and Phytotoxicity of DIMP and DCPD*, iv.
[229] Reynolds, *Rocky Mountain Arsenal Offpost Contamination Control Plan*, 4-1, 5-3.
[230] Department of the Army, U.S. Army Toxic and Hazardous Materials Agency, *Management Plan For the Rocky Mountain Arsenal Installation Restoration Project* (1 October 1979), Database Number 550037-1, Document Number G7901031, 4, JARDF.

to the mink that they did not feed DIMP.[231] Based on Aulerich's findings, the State of Colorado set a DIMP water standard of 8ppb. A year later, the scientist E.R. Hart studied the effect DIMP had on dogs. Hart noted that feeding dogs 75ppm of DIMP per day did not produce observable adverse effects. Based on this result, the EPA set a DIMP water standard of 600ppb. The EPA chose to base its standard on Hart's study instead of Aulerich's for two reasons. First, the EPA cited that captive mink had a naturally high mortality rate. Second, the EPA noted that canines are physiologically closer to humans than mink are.[232] The State of Colorado disagreed with this assessment. It argued that the EPA relied on flawed data to assess the mortality rates of captive mink and that although canines are more similar to humans, the physiology of mink was relevant to the human body.[233] Regardless of these disputes, the Army

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[231] National Research Council, Board of Environmental Studies and Toxicology, Committee on Toxicology, Subcommittee on the Toxicity of Diisopropyl Methylphosphonate, *Re-Evaluation of Drinking-Water Guidelines for Diisopropyl Methylphosphonate* (Washington D.C.: National Academy Press, 2000), 6.

[232] Subcommittee on the Toxicity of Diisopropyl Methylphosphonate, *Re-Evaluation of Drinking-Water Guidelines for Diisopropyl Methylphosphonate*, 25, 3.

[233] Subcommittee on the Toxicity of Diisopropyl Methylphosphonate, *Re-Evaluation of Drinking-Water Guidelines for Diisopropyl Methylphosphonate,* 1; In 1990, the National Research Council Committee on Toxicology found that the Aulerich group conducted the 1979 mink study using poor testing and reporting procedures. Thus, it sided with the EPA's adopted standard. Later in 1997, the National Research Council re-examined the DIMP studies. Revising its position, it found that the 1979 Aulerich mink study provided one of "the most appropriate databases for deriving a drinking-water guideline for DIMP." During that year, the Army funded the scientist Thomas J. Bucci and his group to conduct another DIMP-mink study. Bucci's group concluded that DIMP's "adverse effects were mild" and limited to the mink fed 1250ppm of the chemical. Bucci's group did not published their study in a traditional peer-reviewed scholarly journal until 2003. However, the Army, the EPA, and the National Research Council relied on Bucci's findings as early as 1997. In 1997, the National Research Council considered Bucci's study to "be the best available study for deriving a drinking-water guideline." But this study was also controversial. In 2003, the scientist Edward J. Calabrese determined that Bucci's study was flawed. During their study, Bucci's group "unintellional[ly]" killed six mink via anesthetic overdose. However, Calabrese claimed that those mink "displayed evidence" of DIMP poisoning. In a second 2003 publication, Calabrese concluded that since Bucci's group "medically intervened when mink appeared ill" they "masked [the] effects of diisopropylmethylphosphonate (DIMP) on female mink." See Subcommittee on the Toxicity of Diisopropyl Methylphosphonate, *Re-Evaluation of Drinking-Water Guidelines for Diisopropyl Methylphosphonate,* 3, 1; Edward J. Calabrese, "The Effects of Diisopropylmethylphosphonate, a By-Product of the Production of Sarin and a Contaminant in Drinking Water at the Rocky Mountain Arsenal, on Female Mink," *Regulatory Toxicology and Pharmacology* 37 (2003): 191-192; Edward J. Calabrese, "The Effects of Diisopropylmethylphosphonate on Female Mink:

seemed to have the DIMP situation under control. As the pilot groundwater treatment plant processed water in the north, the Army put its faith in Basin F's tar lining to keep DIMP from further contaminating the soil.

Unfortunately, Basin F's asphalt liner failed to confine liquid waste. After the Army pumped DIMP into the basin, the chemical leached into the underlying aquifer and traveled approximately twelve miles down slope northwest towards the South Platte. Reacting to this, in the late 1980s the Army began pumping the contents of Basin F into a series of tanks, incinerated over ten million gallons of the waste, and filled the remnants of Basin F with soil.[234]

While these efforts removed the source of the contaminant, and even though the water treatment system cleaned some of the soil, DIMP continued to plague the land. In 1990, the Colorado Department of Public Health and Environment (CDPHE), the successor agency of the Colorado Department of Health, sampled private wells in the suburbs near the Rocky Mountain Arsenal to track the movement of the plume and its concentration. Although the CDPHE could only hypothesize as to the exact shape of the plume, its studies demonstrated that DIMP continued to flow northwest underfoot despite the Army's efforts. The next year, the CDPHE petitioned the Colorado Water Quality Control Commission (WQCC) to adopt 2ppb as the highest DIMP concentration allowable in the region's groundwater. However, the WQCC continued to abide by the 1979 Aulerich study and maintained a groundwater quality standard of

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How Medical Intervention Biased Mortality Data," *Regulatory Toxicology and Pharmacology* 38 (2003): 260; Thomas J. Bucci, Robert M. Kovatch, Michael D. Mercieca, Victory Perman, J.S. Klingensmith, "Two-Generation Reproductive Study in Mink Fed Diisopropyl Methylphosphonate (DIMP)," *Reproductive Toxicology* 17, no. 3 (May-June 2003): 327.

[234] Jeffery T. Edson, James V. Holmes, John E. Elliot, and Christine A. Bishop, "The Rocky Mountain Arsenal: From Environmental Catastrophe to Urban Wildlife Refuge," in John E. Elliot, Christine A. Bishop, and Christy Morrissey, eds., *Wildlife Ecotoxicology: Forensic Approaches* (Springer, 2007), 105, 106.

8ppb. Yet, the difference between 2ppb and 8ppb was negligible in comparison to the high concentrations of DIMP in the area's wells. According to the CDPHE, some held up to 3700ppb of the chemical.[235]

As the CDPHE was identifying DIMP in area wells, the U.S. Congress and President Bush approved of the Arsenal's transformation from Superfund site to Wildlife Refuge. The Records of Decision (RODs) outlined the means and processes the RVO used to remediate the Rocky Mountain Arsenal. These documents worked in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as the Superfund law, as well as the National Environmental Policy Act, and the National Oil and Hazardous Substances Pollution Contingency Plan. While one ROD pertained to the remediation of soils, groundwater, and infrastructure on-site, the other identified the extent of remediating off-site groundwater and soil. The RVO, the EPA, and the State of Colorado approved the Off-Post ROD in December 1995 and the On-Post ROD in June 1996.[236] At first glance, the presence of two RODs might have indicated that the RVO weighed the on-post and off-post remediation equally. However, this was not the case. On-post remediation was exhaustive in comparison to off-post effort. The length of the each ROD demonstrates this, with the on-site ROD numbered 1,141 pages and the off-site 126.

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[235] Colorado Department of Public Health and Environment, *State Contaminant Listing: From Identification to Regulation*, by Jeffery Edson (2007), http://www.astswmo.org/Files/Meetings/2007/2007-Annual_Meeting/FFHWJeffEdson_000.pdf.
[236] U.S. Department of the Interior, U.S. Environmental Protection Agency, "National Oil and Hazardous Substances Pollution Contingency Plan; National Priorities List," *Federal Register* 71, no. 80, 26 April 2006, http://www.regulations.gov/#!documentDetail;D=EPA-HQ-SFUND-1987-0002-0002; Colorado Department of Public Health and Environment, "Rocky Mountain Arsenal," https://www.colorado.gov/pacific/cdphe/rocky-mountain-arsenal; Valerie Richardson, "Toxic Dump is now Home for Deer, Cleanup of Denver Arsenal Offers Model for the Nation," *The Washington Times*, 1 October 2000.

The RODs can be broken down into a handful of generalized processes. The On-Post ROD directed the RVO to remove contaminated soil down to ten feet and treat groundwater around the Arsenal's borders and in select locations. It also assigned the RVO to create two landfills on site for the gathered hazardous waste, and then inter them beneath protective covers. This ROD forbad the RVO from excavating the soil ten feet below the waste basins, chemical sewers, manufacturing plants, and disposal trenches. Those layers of earth were too dangerous to remediate. Finally, the On-Post ROD placed restrictions on the use of the Arsenal's land in perpetuity. The ROD prohibited residential developments, agriculture, consumption of fish and game, and the drinking the Arsenal's groundwater until future studies determined their safety.[237] The Off-Post ROD directed the RVO to remove, treat, and reinject contaminated groundwater north of Arsenal in the First Creek and northern paleochannels. In accordance with the State of Colorado's DIMP water quality standard of 8ppb, the RODs also directed the U.S. Army and Shell to monitor groundwater directly north of the Arsenal and provide an alternative water sources to residents whose wells contained 8ppb of DIMP or more. This alternative water came in the form of bottled water and infrastructure that connected rural areas to municipal water services.[238]

While the RODs appeared to offer promising solutions to the DIMP plume, some of the community members on the RAB believed that they were not extensive enough. They argued that the RVO should have provided bottled water to all Coloradans near the Arsenal and that the RVO needed to expand its off-post water

[237] Foster Wheeler Environmental Corporation, *Record of Decision for the On-Post Operable Unit, Volume 1*, June 1996, D5-D8, JARDF Physical Archives.
[238] Harding Lawson Associates Engineering and Environmental Services, *Rocky Mountain Arsenal Offpost Operable Unit Final Record of Decision Rocky Mountain Arsenal Commerce City, Colorado*, 19 December 1995, DS2- DS3, JARDF Physical Archives.

treatment facilities.[239] The most vocal member of the RAB was John Yelenick. Yelenick's history with DIMP began in 1985, when he arranged to have the well water tested on his family farm in Henderson, Colorado. While he was not looking for the chemical, the results of the test revealed that his well water contained 425ppb of DIMP.[240] From that point forward, Yelenick became involved in the struggle against DIMP in the greater Denver area. At first, Yelenick's concerns were personal in nature. Wanting to learn about the compound that saturated his well, Yelenick wrote a series of letters to the EPA requesting information. As time went on, Yelenick became unsatisfied with DIMP's ambiguous toxicological profile and the extent of remediation. By 1996, Yelenick had become an advocate for the health of all Coloradans living near the Rocky Mountain Arsenal.

The history of the Rocky Mountain Arsenal's remediation is a story about community members attempting to work within the RAB's power structure to bring about change. Including concerned residents and representatives from the Sierra Club in the RAB, however, allowed the RVO to contain and manage them. Instead of taking to the streets or organizing grassroots movements, residents voiced their concerns at the monthly RAB forum to the representatives of the supposedly-responsive RVO. In this way the RAB coopted local environmentalists. In November 1996, the RAB community contingent elected Yelenick as their co-chairperson. In this position he pressed the RVO to further investigate DIMP's presence in off-post groundwater and to do more to

[239] Some local environmentalists, such as the founder of Citizens Against Contamination, Beth Gallegos, regarded the remediation as "reasonable." To Gallegos, the criticisms against the Arsenal were only "semi-valid." See Richardson, "Toxic Dump is now Home for Deer, Cleanup of Denver Offers Model for the Nation," 1 October 2000.
[240] Patricia Calhoun, "And Not A Drop to Drink," *Westword*, 3 April 1997, http://www.westword.com/news/and-not-a-drop-to-drink-5057315.

remove the chemical from the land northwest of the Arsenal.[241] However, his efforts did not gain traction with the Army, which permanently filled the second RAB co-chair position. Verbal clashes between Yelenick and the Army's RAB co-chairs ensued. The Army heard but did not act upon the input the RAB provided.

In December 1996, Yelenick obtained a copy DIMP's new toxicological profile published by the Agency for Toxic Substance and Disease Registry.[242] The document suggested the chemical was "far more deadly than previously suspected." Disturbingly, the profile stated that DIMP had a half-life of 530 years, caused neurological disorders, and could cause wildlife mortality with "a single dermal application."[243] In light of this report and the RVO's cursory off-post water monitoring program, the farmer from Henderson took it upon himself to test off-post groundwater for DIMP and presented his results to the RAB. His studies indicated that DIMP in excess of 8ppb existed beyond the Arsenal's borders and its treatment plants. The Arsenal's treatment systems, according to Yelenick, were constructed too late to capture the DIMP that had already flowed off-site. Yelenick especially worried about the DIMP that had already made its way into the South Platte River and traveled downstream throughout the region. Despite his concerns and his report, the RVO refused to alter the course of the remediation.[244]

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[241] Calhoun, "And Not A Drop to Drink," 3 April 1997.
[242] Yvonne Peterson, "Restoration Advisory Board (RAB) Meeting Minutes, December 5, 1996," Site Database Number 2410-2, Document Number 00005108, 1, JARDF; the Agency for Toxic Substance and Disease Registry operates under the U.S. Department of Health and Human Services.
[243] Calhoun, "And Not A Drop to Drink," 3 April 1997. For the full study see U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, *Toxicological Profile for Diisopropyl Methylphosphonate* (August 1998), http://www.atsdr.cdc.gov/toxprofiles/tp119.pdf.
[244] Calhoun, "And Not A Drop to Drink," 3 April 1997.

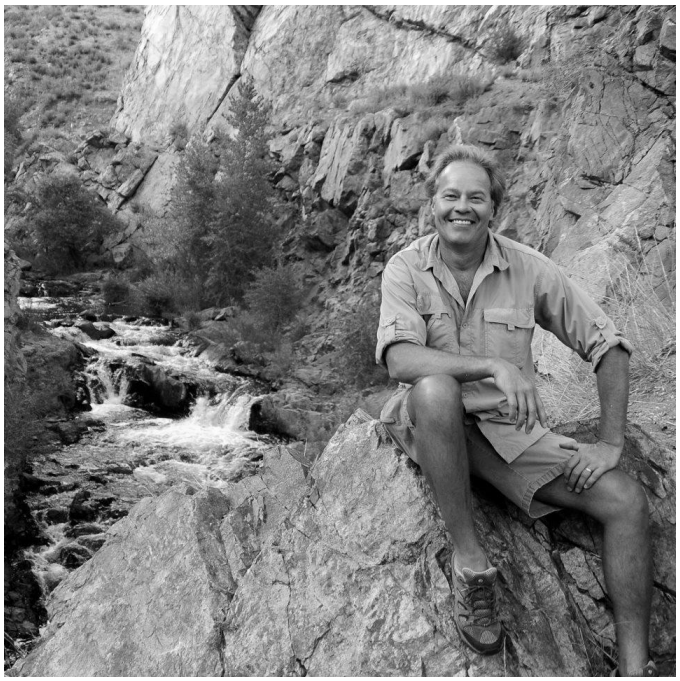

Figure 9: Photograph of John J. Yelenick, co-chairperson of the Restoration Advisory Board from 1996-1998, real estate broker, and environmentalist. Photograph by Sabrina Garvin. Courtesy of John J. Yelenick and Sabrina Garvin.

Failing to sway the RVO, Yelenick reached out to Dr. Thomas Kurt of the University of Texas, an expert on toxicology and chemical weaponry. Yelenick hoped that Kurt would be able to convince the RVO that the DIMP plume required additional measures than the process outlined in the RODs. Yelenick planned to hire Kurt on behalf of the RAB pursuant to a Department of Defense rule that allowed restoration advisory boards to request federal grants to bring in independent technical consultants. In order to file this request, Yelenick had to gain the consent from the rest of the RAB. However, the Army was in charge of distributing information to the board. Even though Yelenick submitted his grant request to the Army on February 5, 1997, the Army did not distribute his materials to the RAB until later in April. When Yelenick looked over the packet the Army dispensed to the RAB, he noticed that it was missing key

government documents. In Yelenick's own words: "They did some serious editing." The proposal never got off the ground.[245]

While the relationship between Yelenick and the Army grew tense, the EPA did not offer any good news to the concerned locals. In February 1997, the EPA advised the greater Denver community that the off-post DIMP plume would continue to exceed a concentration of 8ppm, the state's legal limit, until "at least the year 2005." Furthermore, it told Coloradans that outside of the few treatment plants near the Arsenal, there would be no additional means to treat the plume.[246] Natural dilution over time seemed to be the government's solution to the off-post DIMP problem.

Because working within the RAB's power structure failed to alter the course of remediation, concerned community members wrote to federal authorities in Washington D.C. in the spring and summer of 1997 hoping to find someone who would heed them. Letters made their way to the EPA Administrator, the National EPA Ombudsman, and the Vice President of the United States, Albert Gore.[247] Yelenick's letter to Gore, dated June 11, 1997, is particularly insightful. In it, Yelenick touched on the heart of the tension between the RAB's community contingent and the RVO. He wrote that while community members were outraged that the RODs and RVO allowed DIMP less than 8ppb to concentrate in their drinking water, "they lacked scientific evidence of effect and force of law." The RVO was not responsive to the locals' concerns because of DIMP's ambiguity and the fact that the RAB lacked legal power. Still, Yelenick hoped to persuade the Vice President that "dilution is not an acceptable solution." Along with

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[245] Ibid.
[246] John J. Yelenick to Vice President Albert Gore, 11 June 1997, Site Database Number 2240-1, Document Number 00002794, JARDF.
[247] Sandra Jaquith to Kevin Blose and Laura Williams, 23 March 1998, SITE Database Number 3116-1, Document Number 00007234, JARDF.

pleading with the Vice President on behalf of the health and wellbeing of Denverites, Yelenick wrote that DIMP threatened a much wider area than the plume reached. "Having migrated beyond all present treatment facilities and dumping into the South Platte River," DIMP endangered "the $1.9 billion dollars of annual farm production distributed throughout the country." By couching DIMP as an "interstate" problem, Yelenick hoped to solicit a response from Gore and perhaps procure a more thorough remediation of the region.[248]

When the Vice President failed to respond to the letter, Yelenick and a few other community members formed the RAB DIMP Subcommittee. By gathering in a specialized unit, the environmentalists hoped that they could alter the power structure of the RAB and more effectively alter the current course of DIMP remediation. On December 4, 1997, the Subcommittee tendered its initial report and suggestions to the greater RAB. However, as Yelenick later claimed, this report was purposefully "deleted from the minutes by the Army."[249] The tension between the Army representatives and the locals on the DIMP Subcommittee gave way to volatility in early months of 1998. After leaving the February meeting, the community members of the DIMP Subcommittee reported that they were "treated in an abusive and disrespectful manner." Responding to this mistreatment, on March 23, 1998, the members of the Subcommittee tendered their resignation. "We are not willing to meet under these conditions," one local wrote, "nor with people who come to a discussion without the intent to discuss

[248] John J. Yelenick to Vice President Albert Gore.
[249] John J. Yelenick, "John J. Yelenick RAB Position Paper on Various Chemicals," 5 October 1999, SITE Database Number 10529-9, Document Number 00031226, 11, JARDF.

issues in an open-minded and constructive manner."[250] The DIMP Subcommittee died mere months after it began, failing to increase the extent of remediation.

Later that year, Yelenick's term as the co-chairperson of the RAB ended. Even though he did not convince the RVO to change the trajectory of remediation, he still had the thanks and recognition of the community. During the final month of his tenure, the *Commerce City Beacon* published an article titled, "Yelenick's Legacy—DIMP Information." In it, the paper recognized Yelenick for bringing the public's attention to the DIMP plume and attempting to persuade the RVO to tend to it more aggressively. The paper also interviewed Yelenick's five children about their father. When the reporter asked six-year-old Sophia what her dad does, she proudly declared: "he fights the government!" Thirteen-year-old Katherine shared that her dad was "making sure that no more chemicals get into the groundwater." Jacob, fifteen, provided a more nuanced answer: "all he's trying to do is to get the government to clean up their best before it becomes a bigger problem for everyone in the area." While the seventeen-year-old Jonathon did not have much to share with the reporter, his younger brother Josh did. Doctors diagnosed Josh with diabetes when he was six years old. With no family history of diabetes to blame, Josh, then fourteen, told the paper that his parents connected his condition with drinking the contaminated well-water. "I've spent more than half my life dealing with what the government put out in our water," Josh shared. "They can't say it is not having any affect, because it is."[251] Because he believed that DIMP directly harmed his son, Yelenick did not stop his fight when his term as RAB co-chairperson ended. He continued to gather information, make public presentations,

[250] Sandra Jaquith to Kevin Blose and Laura Williams.
[251] Riste Capps, "Yelenick's Legacy—DIMP Information," *Commerce City Beacon,* 2 December 1998.

and privately test wells north of the Arsenal. However, he had moved on from trying to engage with the RVO to bring about change. And so, despite the concerns of community members, the trajectory of remediation remained the same. Natural dilution over time remained the solution to off-post DIMP pollution.

Two years later, an unfortunate discovery at the Rocky Mountain Arsenal would give Yelenick and concerned citizens another opportunity to try to change the course of remediation. On Monday, October 16, 2000, while children were visiting the Rocky Mountain Arsenal on a school fieldtrip, remediation crews found a live M139 bomblet on site. Workers uncovered the grapefruit-sized munition from a pile of scrap metal in "the Boneyard," a northern region of the Arsenal that previous remediation planners believed to be free of "agent or unexploded ordnance."[252] Manufactured in 1969, the M139 was an explosive device that contained sarin gas. Sarin is a colorless, odorless, tasteless nerve gas that inhibits the junction between the human nervous system and the muscles.[253] When sarin vaporizes and saturates the air it can kill a person within minutes after one deep breath. Although the process is relatively quick, the stages of poisoning are horrendous. After first inhaling the gas, the victim's vision becomes

[252] "Army Safely Destroys Third of Four Bomblets," *Commerce City Beacon,* 25 July 2001; fieldtrip: Sandra A. Horrocks to area principals, 22 November 2002, SITE Database Number 10614-1, Document Number 00031435, JARDF; boneyard, agent, and unexploded ordnance: "Summary and Evaluation of Potential Ordnance/Explosive and Recovered Chemical Warfare Material Hazards at Rocky Mountain Arsenal," 24 January 2002, SITE Database Number 8667-4, Document Number 00026846, JARDF.

[253] Nerve agents often get confused with other types of chemical weapons. As described by the U.S. military, nerve agents are "Agents which, when absorbed into the body by inhalation, by ingestion, or through the skin, affect bodily functions by reacting in an irreversible reaction involving tissue fluids, permitting accumulation of acetylcholine and continual stimulation of the parasympathetic nervous system, as well as affecting other parts of the autonomic nervous system. The passage of nerve impulses is interfered with, thus disturbing essential bodily functions such as vision, breathing, and muscular control." See Departments of the Army and the Air Force, *Technical Manual: Military Chemistry and Chemical Agents, Army Technical Manual Number TM 3-215, Air Force Technical Manual Number AFM 355-7* (December 1963), Database Number 504571, Document Number B6300015, 5, JARDF; For the document that dates the M139 see "Questions and Answers for General Coburn and MG Doesburg," 30 November 2000, SITE Database Number 7236-3, Document Number 00022349, 1, JARDF.

blurry. This is followed by chest pains, poor coordination, and choking. Finally, the weapon inhibits the nerves that coordinate the heart and lungs, killing the victim.[254] Although they could not say with certainty how the weapon found its way into the Boneyard, Army officials surmised that it rolled off an assembly line unnoticed and into the pile of scrap decades ago.[255]

Upon discovering the bomblet, remediation workers at the Arsenal immediately secured the device by constructing a "Large Area Maintenance Shelter" around the scrap pile and slowly informed the public of the bomblet's discovery.[256] Notably, Arsenal officials did not direct the school field-trippers to evacuate the grounds.[257] Following protocol, Arsenal officials later that night notified the RAB that they found an "anomaly" on site. On Thursday evening, over seventy-two hours after the bomblet was found, the Arsenal informed congressional staffers that the "munition potentially contained [a] nerve agent." Finally on Friday, October 20, Arsenal officials held a press conference and divulged the discovery to the public.[258]

The bomblet's discovery drew the attention of the EPA. Its National Ombudsman, Robert Martin, traveled to Denver on November 7, 2000. Although the bomblet did not pose an immediate threat to anyone beyond the Arsenal's boundaries, Coloradans nevertheless flooded the community meeting hosted by Martin.[259] Many of them connected the Arsenal to their families' numerous illnesses and tried to convince

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[254] "Dangerous as A-Bomb," *Denver Post*, 20 March 1954.
[255] Theo Stein, "What More Lurks at Arsenal?" *Denver Post*, 3 December 2000.
[256] Rocky Mountain Arsenal Remediation Venture Office, *Milestones*, Spring 2001, SITE Database Number 7806-9, Document Number 00024313, JARDF.
[257] Sandra A. Horrocks to area principals.
[258] "Questions and Answers for General Coburn and MG Doesburg," 30 November 2000.
[259] General John Coburn, the Commander of the U.S. Army Material Command, also hosted a question and answer meeting in regards to the Rocky Mountain Arsenal on 30 November 2000. See "Questions and Answers for General Coburn and MG Doesburg," 30 November 2000.

the ombudsman to help them alter the course of remediation. Annette Biggs of Commerce City claimed, for example, that living less than two blocks away from the Arsenal ruined the health of her family members. After years of drinking from their well and watering their vegetable garden out of it, both of Biggs's parents developed diabetes. She claimed that this water also poisoned her two sisters. As she told the ombudsman, each of them required hysterectomies "at an early age" because of cervical and endometrial cancer. With no family history of diabetes or cancer to blame, Biggs deduced that the Arsenal must have been the source of her family's medical problems. Another Commerce City resident, Mary Light, requested that the Army monitor the health of Coloradans living in the suburbs near the Arsenal. She related that in 1994 her son died from lymphoma and that her "son had a stillborn son with a wife who grew up eight blocks from the Arsenal." Further adding to her suspicion that the Arsenal caused these medical horrors, Light cited that five other people in her neighborhood suffered from cancer. Former Henderson resident Royace Broynam shared a similar story. She and her family drank the groundwater, and ate vegetables from their garden and fish from the pond behind their home. Years later, doctors diagnosed her with brain tumor.[260] While these residents could not scientifically prove that the Arsenal, or its contaminants, caused their families' illnesses, they refused to believe that their medical problems were terrible coincidences. They hoped that by sharing their personal histories they could convince Martin to act on their behalf.

Despite these comments, other Coloradoans still regarded the Arsenal as a safe place. Two members of the RAB, Reba Drotar and Kathy Teter, said that they had lived

[260] Riste Capps, "Discovery of Sarin Bomblets at Rocky Mountain Arsenal makes the Point that Many Dangers and Unresolved Problems May Remain," *Commerce City Beacon,* 16 November 2000.

near the Arsenal for many years, in Commerce City, and were quite pleased with the remediation efforts. As the *Commerce City Beacon* recorded, "[Drotar and Teter] told the ombudsman and the Army that they and their families are healthy, no health problems, what's the fuss?" Commerce City Councilman Roland Cole also believed that the Arsenal was safe. Perhaps wanting to ease the fears of his constituents, Cole shared that he had no problem with letting his grandchildren play in the western portion of the Arsenal's grounds.[261]

Changes in the Arsenal's identity perhaps contributed to these more positive perceptions. The sign outside of the Arsenal now read "Wildlife Refuge." Deer, prairie dogs, coyotes, and other wildlife lived on the land. Humans have a long history of using animals to determine the safety of environments. Earlier in Colorado's history, when coal reigned king, miners on the Front Range looked to mice, not canaries, to determine the safety of their mine shafts. If a mouse grew lethargic or lost consciousness, it indicated to the miners that high levels of carbon monoxide saturated the air. If a mouse suddenly ran out of a shaft at top speed, it meant that the roof overhead was about to come down. But, if a mouse scampered through the shaft untroubled, then the miners judged the area safe.[262] Later in the 1960s, workers at the Rocky Mountain Arsenal used canaries and rabbits to determine if the sarin was leaking from its containers.[263] In a similar manner, some Coloradans perhaps viewed the presence of animals at the Rocky Mountain Arsenal as a sign of the area's safety.

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[261] Ibid.
[262] Thomas G. Andrews, *Killing for Coal: America's Deadliest Labor War* (Harvard University Press, 2008), 130.
[263] Cal Queal, "The Many Secrets of Rocky Mountain Arsenal," *Empire Magazine*, 13 April 1969.

But wildlife's attendance at the Arsenal did not convince Samantha Capps of the environment's safety. As a fifth-generation Coloradan, Capps had a large network of family and friends on the Front Range. She feared that Coloradans from around the state would go to the Arsenal in search of outdoor recreation and would enter the area uninformed of the dangers that potentially dwelled there. Many of her friends and family, Capps knew, did not keep up with the Denver newspapers, did not watch Denver television, and were not aware of the Arsenal's toxic legacy. In her comments to the ombudsman, Capps shared her concern that the Army, Shell, and the Fish and Wildlife Service used the presence of wildlife at the Arsenal to shape public opinion on the area's health. She claimed that these three organizations purposefully portrayed the animals as healthy in order to demonstrate to Coloradans that the land was safe. However, this depiction, according to Capps, was contrary to the findings of other biologists who recorded that the animals at the Arsenal exhibited abnormal behavior. Moreover, the animals' bodies contained pesticide and nerve agent residues. To ensure the safety of both human and animal life, Capps suggested to the ombudsman that biologists needed to be included in the remediation efforts "because they will require an adequate cleanup for the sake of the animals."[264]

John Yelenick seized the opportunity to make his case to the ombudsman that the course of DIMP remediation needed to be changed. He gave the ombudsman, and the audience, a thorough presentation on DIMP's toxicity and the plume's reach. He also used the data gathered at the RVO's water treatment plants to demonstrate that while the RVO treated 1.3 billion gallons of groundwater per year, it was failing to treat approximately the remaining 429 million gallons of groundwater in the area. Yelenick

[264] Capps, "Discovery of Sarin Bomblets."

told the ombudsman that when he shared this information with the RVO in hopes of changing the trajectory of remediation, he was "silenced" and "kicked off the RAB." In addition to his longtime DIMP concerns, Yelenick addressed another instance of military-induced groundwater contamination in the Denver area. According to recent local news broadcasts, reporters found "high levels of cancer-causing agents" flowing north from the old Lowry Air Force Base located southeast of the city. This too, according to Yelenick, needed to be treated.[265]

Finally, the 2000 RAB community co-chairperson, Lee Kaley, told the ombudsman that the RVO was not responsive to the RAB's concerns. Formerly an outspoken supporter of the RVO and critic of John Yelenick, Kaley became disillusioned with the remediation process after taking a more prominent role in the RAB following Yelenick's resignation. He began his address to the ombudsman by first thanking and apologizing to Yelenick and the other community members who he had criticized in the past. After becoming co-chairperson, Kaley explained, his relationship with the RVO grew tense. He alleged that the Army purposefully edited the transcripts of the RAB meetings to diminish the issues that he raised. Kaley's chief concern was that the remediation process at the Rock Mountain Arsenal constituted environmental injustice. Kaley resided in Montbello, a predominantly African-American and Hispanic neighborhood located directly south of the Arsenal. When he and other citizens of Montbello learned that the Army planned to dispose of the bomblet by exploding it on site, they went into an uproar. Kaley went so far as to claim that the Army's purposed

[265] Bob Thompson, "EPA Ombudsman Gets Mostly Environmental (F)earful from V/L ocal Citizens," *Commerce City Beacon*, 8 November 2000.

plan treated him and the other residents of Montbello "like experimental rats."[266] He later told the *Denver Post* that the EPA was the only agency in which he still had confidence. The RAB's community contingent had grown complacent after years of something akin to Pavlovian behavior modification. The Army, Kaley explained, "spoon-fed you pablum" and, "if you question some of their policies, they try to shut you down."[267] Recognizing that the RAB was a sham, Kaley hoped that the EPA's ombudsman would champion the concerns of the community.

As ombudsman, however, Robert Martin could only make recommendations to the EPA's administration. He could not directly order the EPA to take any sort of action, let alone alter remediation at the Rocky Mountain Arsenal. Martin expressed some sympathy with the local residents, but other matters dominated his career in the early 2000s. Martin, a member of the Makah Tribe of the Olympic Peninsula, was known as "the government watchdog who rides herd" on the EPA.[268] On the lookout for corruption, in 2002, he questioned whether EPA Administrator Christine Todd Whitman's ties to Citigroup and Travelers Insurance Company influenced her actions towards the Shattuck plant, another Superfund site in the Denver area that had connections to both corporations.[269] He also calculated that Citigroup stood to gain financially in cleaning-up the World Trade Center debris if the EPA minimized the

[266] Capps, "Discovery of Sarin Bomblets."
[267] Stein, "What More Lurks at Arsenal?" 3 December 2000.
[268] Robert McClure and Paul Shukovsky, "Watchdog Quits EPA: Silenced, He Says," *Seattle Post-Intelligencer,* 22 April 2002, http://www.seattlepi.com/news/article/Watchdog-quits-EPA-Silenced-he-says-1085783.php.
[269] Robert McClure, "EPA Chief Denies Conflict-of-Interest Allegations," *Seattle Post-Intelligencer,* 25 April 2002, http://www.seattlepi.com/news/article/EPA-chief-denies-conflict-of-interest-allegations-1086106.php.

dangers the dust posed to New York City residents.[270] After Martin accused Whitman of directing the EPA with conflicted interests, he resigned from the agency in protest. As a result, Martin failed to champion the Coloradans who wanted the RVO to adopt a more-thorough off-post remediation process.[271]

Two days after Martin's meeting with the frustrated community members, remediation workers at the Arsenal unearthed two additional sarin bomblets from the Boneyard. A week later, they found another two live bomblets. On November 19, one more bomblet was found, along with "three halves of a bomblet," bringing the total to six and one-half active bomblets.[272] Like the bomblet uncovered in October, according to the Army's records, these devices should not have been in the pile of scrap metal.[273] To destroy the bomblets, technicians placed them in an airtight machine that ignited them and then used a chemical bath to neutralize the poison.[274] After the destruction of the bomblets, workers resumed their investigation of the Boneyard. On June 15, 2001, they found four more live sarin bomblets among the scrap.[275] Technicians destroyed the last of these bomblets on July 27, 2001, and finished their search of the notorious scrap pile.[276]

To ensure it was not caught off-guard again by lingering ordnance, the Army conducted a series of aerial photographs over the land. Reviewing the collection of

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[270] Robert McClure, "EPA Chief Cleared of Wrongdoing in Cleanup Projects," *Seattle Post-Intelligencer,* 16 July 2002, http://www.seattlepi.com/news/article/EPA-chief-cleared-of-wrongdoing-in-cleanup-1091427.php.
[271] McClure and Shukovsky, "Watchdog Quits EPA: Silenced, He Says," *Seattle Post-Intelligencer,* 22 April 2002.
[272] "Bomblet Incident Timeline 16 October-28 November," 28 November, 2000, SITE Database Number 7236-6, Document Number 00022352, JARDF.
[273]"Summary and Evaluation of Potential Ordnance/Explosive and Recovered Chemical Warfare Material Hazards at Rocky Mountain Arsenal," 24 January 2002.
[274] Frank Bell, "Sarin Bomblets Destroyed at Former Area Arsenal," *Aurora Sun Sentinel*, 2 August 2001.
[275] Commerce City Beacon, "Army Safely Destroys Third of Four Bomblets."
[276] Frank Bell, "Sarin Bomblets Destroyed at Former Area Arsenal," 2 August 2001.

photographs yielded over 2,600 "anomalies." Consulting its records, the Army accounted for approximately 2,130 of the "anomalies" and eliminated them as potential hazards. With respect to 370 of the remaining "anomalies," the Army assured residents, it had already known about them and had scheduled them for future remediation. The final 170 "anomalies" should not have existed. The military had no "historical documentation or other existing information" regarding their presence. To investigate, the Army sent workers into the field to make visual observations, excavations, and exploratory trenches at each of the 170 locations. After concluding of this search and reviewing historical documents, the Army expanded its remediation project to include six new sites where they identified the existence of either munitions debris, ordinance and explosives, or a combination of the two.[277] Despite the fact that the discovery of these 170 anomalies demonstrated that the RVO's detailed on-post remediation plan was not thorough enough, the RVO did not alter its comparatively-light off-post remediation policy.

As parcels of the land completed the remediation process, the Army transferred them to the Department of the Interior. In 2004, the Army transferred 4,930 acres. In 2006, it transferred an additional 7,226 acres.[278] Under the auspices of the U.S. Fish and Wildlife Service, sections of the land became available for public use. Visitors could spend the afternoon walking on the Arsenal's trails, enjoy picnic lunches, peruse the exhibits at the visitor center, and fish Lake Mary and Lake Ladora. 1,150 anglers held permits to fish at the Arsenal in 2004 alone. The Fish and Wildlife Service also

[277] "Summary and Evaluation of Potential Ordnance/Explosive and Recovered Chemical Warfare Material Hazards at Rocky Mountain Arsenal," 24 January 2002.
[278] Rachael Salcido, "The Rocky Mountain Arsenal National Wildlife Refuge: On a Rocky Road to Creating a Community Asset," *The John Marshall Law Review* 47, issue 4 (summer 2014): 1409.

collaborated with nearby hospitals to provide activities for the chronically ill. Patients from Children's Hospital Colorado fished at the Refuge once a month from May to September 2004. In May and June, patients from Craig Hospital also fished at the Arsenal.[279] Other public events at the Arsenal included autumn hayrides, guided bike rides, photography tours, and educational programs. Birdwatching was also very popular.[280] With printed checklists and binoculars in hand, visitors attempted to spot each of the 273 birds that traveled to the Arsenal throughout the year.[281]

Figure 10: One of the recreational trails leading to Lake Ladora in 2015. Photograph by the author.

[279] U.S. Department of the Interior, U.S. Fish and Wildlife Service, *Rocky Mountain Arsenal National Wildlife Refuge Annual Narrative Report, Fiscal Year 2004,* 79, SITE Database Number 15629-1, Document Number 00043774, JARDF.
[280] Rocky Mountain Arsenal Remediation Venture Office, *Wild News*, October-December 2008, SITE Database Number 20554-1, Document Number 00054191, JARDF.
[281] U.S. Department of the Interior, U.S. Fish and Wildlife Service, *Rocky Mountain Arsenal National Wildlife Refuge Bird List*, http://www.fws.gov/uploadedFiles/RMA_BirdList_Web%20%282%29.pdf.

As remediation neared its supposed completion, the U.S. Fish and Wildlife Service reintroduced the American Bison to the Rocky Mountain Arsenal in 2007 as part of a larger effort to conserve and protect bison within the National Wildlife Refuge System. The reintroduction allowed the Service to "monitor and evaluate the effects bison have on native short-grass prairie ecology."[282] Bison, the Service explained:

> were historically an integral component of the North American prairie ecosystem. Migrating bison provided essential functions, such as grazing and other disturbances that, together with fire, drove key ecological processes on the prairie. The decimation of the historic bison herds across the continent in the late 19th century removed this component from the prairie ecosystem. As the Service works to restore and conserve prairie habitats throughout the National Wildlife Refuge System, the agency has identified wild bison as a species that can and will play a vital role in this effort.[283]

In other words, the sixteen bison that the Service transferred to the Arsenal primarily served an ecological purpose. The Service needed bison to keep the prairie from becoming woodland.[284]

On March 17, 2007, a crowd of some 100 Coloradans lined a fence to watch the bison return to the Arsenal's prairie. "It's a homecoming!" proclaimed one Fish and Wildlife official. As the *Denver Post* put it, the bison's relocation to the Arsenal "marked both a beginning and an end." After nearly two decades of remediation, and $1.3 billion, the project was nearing its completion. The Arsenal was becoming the Refuge. "How often can we say we have gone from weapons to wildlife, bullets to

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[282] U.S. Department of the Interior, U.S. Fish and Wildlife Service, "News Release: U.S. Fish and Wildlife Service to Establish Pilot Bison Project at Rocky Mountain Arsenal National Wildlife Refuge," 9 January 2007, Site Database Number 15947-4, Document Number 00044782, JARDF.
[283] Ibid.; For a history of the collapse of the bison population on the Great Plains see Andrew C. Isenberg, *The Destruction of the Bison: An Environmental History, 1750-1920* (Cambridge University Press, 2001).
[284] For the history of the role fire played in maintaining prairie ecology see Julie Courtwright, *Prairie Fire: A Great Plains History* (University Press of Kansas, 2011); The Fish and Wildlife Service also used prescribed burns to maintain the prairie. See April Schildmeyer, "Prescribed Burn at Rocky Mountain Arsenal to Produce Heavy Smoke on Sunday," Denver 7 ABC News, 13 March 2016, http://www.thedenverchannel.com/news/front-range/commerce-city/prescribed-burn-at-rocky-mountain-arsenal-to-produce-heavy-smoke-on-Sunday.

bison?" asked the Deputy Director of the Fish and Wildlife Service. "When you're putting back what is the keystone species, it really takes the Rocky Mountain Arsenal full circle." When the trailer doors opened, the bison cautiously exited and made their way west across the prairie. Lee Plenty Wolf, a member of the Oglala Lakota, added to the ceremony's symbolism when he provided a traditional blessing and sang an honor song while beating a drum made of bison hide.[285]

Figure 11: American Bison blocking the roadway at the Rocky Mountain Arsenal National Wildlife Refuge in 2015. Since their reintroduction in 2007, the herd has grown over time due to natural increase. Photograph by the author.

In 2010 the RVO declared remediation complete. A year later, the RAB dissolved.[286] And while many Coloradans journeyed onto the Refuge for fun and

[285] Jeremy P. Meyer, "Bullets to Bison at Wildlife Refuge," *Denver Post,* 18 March 2007; "Bison Arrive at Rocky Mountain Wildlife Refuge," *Commerce City Beacon,* 21 March 2007.
[286] U.S. Congress, *Congressional Record* 157, 112th Cong., 1st sess., (November 2, 2011): E1981.

relaxation, a few still worried about what lurked underfoot. When I met with John Yelenick and a few other members of the old RAB in the summer of 2015, they shared with me that their view of the Arsenal had not changed over the years. To them, the RVO still had not done enough to clean the land, especially in regards to DIMP. In the end, the remediation of the Rocky Mountain Arsenal is not a story of community members working with the federal government to restore the land. The Army, Shell, and the U.S. Fish and Wildlife Service coopted local environmentalists and ignored their concerns. The military-industrial complex continued to dominate the land after the Cold War, albeit under a façade of community collaboration.

Conclusion

The U.S. military and its large corporate partners have long histories in the American West. On one hand, they brought economic prosperity to the region. On the other hand, they dominated and inadvertently degraded the region's environs. The history of the Rocky Mountain Arsenal is a story about people and businesses, all with good intentions, building the means to improve their livelihoods, reap economic prosperity, and protect themselves and their fellow citizens in an era of heightened international tensions. In pursuit of economic and national security, however, they transformed a location they valued for its safety—farmland ten miles northeast of Denver—into a toxic landscape. In short: this environment became a casualty of war. Moreover, the military-industrial complex's domination of this land did not stop with the end of the Cold War. The remediation of the Rocky Mountain Arsenal revealed the military's refusal to cede control of this environment. The complex—as manifested by the Remediation Venture Office (RVO)—remained unresponsive to many local concerns and undermined residents' efforts to shape the course of remediation. Instead, the RVO coopted the clean-up agenda and contained concerned residents and local environmentalists by providing them with a monthly forum and the façade of collaboration.

We know that the Arsenal's wares and waste destroyed cities around the globe, poisoned wildlife, generated seismic activity, and contaminated groundwater, but much of the Arsenal's history remains shrouded in secrecy. For example, information on how the chemicals and weapons at the Arsenal affected the bodies of the people who worked there both during the Cold War and the site's remediation remains scarce. Department

of Defense secrecy and the protection of medical records under the Health Insurance Portability and Accountability Act of 1996 (HIPPA) keeps labor's story hidden

Even though the Department of Defense and HIPPA keeps information on worker health confidential, we do know that Arsenal workers encountered sarin gas while on the job. Sarin was one of the many chemical weapons manufactured at the Rocky Mountain Arsenal during the Cold War. Similar to some pesticides that Shell manufactured at the Arsenal, sarin is an organophosphate. It works by disrupting the nervous system, specifically by blocking cholinesterase from interacting with acetylcholine. This creates an acetylcholine build-up, which causes convulsions and, in certain cases, death.[287]

In its 1969 investigation of the Rocky Mountain Arsenal, the *Denver Post*'s weekly magazine—*Empire*—interviewed Dr. Maurice Gaon, the chief medical officer at the Rocky Mountain Arsenal, about worker health. Gaon explained the measures the Arsenal had in place to monitor the wellbeing of its workforce. Arsenal physicians gave every employee physical exams when they were first employed and when they were terminated. Additionally, physicians monitored the health of laborers who worked "in dangerous areas," such as on the sarin production line. This process included sampling and analyzing body tissues. As noted earlier, canary and rabbit cages were also located in dangerous areas of the Arsenal. The idea behind this measure was that workers could watch the health of the animals and, if they observed their mortality, workers would flee the area knowing that a dangerous leak was present. Doctors at the Arsenal also paid close attention to workers' faces. Eye pupil dilation and runny noses were two common

[287] James Hamblin, "What Does Sarin Do to People?" *The Atlantic,* 6 May 2013, http://www.theatlantic.com/health/archive/2013/05/what-does-sarin-do-to-people/275577/

symptoms of acute sarin poisoning. Gaon also revealed to *Empire* that Arsenal workers did encounter sarin while on the job. "There [were] many hundreds of cases," Gaon related, "where we administered [sarin] antidotes." However, he also reassured the public that exposure to low doses of sarin did not produce "any lasting or residual effects." Along with interviewing Gaon, *Empire* chronicled one serious case of nerve gas poisoning at the Arsenal. In 1963, a worker inhaled "some nerve gas that spilled accidentally in a storage area." Reacting quickly, the Army quickly transported him to the nearby Fitzsimons Army Hospital. There he remained in critical condition for twenty-four hours as doctors used "all the skills of medical science" to save his life.[288]

During his tenure at the Arsenal, Gaon produced an undated "Agent Fact Sheet." These four sheets of paper documented what chemical weapons the Army produced at the Arsenal, their characteristics and effects, as well as guidelines for how to treat exposure. This document reveals that the Army understood the risks associated with manufacturing sarin. "Some personnel," Gaon recorded, "will be exposed to [sarin] through failure to don [their] mask rapidly, through damaged or improperly worn or cared for masks and through failure of the warning system to alert all personnel in the involved area."[289] Whether via employee error or technological failure, employee exposure was unfortunate, but expected to some degree. It was a permitted risk.[290]

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[288] Cal Queal, "The Many Secrets of Rocky Mountain Arsenal," *Empire*, 13 April 1969.
[289] Maurice D. Gaon, "Agent Fact Sheet," Database Number 513019-1, Document Number G0000344, JARDF.
[290] For a study of another permissible risk—human exposure to nuclear fallout in the Great Basin—see Leisl Carr Childers, *The Size of the Risk: Histories of Multiple Use in the Great Basin* (Norman: University of Oklahoma Press, 2015); Michelle Turk's examination of occupational health in southern Nevada's public works, defense, and resort industries also demonstrates how "workplace injuries and fatalities became an accepted risk" in some federally-funded projects, such as the Hoover Dam, as well as defense businesses, such as Basic Magnesium. See Michelle Ann Turk, "Gambling with Lives: A History of Occupational Health in Southern Nevada, 1905-2010." (dissertation, University of Nevada, Las Vegas, 2011), iii.

One worker who suffered from sarin exposure, Ray Laughbridge, offered his story to *Denver* magazine in 1976. Twenty-one years earlier, the Chemical Corps hired Laughbridge, a veteran of World War II and the Korean War, to join the line of technicians that manufactured sarin gas at the Rocky Mountain Arsenal. Before taking the position, Laughbridge and his co-workers all swore an "oath of silence" that prevented them from disclosing what their job entailed or what the Army manufactured at the Arsenal.[291] Laughbridge abided by his promise to remain silent throughout his employment at the Arsenal, even after his five exposures to sarin gas.

Consistent with the story Gaon provided to *Empire*, Laughbridge told *Denver* that doctors treated him with shots of atropine—a drug known for alleviating symptoms associated with organophosphate exposure—after each of his sarin exposures. Following this treatment, the Army sent Laughbridge to see Dr. Joseph Holmes of Colorado General, the medical school at the University of Colorado. There, Holmes conducted electroencephalogram (EEG) tests on him to monitor how his brain responded to the chemical weapon. While this thesis was unable to uncover copies of these test results, Laughbridge did provide an excerpt of his medical records to *Denver*. According to this excerpt, in 1957 Holmes recorded that Laughbridge's test results suggested "a mild brain disturbance most marked in the frontal and central regions." However, Holmes never shared this information with Laughbridge. Holmes told reporters that it was not his job to inform Laughbridge or other Arsenal workers of the results of their examinations. "They just came out here for the tests," Holmes related in an interview, "It wasn't our duty here to tell them anything."[292]

[291] Douglas C. DiMarco, "Code of Silence Broken," *Denver,* September 1976, 34.
[292] Ibid., 36-37.

After each examination, Holmes and the other doctors working at the medical school forwarded Laughbridge's results to Gaon. However, Gaon was not officially Laughbridge's treating physician. Rather, he was in charge of monitoring employee health. While Gaon was concerned about Laughbridge's short-term health, he was confident that mild sarin exposure did not have any long-term effects. Still, Laughbridge insisted that his body was changing. While employed at the Arsenal, Laughbridge later said, he felt a general "loosening" of his muscles. This loosening caused him frequently lose his balance and stumble. Laughbridge also claimed that sarin exposure deteriorated his mental faculties. He told *Denver* that while he worked at the Arsenal he slowly became more forgetful over time. When he reported these symptoms to Army doctors, they reassured him that sarin was not to blame.[293]

Laughbridge claimed that the secrecy of sarin production necessitated that the Army discreetly treated and monitored the health of its employees. To prevent suspicion and panic when workers fell ill, the Chemical Corps set up hospital beds at the Arsenal for employees to rest on during work days. When employees were too ill to drive to work, the Chemical Corps sent ambulances to ferry them to and from the Arsenal. Once there, the Army assigned impaired workers light duties and allowed them to read comic books and relax when they felt too ill to work. According to Laughbridge, some workers were so impaired from sarin exposure that the Army let them read comic books for an entire work day. To keep sick workers who insisted on leaving the Arsenal complacent, the Army drove them around the area for hours on end until their

[293] Ibid., 61, 34.

symptoms let up. These methods allowed the Arsenal to limit their record of lost time accidents and keep the production of sarin out of the public's eye.[294]

Despite the Army's emphasis on secrecy, Holmes published at least one study documenting the effects of sarin gas on human health. In 1969, Holmes coauthored an article for the *Annals of the New York Academy of Sciences* with David Metcalf. In it, Holmes and Metcalf investigate how exposure to organophosphates, such as sarin, altered electrical activity in the human brain. To do this, Metcalf and Holmes examined EEG records and conducted sleep studies on workers from the Rocky Mountain Arsenal. Their findings suggested that exposure to sarin could lead to chronic EEG changes. These EEG changes manifested themselves in a variety of symptoms, such as chronic drowsiness, narcolepsy, disturbed memory, and difficulty remaining focused. Metcalf and Holmes concluded their article by hypothesizing that long-term exposure to sarin could "induce irreversible or only slowly reversible brain dysfunction."[295]

It is reasonable to deduce that a 1979 article coauthored by Maurice Gaon also stemmed from information he gathered by studying the health of employees at the Rocky Mountain Arsenal. Similar to the Metcalf and Holmes study, Gaon's article examined the long-term effects of sarin exposure to the human electroencephalogram. For this study, Gaon and his coauthors examined "seventy-seven industrial workers with histories of accidental exposure to sarin."[296] While the authors did not specifically state that their subjects were laborers from the Rocky Mountain Arsenal, the fact that

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[294] Ibid., 61-62.

[295] Although the body of the article does not specifically mention the Rocky Mountain Arsenal, Metcalf and Holmes do list it as the source of their data in Table 1. See David R. Metcalf and Joseph H. Holmes, "EEG, Psychological, and Neurological Alterations in Humans with Organophosphorus Exposure," *Annals of the New York Academy of Sciences* (June 23, 1969): 359, 363, 365.

[296] Frank H. Duffy, James L. Burchfiel, Peter H. Bartels, Maurice Gaon, and Van M. Sim, "Long-Term Effects of an Organophosphate upon the Human Electroencephalogram," *Toxicology and Applied Pharmacology* 47 (1979): 162.

Gaon co-authored the piece while he worked at the Arsenal along with the fact that the Arsenal was one of three U.S. military installations that produced sarin, suggests that the exposed laborers might have worked at the Arsenal.[297] Even if the data the authors gathered from this study came from another military base, such as Edgewood Arsenal in Maryland, the results of the study nevertheless undercut Laughbridge's assertion that sarin caused his muscles to deteriorate over time.

To uncover the long-term effects of sarin poisoning, Gaon and his coauthors compared EEGs taken from people that had a history of exposure to sarin with EEGs of thirty-eight other "industrial workers from the same plant." After careful analysis, the authors concluded that exposure to organophosphates, such as sarin, "can produce long-term changes in brain function." The study also revealed that it was not possible to diagnose workers based on their individual EEGs. The changes in brain activity were subtle, consisting of increased beta activity, increased delta and theta slowing, decreased alpha activity, and increased amount of rapid eye movement sleep. It was only through large statistical comparison that the scientists uncovered that victims of sarin exposure had abnormal electrical activity in their brains. Furthermore, these changes in brain function did not manifest themselves in terrible symptoms. At most, the authors noted that these neurophysiological changes might be related to abnormal behavior or moods.[298] The EEG tests did not indicate that organophosphate exposure caused muscles or minds to deteriorate over time.

The military and scientific organizations agree that mild sarin exposure does not cause long-term muscle or brain declension. According to data compiled by the Office

[297] The two other military installations that manufactured sarin were Edgewood Arsenal in Maryland and Pine Bluff Arsenal in Arkansas. See DiMarco, "Code of Silence Broken," 36.
[298] Duffy et al., "Long-Term Effects," 161, 175.

of the Secretary of Defense, sarin exposure might cause long-term behavioral and psychological effects, but there is no evidence that suggests mild sarin exposure causes long-term muscle or brain deterioration.[299] The Centers for Disease Control and Prevention's appraisal of sarin's long-term health effects is telling in its brevity: "Mildly exposed people usually recover completely. Severely exposed people are less likely to survive."[300] Indeed, sarin causes mortality in large doses but does not drastically alter human health in small doses.

Despite sarin's scientific toxicological profile, Laughbridge insisted that exposure to the weapon caused his mind and his body to deteriorate over time. Other workers supposedly had similar experiences. *Denver* magazine reported that Joseph Romero experienced a general "fuzziness" all over after his first exposure to sarin. Over time, this fuzziness gave way to muscle deterioration. Romero lost control of his legs and had to rely on a wheelchair. Before his death, Romero insisted that the Arsenal was to blame for his failing health. Undercutting the power of this testimony, *Denver* fails to mention where they got Romero's story from. However, the magazine does mention that Romero and Ray Laughbridge were good friends. [301] Therefore, it is reasonable to assume that Laughbridge supplied Romero's story to the magazine.

After Romero died, his wife Anna joined with Laughbridge and three other former Arsenal employees to file a $23 million lawsuit against Gaon and the University of Colorado Board of Regents. The widow and the former workers claimed that the Arsenal's chief medical officer and the medical school failed to explain the long-term

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[299] Office of the Secretary of Defense, "Appendix B—Hazard Identification," http://www.gulflink.osd.mil/khamisiyah_tech/kham_tech_s17.htm#appb2cChronicEffects.
[300] Centers for Disease Control and Prevention, *Facts About Sarin,* www.bt.cdc.gov/agent/sarin/basics/facts.asp
[301] DiMarco,"Code of Silence Broken," 34.

risks of sarin exposure and therefore were liable. On October 24, 1981, two days before the case went to trial, the two sides settled out of court for an undisclosed amount. The *Denver Post* article that documented the settlement did not mention any admission of liability.[302] Furthermore, it is worth noting that most settlements of this nature do not involve any admissions of liability. While the settlement might have eased Laughbridge's financial problems, it did not stop his health from declining. Ray Laughbridge died seven years after the settlement[303]

Even without access to his medical records, it is highly unlikely that sarin caused Ray Laughbridge's health to deteriorate over time. Sarin's toxicological profile simply does not support such an allegation. But just because science exonerates sarin does not mean that the entirety of the Arsenal's chemical cache is free from scrutiny. Perhaps exposure to another chemical or weapon caused Laughbridge's mind and body to deteriorate. To uncover this, future historians would have to circumvent the military's culture of secrecy and health insurance law to obtain Laughbridge's medical records.

We do know, however, that the Rocky Mountain Arsenal's wares and waste destroyed foreign cities, poisoned animals, induced earthquakes, and contaminated the groundwater. The military-industrial complex in Denver, Colorado, produced both economic prosperity and environmental change. Environmental change came in the form of both declension and remediation. In both polluting the land and cleaning it up, the military-industrial complex demonstrated the extent of its control over the environment.

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[302] John Toohey, "CU Regents Settle in Arsenal Suit," *Denver Post,* 24 October 1981.
[303] "United States Social Security Death Index." Database. *FamilySearch.* http://FamilySearch.org: accessed 2016. Citing U.S. Social Security Administration, *Death Master File,* database (Alexandria, Virginia: National Technical Information Service, ongoing).

The Rocky Mountain Arsenal's history is important in and of itself, but more importantly, it speaks to issues of national significance. The Rocky Mountain Arsenal was a significant part of the military-industrial complex's ecological footprint in the American West. Like Hanford, the Rocky Mountain Arsenal was just one cog in the military-industrial machine. Historians have yet to produce a comprehensive analysis of the military-industrial complex and environmental change in the American West. Such a study would perhaps examine Hanford, the Nevada Test Site, Dugway Proving Grounds, and the Rocky Mountain Arsenal side-by-side. It might take the lesson offered in this thesis and expand it across the West. In producing warfare and national security, the military-industrial complex harmed the American landscape.

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