

THE WILLISTON TIME CAPSULE

by David Moses

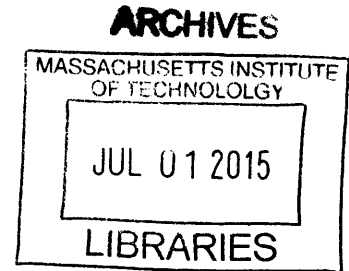
Bachelors of Environmental Design in Architecture
North Carolina State University, 2005

Submitted to the Department of Architecture
in partial fulfillment of the requirements for
the degree of Master of Architecture at
the Massachusetts Institute of Technology

June 2015

© 2015 David Moses. All rights reserved.

The author hereby grants to MIT permission to reproduce and to
distribute publicly paper and electronic copies of this thesis document
in whole or in part in any medium now known or hereafter created.



Signature redacted

Signature of Author _____

Department of Architecture
May 21, 2015

Signature redacted

Certified by _____

Miho Mazereeuw
Ford International Career Development Assistant Professor of Architecture and Urbanism
Thesis Advisor

Signature redacted

Accepted by _____

Takehiro Nagakura
Associate Professor of Design and Computation
Chair of the Department Committee on Graduate Students

Thesis Advisor

Miho Mazereeuw, MArch, MLA

Ford International Career Development Assistant Professor of Architecture and Urbanism

Thesis Readers

Arindam Dutta, MArch, PhD

Associate Professor of the History of Architecture

Cristina Parreño Alonso, MArch

Lecturer in Architectural Design

THE WILLISTON TIME CAPSULE

by David Moses

Abstract

This project is a time capsule of the oil economy, created by entombing everyday objects made from and powered by petroleum into a landscape that spatially recreates the processes of drilling and fracking a contemporary oil well. It consists of two interrelated landscape systems. The first is a giant landform, a marker on the earth's surface commensurate with the scale of the second, a labyrinth of chambers carved out of a subterranean strata of rock. The site is an existing two square mile drill spacing unit on the edge of Williston, North Dakota, in the middle of one of the largest contemporary shale oil booms in the world.

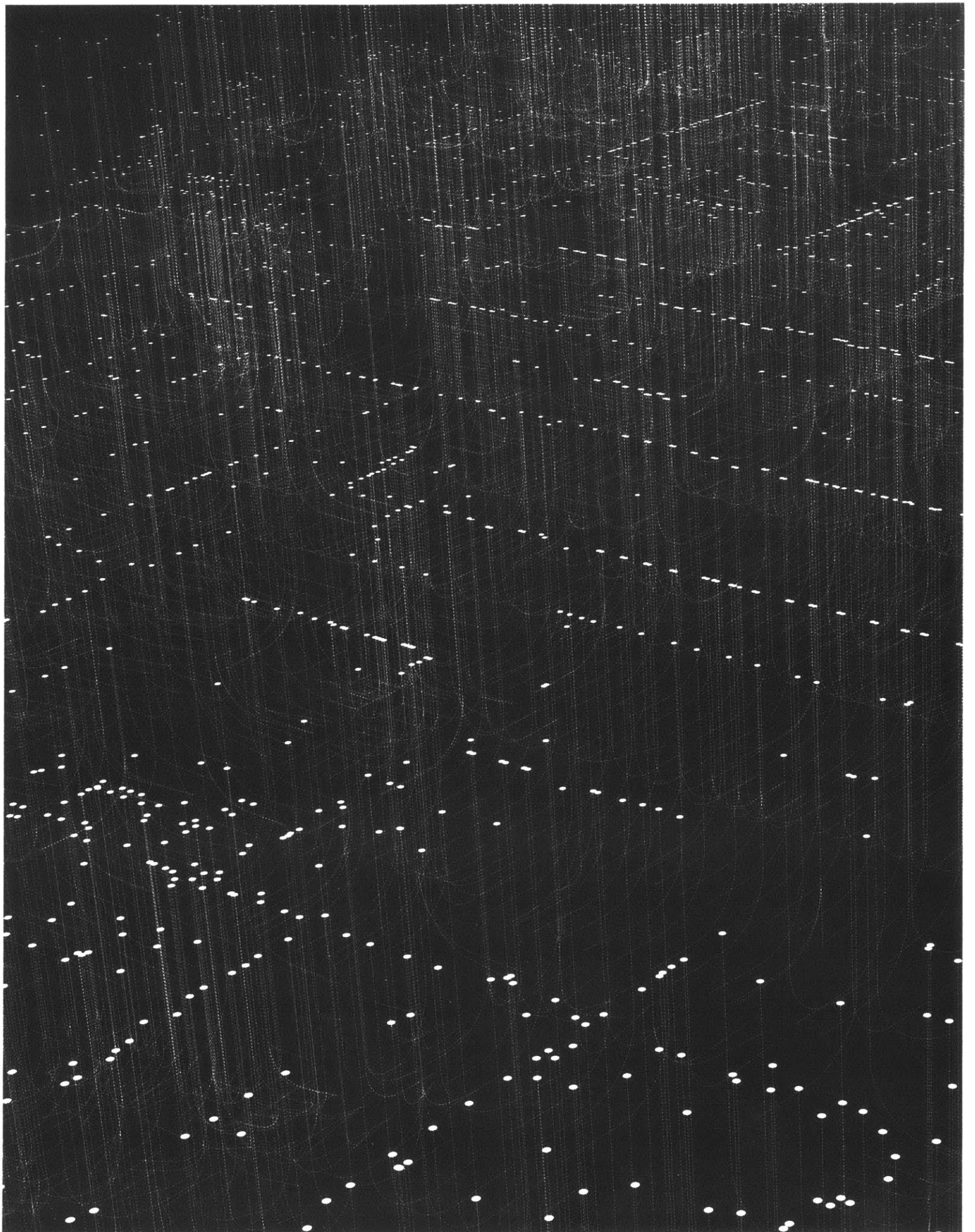
This thesis aspires to be a counter monument to the processes that create massive change on a territorial scale yet somehow remain hidden from the end consumers of those processes. By placing the objects of oil back underground in their place of origin, they become future sites of meditation on the ways that everyday consumption drives the economies of extraction. Their entombment takes place over a long period of future time: as objects and processes of the oil economy become obsolete, they are buried one by one, a long slow motion fracking of the site.

Like most monuments, this one has been designed for a future public, hopefully one that wonders at the strangeness of us and our economies of frenzied extraction and consumption. The thesis is a way of saying that we as a culture at least contended with fracking and its innumerable consequences in way that was more substantial than simply worrying about the price of gas at the pump.

Thesis Advisor

Miho Mazereeuw, MArch, MLA
Assistant Professor of Architecture and Urbanism

Submitted to the Department of Architecture on May 21, 2015 in partial fulfillment of the requirements for the Master of Architecture degree





THE WILLISTON TIME CAPSULE

by David Moses

Miho

Thank you for going on this strange journey with me. Your trust in the project, and my ability to see it through, has been unwavering, and your guidance has been invaluable. It has been a true gift learning from and working with you during my time MIT.

Arindam and Cristina

Thank you for all the appropriate nudges. Your fresh takes on the project helped me see it clearly for what it was along the way.

Barry and Aditya

Thank you for the help at the ragged end before the final review, and for all your support before that too.

My classmates

All intellectual endeavors are of course carried out in dialogue with others. Thank you for being my sounding boards, coconspirators, snack buddies, and friends the last three and a half years.

Mom and Dad

I am finally finished! I will call home more often now, I promise. I would not be here if not for your constant love and support.

Alison,

My rock, I love you.

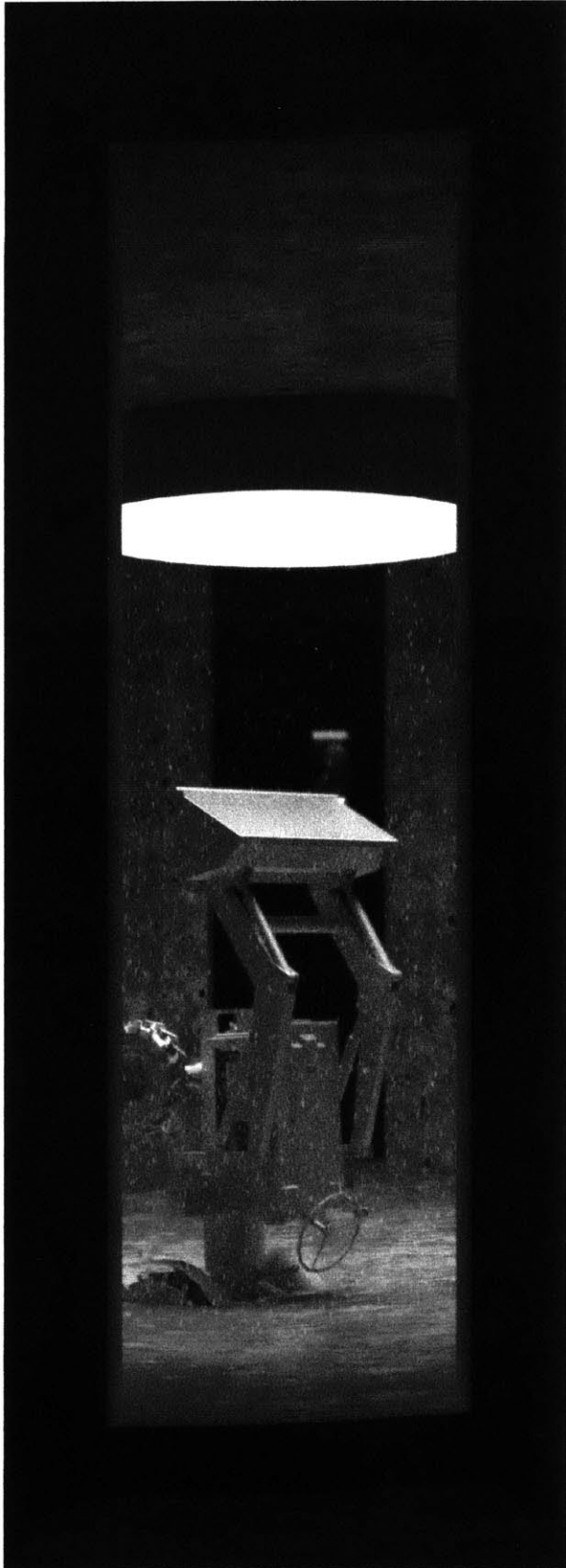
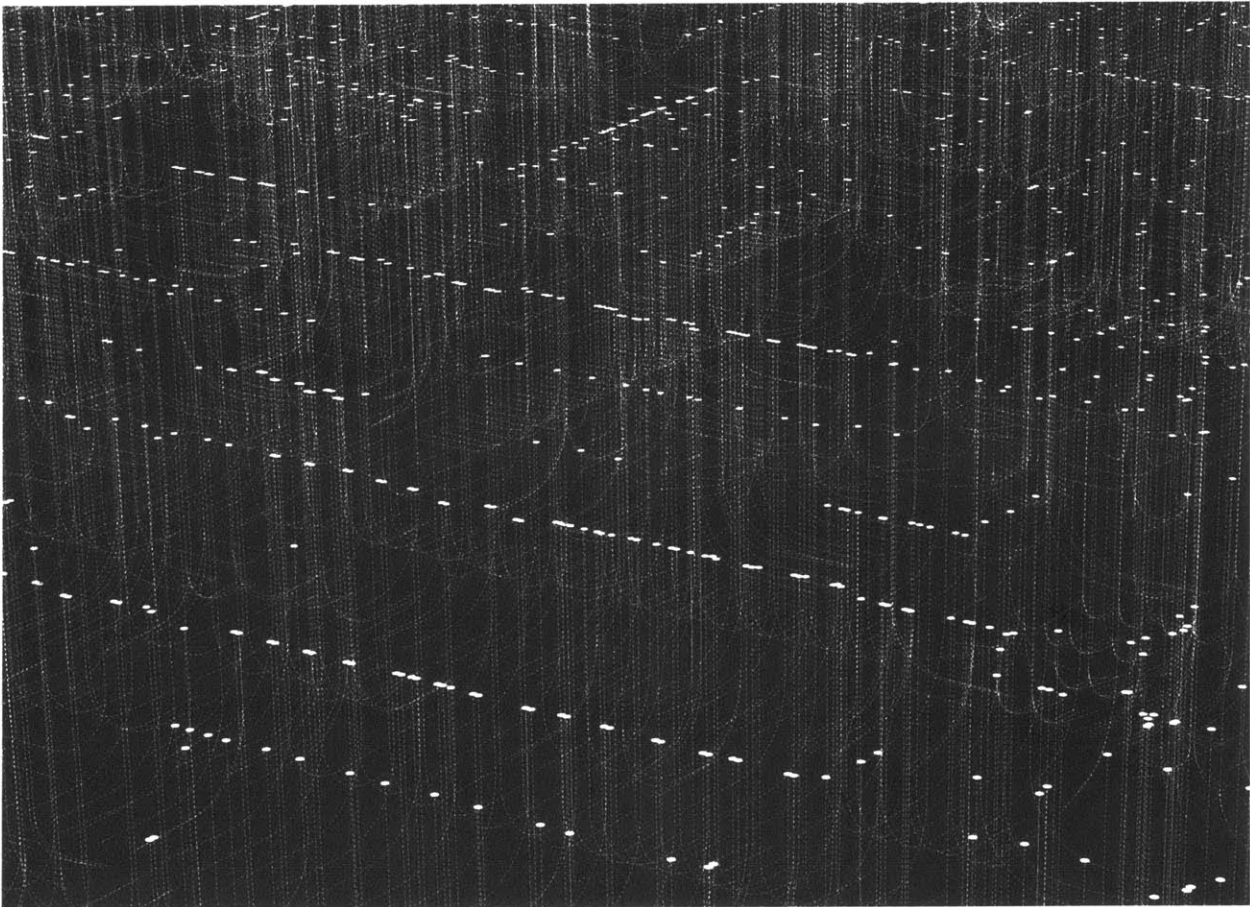


Table of Contents

- 08** Introduction
- 17** A Brief Territorial History
- 30** Territory of Extraction
- 44** Time Capsule
- 66** January 2016...
- 80** Design Process Artifacts
- 94** Appendix I - The Final Review
- 102** Appendix II - The Oil Extraction Process
- 108** Appendix III - The View on the Ground

INTRODUCTION



New technologies have recently opened up vast new areas of North America to oil and gas production. These so called “tight shale plays” from Pennsylvania to Alberta have led to increased American energy independence, one of the few sources of new, well-paying blue collar jobs in the American economy, and a series of new “Boomtowns” at the sites of these new drilling operations. One of the most dramatic of these is Williston, North Dakota located at the center of the Bakken shale formation. The Bakken lies two miles underground of much of western North Dakota, while also stretching into eastern Montana, southwestern Saskatchewan, and southeastern Manitoba. The scale of oil development is massive, with hundreds of wells being drilled every year since 2008, across a vast territory of the rolling Great Plains. The population of Williston has doubled since the 2010 census. As of the beginning of 2014, it had the highest average rent for a one-bedroom apartment in the entire country (higher than San Francisco and New York City). North Dakota is now the second leading oil producing state in the country, behind only Texas. As oil production spreads across a territory three times the size of Massachusetts, natural gas flares roar like jet engines day, night tanker trucks clog the formerly quiet agriculture towns, groundwater

is polluted by spilled oil and fracking chemicals, leaked sulfur gas kills farm animals, and state regulators who are supposed to be overseeing the oil development instead work in concert with oil companies to increase production. When the oil has been sucked out of the ground, what will be left is a disrupted landscape of oil ruins and pollution, and carbon formerly locked in a millions year old sea will instead be in the atmosphere, contributing to the global climate change that affects us all.

There has been a great deal of new architecture and urban design scholarship in recent years about how to theorize and create design projects for the urbanization associated with the oil industry. Lateral Office proposed multifunction oil platforms for the Caspian Sea in the 2010 project Re-Rigging. Neeraj Bhatia recently led an urban design studio at Rice University where students were tasked with designing new urban infrastructure tied to floating oil platforms off the coast of Brazil. Architects are attracted to the territorial scale of development, the massive size of the infrastructure required, the amount of money so quickly generated, and the potential for so much newness. The new oil developments are a spectacle, and their ability to totally transform entire territories is compelling

to architects looking for agency in a culture that seems to be placing less and less value in design agendas. Rather than designing buildings or gardens, why not re-design the oil production process and try to co-opt it for other (non-oil producing) purposes?

One important reason is the inherently ephemeral nature of oil development and its associated urbanism. In the case of the Bakken shale region, new wells dramatically decrease in production immediately once they come online. The only thing that is keeping oil production growing in the Bakken is the drilling of an enormous number of new wells. As the drilling rate inevitably decreases in the coming years, so too will the Bakken oil production. The urban explosion that has so quickly enveloped the region will almost as quickly melt away again, returning Williston, Watford City, and Crosby to the dusty, agricultural railroad towns they were before the oil boom, except this time with decaying and badly planned ghost developments at their periphery. With an expanded historical perspective, the boomtown development in the Bakken is much like previous booms driven by extractive industries (a fur industry that disappeared along with the previously endless herds of bison, unsustainable agriculture

driven by railroad land speculation, and now the oil boom). Northwestern North Dakota is well known for its ghost towns left decaying into the prairie from these previous booms (Fort Union, Temple, Corinth, Ambrose, Colgan...). An architecture project that seeks to create yet another ghost town following a (at most) twenty-five year development window appears self-defeating.

And while oil services industries could certainly use architecture, within the incredibly optimized systems of engineering that pump oil out of the ground there has been left little space for cultural representation. If architecture will always by necessity be less efficient at engineering a process or creating an infrastructural system than the engineers trained to minimize cost and maximize production, then architecture for the oil industry will be consigned to designing the corporate headquarters skyscraper in Dallas or Dubai, or to creating the weekend retreat of the oil executive in the Bahamas. On the ground in North Dakota almost everyone has bought into the get rich quick expediency of tanks and pipes and pump jacks, plowed earth and RV's, and unplanned dross-scape sprawl, all cheap enough to be exactly as temporary as it needs to be. To opt into this process would necessarily require that

the architect would need to be subservient to it, designing in the margins, fitting in a nice shape or a better color scheme here or there.

This thesis does not seek to answer the big question: "What is to be done in the Bakken?" That is certainly a project of sorts, and one that could be pursued within the confines of the academy to a certain degree of success in the contemporary "Ecological Urbanism" discursive environment. On the ground, though, that question is already being answered by oil companies like Continental Resources, Hess Corp., StatOil, Whiting Petroleum, and EOG Resources. They are making the vast Bakken territory an incredibly efficient oil pumping machine. They don't need, or for that matter, want, architects.

A more useful question to ask is instead, "What will become of the Bakken?" and also by extension, what will become of a culture and its landscapes inextricably bound up in the dead end patterns of growth inherent in the pro-development-at-all-costs vision of the world? What is needed is not increased technical sophistication- the oil engineers have that covered. What is needed instead is the sort of cultural reflection and representation that architecture can provide. The

project is a counter-monument to the excesses of the oil industry, and by extension the contemporary cultures (mine and yours) bound inextricably with it. It is representative not only of the territorial processes once again transforming north western North Dakota but also of the global economies driving those processes. It imagines a future where the ruins of our destructive processes are of interest to future generations and where the day-to-day materials of our lives can be re-contextualized into the landscapes these materials were originally removed from. It imagines a public who actually wonder at how strange it is to send pipes two miles beneath the surface of the earth to explode vast territories of 320 million year buried sea beds, and to then pump out the ancient oil only to burn it to fill the atmosphere with carbon dioxide and transform it into boundless piles of insoluble plastics that quickly become unusable only to be discarded in giant, stinky piles of trash. This is a public that is able to ask Bruno Latour's question: "Why has the world been made uninhabitable in the first place? More precisely, why has it not been conceived as if the question of its habitability was the only question worth asking?" What modernity has done to the world?

The power of architectural objects in

communication with territorial ideas is their ability to make the abstraction of the territory graspable at the scale of human senses. It is one thing to look at a map and understand- it is another to somehow experience a map and understand. When calibrated correctly, territorial architectures absorb vastness and make it comprehensible while in no way less vast. We may know the earth is round from the globes in our elementary school classrooms, yet to see the curve of the horizon in the first airplane ride still brings home the physical reality far more convincingly. That curve becomes real when physically experienced for the first time, and forever after the world inhabited is a sphere. Stonehenge is a pile of rocks arranged in calibration with the movement of the sun. Being in the middle of that ring at sunrise or sunset on the correct days of alignment puts the human subject in dialogue with the vastness of the solar system. James Turrel's Roden Crater is seeking the same sort of timeless connection with stars and planets, but in a contemporary idiom of light and mass. Walter de Maria's Lightning Field in New Mexico is a simple grid of steel rods in the desert, yet by discretely measuring space it absorbs the horizon into itself. During thunderstorms, it actually becomes continuous with the atmosphere through bolts of electrical discharge from cloud to earth.

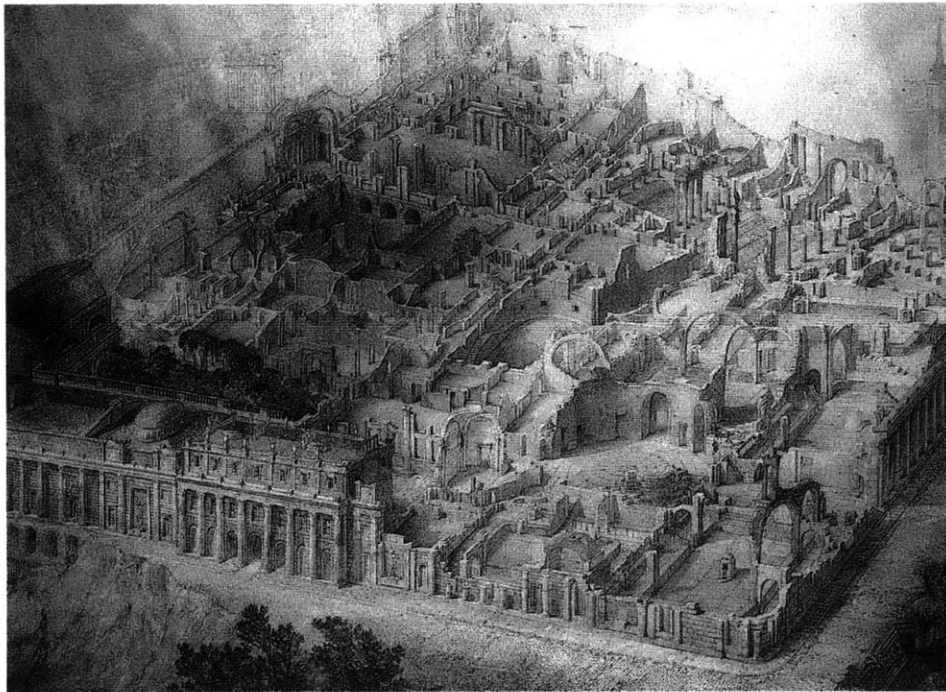
In a similar way, this project seeks to deal in the actual largeness of oil drilling and the violence of fracking as literally as possible, and to put the human subject in direct physical contact with residue of the processes and the actual quantities involved.

The oil extraction industry is represented completely by bland abstractions, and the giant territories of its operations hidden behind quantity graphs and quarterly earnings reports. This of course by design- the oil industrial complex wants to create the impression that fracking is safe, its impacts small, its future secure. Oil wells are pinpricks on the surface, minimal surgeries, and the impacts on the human settlements on the service are only positive: more money, more jobs, and more prosperity. These might be lies, but they are lies that the companies' shareholders and the people that buy their products want to hear. They are only able to make money because of the demand for their products. Our food is grown with machines run on gasoline, and it is cooked on stoves burning natural gas. The disposable plastic products that fill our lives are derivative of oil products. The asphalt that paves our roads, the ink that comes of our printers, the rubber in the soles of our shoes, the paint that coats our

houses, the kerosene used in camp stoves on the trips into the wilderness to commune with nature—these are the materials being pumped out the ground in North Dakota. These too are part of the territory of extraction. What would it look like if the oil extracted from one drill spacing unit outside of Williston was put back in the ground? Not represented as an abstract quantity of commodity, but as the actual materials that act as record of our culture? What if the experience of these materials mimicked the scale and violence of the extraction process itself, to allow the human body to directly experience and understand the scale and quantity of territorial transformation currently happening in the Bakken Shale? What if these transformations were understood to be choices made by human beings rather than inevitabilities of this thing called economic development? If the oil production in the Bakken is at this point inevitable, the way that our society represents this production to itself is a chance to actually take responsibility for it, rather than simply worrying about the price of gas at the pump.

When all the oil is pumped out of the Bakken, when it has been turned into gasoline for cars and plastic cups and tubes of lipstick, when it has all been consumed and the drilling rigs and the

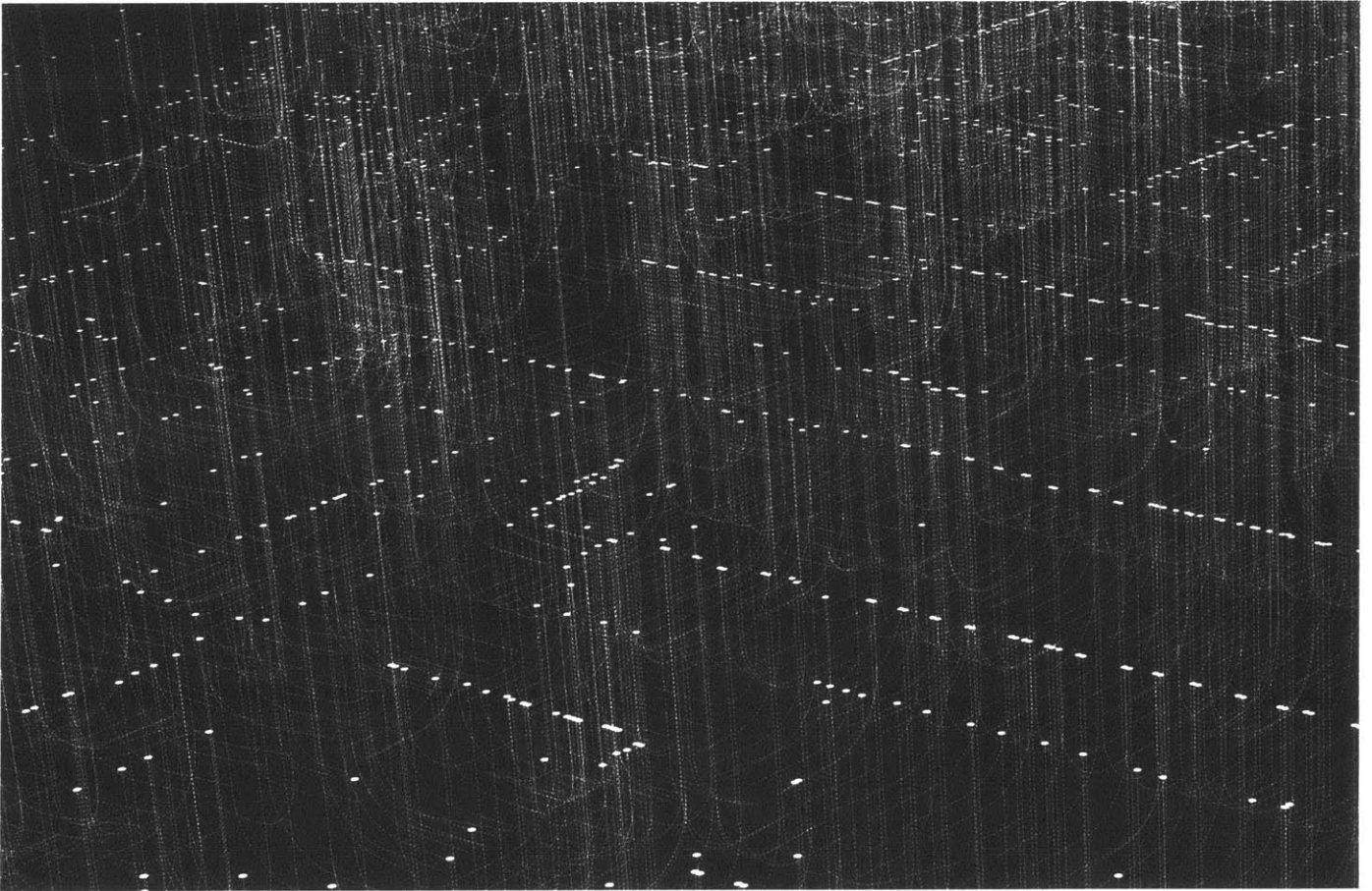
roughnecks and the pumping derricks have moved on, the Williston Time Capsule will remain behind on the prairie, commensurate with the scale of the now gone oil infrastructures, waiting like a ruin in the middle of the now shrunken town, a designed residue of the culture of consumption and its material impacts on the world.



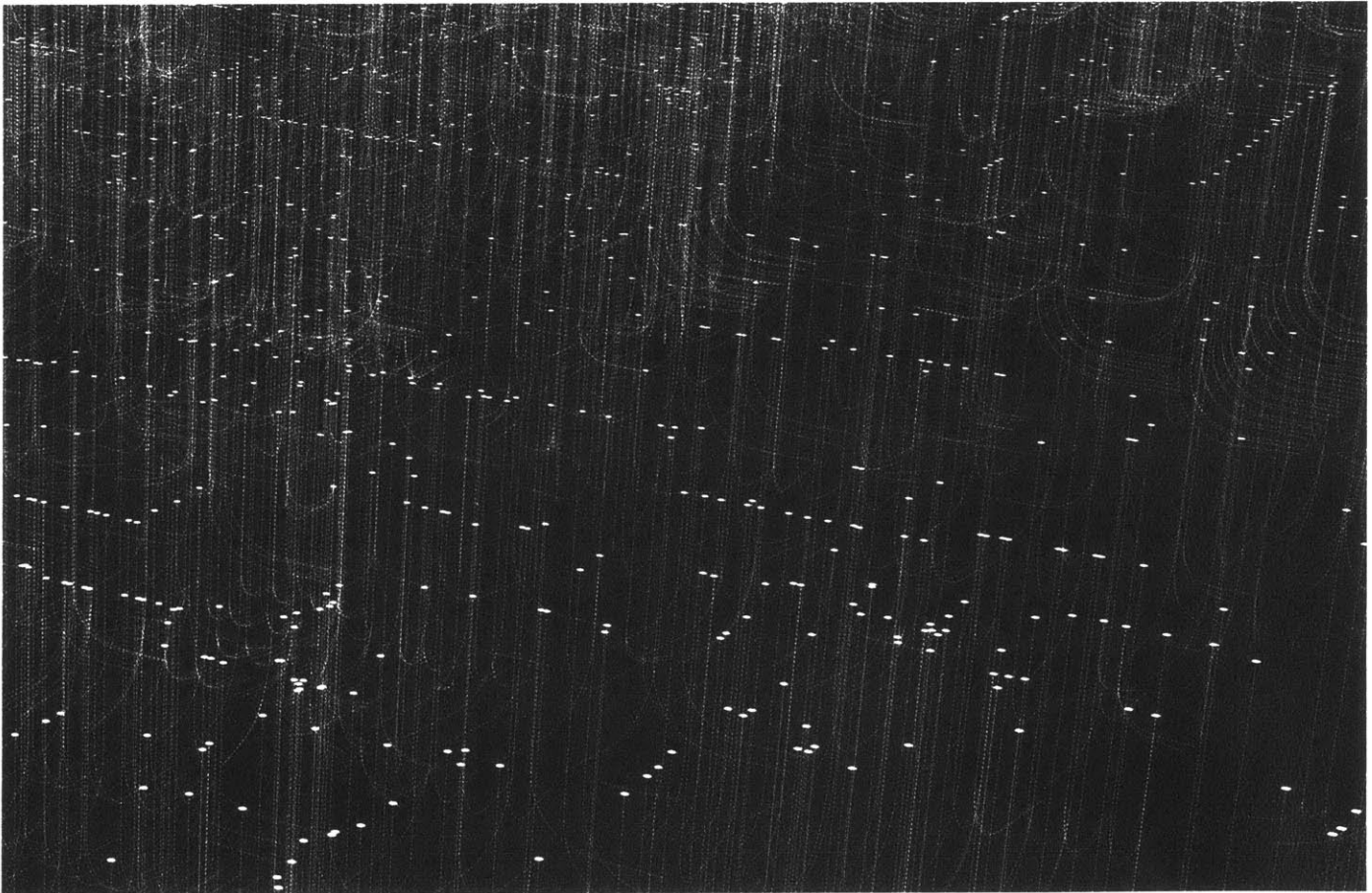
John Soane's Bank of England, the institution designed as a ruin.

Bibliography

- Reyner Banham. "The Vast and the Empty." Landform Building. Baden: Lars Muller, 2011.
- Reyner Banham. "The Great Gismo." A Critic Writes. Berkeley: University of California Press, 1996.
- Neeraj Bhatia and Mary Casper, editors. The Petropolis of Tomorrow. New York: Actar, 2013.
- Neeraj Bhatia, Maya Przybylski, Lola Sheppard, and Mason White. Coupling: Strategies for Infrastructural Opportunism. New York: Princeton Architectural Press, 2011.
- Alan Berger. Systemic Design Can Change the World. Amsterdam: SUN, 2009.
- Neil Brenner, ed. Implosions / Explosions: Towards a Study of Planetary Urbanization. Berlin: Jovis, 2013.
- Luis Callejas. Islands and Atolls. New York: Princeton Architectural Press, 2013.
- William Cronon. Nature's Metropolis: Chicago and the Great West. New York: Norton, 1991.
- . "The Trouble with Wilderness." Uncommon Ground: Rethinking the Human Place in Nature. New York: Norton, 1996.
- Edwin Dobb. "The New Oil Landscape." National Geographic. March 2013. 28-59.
- Hooghe, Alexander d'. The Liberal Monument : Urban Design and the Late Modern Project. New York : Princeton Architectural Press, 2010.
- Rem Koolhaas. Delirious New York. 2nd Ed. New York: Monacelli Press, 1994.
- Bruno Latour. "Spheres and Networks: Two Ways to Interpret Globalization." Harvard Design Magazine. No. 30, Spring/Summer 2009. 138-144.
- . The Politics of Nature. Trans. Catherine Porter. Cambridge: Harvard UP, 2004.
- . We Have Never Been Modern. Trans. Catherine Porter. Cambridge: Harvard UP, 1993.
- Leo Marx. The Machine in the Garden. London: Oxford UP, 1964.
- Mostafavi, Mohsen, ed. Ecological Urbanism. Baden: Lars Muller, 2010.
- David Nye. American Technological Sublime. Cambridge: MIT Press, 1994.
- Frederick Jackson Turner. The Frontier in American History. Tuscon: University of Arizona Press, 1986.
- Varnedoe, Kirk. Pictures of Nothing: Abstract Art Since Pollock. Princeton, NJ : Princeton University Press, 2006.

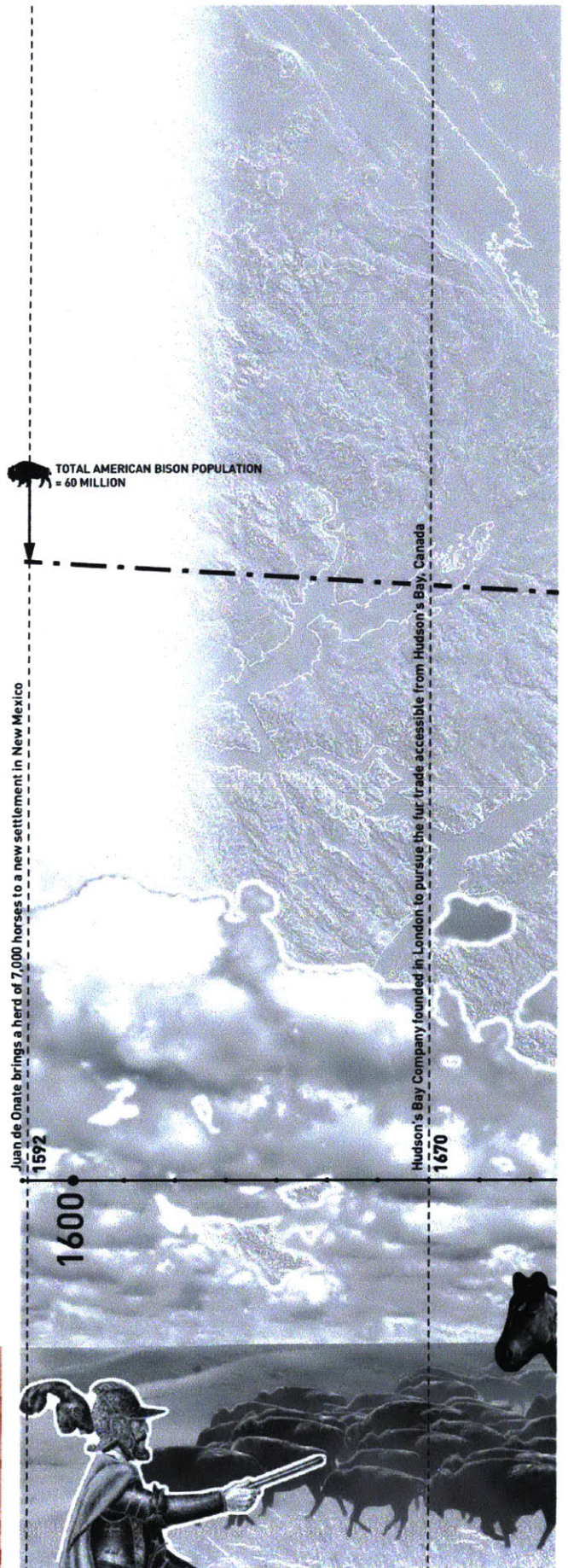
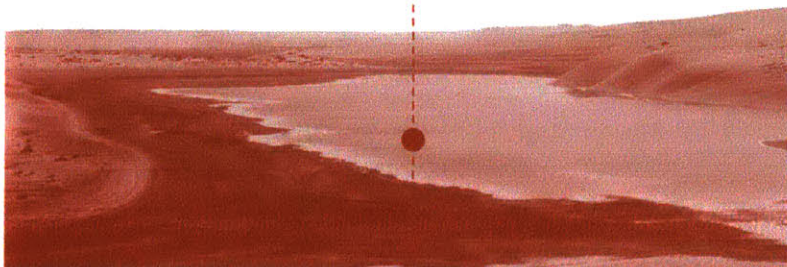


A BRIEF TERRITORIAL HISTORY



Prehistory to 1800: the territory transformed by horses.

Bakken formation formed, probably at the bottom of a shallow sea during the late Devonian period
358 MILLION B.C.

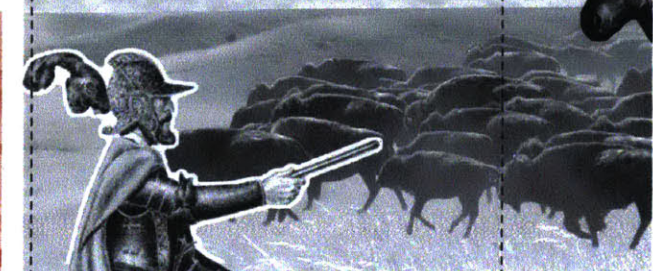


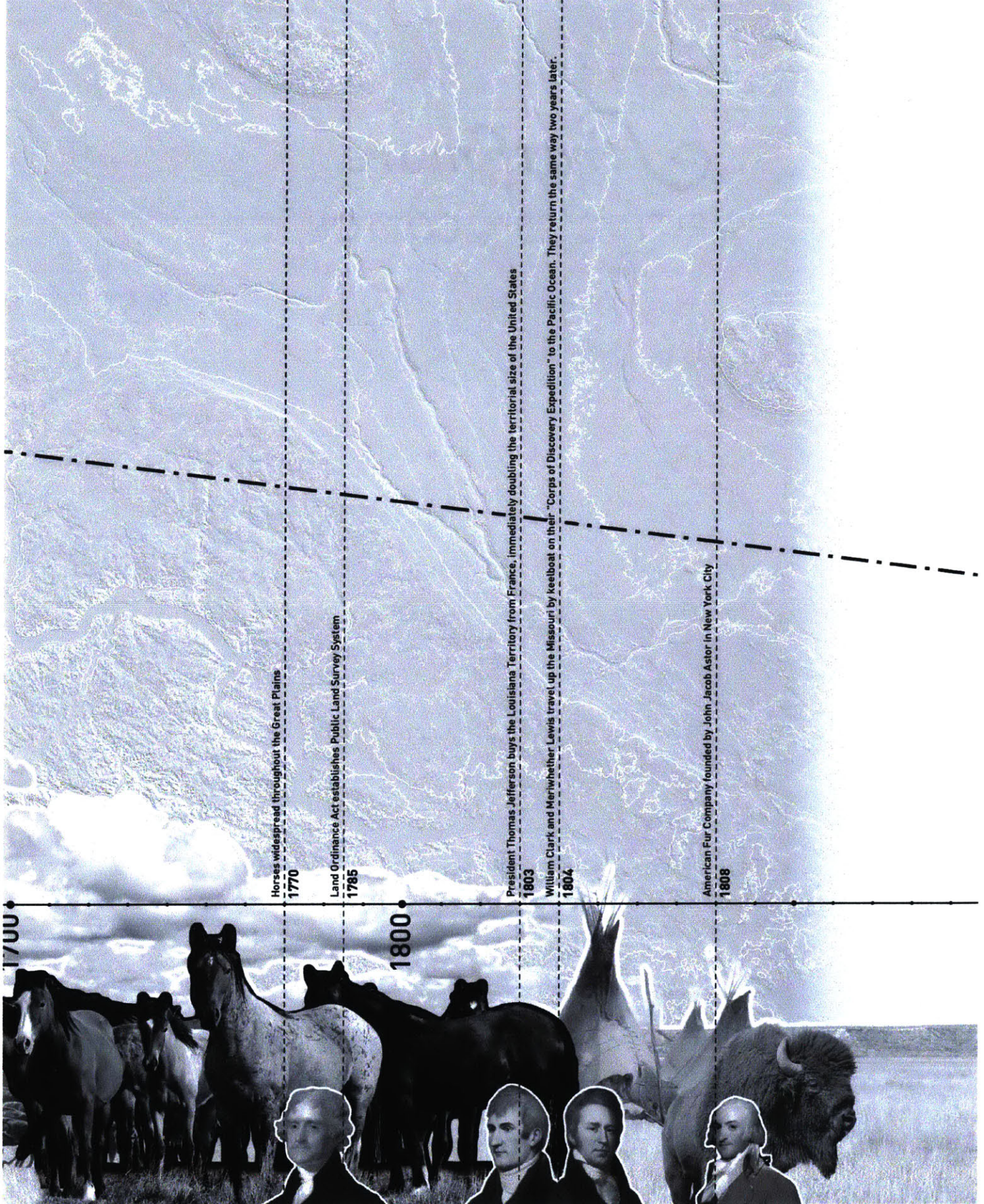
TOTAL AMERICAN BISON POPULATION
= 60 MILLION

Juan de Onate brings a herd of 7,000 horses to a new settlement in New Mexico
1592

1600

Hudson's Bay Company founded in London to pursue the fur trade accessible from Hudson's Bay, Canada
1670





1700

Horses widespread throughout the Great Plains

1770

Land Ordinance Act establishes Public Land Survey System

1785

1800

President Thomas Jefferson buys the Louisiana Territory from France, immediately doubling the territorial size of the United States

1803

William Clark and Meriwether Lewis travel up the Missouri by keelboat on their "Corps of Discovery Expedition" to the Pacific Ocean. They return the same way two years later.

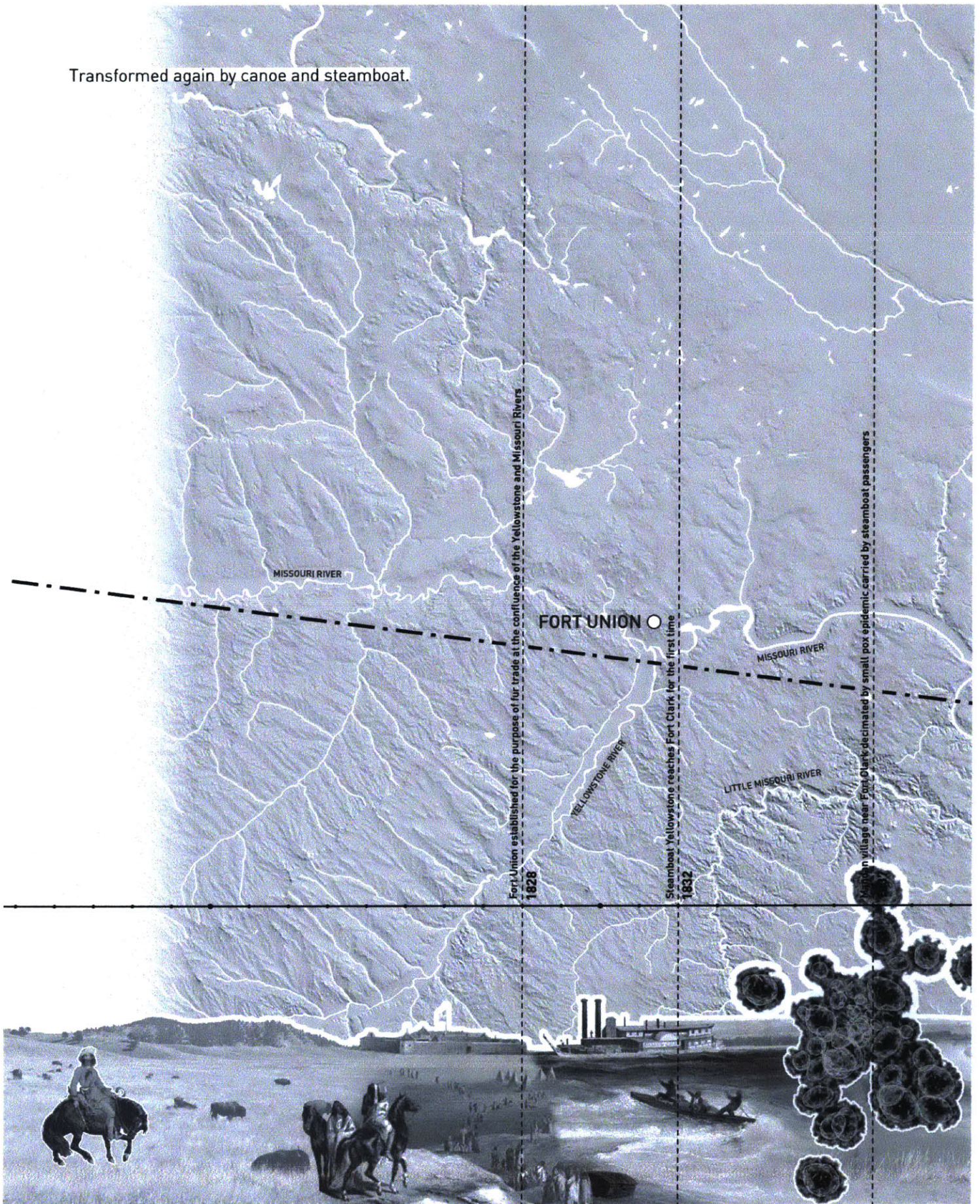
1804

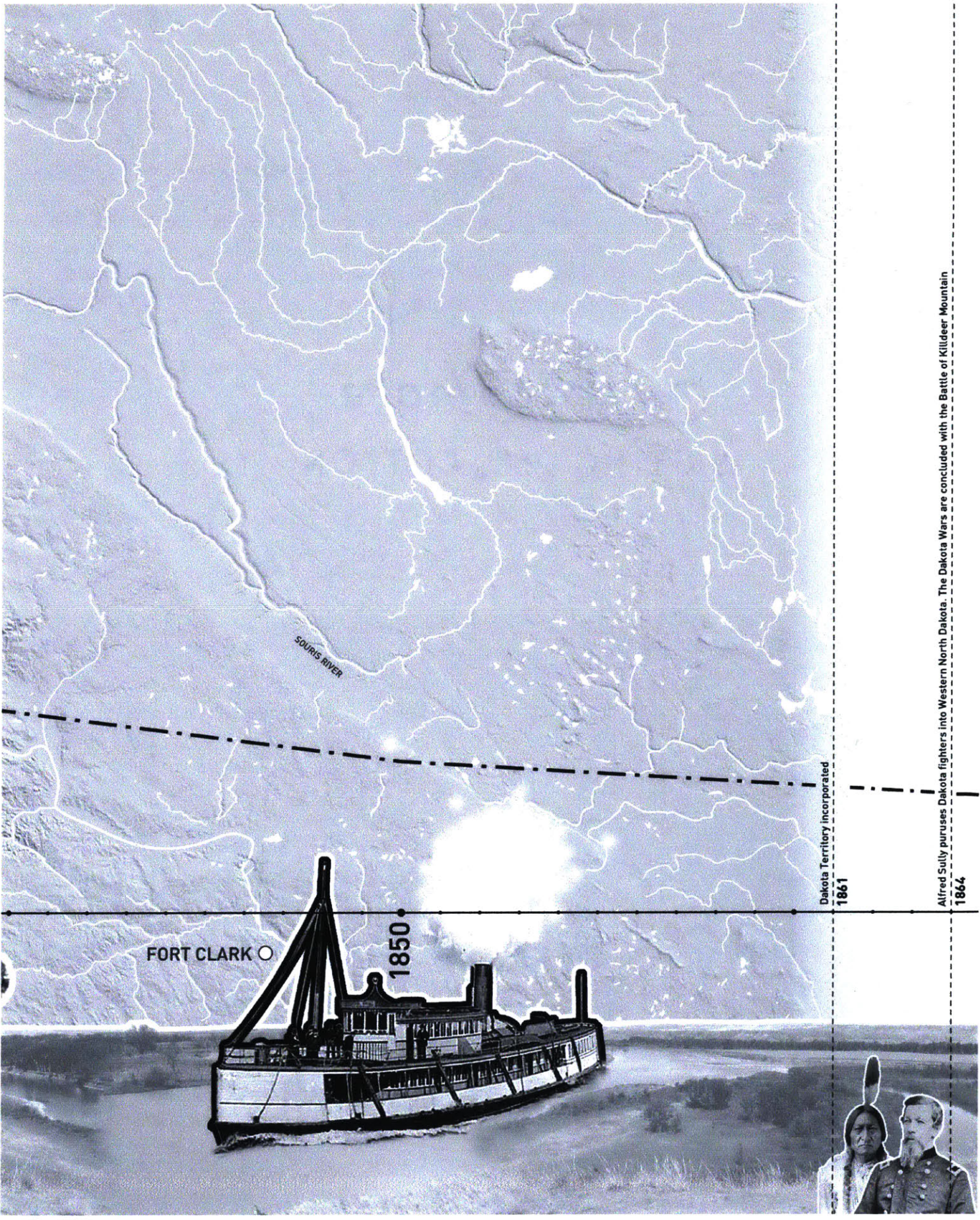
American Fur Company founded by John Jacob Astor in New York City

1808



Transformed again by canoe and steamboat.





SOURIS RIVER

FORT CLARK ○

1850

Dakota Territory incorporated
1861

Alfred Sully pursues Dakota fighters into Western North Dakota. The Dakota Wars are concluded with the Battle of Killdeer Mountain
1864



The land commodified by the railroads

Lucien Smith invents barbed wire in Ohio 1867 Trading post Fort Union dismantled and relocated to help construct military Fort Buford

Fort Berthold Indian Reservation established for the Mandan, Hidatsa, & Arikara Nations 1870

Northern Pacific Railroad reaches eastern bank of the Missouri River at Bismarck, ND 1873

ND founded by Northern Pacific Railroad

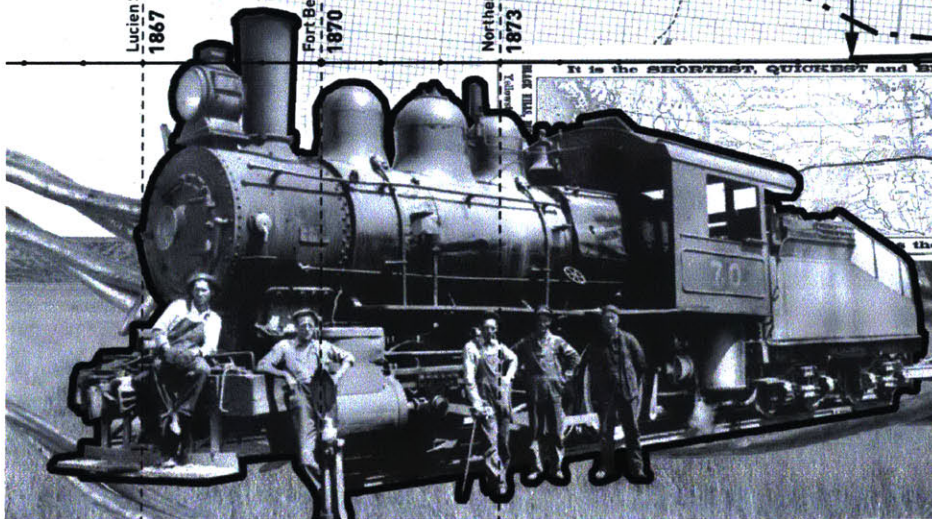
North Dakota becomes the 39th state, Montana the 41st. 1889

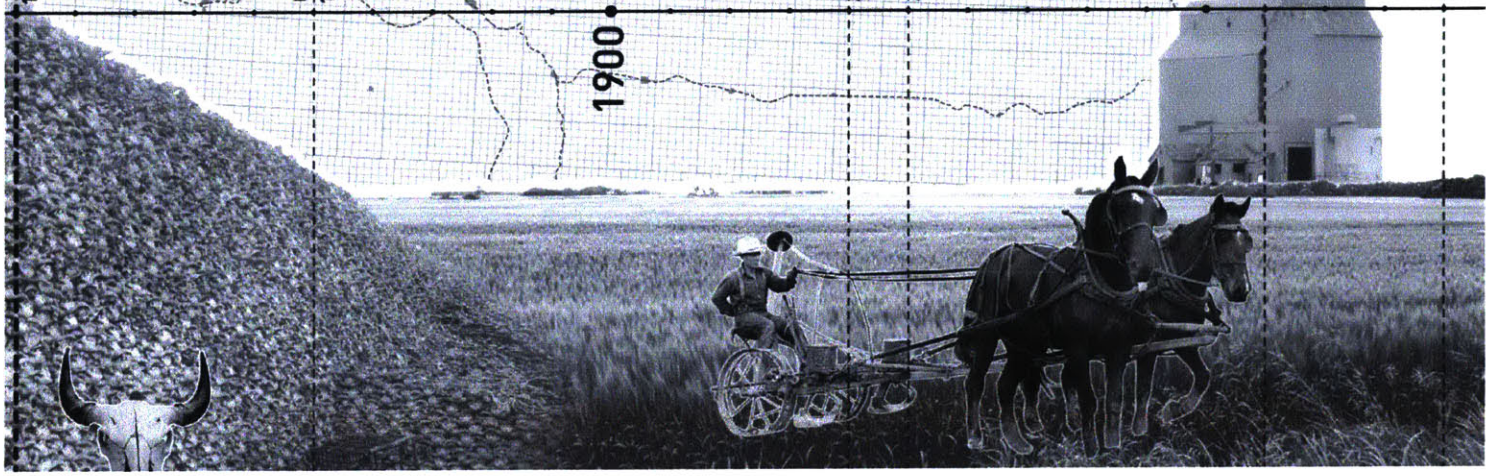
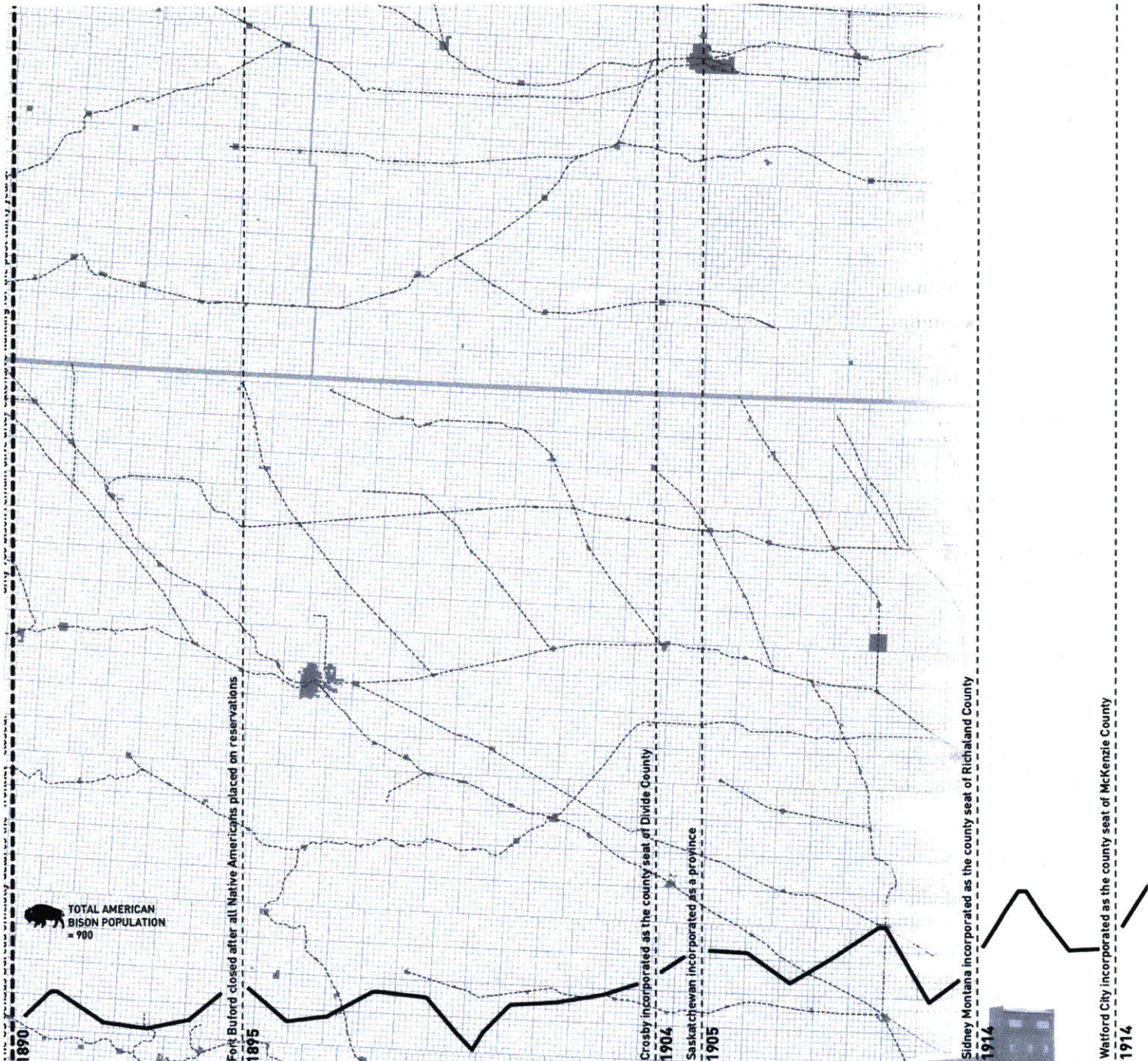
CROSBY

WILLISTON

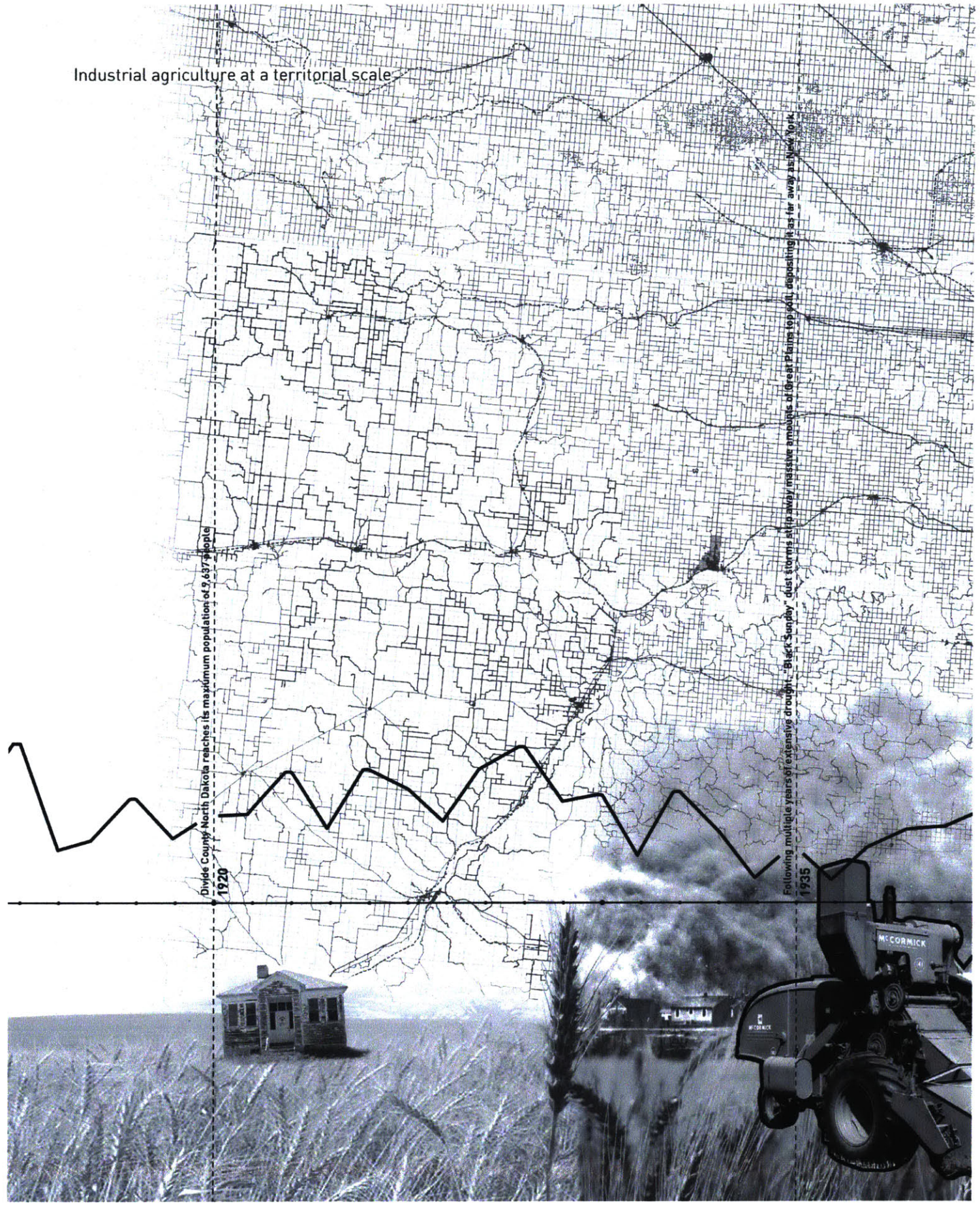
NORTH DAKOTA WHEAT PRODUCTION
40 BUSHELS / YEAR

WATFORD CITY





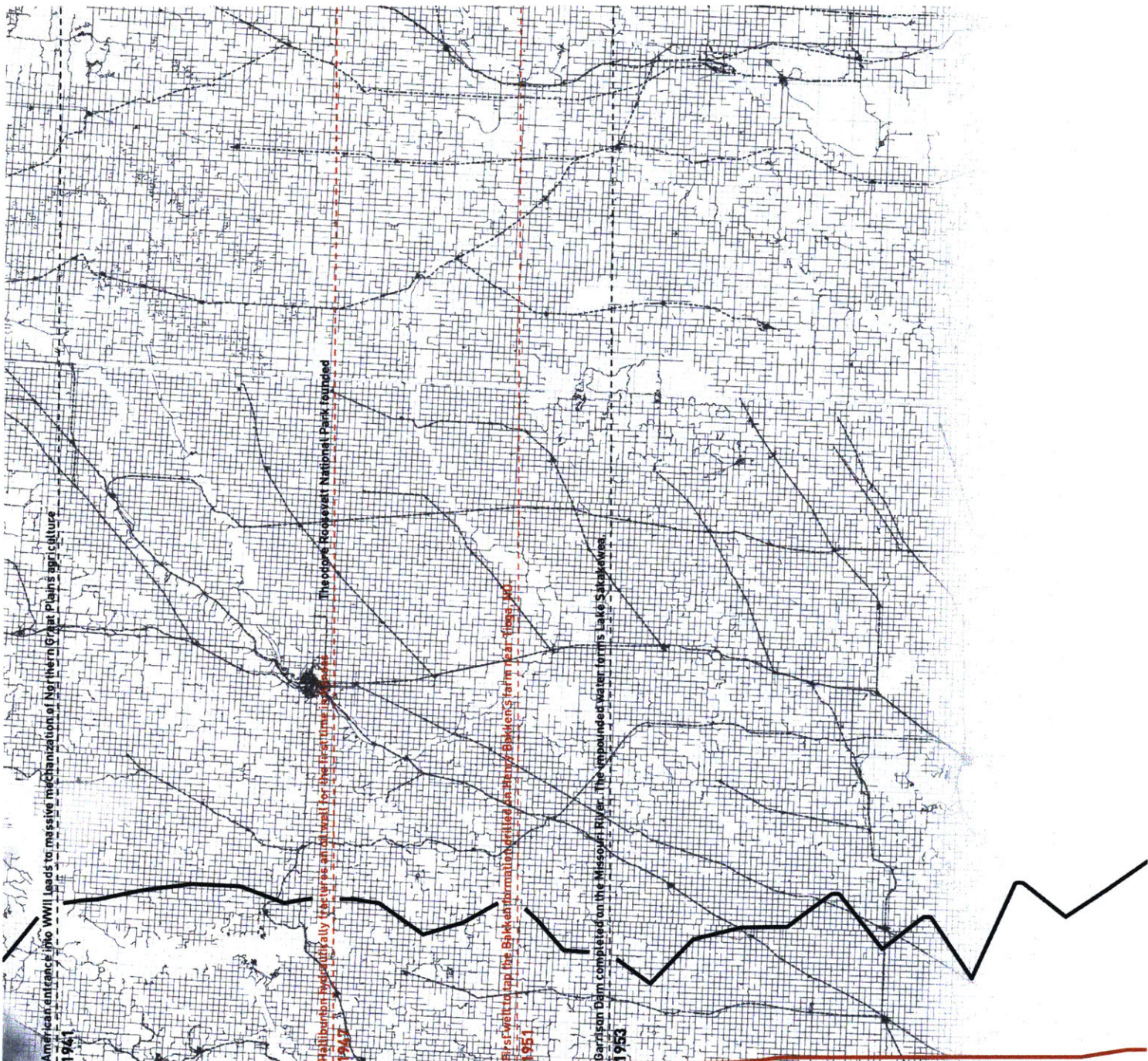
Industrial agriculture at a territorial scale



Divide County North Dakota reaches its maximum population of 9,637 people
1920

Following multiple years of extensive drought, "Black Sunday" dust storms strip away massive amounts of Great Plains top soil, depositing it as far away as New York
1935

MCCORMICK



American entrance into WWII leads to massive mechanization of Northern Great Plains agriculture
1941

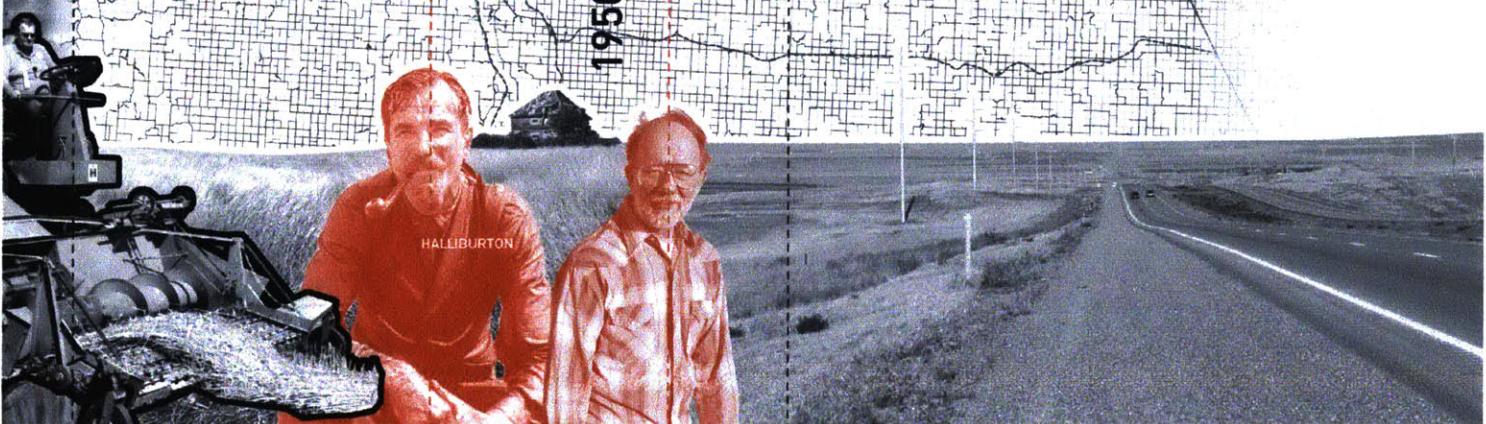
Halliburton systematically fractures and seals for the first time its wells
1947

Theodore Roosevelt National Park founded

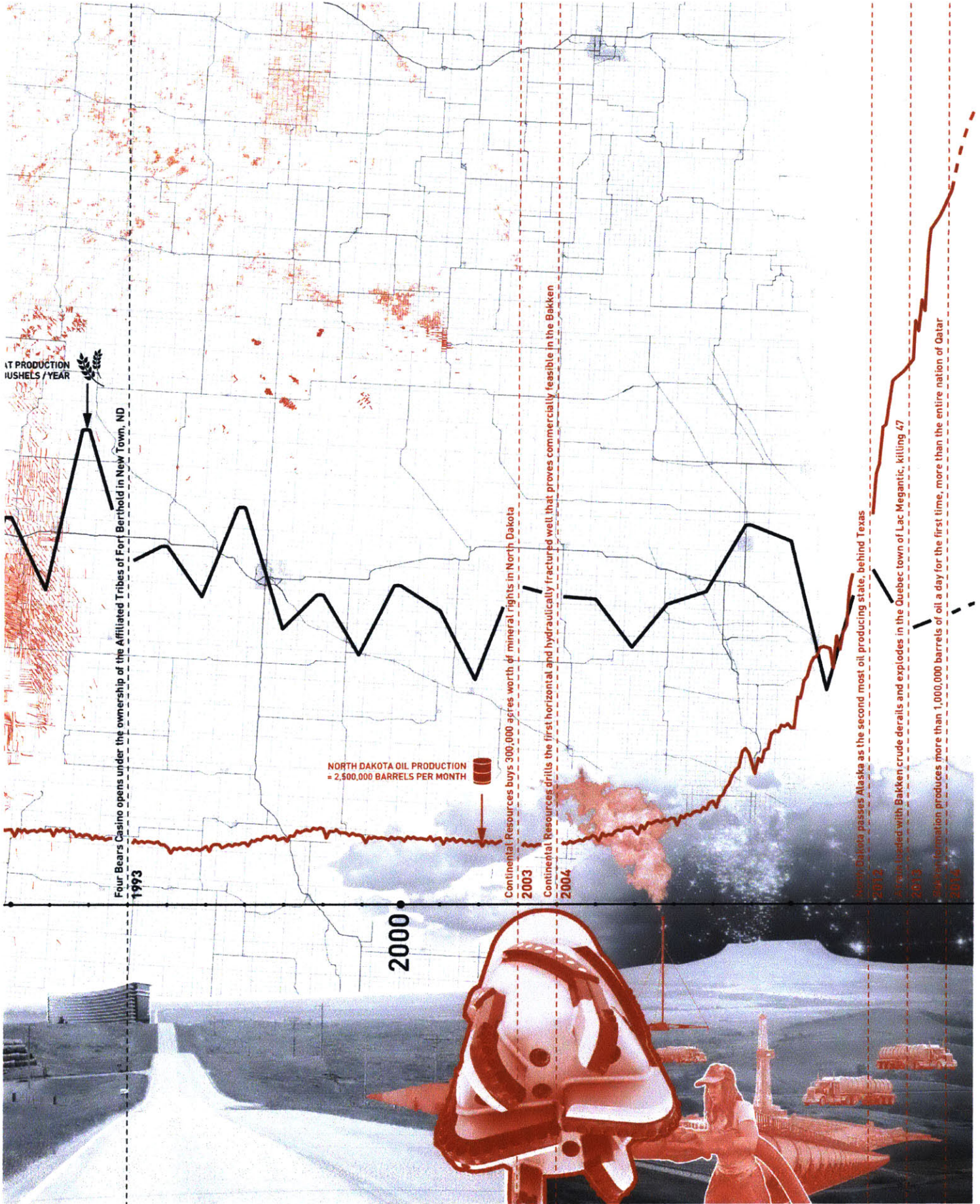
First well to tap the Bakken formation drilled as Henry Bakken's farm near Fargo, ND
1951

Barrison Dam completed on the Missouri River. The impounded water forms Lake Sakakawea.
1953

1950

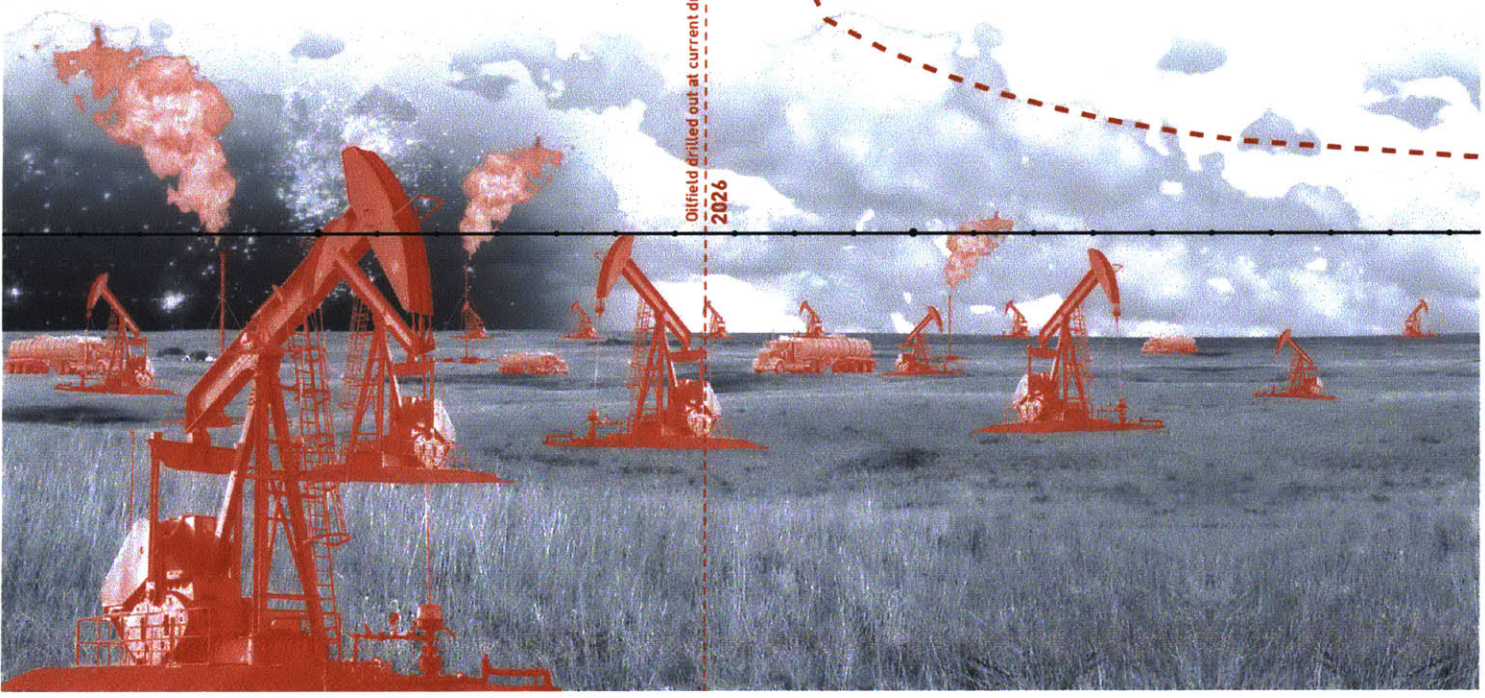
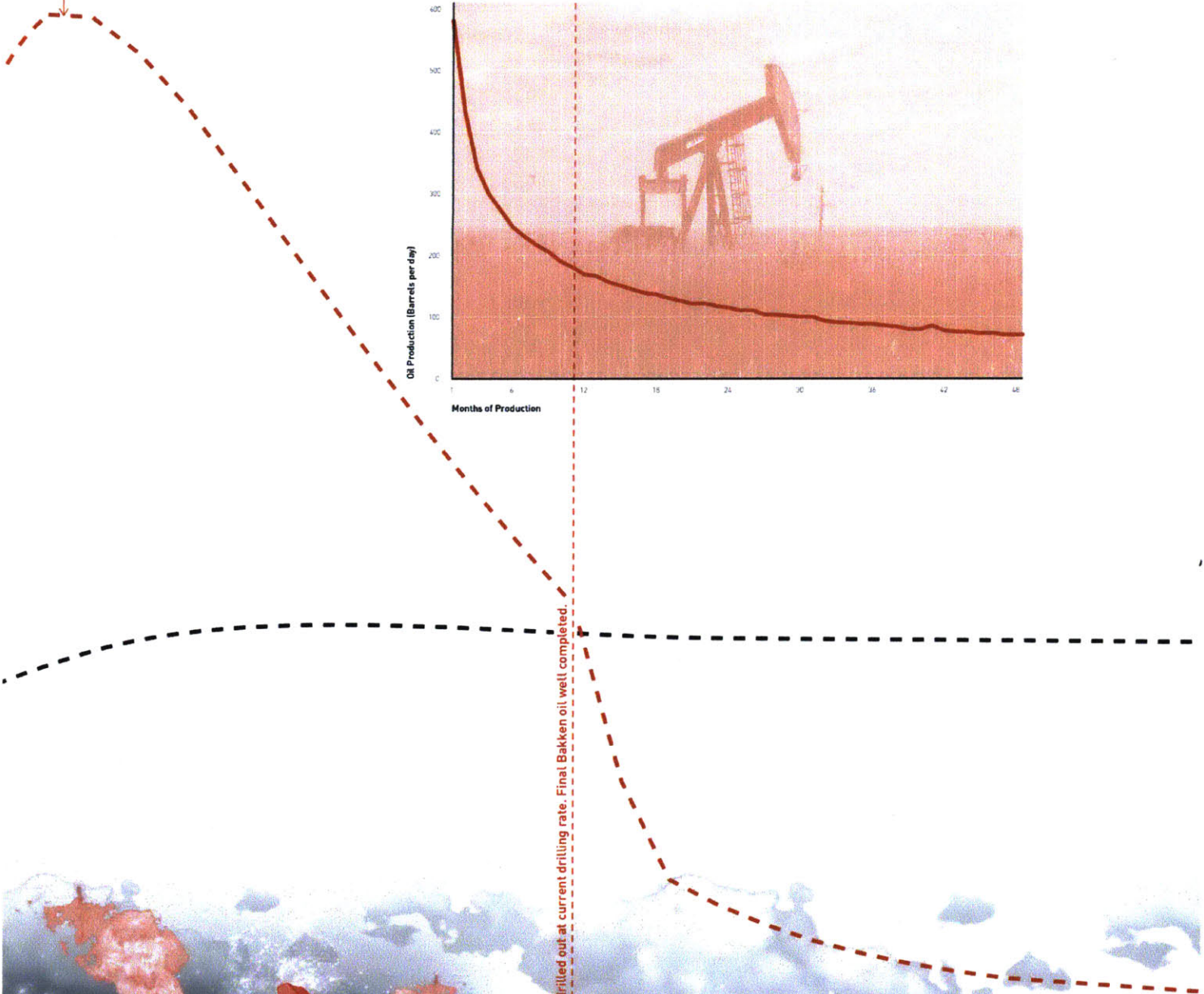
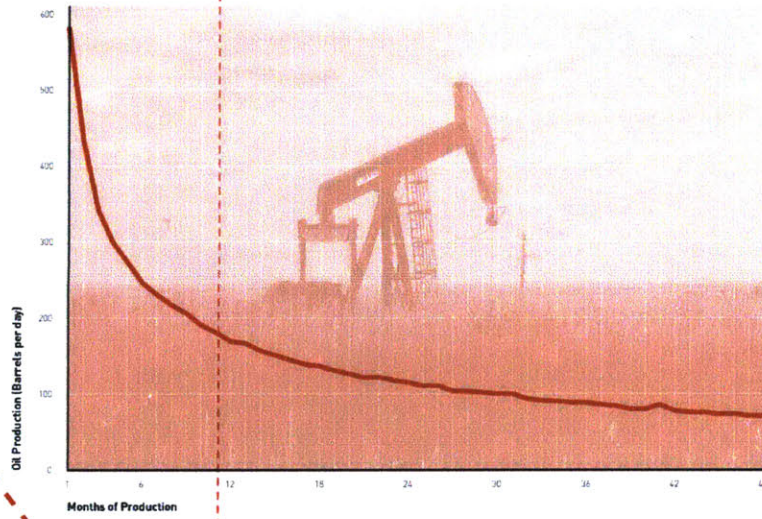


HALLIBURTON



PROBABLE MAX NORTH DAKOTA OIL PRODUCTION
= 30,000,000 BARRELS PER MONTH

Typical Bakken Oil Well Production



Oilfield drilled out at current drilling rate. Final Bakken oil well completed.
2026

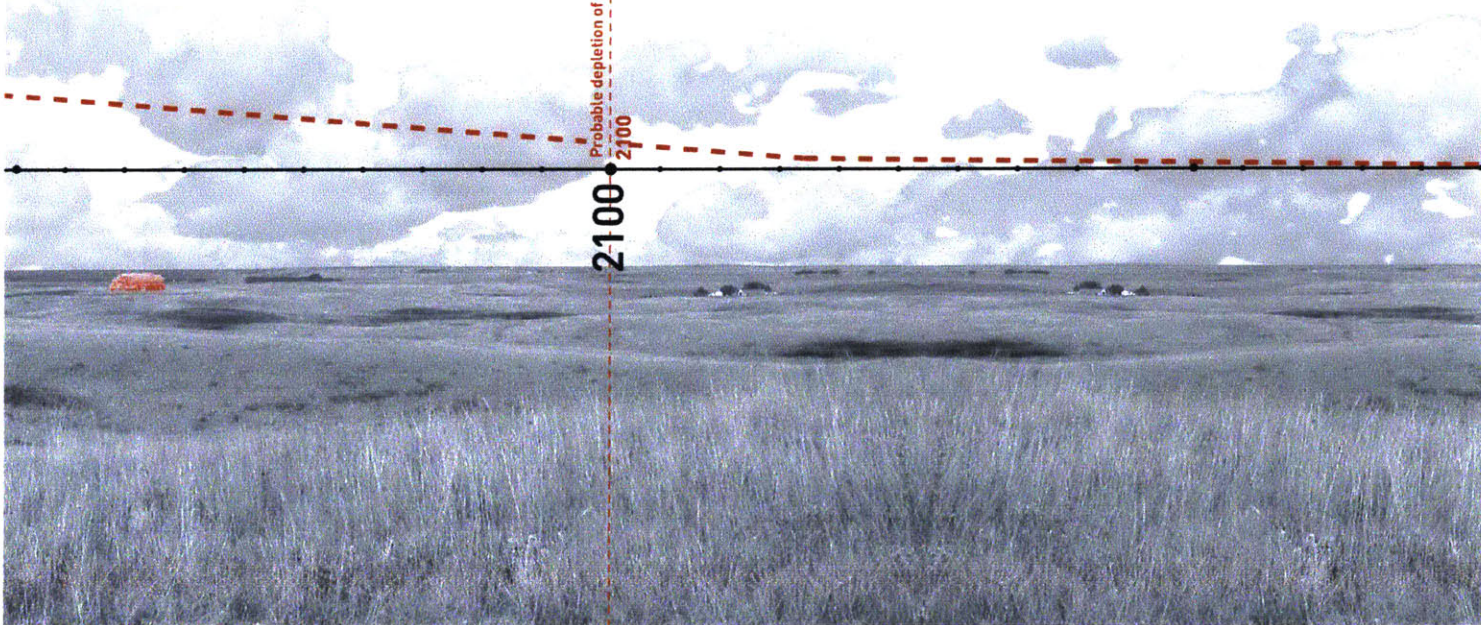
The oil crash, and the emptiness after.
What would a true reckoning with logics of oil extraction entail?

AGRICULTURAL PRODUCTION WILL CONTINUE
TO VARY WITH WEATHER AND INVESTMENT

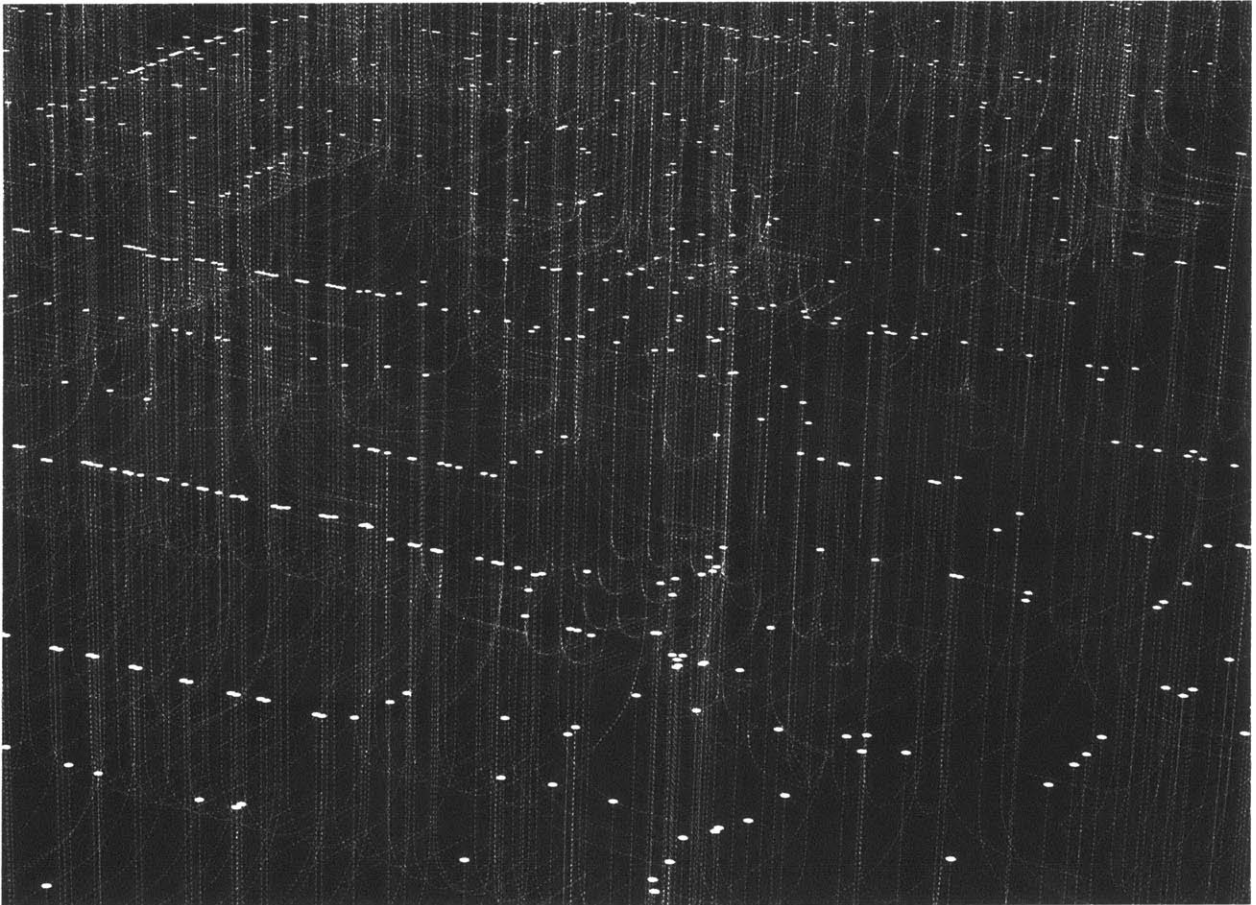





Probable depletion of the Bakken formation, assuming current production rates and mean total volume estimates

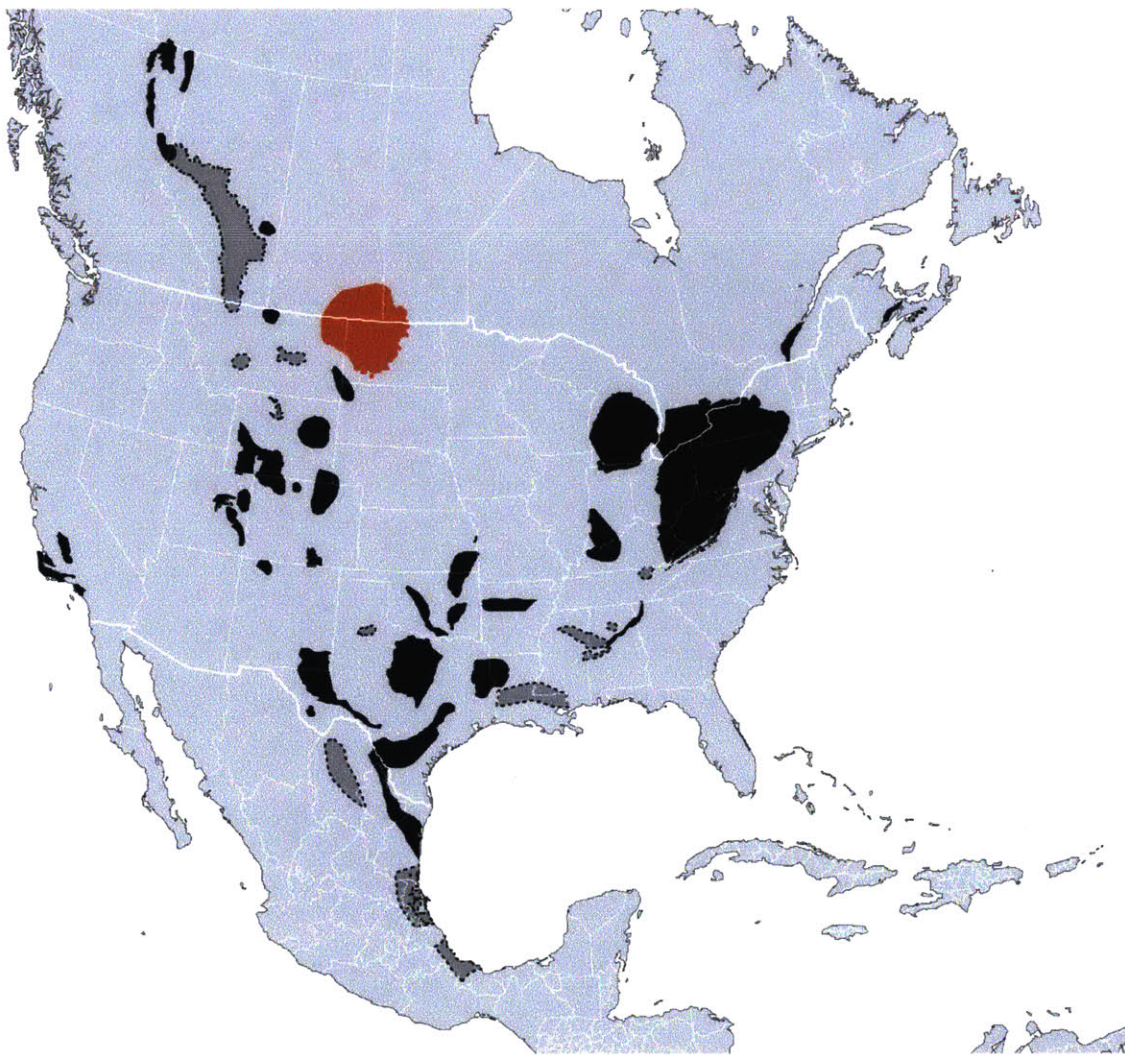
2100
2400

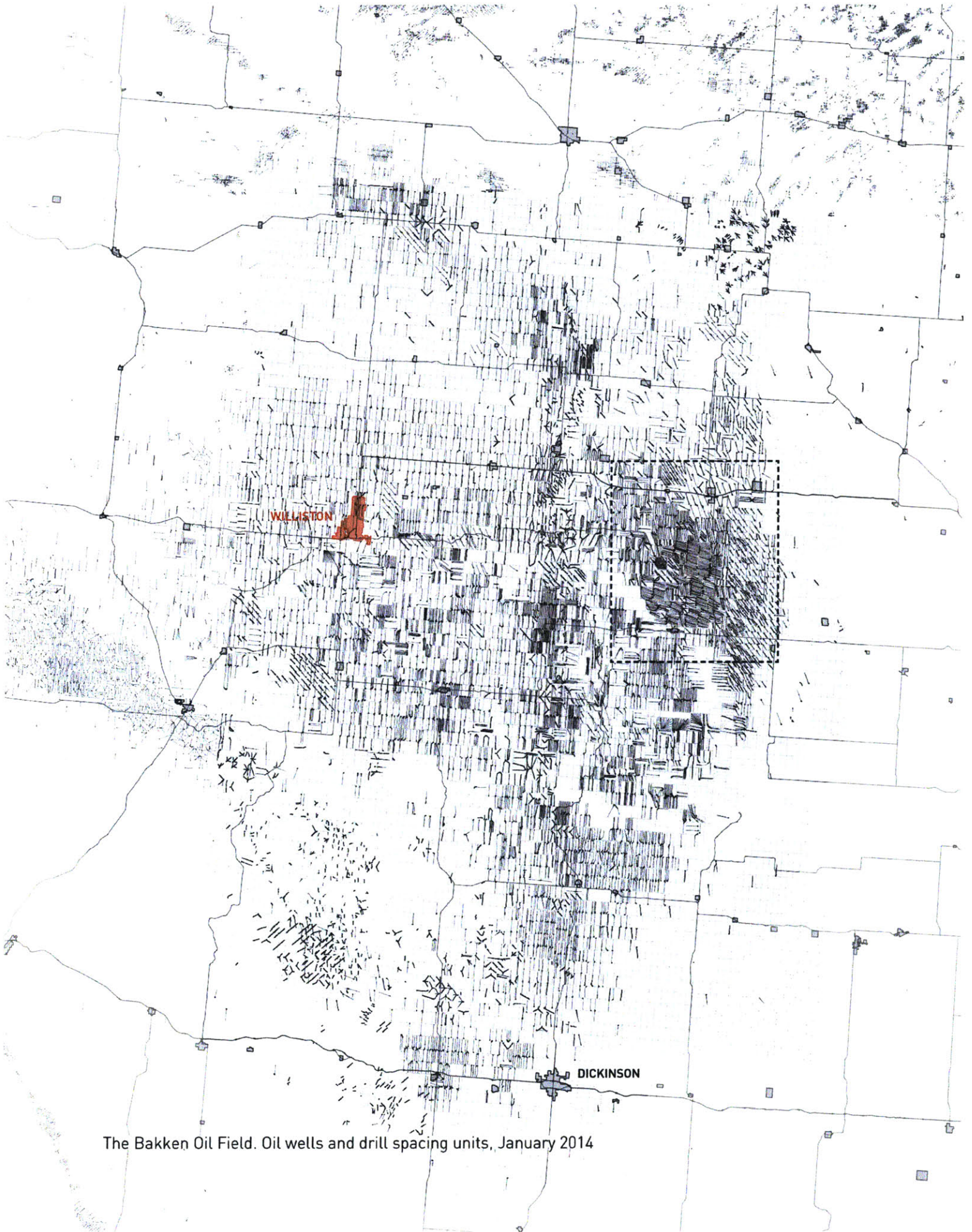


TERRITORY OF EXTRACTION



-  Oil and gas shale territories in production
-  Oil and gas shale territories likely to be developed in the near future
-  Extent of the Bakken Shale

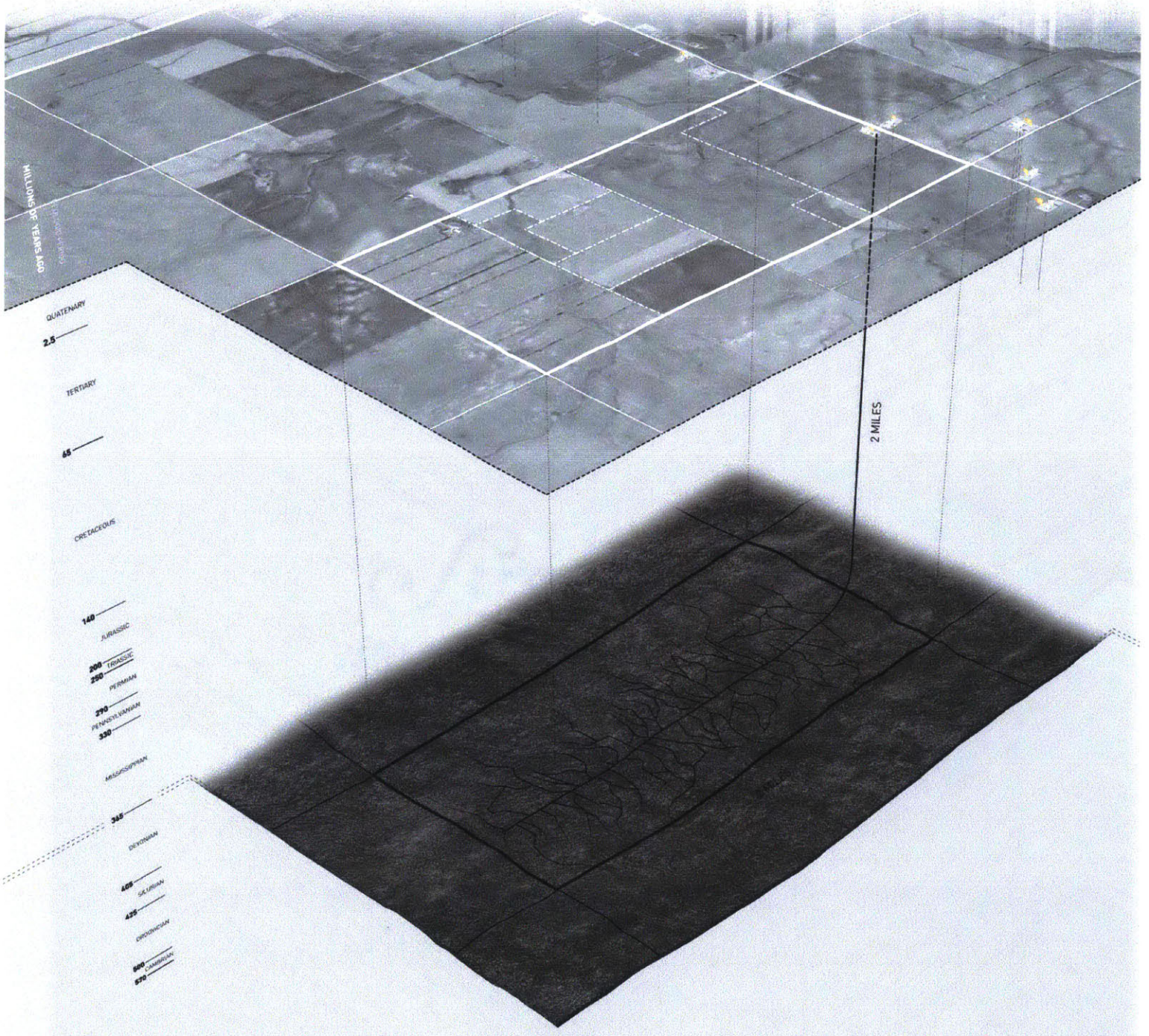




The Bakken Oil Field. Oil wells and drill spacing units, January 2014



The Parshall section of the Bakken Oil Field, the most productive region of the field.



Typical Bakken Oil well. Mining a 360 million year old sea bed two miles beneath the surface.

2X

The population of Williston, North Dakota has more than doubled since the 2010 census.

\$2,394

The cost per month of a 700 SF apartment in Williston.

The same apartment would cost \$1,527 in Boston, \$1,504 in NYC, or \$1,411 in LA.

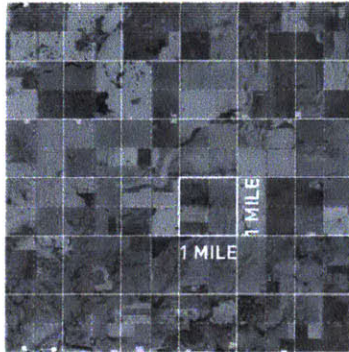
#2

Rank, behind Texas, of North Dakota's annual oil production in the US.



Boom town development outside Watford City

PUBLIC LAND SURVEY SYSTEM



1 TOWNSHIP: 36 SQUARE MILES
36 SECTIONS : 1 SQUARE MILE
144 QUARTER SECTIONS : 40 ACRES

A 3D block representing land from 1880-1910. The top surface is a dark grid of small squares, representing a subdivided prairie. The block is light blue and has dashed lines indicating its edges.

1880-1910

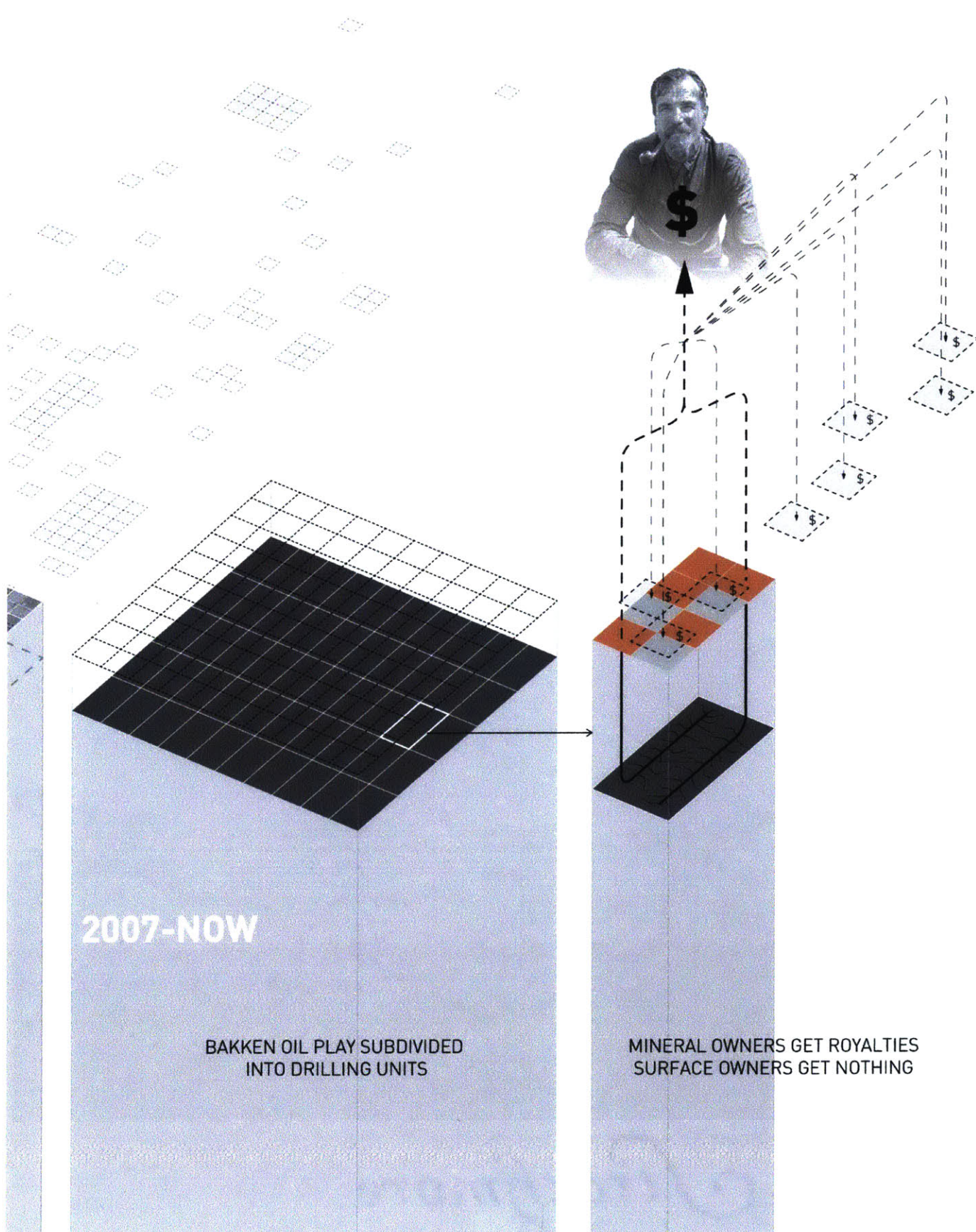
PRAIRIE SUBDIVIDED AND SOLD
BY RAILROAD COMPANIES

A 3D block representing land from 1900-2007. The top surface is a dark grid of small squares. Several squares are highlighted in a lighter color, and arrows point from these squares to a cluster of similar squares floating above the block, representing mineral rights being sold off piecemeal.

1900-2007

MINERAL RIGHTS SOLD OFF
PIECEMEAL BY FARMERS TO RAISE CASH

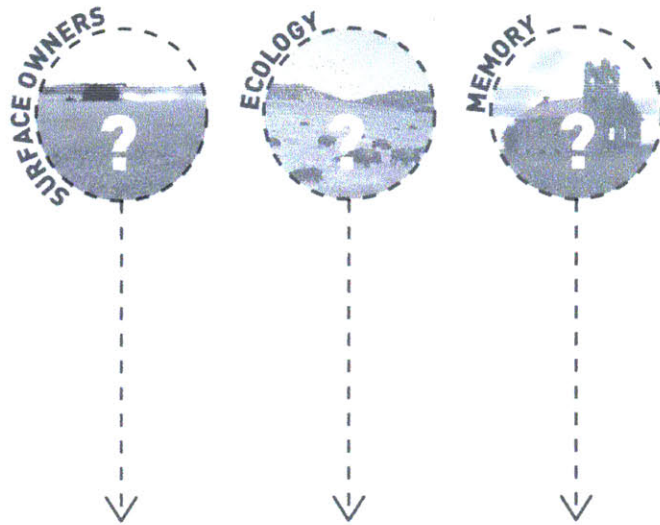
The inevitable conflict between separated surface rights and mineral rights.



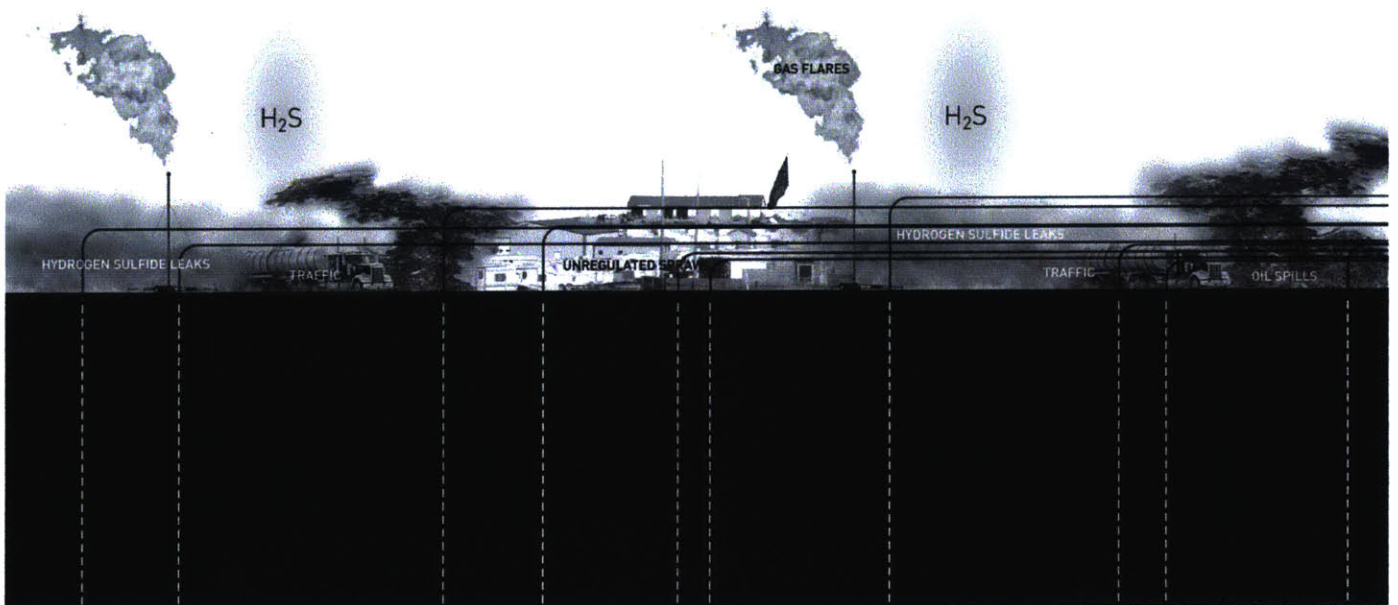
2007-NOW

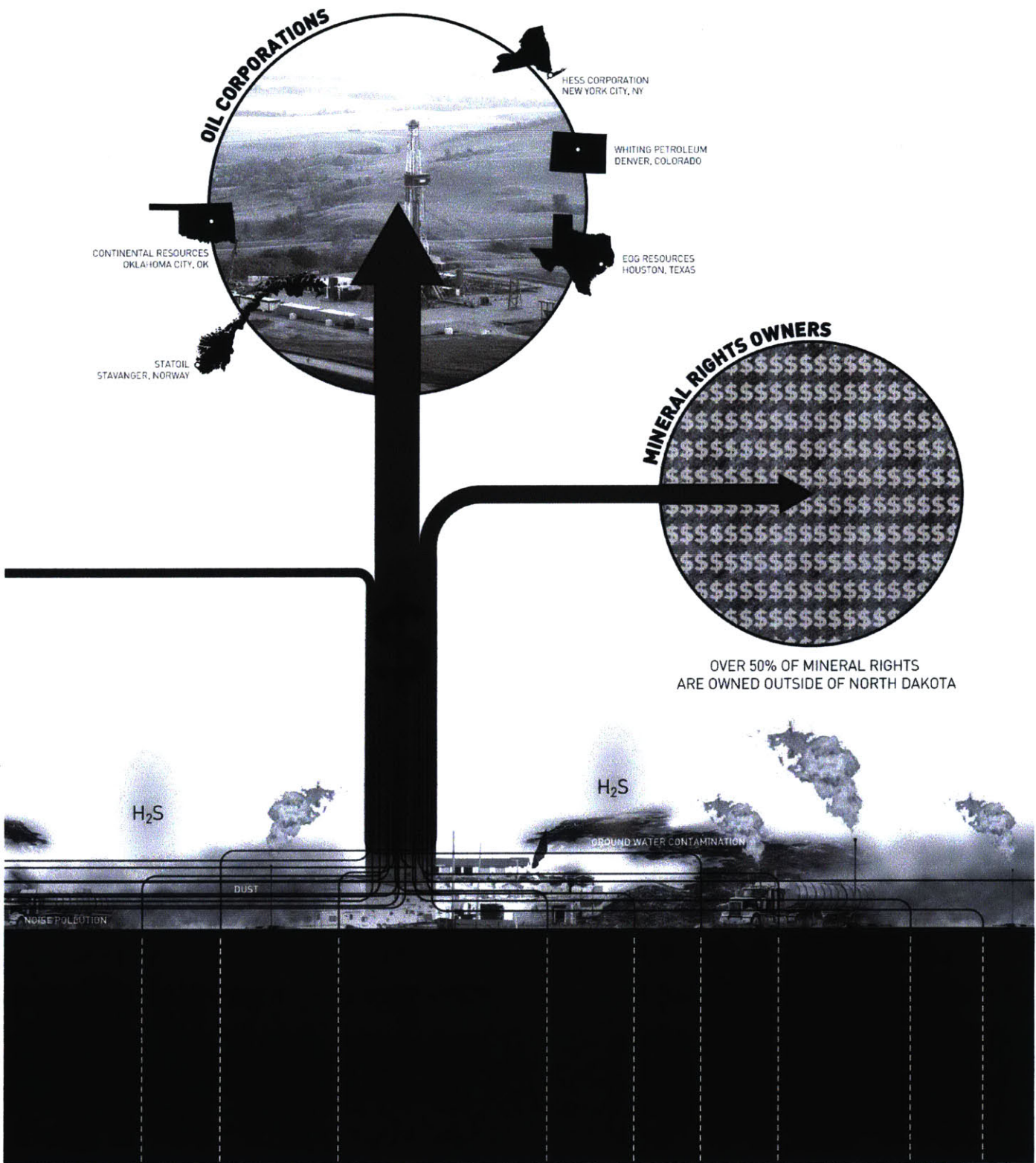
BAKKEN OIL PLAY SUBDIVIDED
INTO DRILLING UNITS

MINERAL OWNERS GET ROYALTIES
SURFACE OWNERS GET NOTHING



MOST NEW WORKERS ARE TEMPORARY WITH PERMANENT HOMES AND FAMILIES ELSEWHERE





OIL CORPORATIONS

HESS CORPORATION
NEW YORK CITY, NY

WHITING PETROLEUM
DENVER, COLORADO

EOG RESOURCES
HOUSTON, TEXAS

CONTINENTAL RESOURCES
OKLAHOMA CITY, OK

STATOIL
STAVANGER, NORWAY

MINERAL RIGHTS OWNERS

OVER 50% OF MINERAL RIGHTS
ARE OWNED OUTSIDE OF NORTH DAKOTA

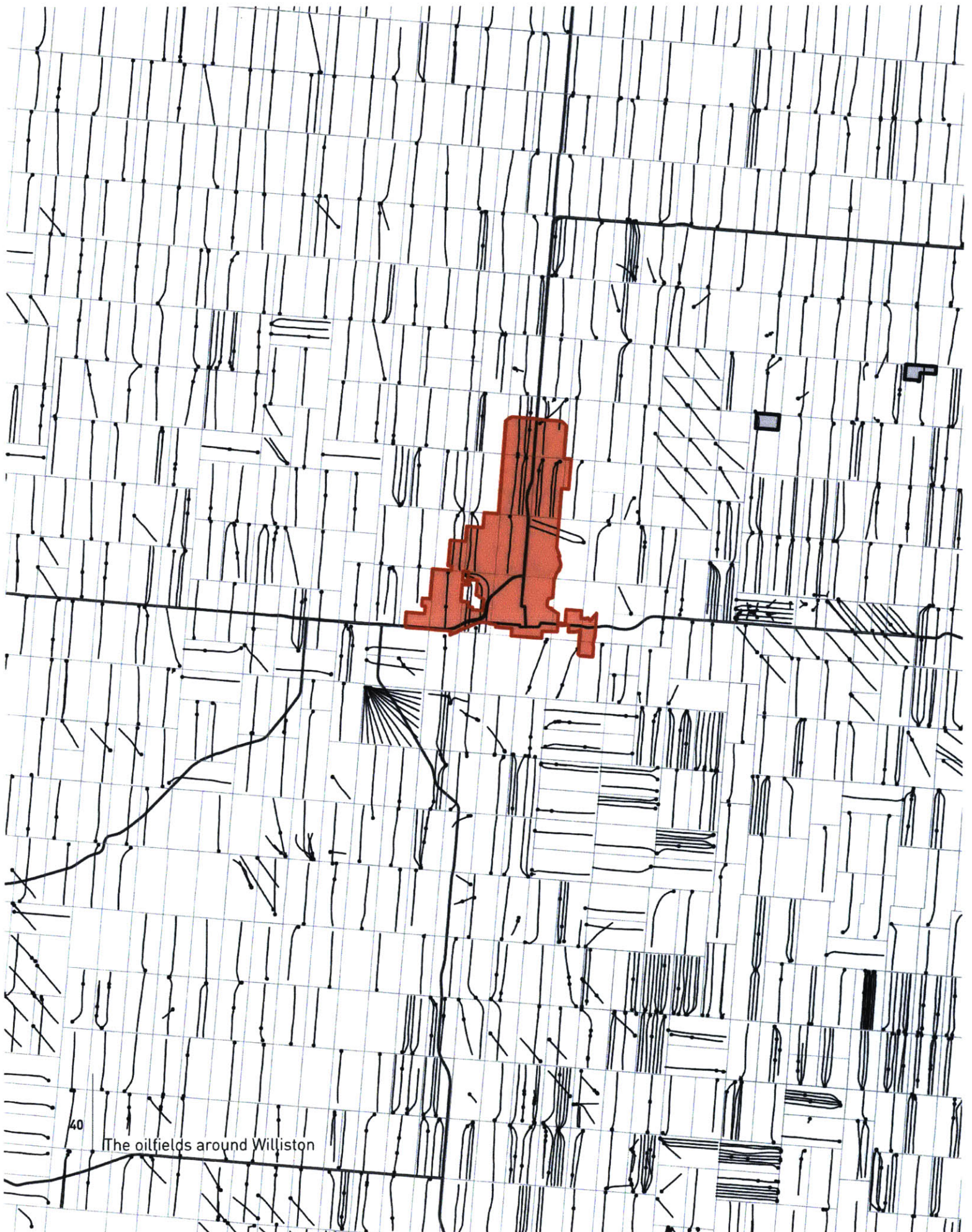
H₂S

H₂S

GROUND WATER CONTAMINATION

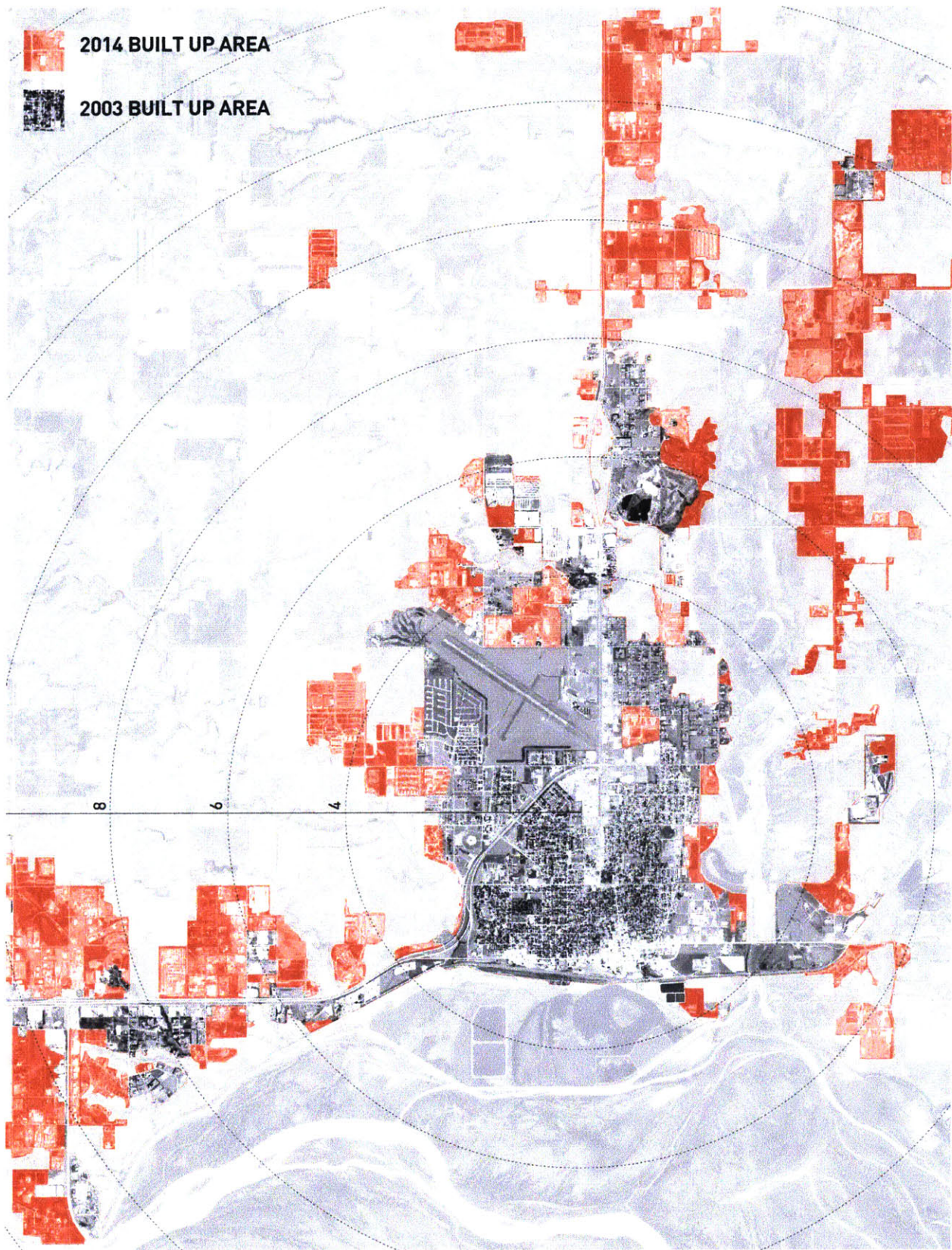
DUST

NOISE POLLUTION

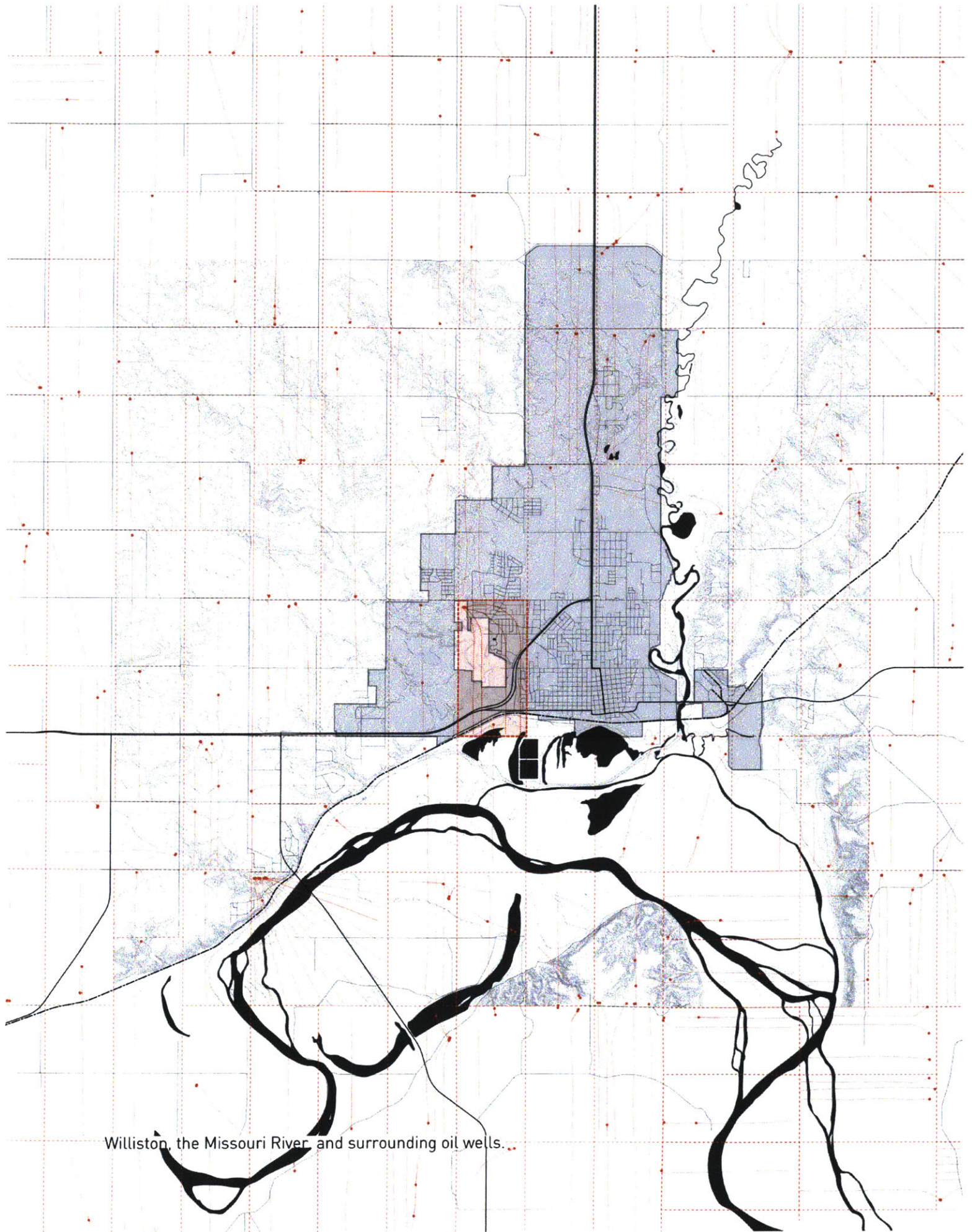


40

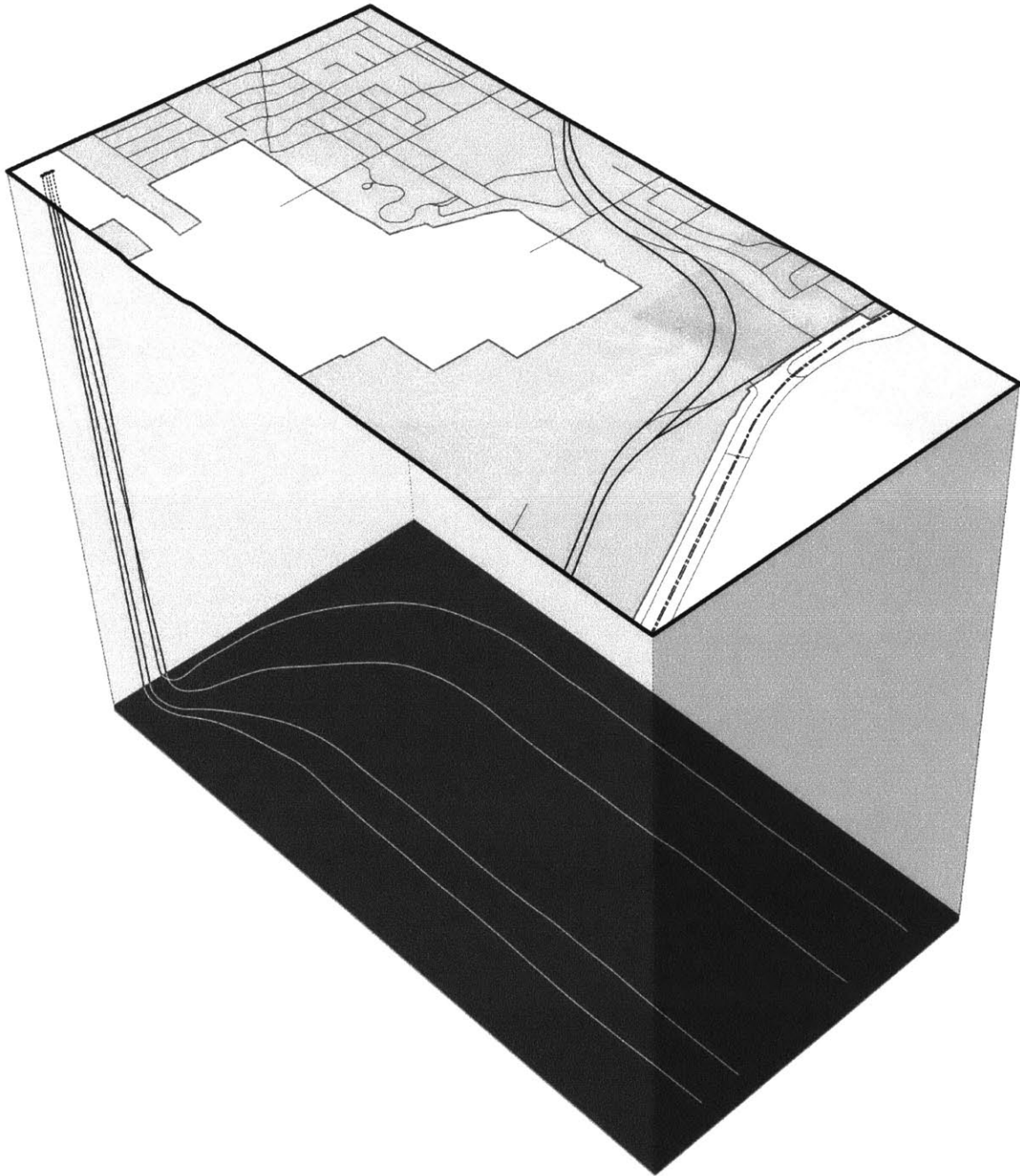
The oilfields around Williston



Williston sprawl since 2003



Williston, the Missouri River and surrounding oil wells.

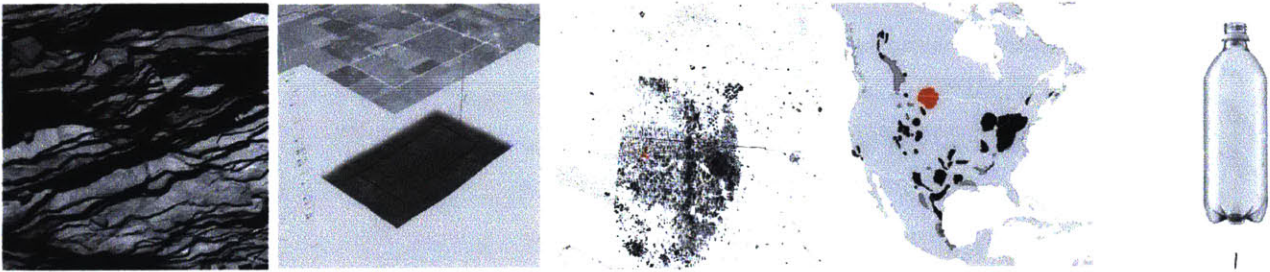


The project site: an existing drill spacing unit, with four active wells owned by Statoil

TIME CAPSULE

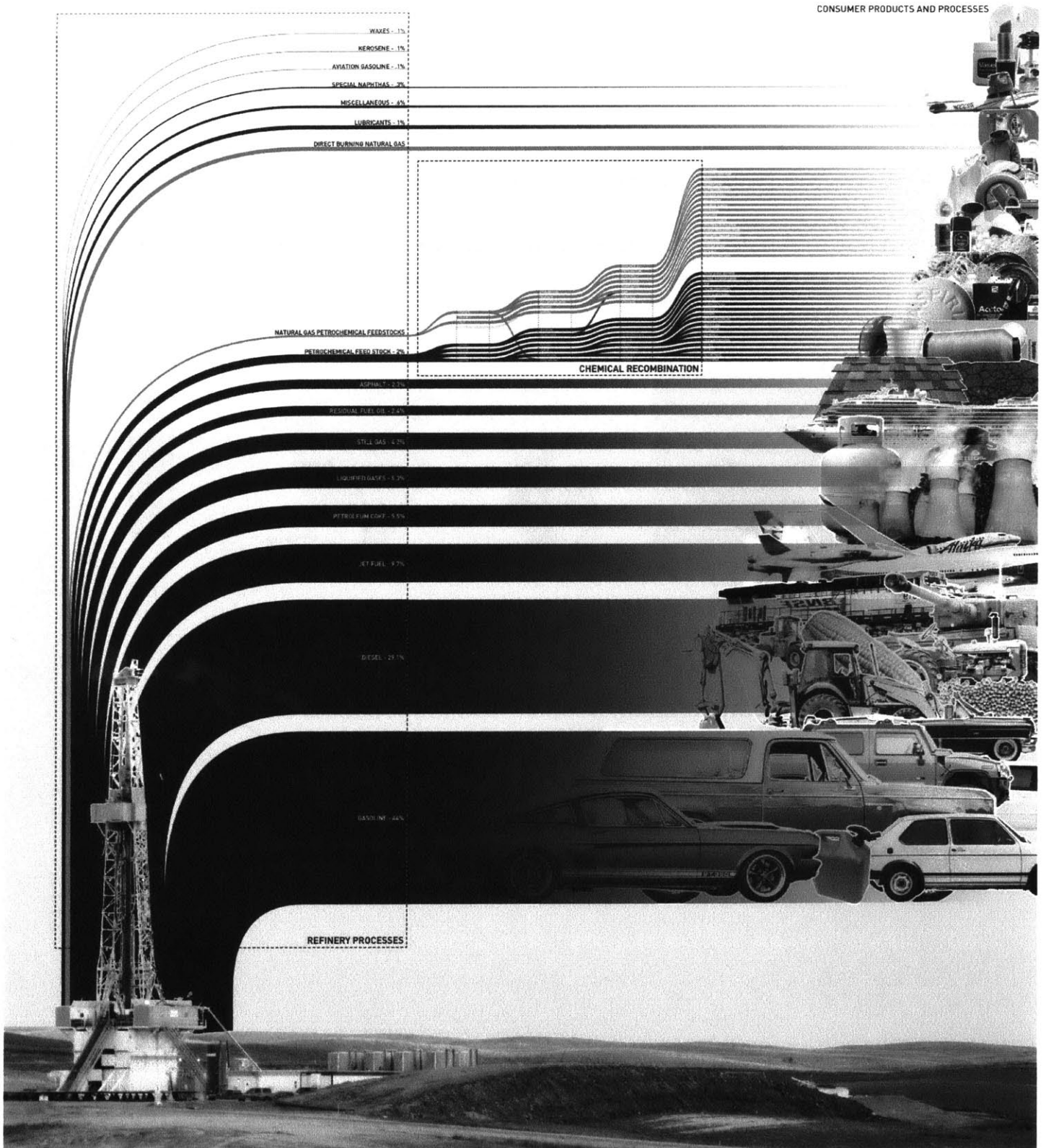


The one way trajectory of shale to consumer product;
territorial scale logistics reduced to a throw away item.

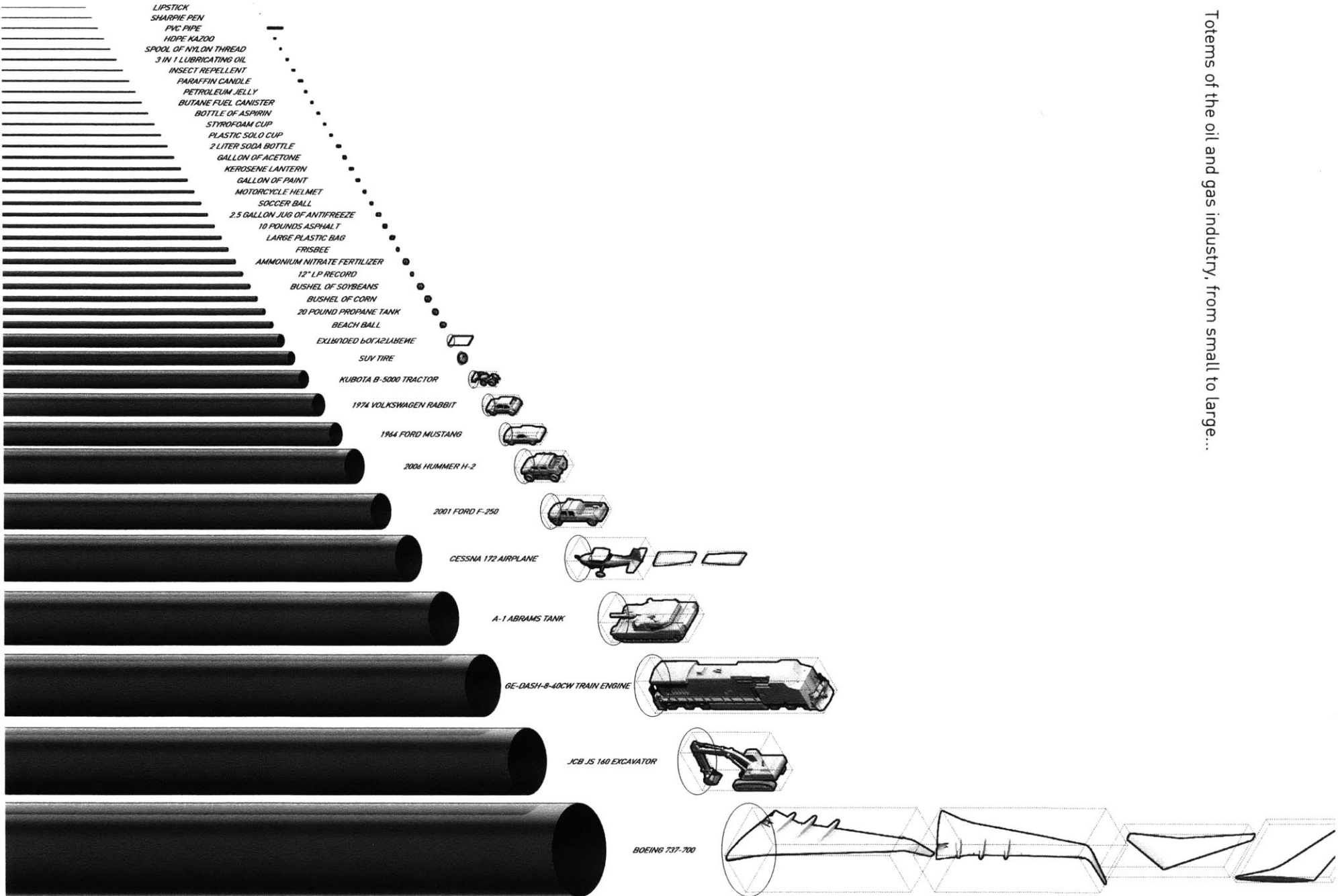


Collapsing consumption back into the site of extraction.

Extraction to consumption: the oil and gas refinery process.



Totems of the oil and gas industry, from small to large...



... buried back in the place they came from.

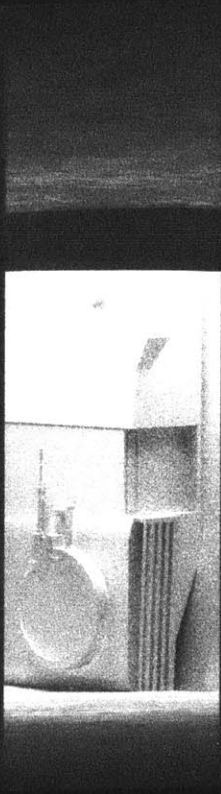
Tube of Lipstick



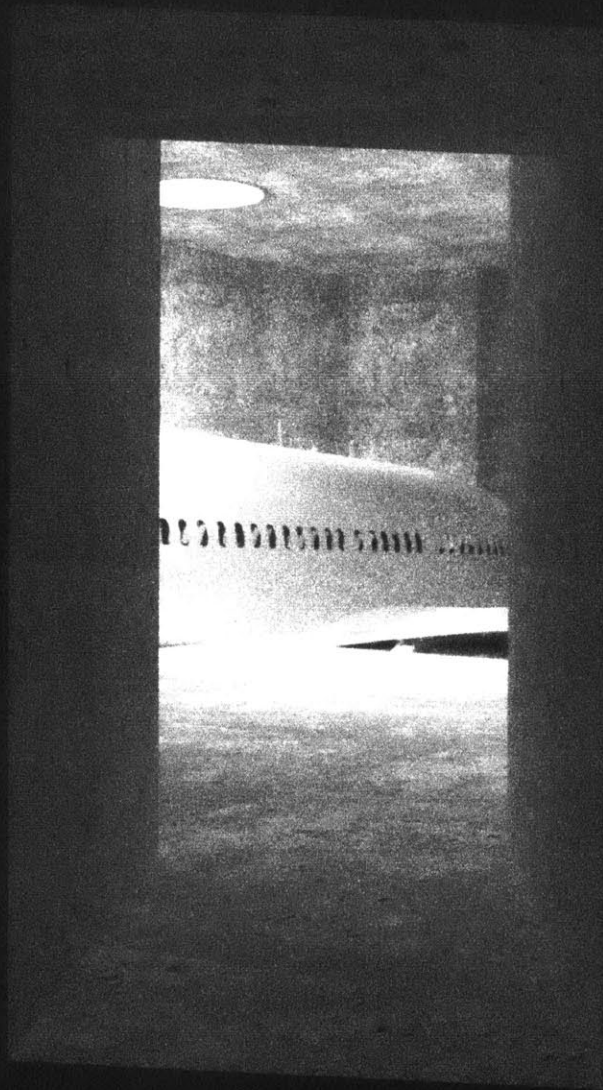
Vinyl Beach Ball

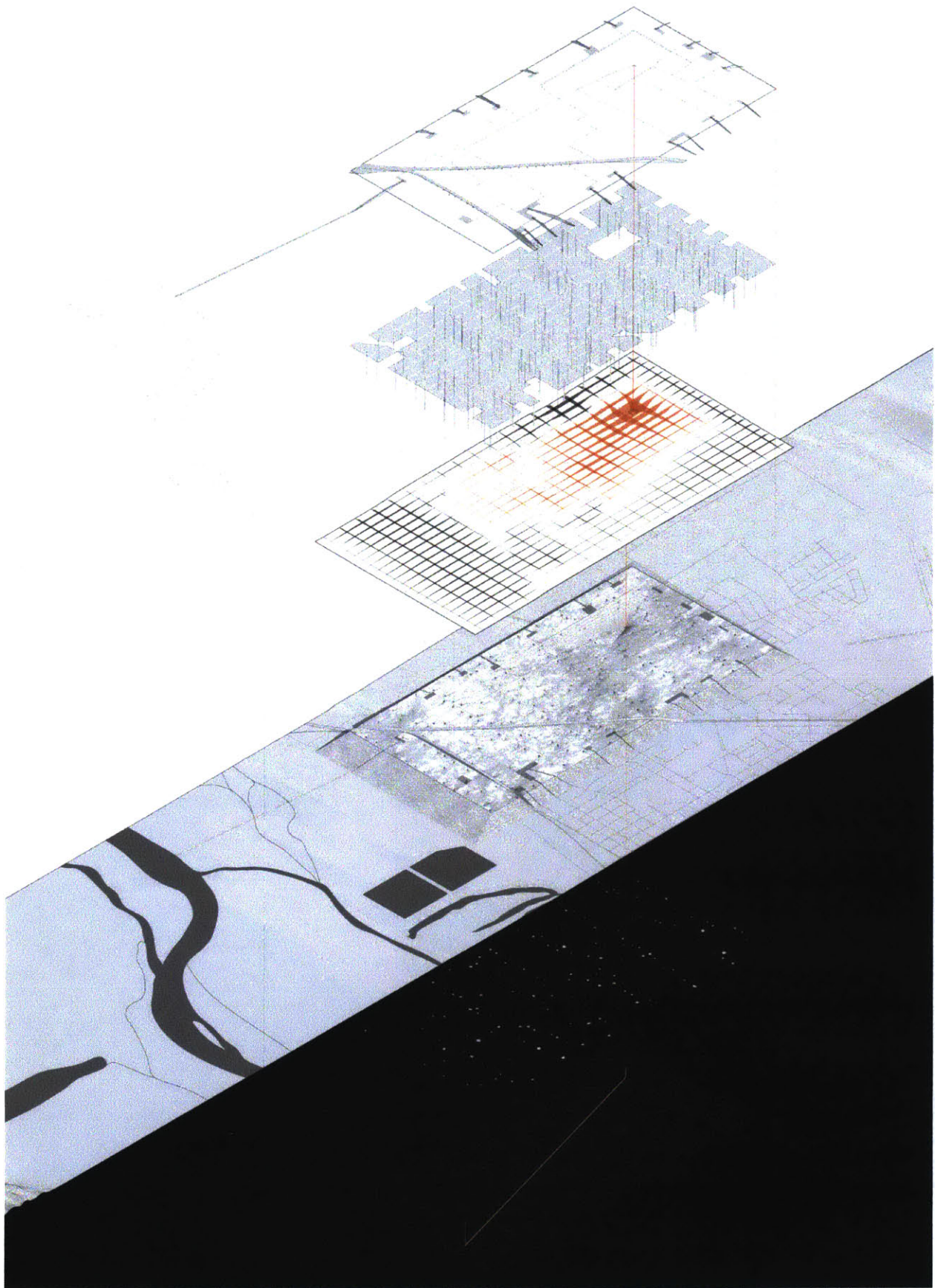


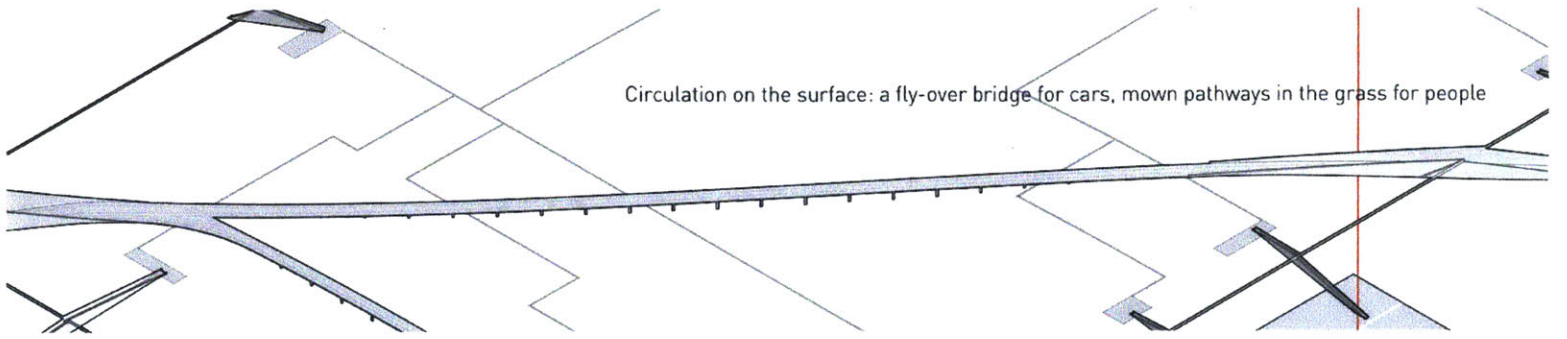
M1 Abrams Tank



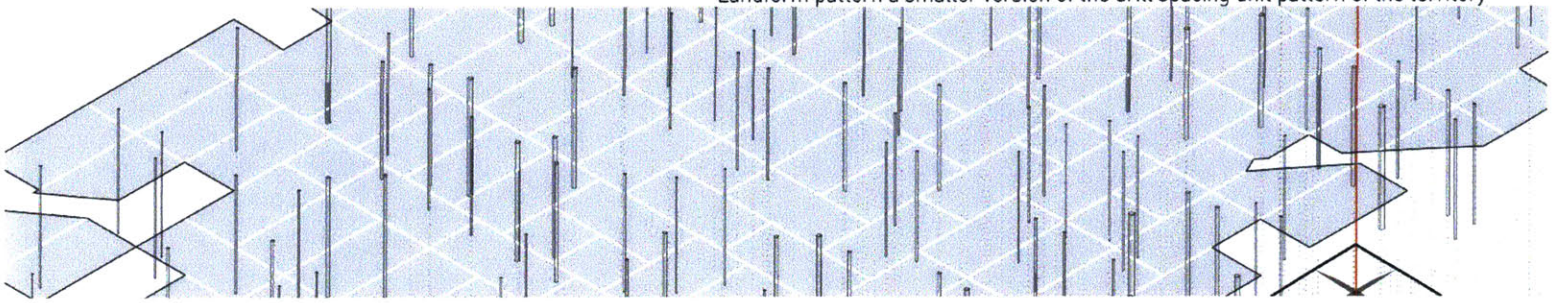
767 - 600 Jet



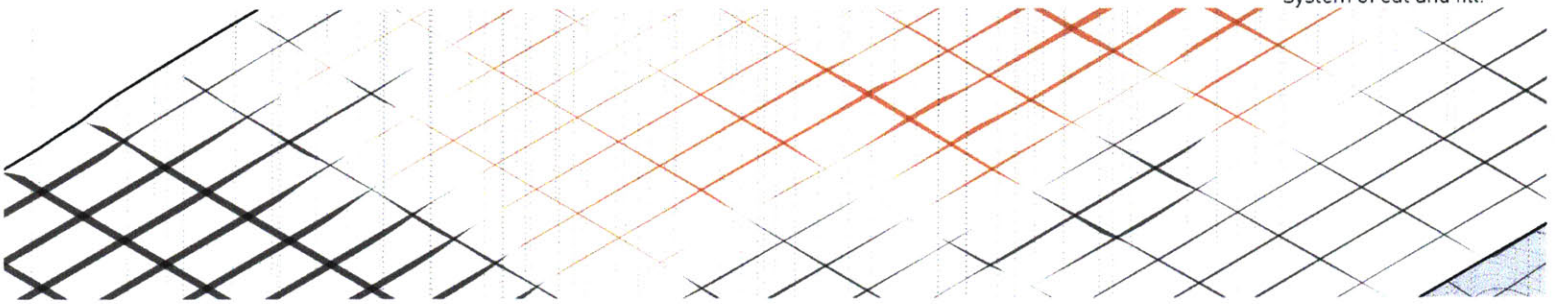




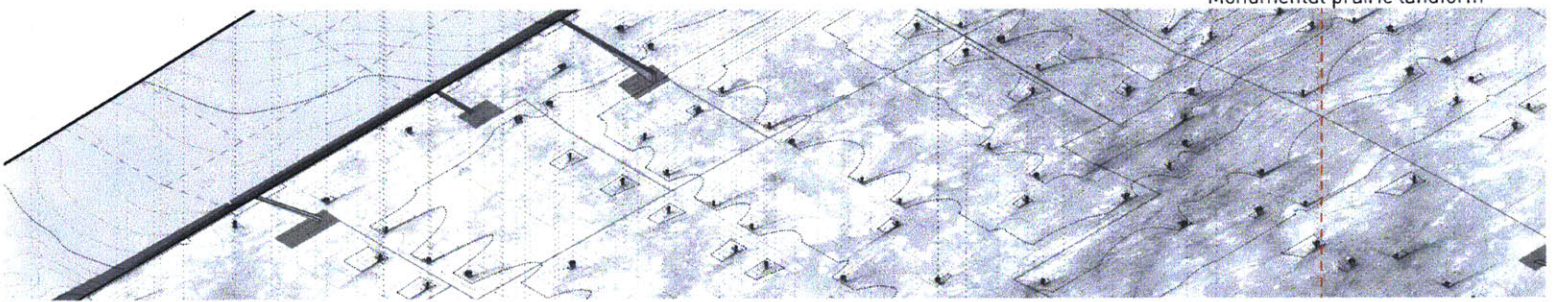
Circulation on the surface: a fly-over bridge for cars, mown pathways in the grass for people



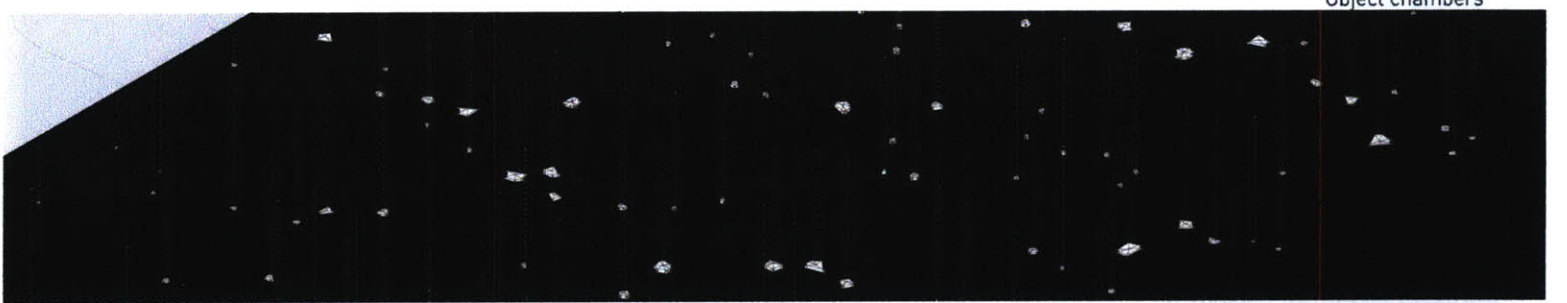
Landform pattern a smaller version of the drill spacing unit pattern of the territory



System of cut and fill.



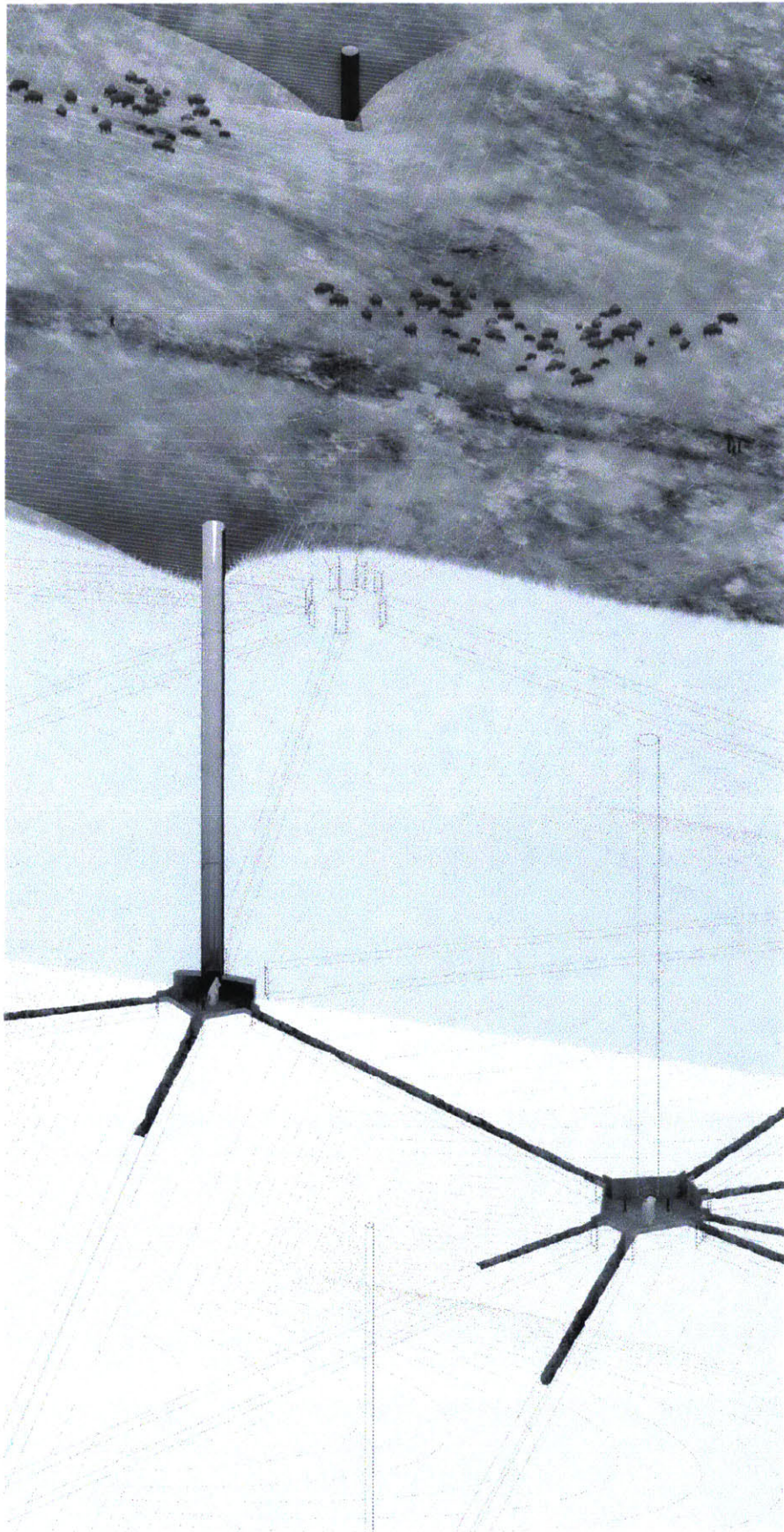
Monumental prairie landform

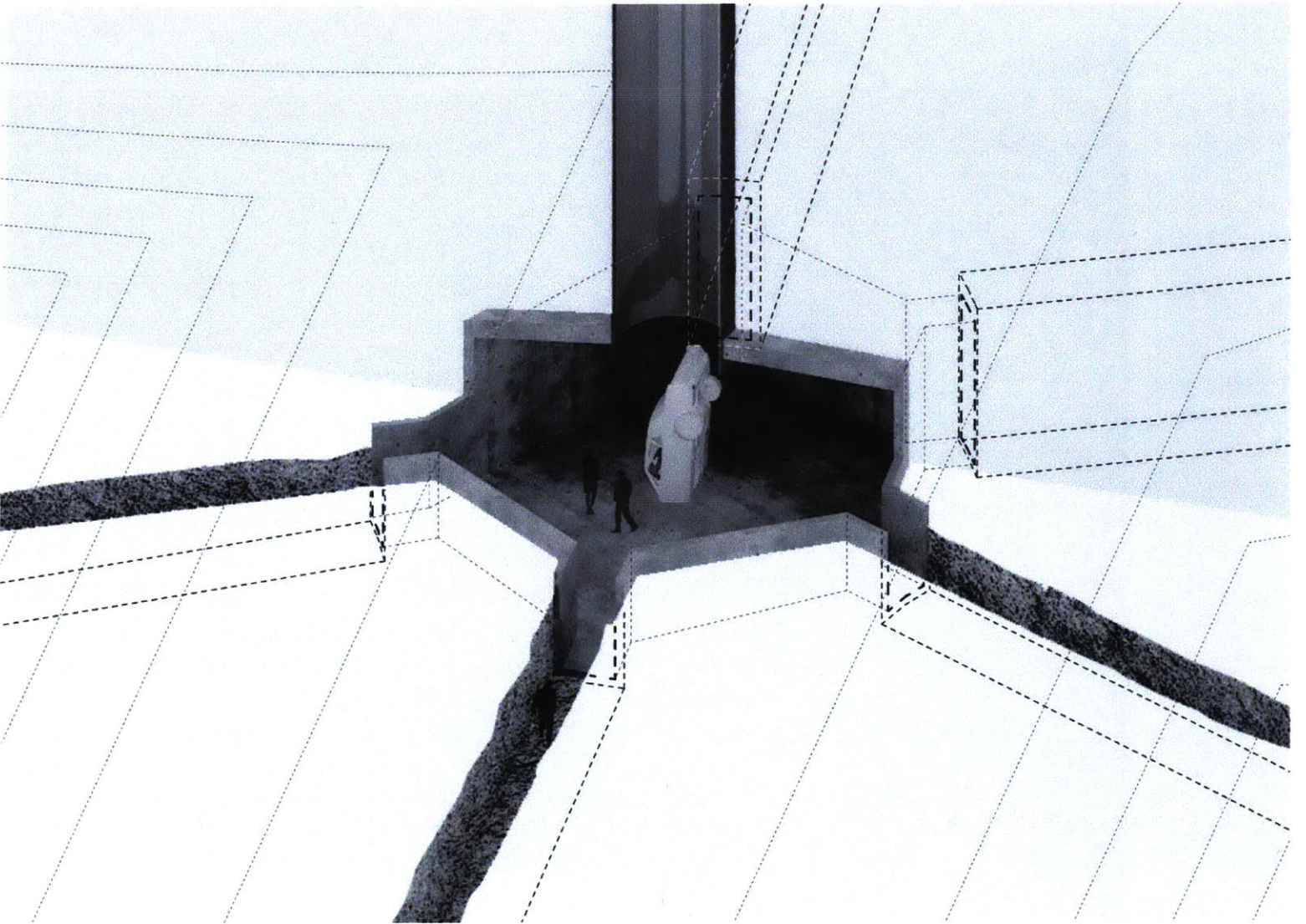
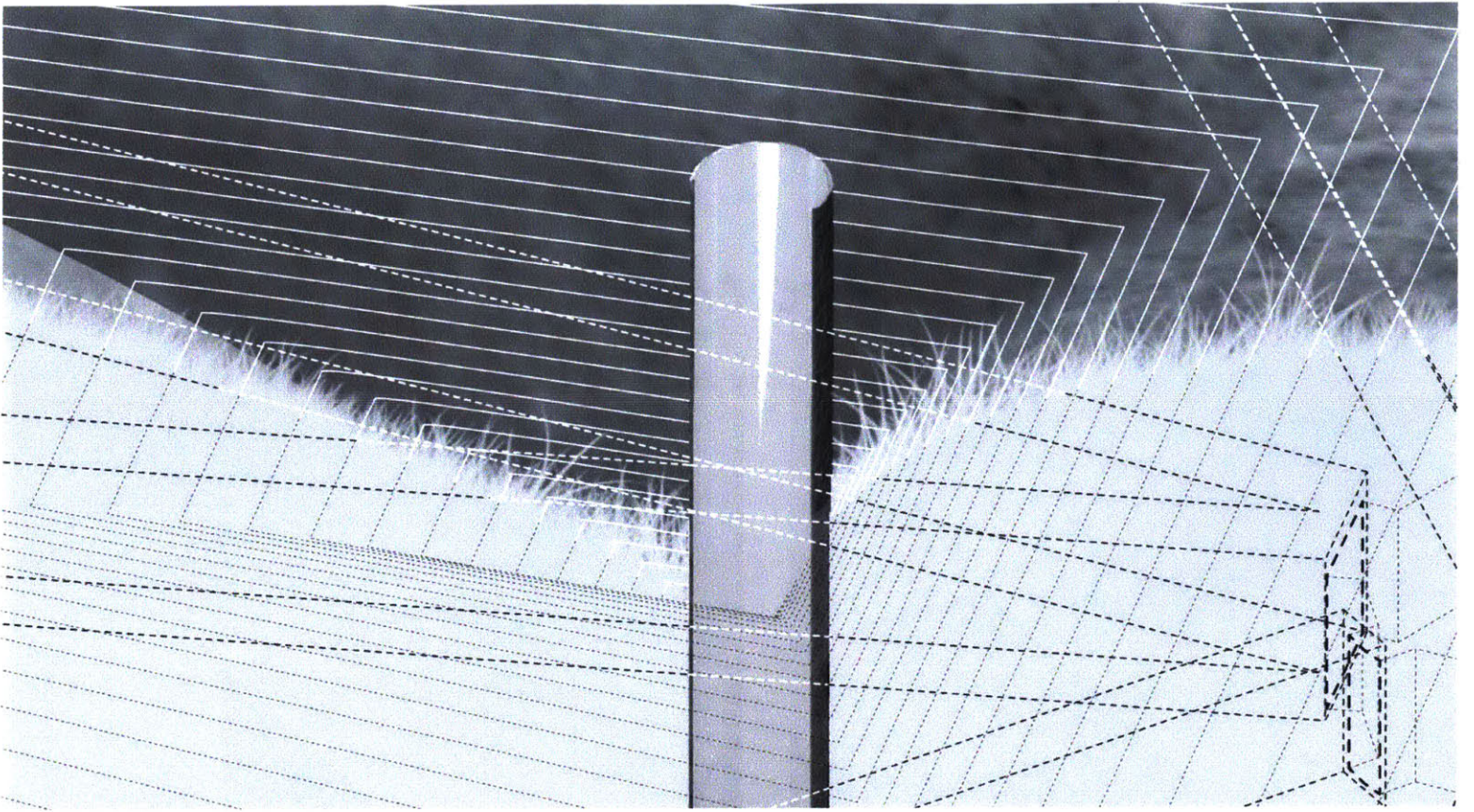


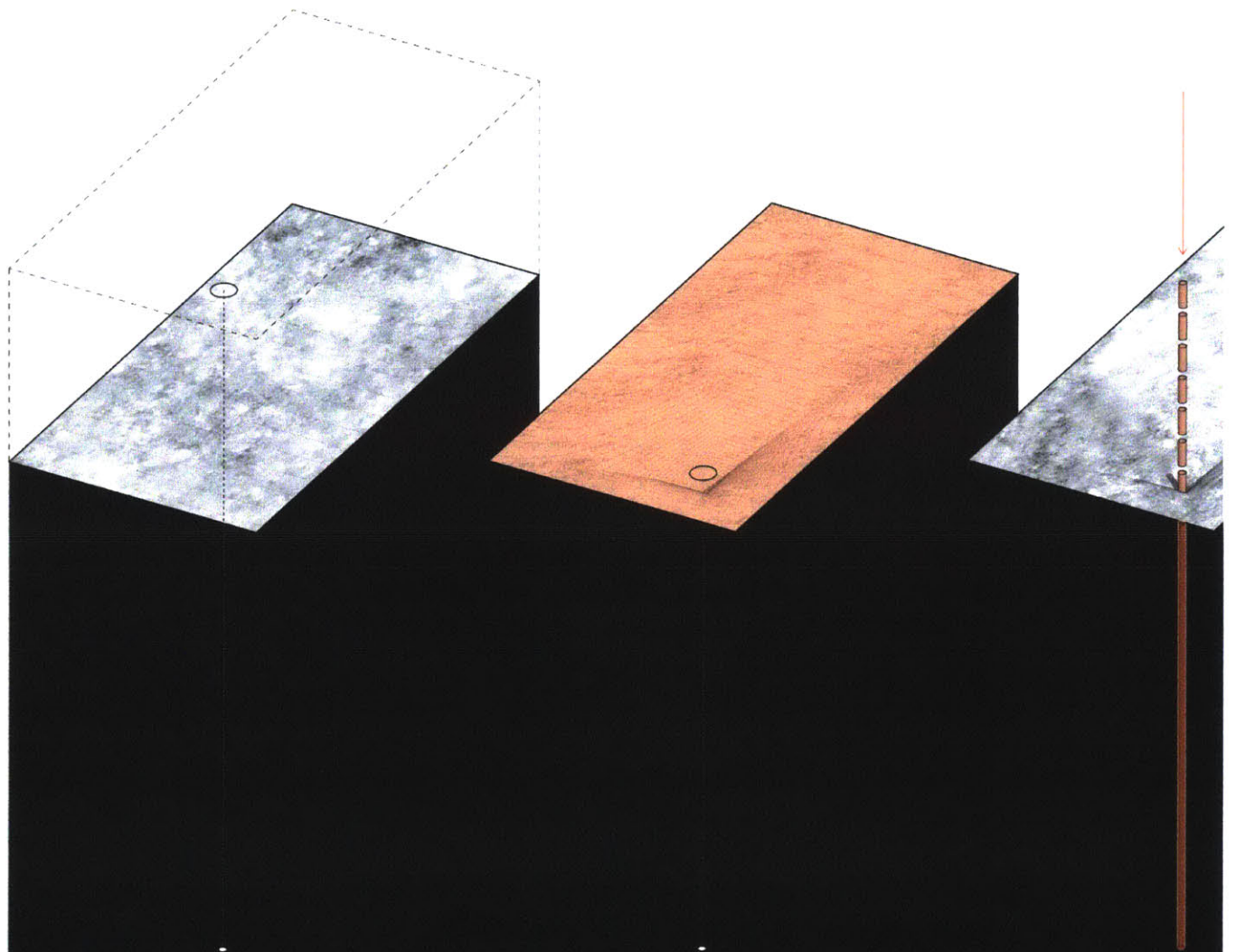
Object chambers



Subterranean circulation: a network of underground passageways



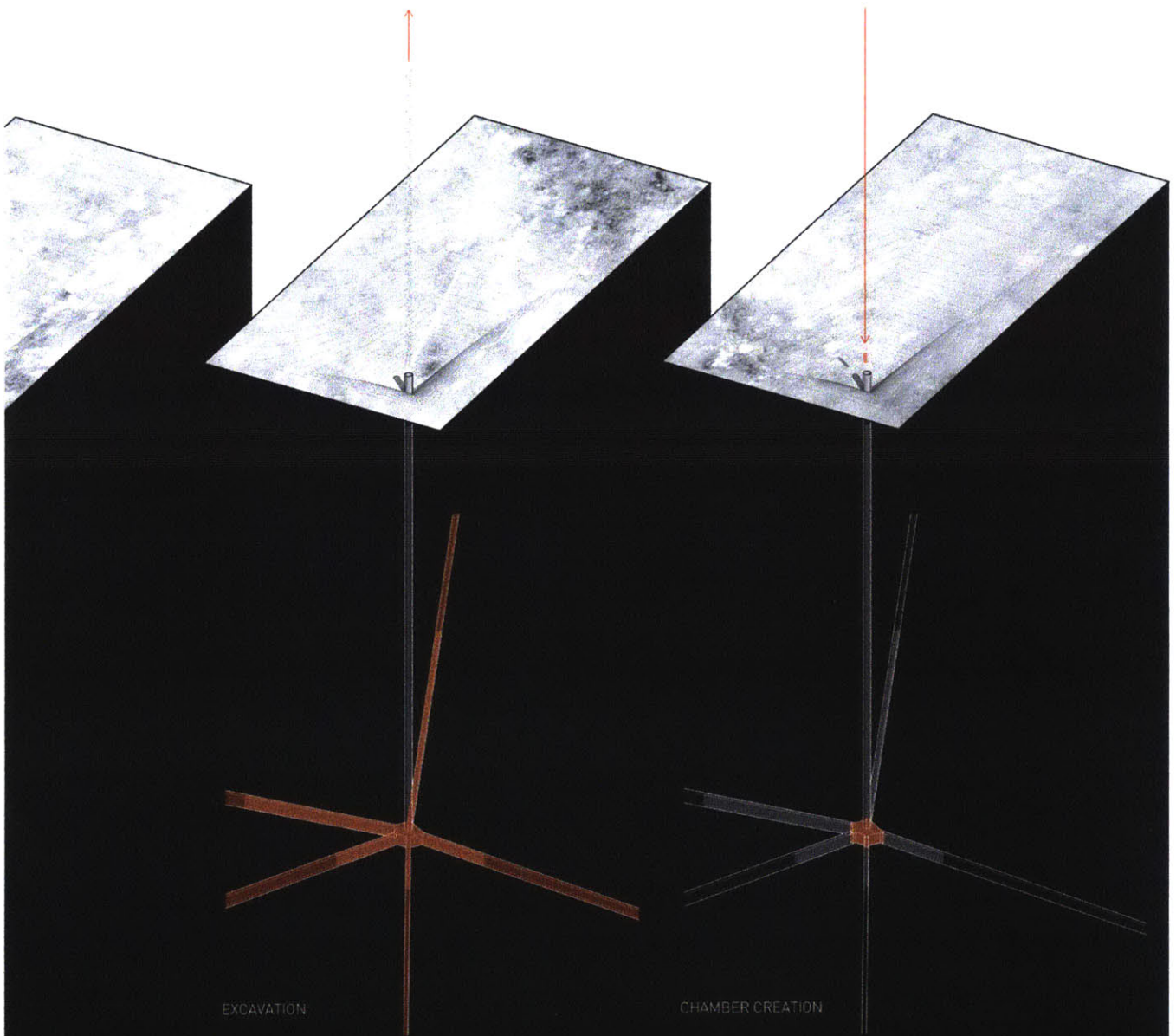




SURVEYING

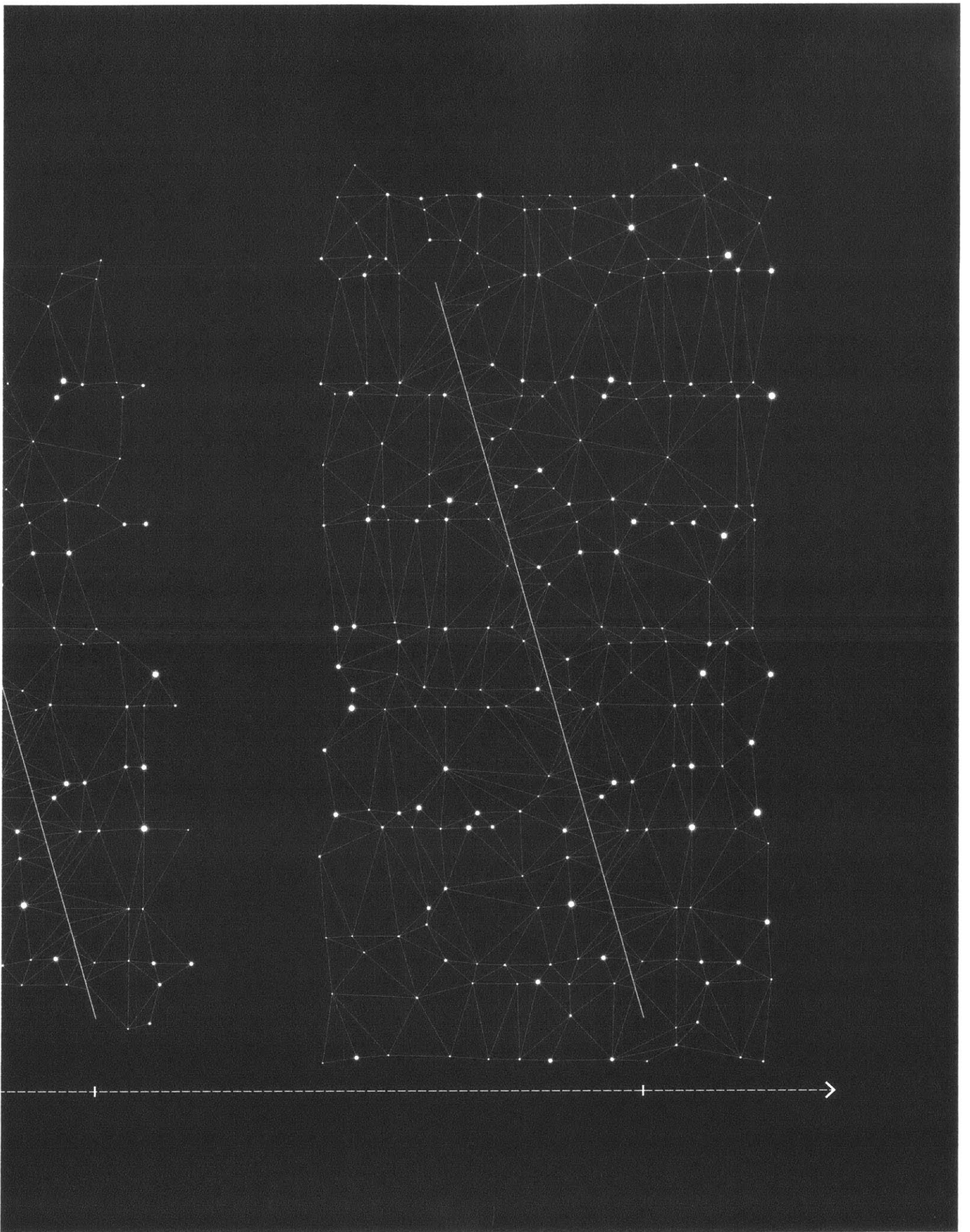
LANDFORM CREATION

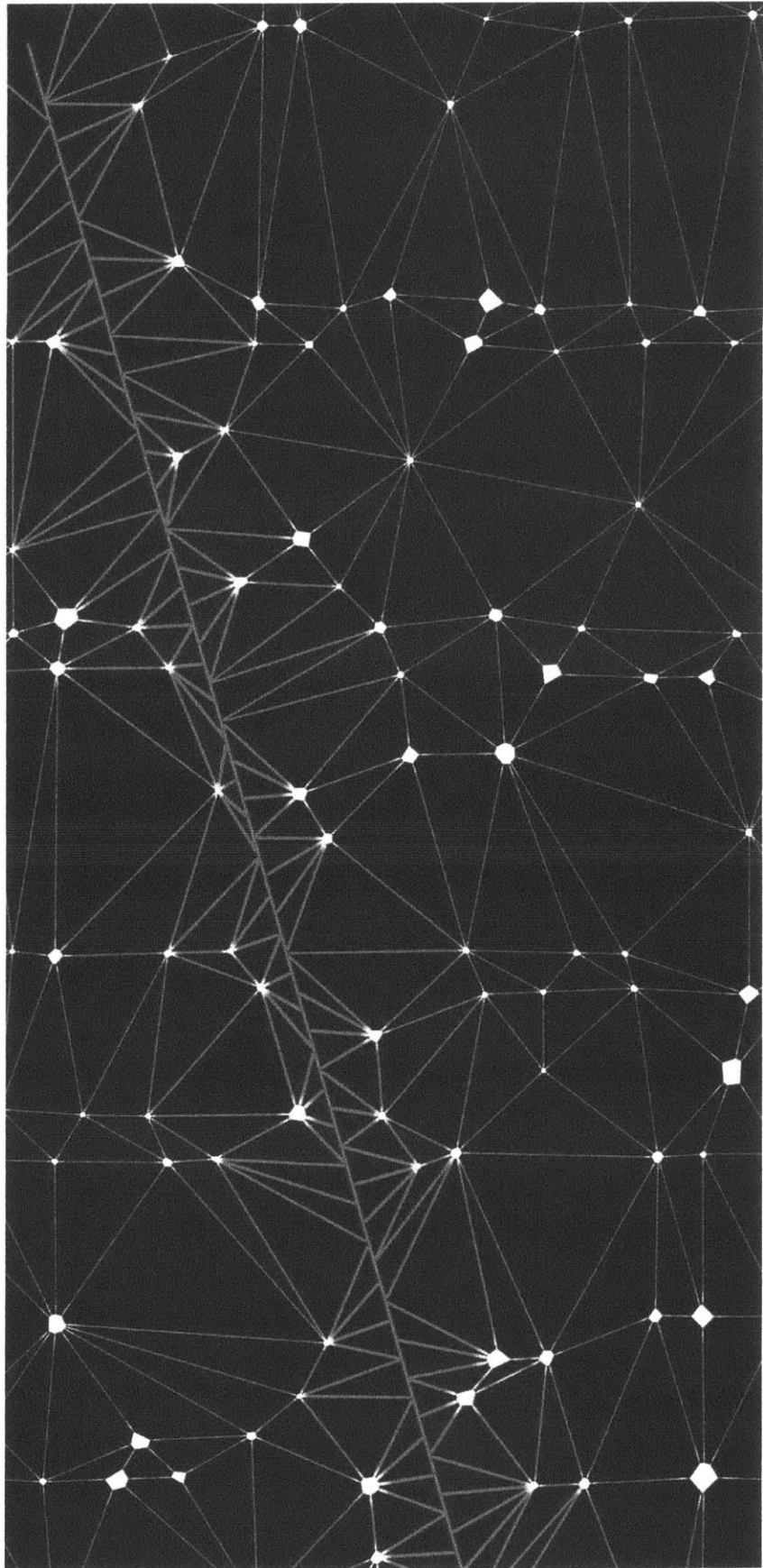
DRILLING AND CASING

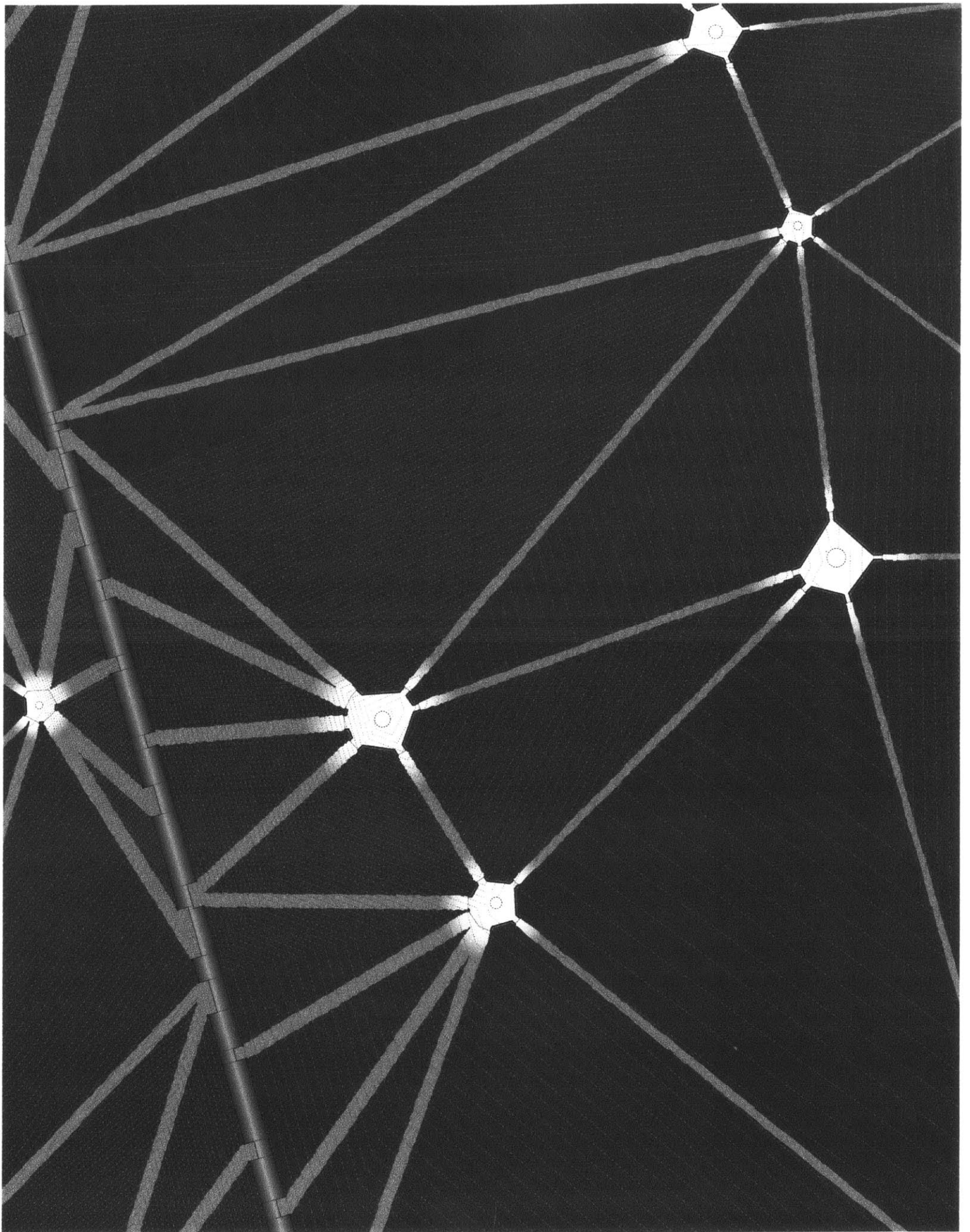




The logic of creation mimics the original logic of extraction: a slow motion subterranean fracking.

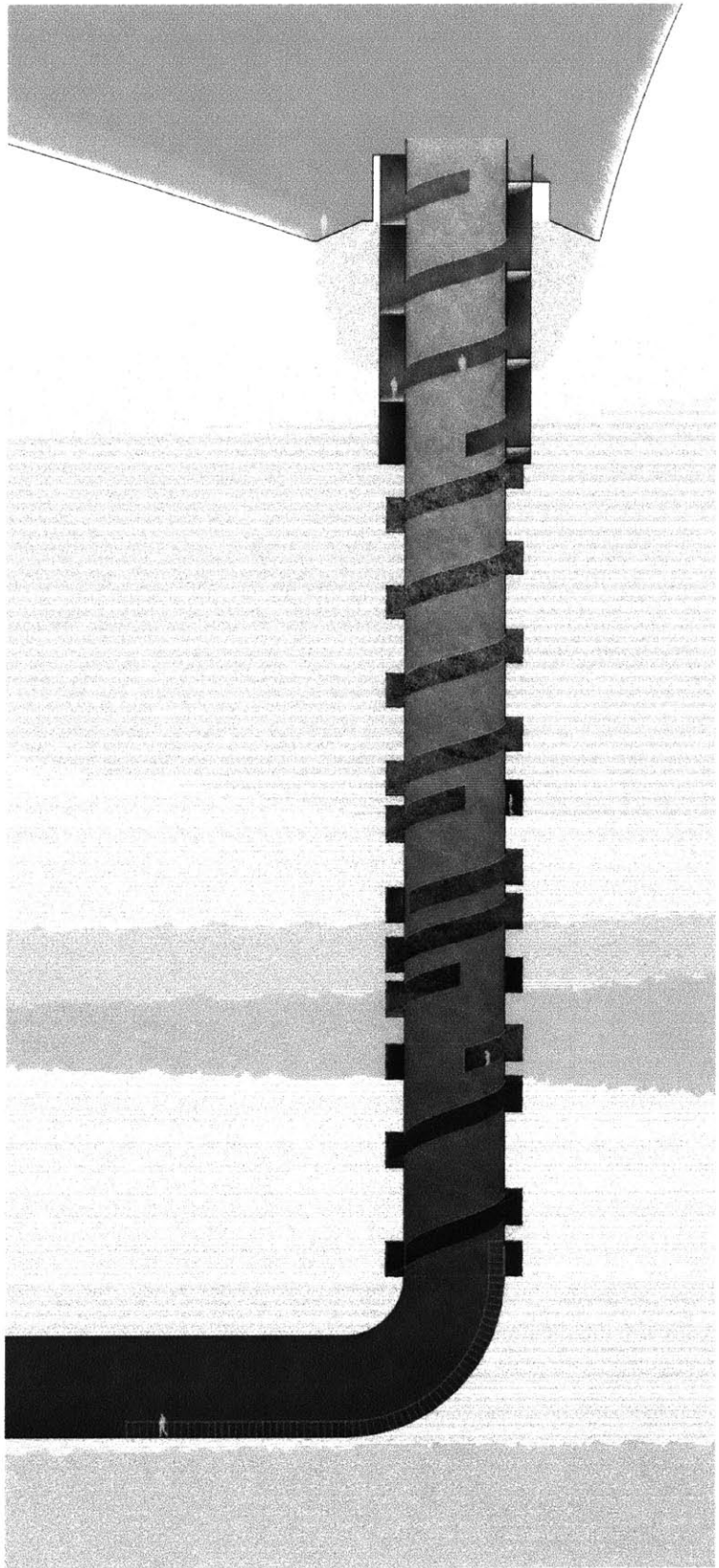
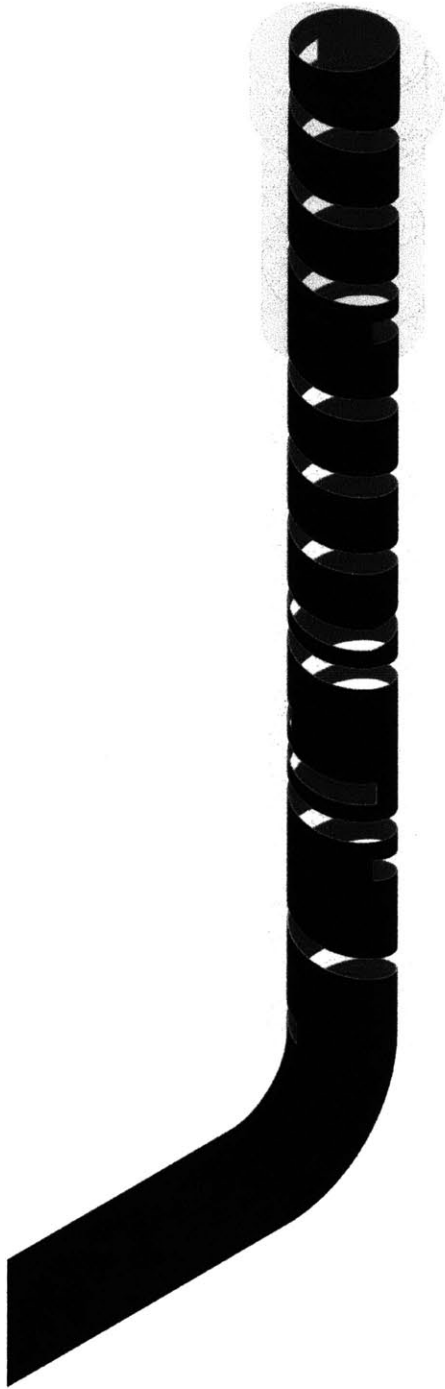


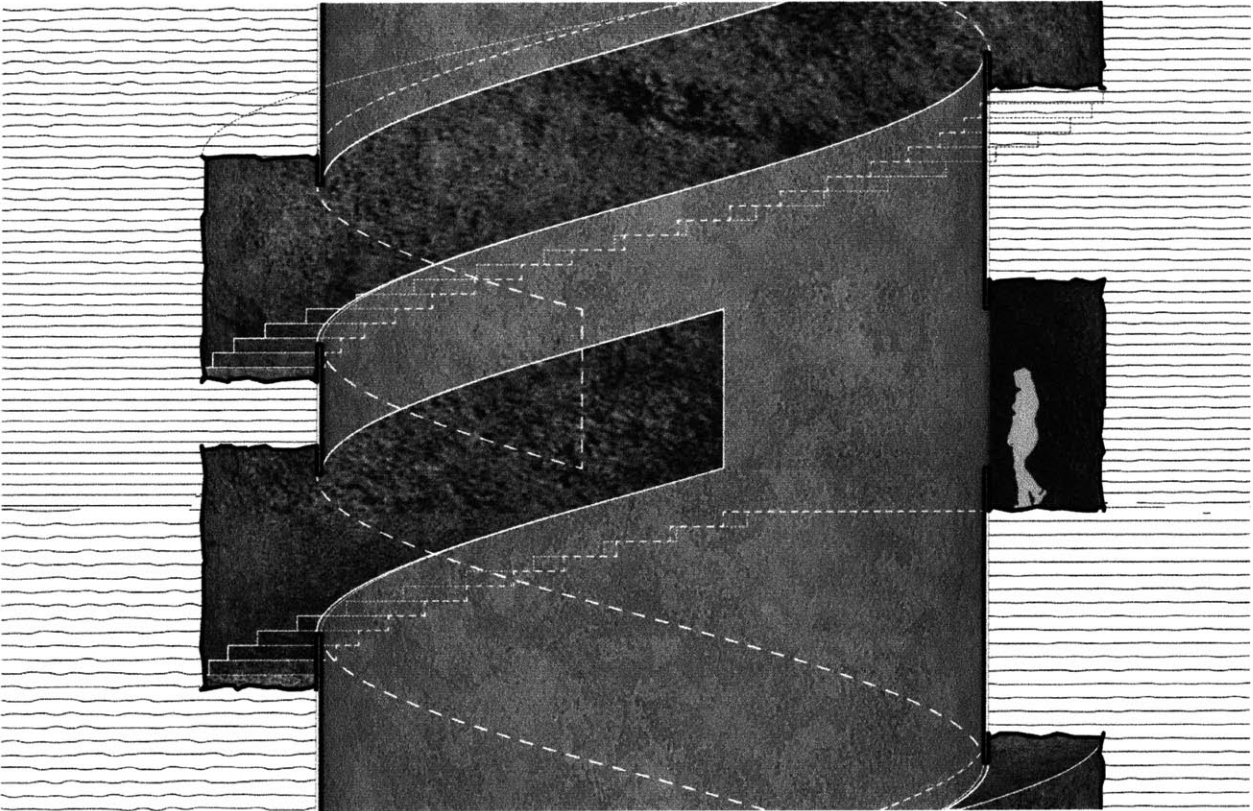
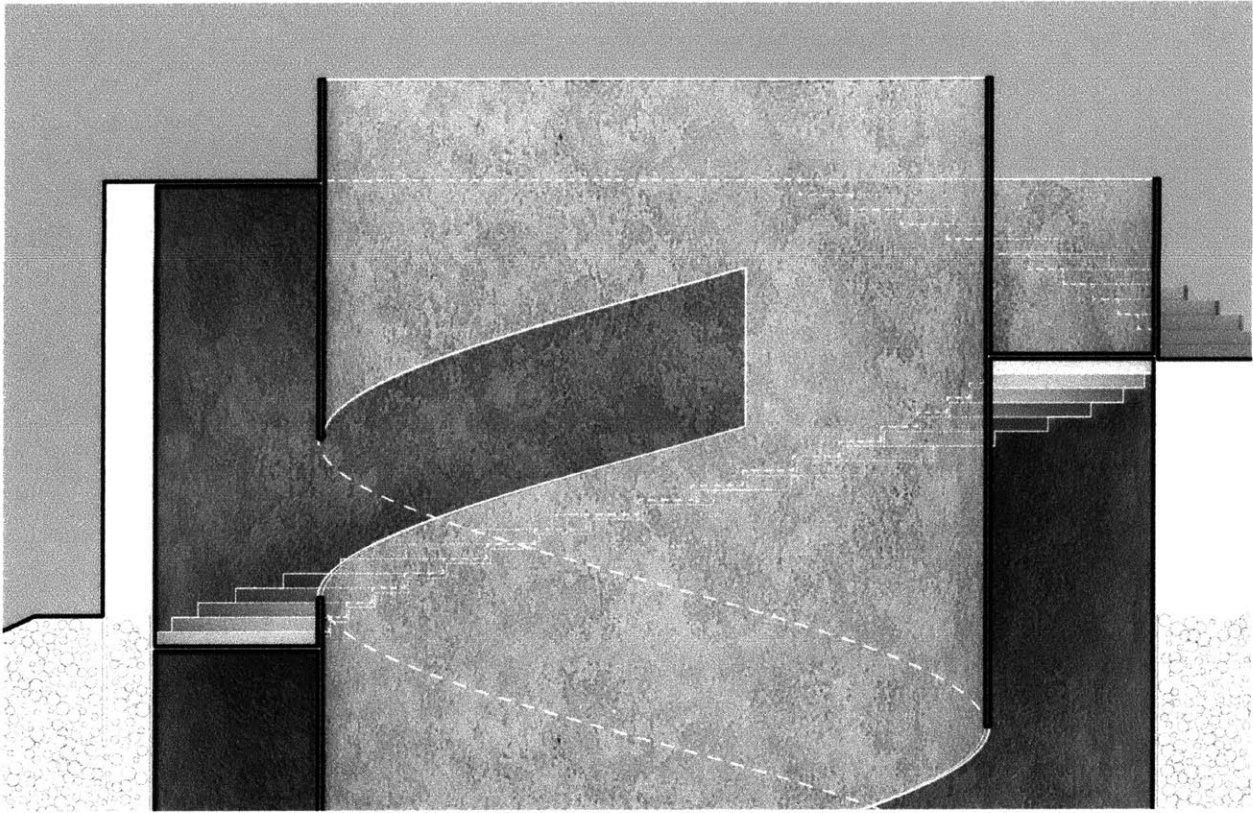




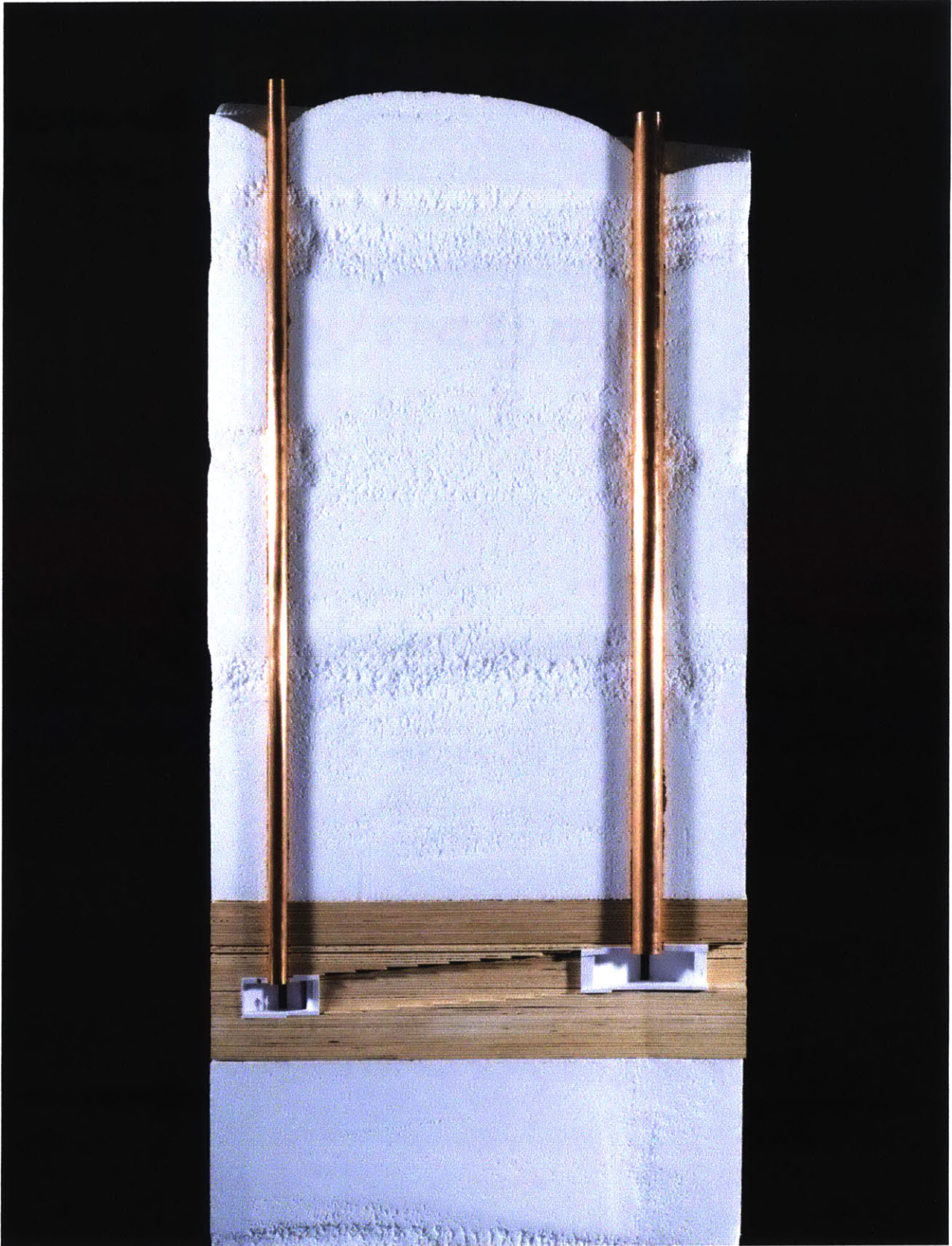


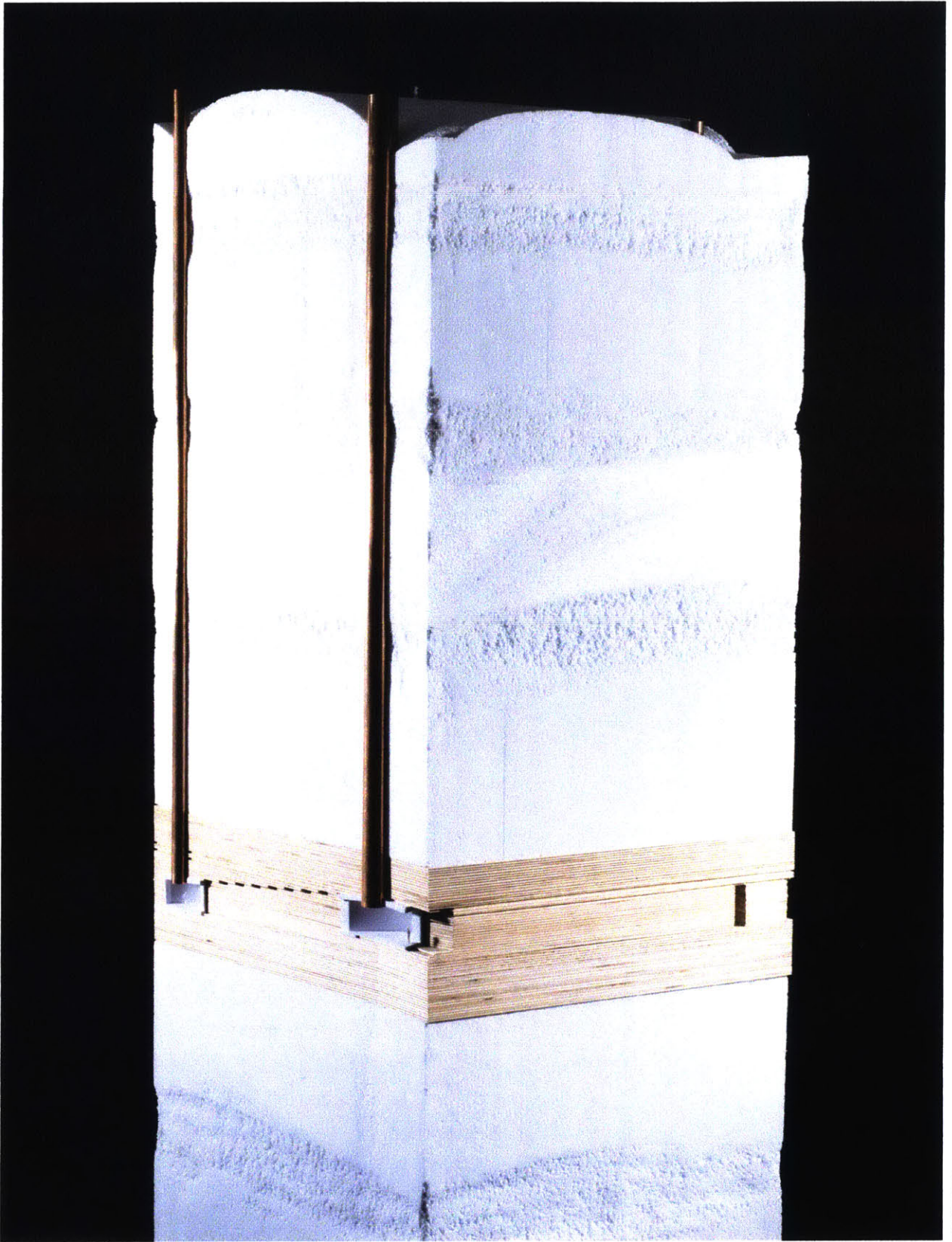




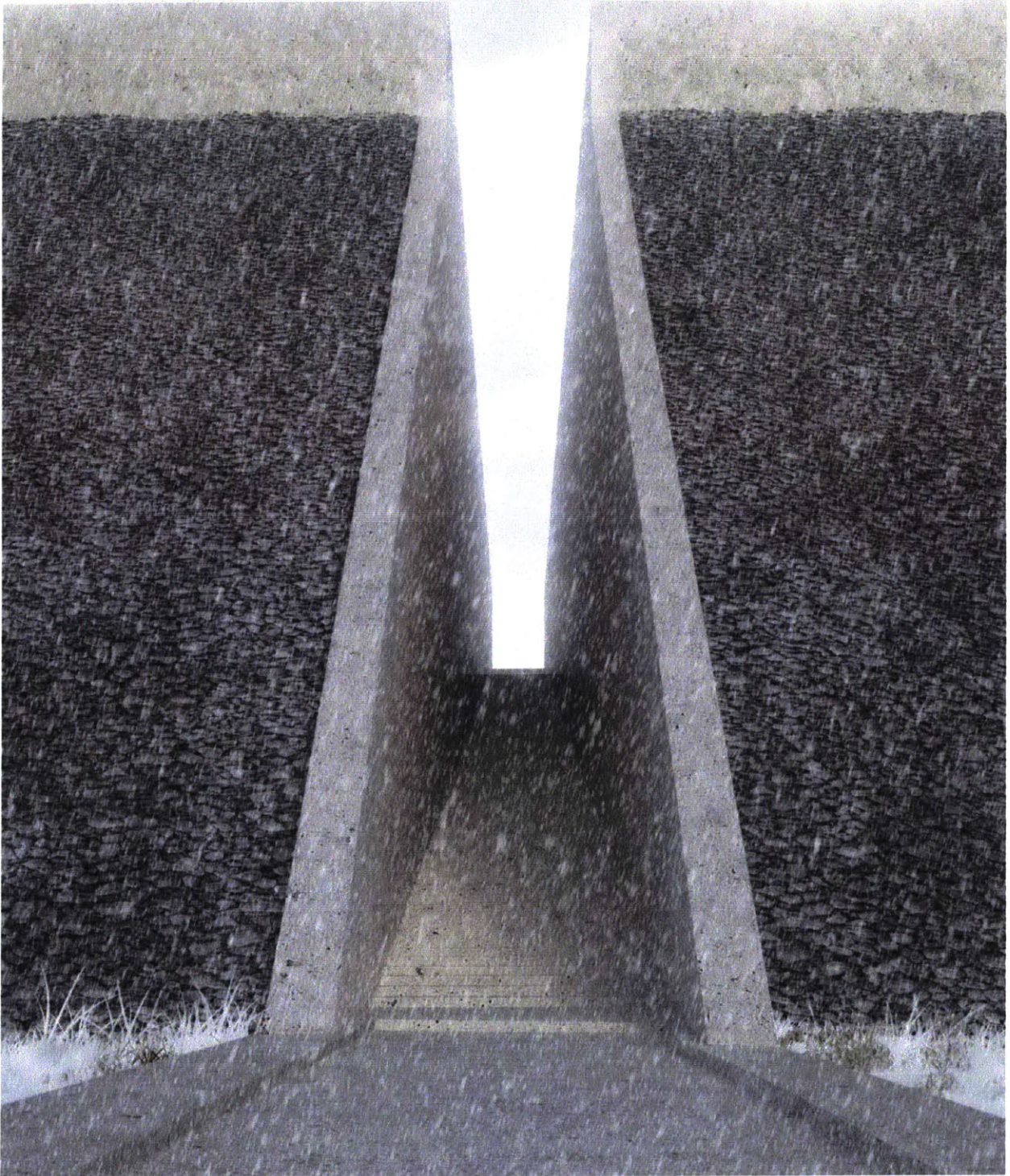


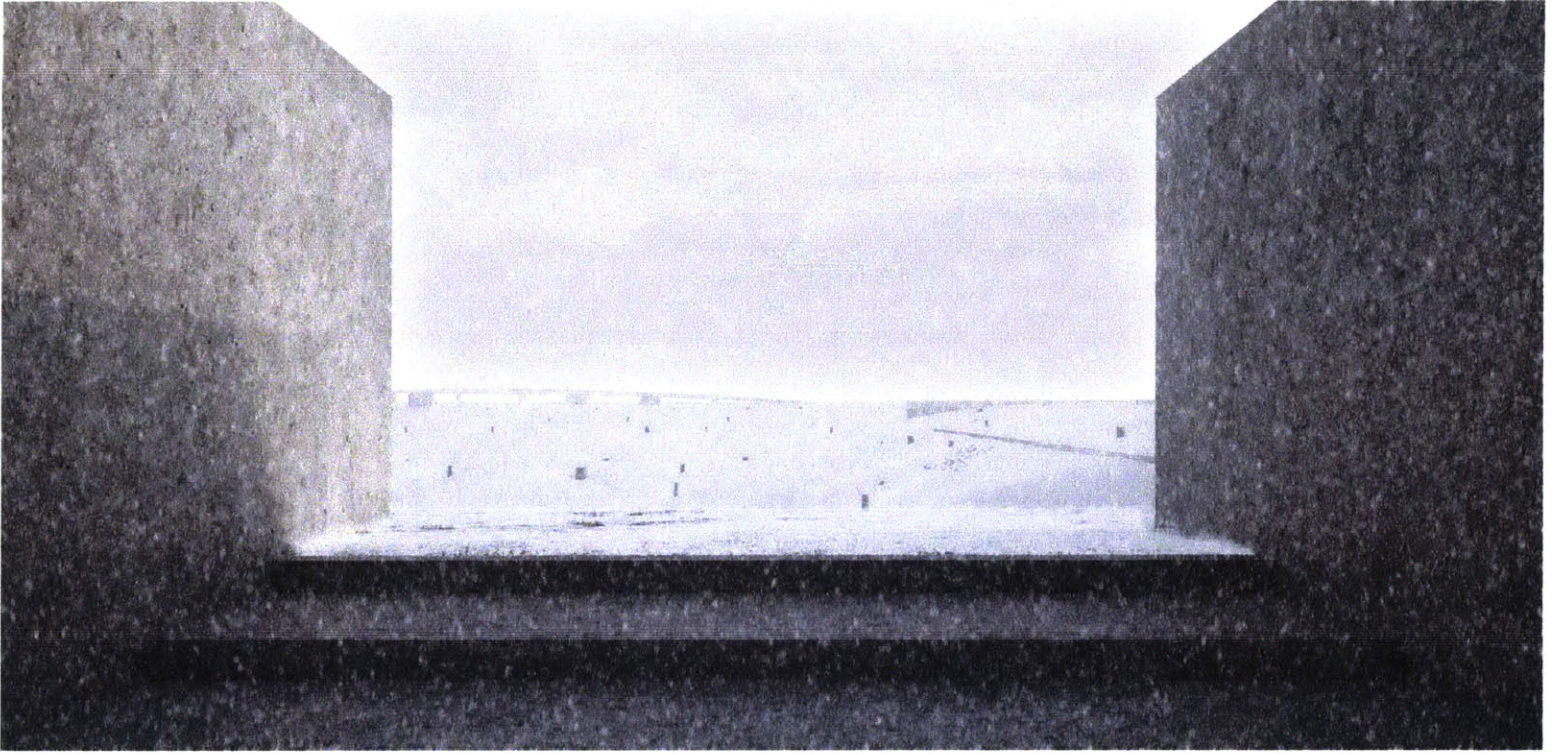
Down and down through the geological layers...



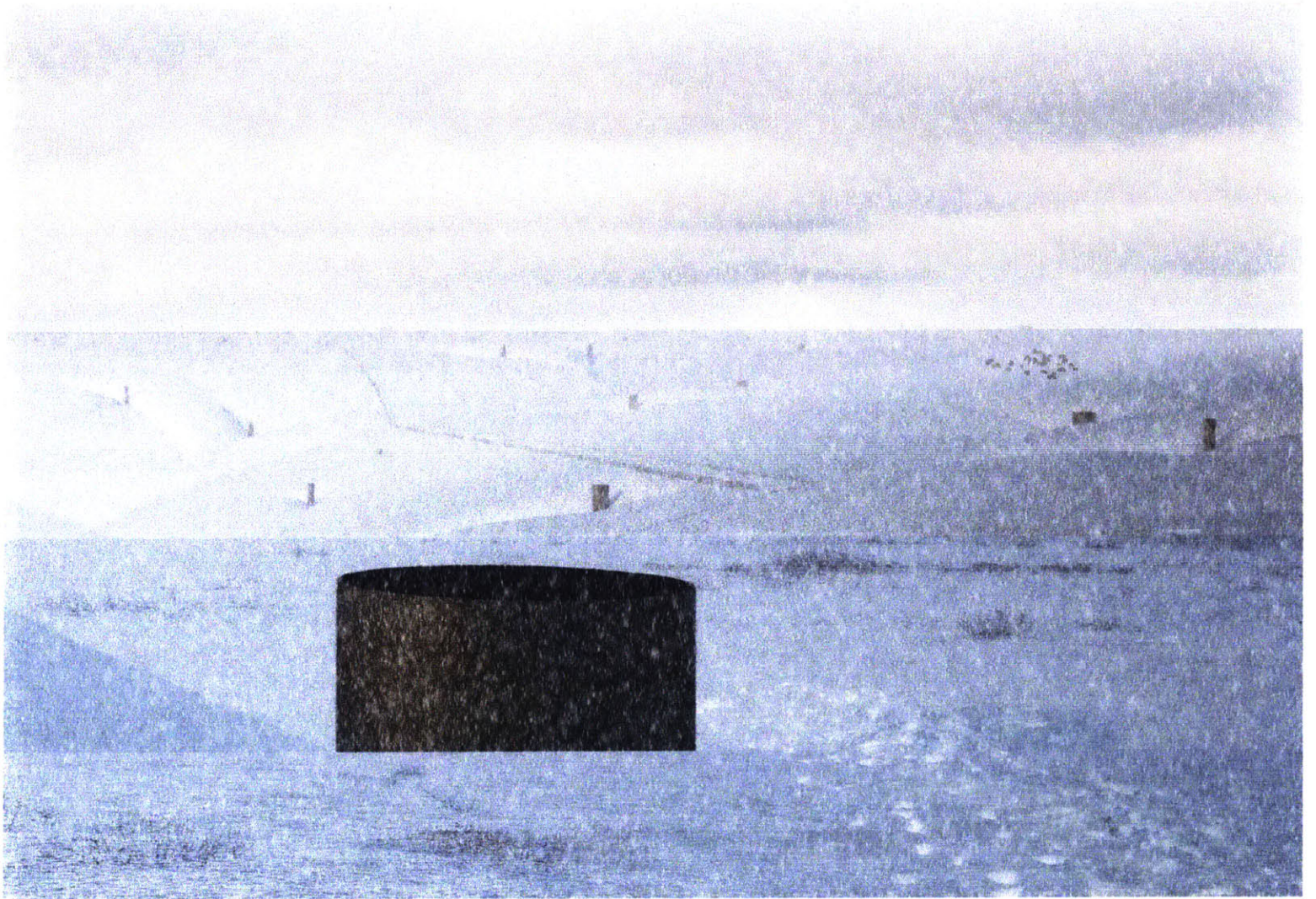


JANUARY 2106...

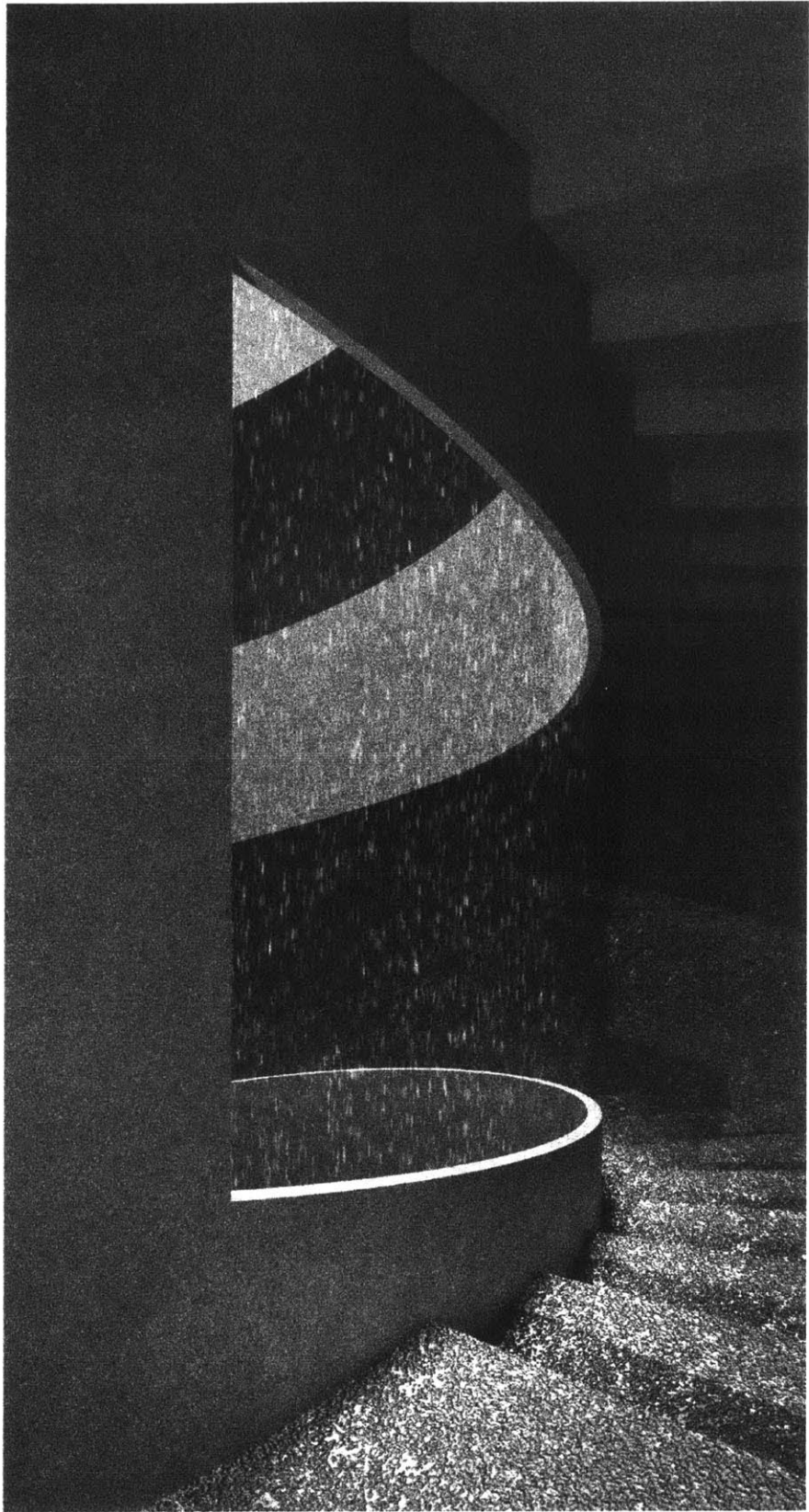




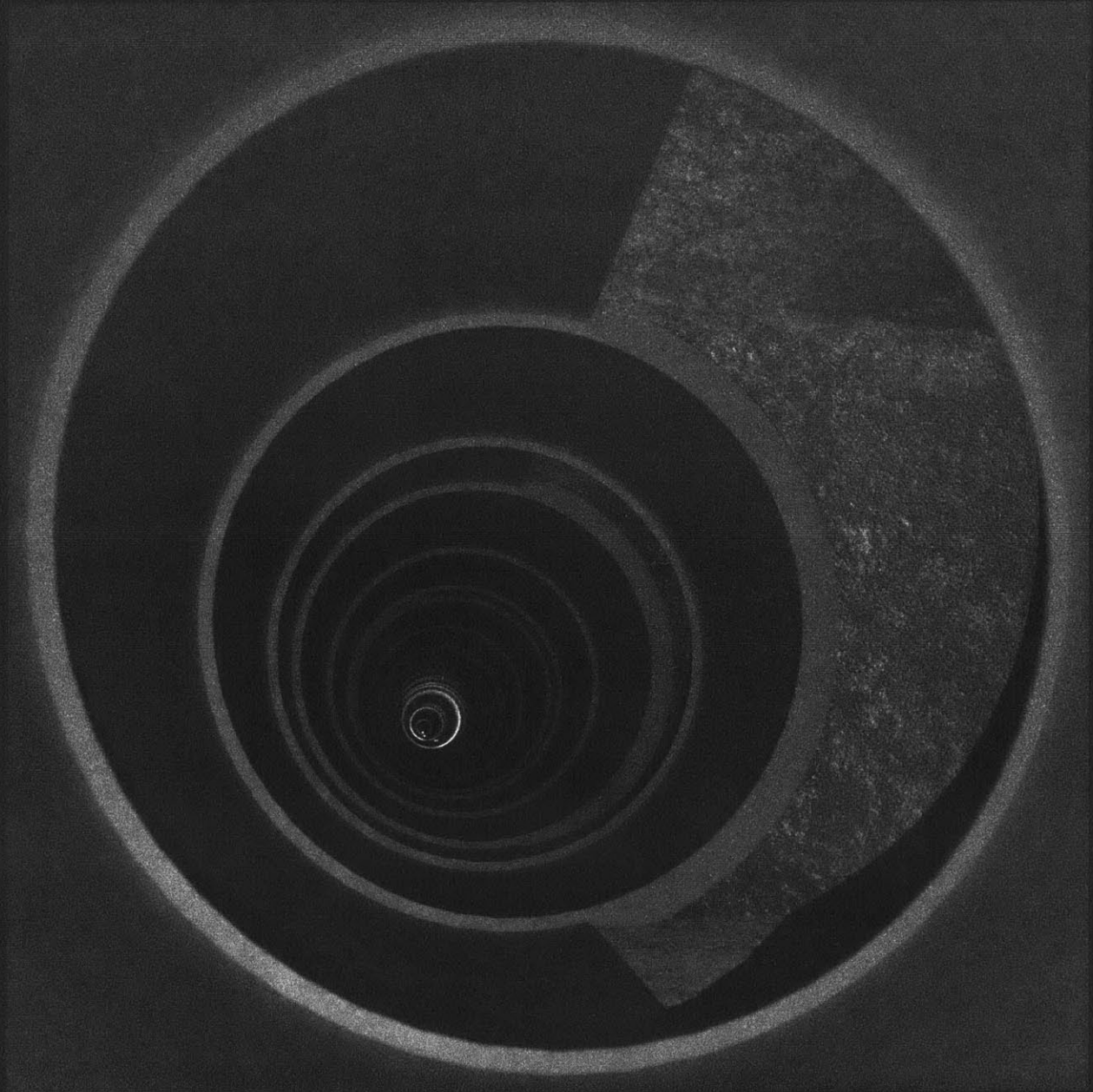




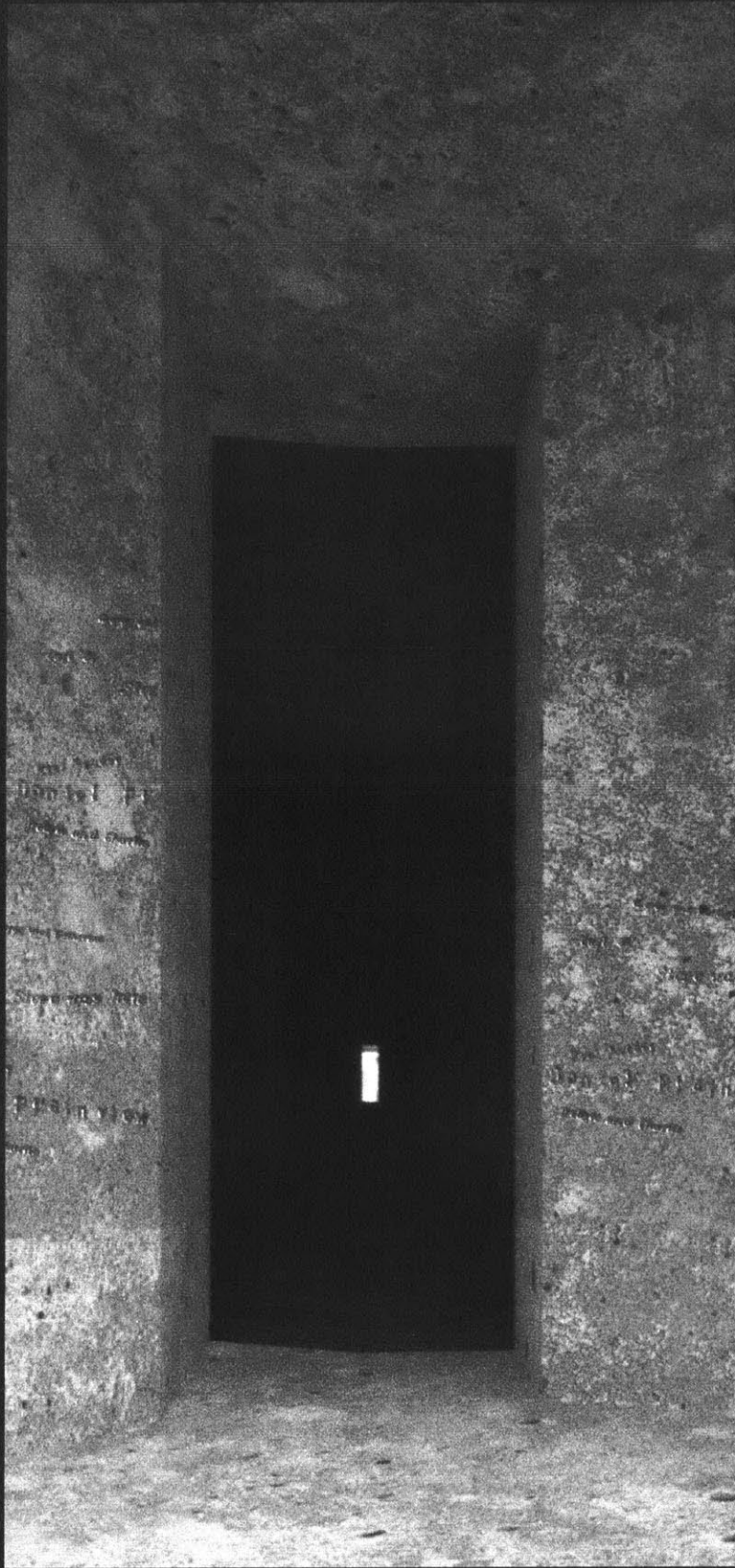


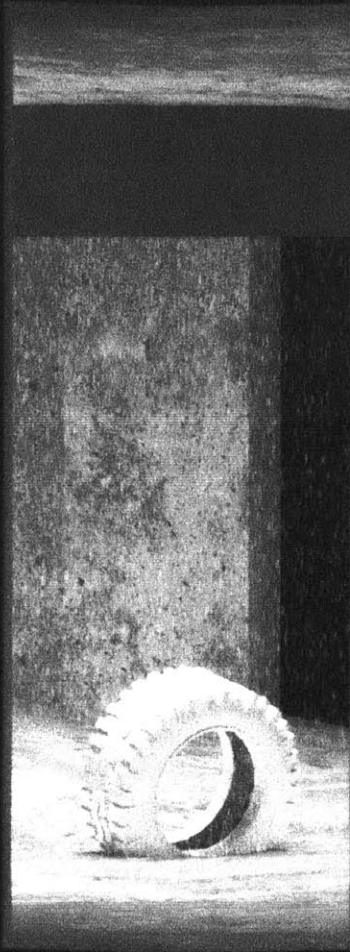


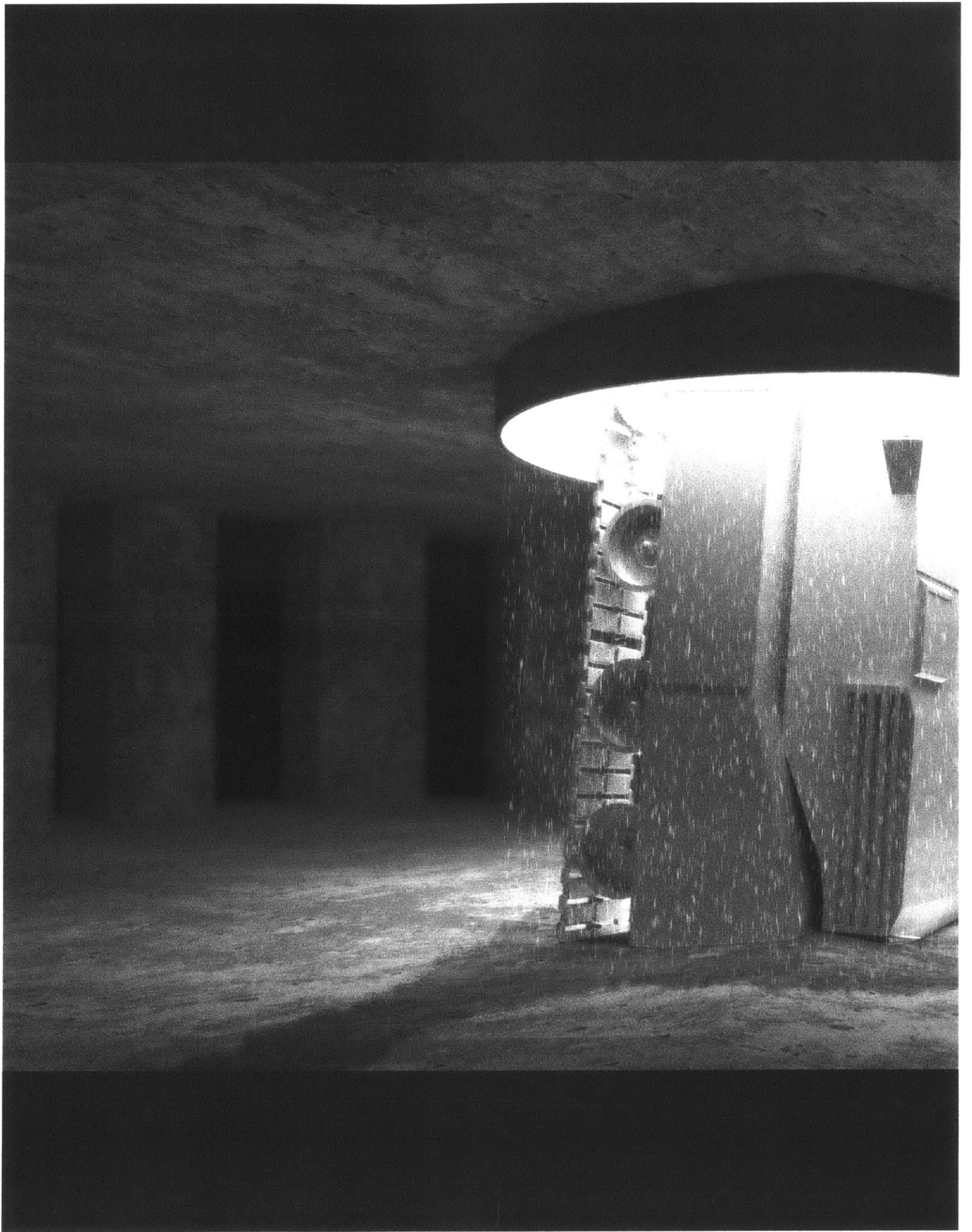
Going down, going back in time.





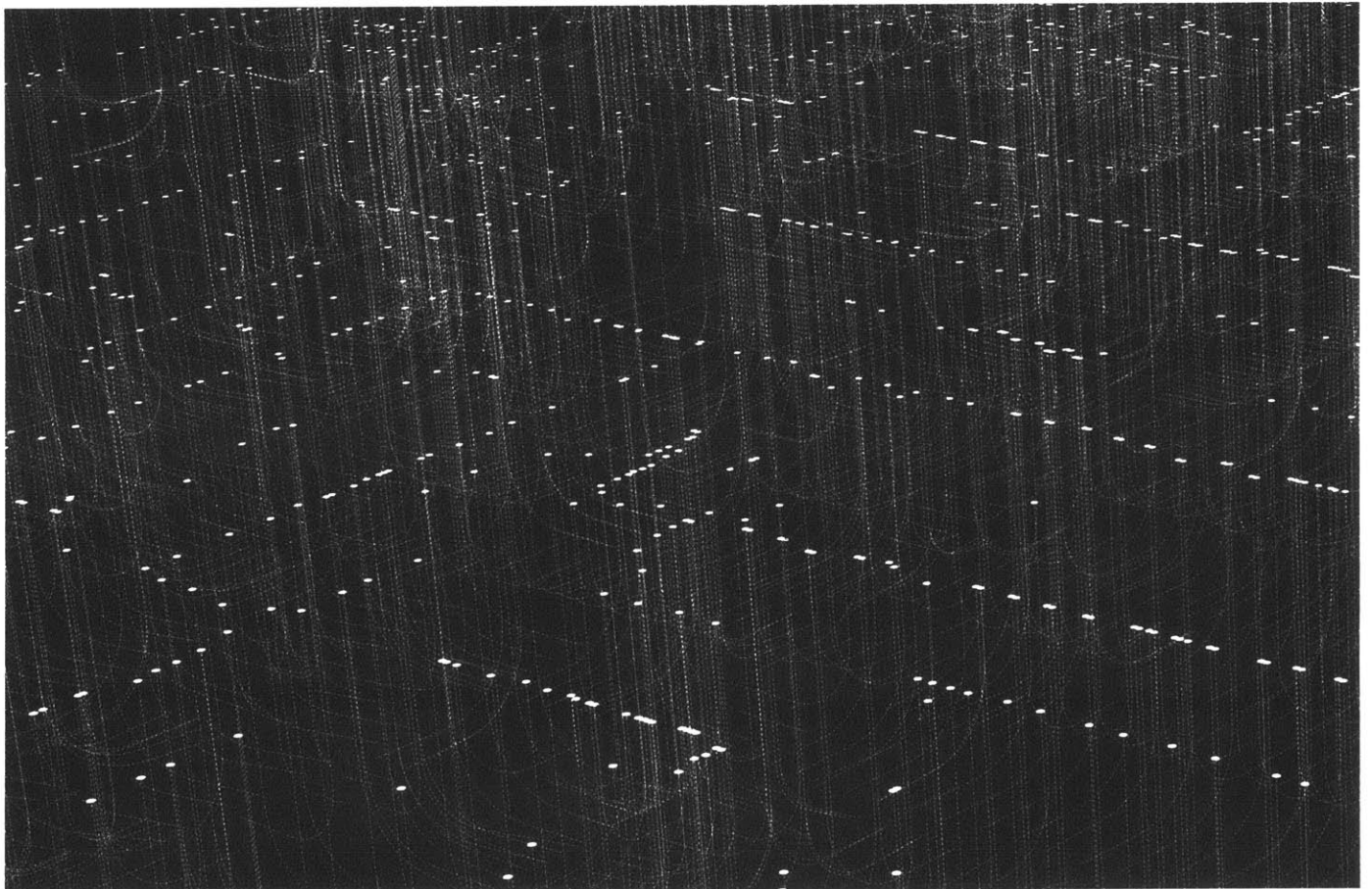


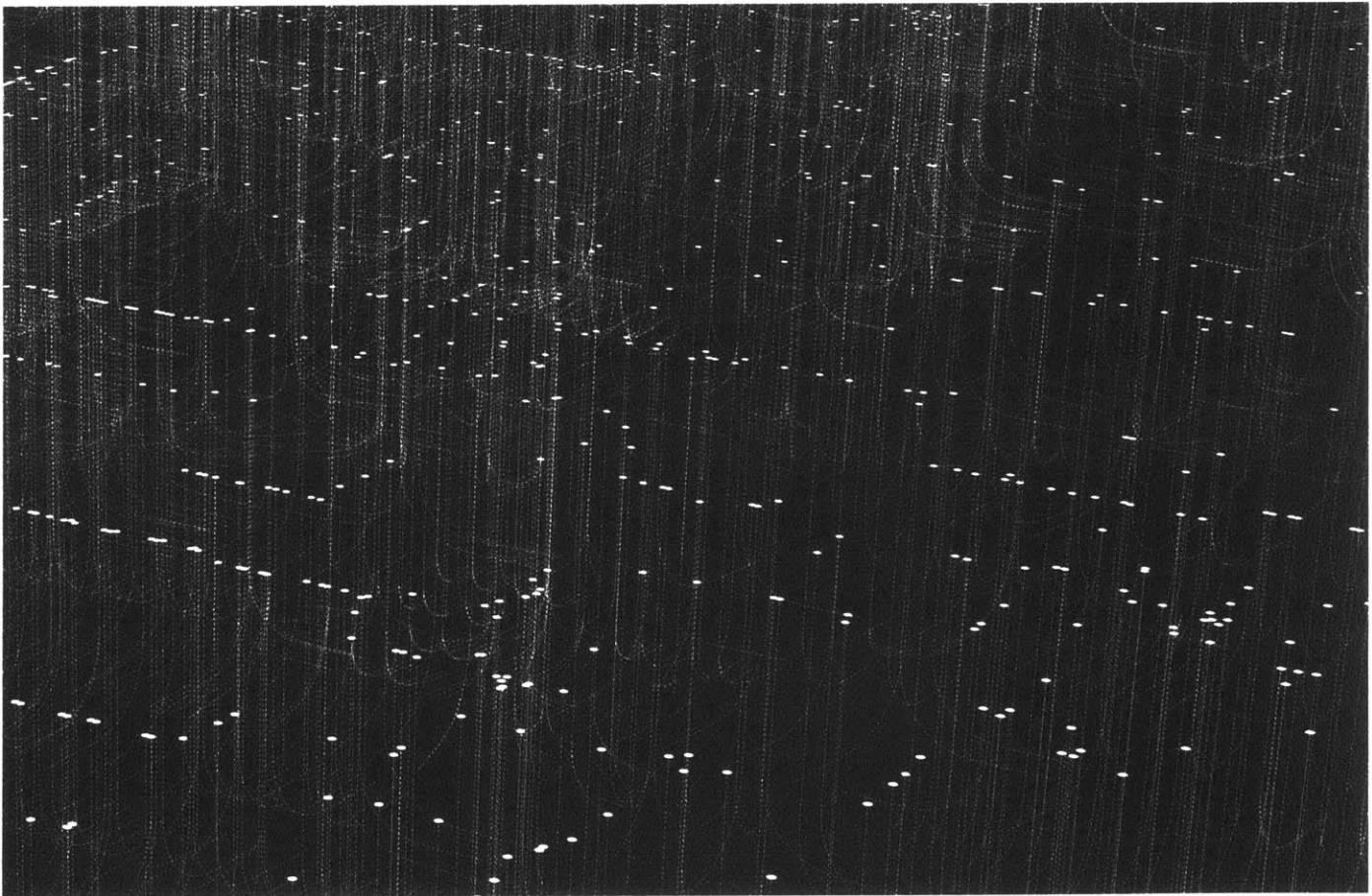


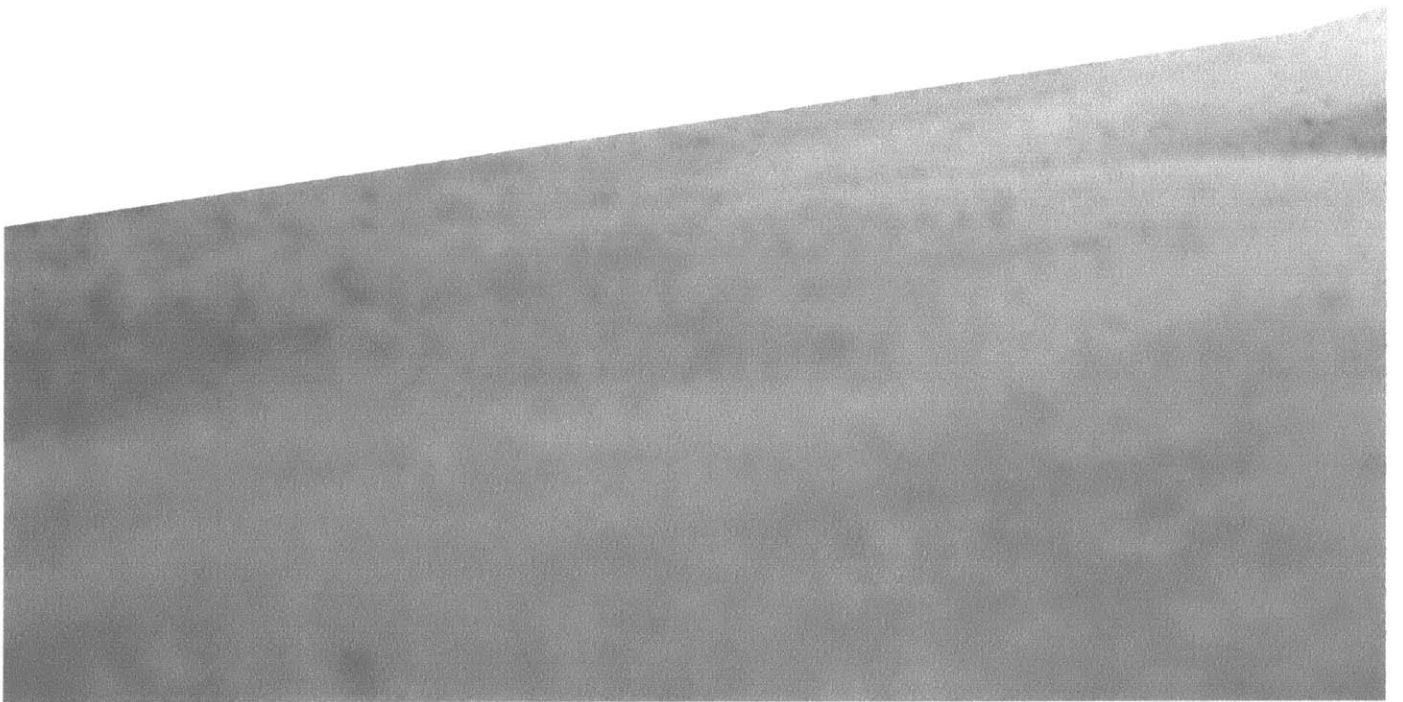


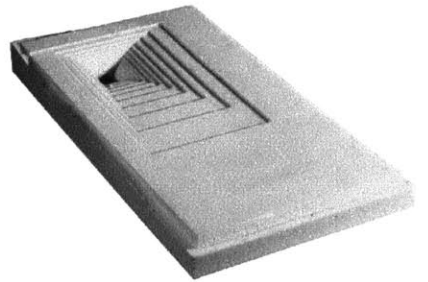
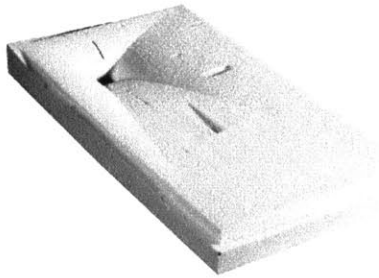
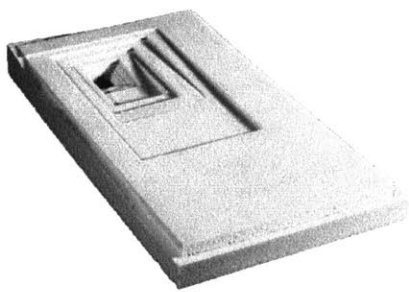


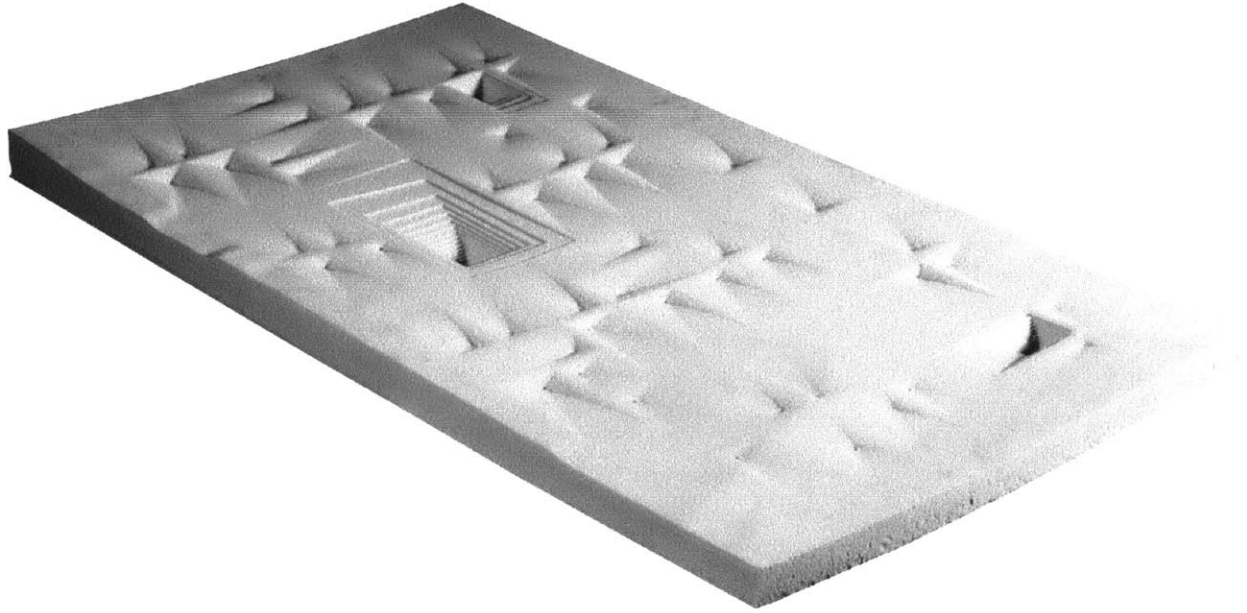
DESIGN PROCESS ARTIFACTS



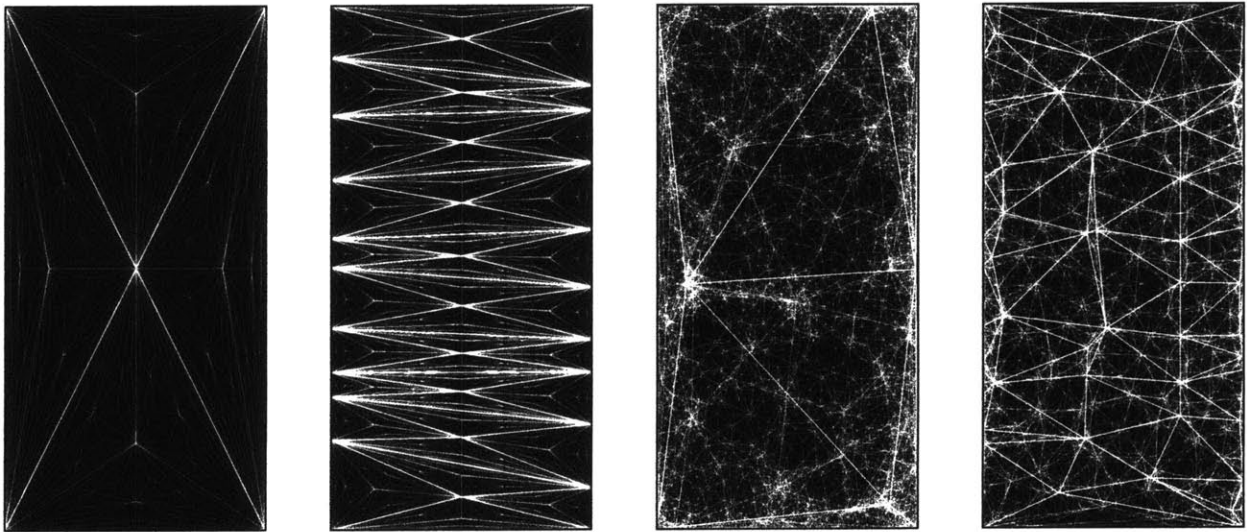


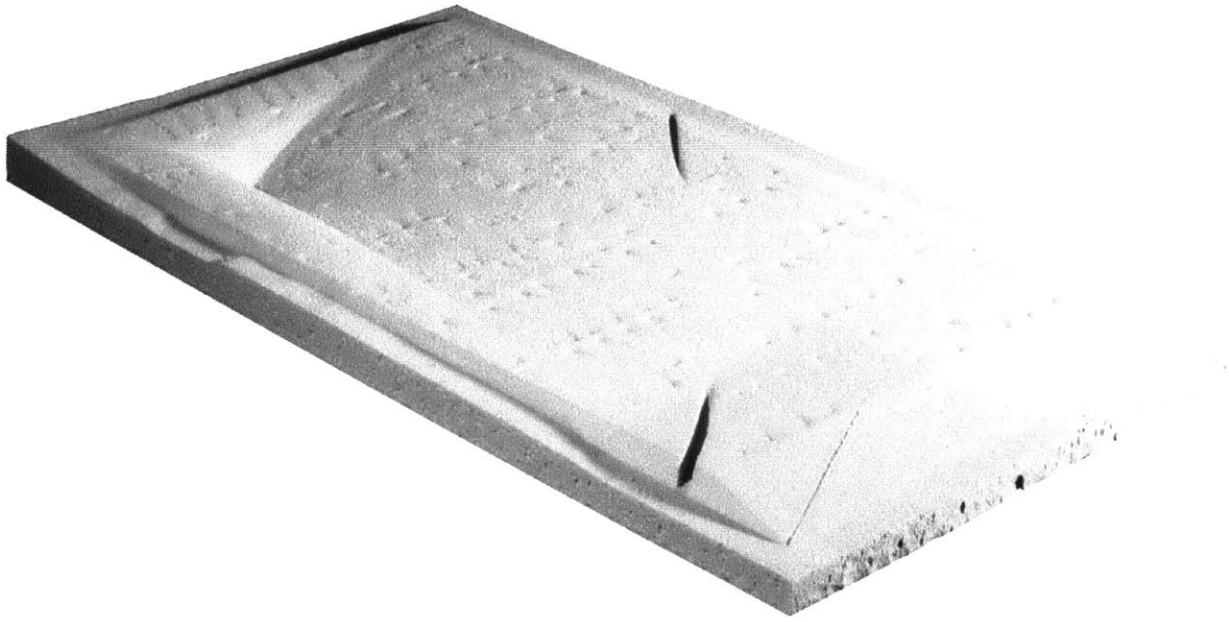




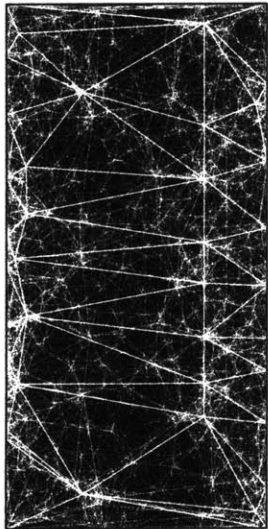


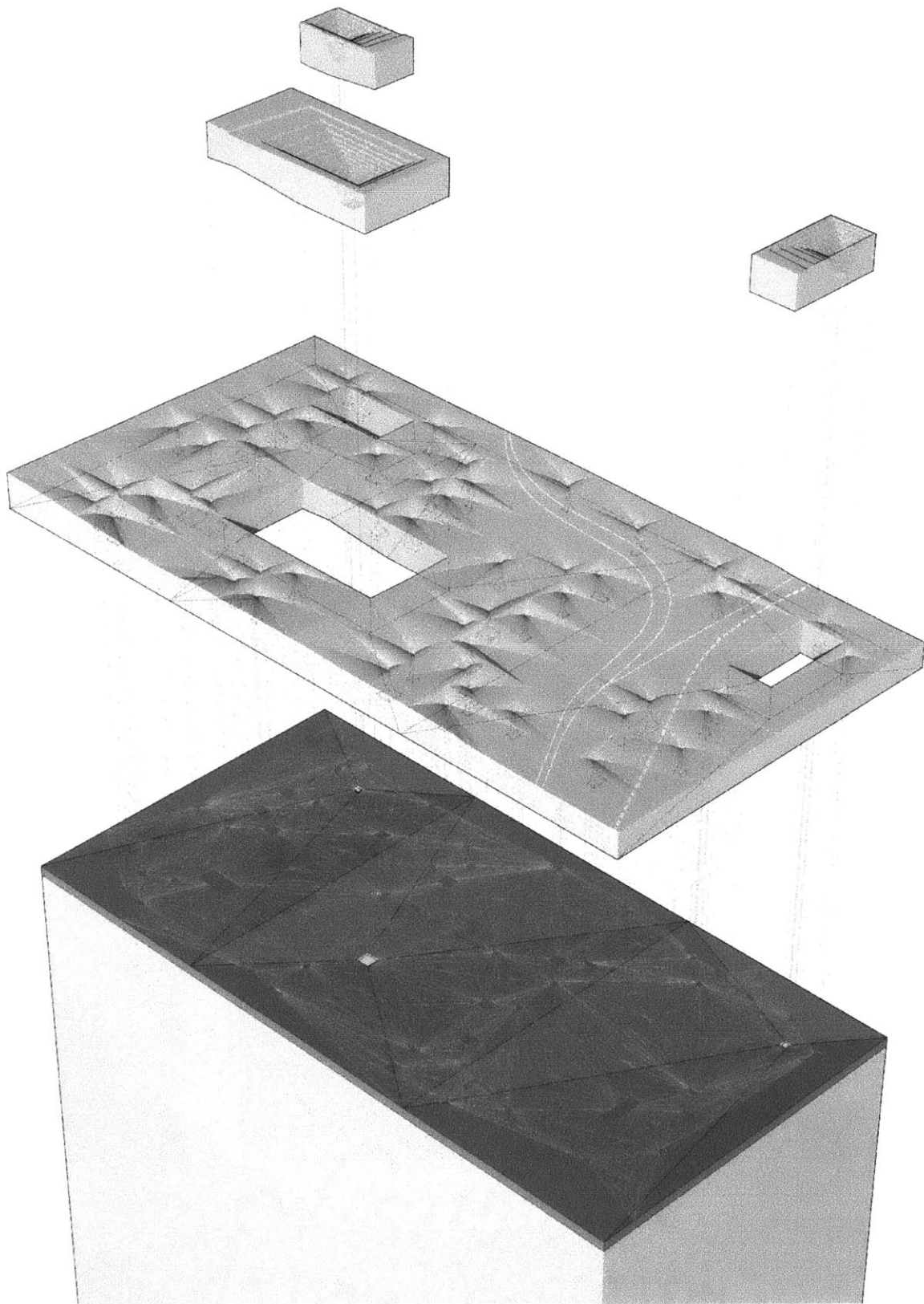
Midterm scheme landform model

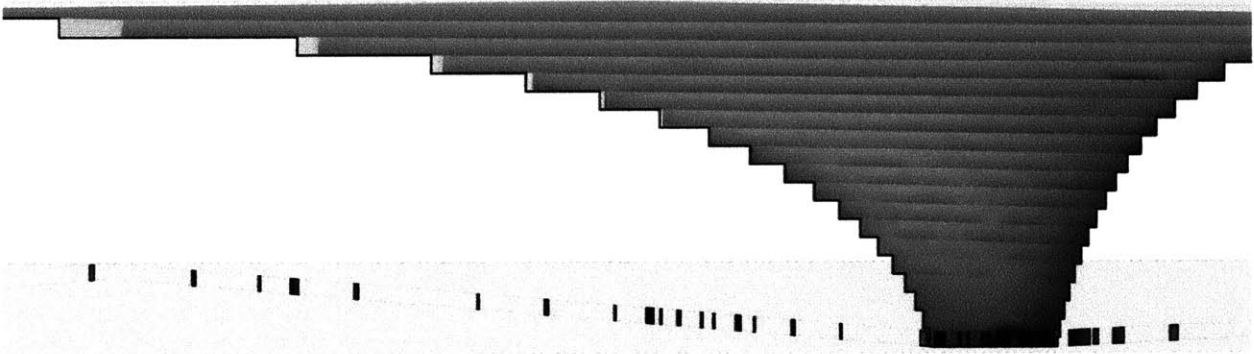
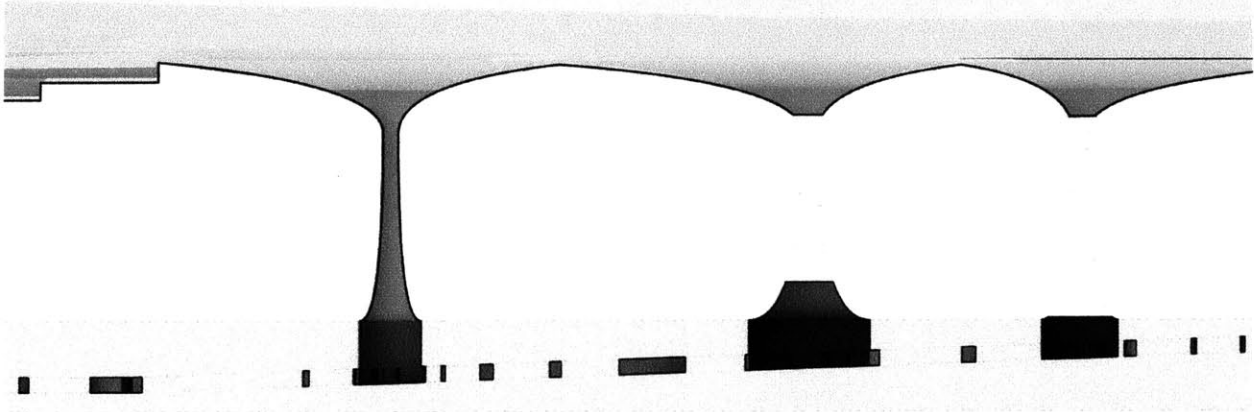


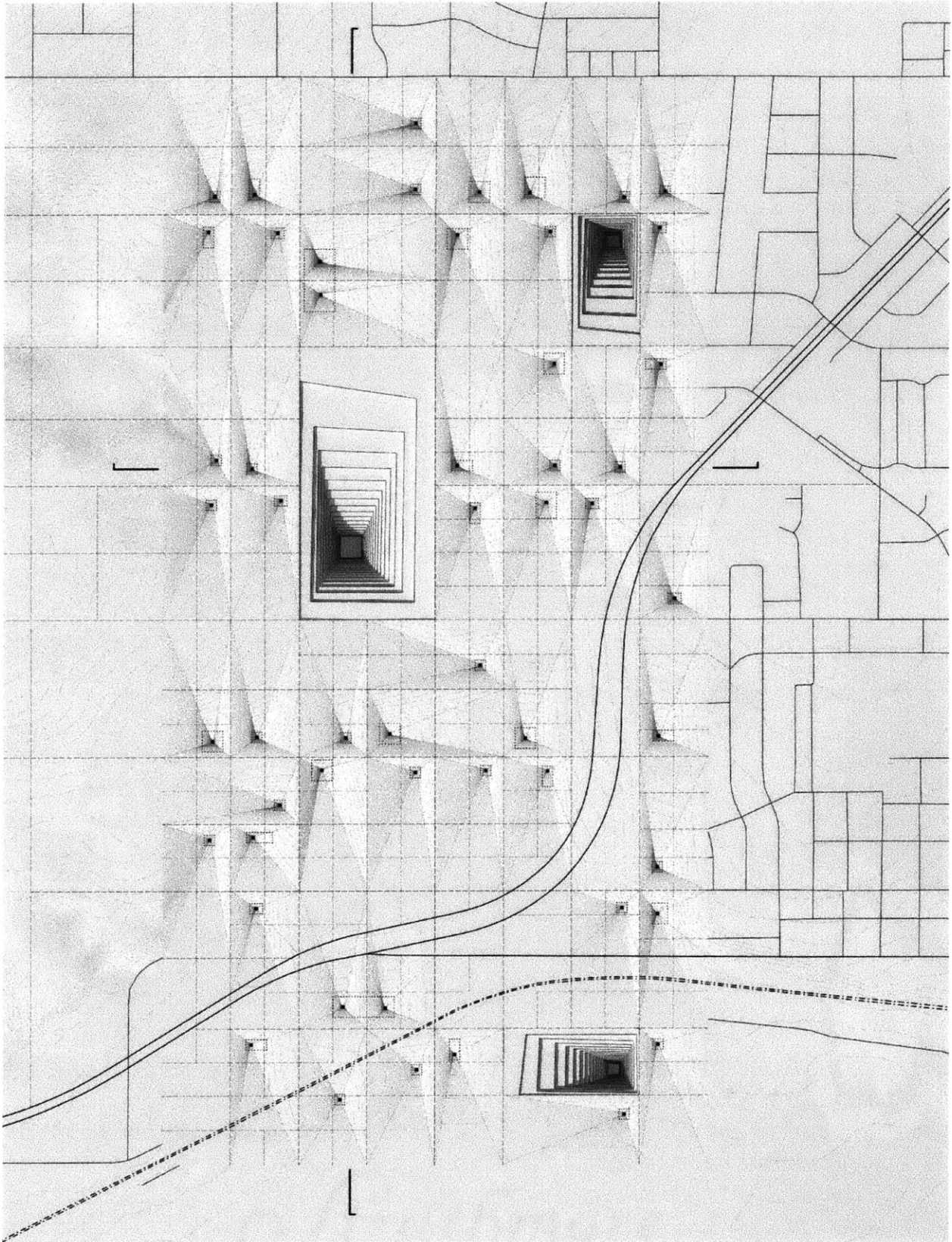


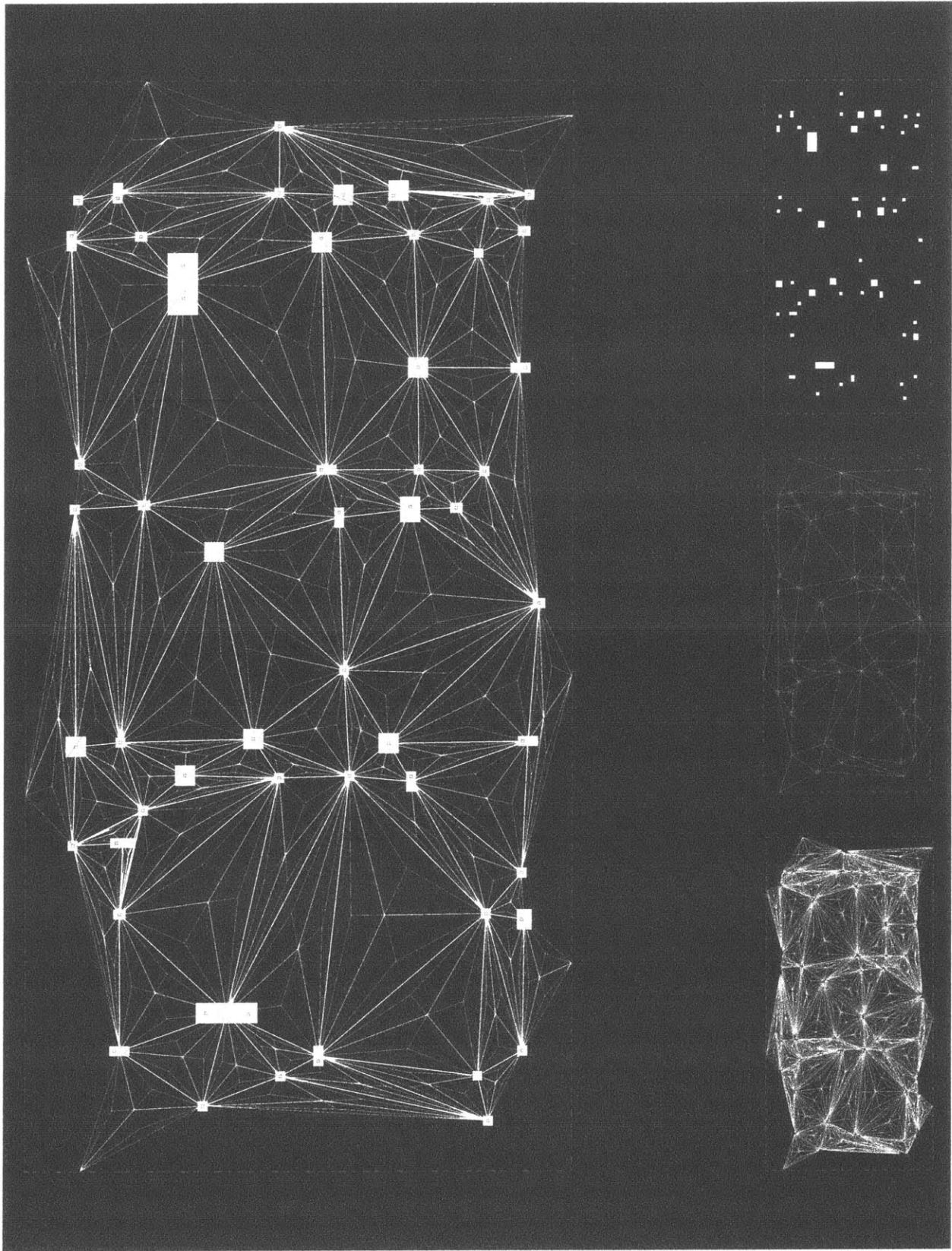
Penultimate landform model



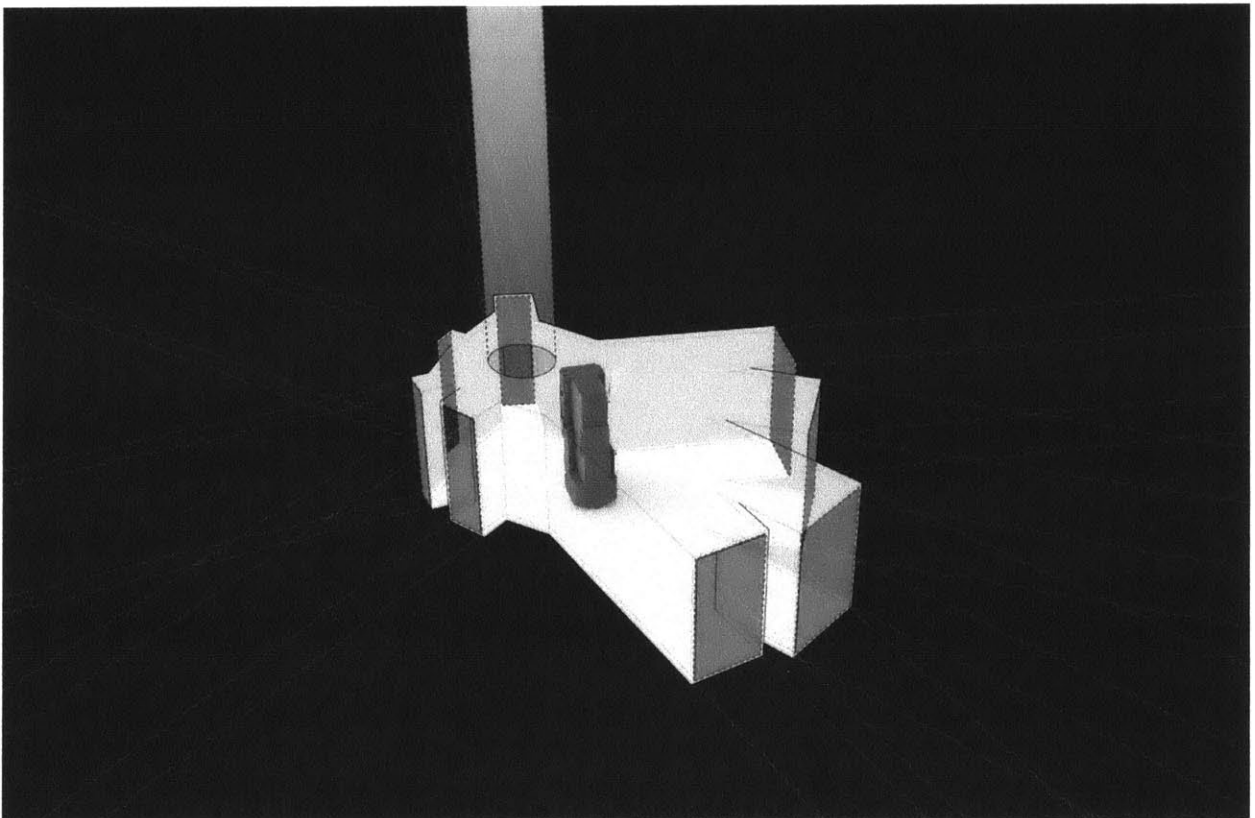
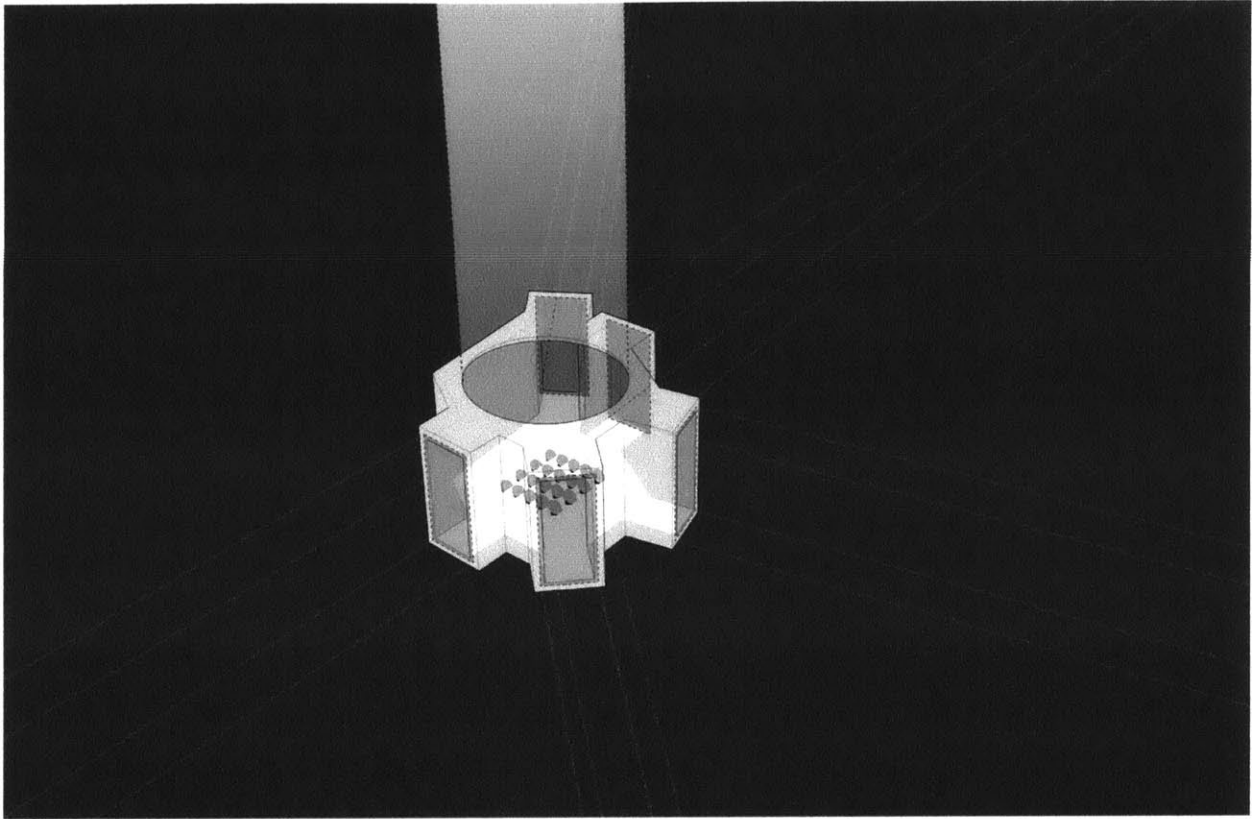


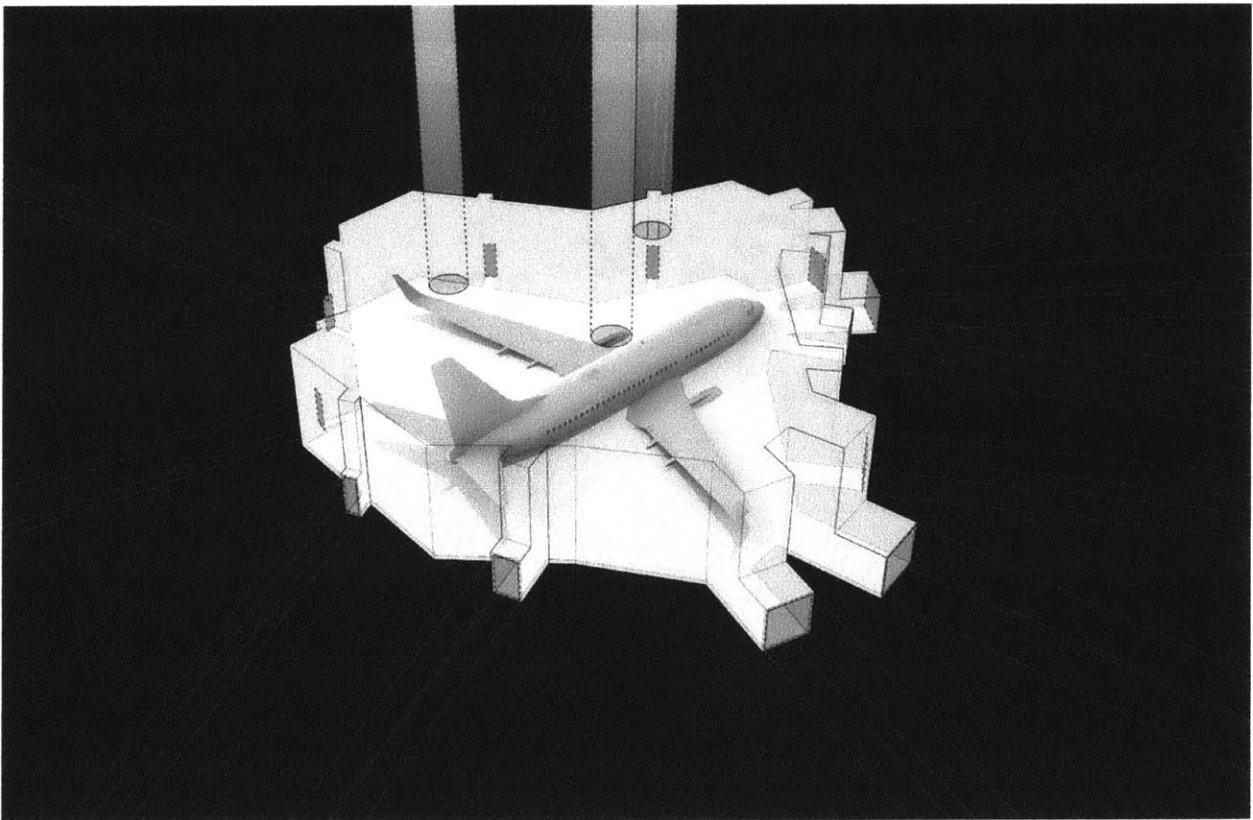
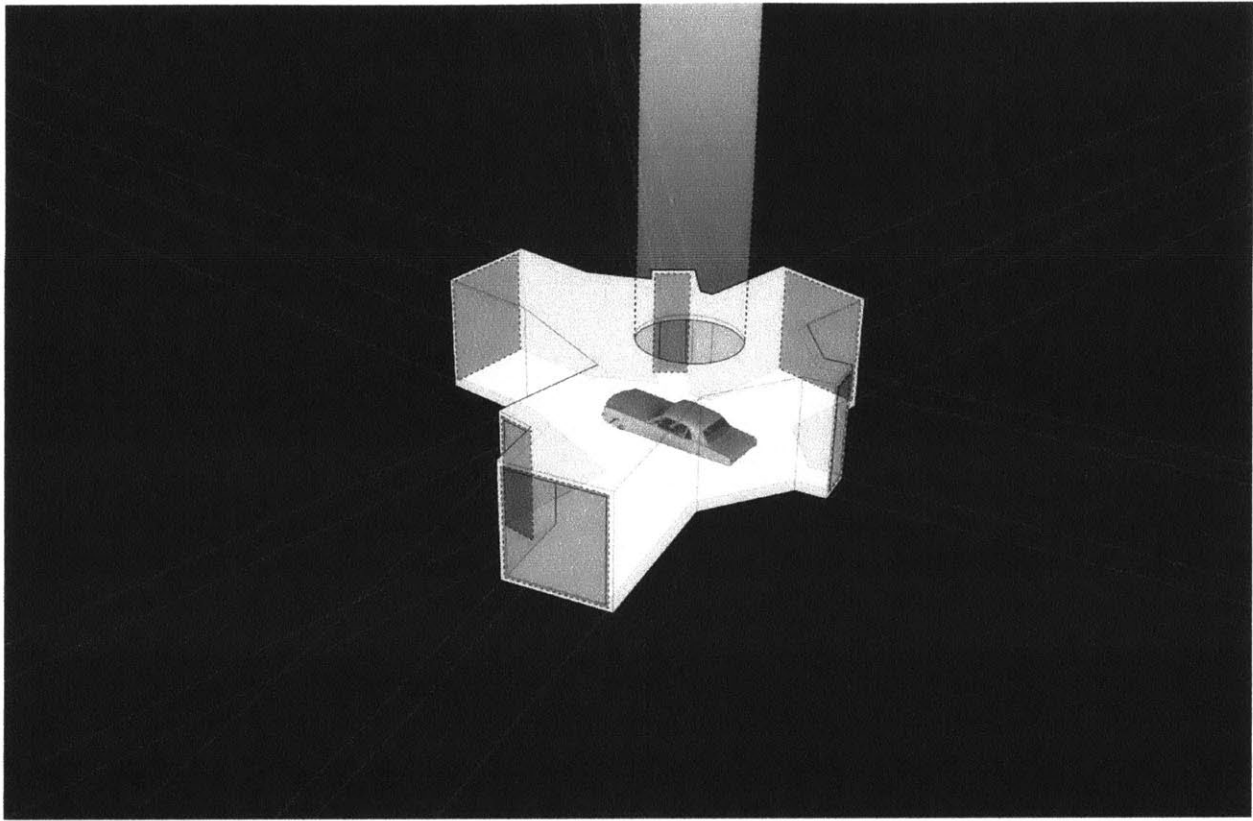


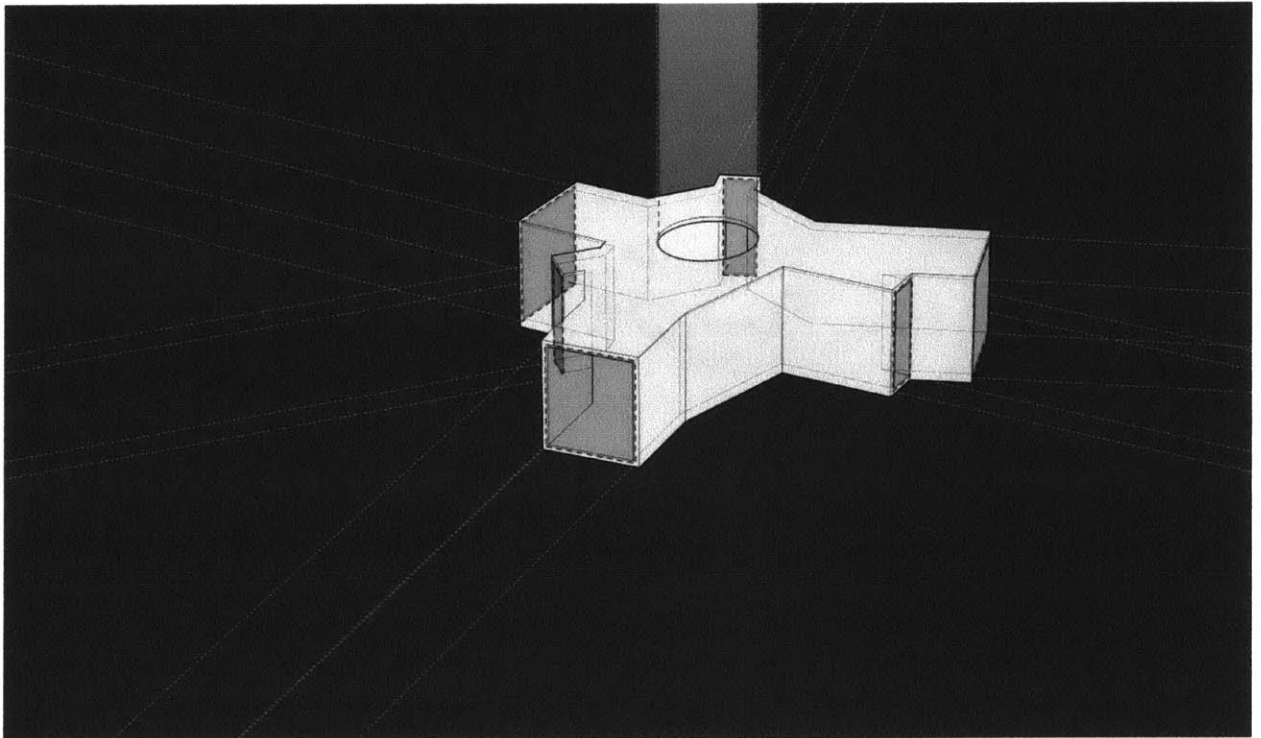
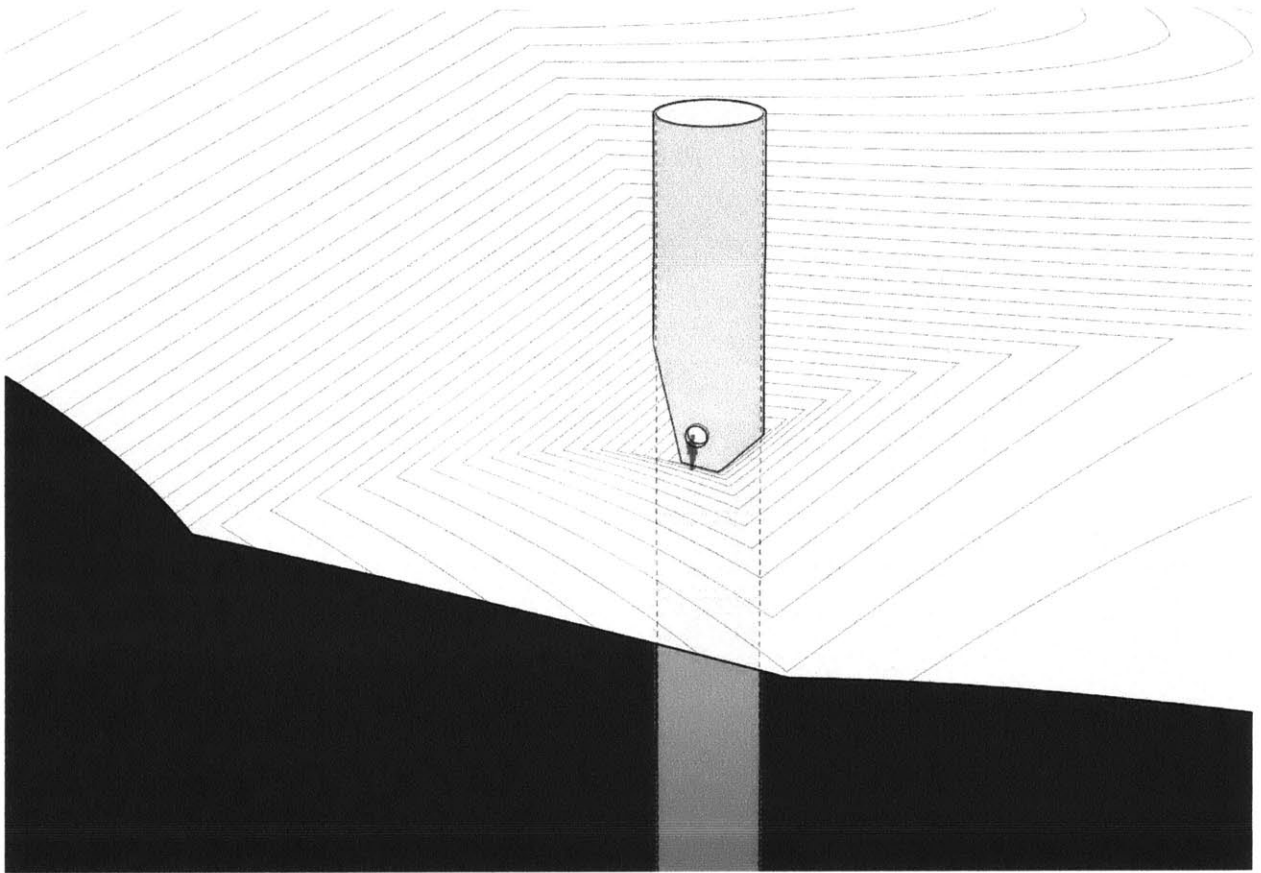


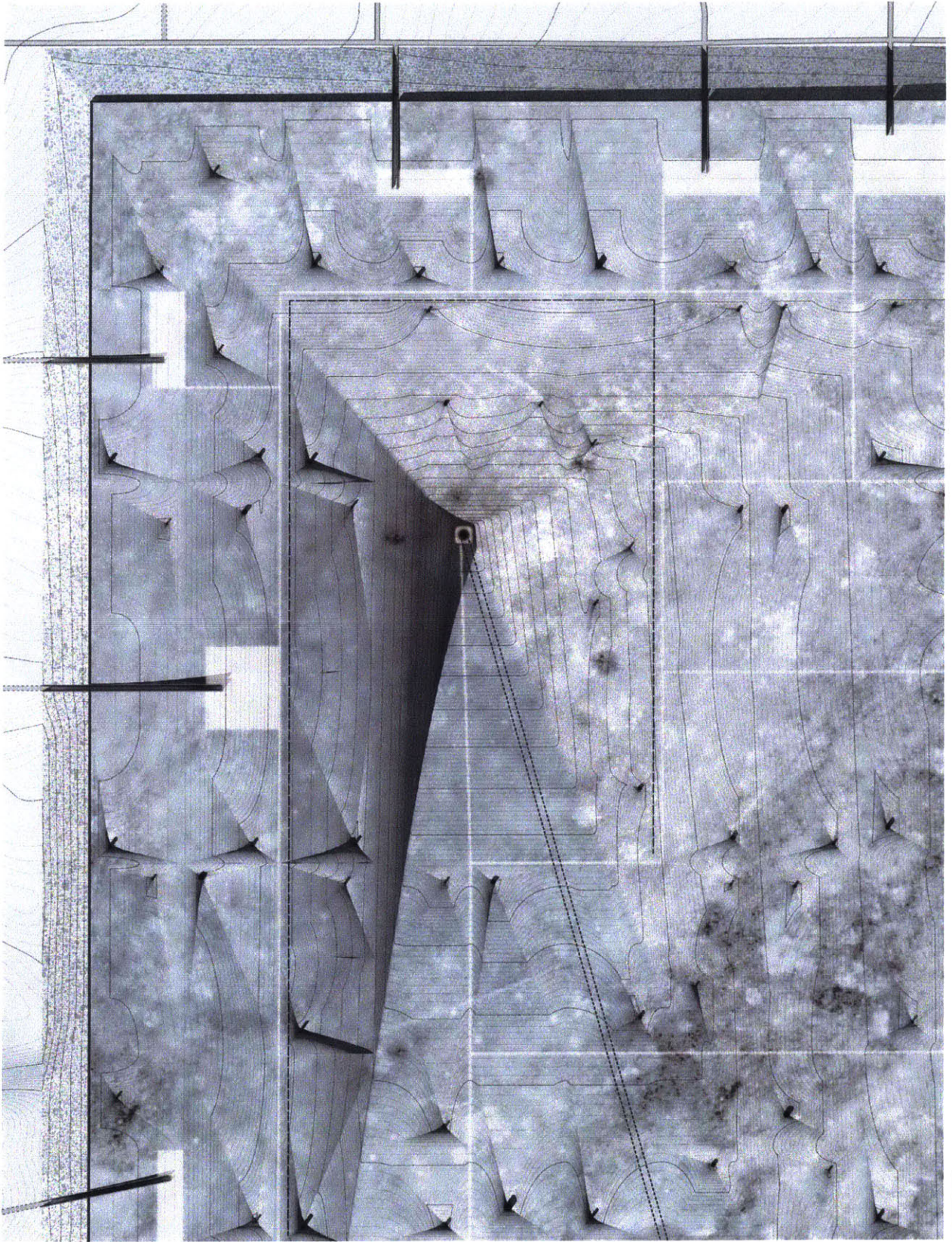


Midterm project scheme: subterranean plan.





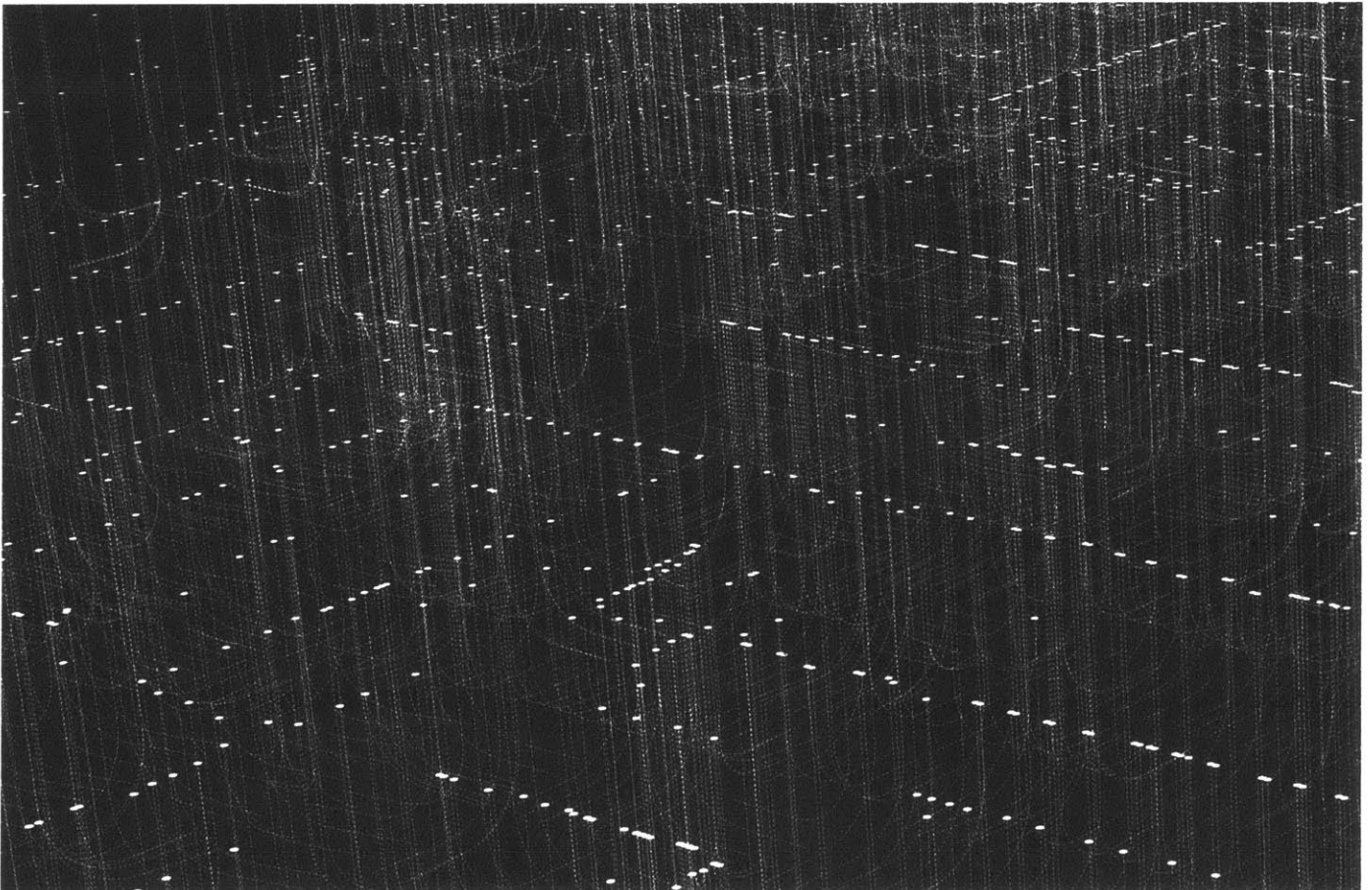


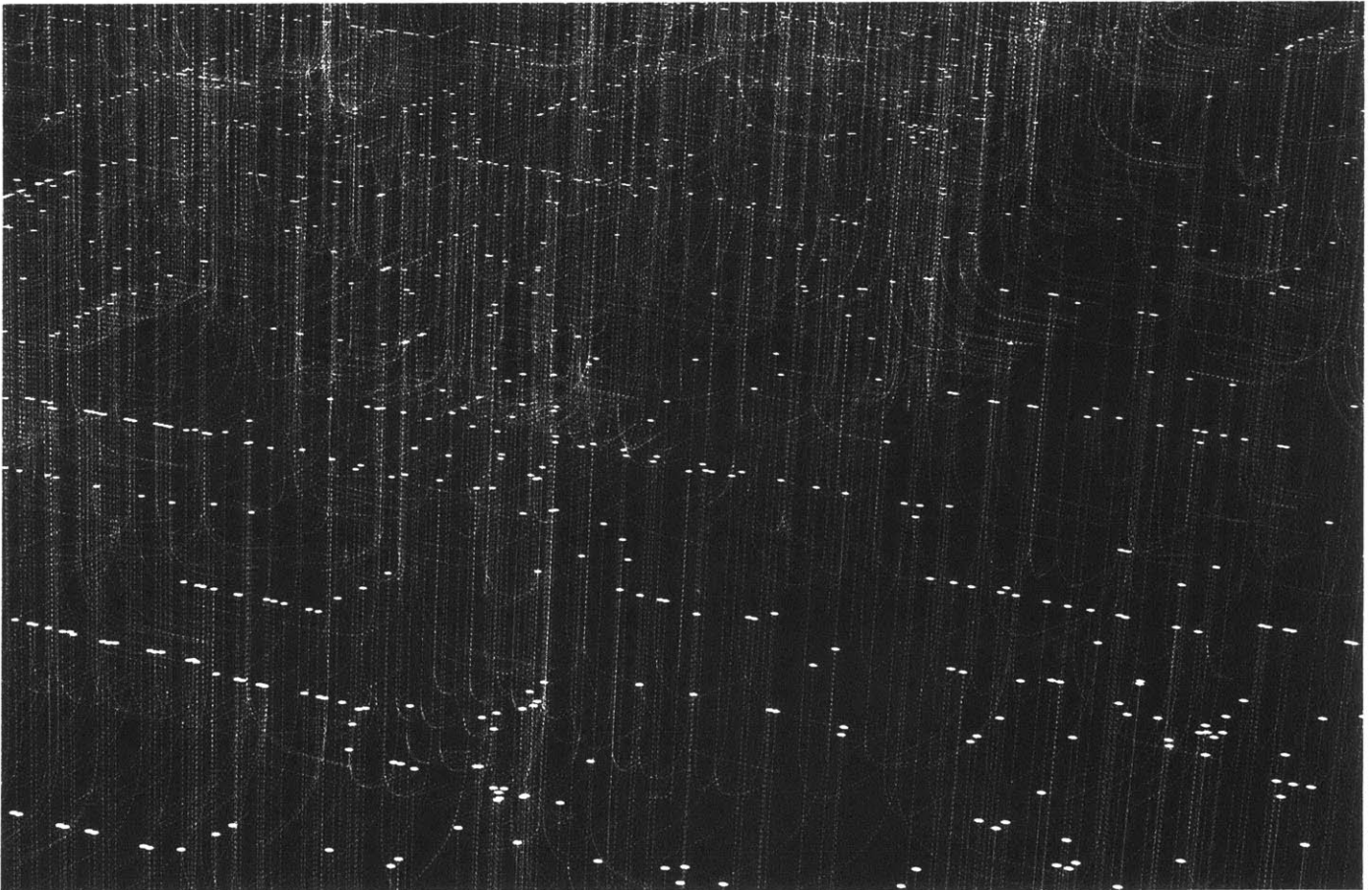


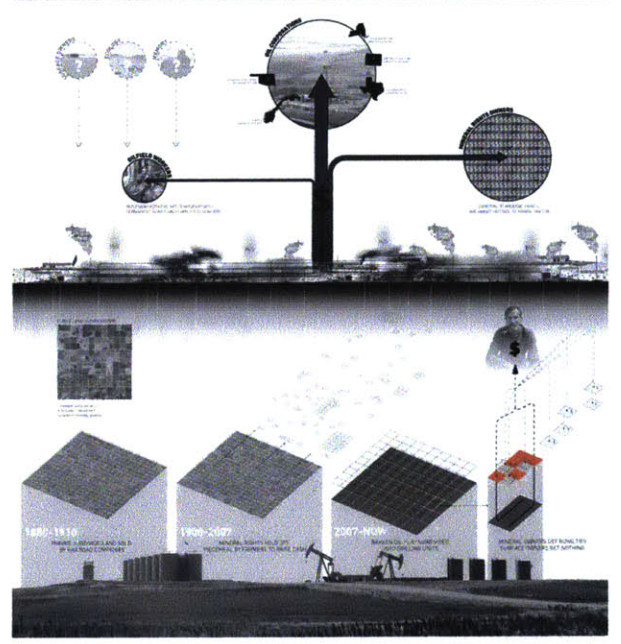
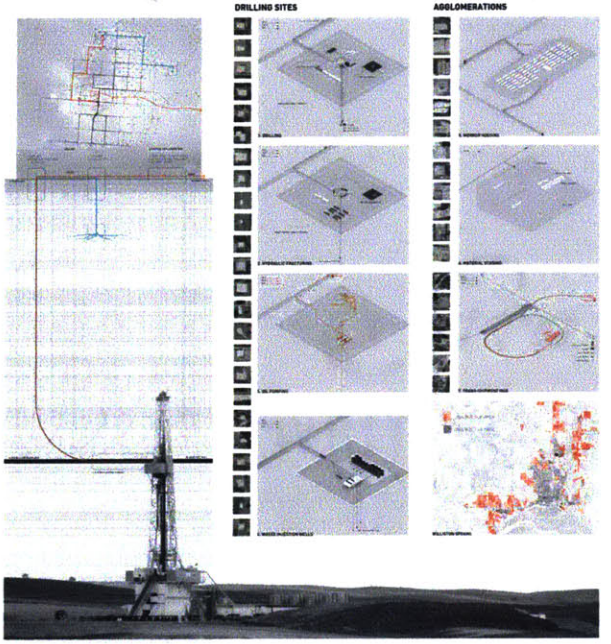
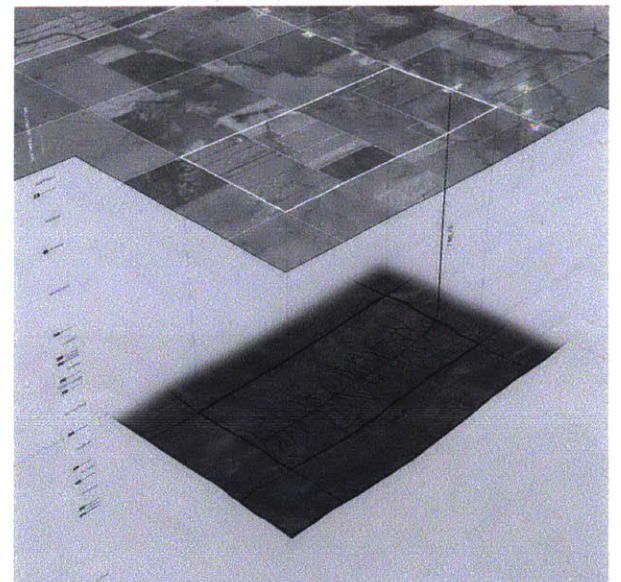
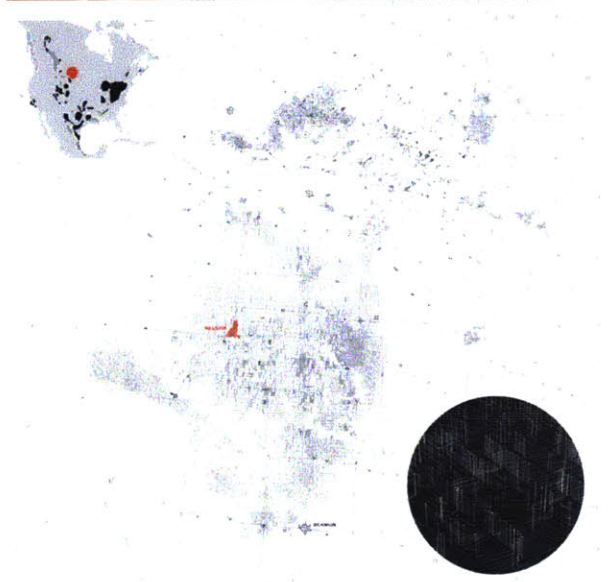
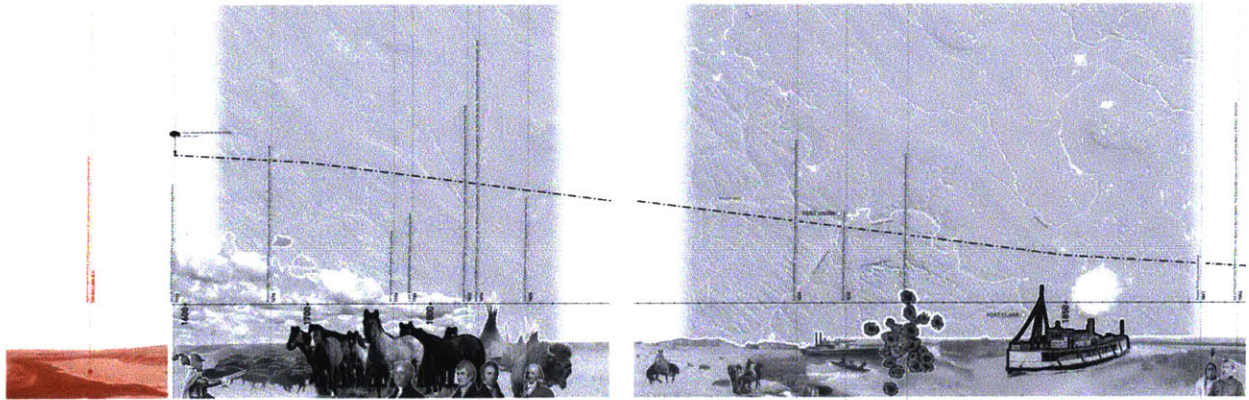
Landform plan

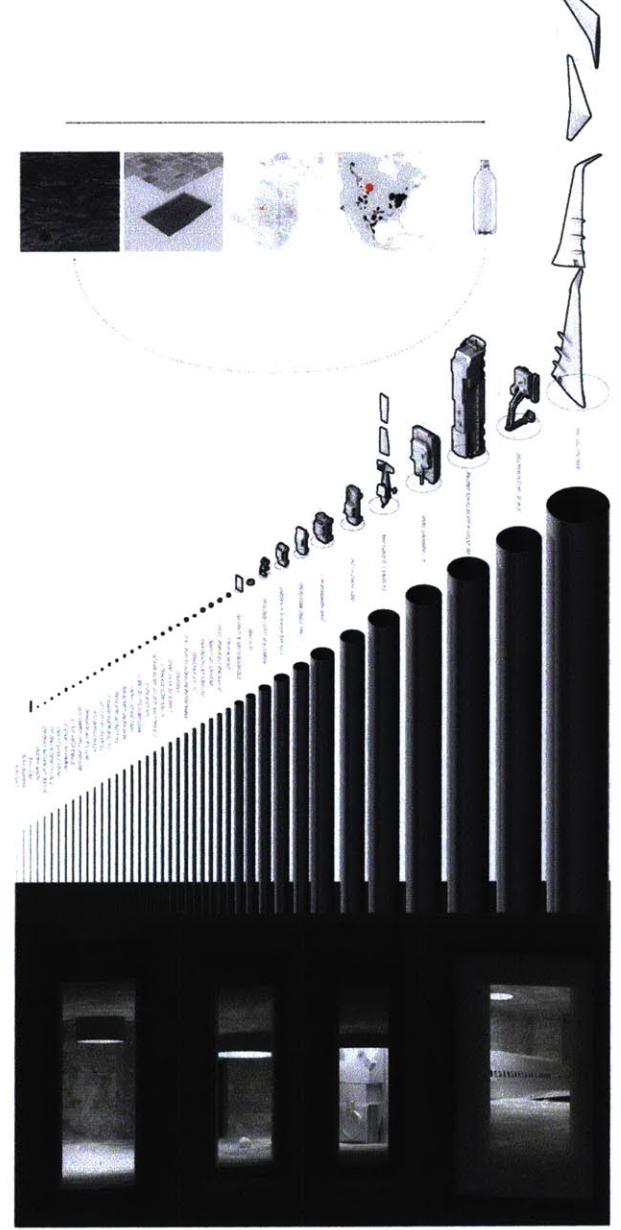
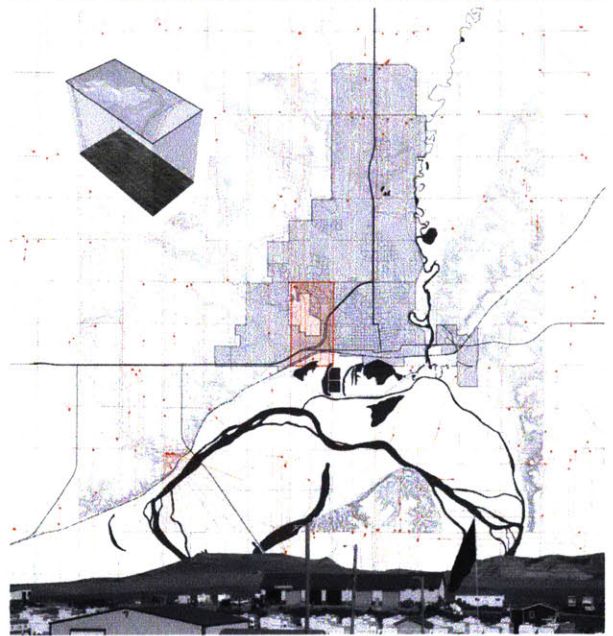
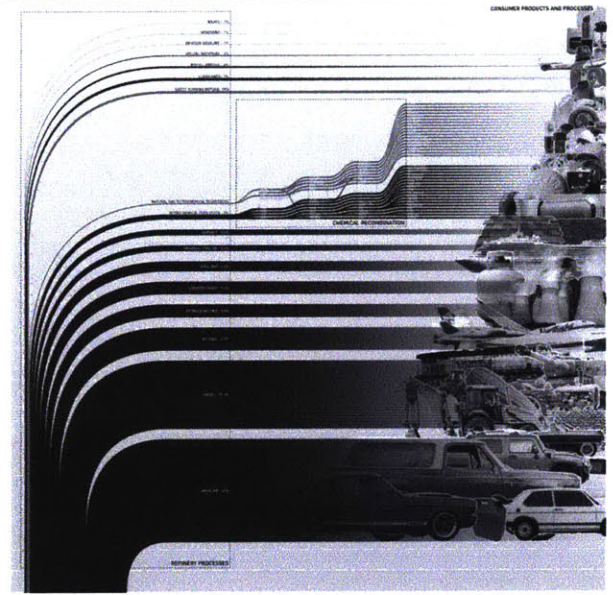
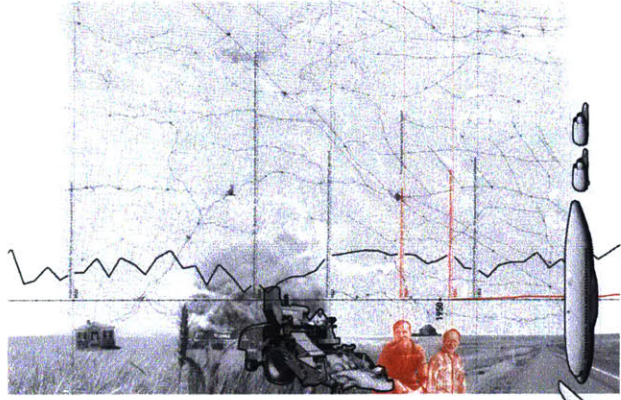
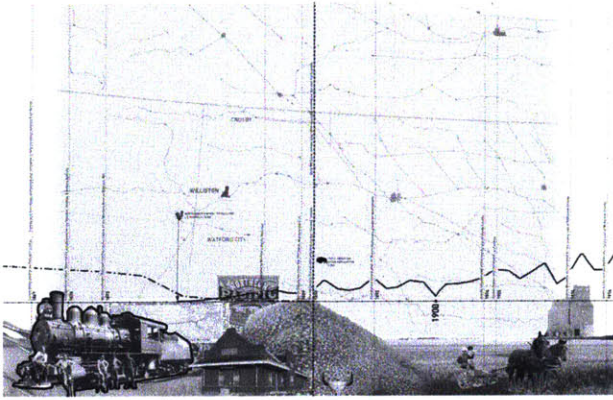
APPENDIX I

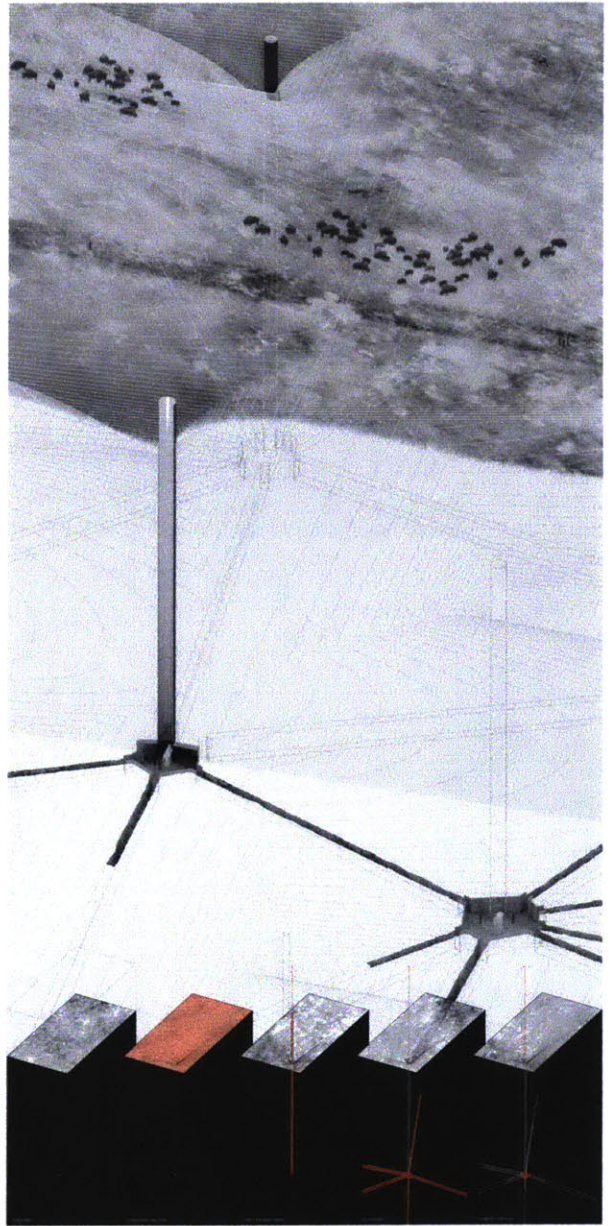
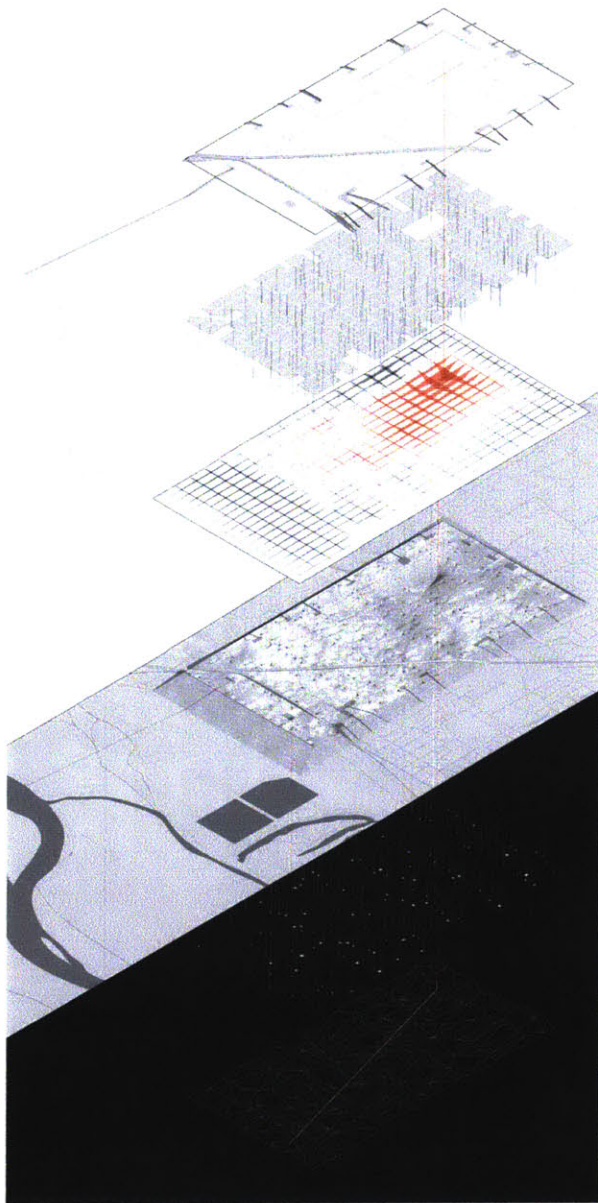
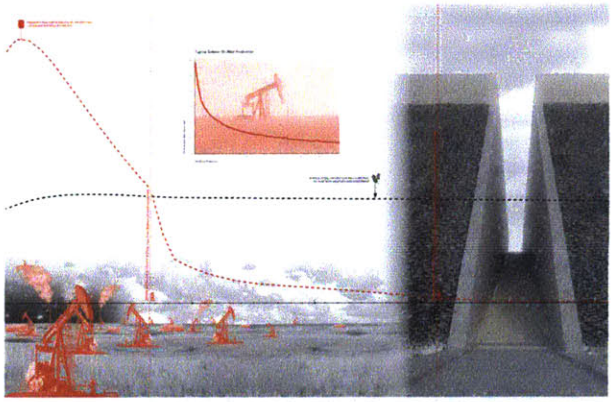
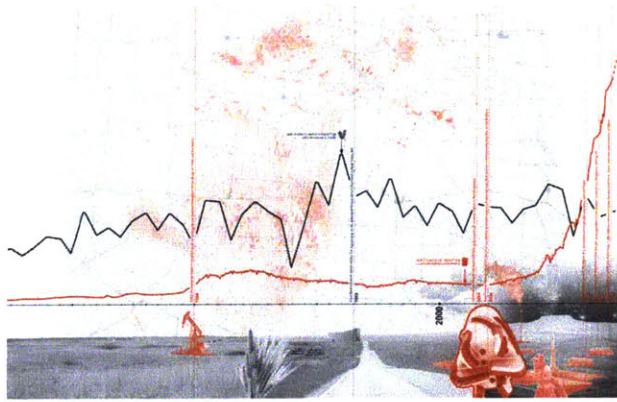
FINAL REVIEW PRESENTATION

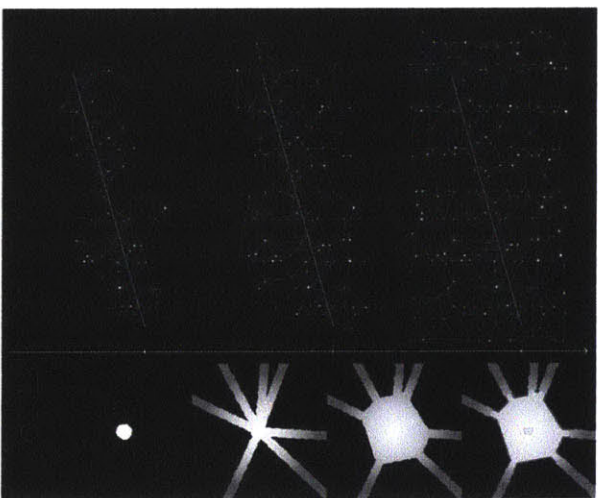
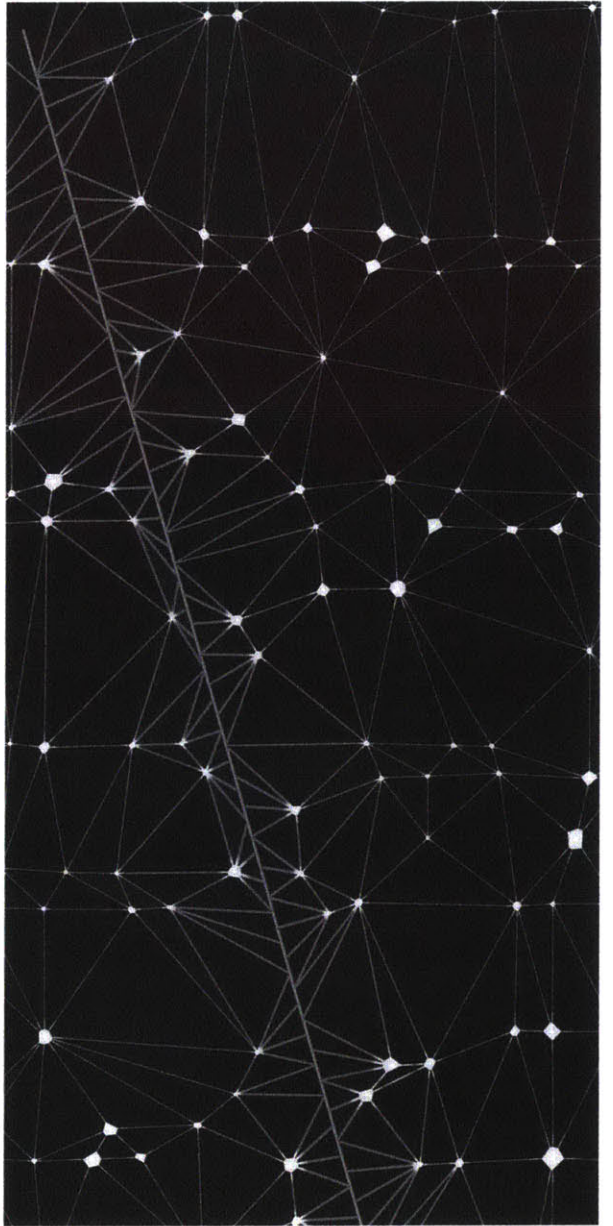
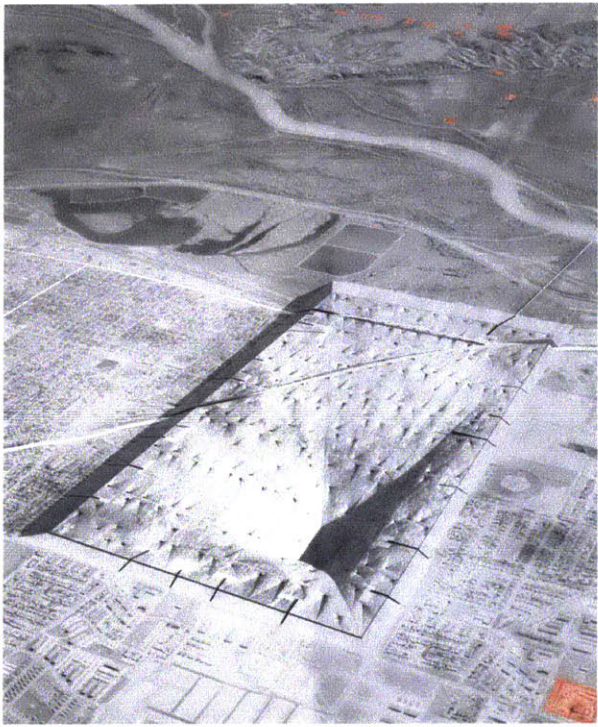
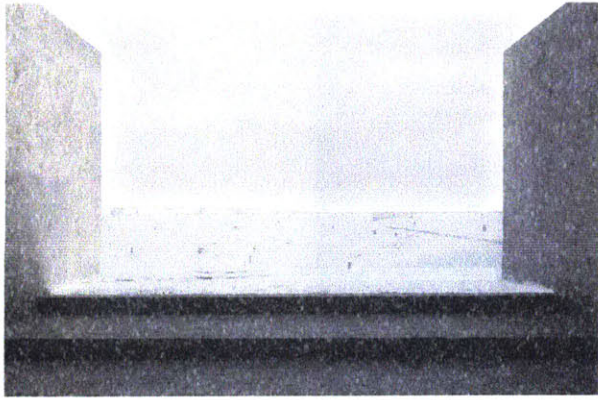


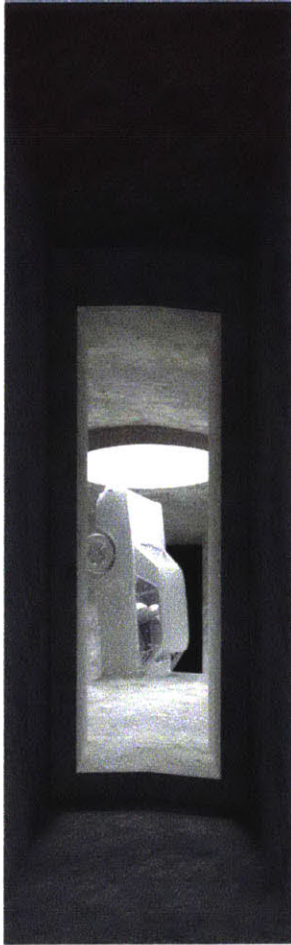
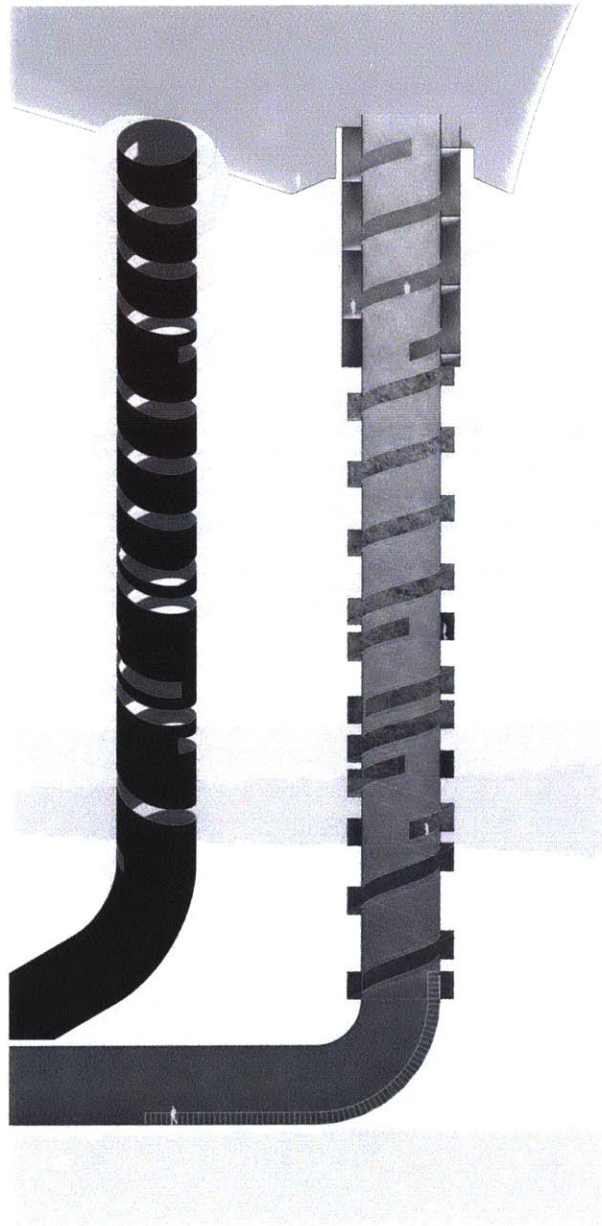
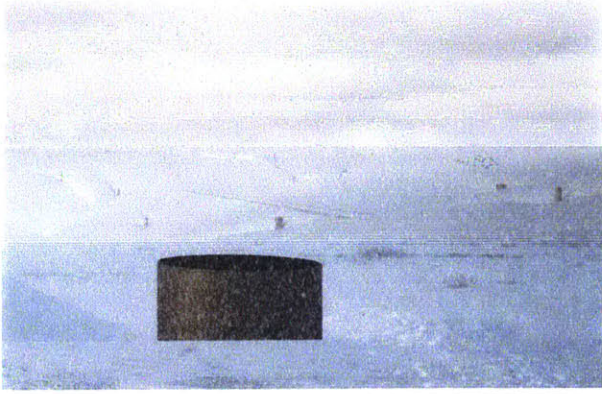














Final Review Jury

John McMorrough, Associate Professor of Architecture, University of Michigan

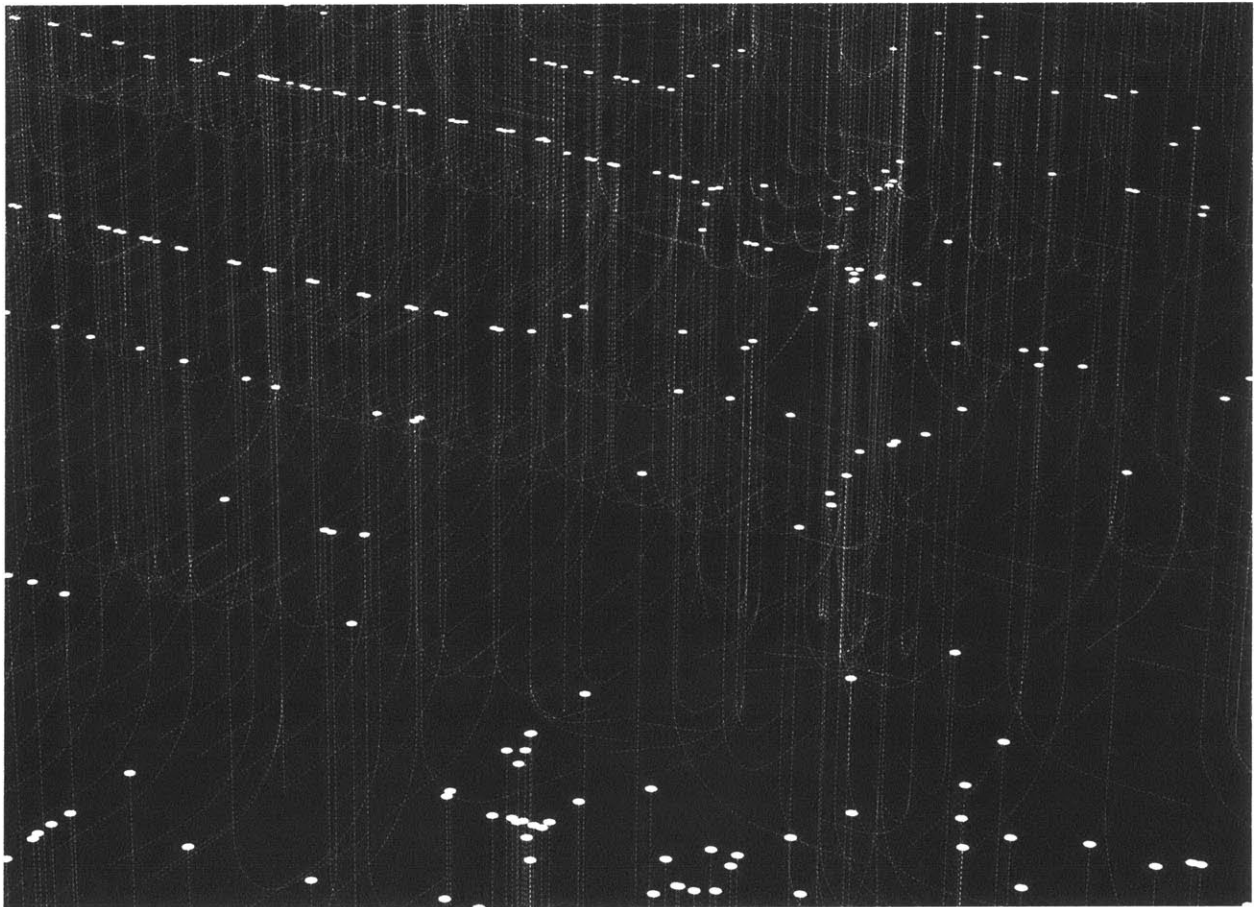
El Hadi Jazairy, Assistant Professor of Architecture, University of Michigan

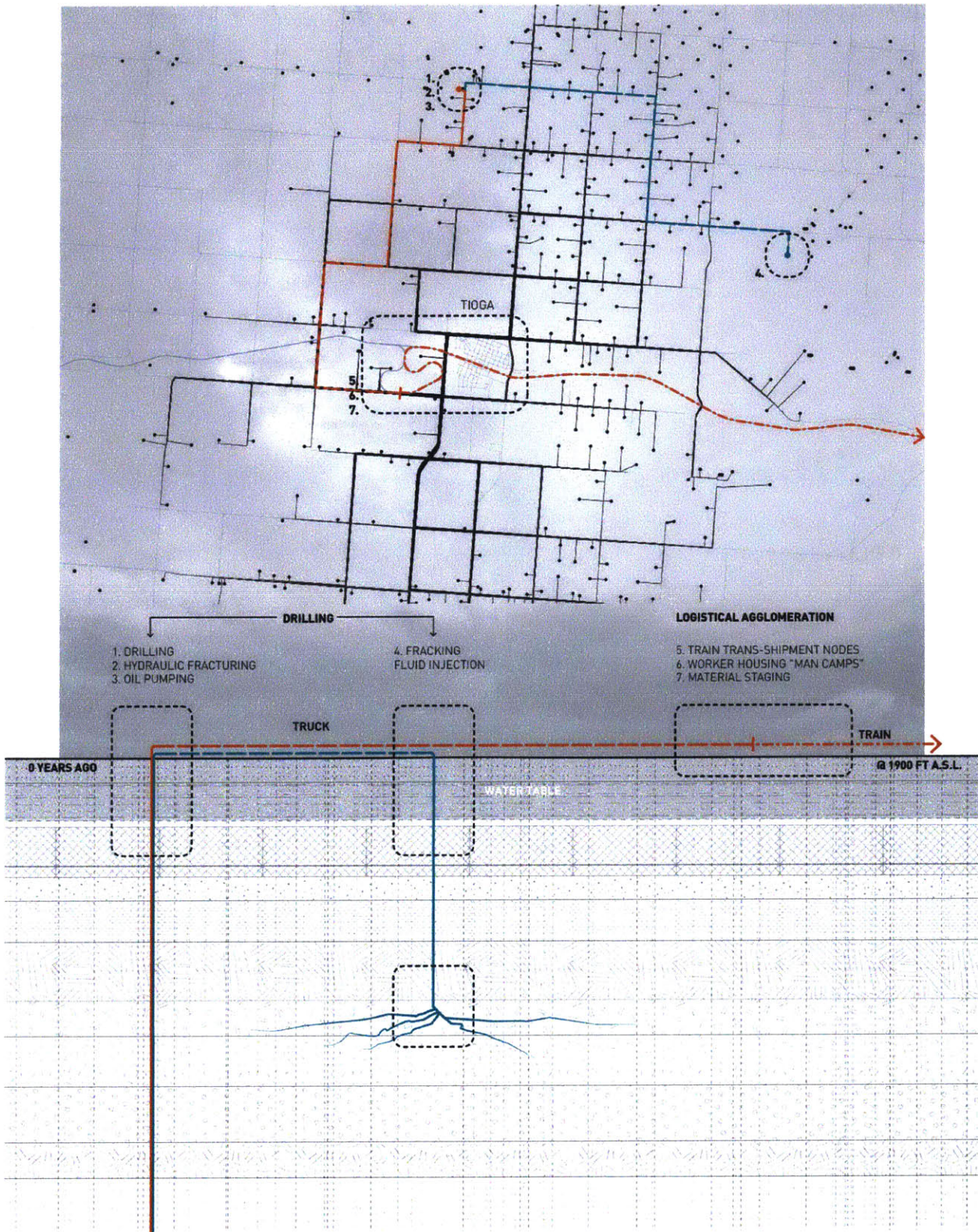
Hashim Sarkis, Dean, School of Architecture and Planning, MIT

Brandon Clifford, Belluschi Lecturer, MIT Department of Architecture

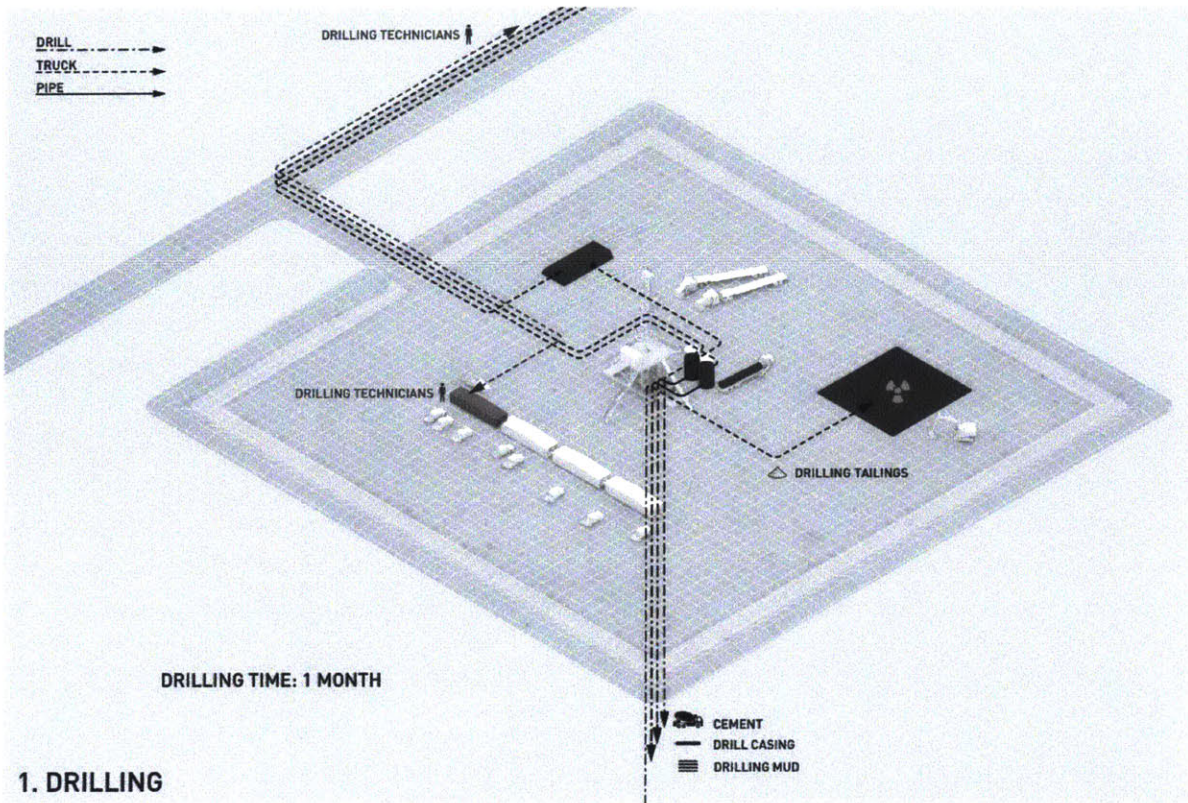
APPENDIX II

THE OIL EXTRACTION PROCESS

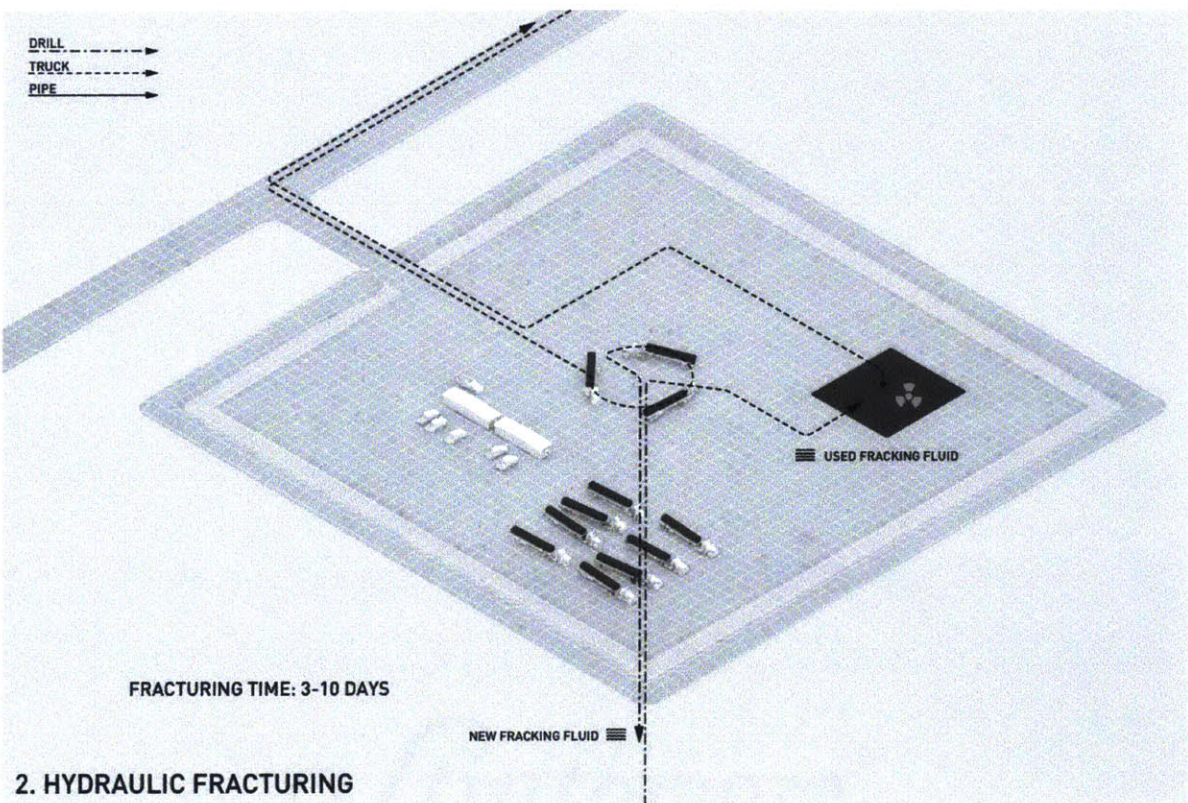




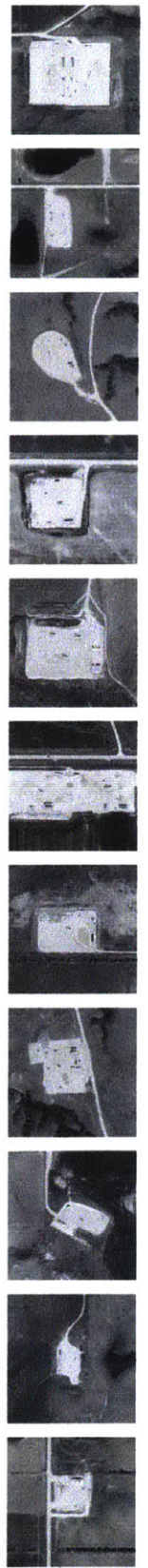
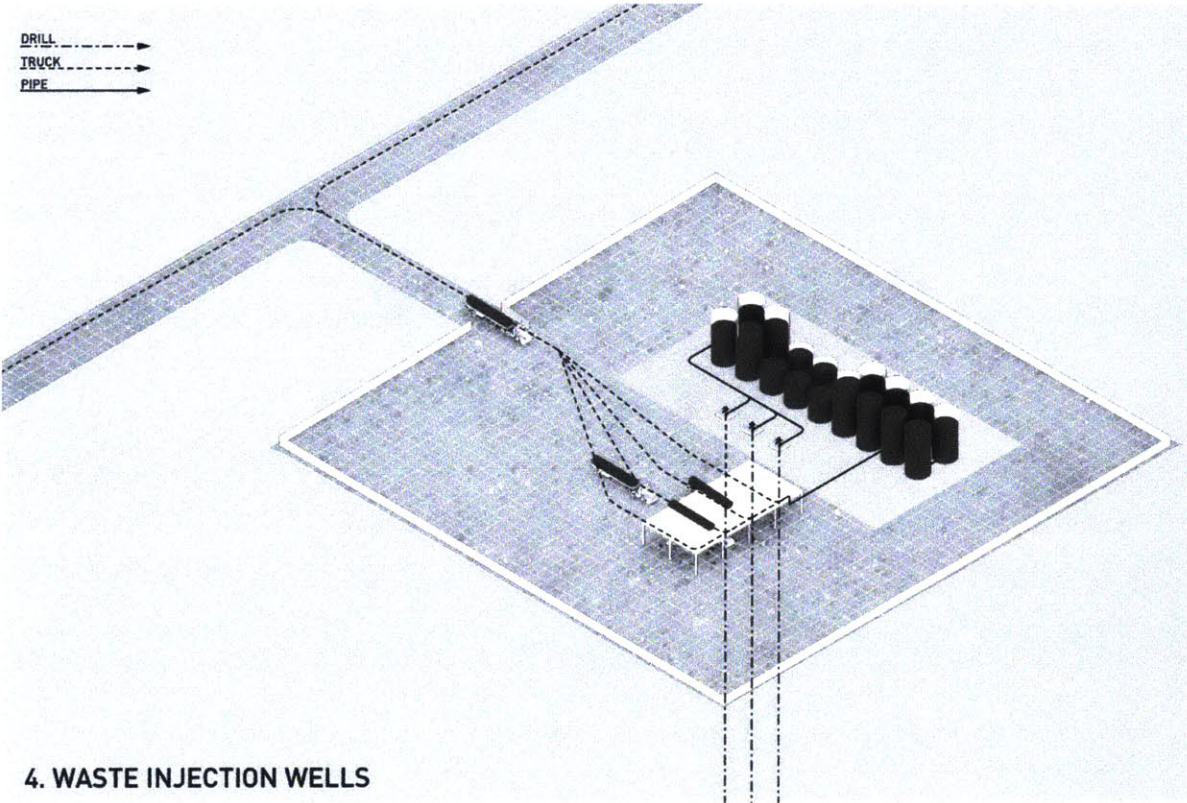
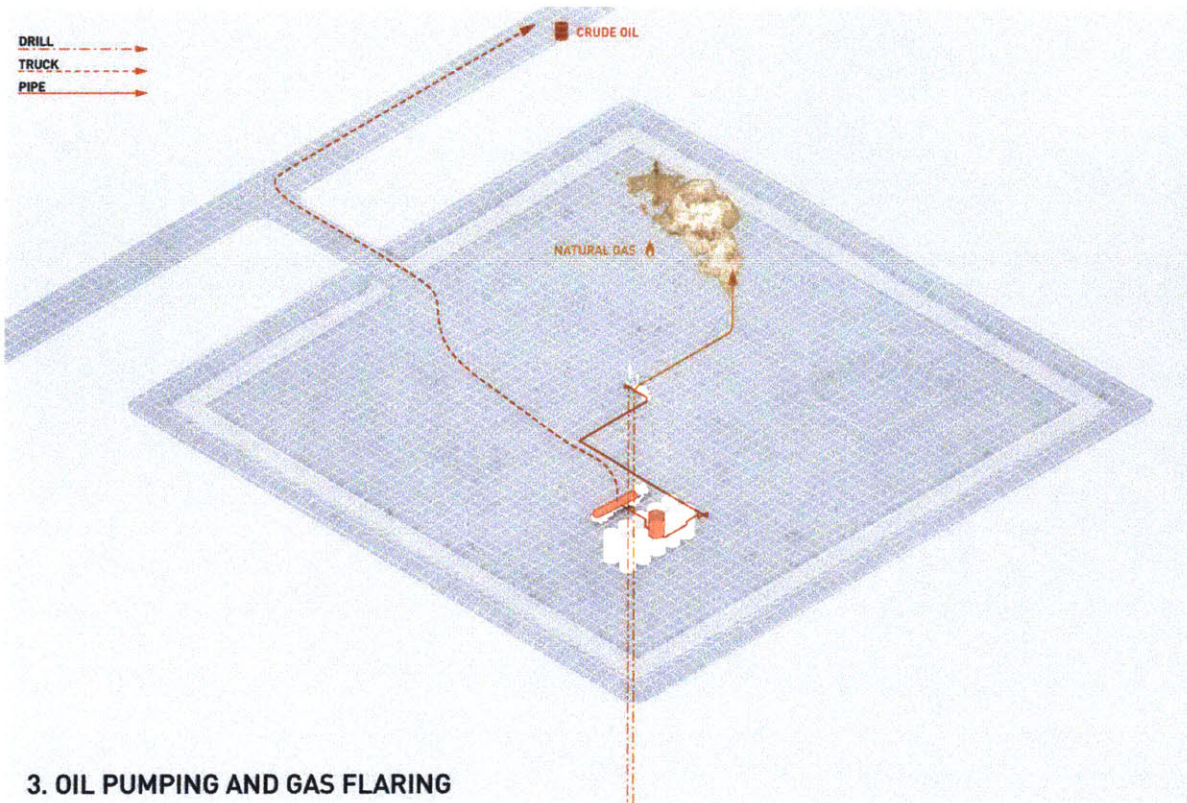
DRILLING SITES



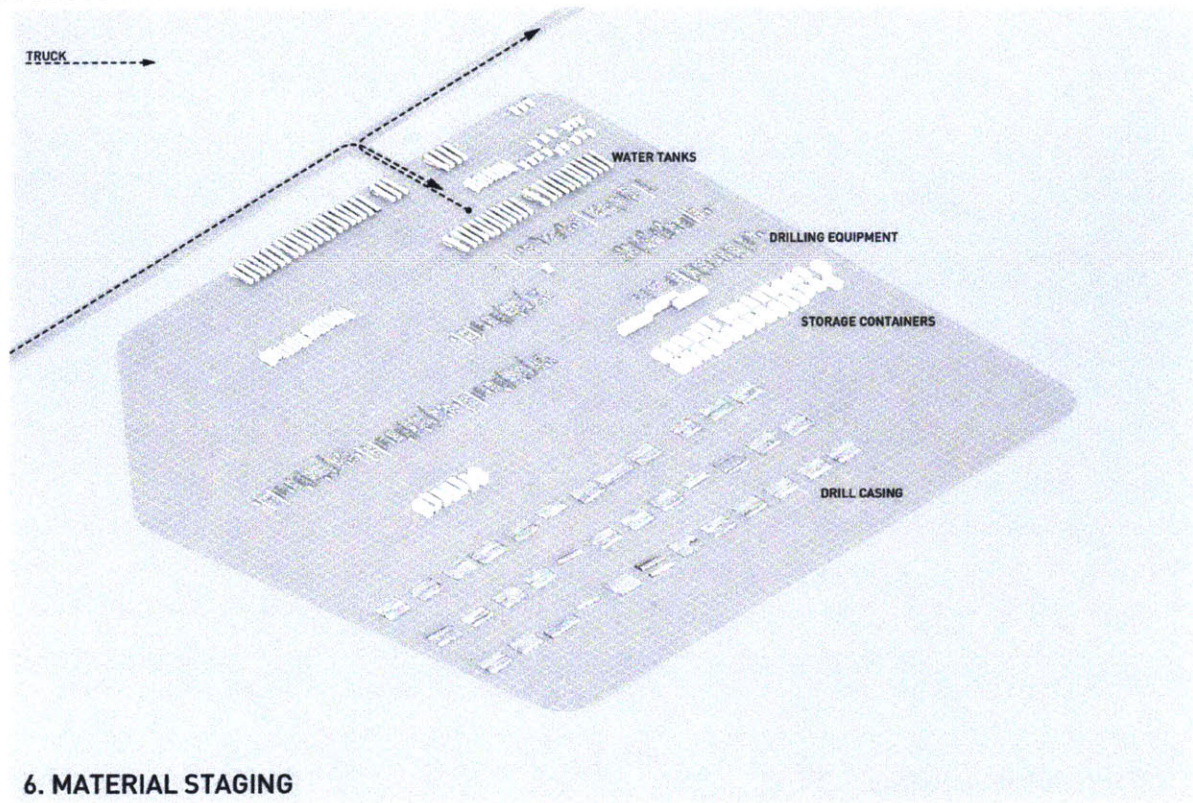
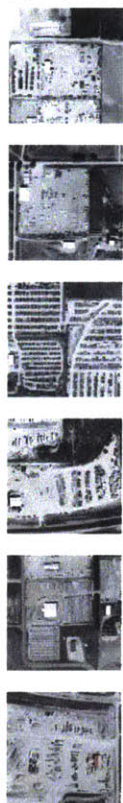
1. DRILLING



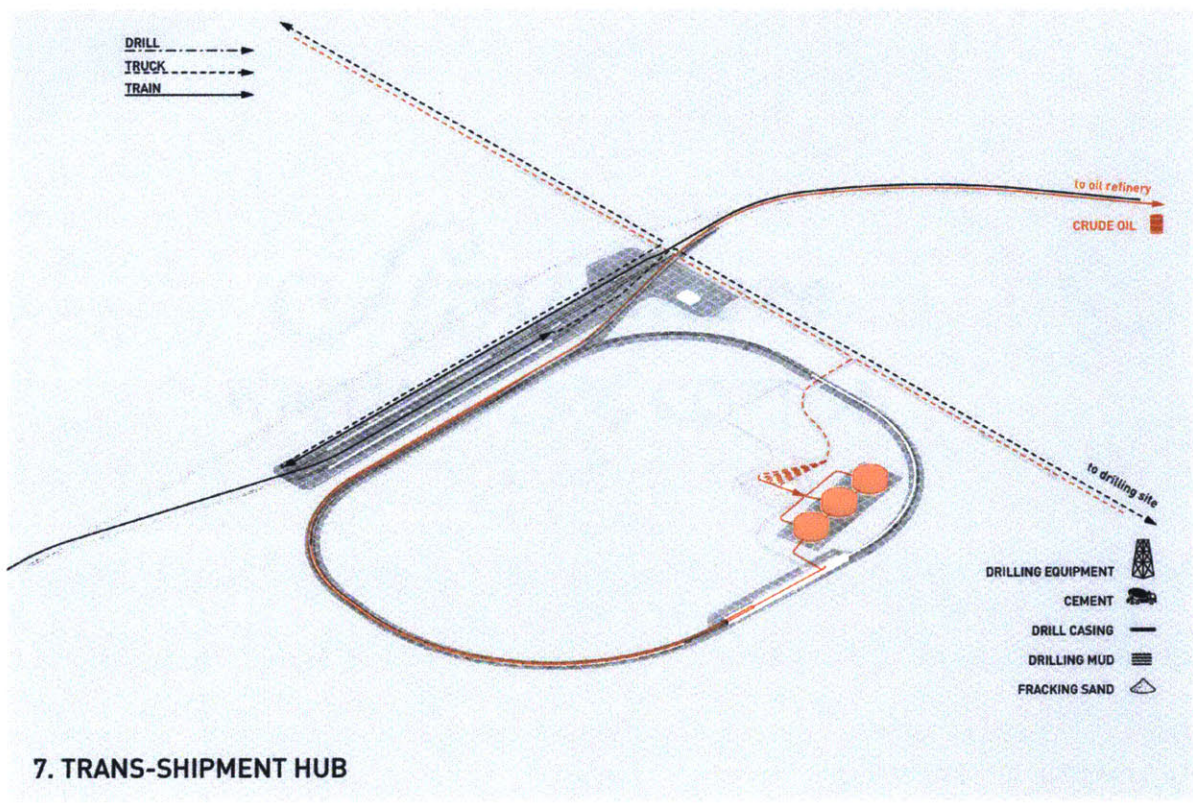
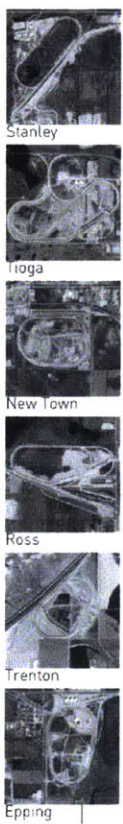
2. HYDRAULIC FRACTURING



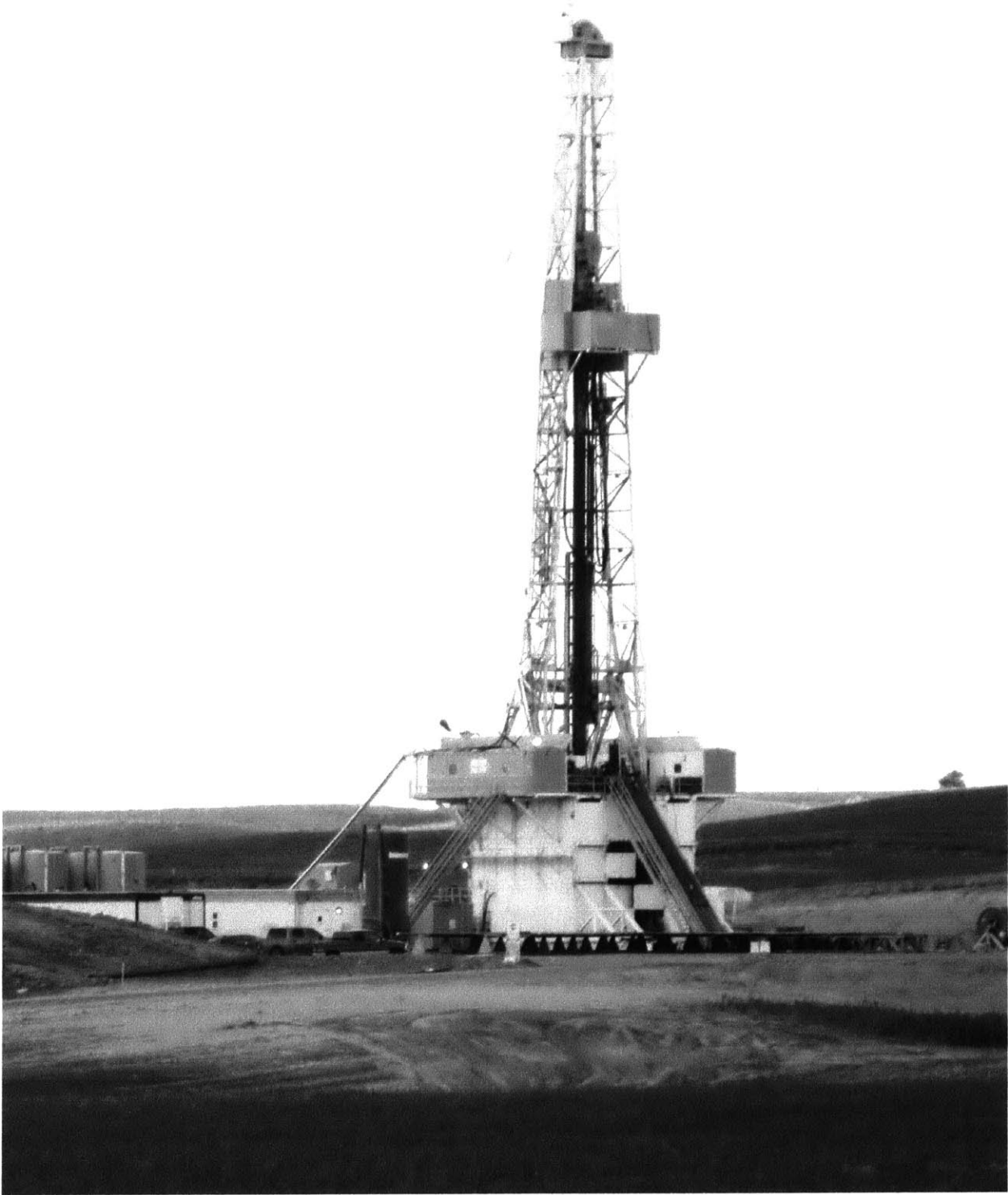
LOGISTICAL AGGLOMERATIONS



6. MATERIAL STAGING

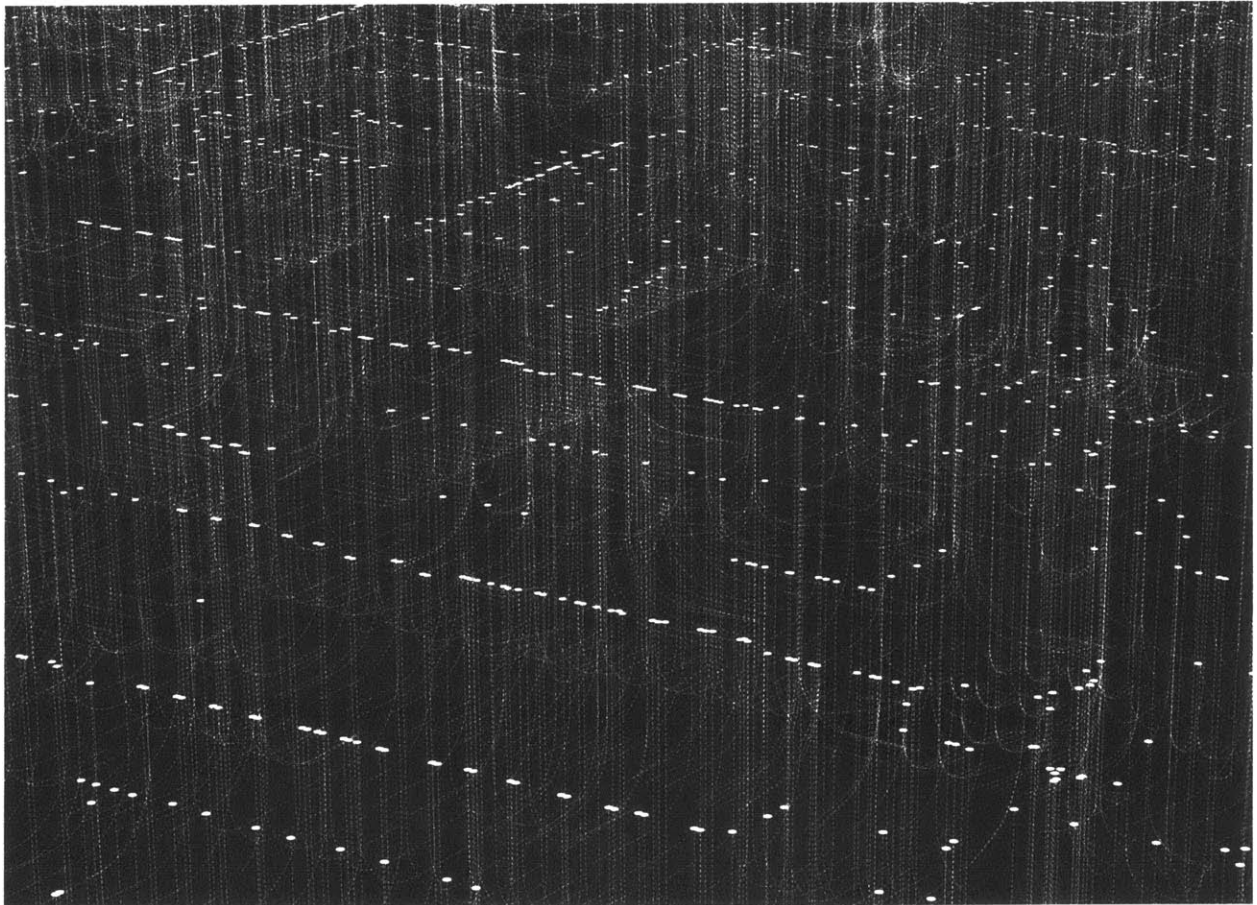


7. TRANS-SHIPMENT HUB



APPENDIX III

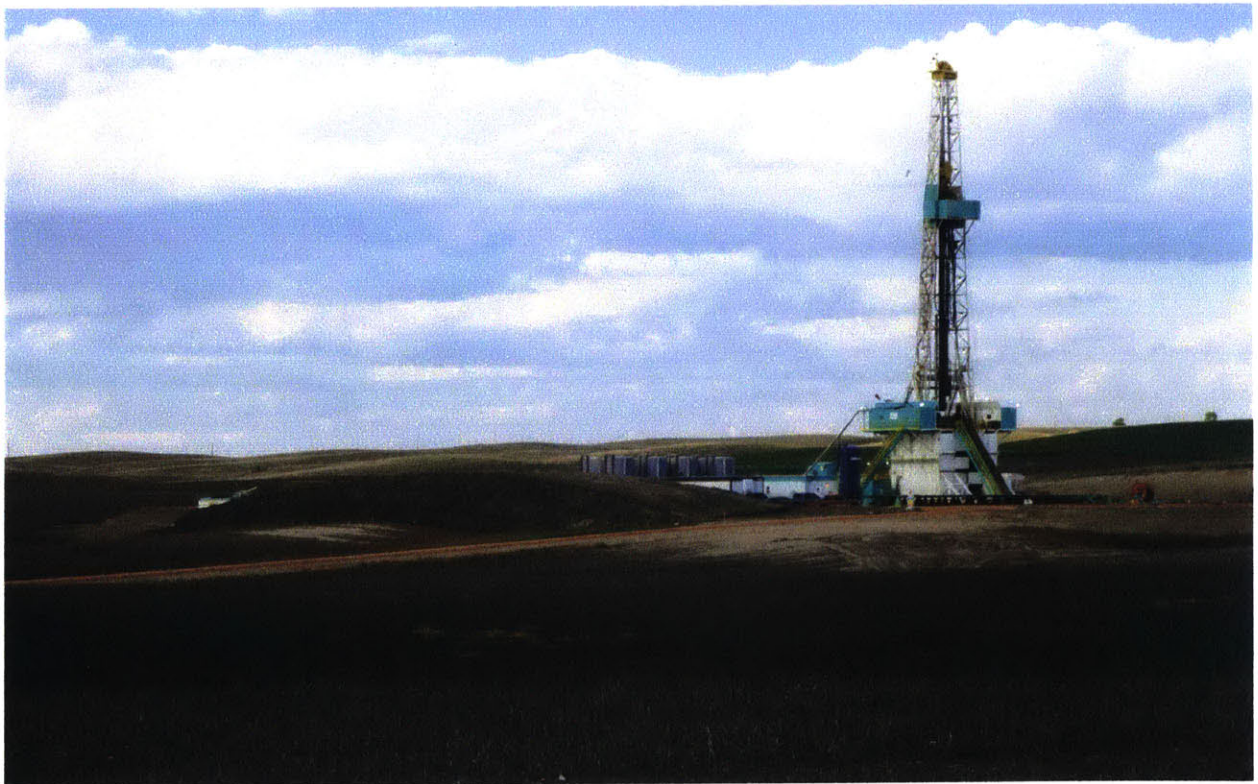
THE VIEW ON THE GROUND

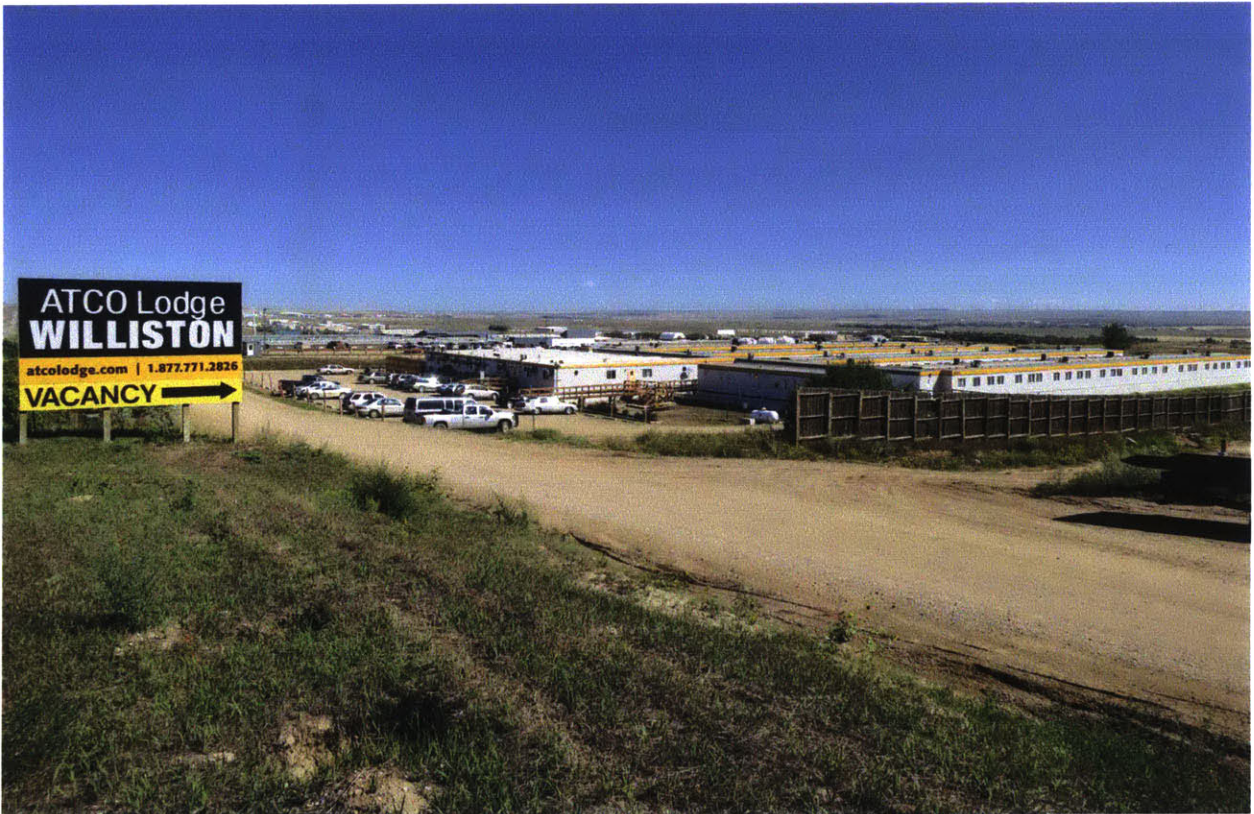




Site visit itinerary, August 2014







Boomtown development: worker housing.











