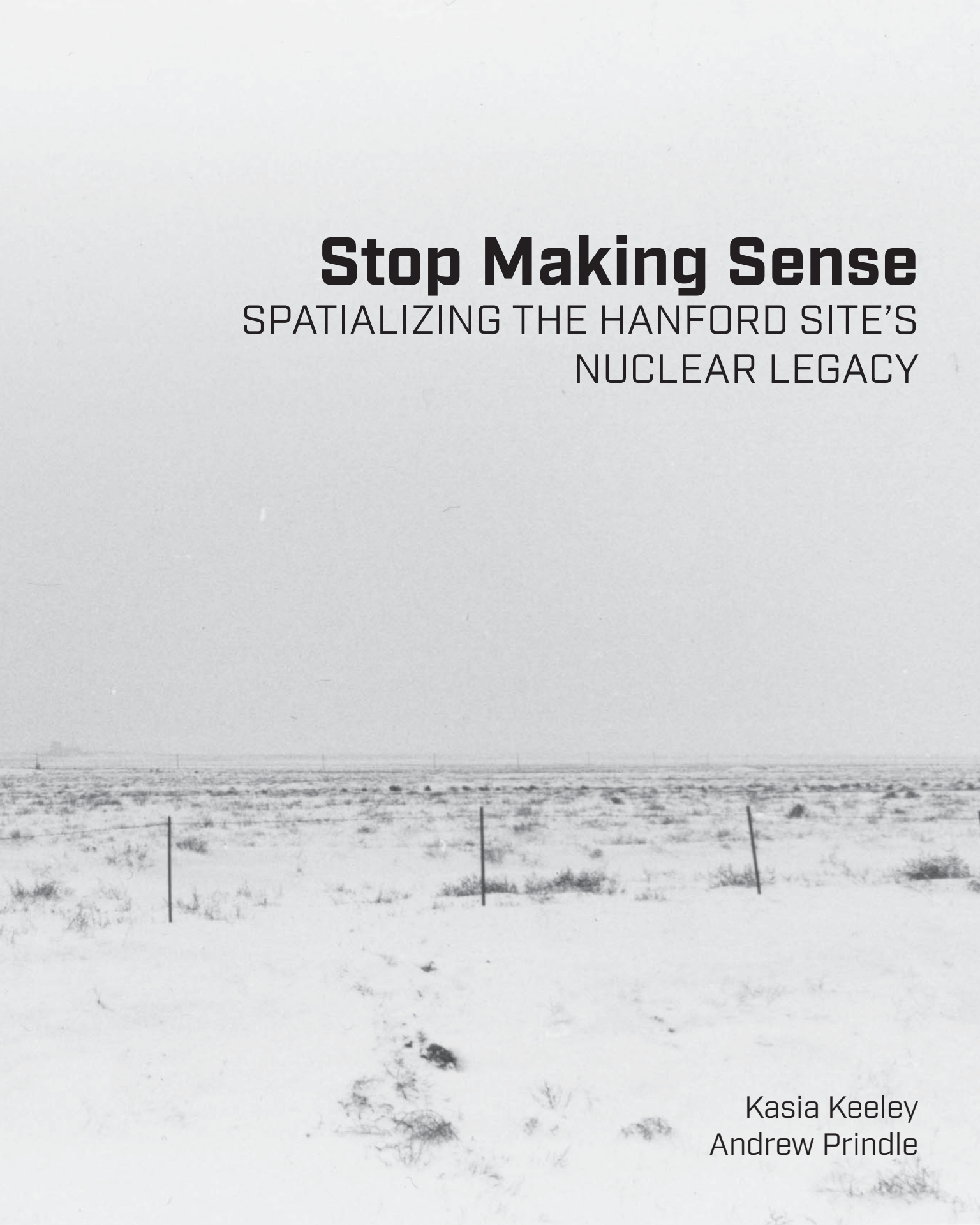
Stop Making Sense

SPATIALIZING THE HANFORD SITE'S NUCLEAR LEGACY



Kasia Keeley
Andrew Prindle

VERY SPECIAL THANKS

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FORWARD:
THE PRODUCTION OF NUCLEAR POWER

Nuclear waste presents a critical challenge to humanity. Since the Manhattan Project was initiated in 1942, the conjoined efforts of the Department of Energy (DOE) and Department of Defense (DOD) have produced and managed expansive nuclear energy and weapon systems. In course of this production of power, hundreds of active and inactive nuclear energy plants have come into existence across the United States and, subsequently, the world. Nine nations are able to produce nuclear weapons, with a total global arsenal representing approximately 15,000 warheads[1] with a destructive capacity capable of rendering Earth uninhabitable. Often referred to as the global suicide machine, the Earth's nuclear networks also provide essential scientific resources and power to millions of homes.

The industrialization of atomic energy for nuclear weapons has produced an unimaginable quantity of irradiated toxic waste products with no universal protocol or procedures for effectively containing this waste for the course of its 300,000 year lifespan. The decisions we make in this generation of how to steward and articulate our nuclear heritage will have consequences for countless ensuing generations. It is critical that landscape architecture use its practices to inject a more robust understanding of the material, ecological, and cultural consequences of military nuclear waste. The challenge of dealing with our current volume of waste means both technical and design solutions will need to be realized. This is particularly true as climate change accelerates and nuclear energy becomes an increasingly attractive carbon neutral option. While nuclear energy plants produce less waste that is less toxic, it requires long-term stewarding of waste. The urgency of the issue is further amplified by current geopolitical struggles as tensions flair amongst nuclear nations, particularly amongst Iran, North Korea, Pakistan, India, Russia, and the United States.

The state of Washington's role in nuclear power is significant: the Hanford Nuclear Reservation is the birthplace of nuclear energy and weaponization, it is also the world's most expensive environmental cleanup project, and host to the Environmental Resource Disposal Facility – the landfill containing irradiated soils, structures, and materials from plutonium production. Hanford is located in southeast Washington state, just outside the Tri-Cities region of Richland, Pasco, and Kennewick. The Columbia River cuts through the site, shortly before it turns west and the Snake River joins it, creating a major portion of the border between Washington and Oregon. The site is 586 square miles of shrub-steppe desert ecosystem[2] consisting of a National Monument, science laboratories, cleanup efforts, and home to two-thirds of the United State's high-level nuclear waste[3].

Hanford was selected as a key site in the Manhattan Project in 1943 and was dramatically reconfigured for plutonium production and continued its production throughout the Cold War[4], contributing heavily to the US's nuclear arsenal. As war pressures mounted, the site eventually became home to a total of nine reactors, however "starting in the mid 60's through 1971, the older reactors were shut down leaving only N Reactor operating on the Site. N Reactor continued its mission of producing plutonium and electricity until 1987"[5]. The DOE remains in charge of the site and its cleanup by overseeing a sprawling network of government and private contractors and science organizations[6]. In 1989, the DOE, US Environmental Protect Agency,

1 Schmidt , Kiersten, and Bill Marsh. "Which Countries Have Nuclear Weapons and How Big Their Arsenals Are." The New York Times. December 23, 2016. Accessed January 02, 2017. https://www.nytimes.com/interactive/2016/12/23/world/nuclear-weapon-countries.html?_r=0.

2 Department of Energy. "Hanford History." http://www.hanford.gov/page.cfm/HanfordHistory. Accessed June 1, 2017.

3 Harden, Blaine, and Dan Morgan. "Debate Intensifies on Nuclear Waste Lawmakers in Affected States Press Bush Administration on Cleanup." The Washington Post. June 2, 2004. Accessed February 15, 2017. http://www.washingtonpost.com/wp-dyn/articles/A7951-2004Jun1.html.

4 Department of Energy. "Hanford History."

5 Ibid.

6 This includes Pacific Northwest National Laboratory (PNNL) and the Laser Interferometer Gravitational-Wave Observatory (LIGO). PNNL is dedicated to a vast array of science work, including nuclear non-proliferation work. LIGO is a physics facility dedicated to gravitational wave detection and works with other international facilities.

and the Washington State Department of Ecology signed the Tri-Party Agreement that marked the site's official transition from a site of production to one of cleanup[7].

Rendering waste a purely technical problem disables broader public awareness of how landscapes are used in partnership with securing and storing nuclear waste and the domestic consequences of nuclear production, particularly at defense sites. The design language of landscape can push beyond typical heritage narratives that conceal the waste narrative of nuclear landscapes, and, instead, reveal prototypical waste storage methods that previously disguised the DOE and DOD's nuclear waste behind secure borders and rendered it invisible through underground storage methods. Through a critical approach to examining Hanford's role in initiating the nuclear age and its current role as a storage site for nuclear waste, we propose a design intervention that illustrates the scale and scope of Hanford's tangible and intangible nuclear heritage.

7 Department of Energy. "Hanford History."

OUR APPROACH TO NUCLEAR WASTE AT HANFORD

The industrial production of weaponized nuclear materials was developed as quickly as possible as a means to issue the final blow of World War II. The Hanford Nuclear Reservation is home to the first successful industrial scale factory for fissile plutonium that was used to create nuclear weapons, including for the first detonation at the Trinity Site and the 'Fat Man' bomb dropped over Nagasaki. The factories, machines, and infrastructure at Hanford were expanded and kept in operation from 1944 – 1989, helping to produce the vast inventory of nuclear weaponry for the Cold War.

A critical consequence of nuclear weapons production is the waste and irradiated by-products. The immense pressure to produce weapons during war time, combined with little knowledge of how radiation and radioactive wastes interact with landscapes, has created a unique geography at Hanford. The purpose of Hanford's nuclear territory has transitioned from production, to clean-up and environmental reclamation. These transitions have involved material choreographies, political designations, and massive amounts of money and technology to try to represent Hanford's landscape as a clean and palatable landscape.

Addressing the fallout of Hanford's machinic production has revealed parallels to its period of production – primarily that it is a technical problem to be solved through engineering. The relative exclusion of other disciplines,



SAFETY ADVISORY BOARDS

Saftey signals are located along public roadways managed by the DOE..

particularly design from toxic military sites, reflects how access is controlled: physical access is rigorously policed and official narratives are carefully curated. The site is understood as a technical problem requiring technical solutions and outside perspectives are frequently viewed as a hindrance[1]. While this is partly due to security concerns and toxic exposure, it also allows Hanford to orchestrate narratives that conform to the interests of the Department of Energy and National Park System. Opportunities to engage in alternative viewpoints or to challenge the narrative of a successful ongoing clean-up are limited and risk narrowing our nuclear legacy to the technical and patriotic.

Taking Hanford as a site of investigation, we aim to explore possibilities for fostering relationships with our nuclear legacy, explore what the nuclear age can tell us about the operationalization and consequences of territories of war and how ecological thinking might change and respond to these conditions. Our work utilizes environmental philosophy, geography, preservation and heritage studies, and the Land Art movement to engage with Hanford. Through a combined approach of surveying how nuclear power's influence and how military nuclear clean-up projects we seek to provoke new thinking regarding our relationship to toxic wastes and their landscapes.

1 Harden, Blaine. 1996. *A River Lost: The Life and Death of the Columbia*. New York, NY: W.W. Norton & Company. (pp. 167-169) While at a conference in Richland titled, Atomic Legacies – 75 Years Since the Manhattan Project, we encountered this sort of experience where there appeared to be a line between outsiders and local engineers and scientists. This was not universal, but these strains can be felt in how the narratives of the site are portrayed by official tour guides, DOE materials, and the work of critical scholars – particularly those of the humanities and social sciences.


Environmental Excellence
HANFORD
Welcome to Hanford
U. S. Department of Energy
WHERE SAFETY COMES FIRST
ONLY
ONLY

WELCOME TO HANFORD: THE SHAPING OF A NUCLEAR POLITICAL LANDSCAPE

ROADSIDE SIGN ENTERING HANFORD SITE
2017.

While the United States was initially reticent to engage in World War II, the 1941 attack on Pearl Harbor prompted Franklin D. Roosevelt to formally enter the country in the war. Combined with the threat of WWII spilling across the Atlantic and the looming possibility of Axis powers becoming capable of constructing nuclear weapons, Roosevelt ordered "the construction of industrial plants to produce uranium-235 and plutonium-239 to be used in creating nuclear weapons"[1].

The industrial production of nuclear weapons was initially developed to issue the final blow of World War II – however the factory units, infrastructure, knowledge networks, and supply chains were sustained for decades afterward to produce the vast inventory of nuclear weaponry called for during the Cold War. The Cold War's logic of "mutually assured destruction" involved a consistent escalation of arms as science continued to work with the atom, elevating destructive power from purely nuclear, to thermonuclear, and ultimately to hydrogen bombs. The gamesmanship of the Cold War between the US and Russia propelled the creation of a nuclear weapons network, known as the Triad. The Triad allowed nuclear weapons to be deployed from fixed land based ICBM sites, strategic stealth bombers, and submarines[2] outfitted with nuclear warheads. The efficacy of the Triad relied not just on the logistical and scientific prowess of the Department of Defense (DOD) but the strategic availability of ports, rail, and highway systems and scientists. Hanford's reactors were heavily used to produce these weapons, contributing roughly 65% to the US nuclear arsenal[3].

Hanford and the Manhattan Project's production sites were chosen because their landscapes were ideal for situating their roles in nuclear production[4]. In return, these sites have profoundly impacted their local geographies: the unprecedented organization required to build whole towns, factory systems, and laboratories required incredible investment and reconfiguration of terrain. Furthermore, at Hanford, plutonium production rendered much of the landscape toxic due to the unfettered and voluminous production of nuclear waste. Over the course of decades of operations, Hanford became "the most contaminated nuclear landscape in the United States (home to) more than two-thirds of the U.S. high-level nuclear waste inventory" and "the largest and most expensive environmental remediation project in human history"[5].

The Department of Energy's (DOE) efforts to "clean-up" the Hanford site's waste is effectively, a series of iterative attempts at containing the effects on water, soil, animals, and humans on both micro and macro scales. These effects are both within the boundaries of Hanford and well beyond. Without the proven ability to contain the byproducts of nuclear armament, Hanford's "clean-up" is better characterized as suspended risk management

1 "Hanford Superfund Site History." EPA. Accessed February 02, 2017. https://yosemite.epa.gov

2 While the US Navy's submarine fleet's engines are powered by nuclear reactors (which when decommissioned are stored at Hanford), only Ohio class submarines carry nuclear tipped warheads. The Ohio class is the largest submarine class in the Navy. There are 14 active Ohio class submarines, capable of carrying approximately half of the US's nuclear arsenal. (Roblin, Sébastien. 21 January 2017. *The National Interest*. "Why Russia and China Fear America's Ohio-class Submarines." http://nationalinterest.org/blog/the-buzz/why-russia-china-fear-americas-ohio-class-submarines-19120?page=show. Accessed May 29, 2017.)

3 The Federation of American Scientists indicates 67.4 tons of plutonium with 54.5 tons of weapons grade plutonium and Westinghouse, under DOE contract, reported that 67 tons of plutonium was produced. The Seattle Times reported in 2017 that Hanford's plutonium made up 65% of the nuclear arsenal. (Federation of American Scientists. Plutonium: The First 50 Years: United States Plutonium Production, Acquisition, and Utilization from 1944 through 1994. "Plutonium Acquisitions, Section 9.1.1 Hanford Reactors." https://fas.org/sgp/othergov/doe/pu50y.html#ZZ0 Accessed: May 29, 2017. Roetman, V.E., Roblyer, S.P., Toffer, H. September 1994. Westinghouse Hanford Company. "Estimation of Plutonium in Hanford Site Waste Tanks Based on Historical Records." Geranios, Nicholas K. 10 January 2017. The Associated Press. "State's congressional delegation urges Trump to fund Hanford Work." Access via The Seattle Times, <http://www.seattletimes.com/seattle-news/politics/congressional-delegation-urges-trump-to-fund-hanford-work/> 31 May 2017.)

4 Landscapes and energy and water availability were key elements of selecting Manhattan Project sites creating intimate and often fraught relationships between processes of production and attending effects on human and natural ecologies around these sites. This was particularly true with Hanford and is well explained in: Harvey, David. *History of the Hanford Site: 1943-1990*. Richland, WA: Pacific Northwest National Laboratory.

5 Cram, Shannon. "Becoming Jane: The Making and Unmaking of Hanford's Nuclear Body." *Environment and Planning D: Society and Space* 33, no. 5 (2015): 796-812. (pp. 797)

with a continuous reorganization of irradiated material and toxic waste. Hanford's Environmental Restoration Disposal Facility (ERDF) is the site's most important element to the cleanup process. ERDF is effectively an ever-expanding burial site located within the Inner Central Plateau area of Hanford, and is one of the most highly concentrated sites of nuclear waste cleanup efforts in the world, rivaled only by the nuclear sites of Chernobyl and Fukushima.

Despite Hanford's pervasive toxicity, large expanses of the site originally set aside as security buffer between military operations and civilians, resulted in unintentional preservation of the largest intact shrub-steppe ecosystem, previously unknown plant species, and the last free flowing stretch of the Columbia River. As such, Hanford presents a strange paradox of conservation and toxification: seemingly wild and open yet also meticulously surveilled and irredeemably toxic.

While the DOE often presents Hanford as a resilient provider, the site has been deeply affected through secrecy, political designations, and reluctance towards embracing more complex site narratives. Hanford metabolized earthen and aquatic resources to produce a territory once ruthlessly dedicated to war time production, and is now dedicated to demonstrating a politically constrained narrative of environmental remediation. The juxtapositions of toxicity and wild, open space at Hanford allow an investigation into processes of territorialization, land use, and legibility that challenge dominant narratives and provoke new thinking about ecology and design.

HOW TO CHOOSE A NUCLEAR TERRITORY

When looking for a site conducive for aggressively upscaling atomic research, the Army Corps of Engineers saw Hanford as an ideal location with its "combination of remoteness, low population, large electricity supply, and access to water" as well as its connections to existing highway and rail infrastructure[6, 7]. The site was deemed a useful and disposable space whose environment contained stable terrain that was rich in aggregates for construction, especially appropriate for making concrete. With few people, abundant necessary materials, and a landscape not considered as being of any value, Hanford was well-suited for state-sanctioned territorialization to be used as a partner, or subjugate, for plutonium production. But Hanford's selection as a site would require significant reconfiguration of the landscape and its context.

The Hanford site's conversion from tribal land and small scale agriculture to fully functioning plutonium factory required the forced removal of 1,500 white residents, forced displacement of four Native American tribes, the construction of 554 buildings, 64 underground high-level waste tanks, numerous open pit disposal sites, 386 miles of road, 158 miles of railroad, 50 miles of electrical transmission lines, and the creation of the science and labor town of Richland, housing the more than 17,500 people necessary for the project's realization[8]. Worker camps were created to house more than 50,000 replete with recreation facilities[9]. The massive mobilization of people, resources, and technologies created infrastructure and a factory network at an astonishing rate with the bulk of the buildings up and running within just 13 months of construction, setting in motion what many might consider as the world's most dangerous assembly lines.

The Columbia River is a critical player in the Hanford landscape. It runs through Hanford for approximately 50 miles, and is the largest river in the American Northwest. The Columbia emerges in the Canadian Rocky Mountains and flows over 1,200 miles into the Pacific Ocean. With a drainage basin approximately the size of France, its tributaries cross seven states, a Canadian province, and 13 federally recognized Indian reservations. Once the home to some of the most ecologically and culturally important salmon runs in the northern hemisphere, the Columbia River is today much closer to a pipe than a wild river. With a total of 14 dams across the mainstem of the Columbia, the river is a vital freight and rail corridor trafficking produce, oil, fish, and trash. Each year over 1.5 trillion gallons of water are drawn from the river in Washington state alone to irrigate crops, orchards, and lawns[10]. We have put the river to work[11]: producing fish, irrigating fields, powering electrical grids, transporting goods, and for approximately four decades as an essential partner in the production of weaponized plutonium.

The river was critical to nuclear production; conversion of uranium ore into plutonium required the Columbia's cool temperatures and massive water flows to stabilize the radioactive material as quickly as possible and prevent

6 Bélanger, Pierre, and Alexander S. Arroyo. Ecologies of power: Countermapping the logistical landscapes and military geographies of the U.S. Department of Defense. Cambridge, MA: The MIT Press, 2016.

7 Environmental Protection Agency. "Hanford Superfund Site History." Region 10 – Pacific Northwest. Accessed February 02, 2017. https://yosemite.epa.gov

8 Ibid.

9 Ibid.

10 State of Washington Department of Ecology "Columbia River Facts and Maps." Accessed January 28, 2017. http://www.ecy.wa.gov/programs/wr/cwp/cwpfactmap.html.

11 White, Richard. *The Organic Machine: The Remaking of the Columbia River*. New York, NY: Hill and Wang, 2001. White's work is central to the idea of using ideas of work as the primary way we know nature – through the organization of infrastructure and labor to extract energy and resources.

COLUMBIA RIVER BASIN

1.5 TRILLION	GALLONS OF IRRIGATION
258,000	SQUARE MILES
12,935	TOTAL RIVER MILES
1,243	MAIN RIVER STEM MILES
44%	OF US HYDROPOWER
14	DAMS ON THE MAIN STEM
9	FORMER REACTOR SITES
1	ACTIVE NUCLEAR REACTOR



Columbia River

Columbia River

Snake River

CRB BOUNDARY

RIVER

DAM

HANFORD

05 25 0 100 150 200 miles

Sources: Esri, USGS, NOAA, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGGS, AeroGRID, IGN, GIS user Community, and Free Vector Maps.com

meltdown. Over 30,000 gallons of water were pumped into each reactor per minute during production[12]. After cooling freshly made plutonium pucks, water was sent to cooling ponds to reduce the water's temperature and allow for enough radioactive decay before being returned to the river. During the height of operations at Hanford, nine reactors extracted and dumped water from the Columbia to cool the plutonium. Now, the Columbia is a highly problematic factor in the ongoing risk-management operations; its contact with polluted soils and groundwater carries waste far beyond Hanford's boundaries. Leveraging the Columbia was essential for plutonium production but its ecosystem has suffered significantly because of it.

Likewise, the soil within Hanford's boundaries was of crucial importance to initial operations as well as a significant factor in the site's current cleanup protocol. When Hanford was initially sited, its geology was expected to provide the materials to build a plutonium factory site, and its soil was expected to be an ideal admixture to disperse and hold nuclear byproducts. The organic vitality afforded by the soils of Hanford made the territory seemingly ideal for siting a dangerous, toxic factory system for three reasons. The DOD and DOE recognized that creating a large factory system from scratch would require vast amounts of aggregates and the "local soil contained enough aggregate to make much of the needed concrete"[13]. The deep, aggregate rich soils also afforded the DOD and DOE the possibility to stably site large, heavy structures: "the engineers were pleased with the hardy ground"[14]. The third terrestrial reason Hanford was selected was that its rapid percolation rates and soil chemistry allowed scientists to presume that it was a "a nearly ideal environment for ground disposal of radioactive wastes"[15].

The perceived usability and expected resilience of Hanford's soil and water would become wildly complicated in ensuing years as scientists found high variation in soil makeup at surface and subsurface levels and a complex basalt layer that made tracking groundwater a Sysphean feat[16]. The irregular soil makeup meant the movement of toxic waste dumped into the soil was difficult to monitor and challenging to understand the extent of its dispersal.

Additional challenges and potential hazards have been discovered within the landscape at the Hanford site. Further subsurface dangers have been revealed by the United States Geologic Survey (USGS) and the Physicians

12 White, R. 2001. (pp. 83)
13 Gerber, M.S. On the Home Front: The Cold War Legacy of the Hanford Nuclear Site. Lincoln, NE (United States); Univ. of Nebraska Press, 1992. (pp. 146)
14 Ibid. Also see: U.S. Army Corps of Engineers, "Basic Data on Hanford Engineer Works, Pasco, Washington" Washington, D.C.: Office of the Chief of Engineers, May 19, 1943. (pp. 2)
15 Rouston, R.C. "A Review of Studies of Soil-Waste Relationship on the Hanford Reservation from 1944 to 1967," BNWL-1464 Richland, WA: Battelle Northwest Laboratories, March 1973.
16 Gerber, M.S. 1992. (pp. 148-150, 156-157, 162-163)



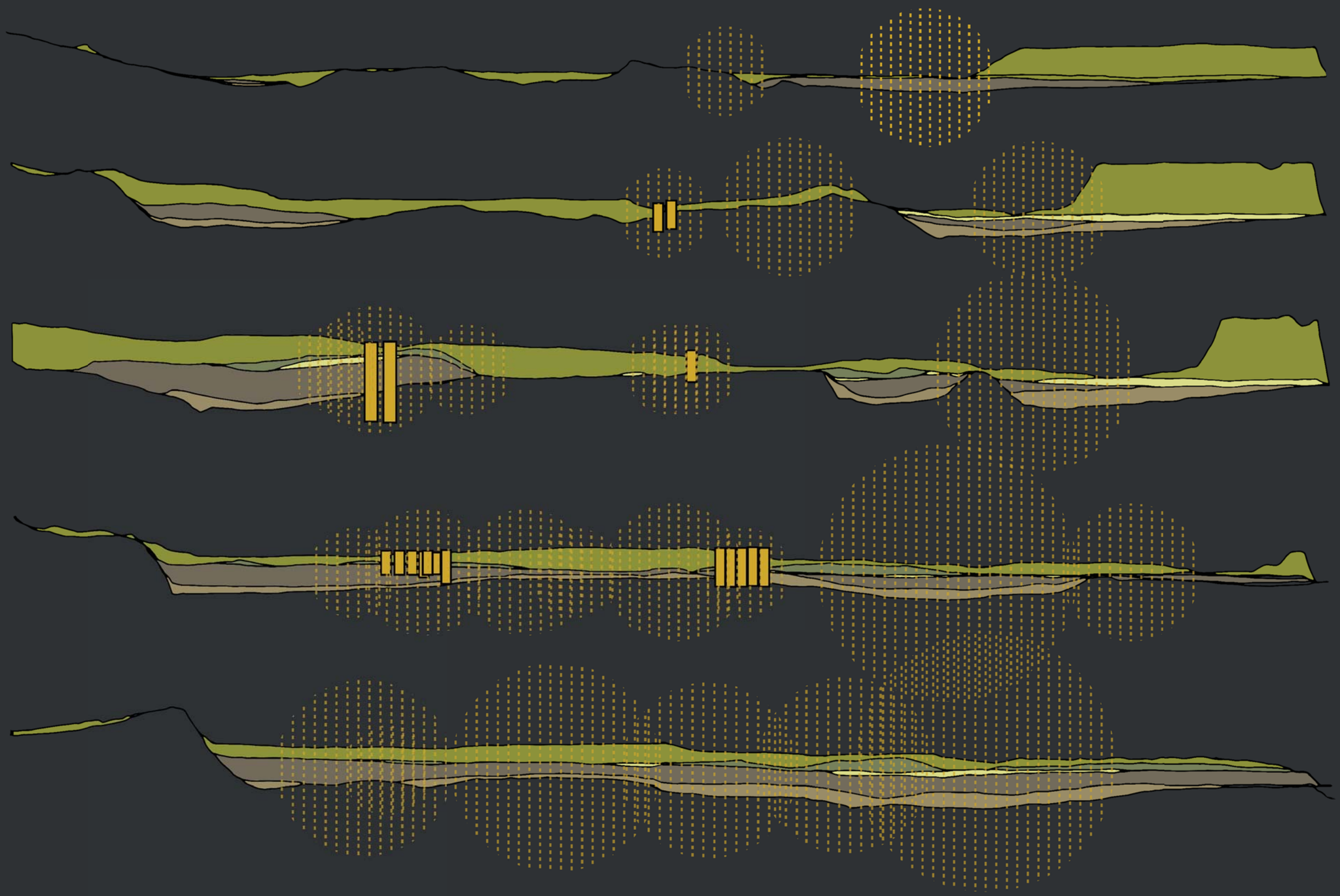
HANFORD SITE BORROW PIT
Aggregates are still extracted for use in infrastructure development and the cleanup process. 2017.

for Social Responsibility (PSR) - an advocacy and research group dedicated to public service regarding nuclear power, nuclear weapons, toxic chemicals, and climate change - have found 11 fault lines criss-crossing Hanford[17]. The site's potential for catastrophic disaster continues to evolve and reveals worrisome contingencies well beyond Hanford's official boundaries. The fault lines that run through the site have the potential to be connected to the Cascadian Subduction Zone, and one of these fault lines passes within 2.3 miles of the Columbia River Generating Station[18], an active nuclear power plant on the Hanford site. The presence of previously unknown fault lines presents problems for Hanford's buried waste tanks and ERDF, but serves as a significant risk should the fault lines breech the nearby Grand Coulee Dam. While these threats are ominous, they may not be immediately threatening. However, they will persist on a geologic scale comparable to the time Hanford's toxins will remain harmful – tens of thousands of years. As much as the site's soils and water were intimately and deeply needed, they would also be deeply impacted through the site's conversion to a nuclear territory.

17 Pearson, John, PhD. 2013 May 2. Rockville, MD. Nuclear Regulatory Commission. Testimony to Nuclear Regulatory Commission Petition Review Board - Petition to revoke GE Mark I & II operating licenses. Accessed: https://www.nrc.gov/docs/ML1314/ML13144A172.pdf
18 Doughton, Sandi. "Hanford nuke plant's earthquake risk underestimated, group says." The Seattle Times. November 01, 2013. Accessed April 15, 2016. http://www.seattletimes.com/seattle-news/hanford-nuke-plantrsquos-earthquake-risk-underestimated-group-says/. (p. 2)

STRATIGRAPHY OF THE CENTRAL PLATEAU REGION

(200-EAST AND 200-WEST)



- Hanford Soil
- Cold Creek
- Ringold Taylor Flats
- Ringold Unit E
- Ringold Lower Mud
- Wells
- Toxic Plume

WHAT HAPPENS TO NUCLEAR WASTE

When plutonium production began at Hanford in 1944, understanding of the threat and duration of nuclear byproducts was nascent and naive. Common waste disposal practices ranged from reverse wells – where contaminants were pumped directly into the ground – to tank encapsulation which was the in-ground burial of double-walled or single-walled tanks capable of holding up to 30,000 gallons of radioactive liquid and sludge materials. As a result of these and similar protocols, a substantial number of contaminants were let loose into the surrounding environment, moving across Hanford's landscape and beyond. During operation: 450 billion gallons of nuclear byproducts were dumped directly into the soil via trenches and cribs; 30,000 gallons of river water flowed through each reactor core per minute staying only several hours in cooling ponds before returning to the river, dangerously "hot" in terms of both temperature and radiation; 149 single-walled tanks and 28 double-walled tanks were constructed for holding a total of 56 million gallons of low to high-level nucleated sludge of which one-third have leaked (equivalent to 1 million gallons of waste directly into the ground)[19]; and there is still 60 square miles of contaminated groundwater across the site[20]. Author and historian Richard White's description of the dispersal and danger of Hanford's nuclear waste reveals the unfortunate ineptitude with which the production byproducts were handled:

> "These materials, so poorly understood, highlighted the limits of science's understanding of the natural world of the Columbia... And all of these things mattered deeply because large releases (of radionuclides) in the earth, air and water - some accidental, some under the rush of production, some as experiments - made that earth, air and water toxic."[21]

19 Department of Energy. *Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site,* Richland, 2012. (pp.13); Brown, Kate. *Plutopia: nuclear families, atomic cities, and the great Soviet and American plutonium disasters.* Oxford: Oxford University Press, 2015. (pp. 62)
20 Department of Energy. *Hanford Site Cleanup Completion Framework*, Richland, 2013. (pp.x)
21 White, Richard. 1995. *The Organic Machine: The Remaking of the Columbia River.* Hill and Wang: New York, New York. (pp. 85-86)

Photo Credit (right page: top to bottom)

1 The Cascadia Courier. "Cleaning Up the Mess at Hanford." October 23, 2012. Accessed June 07, 2017. http://www.thecascadiacourier.com/2012/10/cleaning-up-mess-at-hanford.html.
2 United States Department of the Navy. "Naval Reactor Disposal Site, Trench 94 200 Area East Hanford." *Final Environmental Assessment on the Disposal of Decommissioned, Defueled Naval Reactor Plants from USS Enterprise (CVN 65)* August 2012.
3 Atomic Heritage Foundation. "Environmental Consequences." June 05, 2014. Accessed June 07, 2017. http://www.atomicheritage.org/history/environmental-consequences.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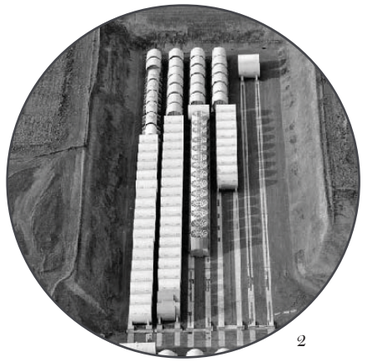
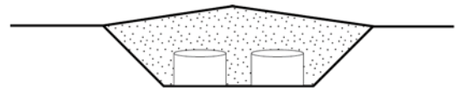
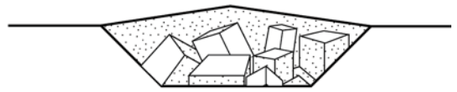
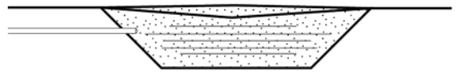

2

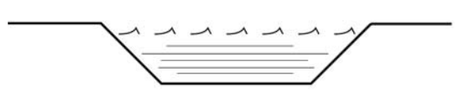

3

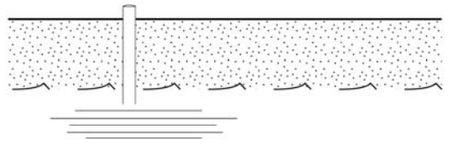
Burial Protocol
1942 - 1989

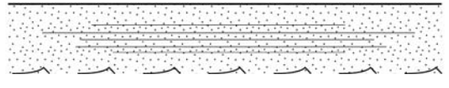

Tank Encapsulation


Burial Pit


Trench/Crib


Pond


Reverse Well


Accidental Release

U

Uranium

With a half-life of 4.5 billion years, Uranium presents one of the most severe challenges. Carcinogenic and dangerous to all life forms. Originally disposed in unlined trenches, it continues to move towards the Columbia.

Cr

Chromium

Originally used as an anti-corrosion agent in nuclear reactor cores, it is now upwelling in the Columbia River. Sustained exposure can affect: skin, liver, and gestation as well as the respiratory, gastrointestinal, and renal systems.

H_2

Tritium

Tritium is a unique form of radioactive water and is carcinogenic to humans, fish, and other species. Tritium was produced by ejecting reactor coolant water into open air pits and is currently the largest radionuclide plume covering 49 mi^2.

^{90}Sr

Strontium-90

Strontium is a radioactive waste product that lodges near blood forming marrow in humans and concentrates in fish tissue. Bioaccumulation risks remain unmeasured.

CCl_4

Carbon tetrachloride

As part of a suite of chemicals used to extract plutonium, c-tetrachloride is carcinogenic and covers over 4 mi^2 at levels unsafe for drinking water. C-tetrachloride will likely continue to affect the Columbia for next 100 years.

^{129}I

Iodine-129

Sustained exposure through ingestion or inhalation affects the thyroid, often resulting in cancer. With a half life of 15.7 million years and a 25 mi^2 plume, its capacity to affect the Columbia bio-region presents serious challenges.

^{99}T

Technetium-99

Tc-99 has a half-life of 211,000 years and high mobility and solubility in water. Able to bind to minerals, it can move through soil and bioaccumulate. Ingestion affects the blood stream, thyroid, bones, liver, and stomach.

$C_2H_3Cl_3$

Trichloroethane

A synthetic, non-carcinogenic toxin whose longevity in the environment is unknown. Inhalation is the most common exposure vector and causes nausea and fainting; sustained exposure can affect the liver, lungs, and nervous system.

Cr^{+6}

chromium

Hexavalent chromium is the most lethal form of chromium, capable of damaging the respiratory tract, eyes, and skin. Lung cancer is a particularly strong possibility when ingested or inhaled.

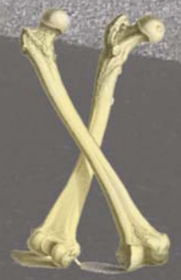
NO_3^-

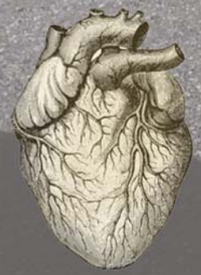
Nitrate

High levels of nitrate exposure can lead to “blue baby syndrome” and was initially diagnosed in 1945. Such exposure levels are most commonly reached through prolonged consumption of contaminated water.

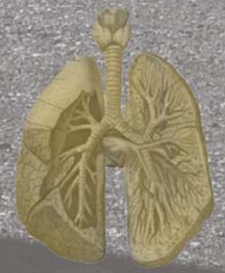


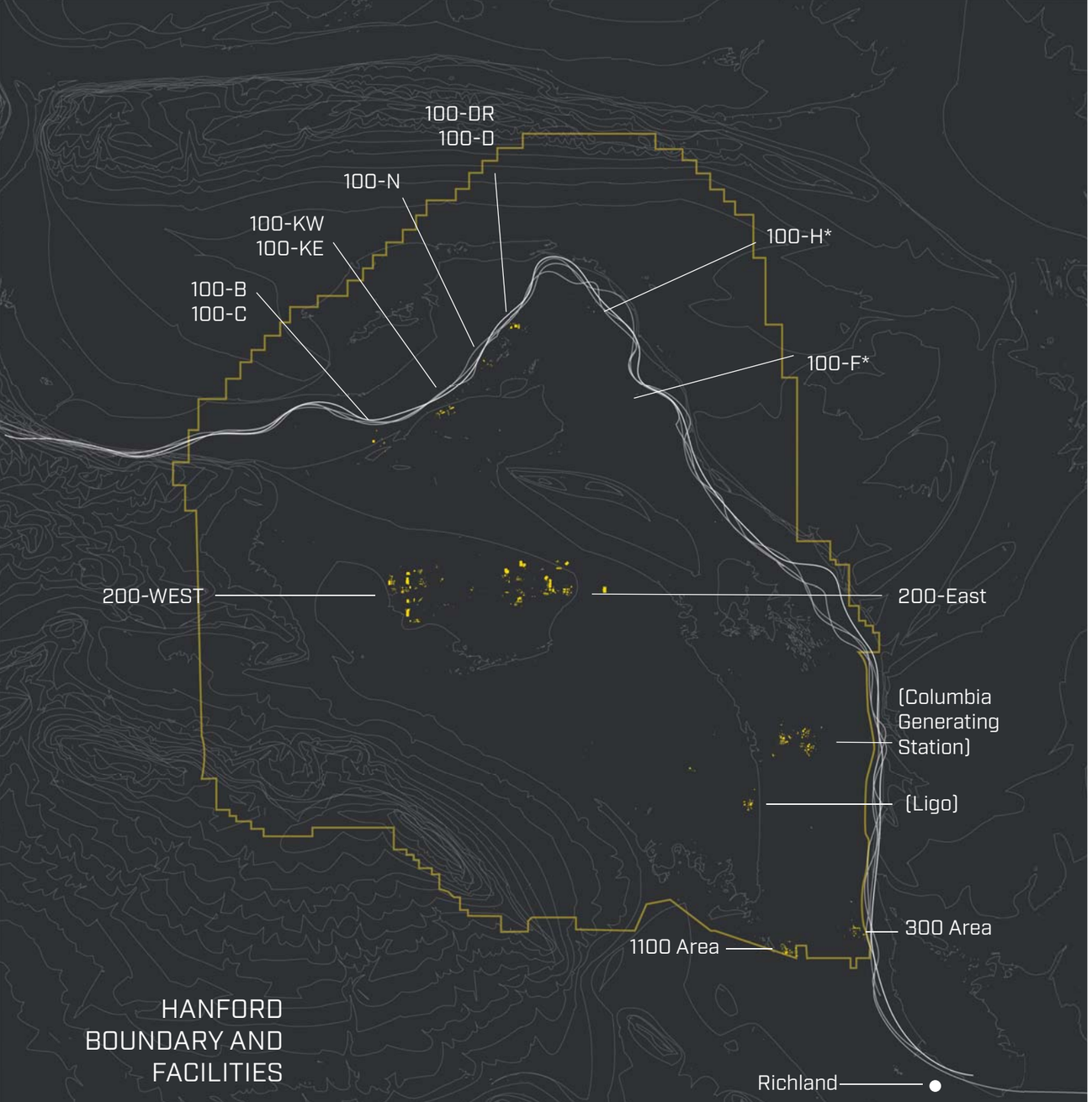








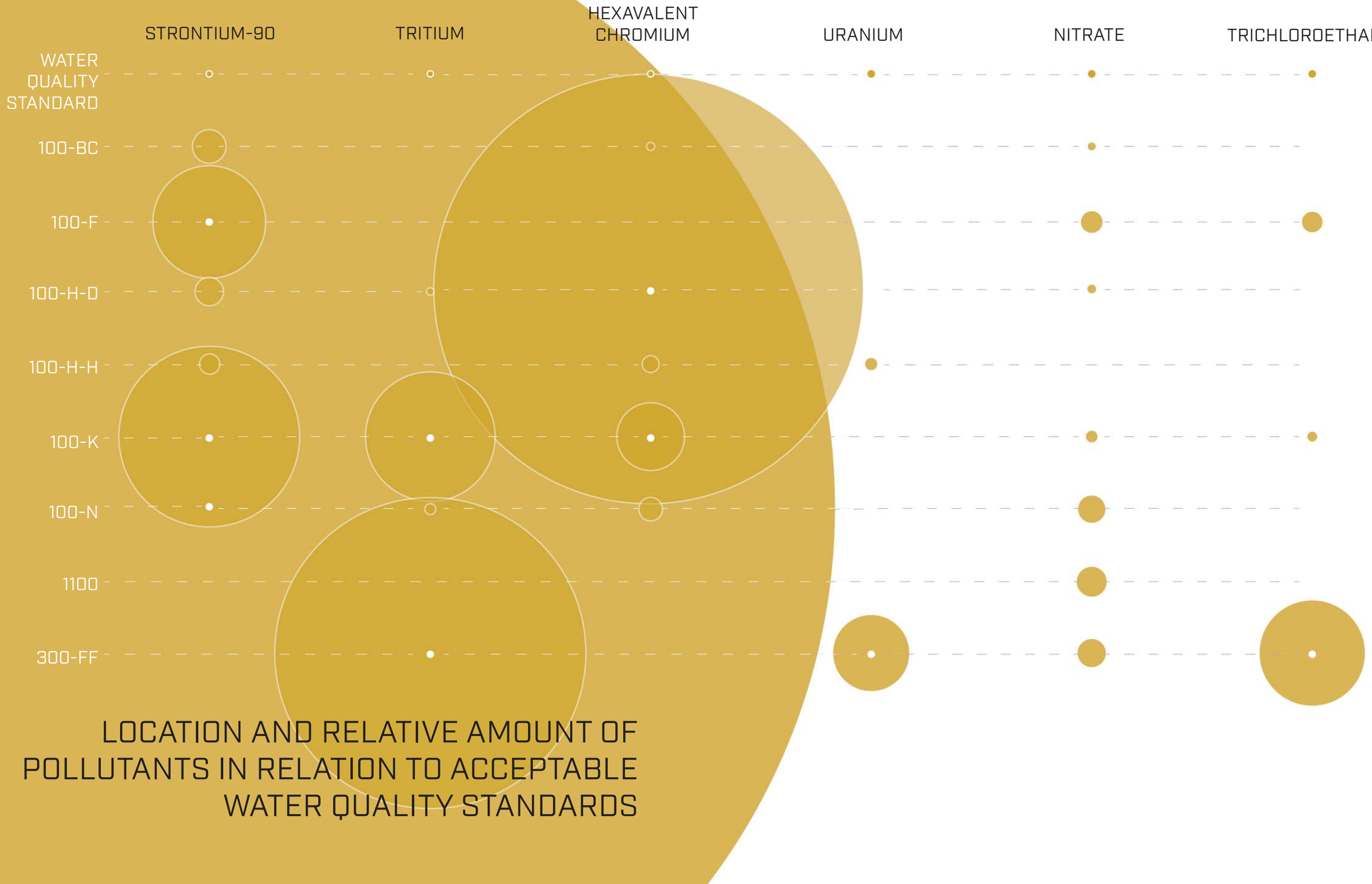




Further complicating matters, research conclusions reached by Manhattan Project scientists were isolated from one another to preserve confidentiality and mitigate public outcry. Lieutenant General Leslie Groves Jr, who directed the construction of Hanford, was an ardent believer in compartmentalization of duty to ensure security and secrecy. Groves called compartmentalization "the very heart of security" and that "each man should know everything he needed to know to do his job and nothing else"[22]. Michelle Gerber, a historian employed by the contractor Westinghouse at Hanford, quoted Colonel Matthias, who along with Groves helped direct Hanford's construction, as writing in his journal that secrecy and compartmentalization allowed a "method (where) we could retain control over the information submitted to and on file with the State"[23]. The legacy of Hanford's production created distinct material geographies conjoined with toxic legacies whose understanding is slowly being unraveled following decades of secrecy and misinformation. Research by government/citizen doctors and scientists over the following decades, particularly those after the DOE released previously sealed documentation about Hanford in 1986, revealed that "a particular radioactive geography was created by the intersection of weather, water, soils, plants, animals, markets, specific radionuclides, and our own bodies"[24].

Exposure to even low doses of radiation was understood even during the production era to cause "infertility, tumors, cataracts, cancer, genetic mutations, and general symptoms of premature aging and death" but the demands of WWII and the Cold War took precedence over concern for environmental and health risks posed by production[25]. Blaine Harden, journalist and author, found that workers at Hanford "have a long history of being misled about the risk of radiation in their workplace. The Atomic Energy Commission knew in 1947 that Hanford workers were exposed to "significant quantities" of radioactive particles, but it chose not to inform them, even as it secretly characterized the exposures as "a series health problem"[26]. This obfuscated the danger posed by radionuclides to human health and the environment[27]. Through increased research, scientists also began to understand that exposure to radiation was not just an immediate threat but something that could accrue danger. Studies of radiation's effect on the body done by the US on Japanese bomb victims found that while connections between exposure and illness could be made in

22 Groves, L. R. 1983. *Now It Can Be Told: The Story of the Manhattan Project.* New York, NY: DeCapo Press, Inc. (pp. 140)
23 Gerber, M.S. 1992. (pp. 49)
24 White, R. 2001. (pp. 86)
25 Ibid.; Brown, K. 2015. (pp. 52)
26 Harden, Blaine. 1996. *A River Lost: The Life and Death of the Columbia.* New York, New York: W.W. Norton & Company. (pp. 167)
27 Brown, K. 2015. (pp. 63)



LOCATION AND RELATIVE AMOUNT OF POLLUTANTS IN RELATION TO ACCEPTABLE WATER QUALITY STANDARDS



some cases, the sustained body burden of radiation presented a much thornier problem – "because the majority of radiation-induced mutations were likely recessive, they would not become evident for multiple generations"[28]. Thus, the impact of the release of radionuclides was as persistent within human bodies as within the environmental carriers creating an invisible nuclear legacy that continued to jeopardize safety long after initial exposures.

HOW TO MOVE FORWARD

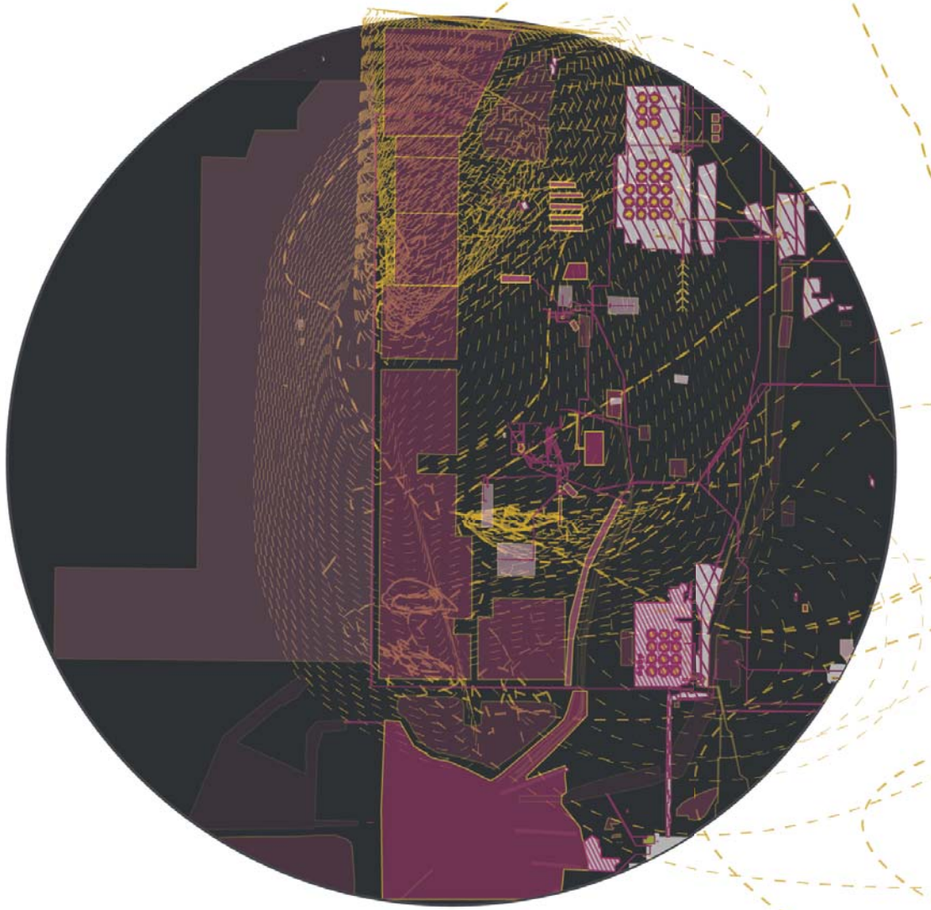
"Large areas of Hanford's soil and groundwater are contaminated, and many of these areas will likely remain contaminated for generations to come, even after final cleanup remedies have been instituted." – Department of Energy, Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site

When plutonium production operations ceased in 1986, the threat of Hanford's landscape to the surrounding community and ecosystems was finally addressed. Hanford was then declared an EPA Superfund property – deemed to be of substantial and detrimental pollution – and the process of attempting to reverse, contain, and remedy Hanford's waste impact began. Over the years, the cleanup effort has vacillated through different priorities, funding structures, and end goals. However, focus on reducing the footprint of the site's pollution and risk to human and environmental health has remained consistent.

In 2015, the DOE drafted the Comprehensive Cleanup Framework (CCF) which combined priorities established through an iteration of cleanup frameworks and plans including the 2010 Comprehensive Land Use Plan and Environmental Impact Statement, the 2012 Final Closure and Waste Management EIS, the 1989 Tri-Party Agreement, as well as over a dozen other documents created by DOE, NPS, and USFWS. The current cleanup operation of the Hanford site, proposes incremental waste consolidation from throughout the 586 square miles of the site to 75 square miles of the Central Plateau Area by 2020 and eventually to a 10 square mile area called the Inner Central Plateau. The Inner Central Plateau is the former 200 East and 200 West plutonium processing areas and is surrounded by still-in-place tank burial areas.

The most polluted areas of Hanford exist within the Inner Central Plateau and

28 Cram, S. 2015. (pp. 799-800)



ONE MILE
RADIUS
200 AREA
HANFORD
WASTE SITES
+ POLLUTANT
PLUMES

- Ditch
- Pit
- Storage
- Burial Ground
- Pond
- Trench
- Migrating Waste
- Unplanned Release
- Burial Tanks



ONE MILE
RADIUS
DOWNTOWN
SEATTLE
CENTURY LINK
FIELD




CENTURYLINK FIELD
SOUNDERS FC

Photo Credit (previous page left):

Department of Energy. "Underground Tank Farm with 12 of the site's 177 waste storage tanks". 2013. Accesssed 8 June 2017. http://www5.hanford.gov/ddrs/index.cfm

the part of the River Corridor area that includes the former fuel fabrication (300) areas and reactor (100) areas alongside the Columbia River. Because of the high levels of toxicity and DOE's desire to protect the Columbia River from further contamination, the 100 and 300 areas have been some of the first parts of the site to be addressed in the cleanup process. Unique to this part of the site, the reactor buildings will be entombed in concrete to restrict the highly radioactive reactor cores from distributing radionuclides into the surrounding environment. These concrete casings are expected to remain impenetrable for the next 75 years at which time radioactivity will have reduced to levels that will allow for the structure to be safely dismantled. However, plant and animal life continues to take up irradiated materials in soils, water, and food items or by living in or adjacent to reactor facilities[29].

In general, the cleanup process involves the removal of polluted surface soils, removal of above-ground facilities[30], and implementation of groundwater remediation systems. These cleanup strategies should not be mistaken as providing complete removal of contaminants or a return to pre-development conditions. The DOE's waste management plan presents an interesting caveat in that they can only remove and isolate that which is technically possible and financially feasible. Within the CCF, plans for cleanup of the River Corridor states that "those instances where remedial action objectives are not achievable in a reasonable time frame, or are determined to be technically impracticable, programs will be implemented to limit contaminant migration and prevent exposure to contaminated groundwater"[31]. There is no absolute definition of "clean" being used by the DOE in their cleanup effort. Rather, "clean" is what is feasible and affordable per land classification and attending degree of safety. As such, there is a lingering material legacy of pollution that will exist across the site after cleanup has completed.

While the un-captured radioactive soils, groundwater, flora, and fauna will likely be dissipated throughout the site to minimally detectable levels, the Inner Central Plateau and ERDF will contain a much more significant and obvious material legacy for those with the ability to access this part of the site. Currently, ERDF occupies 107 acres and, to date, holds 17 million tons of contaminated waste[32]. ERDF has so far received a range of contaminated materials including low- and mid-level radioactive waste, demolished facility

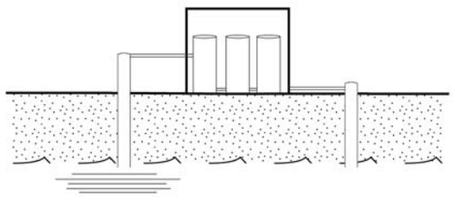
29 Cram, S. 2015.

30 In general, facilities will be removed only to ground plane. Regarding the Fast Flux Test Facility, decommissioning will consist of entombment and "Below-grade structures, the reactor vessel, piping, and other components would remain in place and be filled with grout to immobilize the remaining radioactive and hazardous constituents." Department of Energy. Final Tank Closure and Waste Management Environmental Impact Statement for Hanford, Richland, Washington. 2012. (p.3)

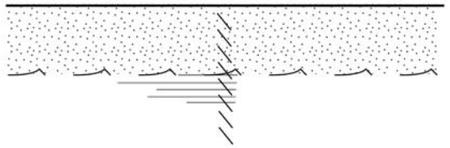
31 Department of Energy, 2013. (pp xi)

32 Department of Energy. "Environmental Restoration Disposal Facility - Hanford Site." 19 Feb. 2017. Web. Accessed 25 Feb. 2017. http://www.hanford.gov/page.cfm/ERDF.

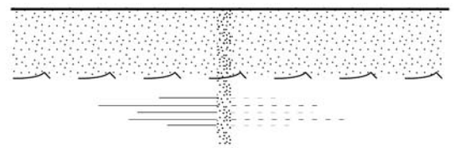
Cleanup Protocol
1989 - PRESENT



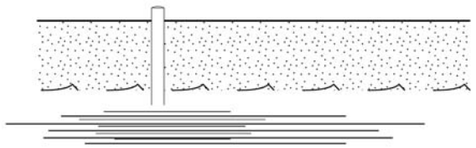
Pump and Treat



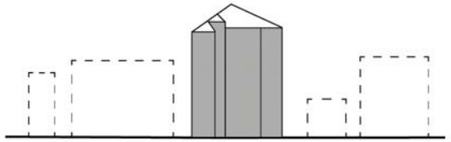
Permeable Barrier



Apatite Barrier



Chemical Injection



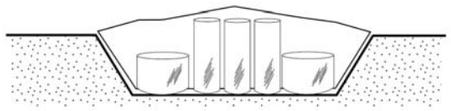
Interim Storage System



Reinforced Tank Encapsulation



Environmental Restoration Disposal Facility



Vitrification

structures, polluted surface soils, and even smaller contaminated materials like worker's safety wear. The goal is that ERDF will also house high level waste collected from the 177 leaking tanks nearby. This high-level radioactive waste will be processed via vitrification at the Hanford Tank Waste Treatment and Immobilization Plant still currently under construction on-site. Vitrification is effectively the glassification of nuclear waste. This method, pioneered at PNNL, is intended to be the ideal method of rendering nuclear toxicity containable and inert. However, its capabilities have not expanded beyond the laboratory scale and worries persist whether the plant will be able to convert high-level liquid nuclear waste into glass at an industrial scale. As of 2017, only low-level waste has been permitted for undergoing vitrification.

There is no limit to the footprint ERDF will occupy as the DOE is prepared to use as much space as necessary[33]. Operating on principles similar to most landfills where waste products are consolidated and sealed, ERDF's cells will be capped with clay, an impermeable plastic barrier, and topped with vegetation to stabilize soil and diminish seepage into the pits. This process is also supposed to help blend the ERDF cells back into the landscape. Once complete, ERDF will require permanent, continuous management to ensure that waste does not breach the disposal cells. Completion of the cleanup is estimated to be around the year 2050, yet no exact date has been provided by the DOE as progress relies heavily on "sustained investment of significant public resources" for which there is much competition[34]. While the DOE attempts to use best available practices for the management of waste, the DOE's attempt at dilution and consolidation for cleanup matches the same systems implemented for waste treatment protocol during the site's operation, chiefly: to use the environment as a partner in waste containment. There is no magic eraser, no true clean for Hanford. It is not possible to return Hanford to the way it was before plutonium production began.

THE PARADOX

Despite the pervasive and expansive scale of waste within the site, the isolation of the site operations to the Inner Central Plateau enables proximity to ERDF only through site sponsored tours, which bar the use of cameras or recording devices. Standing on the boundary of the Hanford site, waste ponds, trenches, burial grounds, and ERDF blend in with the landscape veiling the profound and detrimental impacts production has had on the landscape.

Hanford's landscape has the capacity to both hold and obscure its toxicity which presents a paradoxical simultaneity. While its era of production meant both the intentional and unintentional poisoning of land, humans, and biota, the area's sustained isolation also allowed for the unintended act of environmental conservation. The securitization of Hanford prevented development thus allowing for a preservation of species that now equals the largest in-tact shrub-steppe ecosystem in Washington[35]. USFWS also

33 Department of Energy. "Environmental Restoration Disposal Facility - Hanford Site." 19 Feb. 2017. Web. Accessed 25 Feb. 2017. http://www.hanford.gov/page.cfm/ERDF.

34 Department of Energy, 2013. (p. iii)

35 "Shrub-Steppe - Hanford Reach - U.S. Fish and Wildlife Service." U.S. Fish & Wildlife Service. Accessed January 18, 2017. https://www.fws.gov/refuge/Hanford_Reach/Wildlife_Habitat/Shrub-Steppe.html.



points out that combined with the adjacent DOD Yakima Training Center[36], whose size[37] nearly matches Hanford's at 510.94 mi², these two areas are significant acts of incidental conservation in the Columbia River Basin in Washington. With a combined size of over 1,000 square miles, these two sites are critical given that 60% of that estimated original shrub-steppe habitat in Washington[38] has been lost and what is left is "degraded, fragmented, and/or isolated from other similar habitats. Conversion to cropland has resulted in the greatest loss of shrubsteppe (sic) in Washington, leading to a fragmented landscape and a differentially high loss of deep-soil communities"[39]. The

36 The Yakima Training Center is implicated to have once been an important part of the National Security Administration's (NSA) signals intelligence program as a listening post for global communication interception as part of the Echelon program in partnership with the Five Eyes, an international intelligence consortium consisting of the U.S., U.K., Australia, Canada, and New Zealand. With NSA operations having left for Colorado, the Yakima Training Center now serves primarily as a live-fire training ground. See: Troianello, Craig. "NSA to close Yakima Training Center facility." The Seattle Times. April 04, 2013. Accessed May 9, 2017. http://www.seattletimes.com/seattle-news/nsa-to-close-yakima-training-center-facility/.

37 Department of Defense. "Joint Base Lewis-McChord, Washington Fast Facts, Yakima Training Center." http://www.militaryinstallations.dod.mil/MOS/f?p=MI:CONTENT:0:::P4_INST_ID,P4_CONTENT_TITLE,P4_CONTENT_EKMT_ID,P4_CONTENT_DIRECTORY:5050,Fast%20Facts,30.90.30.30.60.0.0.0.0,1.

38 Department of Energy. Supplement Analysis: Hanford Comprehensive Land-Use Plan Environmental Impact Statement. Richland, 2015. (p.28)

39 Washington Department of Fish & Wildlife, Conservation Division. "Shrub-steppe Ecology." Accessed June 02, 2017. http://wdfw.wa.gov/conservation/research/projects/shrubsteppe/.

territorialization of both sites for intelligence gathering, firing ranges, and weapons building have led to, "some of the best remaining large-scale examples of the shrub-steppe vegetation type in the Pacific Northwest" [40]. The "deep and sandy soil has led to a corresponding diversity of plant and animal communities"[41].

Hanford's landscape diversity helped justify reassigning 303 square miles along the original security buffer as a national monument by President Clinton in 2000[42]. Commonly referred to as the Reach, this land was transferred to USFWS as a National Monument with the DOE retaining involvement by recognizing the Hanford Reach as a National Environmental Research Park[43]. This role of research park is to allow for sustained study of how radiation moves through and impacts the environment.

Hanford's transition from a geography of production to cleanup and then reclamation is not unique amongst nuclear landscapes of the Manhattan Project and Cold War era. Rocky Flats, CO, another former nuclear defense production site, is a salient example of land that has "been re-classified as national wildlife refuges in an attempt to transform the nation's atomic sacrifice zones into spaces of environmental salvation"[44]. These spaces use political designations as a way of articulating nuclear legacies where in irradiated spaces can be seen as either "a threat to be contained" or, as permissibly toxic space creating environments that "simultaneously embody ruin and redemption"[45]. Boundary making and spatial designation can be argued as the means by which the DOE is recruiting nature to do what it cannot - conveying a narrative of resilient healed landscape.

The DOE's evolving spatial designation for Hanford initially involves converting the River Corridor to a "Conservation Area" that would protect fragile habitats by restricting public access but also allow the continued extraction of aggregate from borrow pits that have expanded in footprint as recently as 2012[46]. Eventually this area will be included as part of the

40 USFWS. "Shrub-Steppe - Hanford Reach - U.S. Fish and Wildlife Service." U.S. Fish & Wildlife Service. Accessed January 18, 2017. https://www.fws.gov/refuge/Hanford_Reach/Wildlife_Habitat/Shrub-Steppe.html.

41 Ibid.

42 Clinton, William J. "Proclamation 7319—Establishment of the Hanford Reach National Monument," June 9, 2000. Online by Gerhard Peters and John T. Woolley, The American Presidency Project. http://www.presidency.ucsb.edu/ws/?pid=62329.

43 Department of Energy. "Department of Energy National Environmental Research Parks." Department of Energy National Environmental Research Parks. Accessed June 01, 2017. http://www.nerp.ornl.gov/.

44 Cram, S. (2015). Wild and Scenic Wasteland: Conservation Politics in the Nuclear Wilderness. Environmental Humanities, 7(1), 89-105. (pp. 89)

45 Ibid..

46 Department of Energy. Environmental Assessment for Expansion of Borrow Areas on the Hanford Site. Richland: 2-1, 2012.

Reach and while managed by USFWS, it will still be owned by DOE thus allowing continued resources extraction as needed. While the site appears as if it is being mended, healed and left for nature, the Comprehensive Land Use Plan establishes that the site will still very much continue to work with its role in industrial nuclear waste containment, "industrial development in southern and eastern portions of Hanford, increasing recreational access to the Columbia River", ongoing operation of the Laser Interferometer Gravitational-Wave Observatory, on-going operation of the Environmental and Molecular Sciences Laboratory, and expanding the wildlife refuges on-site and adjacent.[47] Each of these different land uses work in tandem with the levels of residual contamination that are established after the cleanup effort is complete. The complexity of contamination means toxins can be spread "far beyond the points of origin in military sites, through transport by wind currents, leaching in groundwater, or bioaccumulation in wildlife species"[48].

By recalibrating and expanding the DOE's role from "its Cold War mission (of) nuclear deterrence to environmental protection (it can replace) nuclear weapons systems with biodiversity as the security object of the nuclear state"[49]. This "code-switch—alternatively referred to military-to-wildlife, warfare-to-wildlife, and bombs-to-birds—imagines a clean break between human and non-human worlds" where notions of nature as resilient healer and human as destructive force alternatively reinforces "a selective view of nuclear transformation. (This) elide(s) the cellular transgressions and mutant potentialities that also distinguish these parcels of uncommon Eden. Exposure produces disparate effects; each body a distinct expression of nuclear contact. So too, radiogenic illness, especially in the case of low-level exposures, may take decades or even generations to manifest"[50].

Inscribing territory through political designation allows the DOE to keep human and natural worlds cleaved apart by creating a selective political ecology that utilizes nature as a universal metabolizer, ultimately as a container, to hold human produced toxins. This inscription also organizes land-use around toxicity in anthropogenic ways, allowing classifications that exclude permanent human habitation as being permissibly toxic, despite pollution's ability to defy political boundaries. Organizing territory through official land-use classifications and ensuring the continued cultivation of uncertainty around radiation's effects affords sustained research investment, minimizes financial obligation, and shifts the state's burden to material

47 Department of Energy, 2015. (p.2)

48 Martini, Edwin A. Proving Grounds: militarized landscapes, weapons testing, and the environmental impact of U.S. bases. Seattle, WA: University of Washington Press, 2015. (pp. 176)

49 Masco, Joseph. The nuclear borderlands: the Manhattan Project in post-Cold War New Mexico. Princeton, NJ: Princeton University Press, 2006. (pp. 313)

50 Cram, S. 2015. (pp. 96)


1

RESTRICTED PERIMETER

Utility routes leading into Hanford have restricted access. 2017.

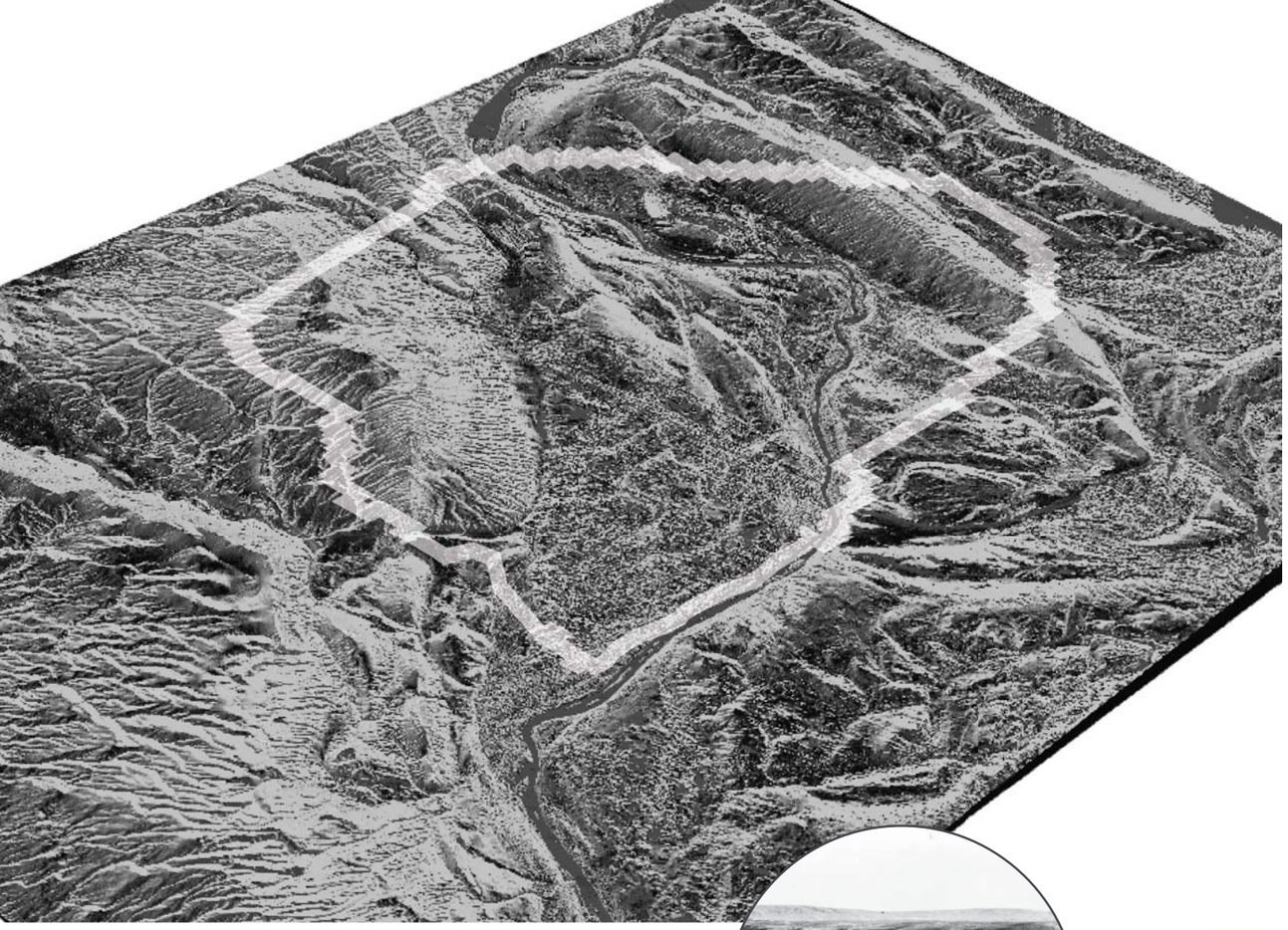
reorganization instead of more fully confronting the slow violence[51] of nuclear waste and radiation. The creation of the Reach curiously means that government conservation of portions of Hanford continues the security role of the site: from physical spatial buffer to political designation, helping to curate what cleanup means in a seemingly naturally reclaimed place.

The ecologies of nuclear territories present a curious paradox where space is understood as reclaimable, where production by-products can either be managed sufficiently or have been appropriately digested and dispersed by their environments. These often-vast swathes of territory, demarcated for security within and relative safety of those outside create large buffers of space that is easy to mistake for being wild. Though the scale of Hanford's infrastructure is vast, its operational network is distributed sufficiently to make the reservation appear as though it is a natural space dotted by a few structures, transportation routes, and telephone poles. But Hanford, like myriad other military nuclear zones are voraciously toxic and full of novel, synthetic human-made substances persisting in soils, groundwater, plants, and wildlife. The ecological system of Hanford has been leveraged to assist in the metabolization of nuclear waste into a permissibly discursive network of toxicity through food chains[52]. This toxic discursivity renders the waste docile by making the body-burden non-human because through the transfer of some land from the DOE to USFWS, allows for "more radioactive waste (to be) in the environment while still remaining legally compliant (…) reinscribing nuclear space as natural space means that less material nuclear management is necessary"[53]. Strangely, environmental management through political designation allows for ecological integrity to be predicated and organized around its toxicity.

The ecology of nuclear territories might aesthetically present itself as believably natural, or at least relatively untouched territory to the uninformed visitor, but the digestion of nuclear byproducts by earth, air, water, and decomposition and digestion through the food web points to the discursive and distributed realities of altered ecological systems. Such systems end up being leveraged through political designation as territories of environmental reclamation that either prove the resilience of nature to withstand our abuses or verify our perceived prowess to master nature and safely organize materials in anthropocentric ways.

Hanford is often understood as a 'still' or 'empty' desert landscape being 'put to bed' by engineers, scientists, and DOE contractors capably organizing and containing toxic waste. However, it is more accurately a landscape rife with movement whose lack of fixity is masked and compounded by the persistent threat of securing and maintaining material organization and confinement on the scale of both geologic time and nuclear half-lives.

51 Nixon, Rob. *Slow violence and the environmentalism of the poor.* Cambridge, MA: Harvard University Press, 2013.
52 Cram, S. 2015.
53 Cram, S. 2015. (pp. 96)





1

TERRITORIAL DEVELOPMENT AND LAND USE

Native tribal use of the Columbia River Basin dates back at least 11,000 years.

11,000

1 Hanford History Project. "Visual Timeline," HanfordLearning.org, 2012, , accessed June 08, 2017, http://hanfordlearning.org/hanford-101/hanford-history/visual-timeline/.



Orchards and the town of White Bluffs

The secrecy of the Hanford Site demanded a large buffer be maintained around operations. The lack of development resulted in preservation of largest shrub-steppe habitats across 290 acres in Eastern Washington. The Reach, however, was not protected from the over 450 million gallons of waste pollutants dispelled across the reservation.



1

1850 1860 1870 1900 1920

1855
The Treaty of 1855
The Nez Perce, Cayuse, Umatilla, and Walla Walla Tribes cede 6.4 million acres of land within the Columbia, Snake, and Salmon River regions to the US Government. The agreement retains the tribe's rights to fish and hunt and gather traditional food on the land.

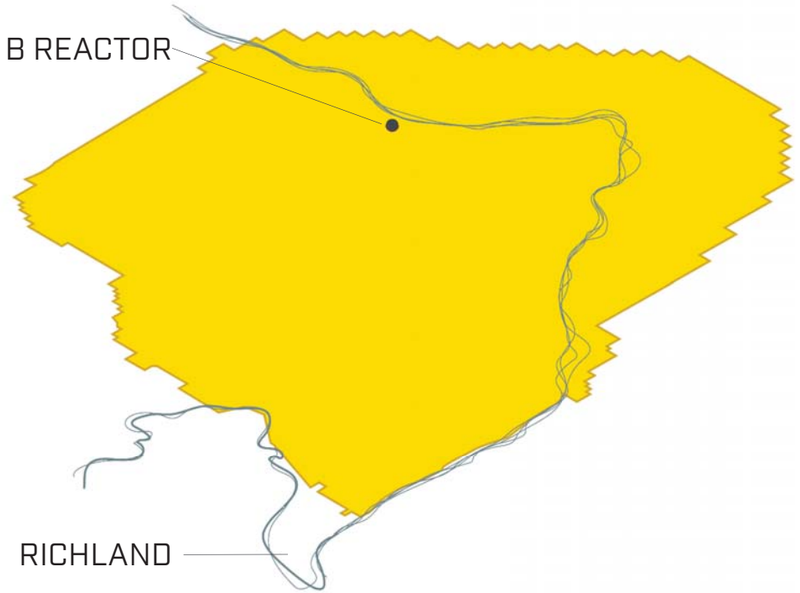
6.4 Million

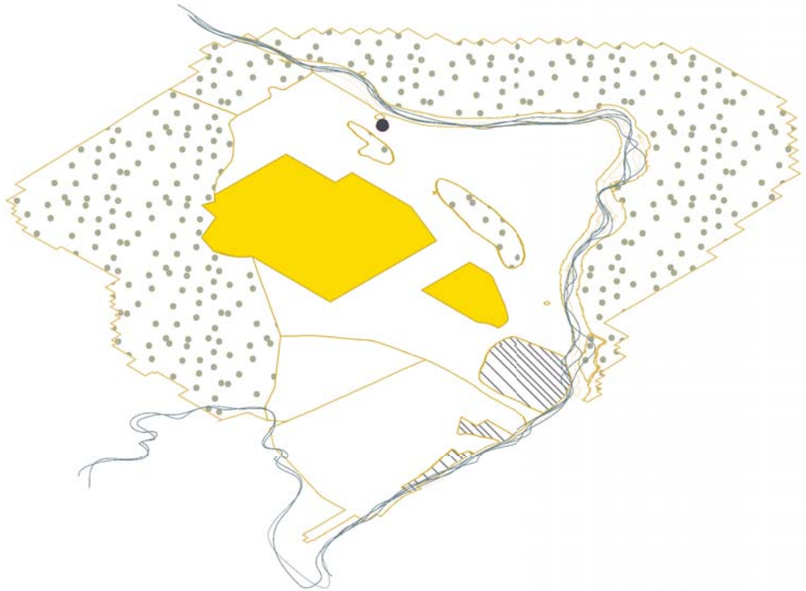
1861
The town of White Bluffs is founded by white settlers.

1 Department of Energy. "74155-3 Corn Field at Riverby Ranch, White Bluffs." 1931. Online. Accessed June 7 2017. http://www.hanford.gov/c.cfm/photogallery/gal.cfm/Settlers/12#

Hanford Nuclear Reservation

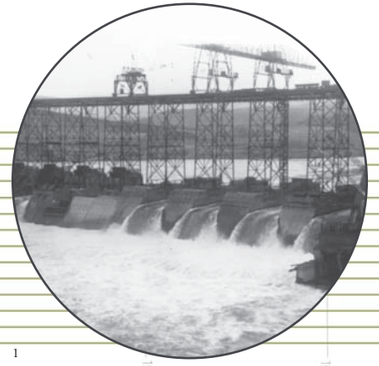
Hanford Reservation spans 586 square miles of land and the longest stretch of free flowing river in the US. The large amount of open, relatively secluded and buffered area with access to ample water supply made it the ideal location of nuclear weapons development.





Hanford Reach National Monument

The secrecy of the Hanford Site demanded a large buffer be maintained around operations. The lack of development resulted in preservation of largest shrub-steppe habitats across 290 acres in Eastern Washington. The Reach, however, was not protected from the over 450 million gallons of waste pollutants dispelled across the reservation.



1933 - 1941

The Grand Coulee Dam , over 100 miles upriver from Hanford, was th largest hydroelectric power plant at the time of its construction. The plethora of cheap power was integral to siting of the Hanford Nuclear Reservation.

100

1942

President Roosevelt authorizes construction of the Hanford Nuclear Reservation.

The 1,500 residents of White Bluffs and Hanford were forced to leave and access to the site was restricted from tribes.

1,500

1945

In 30 months 544 buildings were created.

At the height of construction Hanford employed 55,000 workers and housed them mainly in barracks which were deconstructed after the project was built.

544

1989

Plutonium production operations cease, all nine reactors are shut down, and the site formally closes down.

9

2000

The Hanford Reach National Monument is established on 290 acres of the former safety buffer zone.

290

2008

The B Reactor is officially memorialized as a National Historic Landmark and as part of the Manhattan National Park Project. The reactor is opened for limited access tours not long after.

2016

Six of the nine reactors have been entombed while surrounding buildings have been demolished. Waste is moved from the reactor areas in the River Corridor to the Central Plateau.

6

1 Spokane Public Library. "Grand Coulee Dam: Impacts on Fish". nwcouncil.org/history/GrandCouleeImpactsOnFish January 2010. Accessed June 7 2017.

Restoration/ Conservation

In the cleanup framework established for Hanford, all waste materials are expected to be consolidated from throughout the site, to just ten square miles.

Portions of the site will be set aside for industrial usage and the preservation space occupied by the Hanford Reach will expand to the remaining acreage. Access will continue to be restricted so as to preserve sensitive species and limit contact with residual contaminants.



2040 2050 2060 2070 2080 2090 2100 2110 2120 2130 2140 2150 2160 2170

2020
Cleanup completed for the Central Plateau Outer Area with remaining cleanup activity concentrated to ten square miles.

2050
Projected potential completion of tank waste treatment. This date will depend on funding and permitting. As of yet, permitting has only been approved for low-level waste.

Central Plateau Long-Term Waste Storage



1



2

TRICHLOROETHANE
The longevity of this toxin within the environment has not yet been successfully calculated.

STRONTIUM - 90
Half-life of bioaccumulation is still not yet fully understood.

TECHNETIUM - 99
Has a half-life of 211,000 years.

211,000

IODINE - 129
Has a half-life of 15.7 million years.

15.7 Million

URANIUM
Has a half-life of 4.5 billion years.

4.5 Billion

1 "Hanford, WA." Google Earth. 2017. 7 June 2017.
2 "Seattle, WA." Google Earth. 2017. 7 June 2017.

RANGING RAIDATION - 5 DAYS OF POSSIBILITIES

RADIATION IS INVISIBLE AND ITS CAPACITY TO MOVE THROUGH BIOTIC LIFEFORMS IS PERVASIVE. HANFORD'S CLEANUP OPERATIONS CURRENTLY INCLUDE APPROXIMATELY $2.5 MILLION/YEAR ON CONTROLLING RADIACTIVITY'S SPREAD THROUGH PLANT AND ANIMAL LIFE.

BY MAPPING THE DAILY TRAVEL RANGE OF 10 SPECIES KEY TO THE COLUMBIA RIVER BASIN'S HEALTH, WE AIM TO EXPLORE HOW RADIATION REPRESENTS A NEARLY UNCONTAINABLE PROBLEM THAT DOES NOT OBEY, RESPECT, OR RECOGNIZE OFFICIAL POLITICAL BOUNDARIES OF CONTROL.

RANGING RADIATION

Common Fruit Fly
Drosophila melangaster



Black Tailed Jack Rabbit
Lepus californicus



Chinook Salmon
Oncorhynchus tshawytscha



Tumbleweed
Salsola iberica



Osprey
Pandilon haliactus



Great Basin Pocket Mouse
Perognathus parvus



Mud-dauber Wasp
Sceliphron caementarium



Coyote
Canis latrans



Barn Swallow
Hirundo rustica



Cougar
Puma concolor

10 miles 20 miles 30 miles 40 miles 50 miles

Average maximum daily range

Food pathways

Common Fruit Fly
Drosophila melangaster



The common fruit fly is one of Hanford's most significant containment challenges. Its small size combined with a proclivity for rotten food and detritus and a surprising range, means it is one of the most difficult transporters of radiation to contain.

Black Tailed Jack Rabbit
Lepus californicus



Black Trailed Jack Rabbits have large populations in the Hanford Nuclear Reservation and Reach areas. A combination of burrowing and eating plant and insect life offers a multitude of exposure vectors. The Rabbits are also a favorite prey of area predators, creating possibilities for bioaccumulation.

Chinook Salmon
Oncorhynchus tshawytscha



Damming, irrigation, and urbanization have created a complex and pervasive threat to the vitality of Chinook salmon. The Reach is the last free-flowing stretch of the Columbia and home to the River's most abundant spawning grounds. However, upwelling toxins from plumes present irreversible consequences for this iconic species.

Tumbleweed
Salsola iberica



The invasive tumbleweed presents an especially pernicious challenge. With roots capable of reaching 20' down and the ability to uptake Uranium, the invasive tumbleweed presents an especially pernicious threat. Its use as a food for many herbivores and travel range limited only by wind means its massive swathes present a unique conundrum.

Osprey
Pandilon haliactus



Ospreys have substantial populations throughout the Columbia Basin and many utilize the reach's undeveloped shorelines and free-freeflowing waters as ideal habitat. They rely on rabbits, salmon, and mice as primary foods and are consequently at risk of bioaccumulating toxins ingested by prey.

Great Basin Pocket Mouse
Perognathus parvus



The Great Basin Pocket Mouse is one of many mouse species inhabiting the Hanford Nuclear Reservation and Reach. As a dominant native species, the mice have many natural nesting sites but have developed a habit of utilizing entombed reactors and other contaminated facilities as nesting sites where they are often subjected to unsafe exposure.

Mud-dauber Wasp
Sceliphron caementarium



The Mud-dauber wasp uses water-soaked material to build its nests. Given that Hanford often uses water to control the spread of radioactive dusts, the threat of toxic upwelling along the Columbia, and the wasps' preference of building nests on entombed reactors the wasp is under nearly constant threat of exposure.

Coyote
Canis latrans



Coyotes have long called the Basin home and their highly developed adaptability skills have cemented their presence both on site and off. As one of the area's apex predators, it is at risk of bioaccumulation. Their radioactive urine long confounded Hanford workers when noticing numerous radioactive telephone poles and building exteriors.

Barn Swallow
Hirundo rustica



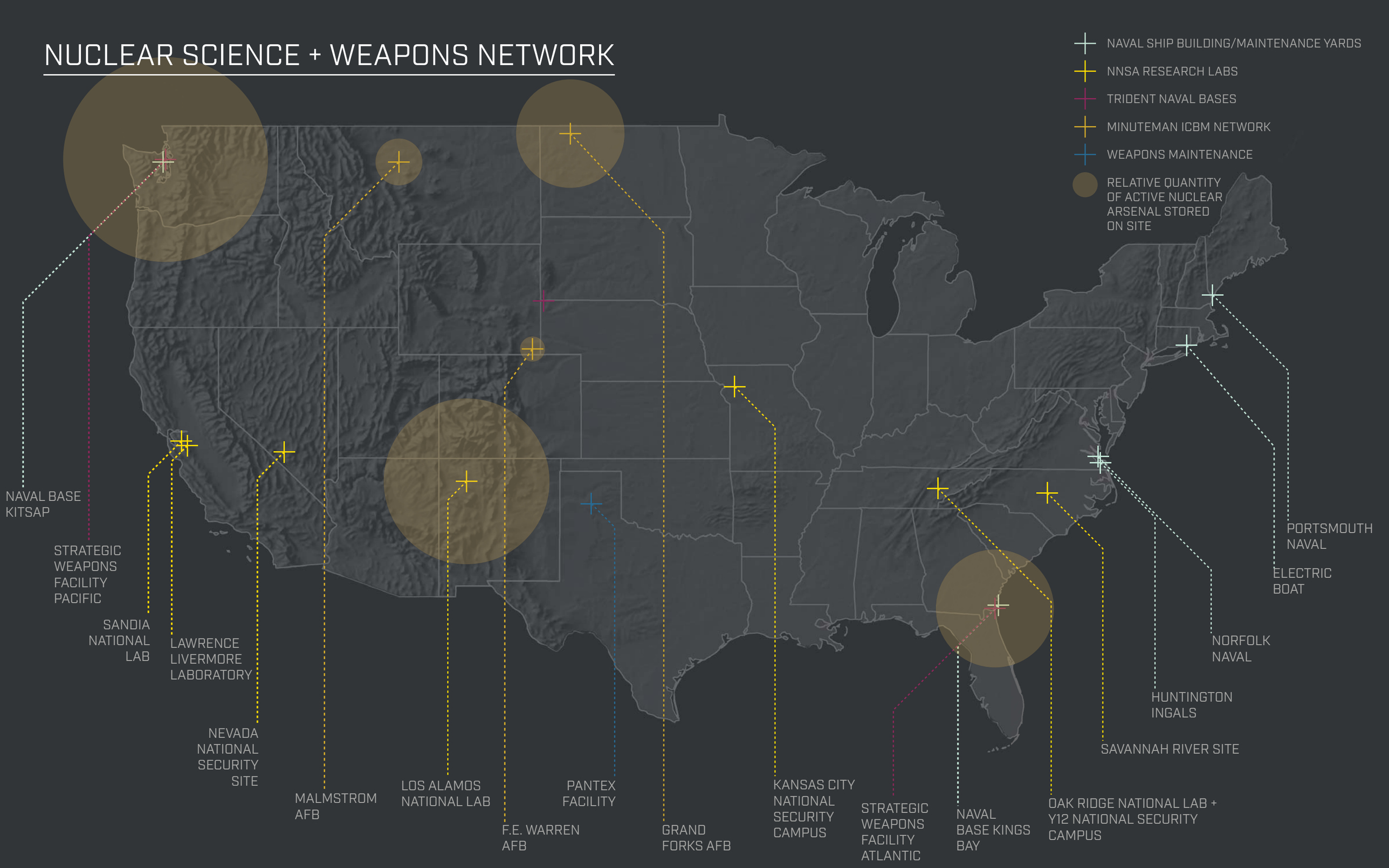
Barn Swallows ingest irradiated spiders, fruit flies, and other seeds and plant material on site allowing for the threat of bioaccumulation. Similar to the Mud-dauber Wasp, the Swallow has also developed a preference for using entombed reactors and irradiated facilities as preferred nesting grounds.

Cougar
Puma concolor



Cougars are the apex predator in the Basin and are thus prime candidates for bioaccumulation hazards. Their significant range means that they can easily transport threats across site boundaries. This iconic species of Eastern Washington is also under threat from urbanization's spread and blocking of transportation routes.

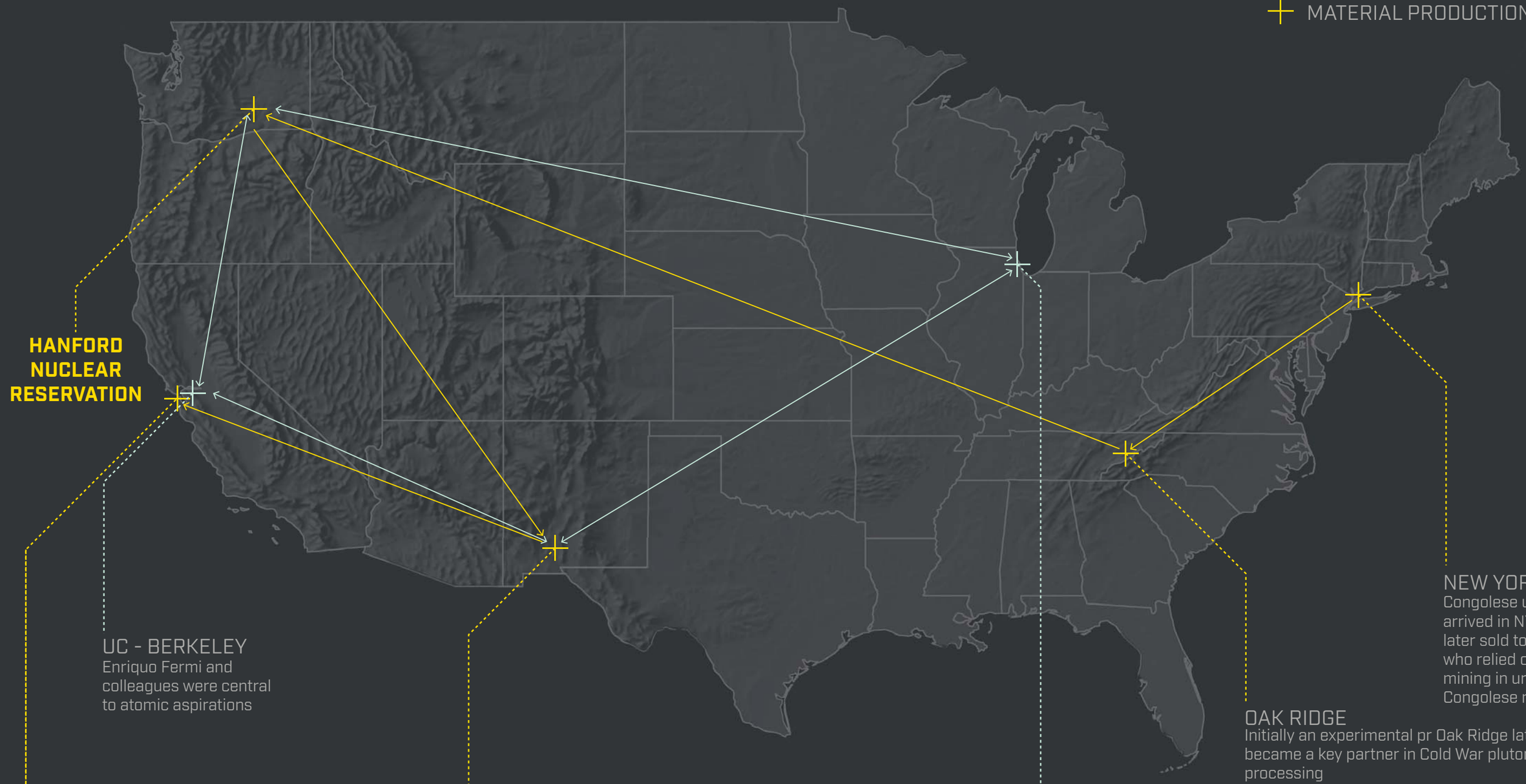
NUCLEAR SCIENCE + WEAPONS NETWORK



THE ORIGINAL ATOMIC SUPPLY CHAIN

KNOWLEDGE INSTITUTION

MATERIAL PRODUCTION



HANFORD NUCLEAR RESERVATION

UC - BERKELEY
Enriquo Fermi and colleagues were central to atomic aspirations

PORT OF SAN FRANCISCO
Weaponized elements and bombs' apparatus were shipped from San Francisco to Tinian Island, MNCI

LOS ALAMOS + TRINITY TEST SITE
Final assembly of bomb implements and nuclear testing of 'The Gadget'

UNIVERSITY OF CHICAGO
The first atomic reactor was built under stadium seating, UC faculty later made valuable contributions to atomic aspirations

OAK RIDGE
Initially an experimental pr Oak Ridge later became a key partner in Cold War plutonium processing

NEW YORK CITY
Congolese uranium arrived in NYC and was later sold to the DOD who relied on rapacious mining in uranium rich Congolese mines

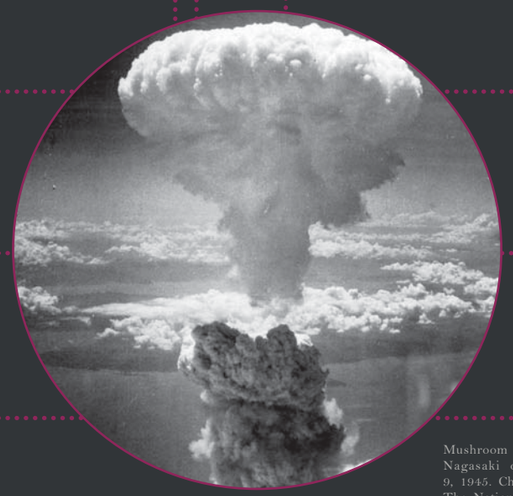
NUCLEAR COLONIALISM

Hiroshima, JPN
Nagasaki, JPN
Tinian, CNMI
San Francisco, CA
Hanford, WA
Los Alamos, NM
Oak Ridge, TN
New York City, NY
Shinkolobwe, DRC

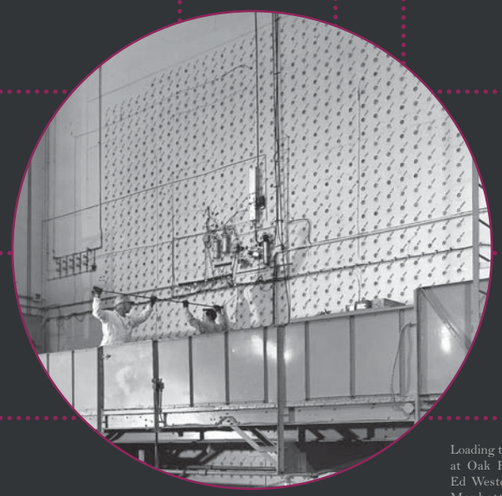
DISPLACEMENT

EXTRACTION

DESTRUCTION



Mushroom cloud over Nagasaki on August 9, 1945. Charles Levy, The National Archive, Wikimedia.

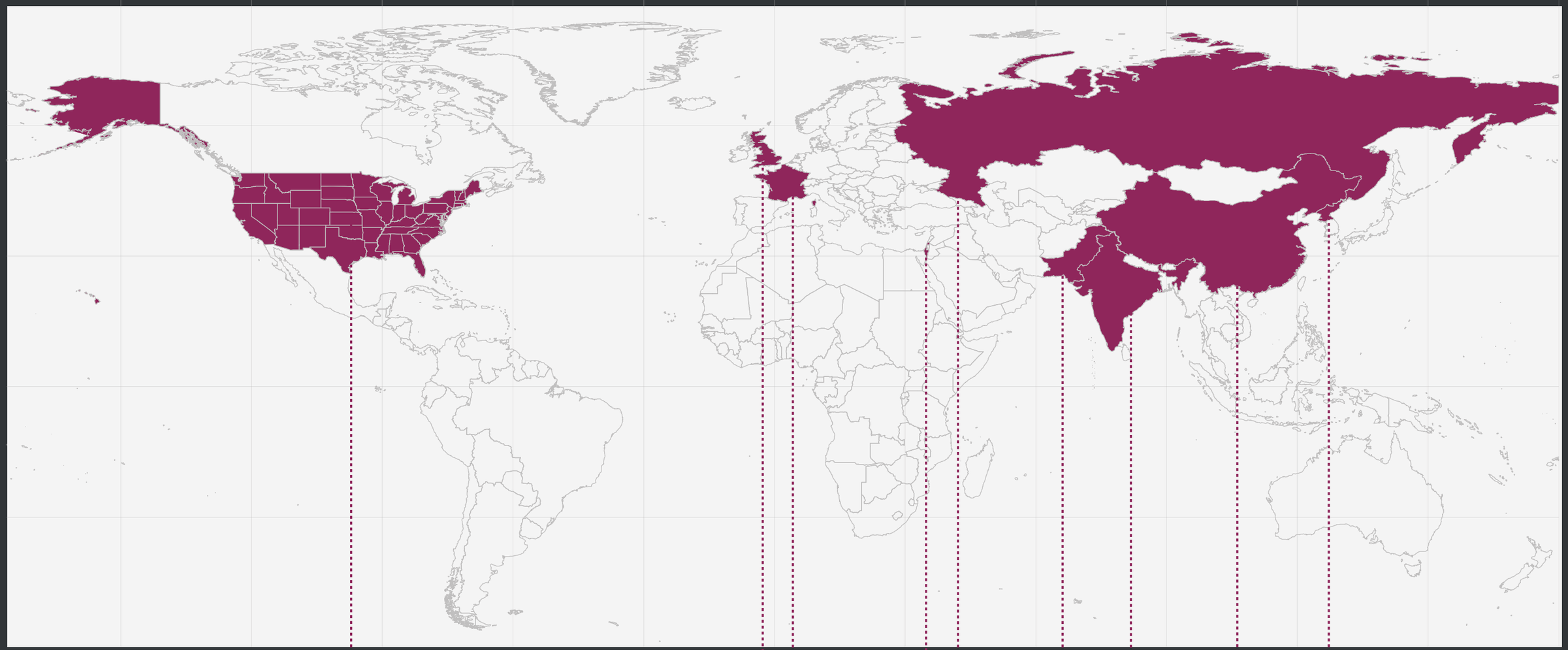


Loading the X-10 reactor at Oak Ridge in 1943. Ed Westcott, US Army, Manhattan Engineer District, Wikimedia.



Guards at Shinkolobwe uranium mine, March 1953. Dmitri Kessel, Life Picture Collection, Getty Images.

GLOBAL NUCLEAR POWER ARSENALS



7,000
UNITED STATES

215
BRITAIN

300
FRANCE

80
ISREAL

7,300
RUSSIA

120
PAKISTAN

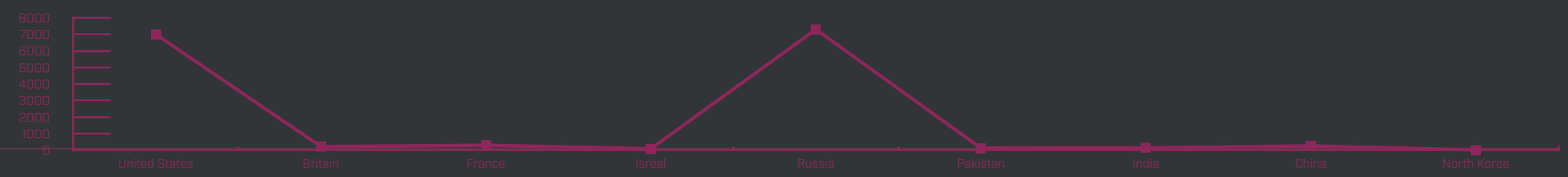
130
INDIA

260
CHINA

<10
NORTH KOREA

While global stockpiles are estimated at approximately 15,000 warheads, a mere 100 detonations are estimated to irrevocably destroy biotic life and render the planet inhabitable.

100



NUCLEAR POWER NETWORK

ACTIVE REACTOR SITE

50 MILE FALLOUT RADIUS

YEAR OF ORIGINAL REACTOR PERMIT



Atomic bombs dropped on Japan August 6 + 9, 1945



First purely commercial nuclear reactor in the U.S. along the Ohio River in PA in 1954

1945 | 1950 | 1960 | 1970 | 1980 | 1990 | 2000 | 2010

Nagasaki on September 24, 1945. Cpl. Lynn P. Walker, Jr. DOD War and Conflict Image Collection.

Shippingport reactor core being lowered into place. DOE & NPS, Library of Congress.

NUCLEAR POWER AND TOXIC MATERIALITIES IN THE ANTHROPOCENE

Our world is the accumulated consequences of production, whose metabolic processes, byproducts, and externalities have accreted across the globe. Understanding our nuclear legacy requires a reading of the larger context of human impact on the planet. The realization of nuclear power at a critical moment in world history through atomic bombs and its spread across the globe during rapid globalization can serve as a model for understanding our relationship to wastescapes, pollution, exposure, and the configuration of terrain and resources for production purposes with disproportionate benefits and burdens. The presence of pollution on a planetary scale has forced a radical rethinking of human-nature connections as all species, including humans, attempt continued survival in an increasingly fragile world. The concept of nature as fundamentally separate from the human has become irrevocably destabilized with climate change and the accumulating evidence of the persistence of human made materials within natural systems. Wilderness and ideas of an original state, or unaltered nature, are increasingly recognized as fictions, frequently with deeply colonial roots[1].

1 The production of wilderness and its connection to dispossession of lands and/or the fetishization of Native Americans is an extensive canon. The reference here is specifically linked to how ideas of wilderness as the untouched picturesque is constructed through colonial dispossession, which frequently involved violence. Mark David Spence's book, *Dispossessing Wilderness: Indian Removal and the Making of the National Parks*, is an excellent account of this history through three case studies at Yellowstone, Yosemite, and Glacier National Parks.

The Anthropocene has initiated increased global extinctions[2], destabilized resource economies[3], furthered global strife[4], and accelerated the migration of humans[5] and ecosystems[6] across once relatively static boundaries. The transition between the Holocene and Anthropocene has been marked by increased density and precarity of life where changes and interactions have the capacity to dramatically reverberate across cultures, species, and ecosystems. This epoch has generated deeply contingent and concomitant challenges that particularly confront design disciplines and those operating in built environments. Suddenly, we have found ourselves in a world where violent conflicts emerge over rudimentary aggregates[7, 8], animals are trained to prey upon robots[9], and we use robots to kill destructive native starfish[10]. Water shortages and levels of contamination are forcing migration or starvation[11] while broadly challenging the sustained viability of ecosystem health and agricultural modes[12]. The fragility of the world is being continuously

2 Ceballos, Gerardo, Paul R. Ehrlich, Anthony D. Barnosky, Andrés García, Robert M. Pringle, and Todd M. Palmer. "Accelerated modern human–induced species losses: Entering the sixth mass extinction." Science Advances. June 01, 2015. Accessed May 1, 2017. http://advances.sciencemag.org/content/1/5/e1400253.short.

3 BARNETT, J. (2000). Destabilizing the environment—conflict thesis. *Review of International Studies, 26*(2), 271-288.

4 Adger, W.N., J.M. Pulhin, J. Barnett, G.D. Dabelko, G.K. Hovelsrud, M. Levy, Ú. Oswald Spring, and C.H. Vogel, 2014: Human security. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and -New York, NY, USA, pp. 755-791. https://www.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-Chap12_FINAL.pdf

5 Slade, Giles. American Exodus Climate Change and the Coming Flight for Survival. Gabriola Island: New Society Publishers, 2014.

6 Milligan, Brett. "Landscape Migration," Places Journal, June 2015. Accessed 28 Jun 2016. https://doi.org/10.22269/150629

7 Beiser, Vince. "The World's Disappearing Sand." The New York Times, June 23, 2016, Opinion sec. Accessed December 1, 2016. https://www.nytimes.com/2016/06/23/opinion/the-worlds-disappearing-sand.html?_r=1.

8 Romig, Rollo. "How to Steal a River." The New York Times. March 01, 2017. Accessed March 01, 2017. https://www.nytimes.com/2017/03/01/magazine/sand-mining-india-how-to-steal-a-river.html.

9 Selk, Avi. "Terrorists are building drones. France is destroying them with eagles." The Washington Post. February 21, 2017. Accessed February 27, 2017. https://www.washingtonpost.com/news/worldviews/wp/2017/02/21/terrorists-are-building-drones-france-is-destroying-them-with-eagles/?utm_term=.2b50968a5fbb.

10 Platt, John R. "A Starfish-Killing, Artificially Intelligent Robot Is Set to Patrol the Great Barrier Reef." Scientific American. January 01, 2016. Accessed April 03, 2017. https://www.scientificamerican.com/article/a-starfish-killing-artificially-intelligent-robot-is-set-to-patrol-the-great-barrier-reef/.

11 Myers, Norman. "Environmental Refugees in a Globally Warmed World." BioScience 43, no. 11 (1993): 752-61. doi:10.2307/1312319.

12 Jiménez Cisneros, B.E., T. Oki, N.W. Arnell, G. Benito, J.G. Cogley, P. Döll, T. Jiang, and S.S. Mwakalila, 2014: Freshwater resources. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 229-269

revealed as we continue to both realize and understand the depth of its interconnectedness.

While we as humans continue to wrestle with the question of when and where all this started, the Anthropocene is increasingly being linked to the advent of nuclear energy[13, 14, 15]. The science and weapons arms race that began during World War II provoked an unprecedented acceleration and aggregation of destructive and constructive capabilities. During the international arms race of the Cold War, nuclear weapons were detonated on an average of 1 per every 9.6 days from 1945 to 1988[16]. Hanford, as a factory site in the Columbia Basin, was busy cementing US military superiority while contributing to the blanket of chemically distinct radionuclides covering the world and marking a geologic phase change.

The arms races of the Cold War were predicated on competition of "colossal excess"[17]. Marking the world with radiation meant the distribution of nuclear weapons and military might on a scale that matched the distribution of pollution – military satellites and space junk; nuclear missile silos, uranium tailings, and toxic groundwater from nuclear production and terrestrial and freshwater contamination; and nuclear submarines plying the oceans and pollution accumulating in the deepest places of the world's oceans[18]. Reaching this magnitude of distribution required massive leveraging of resources for the scientific, technological, material, political, and economic races spurred by World War II and its fallout into the Cold War. Here lies the curious perversity concerning Hanford, nuclear waste, and the Anthropocene – a deep dissonance between the accumulation of world-ending nuclear weapons[19] and pollution at a scale that threatens life both immediately and on a geologic scale *combined with* an apparent distancing[20] and ignorance of their presence and influence in shaping the world.

If we recognize the Anthropocene as physically marked by the realization of nuclear energy, then it is because of the military industrial complex's leveraging material and knowledge production to produce security through the development of destructive capabilities. The realization of this power through "the Manhattan Project drew on virtually every available resource from the nation's academic community to the country's industrial giants"[21]. The production of weapons for state security created a toxic problem that challenges the necessity of an unfettered and unbothered race to produce defensive and offensive weaponry.

The Cold War American state, fixated on winning the arms race, put a premium on beating the Soviets at all costs. Producing uranium, plutonium, and weapons components was a higher priority than protecting the health of nearby residents or the workers at the plants, a disproportionate number of whom died of cancer. Ironically, since 1945, American nuclear weapons, intended to keep the country safe, have mainly killed Americans.[22]

By positing nuclear weapons as a patriotic necessity, the production of nuclear weapons was allowed to be largely unbothered by the consequences of nuclear waste – the territorial spaces, such as Hanford, were created by the networking of infrastructure and knowledge systems where "natural hazards are mediated or enhanced by technological innovation"[23]. The strategy of production emphasized the necessity of maximum production for maximum protection of the state while downplaying the "slow violence of environmental contamination"[24]. In this sense, the capacity of machines, like

13 Carrington, Damian. "The Anthropocene epoch: scientists declare dawn of human-influenced age." The Guardian. August 29, 2016. Accessed April 03, 2017. https://www.theguardian.com/environment/2016/aug/29/declare-anthropocene-epoch-experts-urge-geological-congress-human-impact-earth.

14 Than, Ker. "The Atomic Age Ushered In the Anthropocene, Scientists Say." Smithsonian.com. January 07, 2016. Accessed April 03, 2017. http://www.smithsonianmag.com/science-nature/scientists-anthropocene-officially-thing-180957742/.

15 Jan Zalasiewicz, Colin N. Waters, Mark Williams, Anthony D. Barnosky, Alejandro Cearreta, Paul Crutzen, Erle Ellis, Michael A. Ellis, Ian J. Fairchild, Jacques Grinevald, Peter K. Haff, Irka Hajdas, Reinhold Leinfelder, John McNeill, Eric O. Odada, Clément Poirier, Daniel Richter, Will Steffen, Colin Summerhayes, James P.M. Syvitski, Davor Vidas, Michael Wagreich, Scott L. Wing, Alexander P. Wolfe, Zhisheng An, Naomi Oreskes, When did the Anthropocene begin? A mid-twentieth century boundary level is stratigraphically optimal. Quaternary International, Volume 383, 5 October 2015, Pages 196-203, ISSN 1040-6182, https://doi.org/10.1016/j.quaint.2014.11.045.

16 Ibid.

17 Hoffman, David E. (2009). The Dead Hand: The Untold Story of the Cold War Arms Race and Its Dangerous Legacy. 1st ed. New York City, NY: Doubleday Publishing.

18 Jamieson, Alan J., Tamas Malkocs, Stuart B. Piertney, Toyonobu Fujii, and Zulin Zhang. "Bioaccumulation of Persistent Organic Pollutants in the Deepest Ocean Fauna." *Nature Ecology & Evolution* 1 (02/13/online 2017): 0051. The paper found that in two of the ocean's deepest trenches, "Contaminant levels were considerably higher than documented for nearby regions of heavy industrialization, indicating biocaccumulation of anthropogenic contamination and inferring that these pollutants are pervasive across the world's oceans and to full ocean depth."

19 Robinson, Nathan J. "Pretending It Isn't There." Current Affairs. June 01, 2017. Accessed June 01, 2017. https://www.currentaffairs.org/2017/06/pretending-it-isnt-there.

20 Popovich, Nadja, John Schwartz, and Tatiana Schlossberg. "How Americans Think About Climate Change, in Six Maps." The New York Times. March 21, 2017. Accessed March 21, 2017. https://www.nytimes.com/interactive/2017/03/21/climate/how-americans-think-about-climate-change-in-six-maps.html. These maps show that even when people acknowledge climate change's reality, they fail to think they themselves are endangered.

21 Harvey, David. History of the Hanford Site: 1943-1990. Richland, WA: Pacific Northwest National Laboratory.

22 Gusterson, Hugh. "A predictable nuclear accident at Hanford." Bulletin of the Atomic Scientists. May 19, 2017. Accessed May 19, 2017. http://thebulletin.org/predictable-nuclear-accident-hanford10774.

23 Dalby, S. (2017). "Anthropocene Formations: Environmental Security, Geopolitics and Disaster." Theory, Culture & Society 34(2-3): 233-252.

24 Cram, S. (2015). Wild and Scenic Wasteland: Conservation Politics in the Nuclear Wilderness. *Environmental Humanities, 7*(1), 89-105.; Nixon, Rob. Slow violence and the environmentalism of the poor. Cambridge, MA: Harvard University Press, 2013.

the reactors at Hanford, to enhance innovation and create risk represents a key condition of the Anthropocene. Industry, automobiles, mining, manufacturing, agriculture, and energy production all have contributed towards realizing the Anthropocene by producing the material conditions that afford *and* endanger ways of life in highly uneven ways.

Global extractive practices followed the spread of infrastructure systems and their various assortments of machines. Where telegraph lines once lay, high speed fiber optic cables appeared; where railroad lines crossed territories, super highways created new networks. The conversion of land, sea, and air to political territory accelerated extractive practices to a fever pitch with global warming and the acceleration of attending injustices and precarity.

Radical rethinking across a multitude of disciplines has attempted to articulate the challenges of injustice and find opportunities for intervention. Locating opportunities for interventions presents a significant challenge: it is not just locational but methodological and conceptual. The separation of machines from their social and ecological situatedness continues to reify the challenge by minimizing the connection and dependence we have on machines. Such separation also perpetuates understanding infrastructure and machines purely through their mechanical performativity, efficiencies, and consistencies instead of recognizing them as being intimately tied to landscapes and ecologies. Hanford's machines are seen as necessary participants in national armament whose legacy is sometimes constrained within its scientific and military achievements. In truth, Hanford's machines produced armament by reconfiguring space with impacts across the Columbia River Basin and beyond. The technology used in Hanford created its particularly confounding ecology, including not only the unsettling consequences of radiation but how its presence is constructed through state interests to shield itself from culpability. "Without these technologies and the way in which they are assembled in the world, contemporary empire" and ways of being would not be possible[25].

Design, particularly landscape architecture, should seek to reveal the structuration and organization of people and environments by dominant power systems, actors, and operations. The discipline's capability to countermap[26] dominant spatial organizations to reveal inequities and empower resistance is essential – though perhaps more important is using design to create opportunities and platforms for engagement with dominant power systems and their articulation of geographies that reify and sustain their organization. The distribution of pollution through the creation of geographies, infrastructure, and flows requires the configuration of land and water systems to produce power, products, and waste with deeply unequal benefits and burdens. In the Anthropocene and nuclear age, this particularly means enhancing the legibility of pollution and waste movements and its disproportionate accumulation in bodies and ecosystems and attending effects on lifeways.

Instead of responding to the evolutions of ecological thinking or technological advancements and retaining an arc towards curated naturalism, landscape architecture ought to engage in the inherent politicality of land and cultivate a relationship with not only natural spaces but tease out and respond to the geopolitical narratives of terrestrial, liminal, and oceanic territoralization. If landscape architecture is indeed interdisciplinary then it ought to genuinely take up the earthen history of geopolitics. Engagement with the political ecologies of the Anthropocene means investigating and designing for the full spectrum of conditions created by the land uses *and* wastescapes of our habitation.

For landscape architecture, shifts in thinking about nature and culture in the 21st century have ushered in reassessments of the ecological and the urban. However, as the nature/culture binary dissolves and ideas of traditional wilderness dissipate, traditional conceptualities of wilderness become recognized as either entirely fictive, or as a memory often recognized as settlers' fiction. Landscape architecture has often relied on traditional or bourgeois notions of nature, but given the breakdown of this concept along with the increasing legibility of political forces creating conditions of normative breakdown and inequity, new challenges and possibilities emerge. Thus, practice should analyze and challenge the structuration of our world. The breakdown of classical nature and the advent of nuclear energy speaks to the wickedness of understanding place, influence, and possibilities for action in an increasingly precarious world. Challenging and expanding conventional notions of agency are predicated on upsetting normative notions of the human and ecological to reveal shared constitutionality and affectivity.

How can we rethink consequences of land use through highly toxic sites? And How could we recognize, articulate, and contest the territorialization of space within the Anthropocene? By taking Hanford as our place of investigation, how might we begin to confront our histories and uncover ways of thinking about power and landscapes, the materials and systems we develop to organize our world, and their collective import on the worlds around and within us.

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25 Bryant, Levi R. Onto-cartography: an ontology of machines and media. Edinburgh, Scotland: Edinburgh University Press, 2014. (pp. 260)

26 The term countermap has its origins in: Peluso, N.L (1995). "Whose Woods are These? Counter-Mapping Forest Territories in Kalimantan, Indonesia". Antipode. 4(27): 383–406. doi:10.1111/j.1467-8330.1995.tb00286.x. The thinking here as it is framed in regards to landscape architecture is significantly influence by the work of Pierre Belanger.

NUCLEAR POWER AND NUCLEAR LANDSCAPES

The effects of nuclear power are globally distributed in a material sense due to thousands of nuclear weapons tests and the distribution of novel radionuclides. But the creation of vast energy and weapon's networks that remain active means that nuclear power continues to organize and shape our world in profound ways through its unfolding legacies of nuclear waste, energy, and weapons. The scope and scale of its effect tends to exist in the background of our minds where we are only ever unsettled when a disaster strikes, such as Three Mile Island, or we realize our proximity to nuclear dangers both perceived and real. The naturalization of nuclear power through children's games, advertisements, public relations efforts, and the largely silent yet intensive labors of the DOE and DOD to manage and secure all things nuclear belies the fact that: we could readily destroy the entire world and that in the process of providing electricity and unprecedented destructive military might we have accumulated a scale of waste so toxic and voluminous that we have not resolved a storage method; or that nuclear waste and weapons travel some 3,000,000 miles per year[27] along everyday American highways, rivers, and roads[28].

Across the US, one hundred and seven sites have been identified by the DOE with 15 active cleanup operations covering more than 3,250 square miles[29], an area nearly the same size as the entire Olympic Peninsula in Washington state. "In a perverse way, radioactive contamination has gone from a shameful secret to be concealed to an asset to be milked"[30] – the secrecy and guardedness around contamination has transitioned to a multi-billion-dollar industry for cleanup at Manhattan Project sites. The legacy of defense waste has created a series of locations around the US "that are beginning to look like a permanent archipelago of national sacrifice zones"[31]. These spaces were catalyzed by Hanford and its production.

The social reactions to nuclear power have ranged from horror to wide-eyed optimism. Atomic cities – the science towns created to realize the Manhattan Project's goal – often understood their role as duty bound patriotism. Environmentalists and indigenous communities, who were at first excited about the prospect of jobs and clean energy, came to be deeply reticent and

27 Weinstein, Adam. "Nuclear Weapons on a Highway Near You." Mother Jones. Accessed December 03, 2016. http://www.motherjones.com/politics/2012/02/nuclear-truckers.

28 Vardabedian, Ralph, and W. J. Hennigan. "This troubled, covert agency is responsible for trucking nuclear bombs across America each day." Los Angeles Times. March 10, 2017. Accessed March 11, 2017. http://www.latimes.com/nation/la-na-nuclear-couriers-20170310-story.html.

29 "Cleanup Sites." Department of Energy. Accessed February 03, 2017. https://energy.gov/em/cleanup-sites.

30 Gusterson, Hugh, 2017.

31 Ibid.



NATIONAL NUCLEAR MUSEUM GIFT SHOP
2017.

angry upon realizing how nuclear worker's health was handled and politically constructed in opposition to actual health effects as well as the problem of nuclear waste and fallout risks. These risks became increasingly clear and relevant as adverse health effects accumulated and prospects of war, waste, and contamination became actualities. The post war boom's impact vis-à-vis nuclear power can have some parallels drawn from it – particularly how weapons and energy systems structure political imaginaries and influence urban form. The specific reality is that nuclear power realized more than a shift in scientific and social thinking but also created a discrete set of geographies that were reconfigured for nuclear weapons and then had to deal with the consequences of production.

After World War II, the American highway system served as the primary conduit through which the surplus of the post war boom deposited itself and accelerated urban sprawl. The combination of the automobile, credit financing, and a political economy shifting capacities to a post-war nation rapidly reified existing racial attitudes and normalized sprawl. This era's success and material excess was predicated on vast resource extraction and industrial landscapes. The assembling of resources at this scale required significant amounts of electrical power, as well as immense military power to sustain the new national lab network spawned from the Manhattan Project and produce weapons for the Cold War.

The military protection of the American lifestyle is partly dependent on the DOE and DOD's collaborative work to ensure that U.S. nuclear energy facilities and weapons systems are secure and functioning properly. This curious partnership is a product of the Manhattan Project as the DOE "traces its origins to World War II and the Manhattan Project effort to build the first atomic bomb. As the direct descendent of the Manhattan Engineer District, the organization set up by the Army Corps of Engineers to develop and build the bomb"[32]. Given that the DOD "is the largest institutional consumer of energy worldwide [accounting] for 80 to more than 90 percent of US Government energy use"[33] high connectivity to the DOE is contingent on fueling the logistical network of the DOD. The DOE's post Manhattan Project role includes the sustained oversight of the national lab network. While engaged in a variety of civil science projects giving us advancements in everything from CD-ROMS to high performance crop management, the project has also been integral for producing nuclear weapons, R&D of other military weapons systems, and scanning and detection methods for nuclear arms control and non-proliferation efforts. The DOD and DOE signed a Memorandum of Understanding formally recognizing shared contingencies where the DOE aids in national energy security and the DOD provides test-bed opportunities for DOE research[34]. "Despite its name, most of the Energy Department's budget is devoted to maintaining the nation's stockpile of nuclear warheads and to cleaning up nuclear waste at sites left by military weapons programs"[35] – historically, approximately 66% of the DOE's budget has been allocated to nuclear weapons and related programs[36].

Despite all this attention and funding, nuclear power is often invisible to the general public. The significant investment and large territorial occupation of nuclear power is largely able to exist in the background of our minds in the form of either comedy, occasionally manifested disaster, or reactive anxieties about prospects of nuclear war. Tendencies that lurch towards obscurantism, blithe hope, or unquestioned fear regarding nuclear power fail

32 "Manhattan Project." Manhattan Project | Department of Energy. Accessed May 27, 2017. https://www.energy.gov/management/office-management/operational-management/history/manhattan-project.

33 Bélanger, Pierre, and Alexander S. Arroyo. Ecologies of power: mapping the logistical landscapes and military geographies of the U.S. Department of Defense. Cambridge, MA: The MIT Press, 2016.

34 DOE & DOD. (2010) Memorandum of Understanding Between U.S. Department of Energy and U.S. Department of Defense Concerning Cooperation in a Strategic Partnership to Enhance Energy Security. Retrieved from: https://energy.gov/sites/prod/files/edg/news/documents/Enhance-Energy-Security-MOU.pdf

35 Eilperin, Juliet, and Steven Mufson. "Trump taps former Texas Gov. Rick Perry to head Energy Department he once vowed to abolish." The Washington Post. December 14, 2016. Accessed May 24, 2017. https://www.washingtonpost.com/news/energy-environment/wp/2016/12/13/trump-taps-former-texas-gov-rick-perry-to-head-energy-department-he-once-vowed-to-abolish/?hpid=hp_rhp-top-table-main_perry-1010a%3Ahomepage%2Fstory&utm_term=.a8f6b1ba5bf4.

36 Thanks to Steven Schwartz, an independent analyst who has worked with Brookings Institution and authored Atomic Audit for this information and assistance with DOE budgets.

to account for the fact that nuclear energy and weaponry are highly controlled and monitored networks of power with distinct geographic locations. The disjunction where world-ending power exists as an ephemerality that occasionally reveals itself[37] in moments of failure[38] or imminent risk – but is always in operation and geographically emplaced[39] – denies better cognizance of how distributed systems inhabit space and construct territories. In this way, massively distributed systems are naturalized within daily life due to their ubiquity and our inability to know its full effect or geography. Nuclear weapons and their production are such a network. These entities are overseen by state actors including the Department of Defense (DOD), Department of Energy (DOE), and National Nuclear Security Administration (NNSA). Whose storage, maintenance, and weapons facilities occupy swathes of some of the most heavily surveilled territory in the country. This network has allowed for substantial technological advances in both energy and weapon production by relying heavily on natural resources and supply chains with problematic histories of colonialism[40].

Nuclear facilities have frequently used large terrain buffers and large fortified buildings to obscure their presence. Many weapons facilities are underground and under heavy guard and nuclear waste remains largely limited to whatever methods are immediately available on-site and in accordance with the NNSA and DOE. It is for these physical reasons that nuclear power is invisible to so many.

Such power dynamics and their manifestation in the built environment should be more thoroughly engaged in more territorially minded approaches. These approaches should map the connective tissues that bind, strengthen, and produce their geographies of power. Investigating organizational capacities of nuclear power through design allows inspection of systems opening alternatives that work against dominant narratives and seek revelatory cartographies of agents and operations capable of revealing power and empowering resistance. The capacity for dominant entities to mask or obscure their presence, fundamentally to naturalize or necessitate a particular construct of being, can be challenged by creating visual and spatial

37 Edwards, Paul N. "Infrastructure and Modernity Force, Time and Social Organization in the History of Sociotechnical Systems." In Modernity and Technology, 185-225. Cambridge, MA: MIT Press.

38 Maggelet, Michael H., and James C. Oskins. Broken arrow: the declassified history of U.S. nuclear weapons accidents. Raleigh, NC: Lulu.com, 2007.

39 Burrington, Ingrid E. "The Cloud Is Not the Territory." Creative Time Reports. May 20, 2014. Accessed June 16, 2016. http://creativetimereports.org/2014/05/20/ingrid-burrington-the-cloud-is-not-the-territory-wnv/.

40 Hecht, Gabrielle. Being nuclear: Africans and the global uranium trade. Cambridge, MA: The MIT Press, 2014.

experiences. Such designs can cultivate knowledge by enhancing legibility of state-actor land use to ultimately realize alternative ways of configuring natural resources.

LEARNING FROM NUCLEAR WASTE

The U.S. nuclear production for weapons transitioned at the end of the Cold War from active production to various forms of cleanup. These methods include attempts at remediation through either physical means of removing (i.e. moving elsewhere) or confining toxic substances, or through reterritorialization where alternative classifications are applied to nuclear territories to alleviate the financial burden created by nuclear waste cleanup projects (Cram – article).

While significant strides have been made in handling nuclear waste, there remains no viable method to truly clean, nor to render nuclear waste completely harmless at a scale commensurate with its volume and variety. The act of nuclear site cleanup projects is, in effect, a palatable moniker to suggest definitive capabilities for controlling toxicity. Thus, waste handling practices remain largely ad hoc given that the U.S. has not successfully coordinated a waste storage strategy capable of handling the nation's total waste. Yucca Mountain Nuclear Waste Repository lingered for nearly a decade before being abandoned by the Obama Administration. The Waste Isolation Pilot Plant (WIPP) is the nation's only site where transuranic waste is stored. The WIPP recently resumed operations after a fire in 2014. The WIPP has not and will not receive high level radioactive waste. Thus, most government and domestic energy suppliers rely on either spent fuel pools or on-site dry cask storage[41].

Without sufficiently safe ways to store high-level nuclear waste for its toxic lifespan existing methods of in-situ containment or various modes of material choreography are essentially holding patterns for military nuclear waste to be stored as safely as possible until a more permanent solution is realized. Consequently, waste handling practices are site specific and deal with the identification, classification, extraction, and confinement of waste. The Manhattan Project and Cold War sites were often operating under extreme pressure to produce nuclear arms. These facilities did not yet have proper

41 "Storage of Spent Nuclear Fuel." United States Nuclear Regulatory Commission - Protecting People and the Environment. Accessed May 10, 2017. https://www.nrc.gov/waste/spent-fuel-storage.html.



WASTE ISOLATION PILOT PLANT
As seen from Wipp Rd. 2017.

waste handling procedures and often operated under the false assumption that their environments could digest and disperse waste to sufficiently safe volumes. These facilities must now locate, identify, and consolidate environmental and biological materials, as well as contaminated facilities, into burial sites. Thus, high-level nuclear waste, some of the dangerous material on earth, is effectively stored via the landfill model.

The Hanford scientists and engineers are endeavoring to use vitrification as a way to render waste as inert as possible, where nuclear waste is subjected to extreme heat and turned into a molten glass substance that is then cooled and containerized for below ground burial. This process remains in the experimental phase until the Hanford Vitrification Plant becomes operational. The Plant is currently behind schedule and over budget, with some speculation if the project will never succeed. Until its success is realized there is no viable method to store high-level waste at a scale commensurate with current nuclear waste volumes.

The physical amount and level of toxicity of nuclear waste from military production means it is often understood as an 'other' – one that denies true encounter by virtue of its very existence: a human made product born during war whose physical properties bar proximate encounter. Though nuclear products have purpose as a technological achievement providing

military might and domestic energy protection, the physical byproducts and weapons themselves challenge our restraint and purpose. We have yet to see a technology that can address the full spectrum of consequences of our technological achievements.

Consequently, we argue here that design must begin to challenge notions 'cleanup' operations at Hanford as well as at other contaminated sites. The exclusion of design from these territories is partly powered by assumptions of engineering as the discipline capable of repairing these spaces. This suggests that a history problematic production can be resolved by the same means. The disciplines used to create destruction through nuclear weapons is now being employed in attempts to contain and control nuclear waste. However, the valuation of engineering as an optimized approach to technical resolution of the problem of nuclear waste fails to account for the legacies of local and international nuclear supply chains and production. The combination of engineering's necessitation and site security needs has barred alternative modes of contact with nuclear facilities and legacies. The approaches here severely constrict narrative possibilities for understanding or exploring to nuclear production and its waste cycle.

Continuing to treat nuclear waste as a purely technical problem circumscribes broader discussion of energy and weapons production regimes by nuclear means. Further, it positions the loss of indigenous lifeways, nuclear workforce risk, and downwind communities as an unfortunate necessity or simply collateral damage of nuclear colonialism at home and abroad[42]. By acknowledging processes as ongoing risk management scenarios and articulating spatial experiences that challenge ideas of cleaning or amelioration of systems as an erasure of error we should enhance our capacity to reflect on the consequences of how we use land[43]. The intent in looking at Hanford and challenging official ways of relating to the site is aimed at serving as revelatory in terms of not only the consequences of our uses of natural materials but that such use enmeshes us with the world through the creation of material new to this world that permanently marks our world. From an ethics perspective, negotiating opportunities for and conditions of encounter with the other is deeply necessary challenge for fostering a relationship and cultivating a sense of civic stewardship of waste and its territories.

42 Domestically, the Navajo Nation is one of the most egregious examples of nuclear colonialism. Beyond US borders, nuclear testing in the Marshall Islands and Bikini Atoll by the US has created one of the most catastrophic examples of what unfettered nuclear weapons testing can do. See: Judy Pasternak's Yellow Dirt and Bombs Over Bikini by Connie Goldsmith.

43 Purdy, Jedediah. After Nature: a politics for the Anthropocene. Cambridge, MA: Harvard University Press, 2015. (pp. 265)

The scales of waste and territorial organization across the nation has realized the human as geologic agent in the Anthropocene. This challenges how we are accustomed to understanding nature. History is becoming increasingly replete with examples of a long history of mutual cultivation and transformation between land and humans. We organize territory, and territory organizes us: nuclear wastescapes are one salient example. Approaches that work against realizing co-constitutionality between humans and land risks reifying a fiction of human mastery at the expense of creating opportunities to more deliberately cultivate awareness and intimacy between humans and landscapes of all types.

Efforts to contain nuclear waste have not been met with success in part stemming from the public's distrust of the science and a heightened sense of threat, particularly after major nuclear incidents such as Three Mile Island, Chernobyl, and Fukushima. The Yucca Mountain Repository was canceled after significant opposition from Arizona residents and congressional members. Meanwhile the United States is experimenting with the Waste Isolation Pilot Project (WIPP) outside of Carlsbad, NM as a national deep geologic repository of nuclear waste set to be completed in 2040. However, WIPP is not capable of holding the amount of nuclear waste produced by American nuclear facilities. It is, however, an important iteration in the feasibility of long-term, deep geologic, repository approaches.

Besides burial or vitrification, refinement of spent nuclear fuel is another option often called the 'recycling' of spent nuclear fuel, has largely been avoided for two reasons: 1) nuclear energy remains a high-tension issue after a series of nuclear accidents and disasters both in the U.S. and abroad barring issuance of new permits for nuclear power plants in the US and 2) refining spent nuclear fuel from American nuclear facilities would mean that the material would be upgraded to weapons grade in the process, stoking fears of terrorism.

Risks posed by nuclear waste confirms that we live amongst and within Hanford's legacy. While the clean-up (read: sustained risk management scenario) and mothballing of site facilities through entombment, burial, or vitrification may seem to indicate that its legacy is coming to a close; a closer truth indicates that it is merely transitioning into a phase of experimentation in site remediation and technologies.

Consequently, our task regarding nuclear waste and nature is not about the technical resolution of the problem. Such a power to transmogrify lethal substances might resolve the technical challenge of nuclear waste but in so doing would circumvent broader, more involved discussions of the collective effect and challenge of nuclear waste. A potential parallel to this challenge

can be seen in recent prospects for a plastic eating caterpillar[44] (amongst a slew of other speculative possibilities for employing species and bacteria for biodegradation of plastics), represent a common affinity for a solution that can be found and scaled to the scope of a current problem. These sorts of technical solutions, whether they use biological or mechanical means, operate through logics of optimization[45]. We may find that logistical solutions to problems is akin to binaries that fail miserably at cultivating a richer sense of being, one more aware of the multitudinous and highly complex ways of being in and knowing the world. These sorts of solutions purport to meet our great challenges yet persistently operate according to the logic of the reusable bag – while its use cuts down on the need for plastic and paper bags, it does not change the much more massive use of plastics in shipping and packaging nor, more importantly. Nor does it challenge the destructive patterns of consumption wrought by capitalism. Such thinking, in the case of resolving the burden of plastic, risks characterizing the problem as a simple externality of production that we have satisfactorily resolved through technical resolutions.

Hence, the prospect of transmogrifying nuclear waste into completely inert substances that can be safely hidden away circumscribes broader democratic discussion of the uneven and massively distributed consequences of nuclear weapons and energy systems. As Donna Haraway (2017) explains:

Our task is to make trouble, to stir up potent response to devastating events, as well as to settle troubled waters and rebuild quiet places. In urgent times, many of us are tempted to address trouble in terms of making an imagined future safe, of stopping something from happening that looms in the future, of clearing away the present and the past in order to make futures for coming generations. Staying with the trouble does not require such a relationship to times called the future. In fact, staying with the trouble requires learning to be truly present, not as a vanishing point between awful and Edenic pasts and apocalyptic or salvific futures, but as mortal critters entwined in myriad unfinished configuration of places, times, matters, meanings.[46]

Haraway goes on to write that blind faith in 'techno-fixes' risks repeating a proto-religious aspiration for rescue from a higher being; the archangels of Haraway's 'techno-fixes' or Purdy's logics of optimization just have hardware, software, and algorithms instead of wings, scepters, and divine intent. Key to this line of thinking is that tamping down blind faith in technology does not equate to abandoning technology and aiming for some version of Arcadian salvation. Instead it acknowledges the capacity to think differently and to recognize and cultivate intimacy with the strangeness of our world.

Cultivating and becoming comfortable with such intimacy requires resisting the gravity of oblivion – where the world is understood as irreparably bound for destruction, so why try and stop the inevitable? This disposition can be hard to dismiss, but one that must be confronted if we are to avoid fatalism, reliance on techno-salvation, or ignorant racist Arcadian aspirations. The scale of such fear about the Anthropocene exacerbating existing stressors to breaking points appears to be increasingly common. The Intercept reported in October of 2016 on a Pentagon video used at the Pentagon's Joint Special Operations University[47] titled, "Megacities: Urban Future, the Emerging Complexity." The short clip works to create a convincing narrative of cities as future territories that will ineluctably experience stresses and inequities beyond the capabilities of states or militaries to maintain order. If we retain visions of a dark future without question, we risk failing to create alternatives and surrender to the narratives of state-actors whose stories necessitate their importance and militancy through fear-mongering.

ECOLOGIES OF RESISTANCE – EMBRACING DARKNESS

While contemporary stories about global pollution, erosion, or population surges engender speculative narratives concerning world (up)ending scenarios as seen in The Pentagon's war college video[48]; nuclear weapons have figured prominently. In the words of John F. Kennedy, "today every inhabitant of this planet must contemplate the day when this planet may no longer be habitable. Every man, woman and child lives under a nuclear Sword of Damocles, hanging by the slenderest of threads, capable of being cut at any moment by accident, miscalculation, or madness"[49]. While the Anthropocene is recognized as the key turning point that intertwines the geologic with the collapse of the nature/culture binary it does not simply mean new models are needed for understanding, but that possibilities of world ending pollution

44 Yong, Ed. "The Very Hungry Plastic-Eating Caterpillar." The Atlantic. April 24, 2017. Accessed April 26, 2017. https://www.theatlantic.com/science/archive/2017/04/the-very-hungry-plastic-eating-caterpillar/524097/.

45 Purdy, J. 2015

46 Haraway, D. (2016). *Staying with the trouble: Making kin in the Chthulucene* (Experimental futures). Durham, NC: Duke University Press.

47 Turse, Nick. "Pentagon Video Warns of "Unavoidable" Dystopian Future for World's Biggest Cities." The Intercept. October 13, 2016. Accessed October 25, 2016. https://theintercept.com/2016/10/13/pentagon-video-warns-of-unavoidable-dystopian-future-for-worlds-biggest-cities/

48 Ibid.

49 Kennedy, John F. "JFK Address at U.N. General Assembly, 25 September 1961. "Speech, U.N. General Assembly, 25 September 1961, United Nations, New York City. Accessed May 3, 2017. https://www.jfklibrary.org/Asset-Viewer/DOPIN64xJUGRKgdHJ9NfgQ.aspx.

and destruction through agrilogistics, pollution, or weapons is no longer a speculative possibility, but a material condition of life on earth.

While avoidance of these conditions is not moral, neither is a totally fatalistic view about the future during the Anthropocene, climate change, and emerging resource conflicts. The darkness promulgated by the military as well as the popular press with stories of climate change and population growth, which sometimes adopt an accelerationist approach that employs hopelessness as justified inaction. But such darkness should not be understood as a maw we are already within, as Timothy Morton explains in Dark Ecology, confrontation with darkness in any form should not conjure up visions of death, destruction, or contamination but instead, "dark ecology thinks the truth of death, a massive cognitive relief that if integrated into social form would embody nonviolence"[50].

Thinking towards death can be understood as not apathetic blitheness or utter resignation but a recapitulation of temporality vis-à-vis the primacy of the collective human and open ourselves up to the lethal materialities we have realized in plutonium, petrochemicals, and environmental toxins. This sort of intimacy is a helpful mode of cognizance given the polyester in our food chain[51], plastics in our salt supply[52], and people mining through garbage[53]. Recognition of the breadth and depth of waste's distribution and affectivity on our human bodies can help us to transcend Morton's agrilogistics[54] where the primacy of the human is predicated on a fictional capacity to remove and control the environment. An approach informed by dark ecology realizes not only the totality of change through nuclear weapons or climate change, but recognizes the profound strangeness embedded in the very real materialities of the world, including the human body. The strangeness of the world is not outside the human body as an agrilogistical view might presume, but moves through, is a result of, and constantly co-constitutes both human and world in a way that challenges the idea of the human as a separate entity. Further, it recognizes the affective capacities of non-human materiality, both biotic and abiotic, questioning the deficiency of common linguistic habits to describe the world as human or nature.

50 Morton, Timothy. Dark ecology: for a logic of future coexistence. New York: Columbia University Press, 2016. (pp. 116)

51 Boddy, Jessica. "Are We Eating Our Fleece Jackets? Microfibers Are Migrating Into Field And Food." NPR. February 06, 2017. Accessed February 06, 2017. http://www.npr.org/sections/thesalt/2017/02/06/511843443/are-we-eating-our-fleece-jackets-microfibers-are-migrating-into-field-and-food.

52 Karami, A., et al. (2017). "The presence of microplastics in commercial salts from different countries." Scientific Reports 7: 46173.

53 Grossman, Elizabeth. *High tech trash: digital devices, hidden toxics, and human health*. Washington D.C.: Island Press/Shearwater Books, 2007.

54 Morton, T. 2016.

However, the propensities of taxonomic linguistic habits continue to organize how we know the world, specifically how we organize territory, resources, and extraction regimes. Agrilogistics propelled a "flattening out of the world into empty space filled with manipulable lumps of matter [...] with the emergence of agrilogistics, we stopped seeing other beings as coexisting with us and began our way against their wildness, attempting to tame them, and control them"[55]. The feedback loops created by these habits of speaking, making, and thinking intertwined humanity and materials on a massive geologic scale that motivates us to "distinguish ourselves from nonhumans and develop better methods of control instead of challenging anthropocentric rights to sovereignty"[56]. Adopting and exploring possibilities of this disposition means not only understanding things in terms of flows and systems through assemblage theory, but recognizing the results of these processes to create objects and entities:

Synthetic hormones flow into cows into milk and back into humans, accomplishing life-altering work along the way. Plants need not be genetically modified to ingest more water from polluted streams and pass it on when creatures turn them into food. Uranium extracted from rocks to power turbines yields hot radioactive particles that lung tissue can incorporate in the event of a nuclear meltdown. In this sense new animisms literally reconceive humans as the products of an "environment" that has itself taken shape through embodied human action, often in the pursuit of profit.[57]

Cultivating intimacy means intense friction not only with individual modes of thinking but also culturally dominant ways of knowing. While there are attempts at moving past an industrial capitalism that "packages" things like uranium into "resources" for weapons or energy, we are predominately still guided by a narrative of modern progress "about a Nature that would supply the necessary" material[58]. Habits of managing the environment through calibrated economics that arbitrates acceptable levels of ecological integrity might be a loosely more enlarged disposition, but still assumes the human is the sole operator in a "seat of awareness, bounded by the skin, and set against the world"[59].

This sort of intimacy is not just another nail hammered into the coffin of the nature/culture binary, but recognizes that environments, wildness, or

55 Harris, Derrick. "Timothy Morton. Dark Ecology: For a Logic of Future Coexistence." Environmental Philosophy 13, no. 2 (2016): 303-06.

56 Ibid.

57 Weston, Kath. Animate Planet: Making Visceral Sense of Living in a High-tech, Ecologically Damaged World. Durham, NC: Duke University Press, 2017. (p. 4)

58 Ibid., p. 5

59 Ingold, Tim. The Perception of the Environment: Essays on Livelihood, Dwelling & Skill. London; New York: Routledge, 2000. (p. 243)

nature do not exist in politically circumscribed and managed spaces that we must travel to for soulful amelioration, but are wherever we are and never only in "some unlogged remnant of a far-off nature preserve" but also within postindustrial sites and drossscapes[60], or nuclear reservations[61]. This recognizes that environmental (in)justice is central to how we organize and manage resources, the consequences of our extraction and production machines, patterns of population distributions and exposure or body burden; as well as the recognition of waste as a purely capitalistic externality or an unfortunate byproduct of larger processes that benefit people through living *in modern times.*

Challenging prototypical modes of spatial organization and the separation of human and natural ecologies as distinct systems are central to working against territorializing schemes that seek to reify nature as isolated Arcadian pockets or to organize people in ways that insulate the wealthiest from the body burden pollution. Our world is rife with globally distributed pollution and toxins that disproportionally kill[62] or deny reproductive capacities not only to humans[63], but some of the oceans' charismatic megafauna[64] as well. Orcas are not only endangered in Seaworld, but in the ocean; humans are not only endangered in the uranium mining country[65], but in their homes with hundreds of nuclear tipped warheads shuttling throughout the oceans and locked into subterranean silos across the U.S.'s north-central breadbasket[66].

The ubiquity of nuclear waste, weapons, and pollution generally suggests perspectives recognizing dissolution of binaries and collapse of boundaries should perhaps look no further than nuclear territories. As spaces of dispossession, production, conservation, and toxification these spaces can serve as opportunities for cultivating intimacy through provocation that at first unsettles, but then makes clear: you are not so separate from the world. Landscapes of nuclear production can serve as spaces to play with the idea of what Linda Hogan famously described, "Here is a lesson: what happens to people and what happens to land is the same thing"[67] to start realize the mutuality we share with a landscape's toxic burden, the plight of a salmon with upwelling toxic plumes, or telephone poles irradiated by coyote urine, or the tumbleweed rolling across a landscape being chased by a Biological Control officer trying to catch its nuclear burden before it crosses a political boundary[68].

Nuclear waste and its effects and location – its ecology – are issues of power and justice and offering a place to begin inspecting relationships to land and territorialization. This conversation should not lurch towards some sort of transhumanism or post-humanism thinking through pollution and waste economies, particularly of the nuclear paradigm, and are not aimed at permitting techno-capitalist possibilities where *because* we have a relationship with waste and recognize its impact on the human and non-human, that operations can resume as usual. Cultivating a capacity for kinship or new animisms does not mean that inequities and toxicity become normalized, instead their acceptance becomes a part of a broader realization aimed at illuminating the lives of humans, nonhumans, and objects as living in the ruins of our world – the massively distributed consequences of our machines producing and creating externalities that linger and affect all things. Nuclear power requires infrastructure and logistics like most things in our world, but it's capacity to be massively distributed and largely illegible mirrors the distribution of pollution in our world: ubiquitous and increasingly becoming a constituent part of all things. Attempts at cleaning and reorganizing our world to separate out contamination may be fallacious – attempts to use technology to return or repair our world have yet to be realized. And, even if they could, it would not signal a return – instead we ought to go forward and embrace the strange, the toxic, and disproportionate to better know and understand the toxic burden of the world, and ourselves.

60 Berger, Alan. Drosscape: Wasting Land in Urban America. 1st ed. New York: Princeton Architectural Press, 2006.
61 Weston, K. (p. 15)
62 Bullard, Robert D. Environment and morality: confronting environmental racism in the United States. Proceedings. Geneva: United Nations Research Institute for Social Development, 2004.
63 Singer, M. (2011), Down Cancer Alley: The Lived Experience of Health and Environmental Suffering in Louisiana's Chemical Corridor. Medical Anthropology Quarterly, 25: 141–163.
64 Carrington, Damian. "UK killer whale died with extreme levels of toxic pollutants." The Guardian. May 02, 2017. Accessed May 03, 2017. https://www.theguardian.com/environment/2017/may/02/uk-killer-whale-died-extreme-levels-toxic-pollutants.
65 Brugge, D., & Goble, R. (2002). The History of Uranium Mining and the Navajo People. American Journal of Public Health, 92(9), 1410–1419. Traci Brynne Voyles's Wastelanding: Legacies of Uranium Mining in Navajo Country is another excellent account of extraction, colonialism, and violence exacted upon the Navajo people in the process of producing nuclear weapons.
66 While the total US nuclear arsenal is estimated to be around 7,000 nuclear warheads (per NYT reporting), conversation with nuclear security experts revealed their estimation that between 700-800 warheads are ready for launch at sea in Ohio class submarines and in Minuteman silos. Though representative of approximately 10% of the total arsenal, it is still a world ending capability.
67 Hogan, Linda. Dwellings: A Spiritual History of the Living World. 1st Touchstone ed. New York: Simon & Schuster, 1996.
68 Cram, S. 2015

MEMORIALIZATION AND THE DESIGN POTENTIAL WITHIN NUCLEAR LEGACY

The Department of Energy's (DOE) current cleanup program involves the consolidation and treatment of pollution across Hanford until the existing soil and water can be tested and assessed as within permissible levels of contaminants as defined through federally established safety standards. The techniques employed for this process of cleanup will not erase all evidence of plutonium production at Hanford although it suggests the perception of doing so. this perception perpetuate a narrative that a nuclear site can be returned back to the condition it was in prior to militarization. Such a false perception suggests a narrative of transformation from pollution, dumping, and unprecedented toxicity to a contained, safe, and re-naturalized engineering success.

Simultaneous to the DOE's cleanup program, the National Park Service (NPS) has designated the B Reactor as a National Historic Landmark and as part of the Manhattan National Park Project. This designation suggests a memorialization replete with tours and a visitor center. The NPS has stated that the history presented at the B Reactor will be limited to **the years 1942-1946** with focus on the scientific, social, and political narratives at a local and national scale. The memorialization of the B Reactor follows a common practice within historic preservation to limit and direct the narrative away from past and present controversies towards positive events and lessons learned. The technical accomplishment of the first large-scale nuclear production site will not be accompanied by details on the expansive dumping practices or the perpetual waste management at Hanford's own Environmental Restoration Disposal Facility despite the impact that this environmental legacy will continue to have on the surrounding community.

Exploration of authorized heritage discourse (AHD) sheds light on how and why historic narratives are often limited to the spectacular, proud, and beautiful despite a more recent desire within historic preservation and landscape architecture to expand heritage beyond traditional sites to more inclusive cultural landscapes[1]. One example of the expansion of authorized discourse to more socially and environmentally controversial sites has been the adoption of post-industrial sites as cultural heritage. Despite a lack of traditional aesthetic appeal, these sites embody a narrative of the vernacular that is now deemed culturally significant. With the adoption of these sites into authorized heritage, they have both expanded a cultural understanding of beauty and, on the other hand, been subject to a physical and narrative cleansing, much like Hanford. If post-industrial sites can expand the definition of heritage such that utilitarian structures are understood as a valid contribution to the cultural landscape, can Hanford and other post-production nuclear sites expand it further? In doing so, there is opportunity to encourage a more nuanced dialogue about our nuclear legacy and the aesthetic relationship within toxic wastescapes.

POWER, BEAUTY, MEMORIAL

"The 'authorized heritage discourse' privileges monumentality and grand scale, innate artifact/site significance tied to time depth, scientific/aesthetic expert judgement, social consensus and building. It is a self referential discourse, which has a particular set of consequences." - Heritage scholar Laurajane Smith [2]

Since authorized heritage discourse emerged in the 17th century, the monument and the characteristic of monumentality have played an integral part of the discussion. Through the very designation as "monument," sites and objects become signifiers of authorized heritage and imbued with ideas of power and beauty that are expected to commemorate collective social values[3]. In turn, monuments are understood within AHD to be symbolic

1 Smith, Laurajane. *Uses of Heritage.* London ; New York: Routledge, Taylor & Francis Group, 2006. (p. 12)
2 Smith, L. 2006. (p. 19)
3 Ibid. (p.19)

representations of community identity[4]. However, this identity has long lacked complexity and variability. Sites and objects have traditionally been designated because of their physical values such as aesthetics and materiality or culturally within the narrow scope of historical, scientific, or educational significance[5]. Heritage scholar Francoise Choay has also argued that throughout the global community, those choosing what is memorialized have traditionally been European and upper/middle class experts in the field of historic preservation and heritage, thus representing a narrow and bias interpretation of what is culturally significant[6]. In short, monuments have long represented a very limited and specific perspective of what cultural heritage is.

In the latter half of the 20th century, authorized heritage discourse attempted to expand beyond its traditional, and arguably limited, perspective to include a broader interpretation of cultural heritage. The Venice Charter of 1964 and the Burra Charter of 1979 were each written to clarify that intangible practices - such as language and events - and a wider array of tangible places and objects - such as vernacular and industrial sites - should be included in the heritage discourse. These charters each encouraged a departure from heritage that was overly focused on site or object to one that could be conceptualized as a more nebulous cultural landscape. Situating heritage as landscape "makes both conceptual and physical space for a wider range and layering of competing values and meanings than does the idea of 'site'"[7]. In other words, site was but one part of a greater cultural landscape identity.

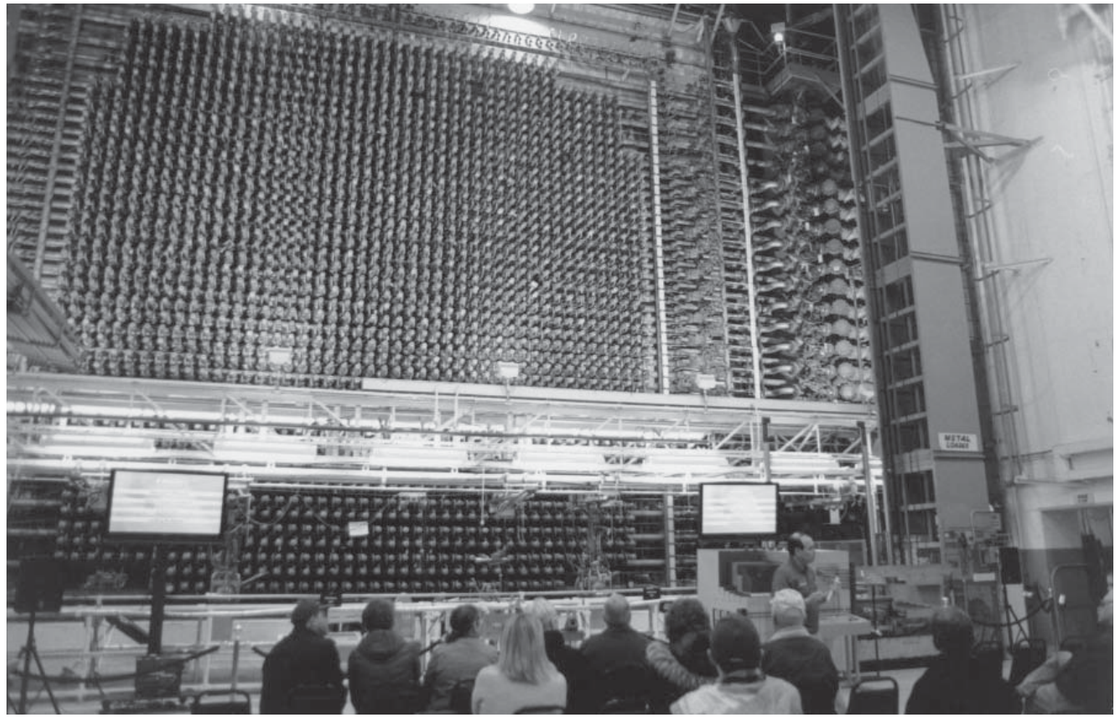
In more recent history, the role of monumentality has also come under critique[8]. Monuments and AHD have been accused of still being overly focused on "power, greatness, and beauty" and even the commemoration of tragic events is seen as being distilled to a glorification of destruction and a simplification of tragedy[9]. Furthermore, both monuments and AHD have been criticized for presenting the past as static, definitive, and separate from the present; in these circumstances, an emotional connection fails to develop between the visitor and the history being represented[10]. In a departure from the traditional dynamics of AHD, countermonuments like the Vietnam War Memorial in Washington D.C. and the Holocaust Memorial in Berlin have been created. These countermonuments take a conscientious step away from traditional depictions of beauty opting instead for abstract, somber, and introspective memorials that offer more flexible visitor interpretation[11]. While neither the Vietnam Memorial or the Holocaust Memorial have been absent from criticism, they both offer a significant departure from presenting history as static and both make gains towards creating a dialogue between present visitors and past events. This, in turn, helps perpetuate a greater cultural landscape - one which recognizes that we are still impacted by these respective events. As we look at Hanford, the memorialization taking place falls more into traditional AHD than this more progressive category of cultural landscape, in part because of the existing material legacy and also because of highly controlled narrative of both the Department of Energy and the National Park Service.

MEMORIALIZATION AT HANFORD

When the cleanup program began in 1989, the Department of Energy (DOE) was understandably prioritizing waste containment and remediation over the preservation of any on-site structures. Radioactive waste was rampant and stabilizing pollutants was most feasible through the demolition of all structures and consolidation of waste at the Environmental Restoration Facility (ERDF). However, the B Reactor - the first reactor to go live - had previously been memorialized as a National Historic Mechanical Engineering Landmark in 1976 and there was ambition at the DOE to preserve and remediate the structure so that it could be used as a museum to Hanford's nuclear history. Cleanup plans and comprehensive frameworks written at this time mentioned potential preservation depending on the restraint of budget and safety. Volunteers mostly comprised of former employees and Richland locals mobilized and formed the B Reactor Museum Association (BRMA) to lobby for historic status for the building and offer tours for the public as early as 1991. As a result, the B Reactor received a series of accolades in the 1990's: in 1992 it was placed on the National Register of Historic Places; in 1993 it received a Nuclear Historic Landmark award; and in 1994 it also became a National Civil Engineering Landmark. With each award the building's prominence was raised and likelihood of completing the expensive and difficult process of cleanup increased. Between 2002 and 2005, the DOE spent $3.3 million cleaning the site and making it suitable for more visits and tours[12]. Then, in 2008, the building was given the honor of National Historic Landmark. This placed the B Reactor in the same group of monuments as the White House and the Hoover Dam.

4 Ibid. (p.30)
5 Ibid. (p.26)
6 Ibid.(p.19); Choay, Francoise. The Invention of the Historic Monument. New York: Cambridge University Press, 2001. (p.110)
7 Smith, L. 2006. (p.31)
8 Bryan-Wilson, Julia "Building a Marker of Nuclear Warning." In Monuments and Memory, Made and Unmade. Chicago: University of Chicago Press, 2003. (p. 194)
9 Choay, F. 2001. (p.110); Brayn-Wilson, J. 2003. (p. 194)
10 Smith, L. 2006. (p. 29)
11 Bryan-Wilson, J. 2003. (p. 194)
12 "B Reactor" 2016"B Reactor." B Reactor Museum Association. 2016. Web. Accessed 15 May 2017. http://b-reactor.org/b-reactor-3/.





TOUR OF THE B REACTOR
Visitors are given a presentation in front of the reactor core. 2017

B REACTOR
2017
(previous page)

Though petitioning for the National Historic Register and National Historic Landmarks was no easy feat, advocacy for the B Reactor was well-timed with the increased interest in historic preservation for vernacular structures. Additionally, the narrative put forth for the B Reactor's heritage value embodied the characteristics of traditional authorized heritage discourse. The priorities stated by the BRMA are: "to save a technical marvel that played a major role in world history; to memorialize the men and women who successfully completed construction of one of the world's largest and most complex engineering and construction projects ever achieved; to educate and interpret for current and future generations the significance and lessons learned from Hanford and the Manhattan Project; to affirm the B Reactor's national recognition as an engineering and historic landmark; and to provide "an interpreted historic landmark" to support the mission of the new Hanford Reach Monument (The Reach) Heritage and Visitor Center[13]. While admirable, these goals are not that of a more inclusive cultural landscape, rather, they perpetuate a heritage that is focused on site, static past, and a cleansed expert narrative.

13 "B Reactor" 2016





TOUR HEADQUARTERS
Tours meet outside the Hanford boundary in a nearby plaza populated with Hanford-themed restaurants. 2017 (left)

VISITORS BUS TO THE B REACTOR
Access within the Hanford boundary is restricted unless visitors are signed up for a tour. 2017
(right)

The National Park Service (NPS) manages the B Reactor and, therefore, the heritage narrative. The tour of the B Reactor focuses on the years 1942 – 1946 but does not emphasize the building's role in the Cold War. The NPS also has Pre-War tours that provide visitors with information on the area for the years 1900 to 1942 however the forced exodus of the people of White Bluffs and native populations will be mentioned only to set the stage for the enormous feat of bringing the site up to running operations within only 13 months. The thirty years of operation after WWII will not be the focus either. And while the NPS has made a concerted effort to include a diversity of voices from employees of Hanford and citizens of Richland - including those of African Americans, women, those who still support the dropping of the bomb on Japan, and those who regret their involvement in the production of the bomb - these voices remain situated in the past and do not include those of the "downwinders," a group of people who are active today and believe their health and well-being has been damaged by living in close proximity to Hanford.

By isolating the B Reactor's history to the 1940's, the history is interpreted as complete; it no longer impacts the population of Richland or beyond. Visitors are spectators of something that WAS rather than seeing nuclear heritage as something still actively impacting people and the landscape. Frequently, the expectation within authorized heritage is that the visitor will only passively engage a site[14]. Although the BRMA and NPS value educating the "current and future generations" to the significance of the B Reactor by engaging them with interpretation, this presents the bias expert narrative that Choay warns of. By providing extensive signage the visitor can arrive, consume knowledge, witness, leave, and the site will remain consistent from one visit to the next, firmly rooted in the past as the NPS sees it. This not only reinforces the disconnection between present and past but also disconnects the visitor and his or her culture from the narrative. At Hanford, the visitor is presented with a site that is frozen in action, as if it is 1945 and all the workers have

14 Smith, L. 2006. (p. 31)

just clocked out for the night, but with the NPS as a guide to what the visitor should take away from the experience. While this is not an uninteresting nor a non-educational experience, the narrative is like that of a history book: scripted and complete.

Also neglected from the narrative of the B Reactor is any discussion of the environmental impact production operations have had on the site's landscape over the long term[15]. There has been no indication from the NPS that they will be communicating either the waste practices that took place during operation or the current cleanup effort underway[16]. This environment is part of an ongoing legacy that has not only deeply affected the immediate site but beyond the official boundaries of Hanford as well. Industrial sites, like other monuments, are often cleansed of tailings, waste, and other toxic remnants of the industrial process in order to anchor the historic narrative of the site to the material presence without complicating the it with any discussion of toxicity. Through this practice of cleansing, sites like the B Reactor become polished relics frozen in the past in a condition they never truly ever existed in. While it is hard to argue with the need for a safe visitor environment, there is room for a more honest and more complete narrative - one that communicates and interprets the environmental impact of the site and its complex history. By creating such a static, traditional narrative for the B Reactor, there is a missed opportunity for the site to embody the more diverse narrative of a cultural landscape. Instead, what has been left for visitors is a cleansed symbol with selective material continuity and a highly controlled narrative.

POST-INDUSTRIAL PRECEDENTS

"The reused landscape scar was commodified and domesticated, made visible, agreeable, and respectable, and thus, from the perspective of heritage professionals, sometimes healed in a bad way, concerning both its physical and its mental structure. In general the places have been cleaned and the stories adapted for those who do not have personal memories of the place when it was in operation in its previous use, although there are, of course, exceptions." - Anna Storm, Post-Industrial Landscape Scars

15 French, Colleen, Tracy Atkins, and Kris Kirby. "Manhattan Project National Historic Park Update." Legacies of the Manhattan Project: Reflections on 75 Years of a Nuclear World. Richland, Washington. 16 Mar. 2017. Speech.

16 French, Atkins, & Kirby. 2017.



GAS WORKS PARK

Sunset view of the lawn at Gas Works Park with preserved towers in the background. 2017

The Venice and Burra Charters each set the stage for the inclusion of industrial structures within historic preservation programs. Today there are now twenty-one industrial sites on the UNESCO World Heritage List and twenty-three such sites on the US National Historic Landmark List. Congruent to the inclusion of industrial sites into the authorized heritage discourse of historic preservation there has been an increased focus on industrial sites within the field of landscape architecture. Books including *Manufactured Sites: Rethinking the Post-Industrial Landscape*, *Drosscapes: Wasting Land in Urban America*, and *Beauty Redeemed* focus on the potential value of post-industrial sites within landscape architecture. Similar to Laurajane Smith's advocacy for a cultural heritage landscape, the conversation around these sites in landscape architecture is forward thinking: how can post-industrial sites embody the spirit and some of the physical material of the past while also addressing our understanding of the site as it exists now, and exploring future potentials?

Landscape architect and professor at the University of Copenhagen Ellen Braae terms design that maintains continuity with the past and establishes a flexible framework for the future "transformation theory"[17]. "The starting

17 Braae, Ellen. Beauty Redeemed : Recycling Post-industrial Landscapes. Risskov : IKAROS Press; Birkhäuser, 2015. (p. 278)

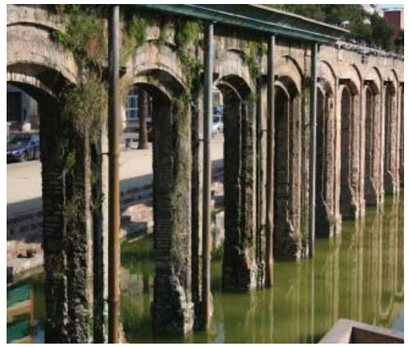
point is to change 'something' into 'something else,' in full awareness that neither the 'before' nor 'after' are static conditions"[18]. This is not to be mistaken for a *tabula rasa* approach; rather Braae is encouraging capitalizing on material continuity of post-industrial structures for future visions of a site. Highlighting continuity with the past enhances the current cultural connection between a visitor and site as opposed to *tabula rasa* development plan whose transformation into something else is not rooted in any kind of history. The transformation theory approach to post-industrial sites is rooted in a present condition; one that does not relegate the visitor to spectator of a fixed narrative but participant in that historic narrative. With transformation theory, cultural heritage is active and adaptive. As Braae explains, change is what makes design more interesting; through this lens, a designer understands that a site shapes design and, in turn, that design shapes a site[19].

Gas Works Park, designed by Richard Haag and opened in 1974, was the first modern example of a site which retained post-industrial structures in order to create physical and cultural continuity between the site's previous life as a gaslight plant and its adapted use as park[20]. Traditional memorialization would likely have explicitly focused the narrative on the gas works plant and its role in the surrounding city development. Traditional redevelopment into a park suggested that the structures be razed and the site turned into an Olmstedian pastoral landscape. Rich Haag and his colleagues, on the other hand, saw an opportunity in marrying the two approaches into a landscape that is at once pastoral and also connected to its previous use through material artifacts. The surrounding community was initially resistant as they did not want to have cultural continuity with a site that had long-polluted their air, water, and soil[21]. Haag persisted and the park is now considered an asset to the neighborhood and city[22]. Gas Works Park's cultural value has grown beyond that of historic relic to modern amenity.

Despite the success of Gas Works Park, it was not until the mid-1980's that redevelopment of post-industrial sites became more prevalent within landscape architecture. This burgeoning interest was happening primarily within Europe. Parks such as Parc del Clot (1986), Zeche Zollverein (1994), and the iconic Landschaftspark Duisburg Nord (1994) all ignited discussions of industrial heritage and interest in shaping spaces that utilized techniques of phytoremediation alongside historic artifacts. Following suite, post-industrial parks began to appear more often in the United States with Crissy

18 Ibid.
19 Ibid. (p. 285)
20 Ibid.
21 Way, Thaisa. "It was a gas! at Gas Works Park." In *The Landscape Architecture of Richard Haag : From Modern Space to Urban Ecological Design.* Seattle: University of Washington Press, 2015. 146-167. (pp 158 – 159).
22 Ibid; (p. 165)





ZECHE ZOLLVEREIN
Crowds gather for tours on the well manicured lawns of the former factory. 2016 (left)

PARC DEL CLOT[1]
Structures preserved from the site's previous life are kept as part of the public park. 2006 (right)

Fields (2001), Alumnae Valley (2005), and FreshKills (2008). In 2001, Alan Berger stated that, "adaptively reusing this waste landscape figures to be one of the twenty-first century's great infrastructural design challenges" and landscape architects seem to be continuing to rise to the challenge[23].

While landscape architecture has capitalized on an opportunity to use post-industrial sites in a way that encourages a broader understanding of cultural landscape heritage, there is also an understandable predisposition within landscape architecture to remediate a site to encourage greater ecological health. This is not dissimilar from the desire within authorized heritage discourse to cleanse a site of both physical and narrative waste. Post industrial parks embody a narrative that presents them as having undergone physical transformation from polluted, derelict detritus to re-claimed healthy landscapes.

Although the narrative of wastescape to healed landscape can be valuable, the post-industrial development has become constrained by this narrative. First, it affects what sites are chosen for development. Only those sites that can embody a narrative of cleaned, healed, and safe are prioritized. Second, in the remediation process, pollutants are either capped and kept in place, carted off elsewhere, or treated with phytoremediation. Of these three options, phytoremediation is the only one generally given a prominent narrative voice on a site after development, if at all. This perpetuates an expectation within society that the environmental damage done from industrial processes is reversible, remediable. While the ability to ameliorate polluted landscapes should very much be celebrated and employed, there is also an opportunity to use this process to create a more comprehensive relationship with waste. Philosopher Timothy Morton suggests that society requires encounters with wastescapes in order to become better environmental stewards in the face of

23 Berger, Alan. *Drosscape : Wasting Land in Urban America.* 1st ed. New York: Princeton Architectural Press, 2006. (p. 199)

1 Photo Credit: "Josemanuel". 2006. Attribution 2.0 Generic (CC BY SA 3.0) Wikimedia.





WELDON SPRINGS SITE, MISSOURI
2004
Home to a former uranium refinery, Weldon Springs is now a recreational area with a stairclimb to the top of a lookout. [1]

LANDSCHAFTS PARK DUISBURG-NORD
2016
(previous page)

an ever-increasing global pollution[24]. What opportunities exist in educating the public about where these pollutants go, if they go anywhere. Are they underfoot; shipped to a landfill; breaking down in a bed of sunflowers?

Since landscape architecture has been at the fore of re-valuing derelict post-industrial landscapes, can the field also expand cultural value to wastescapes that lack prototypical architectural artifacts and opportunities for remediation? Post-production nuclear sites and nuclear waste storage facilities do not have the option of remediation and these sites are engineered such that the waste is buried and covered up with little visible evidence of their past use or current state. How can understanding of cultural heritage continue to expand so as to include these sites as well?

THE APPROACH TO NUCLEAR MONUMENTS

The design of nuclear landscapes is not something wholly unexplored within landscape architecture. There have been several design proposals and built

1 Photo Credit: "jshyun". "Disposal Cell." Attribution-NonCommercial-NoDerivs 2.0 Generic (CC BY-NC-ND 2.0). Flickr. 2017.

24 Morton, Timothy. *Dark Ecology* (pp. 161-162)



HIMMELSTREPPE BY HERMAN PRIGANN
2016

projects within the United States that have broached the nuclear landscape; some of these projects have reclaimed nuclear test sites as wildlife habitat or public resource while others have solely focused on signage to communicate the presence of nuclear waste for the course of its lifespan (around 300,000 years). Similar to expanding the value of industrial structures within cultural landscapes, there is potential value within toxic wastescapes to become landscapes capable of communicating a greater variety of heritage values[25].

In 2002, a former uranium processing factory in Weldon Springs, Missouri was demolished and placed within a nuclear waste disposal cell. Surrounding the disposal mound is an interpretive nature trail and atop the 75' mound is a viewing platform with an "unforgettable view"[26]. This design solution incorporates both the need for long term waste containment and a reappropriation of space from nuclear territory to public amenity. Weldon Spring Site capitalizes on nuclear waste tourism, embracing its role as a nuclear waste storage facility to draw in visitors and educate them about the sites history via signage and a 9,000sf interpretive center[27]. Rising 75'

25 Hardesty, Donald L. "Issues in Preserving Toxic Wastes as Heritage Sites." *The Public Historian* 23, no. 2 (2001): 19-28. (pp. 23-24)

26 Engler, Mira. "Nuclear Effigy Mounds and Catacombs: On the architecture and landscape architecture of radioactive waste burial sites." *There 2* (2006): 10-15. (p. 10)

27 Department of Energy. "Weldon Spring, Missouri, Site" 22 Dec. 2016. Web. Accessed 10

above the surrounding landscape, the park is a commanding presence that is shockingly similar to a piece from the Land Art movement, *Himmelstreppe*, created in 1989 – 1990. Created by artist Herman Prigann, this work converted a slag heap from nearby industry into a viewpoint amidst the relatively flat Ruhr Valley. Prigann was one of the artists within Land Art movement, and was interested in engaging a landscape of industrial by-product[28]. Through his work Prigann showed "it was possible to re-integrate a devastated landscape by putting its former industrial use into the cultural context of a region. It could become a leisure space reintroducing nature while preserving its recent past"[29]. Possibly just through coincidence, nearly fifty years later, Weldon Spring Site is approaching their waste pile through a very similar lens. However, unlike Weldon Springs Site, *Himmelstreppe*, is not covered in obvious signage directing viewers to a detailed history of the site. Instead, there is a sign, downhill from the sculpture describing the work and when it was built but allowing visitors to draw more of their own conclusions about the site and its history as well as its current role in the cultural landscape. As of 2016, the concrete blocks at the top are covered in graffiti thus providing a literal platform for the current cultural voice.

Also prior to Weldon Springs Site,a design competition was proposed by the Bulletin of the Atomic Scientists in 2001 that asked designers to consider both plutonium waste containment and public access. Part of the design challenge was that the site should be transparent about its nuclear legacy. In this project, the waste containment was not allowed to just be buried and forgotten but would continue as part of our cultural landscape[30]. In short, the competition was asking that we create a monument out of nuclear waste management.

On the other end of the nuclear legacy spectrum is Rocky Flats Colorado - a former nuclear weapons manufacturing complex. The site underwent ten years of remediation and, in 2007, a significant portion switched ownership from the Department of Energy (DOE) to the US Fish and Wildlife Service, adopting the name Rocky Flats Wildlife Refuge. Unlike the nuclear park in Missouri, the wildlife refuge is not open to the public and it is not embracing the narrative of nuclear landscape. Rather, the DOE and Atomic Energy Commission are focusing on the unusually high amount of biodiversity within the site in an attempt to affirm the narrative of self-healing landscape[31].

May 2017. https://www.lm.doe.gov/LMSites.aspx?id=1399.

28 Llull, Paula. "Herman Prigann and the Unfinished Ecology of Sculpture." In *The New Earthwork: art, action, agency*, edited by Twylene Moyer and Glenn Harper, 78-95. Hamilton, NJ: ISC Press, 2011. (p. 78)

29 Llull, P. 2011 (p.82)

30 Engler, M. 2006. (p. 13)

31 Coates, Peter. "From Hazard to Habitat (or Hazardous Habitat)." *Progress in Physical Geography* 38, no. 3 (2014): 286-300. (p. 287)



THE WIPP SIGNS

Minimal signage directs trucks and cargo to the site outside Carlsbad, NM.
2017

THE WIPP SITE

Aside from minimal facility signage, the site blends into the landscape with oil derrecks and cattle in view. (next page)
2017

This relabeling does not mean the site is free from vasts amount of contamination. In fact, the designation of wildlife refuge has lower standards for contamination than sites that are open to the public[32]. In this case, a bias narrative of rehabilitation is prioritized over a more transparent narrative about the actual state of the site.

The Waste Isolation Pilot Project in Carlsbad, NM is a repository of transuranic waste, and will not only restrict public access from the grounds but is focusing considerable attention on preventing any kind of breach of the site's waste containment for its 300,000 year lifespan. As such, the DOE appointed a team of linguists, anthropologists, archaeologists, engineers, artists, and designers to create a marker that would deter future generations from disturbing the site[33]. The design team referenced ancient monuments and languages in an attempt to understand how to communicate over long periods of time. In the end, the team created a three-hundred page document entitled, *Expert Judgement on Markers to Deter Inadvertent Human Intrusion into High Level Waste Sites.* This document proposed the means of signifying waste through a series of large scale moves and smaller repetitive warnings

32 Lippard, Lucy R. *Undermining : A Wild Ride through Land Use, Politics, and Art in the Changing West.* New York: New Press, 2013. (p. 116)

33 Bryan-Wilson, J. 2003. (p. 185)



buried into the site[34]. Oddly, the need for such a legible monument stems from the conflicting desire of the DOE to have this site forgotten and unspoken of amongst immediate generations yet legible to those who may stumble on the site hundreds of years from now. Similar to the authorized heritage of monuments that asks waste to be removed from the conversation, the DOE perpetuates a nuclear heritage narrative that allows for the memorialization of places like the Trinity Site (also in New Mexico) but asks that sites like WIPP be only seen as remote, managed, and not of the public's concern.

As we address the waste containment practices at Hanford, there is an opportunity to engage the public beyond the memorialization of the B Reactor and elucidate the site's broader nuclear legacy. As of yet, the narrative being put forth by the DOE at Hanford is much more closely aligned with that of Rocky Flats or WIPP than Weldon Springs Site. While the B Reactor undergoes memorialization, the waste containment practices managed by the DOE will continue to exist in relative obscurity, buried quietly in the Inner Central Plateau of Hanford. Still, there exists an opportunity to expand upon the nuclear heritage narrative of the site by re-examining the design principles established within post-industrial landscapes. Additionally, Herman Prigann was part of an entire movement of artists engaging with industrial landscapes and processes. By revisiting the formal and conceptual work of other artists of the Land Art movement, there is additional potential to expand the design tools at hand for nuclear sites.

LAND ART AND THE DESIGN POTENTIAL AT HANFORD

"There is a point where artists too must take some responsibility for the things and places they love, a point at which the colonization of magnificent scenery gives way to a more painfully focused vision of a fragile landscape and its bewildered inhabitants. The land is not separate from the often harsh realities of lives lived upon and around it. A land art in the New West could acknowledge the rough edges as well as the romance." – Lucy Lippard

In 1969, artist Michael Heizer took to the expansive, isolated desert landscape of Nevada to create one of his most iconic artworks, *Double Negative*. Heizer's interest was in using the techniques of industry to communicate geologic timescales and expansive spatial scales that, if ever visited, would connect the viewer to the landscape surrounding them[35]. Heizer is one of the iconic artists of the Land Art genre and *Double Negative* one of its most cited artworks. In general, this movement focused on embodying - rather than illustrating - force, time, scale and phenomenological experience within remote or industrially impacted landscapes[36]. The art generally ignored its attendant ecological impact as many of the artists were more interested in initiating a catalytic response with the environment than considering how this may encourage positive or negative ecological responses. Thirty years after the movement began, land artists' interests in perception and industrial landscapes began to seep into theoretical discussions within landscape architecture, but the discussion rarely created more than a formal impact in the field[37]. Today, the expanse of industrial landscapes vacillate between overwhelmingly legible and uncomfortably imperceptible; Hanford is one such example of the latter. A re-examination of the formal and conceptual framework of Land Art could, once again, encourage new discussion on how to treat landscapes of exceptional and irreversible pollution within the field of landscape architecture.

The Land Art movement began with artists of different media rejecting the physical and conceptual restraint of the gallery and turning, instead, to exterior landscapes that were predominantly remote, industrial, or both[38]. Artists of the movement operated across a conceptual spectrum varying from perceiving landscapes as metaphor, subject, or even just material. However, there was continuity in that, unlike sculptural works of other genres, the movement did not prioritize the artist's object nor aesthetics but rather the ability to facilitate choreographed perception. For many, this was a continuation of ideas begun in Modernism but operating across far greater temporal and spatial scales. Nancy Holt's *Sun Tunnels* used four industrial concrete tunnels, placed in the desert in the shape of an X, and strategically drilled with holes to direct visitors' gazes to the surrounding terrestrial and celestial environments. This work embodies much of the ethos of the Land Art movement with its attention to observing natural phenomena through the use of industrial materials. Similarly, artist Robert Morris used works like *Observatory* to reflect on gestalt and phenomenology by creating something so large that viewers need to explore it through multiple places at multiple

34 Ibid.; Engler, M. 2006. (p. 12)

35 Baker, Elizabeth C. "Artworks on the Land," In *Art in the Land: A Critical Anthology of Environmental Art*. New York: E.P. Dutton, Inc, 1983: 73-84. (p.75); Beardsley, John. "Earthworks: the Landscape After Modernism." In *Denatured visions: landscape and culture in the twentieth century*, New York: Museum of Modern Art, 1991: 110-117. (p. 111)

36 Tiberghien, Gilles A. *Land Art*. New York: Princeton Architectural Press, 1995. (p. 4)

37 Treib, Marc. "Pointing a Finger at the Moon: the work of Robert Irwin." In *Modern Landscape Architecture : A Critical Review*. 266 – 285. 1st MIT Press Pbk. ed. Cambridge, Mass.: MIT Press, 1994. (p. 266)

38 Beardsley, J. 1991. (p. 110); Weilacher, Udo. *Between Landscape Architecture and Land Art*. Basel ; Boston: Birkhauser, 1996. (p. 11)









DOUBLE NEGATIVE
MICHAEL HEIZER[1]
1969

OBSERVATORY
ROBERT MORRIS[2]
1970-1977

BROKEN CIRCLE, SPIRAL HILL
ROBERT SMITHSON[3]
1971

SUN TUNNELS
NANCY HOLT[4]
1973-1976

(previous page clockwise from upper left)

times[39]. At the core of the Land Art movement was an interest in stripping away excess gestures such that only the very minimal amount of materials were needed to create an emotional, affective experience of place. Further, it was places not often considered: the remote, the abandoned, the neglected.

Political position on the impact of industry upon nature was somewhat rare within the genre of Land Art.[40] One of the most notable artists of the movement, Robert Smithson, stated that he found no need nor interest in discussing "nature" since he was primarily concerned with mark making[41]. Similarly, Michael Heizer said of his iconic *Double Negative*, "I don't care about landscape. I'm a sculptor. Real estate is dirt, and dirt is material"[42]. Each of these artists relished the use of bulldozers and large-scale machinery and were at times condemned by fellow artists and critics who felt that it was not only environmentally irresponsible but also little different than treating the land as a giant canvas without context or impact[43]. While this work could be reduced to merely an exploration of new materials and methods, that would be denying the conceptual weight of materials and methods. While indeed Heizer and Smithson were creating dramatic environmental impacts on the sites of their work, they were also setting in motion a reaction within the landscape that brought to the fore the relationship between humanity, nature, and time. Perhaps artist Walter de Maria (whose work matched the scale and materials of Smithson and Heizer) said it more eloquently when he argued that, "the dirt (or earth) is there not only to be seen but to be thought about[44].

While large-scale impacts to remote landscapes is counter to many of the values of landscape architecture, Smithson's ambivalence to the line between nature and human would inspire some of the discourse surrounding the redevelopment of post-industrial structures in the 1990's. Smithson's stated that "Industrialism's leftovers are a natural consequence of a natural course of events and must be regarded as a contemporary condition"[45]. This resonated deeply with attempts to not only expand cultural heritage to include industry but to welcome industry as a valuable and unavoidable part of the cultural and physical landscape. As such, landscape architects began to reconsider the human mark from something alien to something entwined with nature.

1 Photo Credit: "Retis". 2012. Attribution 2.0 Generic (CC BY 2.0) Flickr. 2017.

2 Photo Credit: "Retis". 2006. Attribution 2.0 Generic (CC BY 2.0) Flickr. 2017.

3 Photo Credit: "Retis". 2006. Attribution 2.0 Generic (CC BY 2.0) Flickr. 2017.

4 Photo Credit: "Retis". 2015. Attribution 2.0 Generic (CC BY 2.0) Flickr. 2017.

39 Tiberghien, G. 1995. (p. 77)

40 As the movement progressed, environmental activism became more prominent. This turned into Environmental Art and, now, much more common than Land Art are artists engaging remediation of or criticism for harmful environmental practices.

41 Rosenthal, Mark. "Some attitudes of Earth Art: From competition to adoration." In *Art in the* Land, 1983: 60-72, (p. 64)

42 Beardsley, J. 1991. (p. 111)

43 Hall, Carol. "Environmental Artists: Sources and directions." In *Art in the Land,* 1983: 7- 59. (p. 28)

44 Weilacher, U. 1996. (p. 14)

45 Braae, E. 2015. (p. 187)

Concurrently, landscape architects were also advocating for a return to the forgotten tool of aesthetics - both within and without of industrial contexts. Weary of the emphasis placed on ecological and social functions, Elizabeth Meyer argued for the need to revisit aesthetics because, it too, was performative not least as a cultural product and cultural producer[46]. Though she did not directly reference Land Art, Meyer encouraged viewing aesthetics as a fluid concept and framework. This was in many ways similar to the creative process of Land Art that fully intended a piece would be changed by environment and, in turn, change a visitor's perception of environment[47]. Each of these discourses shared an understanding that affect between landscape and visitor encourages a meaningful connection that can enhance experience and, further, potentially incite stewardship[48].

While concepts of aesthetics may have expanded today to recognize the value and need for perceiving post-industrial sites or ecological functions through the lens of aesthetic value, there remains a disconnect between the conceptual scope of Land Art within which there is untapped potential. Through a re-examination of the formal and conceptual tools of Land Art one may find a way to focus design beyond aesthetics to instead incubate perception of land use practices and persistent waste within unmarked and remote nuclear wastescapes. Authors Udo Weilacher and Mark Treib, specifically called out a need for greater reflection on Land Art in the 1990's because of its focus on communicating perception. In his essay, "Pointing a Finger at the Moon: The Work of Robert Irwin," Treib argued that although landscape architects operate within a greater number of ecological and social restrictions than artists, designers rely just as much on the experiential. However, despite advocating a comprehensive integration of Land Art's conceptual thinking into landscape architecture, the term "Land Art" was often loosely applied to any placement of large-scale sculpture into the landscape[49]. While Treib reiterated that some designers merely adopted the movement's sculptural forms, he also stated that "others have shown that by better understanding the full range of factors that govern the making of art, much can be learned to enrich landscape architecture both as a profession and as a discipline"[50]. In speaking of the artist and sculptor Robert Irwin, Treib stated that perception "is but one of a host of factors that configure landscape design; but it is the one consideration without which all the others are deprived of their reason for existence"[51].

46 Meyer, Elizabeth K. "Sustaining Beauty. The Performance of Appearance." *Journal of Landscape Architecture* 3, no. 1 (2008): 6-23.

47 Auping, Michael. "Earth Art: A study in ecological politics." In *Art in the Land,* 1983: 92-104. (p.103)

48 Meyer, E. 2008. (p.10)

49 Weilacher, U. 1996. (p. 9)

50 Treib, M. 1994. (p. 282)

51 Ibid.

As it stands, the field of landscape architecture is more acutely focused on landscapes that perform explicit functions whether these be ecological, social, or aesthetic. Although post-industrial sites have been welcomed into the landscape architecture lexicon, the narrative of amelioration and healing still dominates the practice. However, it is worth remembering that landscapes have the ability to shape understanding of and value for a range of environments – beyond the Edenic or restored. Wastescapes - like those of nuclear waste containment – that cannot be truly cleaned, accessed, and blend with the landscape should be folded into the purview of landscape architecture because of their potential performative function of communicating an integral relationship between nature, culture, and land use beyond the purely ameliorative. The spatial tools within Land Art, focused on the more ambiguous function of situating an individual in a way that connects them with a perception of self, humanity, time, and space now seem uniquely applicable to the need for finding ways of connecting the public with wastescapes. Confronting landscapes heavily altered by toxicity works to upset predispositions towards always being capable of repairing landscapes to erase or contain problematic legacies. Nearly sixty years after the initial explorations of Land Art, landscape architecture seems due for another examination of the genre; this time with the intent of developing an even more expansive understanding of our cultural heritage - one that it includes vast, irremediable landscapes - and our place within them.


No Trespassing
122A

INTERACTING WITH OUR NUCLEAR LANDSCAPES

BARRICADE 122A ALONG RT. 240

Road blocks and barbed wire keep visitors from driving down formerly active Hanford Site roads. Entombed reactors can be seen in the distance. (previous page)

"Art suggests a way for us to see the world in which we live, and, by seeing it, accept it and integrate it into our sensibility. The open work assumes the task of giving us an image of discontinuity. It does not narrate it: it is it. IT takes on the mediating role between the abstract categories of science and the living matter of our sensibility; it almost becomes a sort of transcendental scheme that allows us to comprehend new aspects of the world." – Umberto Ecco, Author and Critic

Running north from the Tri-Cities, Rt 240 divides the Hanford Nuclear Reservation and the southern portion of the Hanford Reach National Monument. Alongside the road is a three feet tall barbed wire fence about ten feet off the shoulder on either side. Occasionally, the fence is interrupted by a road, typically dirt, barricaded, and sometimes accompanied by armed guards. Rt 240 intersects Rt 24 which runs east-west, turn east and the fence continues but is broken occasionally by dirt roads heading into accessible areas of "wilderness protection".

There are three pull offs along Rt 24 that contain information about the surrounding environment. On a clear day you can often see the sinewy path of the Columbia's last undammed section moving past Hanford's entombed reactors – material relics to the site's former plutonium production. The Hanford Reach National Monument has put up signs at each of these pull offs that describe the site's transformation from its ancient geology, to its use by the Department of Energy (DOE), to the preserved shrub steppe ecosystem. However, none of these signs make mention of the ongoing cleanup effort taking place across the site that will consolidate structures, equipment, soil, and contaminated sludge into the Environmental Restoration Disposal Facility (ERDF). ERDF's disposal cells will house this waste in the Inner Central Plateau under guided management for the foreseeable future.

The disposal cells at ERDF are 400' wide, 1000' long, 60' deep and will rise 20' above the landscape once capped. These cells currently occupy 107 acres and will expand as far as needed to accommodate the DOE cleanup effort. While people can sign up for a tour of waste cleanup site, to understand the full picture of the waste management practices takes digging beyond the tour, brochures, or websites to the DOE Comprehensive Cleanup Framework, DOE Final Tank Closure and Waste Management Environmental Impact Statement, and Hanford Site Comprehensive Land-Use Plan – thousands of pages of reports where details of the sites waste control are examined through groundwater testing, waste migration analysis, and development plans. It is within these documents that the story of the site's enduring toxicity unfolds. There is a nearly invisible movement of radiated material through the soil, air and water of the site. To people passing by, the tumbleweeds piled up against the fence are just that, but tumbleweed's roots can descend 20' and uptake toxic groundwater and then go wherever the wind blows them[1]. While some are caught by the barbed fencing, others push through eschewing the DOE's territorial boundedness.

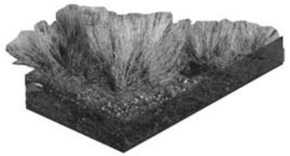
While the cleanup effort does its best to diminish outflow of irradiated material from the site, it is an impossible task. For over 44 years, the landscape was treated as the primary dumping ground for irradiated byproducts and these materials cannot be entirely collected for containment in ERDF; they are too diffuse.

There remains a lack of transparency between the nuclear legacy of Hanford and its surrounding environment. Significant physical distance between the fence line and any material evidence of the site's former use or present operations easily leaves passing drivers ignorant of the historic and on-going environmental impact of Hanford. The DOE and the National Park Service have set up tours to both the B Reactor and ERDF, however, each presents highly curated narratives dedicated to celebrating technological ingenuity and excellence; there is no room in this official heritage narrative for discussion of the still relevant waste legacy existing across the landscape.

1 Marshall, Eliot. 26 June 1987. "Hanford's Radioactive Tumbleweed." Science 236(4809), pp. 1616-1620.


B Reactor

ENVIRONMENTAL
DISPOSAL
RESTORATION
FACILITY



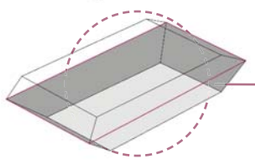
Native Vegetation



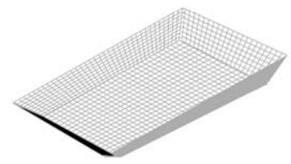
Clay and Soil Cap



Impermeable
Plastic Barrier

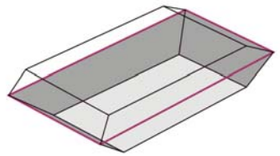


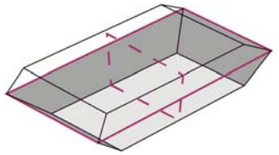
1000'L x 400'W x 80'H
Disposal Cell

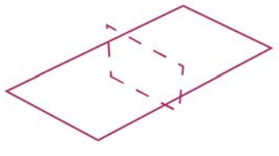


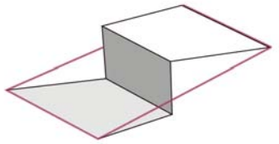
Impermeable
Plastic Barrier

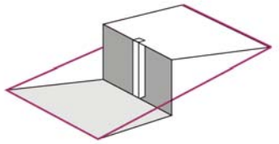
An impermeable liner is built into each of the cells along with a drain that leads treatment for any water that may permeate the cell from the top. Once treated, water will be returned to the ground "with no harm to the environment." Everything from contaminated soil to building structures to operating equipment like gloves and shovels will be contained within these cells. Once filled, the cells are topped with another liner, clay, soil, and vegetation that will stabilize the soil.



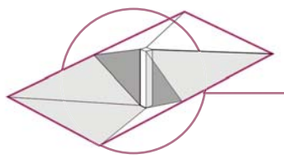


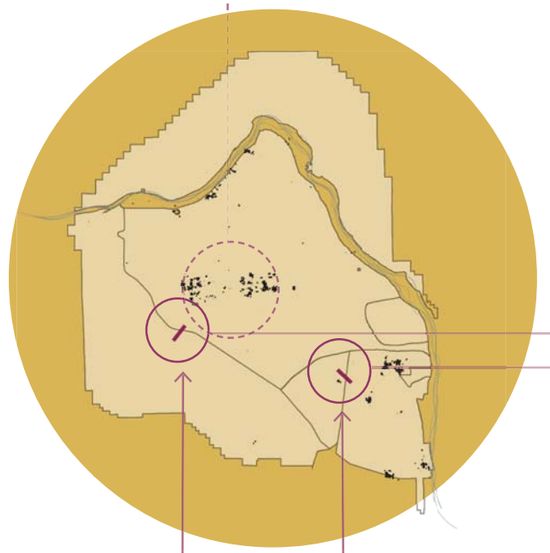






DESIGN
PROPOSAL





SITE II
SITE I

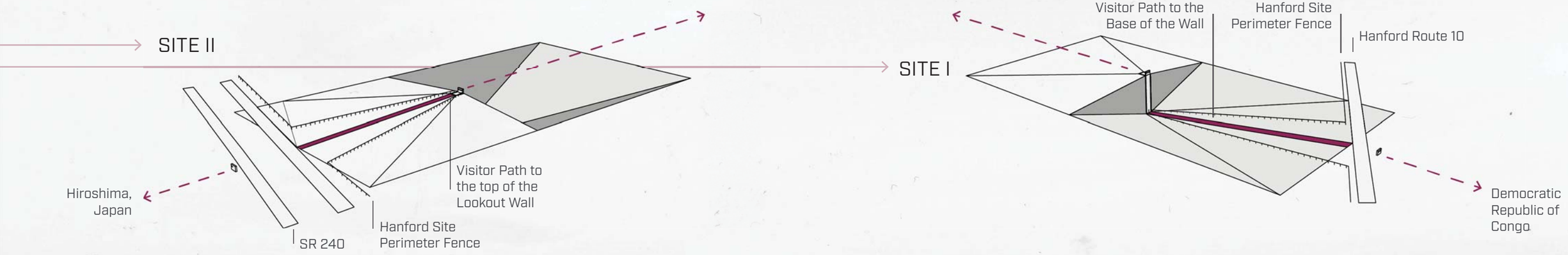
PROPOSAL

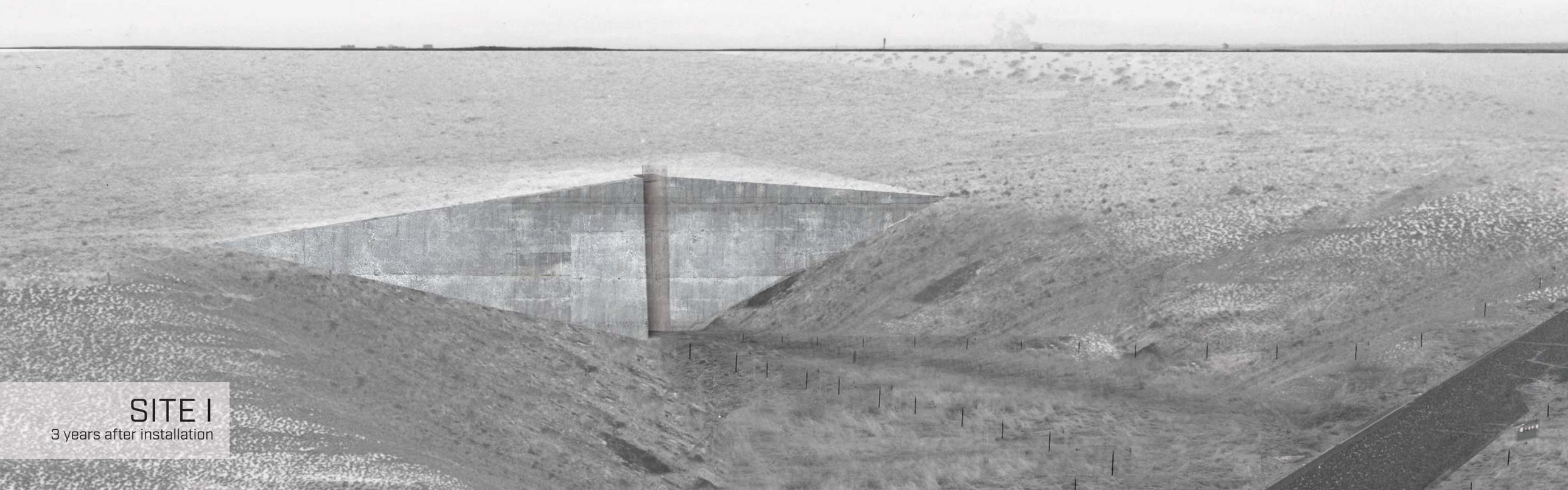
While the amount of waste that has accrued across the 586 square miles of the site over 47 years of operation may be spatially incomprehensible, there is indeed a size and scale to ERDF. On par with standing next to a pit that has been strip mined or a gas plant, ERDF represents an industrial solution to an industrial problem. Currently, the public is allowed access to ERDF through tours run by the National Park Service. On these tours visitors witness bulldozers packing dirt around waste containers and digging out ground, however, the site will eventually be capped and access restricted; there is no current plan to turn ERDF into the next Weldon Springs Site, Missouri.

In order to engage ERDF through methods other than those employed by the DOE, our design proposes two installations. These installations, Site I and Site II, each take the footprint of an ERDF disposal cell and place it across a road that runs parallel to the Hanford Boundary. Half of each ERDF footprint will be an excavation down 60' and the other half will use that excavated soil to build the topography 20' above the ground. At the center of this excavation and deposition is a concrete wall that holds the two sections of the sites separate from one another.

SIDE OF THE
ROAD STOP

Pull offs along the border of Hanford provide signage indicating the site's previous use. (previous page)





SITE I
3 years after installation

Site I exists along Route 10, about 15 miles outside of Richland. Route 10 leads towards the heart of the Hanford site but any casual driver will eventually be stopped by a barricade staffed with armed guards looking for security clearance and be forced to turn back. (**Image)** Before the barricade, visitors will encounter Site I. Immediately upon arrival, visitors are presented with an expansive depression pierced by a concrete wall at the very base. There is a straight path of crushed concrete that leads visitors to the base of the wall and of the site's excavation. Running along the path, the barbed fencing that the DOE uses throughout the rest of the site will make sure that visitors don't wander off into what is inconspicuous conservation. Once at the bottom of the path, they will experience the sensation of being at the depth of an ERDF cell, with 80' feet between themselves and the top of the wall. Here also exists a glass wall, twelve feet wide and running all the way to the top of the wall. On the other side of the glass wall is a concrete chamber devoid of anything, including any waste. The void represents loss and absence as the waste across of Hanford cannot be completely accounted for at ERDF. A substantial amount of waste has migrated off the site via wind, water, soil, animal and machine.

As visitors return back to the top of the path, there is a second glass wall. This one is also 12' wide but only 8' tall. Along the center of the wall, at head height, are concrete plugs blocking the view outward to the landscape. This wall is pointing visitors toward the Democratic Republic of Congo, where Hanford's first uranium supply came from. Site I speaks to the extraction of materials both across Hanford and in the Congo. Something has been taken from the Earth in order to create nuclear arms and nuclear power. This does not come from nowhere, and it leaves a scar behind.

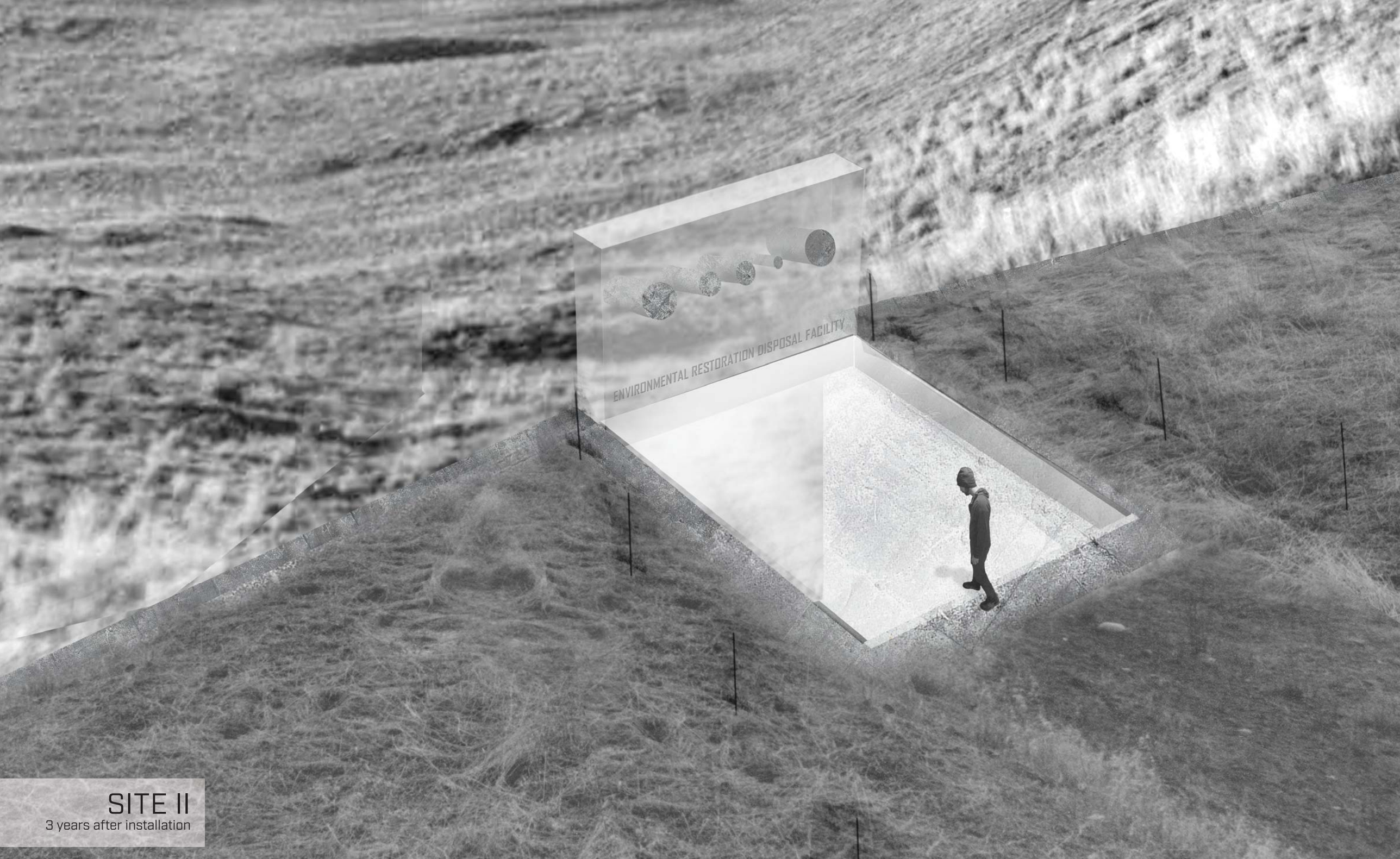


SITE I
First year of installation

Site II is located along Rt. 240 and has a path that leads visitors directly to the top of the 20' soil deposition and the 80' concrete cut. This is a straight path at a subtle 5% grade and also formed with crushed concrete. As visitors approach the top, a glass wall similar to that at Site I comes into view. As one approaches closer, the ground transitions from crushed concrete to a glass plate. Underfoot is an 80' void. The distance from the visitors' feet to the bottom of the void is the same as distance as from the top of ERDF to the ground it rests within. The footprint of this platform and glass wall match that of the bunkers at the Trinity Site in New Mexico. The bunkers at Trinity were made of concrete with glass viewing portholes whereas at Hanford the here the material language has been inverted; the concrete now blocks visibility and the glass does not protect. Although the view is partially obstructed by the concrete plugs that are 12" in diameter and match the depth



SITE II
3 years after installation



SITE II

3 years after installation

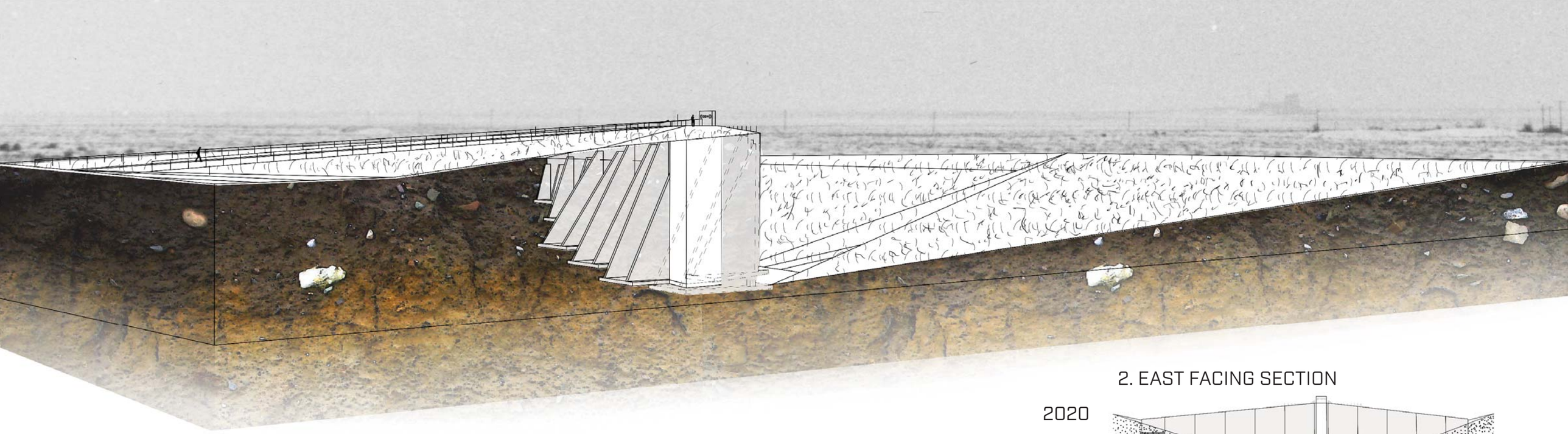
of the glass wall, visitors can still take in the vast landscape in front of them. Etched into the glass wall is a label instructing visitors that they are looking towards ERDF despite the small likelihood that ERDF facilities will actually be visible from such a distance. This viewing platform speaks to the inability to see rather than providing increased visibility or protection. Looking down through the glass wall, one can see the void left behind from the other half of the design intervention's excavation.

As the visitor returns back to the bottom of the path, there is another glass wall with concrete plugs sitting across the road. At Site II, this second wall is pointing towards Nagasaki, Japan. This information will also be etched onto the glass wall. Site II's path to the top of a spatial replica of an ERDF cell speaks more broadly to the deposition of nuclear waste and nuclear byproducts the world over, not least of all in Nagasaki.



SITE II

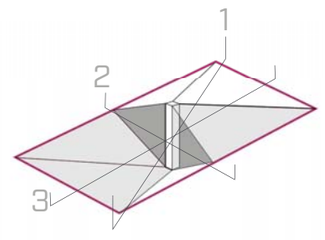
First year of installation



Tradescantia is known in the scientific community for its ability to indicate the presence of radioactive contaminants through a change in the color of its stamen from pink to blue[2]. This is not a trait that has been found in other species of Tradescantia. It is also known for being able to detect non-radioactive air pollutants[3] which means the change in stamen color can also be attributed to exposure to exhaust fumes or other urban air pollutants. That this indicator is neither consistent nor particularly reliable is not of concern. Instead, conceptually, it mirrors the scientific community's own inconsistent relationship with understanding the complex environmental toxicity of nuclear products. It is also not of concern that Tradescantia is not a native plant to Eastern Washington. That the Tradescantia is not meant to be there, and has instead been brought there to perform a task. It is native to southern Florida and California but has been known to survive in hardiness zones as high as 7. As a result, there is very low survivability

2 Rusli, Ibrahim, Hussin Rosinah, Mohd Nur Suraijah, and Talib Norhafiz. 2012. "Plants as warning signal for exposure to low dose radiation". R and D Seminar 2012: Research and Development Seminar 2012, Malaysia.

3 Nairo Massakazu Sumita , Maria Elizabete Mendes , Mariangela Macchione , Eliane Tigre Guimarães , Ana Julia de Faria Coimbra Lichtenfels , Débora-Jã de Araujo Lobo , Paulo Hilário Nascimento Saldiva & Mitiko Saiki (2003) Tradescantia pallida cv. purpurea Boom in the Characterization of Air Pollution by Accumulation of Trace Elements, Journal of the Air & Waste Management Association, *53:5*, 574-579, DOI: 10.1080/10473289.2003.10466197



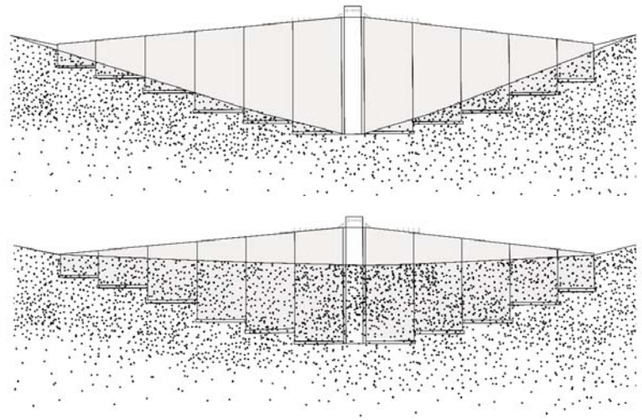
2020

2100

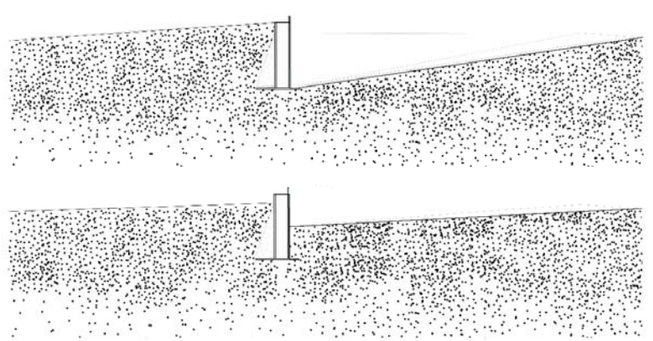
Change Over Time

As the structure ages, the landscape will erode from where it has been modified. Eventually, the platform may not be accessible and the true depth of the vertical chamber will be hidden.

2. EAST FACING SECTION



3. NORTH FACING SECTION



Tradescantia pallida 'Purpurea'
Spider lily
'Purple Heart'

Zone: 10 - 11
Herbaceous perennial

Tradescantia plants are known to over winter all the way to hardiness Zone 7 which would suggest they may be able to survive a winter at Hanford, especially in the wake of climate change.

These plants are drought tolerant and have brightest purple in full sun.



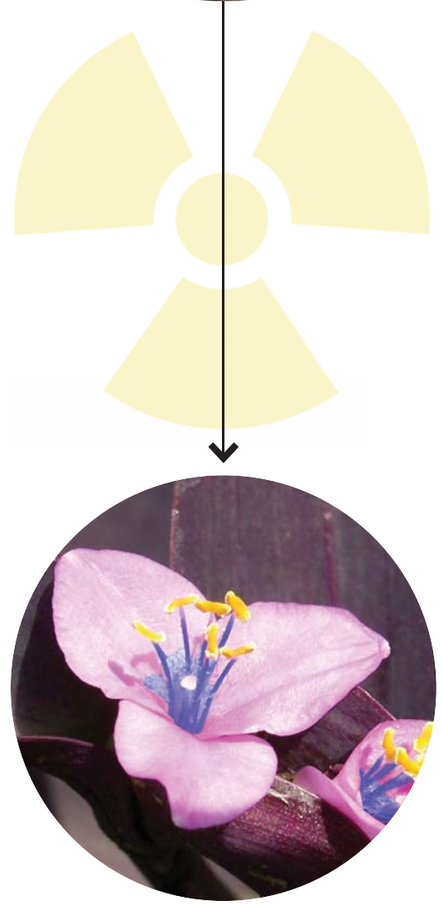
CURRENT CLIMATE RANGE AND PROJECTED CLIMATE CHANGE GROWTH

Visualizing Exposure

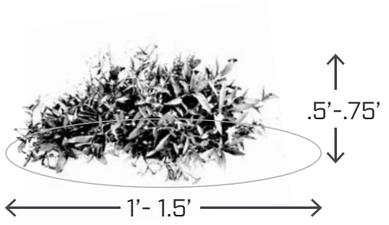
"The stamen-hair system of Tradescantia for flower colour has proven to be one of the most suitable materials to study the frequency of mutations induced by low doses of various ionizing radiations and chemical mutagens... *Tradescantia pallida 'Purpurea'* can be regarded as a biosensor plant or a biological warning signal of exposure to low dose radiation which exhibits a noticeable quantity of cell alteration in a short time following exposure to radiation. Hence, the effects caused on the environment might be anticipated, and by extension on the human being, as a result of its occupation exposition level."

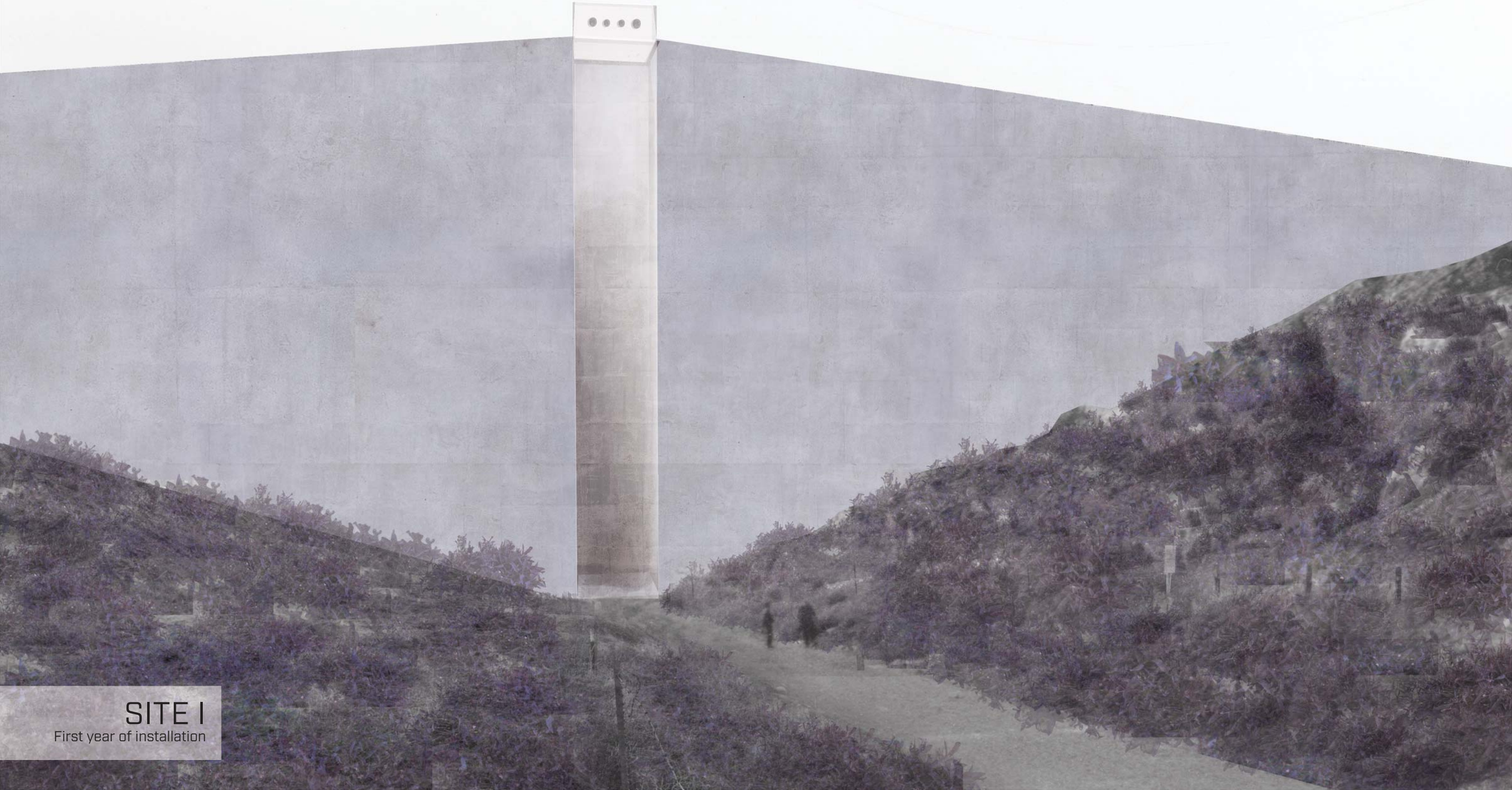
- Ibrahim, Hussin, Mohd, and Talib, "Plants as a Warning Signal for Exposure to Low Dose Radiation"



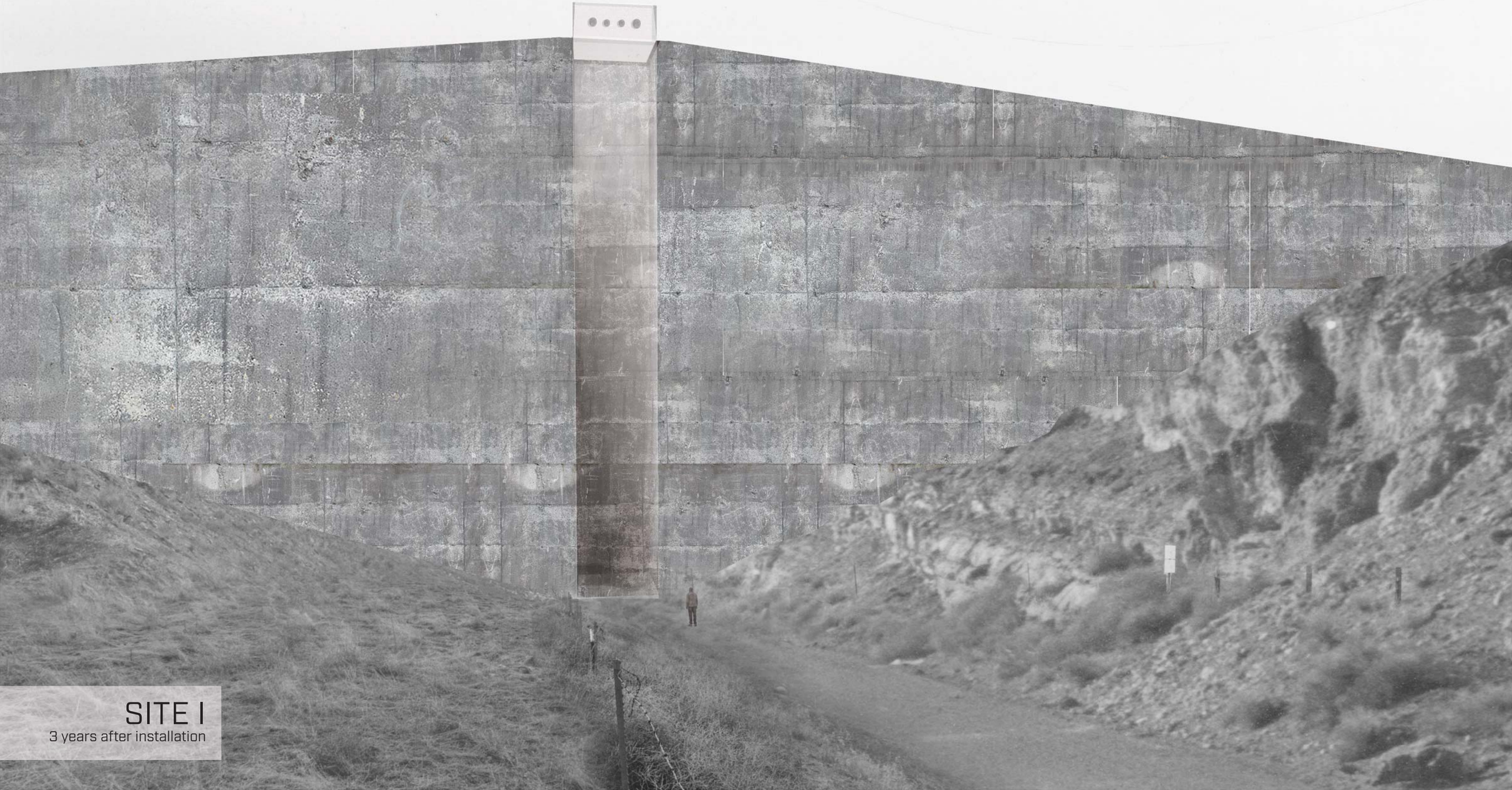








SITE I
First year of installation



SITE I

3 years after installation

expected of the plantings. However, if any do survive, they will blend back into landscape, perhaps tricking passersby into thinking they are native and not a foreign intruder much like the radioactive blanket across the rest of the site.[4]

These installations are not meant to be flashy tourist attractions with visitor kiosks, paved parking, or roadside restrooms. Rather, they are meant to encourage questions and curiosity. Only information that helps to situate a person within their current environment is included and, otherwise, it is up to the visitor to ask the questions about the sites history. It is in this way that these design proposals reject the tool so often employed at monuments of providing the visitor with a directed and controlled narrative that leads to the assumption that they have been given the full story. These installations do not control the narrative, and do not create a static monument that creates division between the past and present; they are a living and changing part of our nuclear heritage landscape.

These installations are using the tools of industry to comment on industry. Like the works of Smithson, Heizer, and de Maria, this work does not try to ameliorate the landscape or diminish the impact Hanford's industrial processes have had on the surrounding environment. Instead, this installation attempts to create a scalar impact on the landscape to better connect the visitor with a place he or she may never actually visit or even see, ERDF. These installations do not present fixed solutions or examples of containment, rather they further disrupt the landscape and do not demonstrate effective encapsulation. The displacement of the soil and emptiness of the concrete and glass column speaks to the displacement of people, resources, and irradiated materials required for the nuclear armament. These sites do not feign to re-naturalize the landscape and instead cause a disturbance such that visitors are inspired to ask questions: How is this allowed? Why is this here? Do these plants belong here? Where am I looking? Through this questioning, this work aims to incite greater perception between the visitor and their surrounding environment as well as their regional and global placement.

This works hopes to inspire similar interventions throughout Hanford's region and even beyond. There is opportunity to exploit the unbound nature of Hanford's pollution through a greater number of installations that mark the environmental and social areas of impact. (See Appendix) The pervasive pollution at Hanford, while exceptional, is not unique. Encouraging public encounters with wastescapes is an opportunity not yet well-explored in the field of landscape architecture. Nuclear waste cannot be ameliorated, erased, contained, and, in the case of Hanford, accessed. As such we can use some of the formal tools put forth by Land Art to engage the public and promote understanding of the nuclear landscape. These installations present a somber reminder that Hanford is not just the technical, engineering accomplishment valued within the authorized heritage discourse put forth by the DOE and NPS but is also indicative of an exploitive, extractive, and environmentally degrading industrial operation that will continue to impact the landscape for hundreds of thousands of years.

4 There is also potential that this large scale planting could become an annual tradition for nearby communities looking to communicate the persistent toxic variability of their landscape. However, that requires a level of community engagement that cannot be assumed.


300 AREA
REMEDIAL ACTION PROJECT
WARNING
HAZARDOUS AREA
Area May Contain Hazardous Soil
Only Authorized Personnel Allowed
For Information Call: 509-376-7501

MOVING FORWARD

RESTRICTED ACCESS TO THE 300 AREA
Signs warning not to access the landscapes currently undergoing remediation. 2017

Power is produced through the physical demarcation of territory and culturally through the articulation of authorized narratives that curate the stories of territories. Reliance on predominant or official narratives diminishes opportunities for viably engaging with alternative possibilities, and can also help affirm the spatial and discursive preferences of dominant powers. This can be further complicated by disciplinary organization where certain types of problems are relegated to specific disciplines.

Nuclear ecologies have helped separate the Anthropocene from the Holocene and mark a critical accumulation of pollution, density, and precarity in our world. Instead of expecting some form of techno-salvation or retreating to dichotomous ambitions for Arcadian salvation or despotic nihilism, a critical engagement with our past can open new possibilities for understanding and relating to how we alter the world.

In the case of nuclear waste, weapons production and escalation has created a distinct geography dedicated to securing, storing, and engineering nuclear power and waste. This attempt to secure and consolidate power has heavily utilized and impacted the land. The reconfiguration of water and land systems along with the production of narratives of patriotic necessity and scientific primacy helped insulate such destructive capacities, resulting in the disproportionate accumulation of toxicity in bodies and ecosystems. This operationalization of landscape is not unique to nuclear production and there is great opportunity moving forward to continue to engage wastescapes through diverse, collaborative, multi-disciplinary teams.

COLLABORATION

The Hanford site is defined by a complex combination of macro and micro impacts – from the extraction of uranium in the Democratic Republic of Congo to the radioactive fruit flies chased and captured across eastern Washington. A collaborative approach has allowed for multi-scalar, multi-directional investigations of Hanford that begins to tackle a number of these impacts. The complicated historic and present conditions of Hanford have been examined through the lens of politics, philosophy, history, heritage, and art; if approached by any single individual these would have been too eclectic, too scattered, to reach any cohesive conclusions. However, by working as a team, there was the ability to simultaneously pursue different paths of investigation thus allowing for a broader understanding of how Hanford relates to our collective cultural heritage. This approach revealed through several different lines of inquiry that wastescapes may be able to serve as models for inspecting how production, power, and toxicity produce both physical and cultural landscapes. Understanding how machines are employed to metabolize resources and alter ecologies can offer further opportunities for inspecting the consequences of land use through waste ecologies. Collaboration has allowed us to use our different backgrounds to produce an investigation into Hanford that neither of us would could have achieved on our own. Our divergent but complimentary research has allowed for the beginning of a more nuanced understanding of how Hanford impacts and iterates on the collective social psyche.

MOVING FORWARD

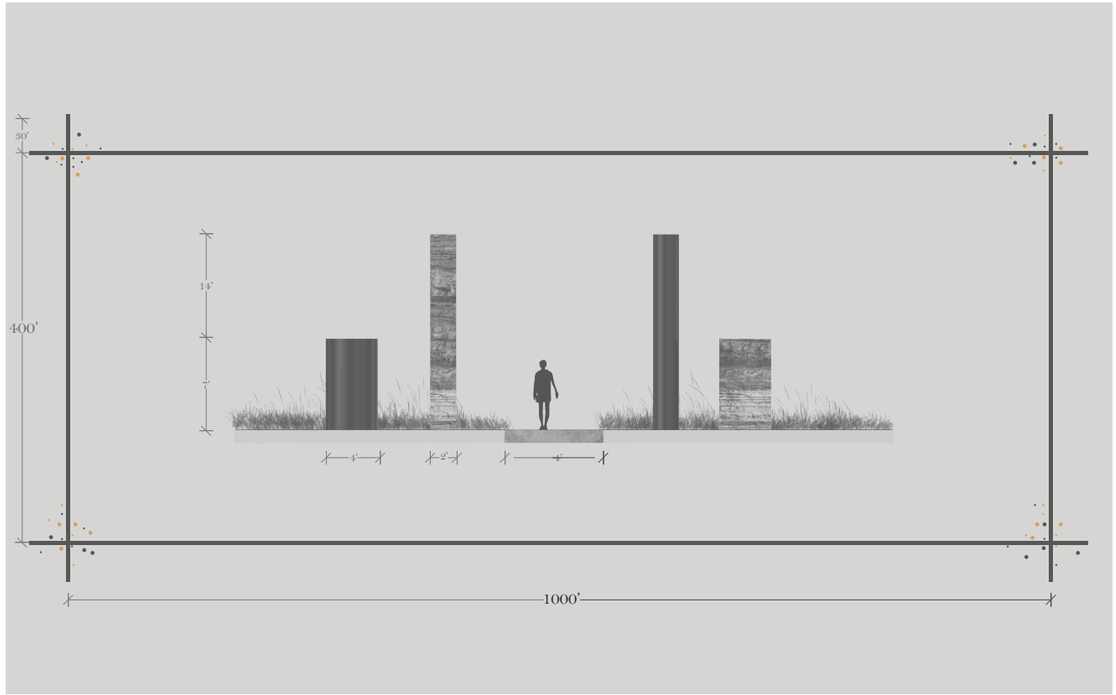
While the work over the last nine months has created greater understanding of Hanford's history, present, and potential futures, not surprisingly, it has created more questions than answers. By continuing to investigate the implications of how DOE has and will manage the site, we can also continue to examine the role of landscape architecture within nuclear ecologies, and more broadly, wastescapes. Nuclear landscapes, especially military sites, present a unique wickedness where dispossession, violence, and toxicity intersect and open these sites as potential models for thinking about landscape

in the Anthropocene. Future research into these conditions should work to better track the agents, operations, and systems creating these spaces to find patterns and possibilities for relating to and understanding land use. It should also continue to investigate design potentials for public engagement with these ideas and landscapes.

These spaces are fundamentally about the production of power. By engaging with this domestic war-born landscape we believe new models for understanding and relating to land can be made available that could be particularly useful as violence, precarity, and pollution accumulate in our world. Confronting these spaces may be vital to coming to terms with contemporary conditions, building broader and more inclusive understanding of the consequences and burdens realized through the production of power. The combination of history, theory, art, design, science, and narrative are key parts of continuing such investigations. Using narrative and design to realize new possibilities for the legibility of land use impact and waste's movement can allow for landscape architecture and the public to critically engage with nuclear landscapes and, therefore, dominant power systems that orchestrate and sustain their organization.

Given the challenges of climate change and current geopolitical tensions, understanding how nuclear power impacts land, water, and people can help inform stronger, more robust thinking and engagement. The impact of wastescapes such as Hanford will continue to reverberate well into the future. Given impacts on culture, urbanism, and natural systems, knowing how to build relationships with these spaces will likely be a necessary task moving forward. Through situating people within wastescapes, we can provoke questions about the immediacy and intimacy of how our culture manages, utilizes, and engages with land as resource. Using design to find ways to recognize, articulate, and contest spatial territoralization can help us rethink consequences and possibilities of land use. In moving forward with Hanford, we hope to collectively broaden our application of these ideas within writing and design to explore relationships between power, toxicity, and territory in the hopes of contributing to landscape architecture and open possibilities for better relating to the ecologies of the 21st century.

APPENDIX A



The following work was created as explorations of potential off-site installations as compliments to the two interventions along the border of the Hanford site. While the proposed installations work to engage viewers with the bound and unbound material and cultural heritage, there is also allusion to the permeability of the boundary and the scattered displacement of materials beyond the site. Despite significant attempts to control and contain byproducts and waste within Hanford, they have migrated.

The off-site interventions proposed here characterize this movement in their own dispersed, non-ceremonial placement throughout the affected landscape. Each of the proposed sites has been chosen due to its proximity to Hanford and its likelihood of still encountering contaminants despite this distance. At each of the off-site installations, there will be totems placed; these will either be soil core samples or vitrified soil either of which will be collected from the excavation process of Site I and Site II. For those who look in the concrete voids at Site I and II, wondering where the contents of gone, they are here, scattered the same as the nucleated dust, water, flora and fauna that has coasted beyond the boundaries of Hanford for decades. The totems will take the size and shape of low to high level waste containers, and become more prevalent as one approaches closer to Hanford.

The materiality of these totems speaks to the movement of waste and attempted capture of it through the process of vitrification. At each of these sites, inscriptions could be found on the core sample and glass totems encouraging visitors to inquire further about why these totems are where they are and why would the waste practices of a site however many miles a way matter.

This design proposal is meant to encourage communities, artists, designers, and whoever else to pursue their own methods of articulating nuclear heritage. No one person or landscape is completely removed from the production of these materials and, as such, there is great opportunity for diverse interpretation and articulation of this cultural heritage.

SCALE AND DESIGN OF PROPOSED TOTEMS

Black columns represent vitrified soil whereas the others are core samples. Both take the size and shape of low-level and high-level waste containers.

1 SOUTH JETTY

Part of approximately 10 miles of jetty the US Army Corps of Engineers manages for minimizing naviagation maintenace at the Columbia's mouth.

2 JULIA BUTLER HANSEN REFUGE

Dedicated to the Columbian White-tailed deer, this site was set up to help increase and protect deer populations due to flood risk in remaining habitats.

3 GIFFORD PINCHOT NATIONAL FOREST

Pinchot was the first head of the US Forest Service and pioneered conservation through intensive management - taking a somewhat agricultural perspective on timber resources.

4 PORTLAND

Oregon's largest city, Portland relies heavily on the Columbia for energy, water, and commerce.

5 BRIDAL VEIL FALLS

Bridal Veil is a major tourist attraction right off US rt. 40. The site boasts a 1,328' waterfall before entering the Columbia.

6 THE DALLES DAM

The Dalles Dam destroyed Celilo Falls, the most important cultural site for Native Americans on the Columbia and home to the oldest continuously inhabited settlement in N. America.

7 MARYVILLE MUSEUM OF MODERN ART

Sited upon a bluff looking south into Oregon, MMMA's collection includes artifacts, 2D, and 3D works. MMMA was originally intended to be the home of Samuel Hill, a lawyer and relentless advocate of paved roads and railways.

8 UMATILLA REFUGE

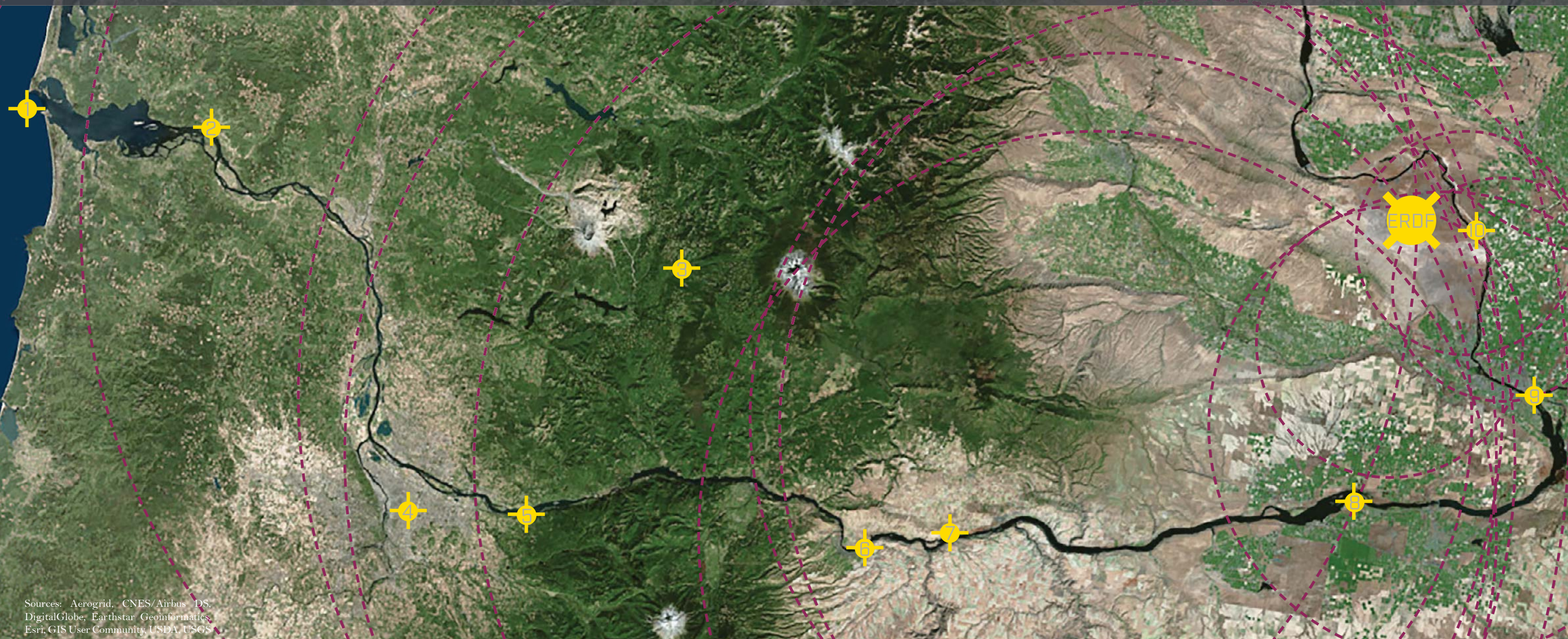
A critical stopover fo the Pacific Flyway, Umatilla is also refuge for indigenous wildlife suffering habitat loss due to development and dams.

9 SNAKE RIVER

The Snake River is the Columbia's major tributary and comes in from Idaho. The steep river was once home to abundant salmon runs, but runs have fallen primarily due to dams and development.

10 HANFORD REACH

The reach is home to arid lands research, conservation, and a number of outlooks and fishing pulloffs.



Sources: Aerogrid, CNES/Airbus DS, DigitalGlobe, Earthstar Geoinformatics, Esri, GIS User Community, USDA, USGS

HAYDEN ISLAND, COLUMBIA RIVER

Hayden Island is situated between Vancouver, WA and Portland, OR in the Columbia River. The Island is bisected by by I-5 and the BNSF railway. Hayden Island is divided into an East side that is heavily developed with shopping, housing, and substantial boat and yacht moorings. The West side is owned by the Bonneville Power Administration, public trusts, and the Port of Portland. Hayden is an island caught between consumption, preservation, and operationalization making it an ideal metaphor for the Columbia Basin at large.





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Unless cited otherwise, all images are courtesy of Kasia Keeley and Andrew Prindle.

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Stop Making Sense

SPATIALIZING THE HANFORD SITE'S NUCLEAR LEGACY



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