IN THE GARDEN OF THE APOCALYPSE: NARRATING MYTH AND REALITY IN THE HANFORD LANDSCAPE

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Program Authorized to Offer Degree:

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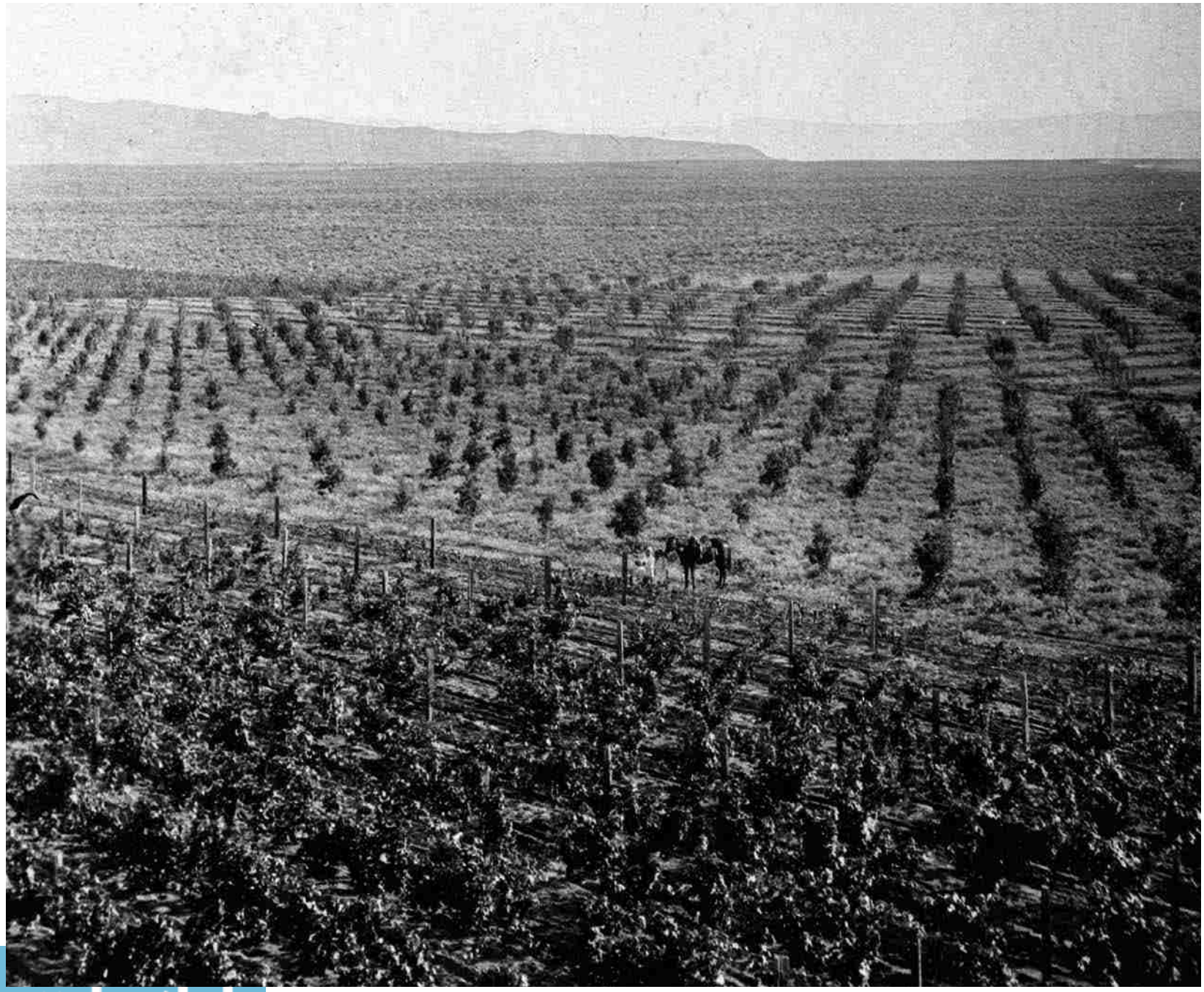
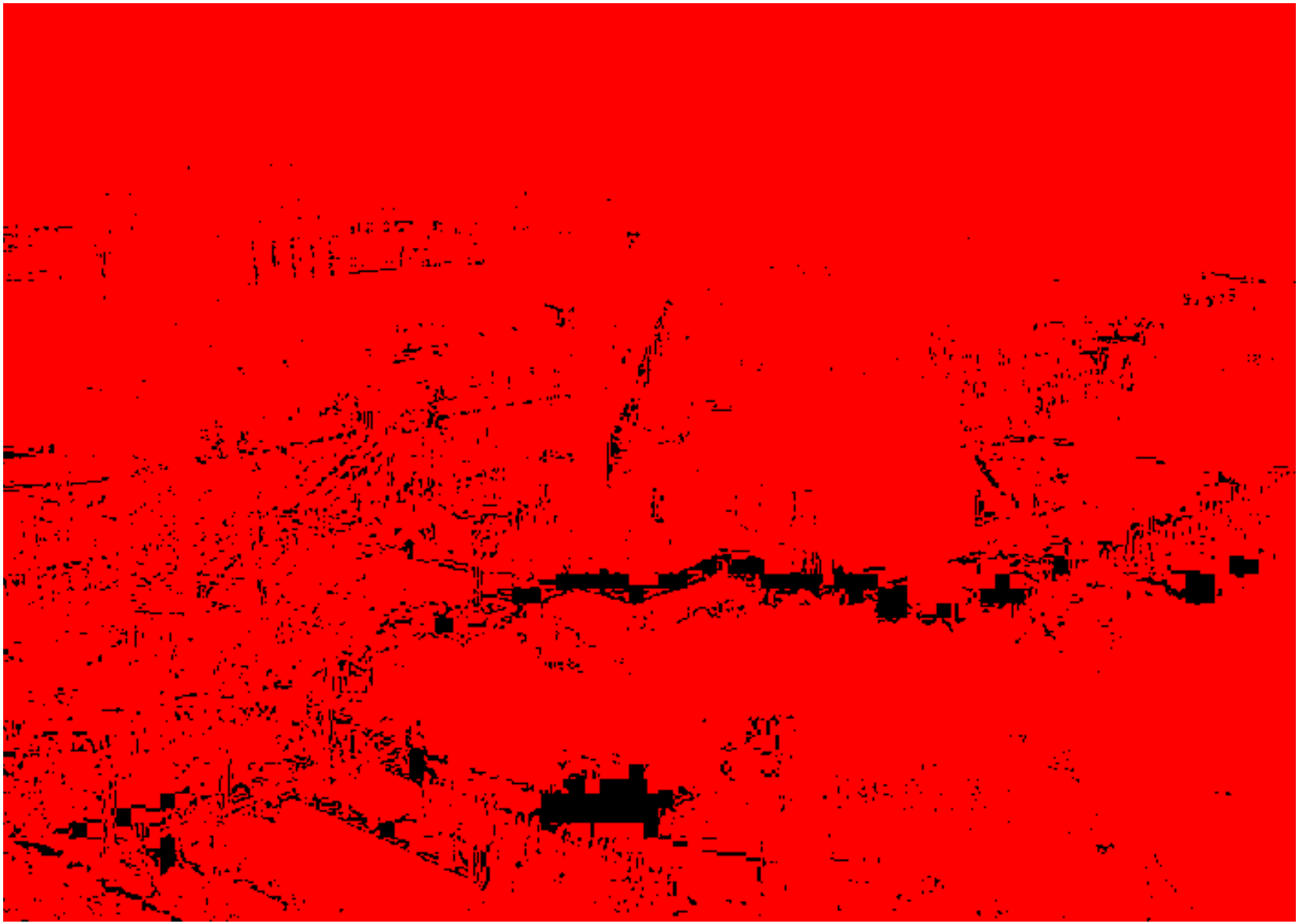
The author would like to acknowledge Louisa Iarocci, Brian McLaren, Josh Distler and Brad Khouri for their encouragement, dedication and insight throughout the long thesis process. Additionally, to my friends and family for providing their support and a occassional dose of real life along the way.

Introduction

In March of 1943, the US army notified residents in the small farming communities of White Bluffs and Hanford, Washington they had 30 days to vacate their property. Members of the Wanapum tribe were told to leave their ancestral homes along the Columbia River.[1] They were told only that their properties were to be a site of utmost importance to national security and the war effort. This site was to be the production facility for the top-secret Manhattan Project, the U.S. effort to develop an atomic bomb. The military and political establishment hoped this bomb would end the ravages of World War II and usher a new era of geopolitical stability. On July 16, 1945 the world's first atomic bomb was detonated at the Trinity test site in southeast New Mexico and three weeks later the US dropped "Fat Man" on the Japanese city of Nagasaki, instantly killing 40,000 people. The nuclear fuel for these first two atomic bombs was produced at this 600 square mile site, in the eastern Washington shrub steppe desert, given the new name of Hanford Works. Over the next 50 years this "garden of the apocalypse" would produce the majority of plutonium used in the US nuclear weapons program.





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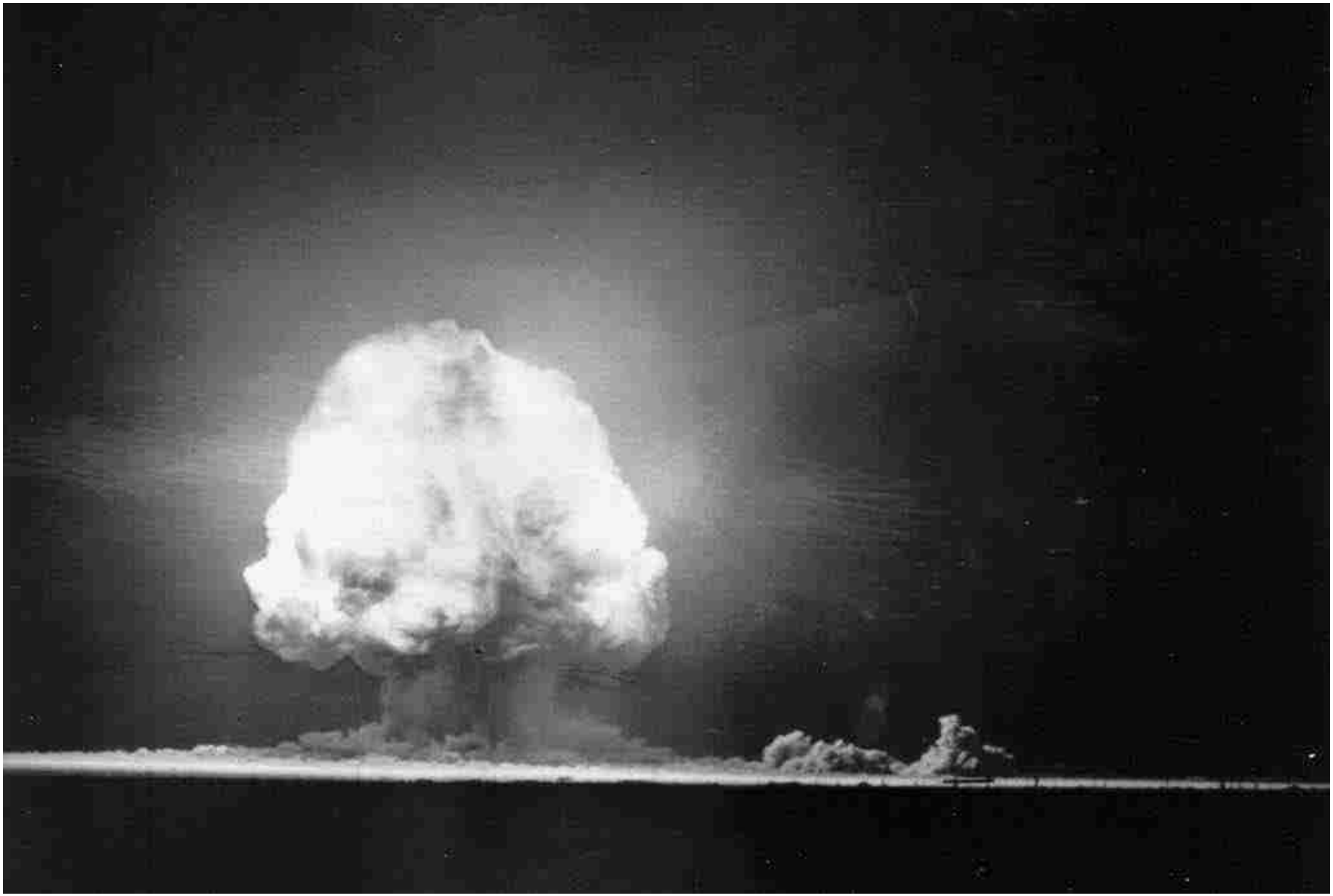
1. (Previous), White Bluffs Orchard, 1914
2. B-Reactor, 1944
3. Trinity Test Detonation, 1944



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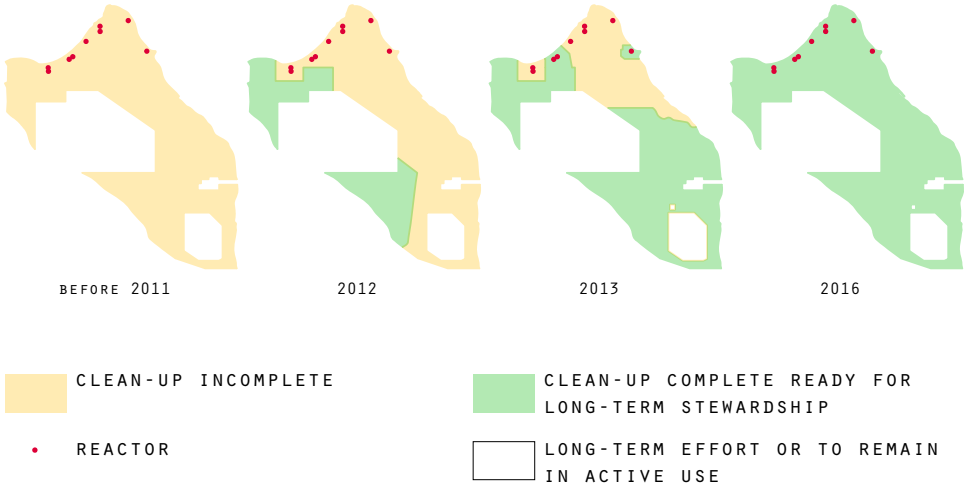
Today, the primary mission at Hanford has changed from weapons production to large scale environmental remediation. Massive projects are underway to remove the site's built infrastructures and dispose of the 53 million gallons of radioactive waste currently buried beneath the surface of the site. Remediation is slated to be completed in the coming decade while efforts to dispose of the radioactive waste will continue for the next forty to fifty years.[2] The reactor buildings themselves will remain entombed in concrete in the stark Hanford desert for 100 years as their radioactive cores decay. The future of this site rasies compelling questions. How will it function in the landscape of the New American West? As the site is cleaned and the waste removed, how will the lasting effect of our nuclear legacy stay within the realm of public consciousness?

This thesis project has two primary objectives. The first is to address the very real need for a physical storage site for the waste that will be removed from its current location at Hanford. This issue has highly political, environmental and technical implications that go beyond the scope of an architectural thesis. Yet at the same time, the storage of this radioactive waste has an implicit architectural and spatial significance. The technical demands of the storage require it to be buried below the ground, out of site and mind. The problem raised by this waste engages both collective memories and ongoing cultural debates regarding our obligations to the environment, to war and to the future that will inherit its effects for the next 10,000 years. This thesis will address these issues in the specific context of the Hanford site.

4. Demolition, K-West Sedimentation Basin
5. Depleted Uranium Canisters
6. Hanford Remediation Timeline

The second objective of this thesis project is to address Hanford as it exists in reality and myth, landscape and ruin. Currently, plans are under way for a traditional interpretive center to act as the public interface with the site, its significant history and the surrounding natural landscape. This thesis serves as a critique of this interpretive model. Rather than follow the didactic approach of a traditional interpretive center that relies on imagery and text to convey meaning, this thesis proposes that an experiential and bodily interaction with the landscape can lead to a more subtle and more personal understanding of the site's multiple meanings. Through a series of architectural interventions, this project will provide a narrative means of confronting our nuclear legacy and the waste it has created while exposing the human and natural history of the Hanford landscape.



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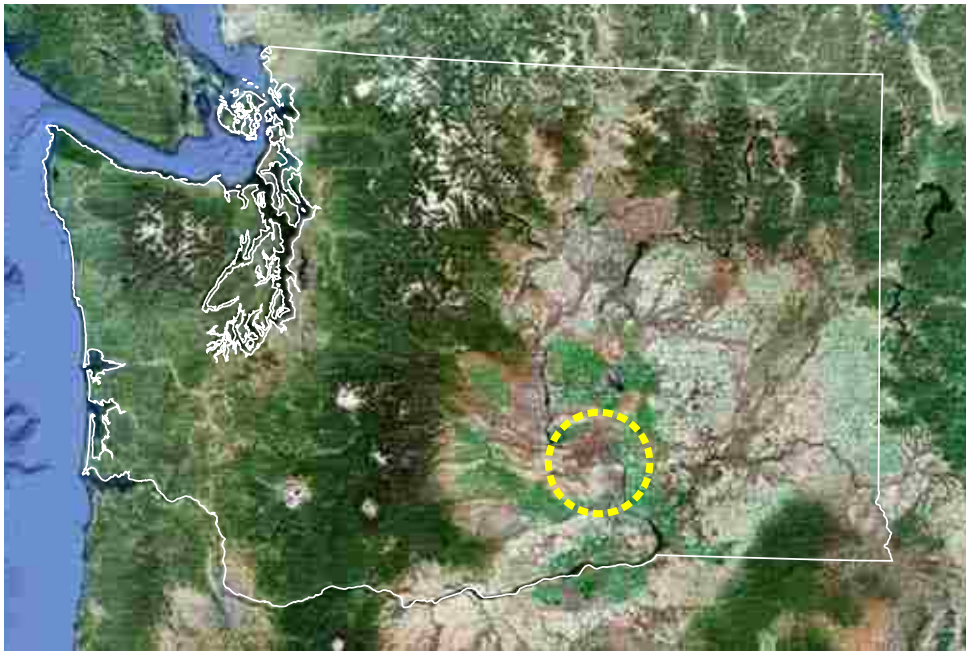

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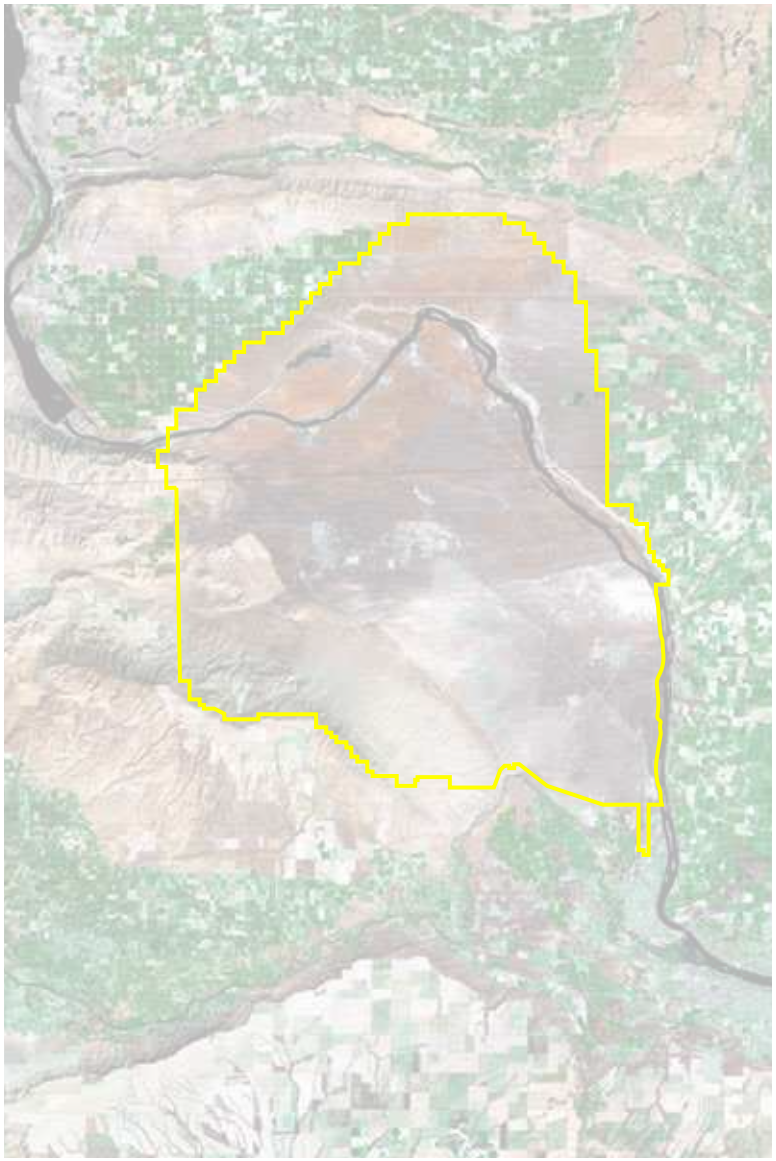
GEOGRAPHIC CONTEXT

Hanford occupies some 600 square miles along the Columbia River in eastern Washington. Land administration is broken up into three primary zones. The Hanford Reach National Monument and the Arid Lands Ecology Reserve represent two large areas of Hanford that have been turned over to semi-public uses and ecological preservation. A large area of Hanford, south of the Columbia and north of Highway 240 remains under active US Department of Energy regulation and is closed to the public. The area is surrounded by irrigated farm land and is adjacent to the large urban center of the Tri-Cities to the southeast.

7. Regional Context
8. Local Context
9. Land Designations and Adjacenies



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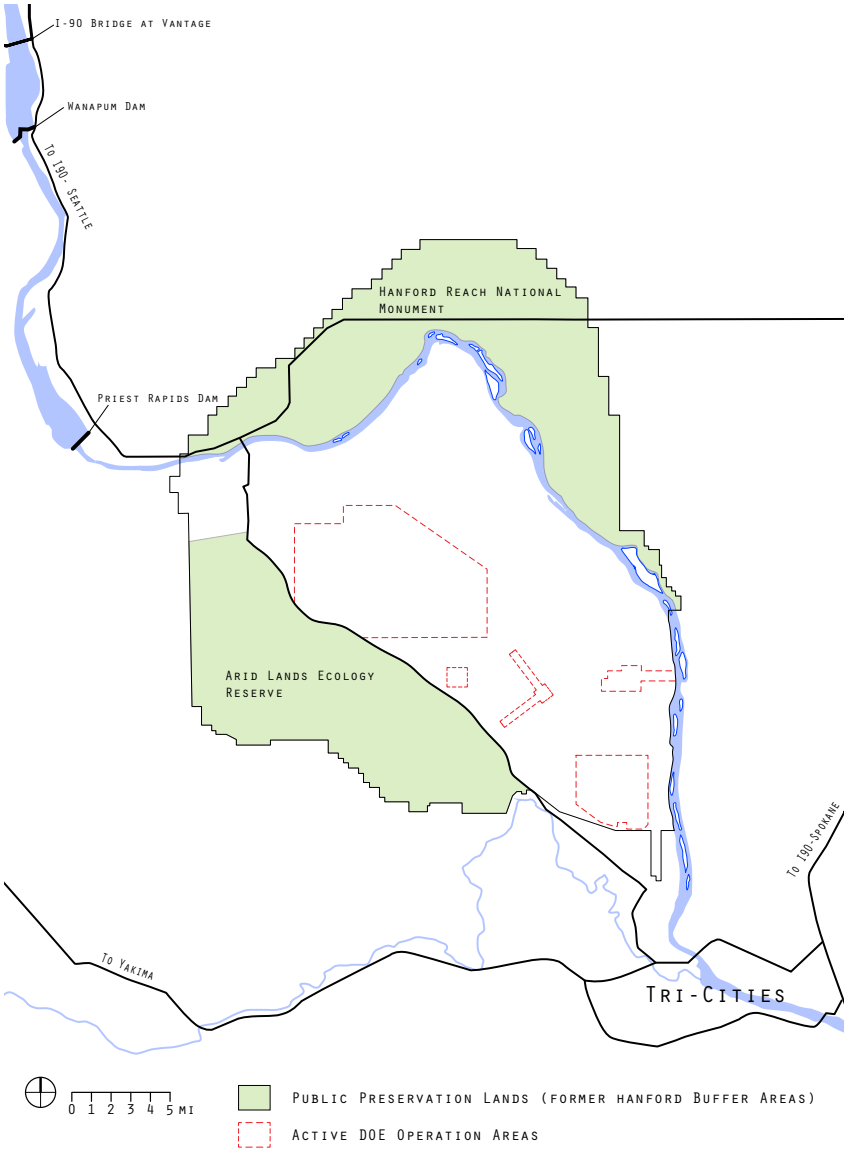

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Theoretical Framework: Reading the Nuclear Landscape

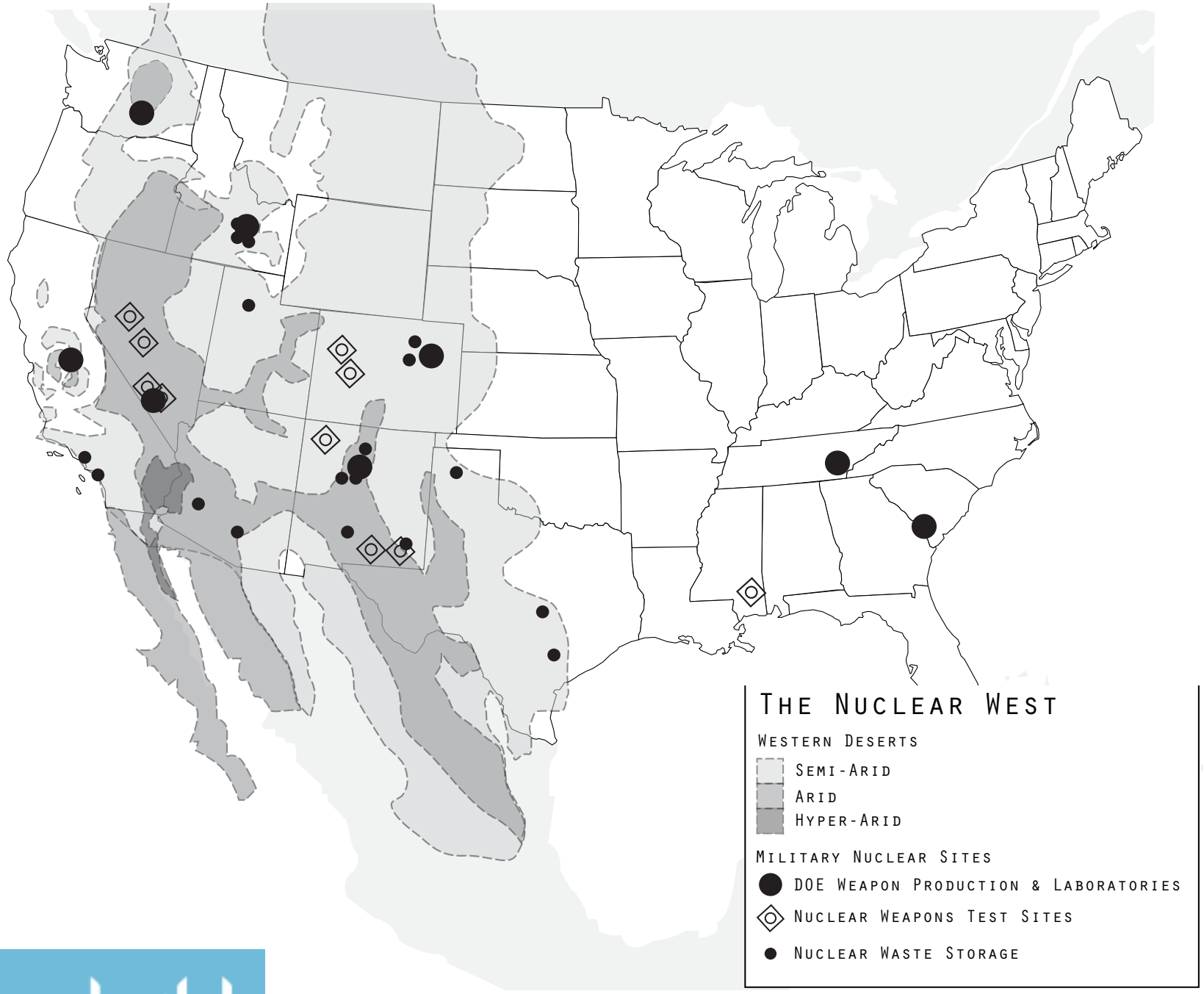
The Nuclear West

"In my mind the terrain of strategic death will forever be desert… isolation, aridity, stable weather, and exceptional visibility provided the geographic equivalent of "neutral" laboratory conditions for the largest physics experiments of the time. Common to these lands is a consensus of their worthlessness and the assumption that local populations were invisible, expendable, or relocatable. Paramount objectives throughout the era were weapons production and the utmost secrecy. A land dominated by silence and sky, dust and time, held those secrets well."

- Ellen Melloy, *The Last Cheaters Waltz*

The siting of Hanford in the arid central plateau of Washington state was not a coincidence. As the Manhattan Project scaled up in 1942, it became clear that production and testing of the atomic weapon would necessitate a certain set of geographic criteria. The plutonium production facility needed to be sited in a place with no highway or railroad within 10 miles and no town of over 1,000 people within 20 miles. In other words, the site needed to be expansive, with minimal population, and be a location that would conceal the secret and controversial nature of the activities being undertaken. [1] The US nuclear complex thus developed as an extension of the vast deserts of the Western landscape that met these criteria and were quickly transformed into what Ellen Melloy calls the "terrain of strategic death."[2] The intimate relationship between nuclear weapons and the western deserts is powerfully demonstrated in a map that overlays US nuclear sites onto the arid landscapes of North America (Figure 10). This map showing the full development of the nuclear west also highlights the need to understand this broader context before zooming into the specific architectural questions at Hanford.

As much as they exist as physical places, the western deserts also endure as a set of ideas forming a natural and cultural mythology that influences our narratives and perceptions of them as landscapes. Sociologist Valerie Kuletz frames this idea succinctly in *The Tainted Desert,* explaining that the Western landscape must be understood as a manifestation of different "cultural representation[s] of nature." [3] Development of the desert landscape as nuclear production and testing sites is the product of a distinctive perception of natural



11.

terrain. The modes of perception explored in this literature review represent some of the dominant ways in which the reading of the landscape influenced the development of Hanford and other nuclear sites throughout the West.

Desert Wastelands

In 1885, Guy Waring was crossing through the area of the future Hanford site with his wife and children on their way to the Okanogan valley. He described the area as an inhospitable, windy and treeless no-man's land, scoured by deep gullies and rock formations that made it an obstacle to travel and worthless for development. Even in the roaring waters of the Columbia, he saw nothing but hindrance and difficulty.[4]

Though anecdotal, the above passage represents the dominant perception of desert landscapes influencing Euro-American settlers who came to colonize the lands west of the continental divide in the second half of the 19th century. In *This Ecstatic Nation,* Terre Ryan discusses how these ideas about landscape were rooted in European aesthetics that only valued landscapes exhibiting aesthetic qualities of the sublime, picturesque and pastoral. Popularized by landscape paintings like those of the Hudson River School (Figure 11), these perceptions were extremely influential in shaping American's expectations of the landscapes that awaited them. However, when actually experiencing them firsthand these early emigrants often perceived the desert landscapes they encountered as at best worthless and at worst, hellish, endowing them with names like Death Valley and Hell's Canyon.[5] In the sagebrush steppes and rocky deserts these settlers saw nothing but marginal wastelands, lacking intrinsic value and unfit for use without human intervention.[6]

Ryan also discusses the 19th century idea of landscape as a resource, something to be made productive through human manipulation. The dominant perception of the western deserts

11. Grand Gateway to the Yellowstone, Thomas Moran, 1893
12. Spirit of the Frontier, John Gast, 1872
13. General and Wanapum at Celilo Falls, 1945

as barren frontiers was a Manifest Destiny ideal that allowed for a *deterritorialization* of the land.[7] In John Gast's 1872 painting S*pirit of the Frontier* trains, settlers and power lines stretch from right to left (east to west) across the scene as the figure of Columbia looms over head, bringing illumination to a land of darkness. Indians, buffalo and other remnants of the native west are seen disappearing with the darkness. According to this view, only through human reclamation and development in the name of the nation would these vast arid "wastelands" find meaning.

12.

Nuclear Frontier

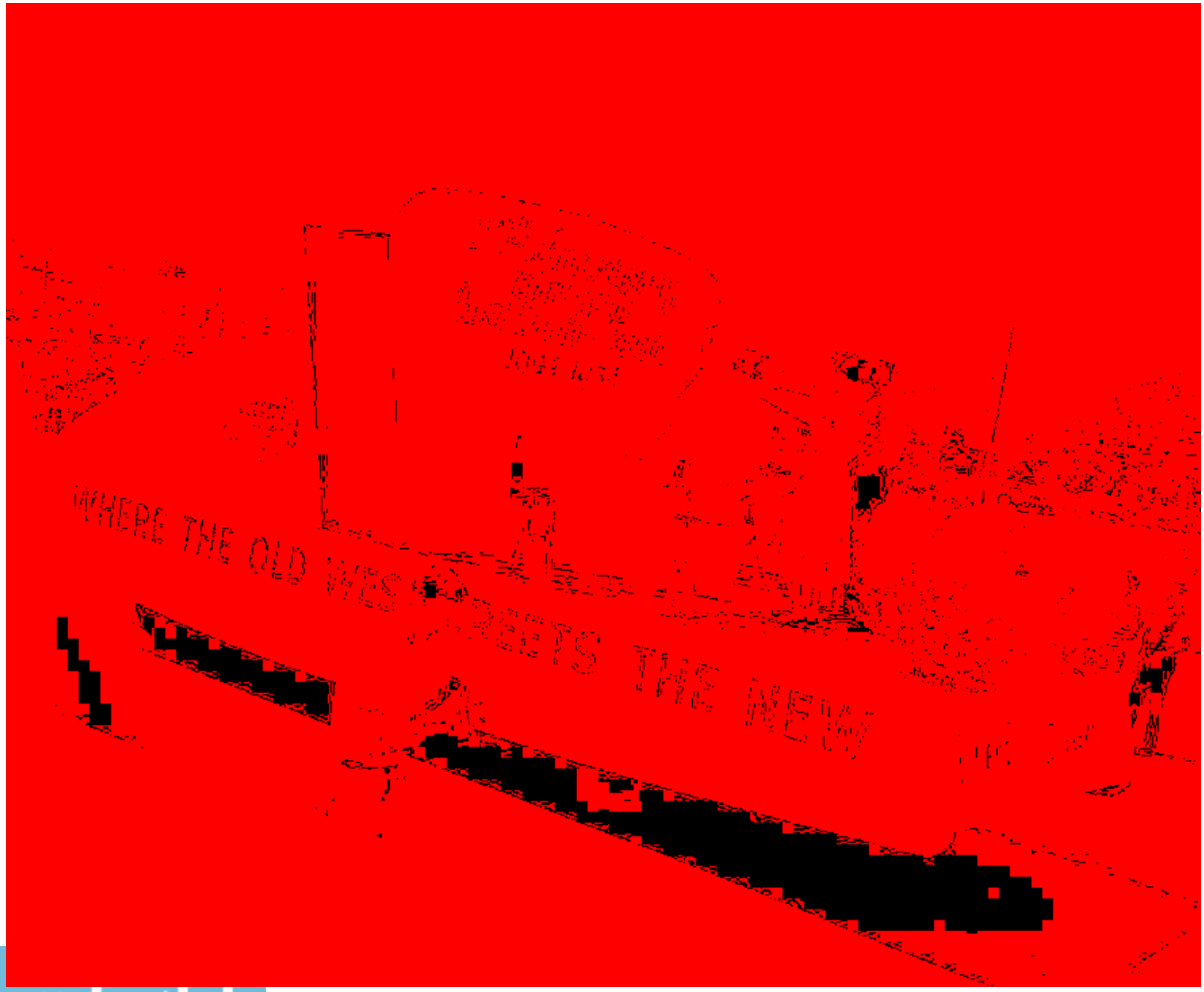
The perception of the desert landscapes as places without inherent worth influenced their appropriation as nuclear grounds in the 20th century. Deterritorialization of the land (and the people already living on it) into marginal wastelands rendered the idea of putting them to the destructive uses of atomic bomb testing, uranium mining and plutonium production a matter of common sense. In *The Last Cheater's Waltz,* Ellen Melloy captures this process noting that "the sterilization of landscape allows its reinvention… land considered barren and empty of life cannot be stripped of life."[8] The narrative of "reclamation" and de/ or reterritorialization played out in the development of Hanford as a primary impetus in shaping its landscape. Even before the plutonium production complex came to define the area, the Columbia Plateau was being reshaped from a wide-open and arid frontier into a "productive" landscape by the construction of dams along the Columbia River. Built by the US Army under the auspices of the Reclamation Act of 1902, the idea of reclaiming the desert west was official national policy.[9]

13.

14.

The Hanford Works site was settled by the US government based on a patriotic sense of necessity and a perception of the existing landscape as undesirable. These perceptions validated the reservation of nearly 600 square miles as a zone of top-secret plutonium production, radioactive waste dumping and storage. Those who came to work at Hanford for its construction and operation perceived themselves and the land through the lens of the mythical frontier. Richland, the new "company town" for the Hanford site manufactured this pioneer identity, illustrated well in images from Richland's Atomic Frontier Days celebration and parade. This three day festival was held continuously from 1948-1959, at the height of the area's development, celebrating an atomic age western frontierism.[10] A 1948 promotional poster depicts a pioneer wagon and cowboy set in a desert landscape of the west, illuminated by a glowing atomic symbol, all imposed on the new horizon of industrial cityscape (Figure 14). The US government imparted "meaning" to the deserts as sites of production, science and national security giving the region the identity of the Nuclear West. However, this understanding and perception of the desert landscape belies the fact that there was already a meaning in this landscape, albiet one from a different perspective.

14. Atomic Frontier Days Poster
15. (Opposite), Atomic Frontier Days



16.

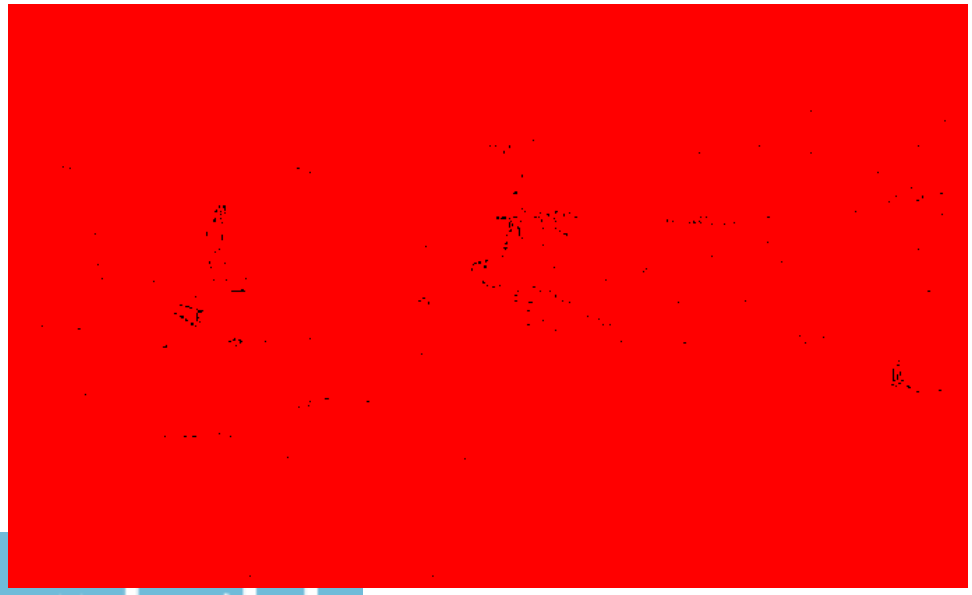
The Mythographic Landscape

The indigenous peoples that inhabited the deserts of the west perceived the land much differently than the American settlers who came seeking to "reclaim" it. Valerie Kulutz contrasts the desert wasteland discourse with the oral narratives of the Native American tribes that "often depict the land's life sustaining and healing properties."[11] Describing their perception of the landscape as "mythographic" Kuletz relates how different songs from tribes in the Southwestern deserts provided an oral mapping that narrates movement through a landscape of nodes and paths, places of shelter and exposure.[12]

Kuletz also makes connections between Native American modes of perception and the notion of phenomenology, especially as described by Merleau-Ponty. Emphasizing the importance of the oral tradition over the textual, she writes that "the natural world in oral cultures is perceived more directly by being in it; perception occurs by hands-on experience as opposed to the mediation of textual accounts, which presumes a distance between the sender and the receiver."[13]

The Hanford site was home to many nomadic tribes in its pre-military industrial history, the primary being the Wanapum. The Wanapum maintained a sacred relationship with several features of the Hanford desert including the river itself, the basalt protrusions of Gable Mountain and Gable Butte and the bunch grass covered sand dunes called Mooli-Mooli.

16. Wanapum Petroglyphs
17. Hanford Site
18. Fishing at Celilo Falls, 1899



Re-making the Nuclear West and Contemporary Issues

Public Perceptions and Existing Narratives

As nuclear lands across the West largely decommission, they await new readings as natural and cultural landscapes. However, the conflicted nature of their histories creates controversial discussions about the futures of these sites. In *Atomic Frontier Days* Bruce Hevly and John Findlay recognize this issue and outline the discussion as it has applied to the Hanford landscape thus far. They explain how one common perspective is to grant Hanford importance as a place solely for its role in ending World War II and defeating the spread of communism during the Cold War. This is the perspective brought to the notion that only the B-Reactor (which produced the material for the Trinity and Nagasaki weapons) is worth saving as a historical site.[14] Public tours of the Hanford Site currently focus only on the physical monuments of military and scientific triumphs while the natural landscape and pre-nuclear settlements are ignored. Of the largely healthy and intact desert ecosystem, one tour guide simply commented there were a lot of "critters" running around.[15] With this perspective the physical relics of Hanford's reactor buildings become monuments to American military and scientific power.

Citing another narrative of environmental and political activism that began in the 1960s, Findlay and Hevly also present the view of the "accusatory perspective" that focuses on the environmental damage and negative health effects of nuclear development. Environmentalists, Native Americans, sick residents and other stakeholders became critical voices in the discussion of nuclearism in our society. At Hanford in particular, they have served as needed watchdogs in the clean-up process always fighting for

19. (Opposite) Rockys Flats Before and After Clean-Up
20. Occupy Hanford Rally
21. American Flag, B-Reactor Tour

20.

21.

more transparency, review and accountability. However, in their focus on the problems of Hanford, they fail in "sufficiently explaining the context in which the damage was done."[16] In *Remedies for a New West,* Len Acklund describes how the outcome from this perspective at the decommissioned Rocky Flats nuclear site in Colorado resulted in an environmentally clean landscape, but one that discourages "the public from remembering and considering the broad historical legacies" of the site.[17]

Land Use

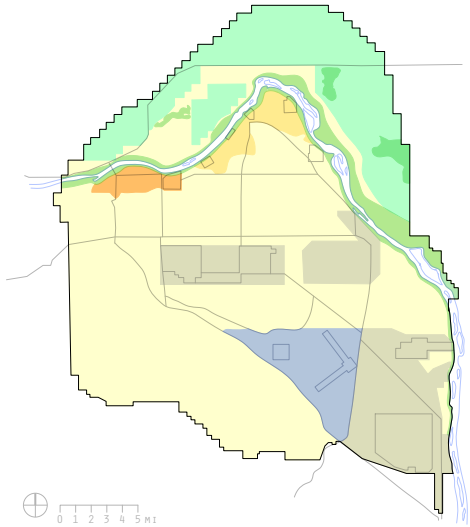
Kuletz distills these different cultural perceptions of the Nuclear West into three distinct notions of landscape. The wasteland discourse of *expendable* landscapes led to the western deserts use as the mines, factories and laboratories of military nuclearism embodied by the Hanford site. To the Native American tribes, on the other hand, these lands were naturally rich and productive, holding great intrinsic value as sites for human habitation. The archeological sites that still dot the Hanford landscape are evidence that it also embodies the mythographic *geography of the sacred*. Finally, the decline of Cold War foes and the rise of the environmental movement have presented alternate perceptions of former nuclear sites. They are seen both as triumphant monuments to the successful efforts of US Cold Warriors, and as places of grave environmental damage. Concerned alternately with the actors upon the landscape or the landscape itself, the nuclear landscape can be read as *landscapes of sacrifice*, physical embodiments of human suffering for power and control. [18]

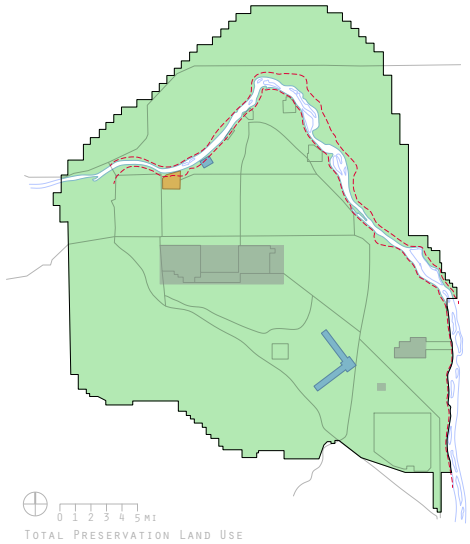
Many see large areas of Hanford as ripe for redevelopment as farmland and vineyards in a theme that continues to see the desert as a place needing reclamation. Alternatively, an official video series by the US Department of Energy promotes a continued "frontier"

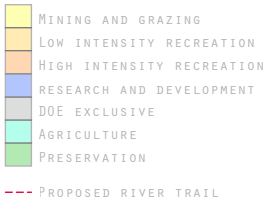
22. (Opposite), Proposed Hanford Land Use Maps, adapted from DOE Comprehensive Land Use Plan

myth at Hanford. With the site's ample sun and wind, supporters of this idea envision the Hanford site as a place for new clean energy development with factories, solar panels and wind farms. The frontier is no longer the land of the dusty west itself but is instead a place for industrial and scientific pioneering. Some argue for its preservation as a monument to American power. Still others would see the land stripped of any sign as to its place and role in history.

These singular and oppositional understandings of the Hanford landscape display the need for a more nuanced and holistic approach to the site's future. This thesis argues for the recognition that Hanford is simultaneously a frontier, a garden and a monument. A new land use for the site's future must address all of these aspects of Hanford's contemporary reading. This is not an "on the fence" position but one that recognizes that any singular representation of this place will be false, and that a holistic attitude is the only way of honestly approaching this conflicted landscape.







Site Analysis and Design Methodologies

Site Analysis

Before developing an architecture that is appropriate to the intent of narrating the conflicted Hanford landscape, it is first necessary to better understand the constituent parts of this site. This site analysis section will seek to map, diagram and display the fundamental parts of the site that the final architectural solution can and should address. The elements are the roughly 600 sq. miles of natural landscape itself, the enormous reactor buildings that stand throughout the site and the physical presence of the waste itself. The site will be analyzed with a focus on these elements as the inspiration for a design response.

23. H-Reactor Against the White Bluffs

23.

Ecological Conditions

As noted previously, a perverse bi-product of Hanford's allocation as a nuclear site is the state of its relatively intact ecological conditions. Figure 24 powerfully shows the difference in conditions between the Hanford side of the Columbia River and the privately owned side in which the desert landscape of the Columbia Basin has been transformed into irrigated farmland. Indeed, the Hanford site represents the largest continuous area of intact Columbia Basin shrub-steppe desert left in Washington State.

Weather and climatic conditions on the site are important for architectural interventions into this landscape. The Hanford area can be described as a harsh environment with large swings in temperature between day and night and season to season. In the winter daily temperatures can range from 21° F to 36° F and occasionally get even colder. Daily average highs in the summer exceed 90° F over 50 days of the year and can often exceed 100° F. Average annual precipitation is only 7 inches and the area is subject to consistent winds from both the northwest and southwest directions. The area is characterized by a high degree of exposure to sun and wind. Architecture in this landscape must make strong responses to these conditions to provide basic shelter.

Finally, it is important to note that despite the richness of these ecological conditions at Hanford, there is still very limited access to these areas both because of a lack of established trails or amenities and the still strictly enforced public access policies. As noted on the Hanford Reach National Monument website, if you plan to visit the monument area "don't come expecting a lot of visitor facilities---they don't exist." "You'll be experiencing the monument on its own terms."[1]

24. Desert and Irrigated Farmland

25.

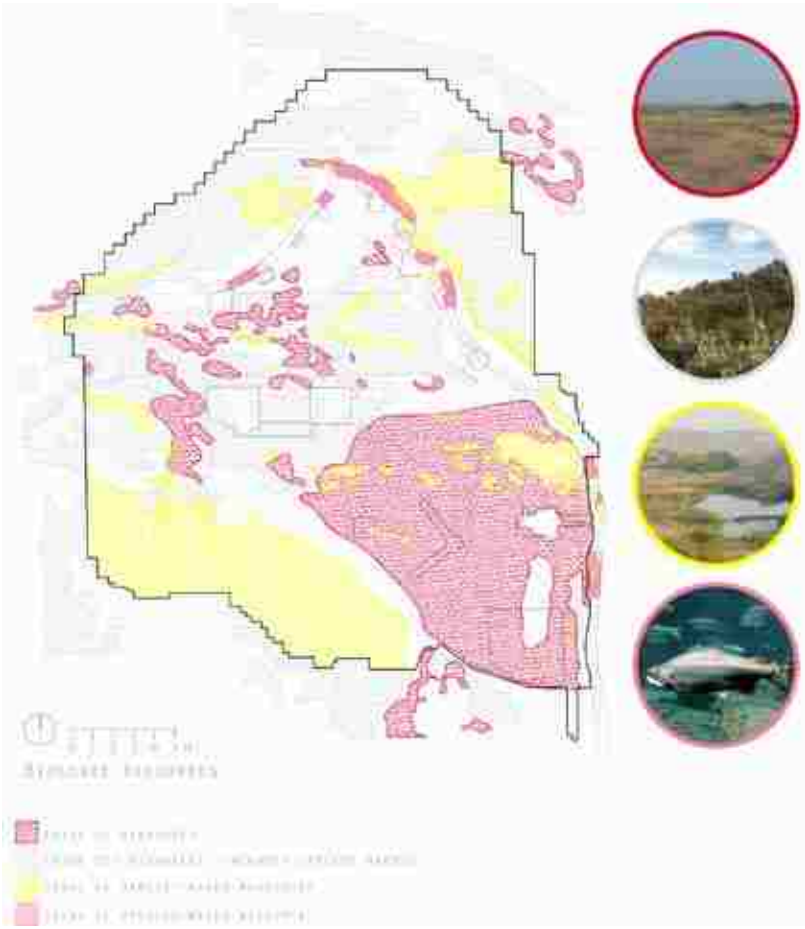
25. Sage Brush, Sand Dunes at Hanford
26. Biologic and Habitat Resources at Hanford
27. (Following) Hanford Reach, Columbia River
28. (Following) Sand Dunes, Hanford Reach National Monument

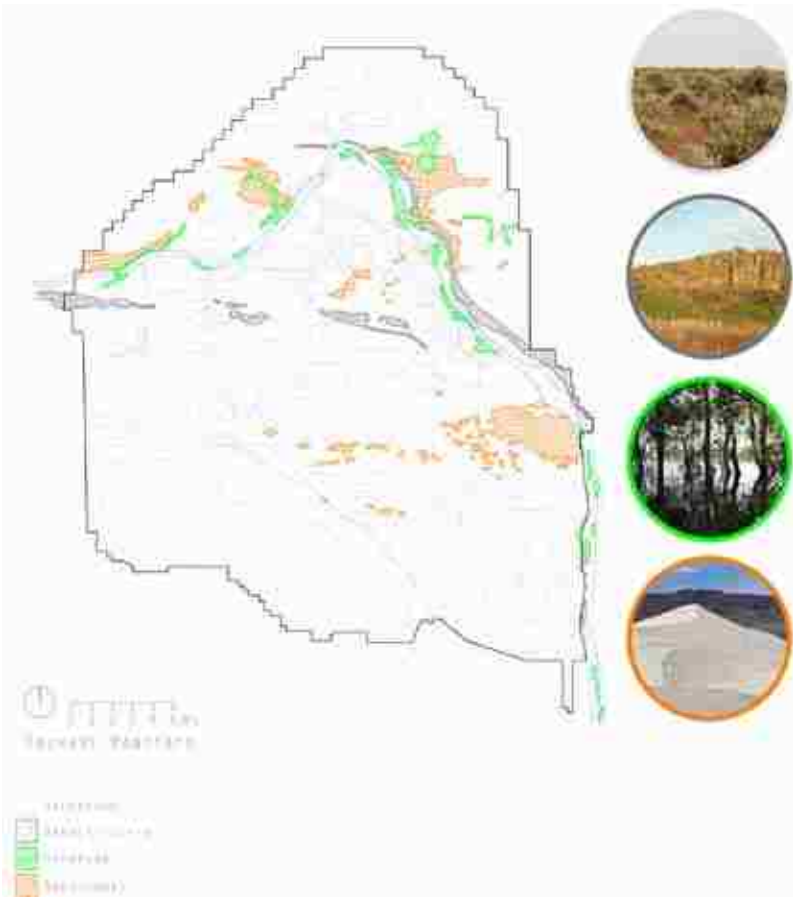
Shrub Steppe: The area is broadly characterized by a flora of sage-brush and other woody shrubs, perennial grasses, wildflowers and a fragile biotic ground crust of lichens and mosses.

Sand Dunes: Hanford's unique habitats of stabilized and active sand dunes include the black sand dunes of central Hanford, the White Bluffs cliff dunes and a large area of active barchan dunes along the river.

River and Riparian Ecologies: The Hanford Reach is the longest free flowing stretch of the Columbia River left undammed. Still, upstream dams greatly affect the reach and limit high and low water marks, resulting in a limited riparian zone. The long reach of habitat does provides valuable spawning grounds for salmon and steelhead and numerous islands in the river serve as seasonal grounds for many protected and endangered migratory bird species.

Basalt and Sand Cliffs: The white sand cliffs along the river and the exposed basalt outcrops of Gable Mountain and Gable Butte within central Hanford provide strong points of contrast within the otherwise flat area.





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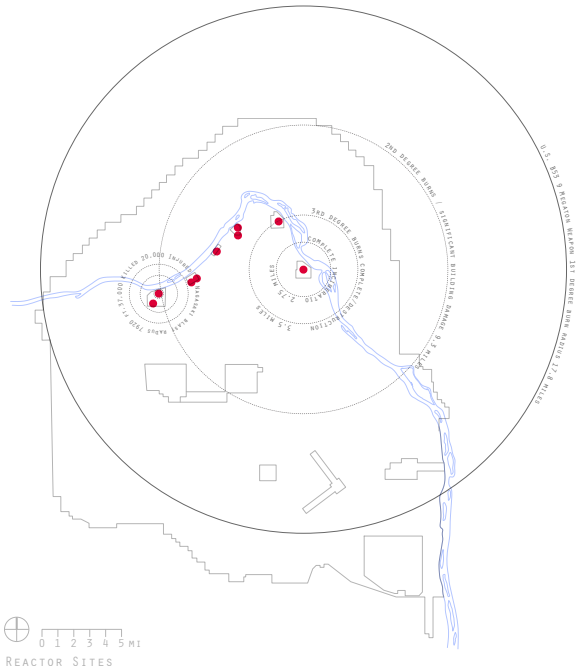


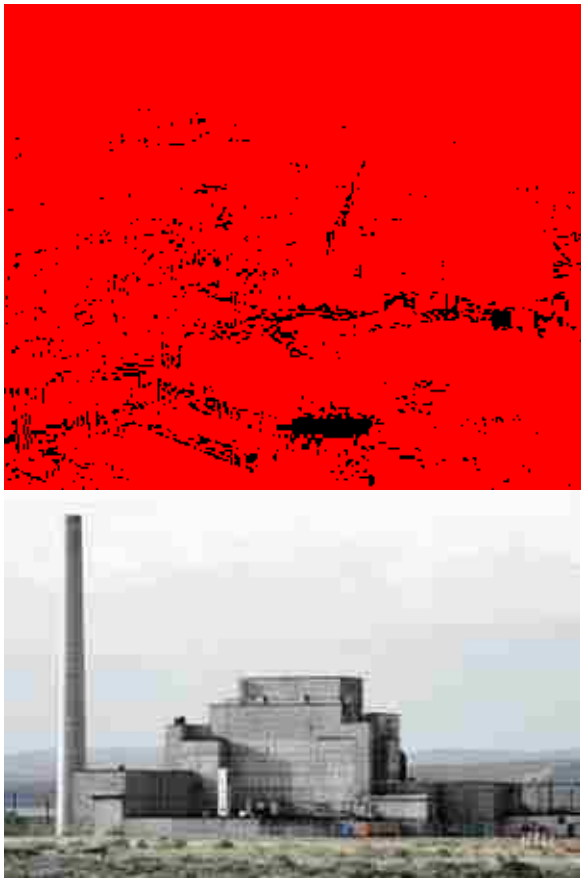
29.

Reactor Buildings, Silent Monuments

The next area of analysis concerns the buildings that stand along the Columbia River as silent monuments to Hanford's reason for being. These are the nine buildings housing the reactor cores in which uranium was converted to weapons grade plutonium. The nine reactor buildings were spread out miles apart along the Columbia as a precaution against magnifying the results of any accidents and to make them more difficult to target as military objectives. These reactors are significant in their construction and enduring monumentality in the landscape. They are also symbols of the power of the weapons they produced. Figure 27 displays their positioning within the site along with an overlay of the astonishing magnitude of destructive capability produced within the black graphite reactor cores of these buildings.

During their operational period these buildings were surrounded by large complexes of infrastructure and support buildings. Since the last of them closed in 1987 they have since undergone dramatic changes. Their conversion from operational readiness to remediated sites is called "cocooning." In this process, the support buildings and infrastructure surrounding these buildings is ``stripped away and the inner reactor cores are entombed in thick layers of concrete. The remediation schedule stipulates human entry once every seven years for checks but essentially, these buildings are planned to stand as monoliths in the landscape for the next 100 years, silent as to their purpose or reason for being. The B-Reactor, the first of the reactors built in WWII is on the National Register of Historic Places and has been left un-cocooned as a museum site of historic significance. The visitor's experience of the reactor is highly controlled and given a positive perspective, leaving little to come to one's own conclusions about the significance of it as a place.

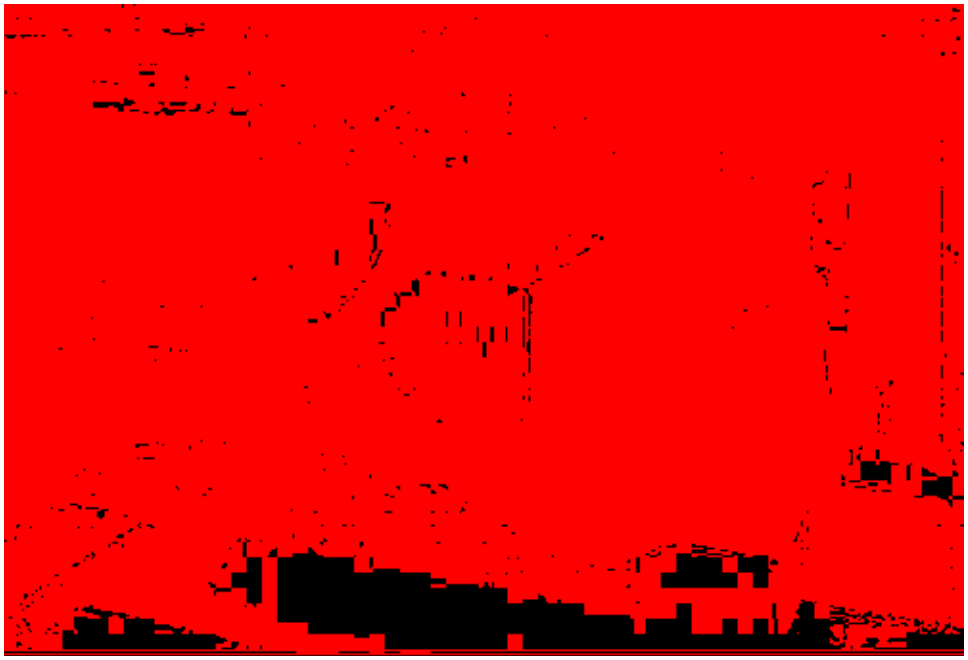
29. Reactor Locations
30. (Opposite), F-Reactor, Cocooned



31.

It is also important to note the construction of the cores themselves. Inside the large concrete buildings, these cores are 32 ft. x 32 ft. 29 ft. and are constructed of solid graphite blocks into which rods of uranium were inserted for conversion to plutonium. As a material, the graphite acted as a stabilizer to the reaction taking place. The size and material quality of the reactor blocks is richly illustrated in the historic diagram shown in figure 30.

31. Reactor Cocooning, Before and After
32. Reactor Core, from Life Magazine
33. Reactor Core Diagram
34. (Following), F-Reactor



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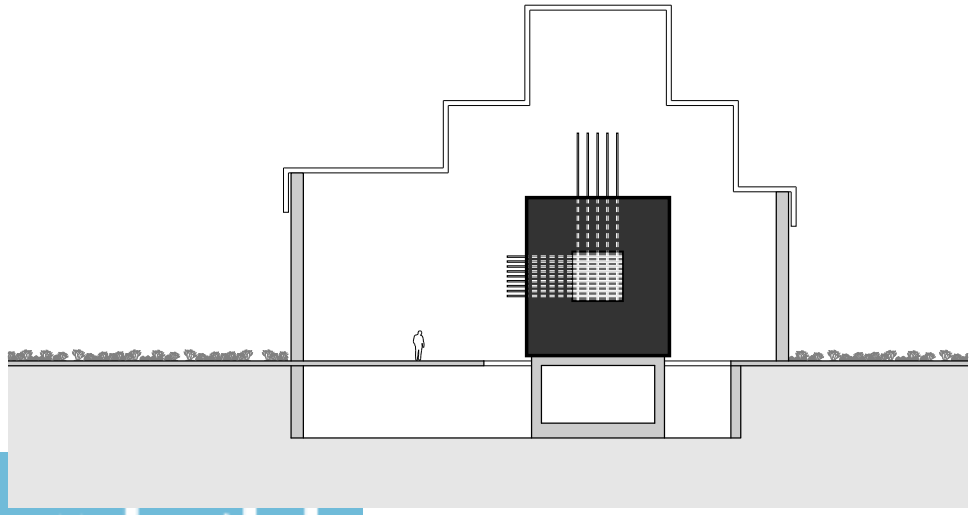
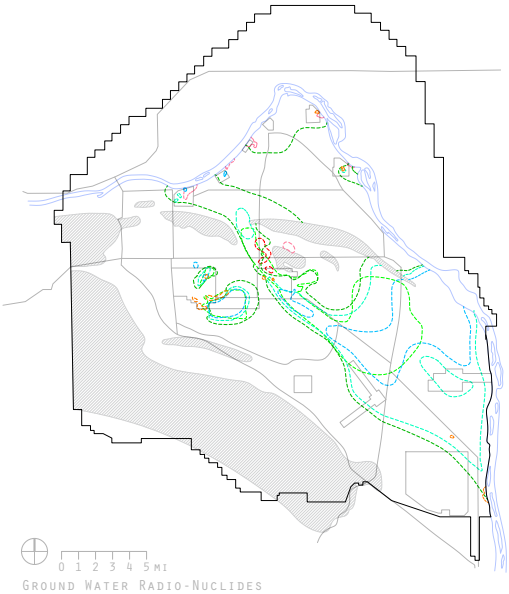
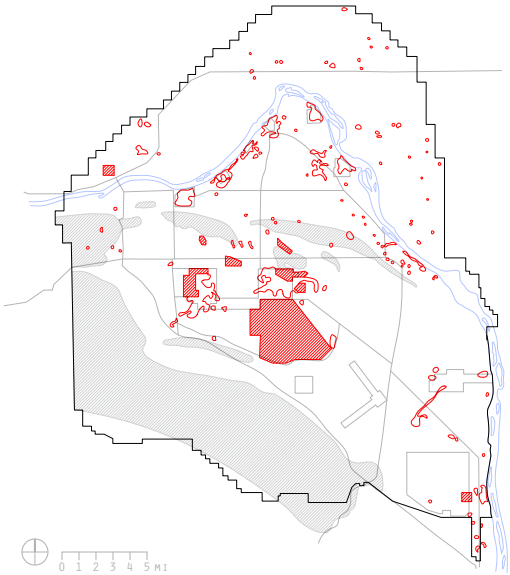


Cathedrals

They stand black against the white bluffs
    rising beyond the river, monuments
        to miracles we performed
in their deep blue pools. Atoms flashed
    apart. Wonders appeared
        over cities in a distant land.
Their purpose complete, we encase them
    in stone. If you follow this road
        due north, you'll find
the old school facing the water. Tumbleweeds
    flit by its empty windows like neutrons
        dancing toward their new life.
Wind and soldiers have taken the wood
    from homes left behind
        to make way for all this science.
Submarines rust in pits.
    The salmon don't run. There are no
        signs to explain what this place means.
That shimmer you feel on the wind,
    the way the ground sometimes shudders —
        the power we achieved
in those black buildings hangs in the air
    and lingers in the soil. Out there on the horizon,
        they will remain when all of us are gone.

- Andrew Becraft, http://www.andrew-becraft.com/2011/07/09/cathedrals/

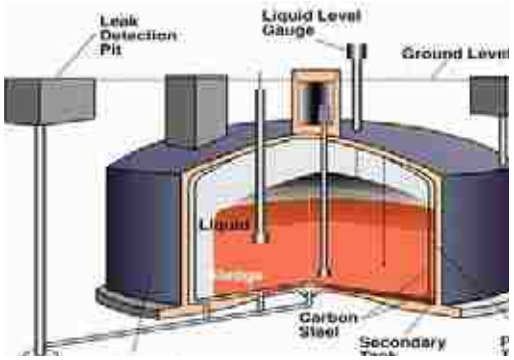




35. (Above), Waste Patterns on site
36. (Opposite), Hanford Waste Tanks under-construction, 1944

Nuclear Waste

The by-products of the processes that occurred in the reactor buildings at Hanford are some 53 million gallons of semi-solid/liquid radioactive waste and nearly 200 million gallons of polluted ground water. The maps in figure 32 show the relative positions of surface waste locations and the general flow of polluted ground water on the site. This water is currently being pumped out the aquifer and treated at numerous locations throughout the site. The focus of the thesis however, is the 53 million gallons of waste that sits in 177 buried steel and concrete tanks in a central location on the site. These tanks and their contents are often in the news as more than one third are leaking their contents into the surrounding environment and there is an enormous amount of controversy regarding the 12 billion dollar project under way to deal with the problem. The DOE's solution for dealing with the waste is through the construction of a vitrification plant that will turn the waste into environmentally isolated glass containers. The vitrification process is explained in figure 33. Though mired in controversies regarding cost overruns, time delays and the effectiveness of the final solution this process is moving forward as the technical solution to Hanford's waste. As such, this thesis engages with this process in seeking an appropriate architecture for the storage of nuclear waste. First, to more accurately discuss this process and the resulting architectural implications several definitions are needed.

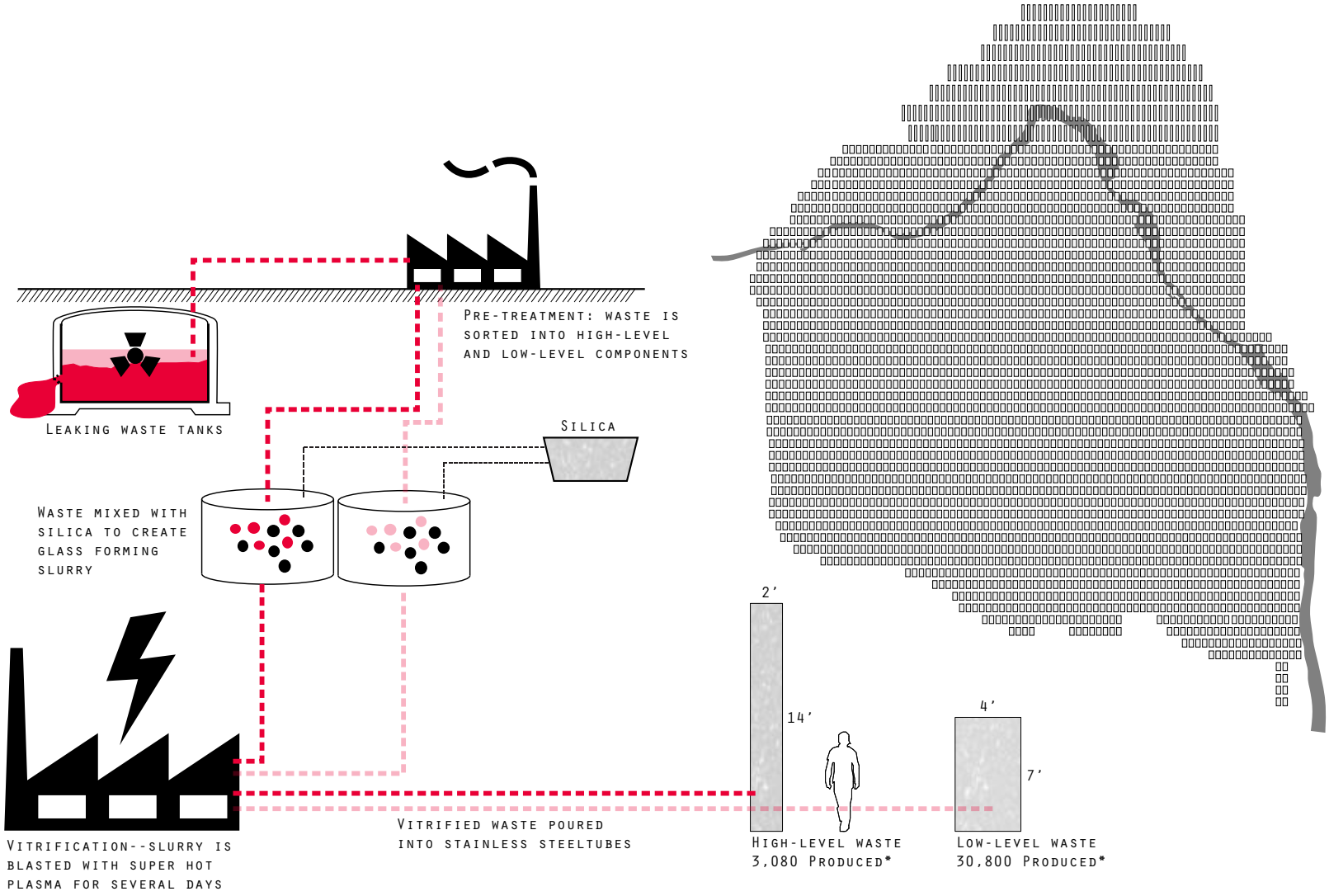


Vitrification: a process that will mix the semi-solid/liquid waste, currently in underground tanks, with silica and super heat the mixture to form an environmentally stable glass solution.

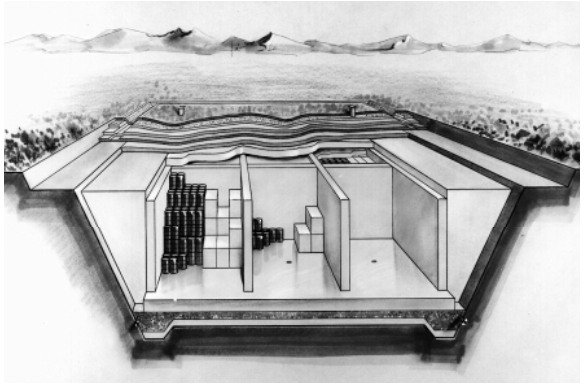
High-Level Waste (HLW): Spent fuel rods, reprocessing wastes and wastes containing the most highly fissile radio-nuclides and compounds. It has long-lived radioactive decay periods of up to several 100,000 years.

Low Activity Waste (LAW): Waste with relatively low levels of radio-nuclides but also may contain other harmful chemicals. Its decay periods range from just several years to several hundred.

Through the process of vitrification, the waste from the underground tanks will be divided into the low activity and high level designations. After being super-heated, the vitrified glass mixture will be poured into cylindrical stainless steel vessels of two different sizes per each designation of waste. Over an estimated 40 year operating lifespan, the vitrification facilities are projected to produce roughly 40,000 LAW containers and 10,000 HLW. Final disposal of the HLW is planned for a deep geologic repository such as Yucca Mountain while the LAW containers will remain and be disposed of at the Hanford site for perpetuity. In keeping the focus of the project within Hanford, the LAW containers thus become the main concern of this thesis and its approach to tackling the issue of nuclear waste disposal and humanity's interaction and understanding of that issue.



37. (Opposite), Waste Tanks, Vitrification Plant, Vitrified glass
38. (Above), Vitrification Process



39.

40.

The size and volume of the LAW containers to be buried at Hanford raise significant spatial issues that this thesis seeks to explore as questions about an appropriate architecture for the burial of nuclear waste. The typical methods, constructions and typologies for similar waste disposal inform the program and requirements of the design proposal. For waste of this classification, the burial typology is similar to a standard landfill with the exception that concrete vaults are placed at the bottom of the ditch and capped with heavy concrete roofs. These vaults are then covered with an engineered soil cap to further prevent environmental intrusion or the escape of waste. Waste containers are often stacked several layers high using overhead cranes and/or heavy forklifts. Once vitrified and in the stainless steel containers, low-activity waste is safe enough for short term exposure to humans.

AD 2020:
Hanford VIT Plant begins producing glassified waste

AD 2070:
Last of 53 Million Gallons Processed

Waste Complex Filled and Sealed

AD 9000:
Majority of Waste Reaches Safe Radioactive Levels

AD 26000:
Plutonium-239 Half-Life, Waste is Safely stabilized

41.

42.

39. Below-Ground Vault Disposal
40. Green River Disposal Cell, Utah
41. Deep-Geologic disposal access tunnel, Onkalo Finland
42. Dante and Virgil before Farinata, Gustave Dore, 1890

43.

44.

43. Kayaking, Hanford Reach Columbia River
44. Occupy Hanford Protesters
45. School Tour, B-Reactor

Users

One of the most important questions is who comes to Hanford and who is interested in this place? Presently, access to the site by the general public is fairly restricted but ideas about future users can be derived from current patterns on the site. Within the confines of the Hanford Reach National Monument and the Arid Lands Ecological Reserve, the site is actively used by hikers, hunters, bird watchers and anglers who access the several boat launches and few trails that exist there. Native Americans continue to use the site as a sacred place and are occasionally allowed to practice traditional hunting and fishing there. In the DOE restricted areas there are publically available bus tours currently given on the site during the spring, summer and fall on a limited number of days per week that take visitors to the historic B-Reactor and other important locations. Both tours consistently fill up their first-come, first-serve registrations that open in March of each year. Though it is an anecdotal understanding, the demographics of those on the tour range from parents of workers on the site, to students, artists, former Cold Warriors and interested citizens.[4] The wide range of visitors demonstrates that without any additional program the site is already a destination of interest for many people. In addition, one proposed DOE land-use map currently under consideration shows plans for a river trail running from Richland to the Vernita Bridge just below Priest Rapids Dam, opening the possibility of a recreational route for people from the Tri-Cities area to come through the site. If and when the B-Reactor is opened to further access as it becomes a part of the proposed Manhattan Project National Historic Park, it can be expected that the user group on the site will expand even more.

45.

46

Program

As understood through the literature review and theoretical framework, current perceptions of Hanford are often singular in their reading, falling into narrow and oppositional views. Is it a garden, a wasteland or a monument? This thesis critiques these interpretations in favor of exploring a way to present and uncover the site's multiple meanings. A traditional building program for this task would be the interpretive center. This thesis instead proposes that the landscape itself become the interpretive center. This approach is grounded in the idea that one has the ability to develop more subtle understandings when engaged in direct bodily experience than through the mediated experience of a textual or purely visual account. At the Hanford site there is already a dialogue between the natural landscape and the human legacy of the built environment. New architectural interventions will support, highlight and interpret the visitors experience and place in this dialogue. Within this framework, this thesis does not have a building program in a traditional sense.

A second goal of the thesis is to deal with the issues of the low-activity waste that is to be buried at the Hanford site over the next 40 years. This is not merely a technical question but also an issue of how to appropriately mark the significance of the burial of this waste. Thus the design proposal also includes a space in which visitors can enter into a visual and physical dialogue with the buried waste.

46. Hiking, Hanford Reach National Monument
47. Nuclear waste handling, Germany

Interpretive Landscape

1. A network of trails that serve as the narrative path of the project.
2. Proposals for a series of structures along the path to support the interpretive function and provide places of rest, shelter and outlook.
3. A structure for interpreting the meaning of the entombed reactor buildings.

Waste Storage

1. Storage vaults for 40,000 LAW canisters ~ 3,520,000 ft.^{3}
2. Waste receiving, monitoring, and support space ~ 10,000 ft.^{2}
3. Interpretive space

Precedents and Case Studies

The precedents and case studies apply to the two general themes of the thesis. The Landscape Park of Duisburg Nord by Peter Latz provides a case study in designing a large landscape that deals simultaneously with both natural/industrial systems and layers of historic/new use. The imaginings of a group commissioned by the DOE to envision communicative elements for the burial of nuclear waste serves as case study for this theme.

47

48.

48. User-defined reading, blending natural and industrial at Landschaftspark Duisburg-Nord

49. (Opposite) Marking nuclear waste, architecture as communicator through time

Landscape Park at Duisburg-Nord

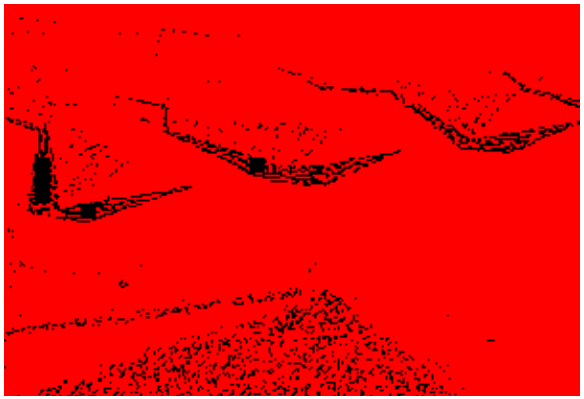
In a series of essays and built examples, the book *Manufactured Sites* introduces the topic of how to use design to address issues of sites with industrial pasts and conflicted futures. The Landscape Park of Duisburg-Nord, like Hanford, was designed to approach a contaminated site of industrial/historical/natural meaning. Designed and built by Peter Latz + Partner between 1990 and 1999, the park occupies 230 hectares of former steel and coal plants in northern Germany. A main goal of the project, which parallels those of this thesis, is the idea that rather than "building objects for specific uses, fantasy and playfulness allow the existing abstract structures to function in new ways."[2] The landscape is thus transformed through adaptation and interpretation rather than strict assignment of new program and use.

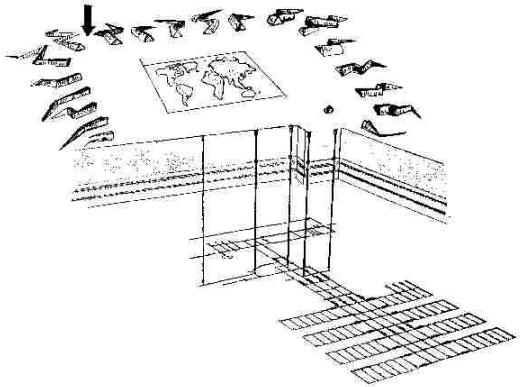
Reframing the landscape in this way allows visitors to understand the history of the site while creating their own narratives of its present experience instead of turning it into a museum or mere attraction. Several other aspects of the design for the Duisburg-Nord Park are interesting. Latz writes that because of the overwhelming size of the park, some areas were simply left *untreated* by design. Additionally, in the park nature and the remains of industrial buildings weave together to present a holistic landscape that is more in similar to the mythographic landscapes as defined by Kuletz than the textual landscape of a museum or interpretive center. Finally, Latz speaks of the park as a series of layers that "connect only at certain points through specific visual, functional or merely imaginary linking elements."[3] The importance of this statement is that all elements of the design to not need to tell the whole story of these complex former industrial sites, but can give portions of history and new use together in pieces, that when viewed as a whole provide an understanding of place.

Marking the Storage of Nuclear Waste

The US Department of Energy commissioned Sandia National Laboratories to produce a report on the design of a marking system to warn future generations about nuclear waste repositories in the US. Sandia National Laboratories brought together a team of archeologists, anthropologists, linguists and sociologists to explore what the nature of long term communication of nuclear waste might look like. The images in figure 44 display the fantastical nature of the markers the panel designed. Neolithic architectures of landscape mounds, monolithic obelisks and hidden underground rooms create a *semiotic* architecture that is supposed to impart a message of foreboding and danger in the designs. The architecture of these markers also relates strongly with the landscape, or the notion of a constructed landscape. Other ideas include radar reflectors and “hot cell” rooms that emit low-level radiation warning.

While easily dismissible as somewhat cartoonish, these designs are important for several reasons. Firstly, they are specifically intended to carry meaning without description which is a primary goal of this thesis’s exploration. Second, it is significant to note that they are all architectures that speak to endurance through time. An architecture that is marking a material that will remain dangerous for hundreds or thousands of years must materially and of its construction speak to the time scales involved with nuclear waste. Finally, these examples show the power and universality of funerary and crypt-like spaces and of the connection between these archetypes of human burial and the burial of humanity’s deadliest creation. The intent of this thesis is not to presuppose the need for a space or marking that lasts 1000 years, let alone 26,000. Marking, experiencing and creating a space for dialogue in our own time is important enough. Still, the design should respond to the issue of time in some fashion.

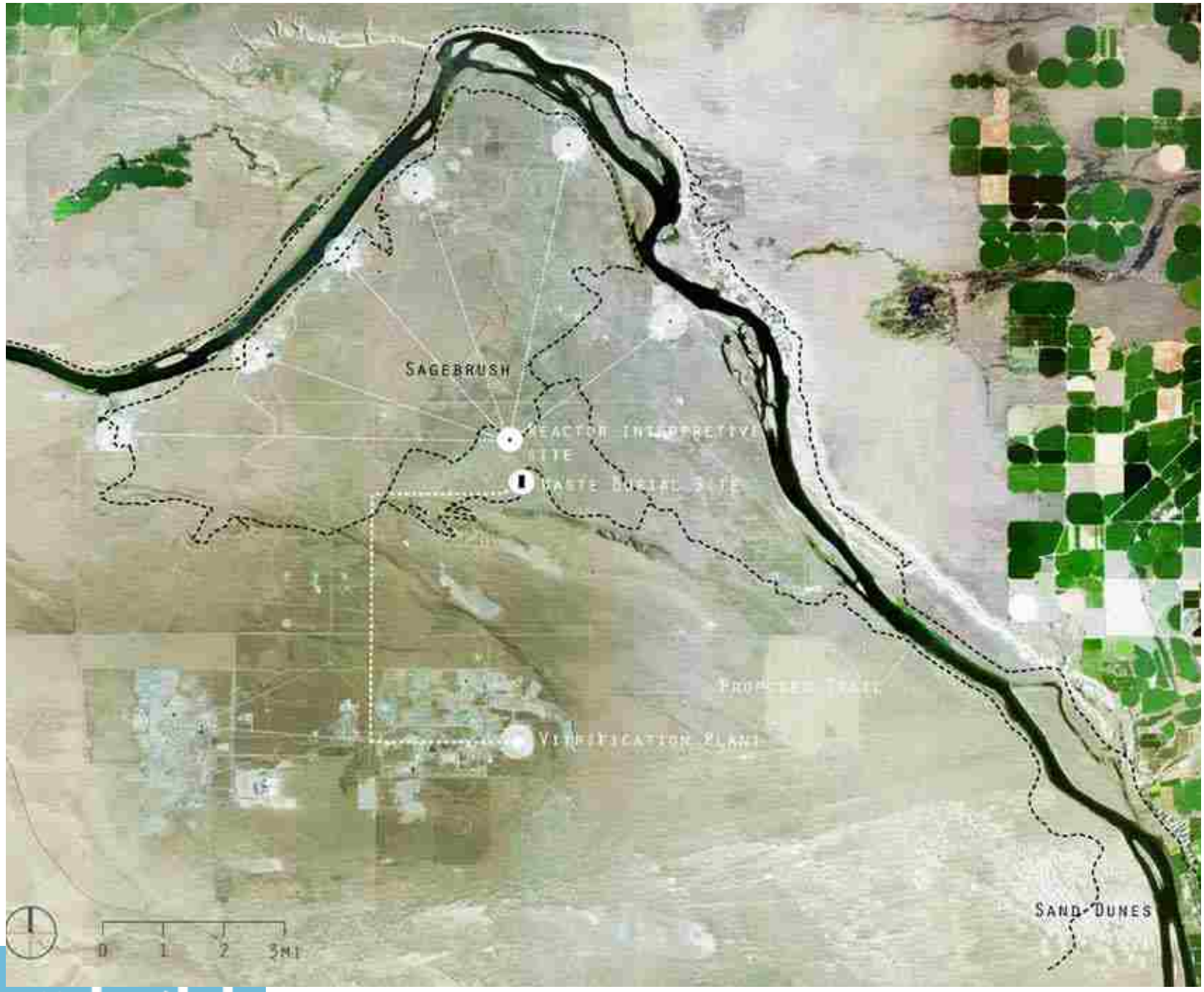


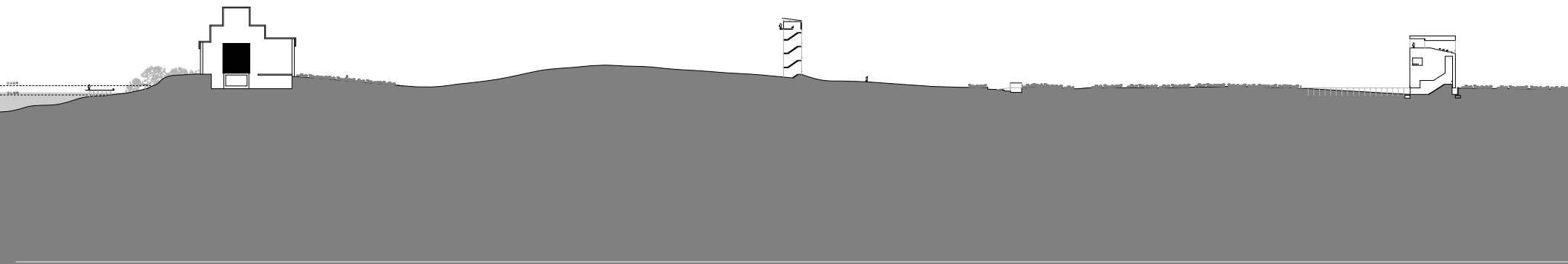


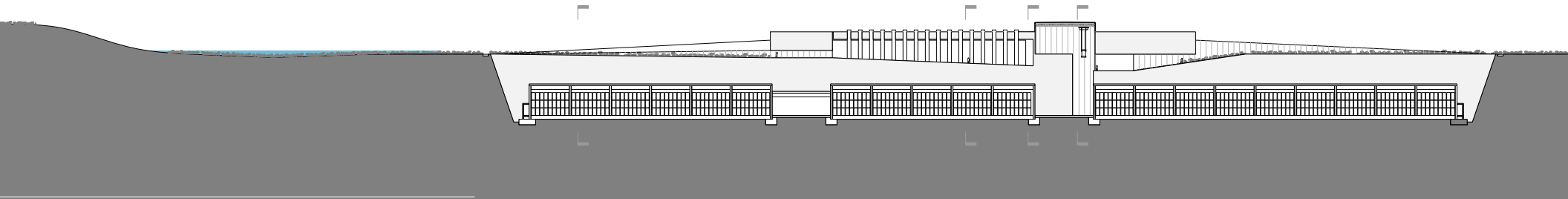
Design Response: Narrating Myth and Reality

The site research concluded in a process that identified the elements of the natural landscape, the built legacy of the reactor buildings and the burial of nuclear waste that the design responses will address. Though the interventions will be explained sequentially, it is not the intent of this thesis that they must be experienced all together, or in any particular order. These interventions are intended to serve as interpretive elements in the landscape, but they are not intended to provide a complete and whole picture of the place. To do so would require giving order and precedence to this ecological landscape, its cultural history and its future legacy when the very intent of the thesis is to identify all of these as equally important elements in narrative of this place. The interventions should thus be read as a series of nodes with an experiential, sheltering or interpretive quality that exist along a narrative path of trails through the site.

50. (Opposite), Interpretive Landscape proposal



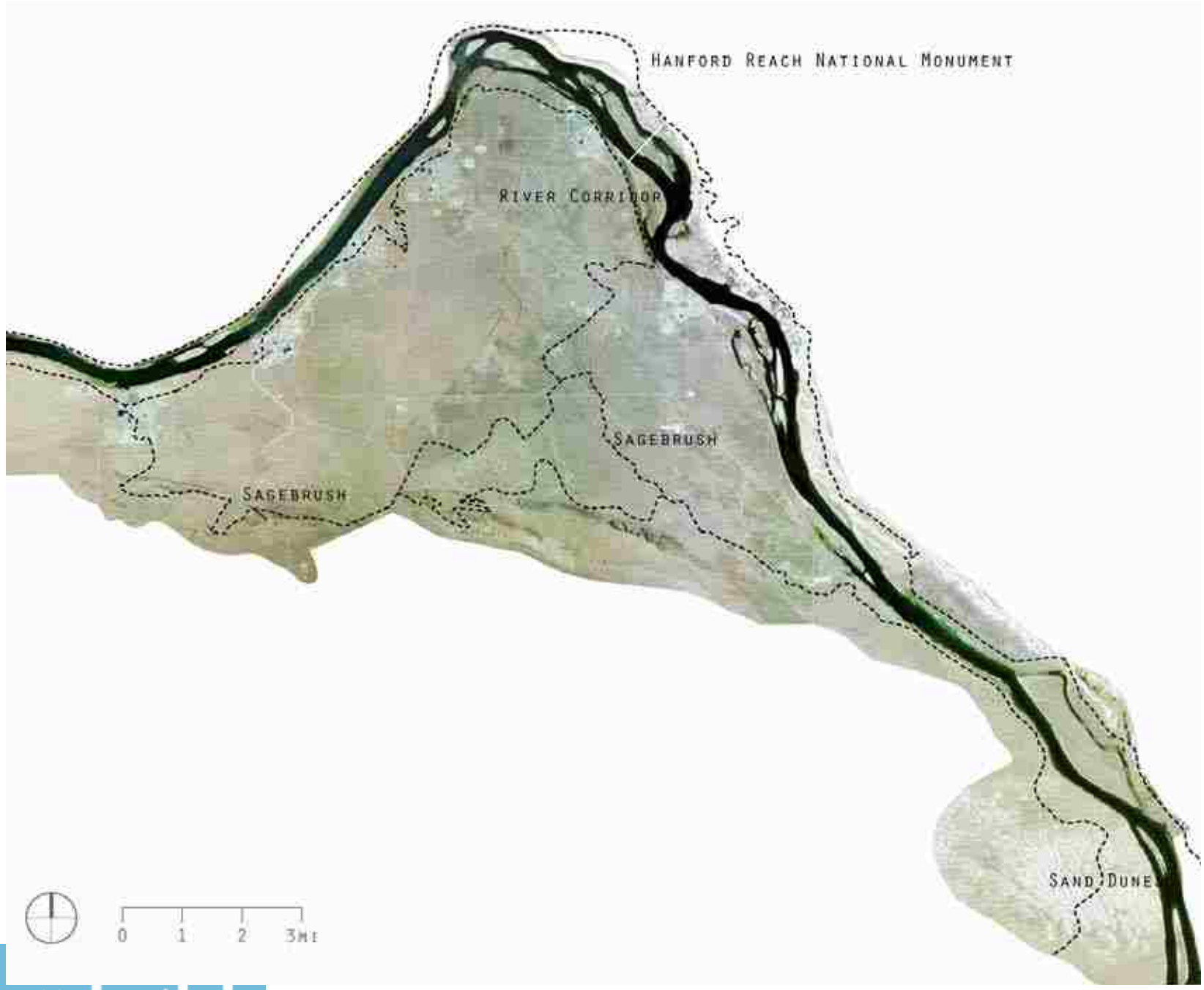




Experiencing the Desert

As a series of discrete interventions, the architecture responding Hanford's ecological conditions serves dual purposes. Firstly, the sites are pragmatic in their function as places of shelter, lookout, way-finding and access. Secondly, they serve as a datum with which to measure natural conditions of the landscape against the users' bodily experience of the desert. The measurement of time or perspective that each intervention affords the user is a response to the notion of the "interpretive landscape." The interventions might be seen as not just a series of follies but also an approach to the experience of the trail in the landscape. Additionally, there exists at the Hanford site a duality between natural and created environments. The trail mirrors this duality, sometimes letting the natural dominate, other times the constructed nature of the trail and the site is brought to the foreground.

51. (Previous), Diagrammatic Site section
52. (Opposite), Trail network in the desert landscape



Sand Dunes, Measurement and Time

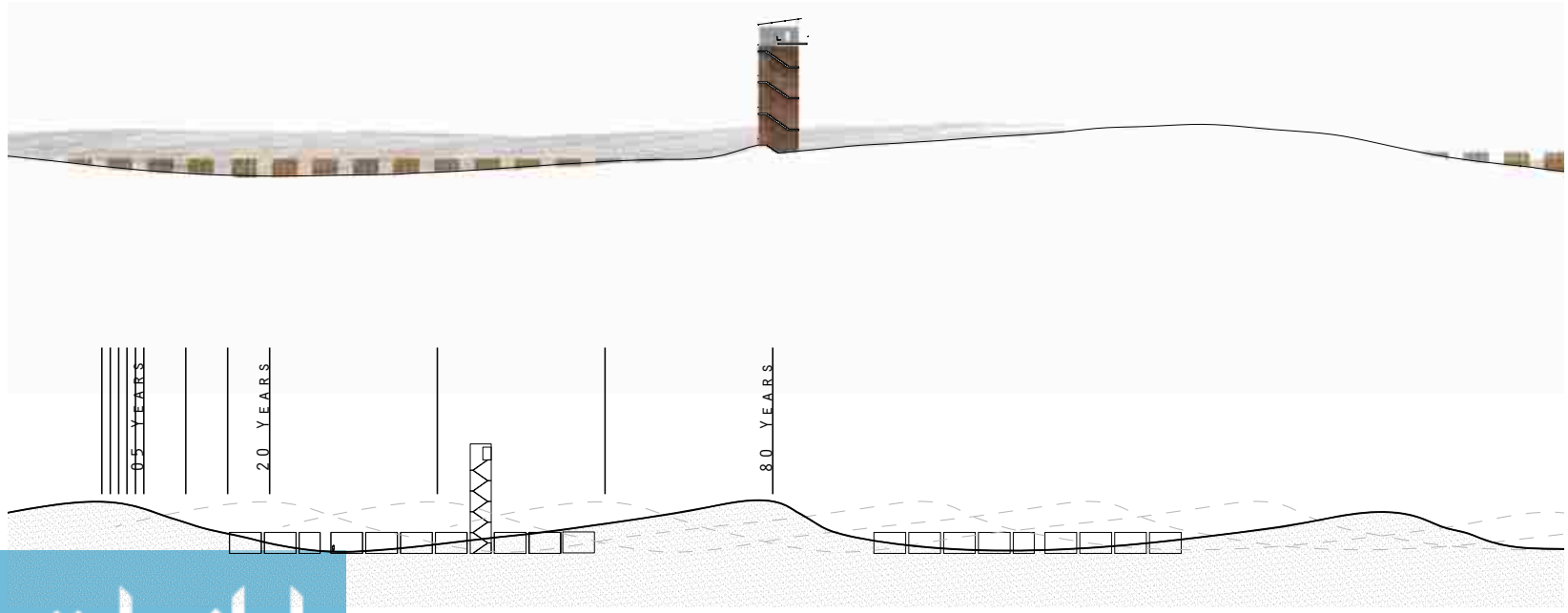
As noted in the site research section, Hanford is home to several large fields of both active and inactive sand dunes. In figure 48 the largest of these areas, comprised mostly of active barchans dunes, can be seen pushing up against the western shore of the Columbia River, rippled and scarred ground stretching for miles in its wake. The dunes can move between five and twelve feet per year, shifting generally in a west-northwest direction with the prevailing winds. This thesis proposes that a section of the interpretive trail stretches through this dynamic and rare ecological condition. The architecture of the trail is faced with the following questions in this condition.

1. How can a trail be established on a ground surface that is constantly shifting?
2. Without a traditional trail to follow, what can architecture do to provide a means of way-finding in a landscape that has no landmarks and in which long lines of sight are rare?
3. How can architecture respond to important and basic necessities of shelter in this stark desert dune-field?
4. What can architecture do to add a layer of understanding about the ways in which the dunes work?

The architectural response to these questions is a series of walls placed perpendicular to the primary direction of the moving dunes. The walls are Corten steel sheets attached to steel poles driven deep into the surface of the sand. Steel and the construction technique employed are chosen as a less invasive option than heavy concrete for intervention into this fragile landscape and additionally to provide a thinness that most easily allows the dunes to slip past and around the walls. The planar nature of the steel walls provides a strong contrast to the organic curves of the sand dunes, continuing the dialogue between natural and built. The walls do not form a continuous surface and do not stretch as a single

53. Sand movement map, diagram
54. Walls as measuring device

53



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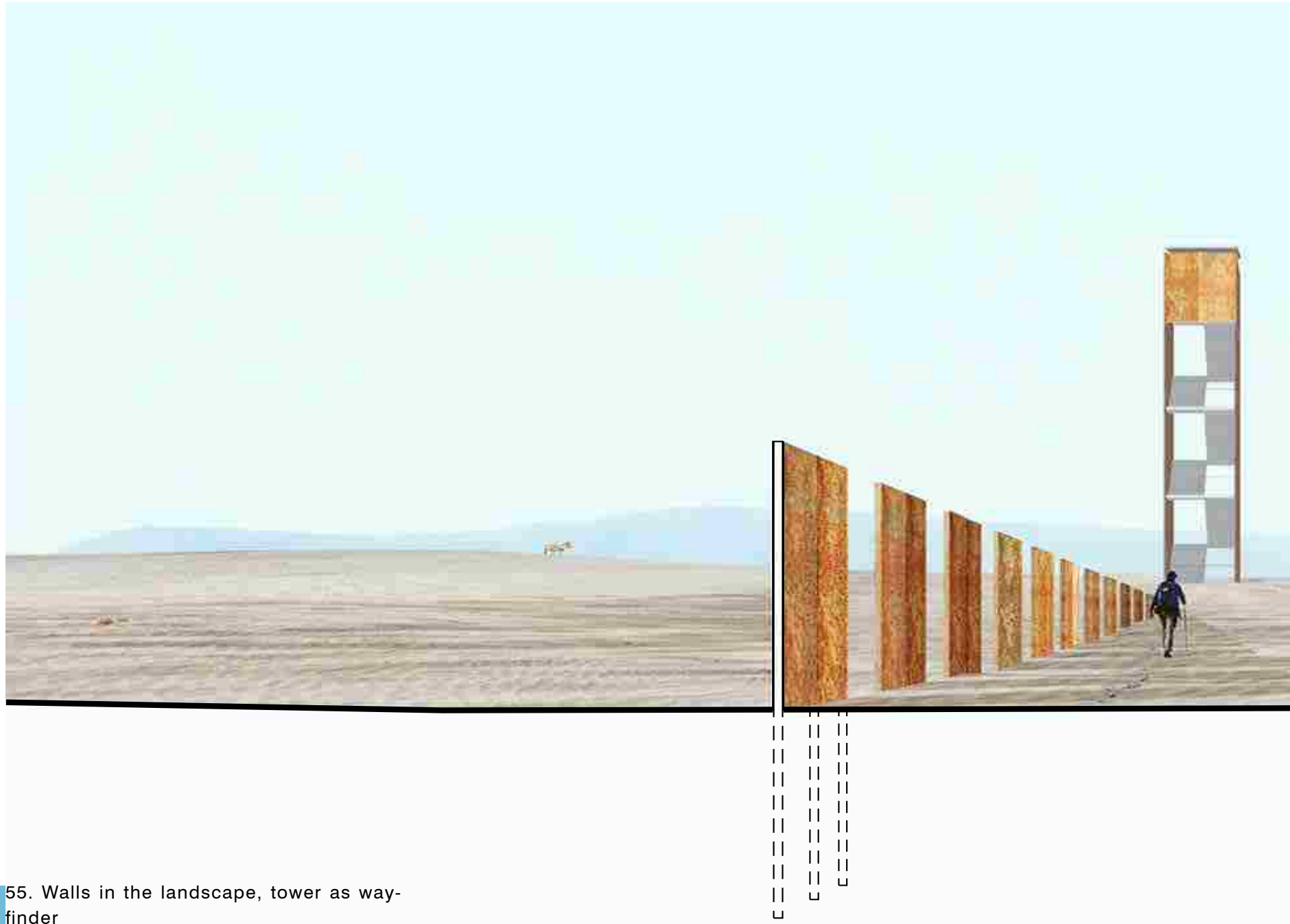


55. Walls in the landscape, tower as way-finder

56.

element through the extent of the dunes. Instead they are formed by a series of spaced panels, stretching for several hundred feet at time and spaced apart in the landscape in the minimum configuration that they can still fulfill their purpose.

Functionally, the walls serve to establish and define a path over the shifting ground surface and fulfill the necessity of way-finding. Like a traditional trail, the walls direct the visitors' movement through the landscape. They are perpendicular to the dunes, echoing the forces of wind that move the dunes, becoming a datum with which to measure and understand the dune's movement over time as they are buried and resurface through the years.

A series of towers, placed at an interval of one mile throughout the dunes create visible landmarks and places of shelter and outlook. The towers simply extrude the construction of the walls as two steel planes rising out the sand with a light stair spanning between them, allowing sand to flow around and underneath the constructions. At their tops a pre-fabricated concrete shell is inserted between the steel walls to create a comfortable and sheltering environment isolated from the sun. The concrete wraps the sheltered space on three sides, opening to the north to provide controlled sunlight and a long distance view of the sea of dunes and next tower along the trail. A light steel roof sitting elevated above the concrete shell blocks the sun while letting the breeze continue to move through the space.

56. Shade, shelter in the tower
57. Navigating in the dunes

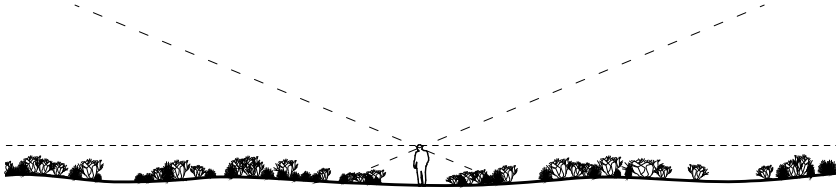
57.

Perspective, Shelter and Sagebrush

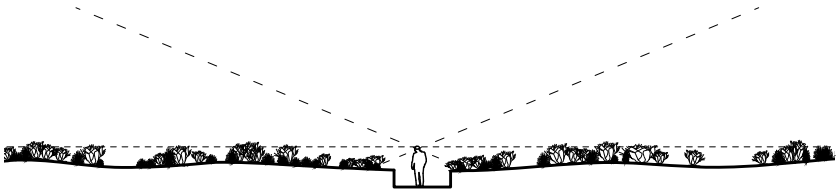
Growing up to a meter or more tall, sagebrush once covered like a blanket the seemingly flat expanses of Columbia Basin. As discussed earlier in the document, the expanses of sagebrush in the west have traditional been viewed abstractly as wastelands, endless fields of weeds. The perception that there is nothing to see in the shrub steppe comes as a response to the long distance view and the intangible effect of earth and sky that typically dominates one's experience in the sage. Figure 55 diagrams this phenomenon and provides some spatial alternatives to counteract the material abstraction of the long distance by sinking the trail to bring the texture of the desert into the field of view. Sinking spaces into the ground of the shrub steppe also offers the opportunity for shelter from wind and sun, and creates a sense of enclosure in the otherwise spatially exposed experience.

58.

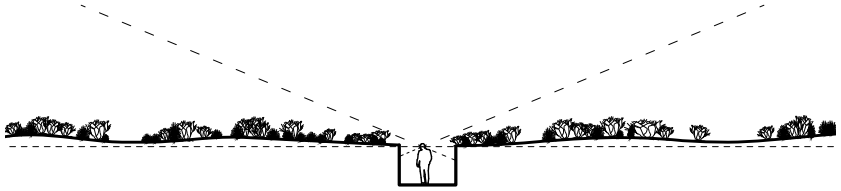
58. Diagrammatic plan, shelters
59. Sagebrush perspectives diagram



NO ENCLOSURE,
CONSTANT HORIZON,
LAND IS ABSTRACTED,
PERCEPTION OF
FLATNESS



GROUND GAINS DETAIL,
SENSES ARE ENGAGED,
SUBTLE CHANGES IN
TOPOGRAPHY APPARENT,
SPATIAL ENCLOSURE



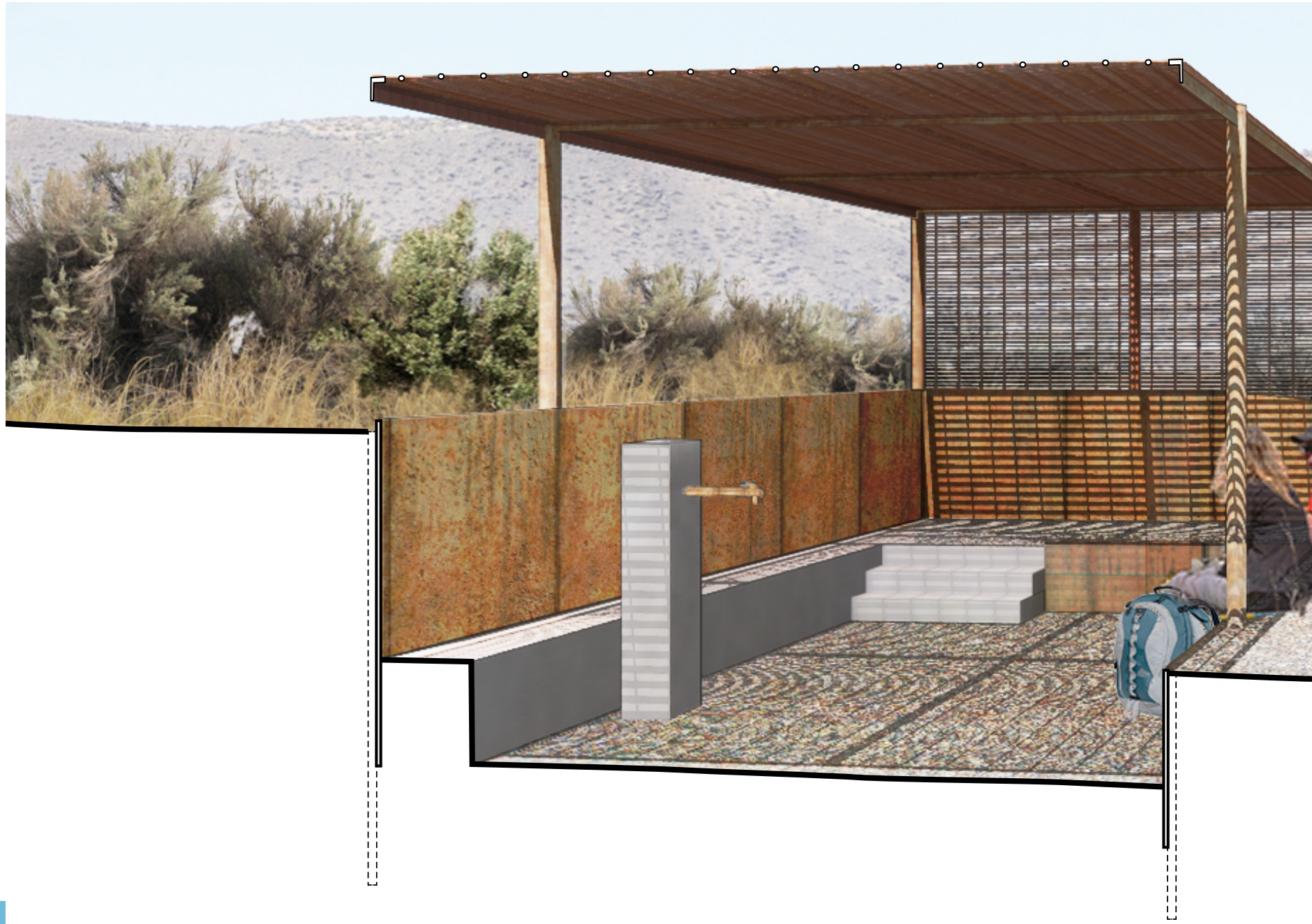
SHELTER FROM
EXPOSURE,
CHANGE IN
TEMPERATURE,
FIELD OF VIEW IS
INTROSPECTIVE

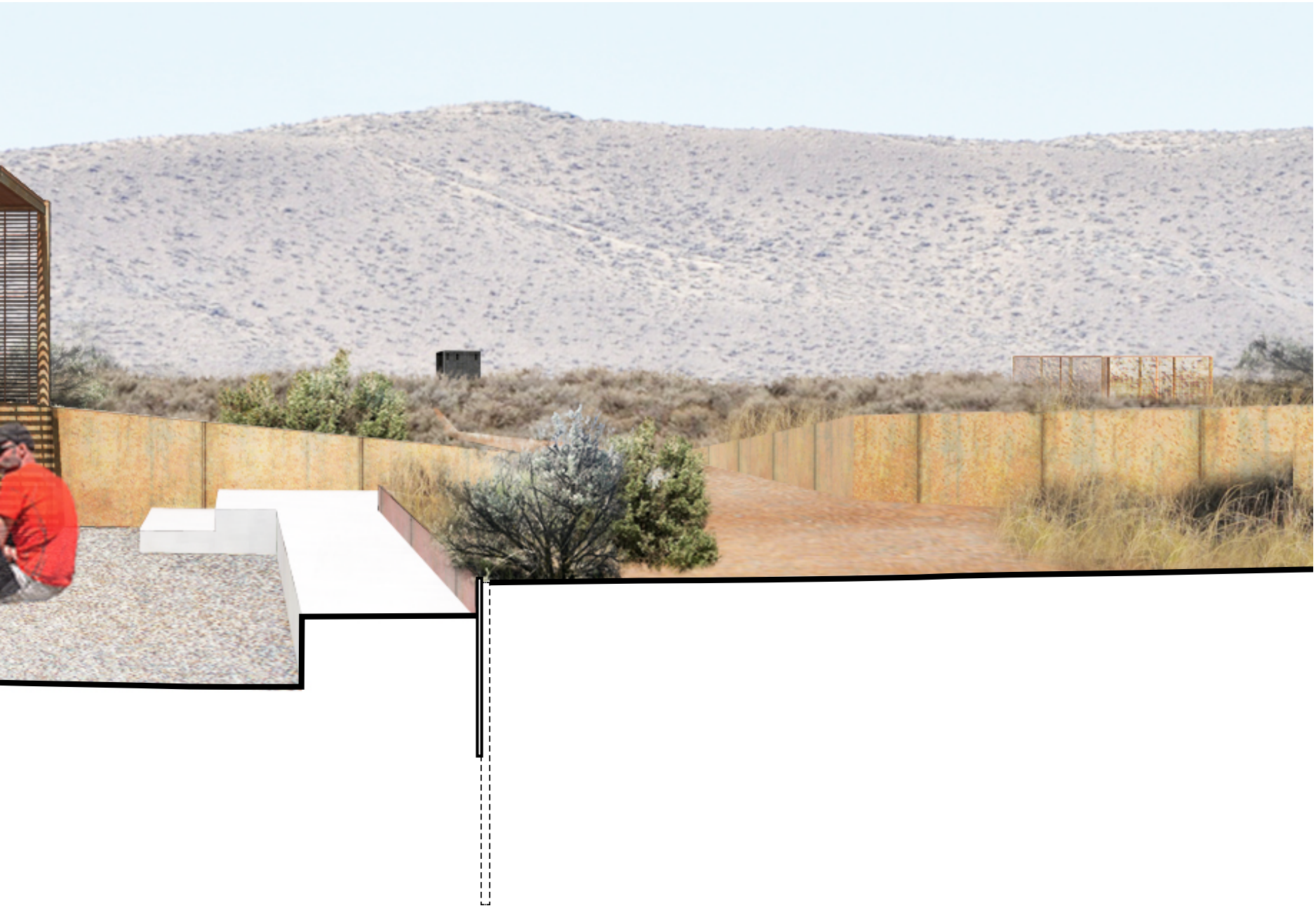
As the trail winds its way through the shrub steppe, it begins to undulate up and down to reveal the subtly mounded topography of the shrub steppe and bring a more textured and enclosed experience of the desert to the visitor. Steel plates hold back the earth as the trail digs into the sage, creating material connections to other portions of the trail. As in the sand dunes, this construction also limits the impact upon the fragile sage environment during construction. The ground surface is a simple and unconstructed sand and gravel mix.

Spaced out throughout the sagebrush, shelters are sunken into the ground. The shelters are reminiscent of the traditional Native American pit-houses, dug into the earth for thermal qualities, protected from the wind and covered with a light frame and skin to block the sun or keep in heat. Similarly, the shelterss steel walls hold back the earth while a light steel frame and extruded steel grating provide shade from the sun. Concrete is used as a more familiar seating surface, making use of thermal qualities of radiating coolness or heat depending on the conditions. Water, being a quintessential marker of place in the desert, is provided in the shelters. The structure is sunken at different levels to create a range of sheltered experiences from more exposed (winter) to more enclosed (summer) and to respond the differing spatial experiences of view.

60. Altering perspective with the trails ground relationship
61. (Following), Sunken-shelter, shade and altered view

60.



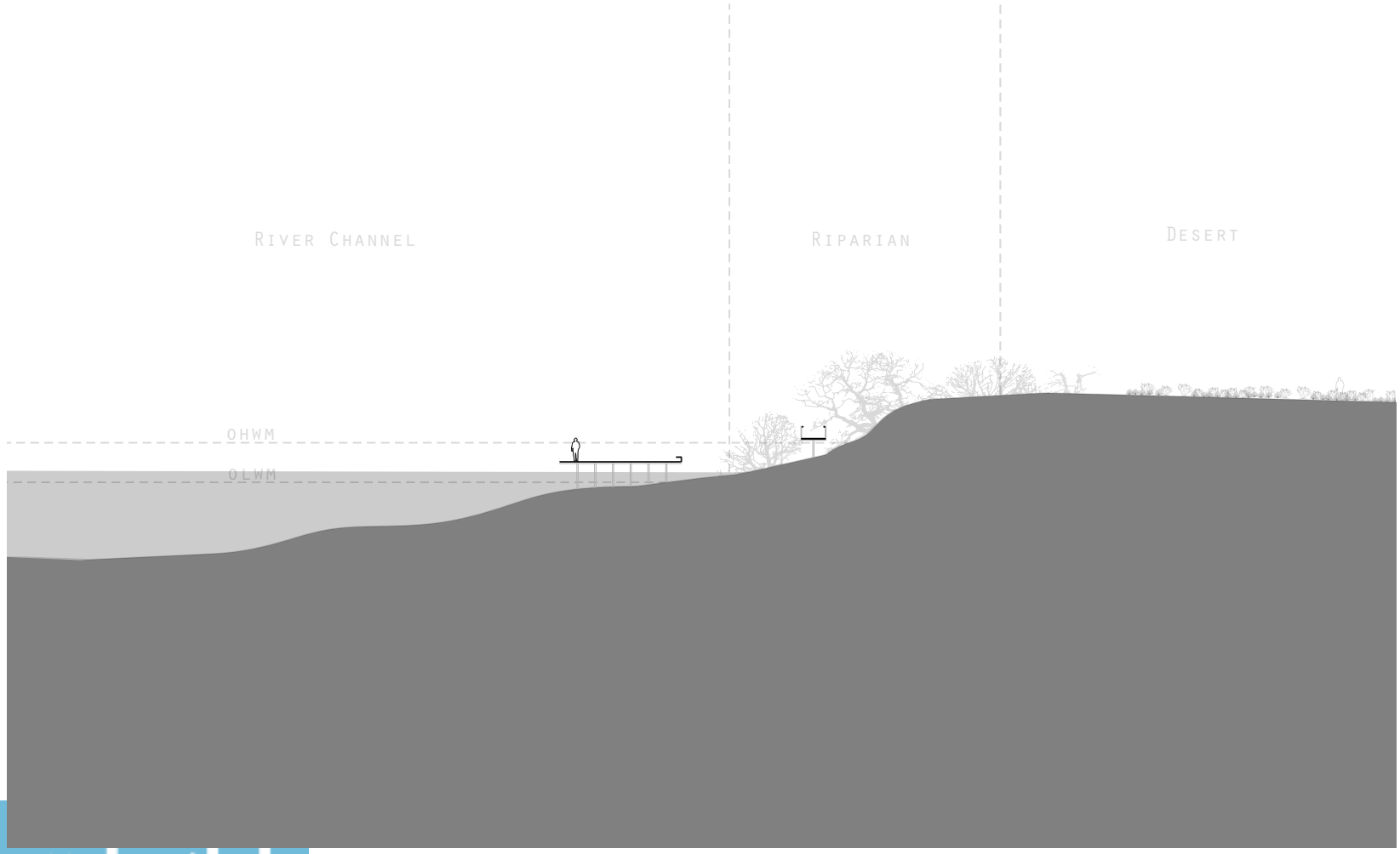


Accessing the River

The river is already the most accessible, frequented and understood of all the ecological conditions as Hanford. The intervention of the trail at the river's edge is thus primarily concerned with allowing further access to the already strong recreational use the river gets. The new trail proposed along the south side of the river will improve access to the central Hanford site and the rest of the interpretive landscape by providing places for kayakers and boaters to tie up. Additionally, the intervention of the trail along the river brings the trail into the unique and rare experience of the riparian zone on the site. This narrow band of grasses, reeds and shrubs is the intersection of the desert and the river.

62.

62. Diagrammatic plan, trail along river
63. (Opposite), Trail along river, section diagram



Along the river the trail is constructed elevated above the ground, sitting on steel posts with a perforated mesh floor surface. Its elevated nature is a response to the ever changing water levels associated with out-flows from up-stream dams. It maintains a clear path along the changing ground of the shoreline while allowing the riparian reeds and trees to grow around and through it. At certain points, it stretches out into the river offering places for boats to dock and shore bound anglers to access the water

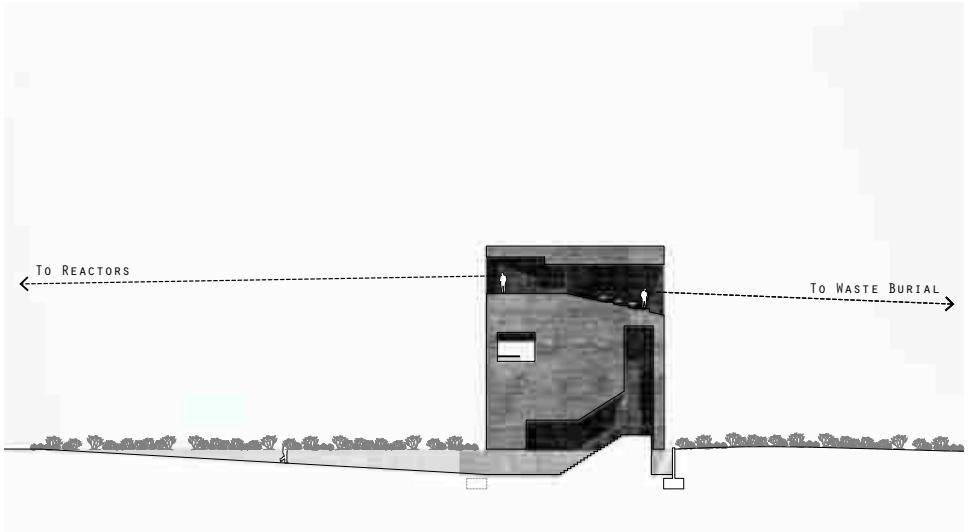
64. Perspective, trail hovers above bank, extends access

64.

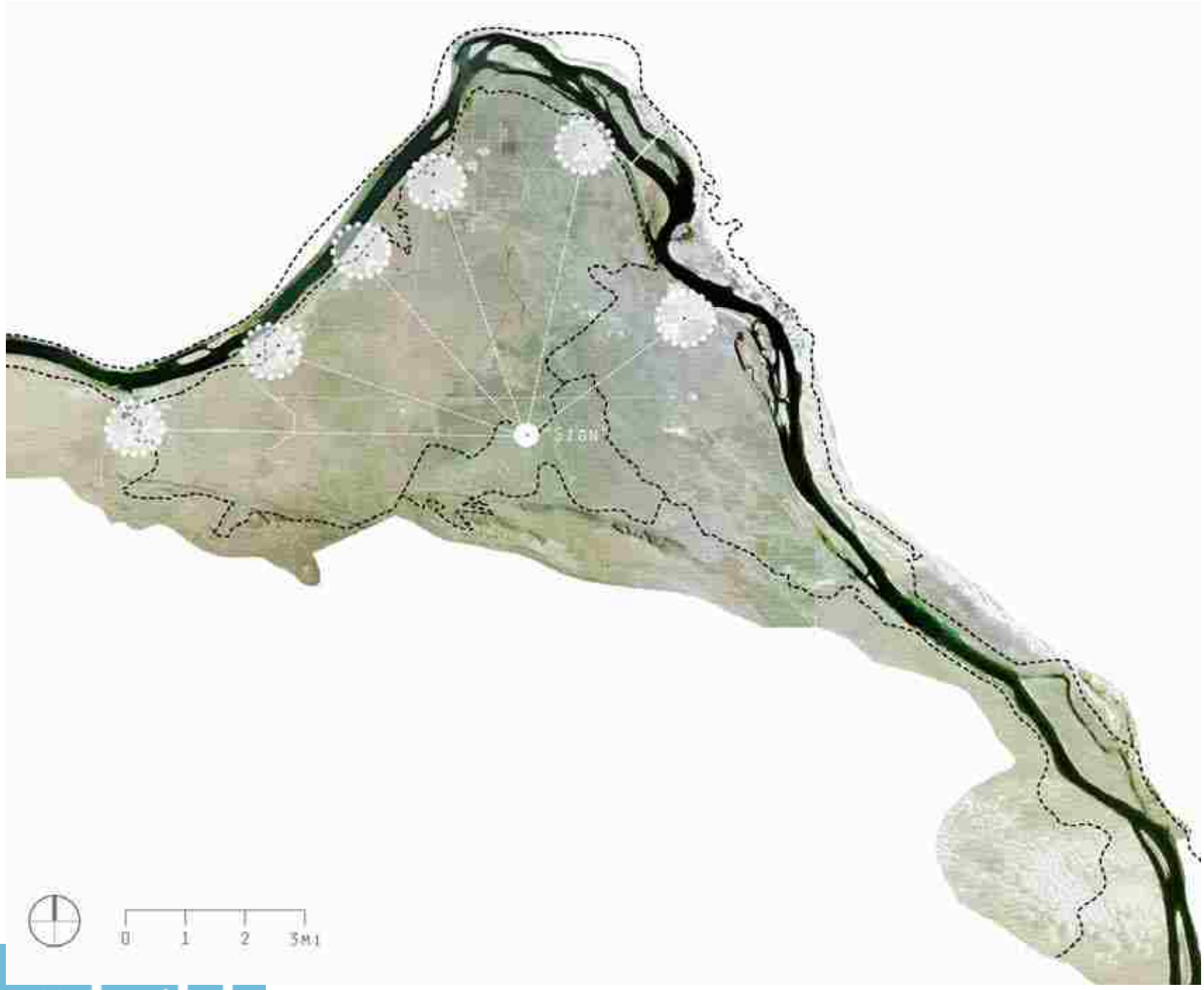
The Reactor as Sign

The existing reactors stand strongly against the horizon of this flat landscape and left untouched by design already serve as landmarks, marking space and defining direction. They are uninhabitable monoliths. What role does a new architecture have in relating to them? How does a new architecture explain and interpret their meaning? This design proposes the addition of a new structure, placed between the existing reactors and the waste burial location that creates a visual relationship with both the reactors and the waste.

65.



65. Section, displays relationship between reactors and the waste disposal site
66. (opposite), proposed intervention is placed in a relationship central to the existing reactors



67.

67. Intervention becomes a new sign in the landscape, relates to existing reactors
68,69. Materiality of graphite and the focused views of the lens spaces

This intervention is referential in form to the existing reactors to create an immediate relationship. It is constructed of graphite blocks, creating a material understanding of the cores within the entombed reactor buildings. The entry is a manipulation of the ground plane as one slowly descends a long ramp, slipping under the pure geometry of the cube before climbing a set of concrete stairs up and into the structure. Its spaces are carved out of the graphite, each opening acting as a large lens for particular views. The height of

68.

69.

the structure allows views to stretch out across the clear, flat desert to each of the nine reactor buildings, in the opposite direction to the waste storage location, and straight down to the landscape flowing around it. Inscriptions on the walls and artwork placed throughout begin to tell the reactors' stories. This structure is a place for interpreting the meaning of the reactors and for creating a dialogue between the reactors, the waste and the landscape itself.

70.

A Bodily Experience of Nuclear Waste

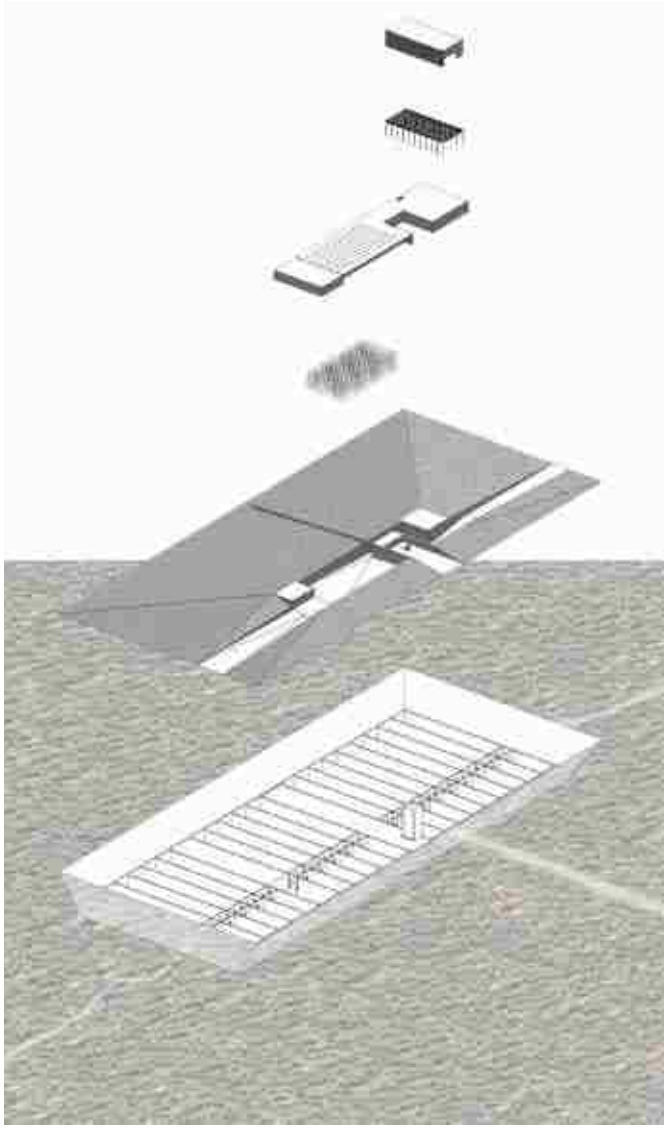
The final intervention into the proposed Hanford interpretive landscape is the final burial space of the waste itself. It is a space for safe disposal, and a space for experiencing and marking that disposal. Intentionally taken out of the area of ongoing DOE restriction, it is placed to establish a stronger relationship with the other interventions and existing reactors as well as to have a more public presence within the interpretive landscape. Its placement and these relationships are seen on the maps in figures 67. The intervention itself is shown in figure 66, a geometric concrete form embedded within the constructed landmass of the landfill cap. Perpendicular to the concrete mass, a light framed steel volume covers the waste receiving area.

70. Waste Disposal site in the landscape
71. (Opposite), Relationship of disposal site, Vitrification plant and interpretive landscape

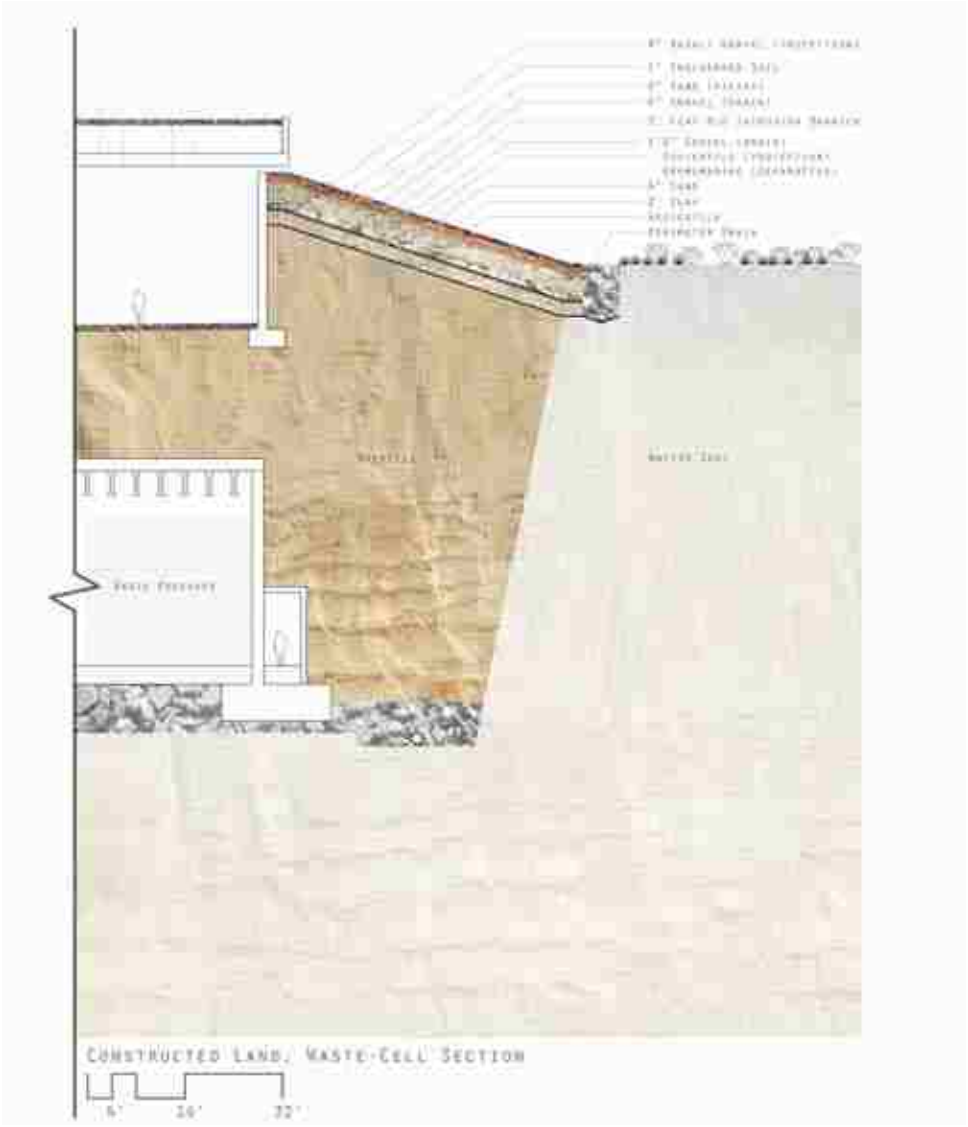
Storage and Technical Details

The axonometric drawing in figure 68 shows the major building elements. Forty-two rectangular concrete vaults, arranged in two asymmetrical rows with an access spine running between sit at the bottom of the excavated trench. Three foot thick concrete walls isolate the waste within the vaults as well as bear the weight of the soil and construction above. A narrow inspection tunnel follows the perimeter of the vaults. The vaults are sized to receive roughly 40,000 LAW canisters stacked three rows high. Waste canisters come from the vitrification plant on a truck and are inspected for final burial in the receiving hall. They are then lowered underground by an overhead gantry crane through an access shaft that connects the receiving hall with the vault spaces below. A large void beneath the access shaft serves as a below ground receiving and equipment storage space. The detail in figure 69 shows the earthen mounding above the vaults and the engineered cap that includes a series of drainage, biointrusion and membrane layers to protect and isolate the vaults from the surrounding environment.

72. Axonometric of major building elements
73. Constructed landfill detail



72.



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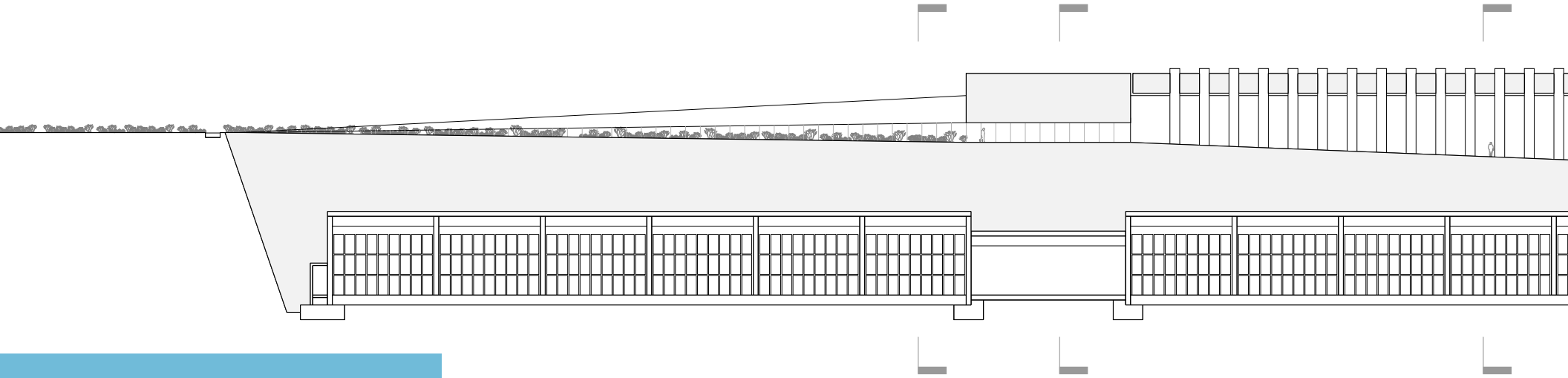
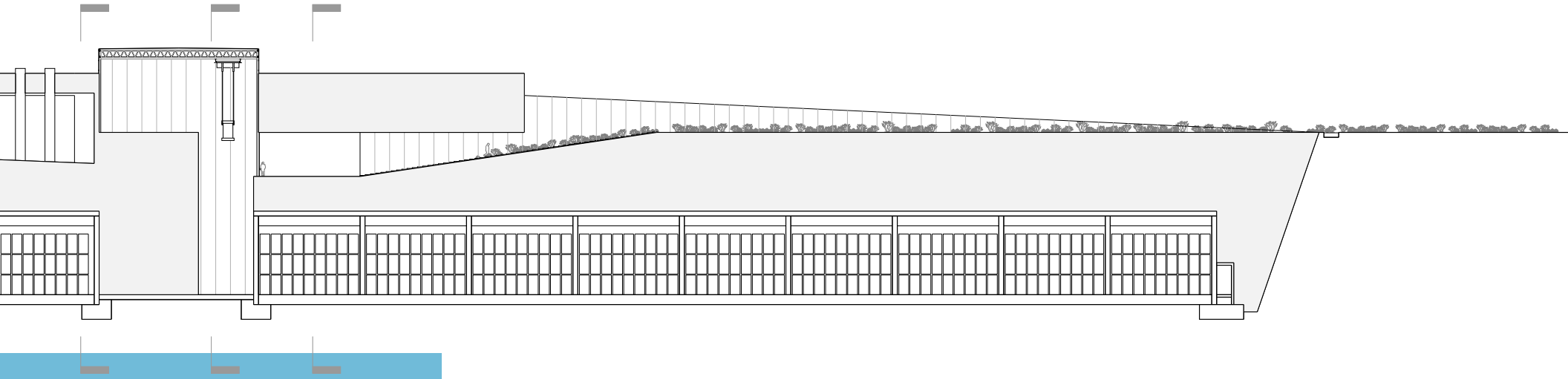
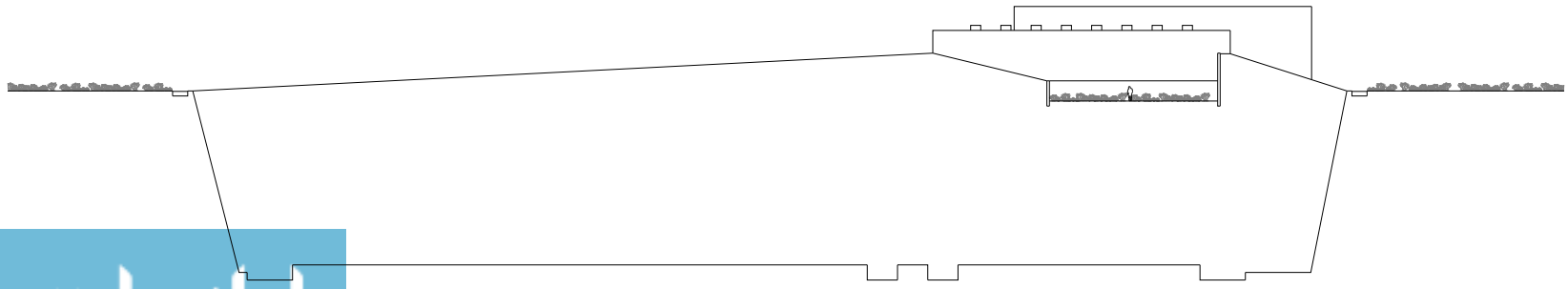




74. (Previous), Longitudinal Section showing circulation and relationship of major spaces
75. (Below), Section A
76. (Opposite), “Curiosity,” descent to the world below

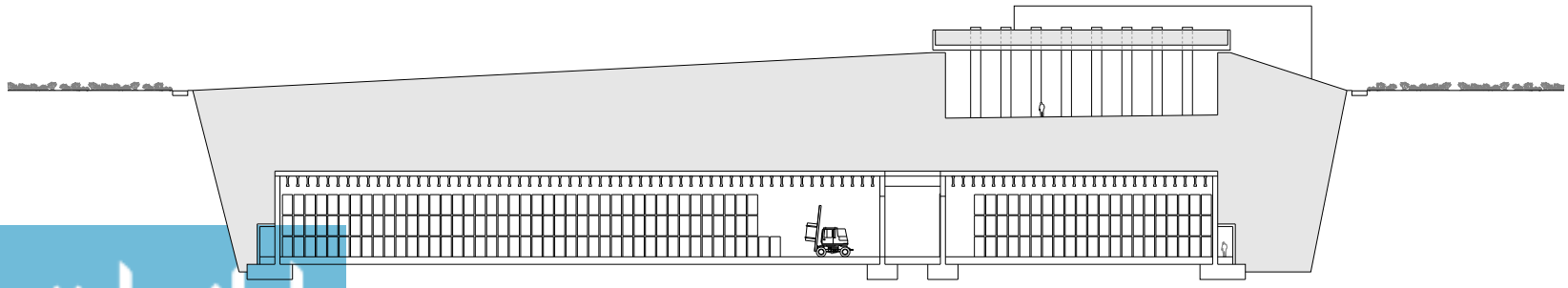
Curiosity, Questioning and Understanding

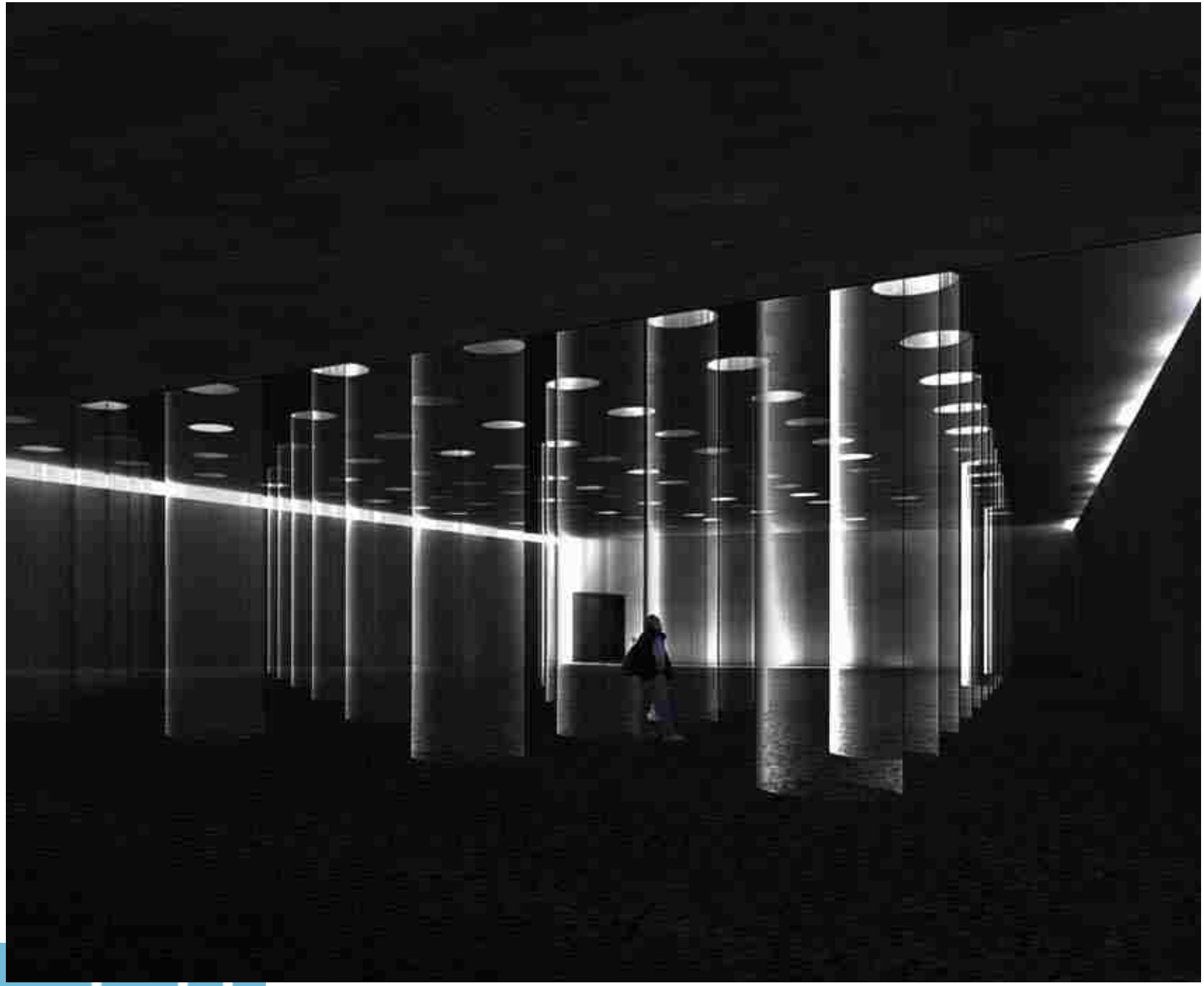
As a building the intervention is intended to simply be a more constructed experience of the greater narrative trail. There is no visitor parking lot or entry kiosk. The landscape and the sequence of spaces flow into each other, mediated only by the size of openings and changes in the ground plane. The spatial sequence is simple and unfolds as an experience of curiosity, questioning and understanding. The ground slopes gradually downward over several hundred feet until one passes under the heavy concrete mass of the entry. This is an encounter not unlike coming upon an unexpected cave, the design intending to stoke both curiosity and apprehension alike. In the low and wide space of the entry one grows accustomed to the darkness and the chilled temperature. The entry experience displaces the visitor, removing them from a relationship of being upon the earth to one that is below it. This is a space of burial.



77. (Below), Section B
78. (Opposite), “Questioning,” among the glass columns

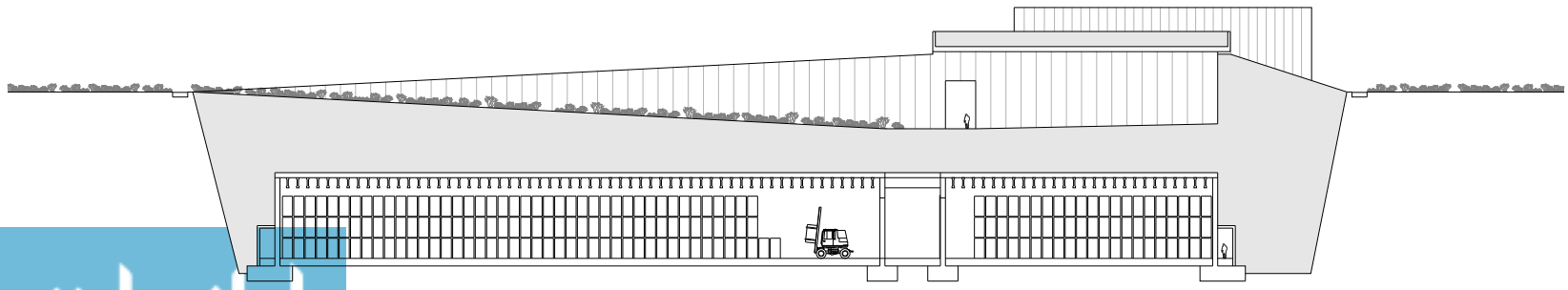
One sees a strange glow of bodies ahead and enters a large hypostyle hall of glass columns. The glass columns pierce through the roof, light bouncing down their shafts, refracting and glowing in the space. They do not sit on pedestals but instead reach down into the ground, never revealing their depth to the visitor. As tall as thirty feet tall and four feet wide, the columns fulfill several purposes. They match in material and form the vitirified vessels that contain and isolate the nuclear waste below. They create a space of intense wonder, sparking interest and raising questions about their meaning. As a field of glowing bodies, they are reminiscent of the ancient tradition that associates columns with ancestors.[1] The reflection of oneself off the glass columns amplifies the spiritual and ethereal qualities of the space. Although one’s body can physically relate to the single column, it is lost in the repetitive hall, the columns creating a space in which the body struggles to orient itself. It is a spatial void that serves as a metaphor for the void of time and of understanding the significance of nuclear waste below. A penetration of light coming in from the far corner of the space serves as a beacon that moves visitors through the space.



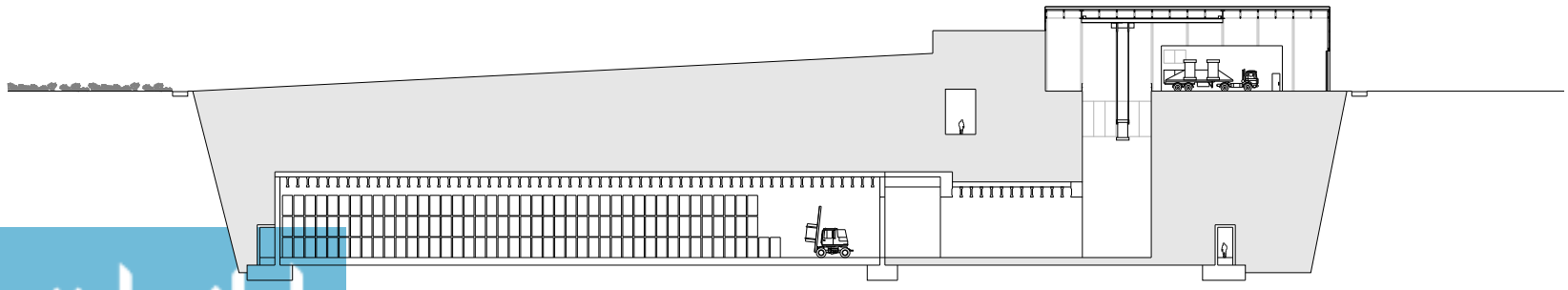


79. (Below), Section C
80. (Opposite), Perspective, side-light and passage

The shaft of light, cutting through the columns is positioned in the far corner of the hall opposite the entry to draw visitors diagonally through the space rather than navigating them on the periphery. In coming to the cut in the walls, the visitor is lead to a passageway out of the hall. A light well illuminates the end of the passage where upon turning the corner the visitor comes to the final space in the sequence. This is the space of understanding where, from behind the safety of a thick wall of windows, the visitor is confronted with the waste conveyer shaft leading down to the burial vaults. Whether the shaft is in operation or not, the deep well into the ground communicates in a visceral way the significance of what lies below. From the windows one also sees up into the waste receiving hall where some limited activities associated with preparing the waste for burial take place, further educating the visitor *by experience.* Behind this final space, the ground slopes upwards to a narrow gap under the roof through which the visitor exits the space and returns to the world of above where the trail continues to wind through the Hanford landscape.



81. (Below), Section D, Disposal Shaft
82. (Opposite), “Understanding” experiencing waste burial



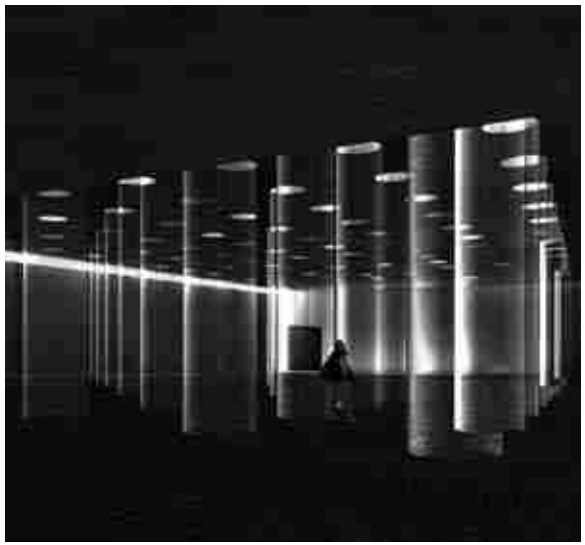
Conclusion

This final intervention of marking the burial of waste is not meant to provide answers or facts regarding the enduring issue of nuclear waste. Through the strength of the sequence of these spaces, the visitor is meant to come away affected by a need to further question the significance of our nuclear legacy. The facts of nuclear waste are very real and can be read in a book, but an experience of the mythical character of the waste in its relation to society and to time offers the opportunity for a more powerful understanding. The human body made to feel uncomfortable, made to sense the weight and depth of burial is an architectural experience that may move someone to form an opinion or take action in their own relationship with nuclear power in our world.

83. Perspective, the Return to above

Facilitating the body's experience of our nuclear legacy and the shrub steppe desert is the goal of this thesis. This exploration questioned the number, placement and specific intention of the final interventions. In the end, this process did not explicitly reveal answers to all questions. There are a whole range of other experiences in the desert that could have been addressed. Likewise, the project did not propose interventions in the locations of former human pioneer and Native American settlement. Thus this thesis should be read not as a final solution in number and location of architectural interventions in this narrative landscape, but as a set of ideas that could be expanded upon. It is clear in the research and final solution that each category of intervention; the landscape, the reactors and the nuclear waste are equally important to the success of an interpretive landscape that narrates a relatively complete picture of this site.

Despite the ambitions of this thesis, a number of questions remain. Is vitrification the best soultion for dealing with nuclear waste? Would the DOE ever mix an interpretive site with nuclear waste disposal? Will the DOE ever allow close proximity to the entombed reactors or even open the site to a wide-ranging network of trails? Ultimately, the goal of this thesis is to provoke the notion of a new approach to the nuclear reservation at Hanford, as well as the many others throughout the desert west. These are places with real concerns and conditions that also occupy the collective myths of our society's consciousness. Architecture, as it has always done, serves a function in shaping that mythology.



Endnotes

Introduction

1. John M. Findlay and Bruce W. Hevly. *Atomic Frontier Days: Hanford and the American West* (Seattle: Center for the Study of the Pacific Northwest in association with University of Washington Press, 2011), 102.

2. US DOE. *Hanford Site Cleanup Completion Framework* (Richland: United States Department of Energy, 2012), iii.

Theoretical Framework

1. John M. Findlay and Bruce W. Hevly. *The Atomic West* (Seattle, Wash: University of Washington Press, 1998), 24.

2. Ellen Meloy. *The Last Cheater's Waltz: Beauty and Violence in the Desert Southwest* (New York: Henry Holt, 1999), 26.

3. Valerie Kuletz. *The Tainted Desert: Environmental Ruin in the American West* (New York: Routledge, 1998), 141.

4. Findlay and Hevly. *Atomic Frontier Days*, 12.

5. Kuletz. *Tainted Desert*, 212.

6. Ibid, 13.

7. Ibid, 7.

    Kuletz's discussion of deterritorialization is based on idea presented by Gilles Deleuze and Félix Guattari

    Anti-Oedipus: capitalism and schizophrenia. New York: Viking Press, 1977)

8. Meloy. *The Last Cheater's Waltz*, 29.

9. Findlay and Hevly. *Atomic West*, 23.

10. Findlay and Hevly. *Atomic Frontier Days*, 96.

11. Kuletz. *Tainted Desert*, 210.

12. Ibid, 212.

13. Ibid, 228.

14. Lisa Toomey. "News From the Reach," *The Moderator: B- Reactor Museum Association, 18,* 2012, 8.

15. The account of the tour comes from this authors experience on an official site tour on May 8th 2012. I recognize the fact that the narrative of the tour is interpreted through my own cultural biases and pre-existing knowledge of the site. Still the tour is administered by the Department of Energy and is representative of the official governement narrative of Hanford.

16. Findlay and Hevly. *Atomic Frontier Days*, 7.

17. Len Acklund, “Open Wound From a Tough Nuclear History: Forgetting How We Made Ourseleves an Endangered Species,” in R*emedies for a New West: Healing Landscapes, Histories, and Cultures, ed.* Patricia Limerick, Andrew Cowell and Sharon Collinge (Tucson. The University of Arizona Press, 2009), 248-261.

18. Kuletz. *Tainted Desert*, 13.

Site Analysis and Design Methodologies

1. “Hanford Reach National Monument,” accessed on Decemeber 10, 2012. http://www.fws.gov/hanfordreach/

2. Peter Latz. “Landscape Park Duisburg-Nord: The Metamorphosis of an industrial Site,” in *Manufactured Sites*, ed. Niall Kirkwood (New York: Spon Press, 2001), 151.

3. Peter Latz, *Manufactured Sites*, 153.

Conclusion

1. Simon Unwin. *Twenty Buildings Every Architect Should Understand* (New York: Routledge, 2010), 125.

References

Arid Lands. Directed by Aaker, Grant, Josh Wallaert, Sidelong Films. and Bullfrog Films. Oley, PA: Bullfrog Films, 2007.

Acklund, Len. "Open Wound from a Tough Nuclear History: Forgetting how we made Ourselves an Endangered Species." *In Remedies for a New West: Healing Landscapes, Histories, and Cultures*, edited by Collinge, Sharon, Andrew Cowell and Patricia Limerick. Tuscon: The University of Arizona Press, 2009.

Berleant, Arnold. *Living in the Landscape : Toward an Aesthetics of Environment*. Lawrence: University Press of Kansas, 1997.

Corner, James. Recovering Landscape : *Essays in Contemporary Landscape Architecture*. New York: Princeton Architectural Press, 1999.

Corner, James, and Alex S. MacLean. T*aking Measures Across the American Landscape*. New Haven: Yale University Press, 1996.

Crawford, Rex, Lisa A. Hallock, and Ryan D. Huago. *Natural Heritage Report: Conservation Strategy for Washington State Inland Sand Dunes*. Spokane: Washington State Department of Resources, 2007.

Findlay, John M., and Bruce William Hevly. *Atomic Frontier Days : Hanford and the American West*. Seattle: Center for the Study of the Pacific Northwest in association with University of Washington Press, 2011.

Fox, William L. *The Void, the Grid and the Sign*: Traversing the Great Basin. Reno: University of Nevada Press, 2000.

Giblett, Rod. "Wilderness to Wasteland in the Photography of the American West." *Continuum: Journal of Media & Cultural Studies 23, no. 1* (02, 2009): 43-52.

Guzowski, Robert V., Stephan C. Hora, and Kathleen M. Trauth. *Expert Judgment on Markers to Deter Inadvertent Human Intrusion into the Waste Isolation Pilot Plant*. Albuquerque, New Mexico and Livermore, California: Sandia National Laboratories, 1993.

Hanford Cultural and Historic Resources Program. *Hanford Site Historic District : History of the Plutonium Production Facilities, 1943-1990*. Columbus: Battelle Press, 2003.

Hanford Site Cleanup Completion Framework. United States: United States Department of Energy, 2012.

Hatton, Brian,. "Strategic Architecture." *AA Files AA Files 42, no. 42* (2000): 28-35.

Hevly, Bruce William and John M. Findlay . *The Atomic West*. Seattle, Wash.: University of Washington Press, 1998.

Jacob, Gerald,. Site Unseen : *The Politics of Siting a Nuclear Waste Repository*. Pittsburgh, Pa.: University of Pittsburgh Press, 1990.

Kirkwood, Niall, ed. *Manufactured Sites*. New York: Spon Press, 2001.

Krinke, Rebecca. "Overview: Design Practice and Manufactured Sites." *In Manufactured Sites*, edited by Kirkwood, Niall. New York: Spon Press, 2001.

Kuletz, Valerie. *The Tainted Desert : Environmental Ruin in the American West*. New York: Routledge, 1998.

Latz, Peter. "Landscape Park Duisburg-Nord: The Metamorphosis of an Industrial Site." *In Manufactured Sites*, edited by Kirkwood, Niall. New York: Spon Press, 2001.

Meloy, Ellen. *The Last Cheater's Waltz : Beauty and Violence in the Desert Southwest*. New York: Henry Holt, 1999.

Nuclear Energy Agency Radioactive Waste Management Committee. *Moving Forward with Geologic Disposal of Radioactive Waste*: Organisation for Economic Co-operation and Development, 2008.

O'Connor, Georganne, and Karen Wieda . *Northwest Arid Lands : An Introduction to the Columbia Basin Shrub-Steppe*. Columbus, OH; Seattle, WA: Battelle Press ; Distributed by University of Washington Press, 2001.

The Hanford Story: Future. online video. Anonymous 2012.

Stanford Encyclopedia of Philosophy, http://plato.stanford.edu/entries/husserl/#EmpIntLif.

Unwin, Simon. *Twenty Buildings Every Architect should Understand*. New York: Routledge, 2010.

US Department of Energy. *Below Ground Vault-Disposal*: *Low-Level Radioactive Waste Basics.* Germantown: US Department of Energy Office of Environmental Management

US Department of Energy. *Draft Environmental Assessment for the Replacement Capability for the Disposal of the Remote-Handled Low-Level Radioactive Waste Generated at the Department of Energy's Idaho Site*. Richland: US Department of Energy, 1999.

US Department of Energy. *Final Hanford Comprehensive Land-use Plan Environmental Impact Statement*. Richland: US Department of Energy, 1999.

US Fish and Wildlife Service. *Hanford Reach National Monument Comprehensive Conservation Plan*: US Fish and Wildlife Service, 2008.

Wanapum Heritage Center, accessed May 8, 2012, http://www.wanapum.org/aboutthewanapum.pdf.

Image References

All Images created by auther unless otherwise noted.

1. US DOE. *White Bluffs Orchard*. 1914. http://www.hanford.gov/imageLibrary2/Settlers/full/79190-5.jpg

2. US DOE. *B-Reactor.* 1944. http://www.hanford.gov/page.cfm/BReactor

3. *Trinity Test Detonation*. 1945. http://thenuclearworld.org/2011/02/11/nuclear-bomb/

4. US DOE. *Demolition, K-West Sedimentation Basin*. 2010. http://www.hanford.gov/c.cfm/photogallery/gal.cfm/86F5A7A5-8A98-4F38-8D82-F939336A686A/2#

5. US DOE. *Depleted Uranium Hexafluoride Cylinders*. 1992. http://www.pppo.energy.gov/duf_history.html

7. Hanford Remediation Timeline, adapted by author from Hanford Clean-Up Environmental Impact Statement 2009

8. Regional Context Satellite, adapted by auther from Bing Maps. http://www.bing.com/maps/

9. Local Context Satellite, adapted by auther from Bing Maps. http://www.bing.com/maps/

11. Moran, Thomas. *Grand Gateway to the Yellowstone*. 1893. 19thcentury.blogspot.com/2012/05/Thomas-moran-ctd.html

12. Gast, John. *Spirit of the Frontier*. 1872. http://en.wikipedia.org/wiki/File:American_progress.JPG

13. Olmstead, Everett. *General Jonathon Wainwright, Charley Quetuhkin, Wyam Chief Tommy Thompson at Celilo Falls*. 1945. http://www.nwcouncil.org/history/CeliloFalls.asp

14. Center for the Study of the Pacific Northwest, University of Washington. *Atomic Frontier Days Poster*. 1948. http://www.washington.edu/uwired/outreach/cspn/Website/Classroom%20Materials/Pacific%20Northwest%20History/Lessons/Lesson%2024/24.html

15. US DOE. *Atomic Frontier Days Parade*. 1954. http://www5.hanford.gov/ddrs/common/findpage.cfm?AKey=N1D0003098

16. Drosendahl, Glenn. *Petroglyph at Ginko Petrified Forest State Park*. 2005. http://www.historylink.org/index.cfm?DisplayPage=output.cfm&File_Id=7396

17. Pacific Northwest National Laboratories. *Hanford Site*. 1976. http://picturethis.pnl.gov/picturet.nsf/by+id/SMAA-46PMRV

18. Gifford, Benjamin. *Indians Fishing at Celilo, Columbia River*. 1899. http://www.ohs.org/education/oregonhistory/historicviewer/celilofalls/celiloFalls1899.html

19. SLAC National Accelerator Laboratory. *Rocky Flats Before and After Clean-Up*. 2006. http://www.today.slac.stanford.edu/feature/rocky-flats.asp\

20. World News. *A15 Occupy Hanford Rally*. 2012. http://wn.com/hanford/images

21. Mosher, Chelsea. *B-Reactor Tour*. 2009. http://www.zcommunications.org/hanfords-b-reactor-by-joshua-frank

22. Hanford Land Use Maps, adapted by author from Hanford Comprehensive Land Use Plan, 2012

23. Brown, Paul Joseph. *H-Reactor*. 1984. http://www.seattlepi.com/local/article/New-concerns-about-Hanford-nuclear-waste-plant-2396040.php

24. Bing Maps. *Hanford Sand Dunes*. 2012. http://www.bing.com/maps/

25. Heather on Flickr. *Sand Dunes, Hanford Reach National Monument*. 2012. http://www.flickr.com/photos/verybadlady/7308776960/in/photostream/

26. Biologic resource maps, adapted by author from Hanford Clean-Up Environmental Impact Statement, 2009

27. Dannells, Bonita. *Hanford Reach Columbia River*. 2010. http://www.flickr.com/photos/85934826@N00/4922220813/in/photostream/

28. Luetzelberger, Kunigunde. *Active Dunes and Wahiti Peak on Saddle Mountain*. 2006. http://www.flickr.com/photos/38427292@N00/5278716046/

30. US DOE. *F-Reactor, Cocooned*. 2003. http://www.hanford.gov/imageLibrary2/A31D3003-C713-4D2B-9D93-AF3F4DF3F0C6/full/FAreaComplete-9.jpg

31. US DOE. *B-Reactor*. 1944. http://www.hanford.gov/page.cfm/BReactor

31. US DOE. *B-Reactor*. 2012. http://www.hanford.gov/page.cfm/BReactor

32. *Hanford Reactor Core*. Originally in Time Magazine. http://atomic-annhilation.blogspot.com/2011_12_01_archive.html

34. Rentz, Lee. *F-Reactor*. http://leerentz.photoshelter.com/image/I00003CU11dTIuZI

36. *Hanford Waste Storage Tanks*. 1944. http://www.rosemerena.org/home/2009/05/14/more-delays-at-hanford-cleanup/

37. US DOE. *Tank Waste Diagram*. http://www.forbes.com/sites/jeffmcmahon/2012/08/27/whats-inside-the-suspect-nuclear-waste-tank-at-hanford/

37. Bechtel. *Vitrification Plant Under Construction*. 2012. http://www.tri-cityherald.com/2012/11/09/2164099/energy-secretary-to-move-forward.html

37. Pacific Northwest National Laboratories. *Vitrified Glass*. http://hanford-site.pnnl.gov/envreport/2001/summanage.stm

39. US DOE Office of Environmental Management. *Below Ground Vault-Disposal*. Low-Level Radioactive Waste Basics

39. *Below Ground Vaults*. http://cementbarriers.org/applications/

40. Center for Land Use Interpretation. *Green River Disposal Cell*, Utah. 2012. http://www.clui.org/section/perpetual-architecture-uranium-disposal-cells-america

41. Posiva. *Tunnel at Onkalo Waste Disposal Site, Finland*. http://www.posiva.fi/en/research_development/onkalo/

42. Dore, Gustave. *Dante and Virgil before Farinata*. 1890. http://bldgblog.blogspot.com/2012/08/the-auditory-configuration-of-hell.html

43. Columbia Riverkeeper. *Hanford Reach Paddle*. http://columbiariverkeeper.org/wp-content/uploads/2011/09/hanford-group-paddle-10.jpg

44. World News. *A15 Occupy Hanford Rally*. 2012. http://wn.com/hanford/images

45. Tri-City Herald. *B-Reactor Tour*. 2012. http://www.tri-cityherald.com/2012/07/04/2011038/more-seats-available-for-b-reactor.html

46. *Hiking in Hanford Reach National Monument*. 2010. http://1.bp.blogspot.com/_SdQMlfluh6I/THMzdVKu9jI/AAAAAAAAH0A/DJ8oztihQ_I/s1600To+Hanford+Reach+%26+back+380.JPG

47. National Geographic. *Nuclear Waste Canister*. 2011. http://news.nationalgeographic.com/news/2011/01/pictures/110119-nuclear-waste-train-castor-antinuclear-protest-germany-power-energy-pictures/

48. Wikipedia. *Landschaftspark Duisburg Nord*. 2008. http://upload.wikimedia.org/wikipedia/commons/d/d1/Landschaftspark_Duisburg-Nord_-_Kletterwand_Erzbunker.jpg

48. Wohlrab, Mark. *Landschaftspark Duisburg Nord*. http://s3.germany.travel/media/content/erholung/schloesser__parks___gaerten_1/landschaftspark_duisburg_nord/3541_RET_1024x768.jpg

50. Abidi, Safdar and Brill, Michael. *Menacing Earthworks*. 1993. Expert Judgment on Markers to Prevent Inadvertent Human Intrusion into the Waste Isolation Pilot Plant

50. Brill, Michael. *Menacing Earthworks Diagram*. 1993. Expert Judgment on Markers to Prevent Inadvertent Human Intrusion into the Waste Isolation Pilot Plant

50. Brill, Michael. *Level IV Marker*. 1993. Expert Judgment on Markers to Prevent Inadvertent Human Intrusion into the Waste Isolation Pilot Plant