

DESIGN INVESTIGATION OF THE LAKE CALUMET COMPLEX:
IMPROVING WATER QUALITY TO REGENERATE LOCAL INDUSTRIAL,
COMMUNITY, AND ECOSYSTEM RESOURCES

BY

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THESIS

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ABSTRACT

This design thesis is an inquiry of the highly industrialized urban landscape of the Lake Calumet Complex on the South Side of the City of Chicago. It examines geologic and anthropogenic strata within this region as waste used for staging various social, industrial, and ecological systems. Today, these social, industrial, and ecological systems are not responsive to each other and certainly do not possess resilient attributes that would allow them to interact within the landscape in perpetuity. The resulting design strategy seeks to re-think the treatment of waste in the landscape into a new framework for future park design. This park will serve as grounds to interweave these complex systems in order to rehabilitate ecosystem functions and improve water quality. Additionally the park hybridizes many social and ecological functions to improve community recreational opportunities and gain public acceptance and appeal.

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INTRODUCTION

This project will reveal how landscape architecture, as a design discipline, can expose and reintegrate waste within the land into a new, productive urban landscape. Movement of water across the landscape serves as a critical indicator for how waste has been generated, transported, and stored. Careful analysis of water, waste, and landscape systems inform design for the creation of a new landscape type serving ecological, recreational, and industrial needs. This design uses Lake Calumet in Chicago, IL as the ground upon which to explore these ideas. Practical goals include the creation of a new park system that will use the improvement of water quality as a device to advance ecological, economic, and social systems of the area. This paper will focus on design and research done during the course of 2008 in the landscape architecture graduate thesis studio.

Understanding what the concept of waste means in this urban landscape and its relationship to complex ecological systems is crucial to designing future park systems. The point is not necessarily to understand how and why everything works but to identify and be aware of dynamic systems which are changing through time. The first chapters will explore this region as an accumulation of stratified layers of materials, both geological and human in origin. Understanding the history of this stratum will reveal how waste can be integrated into the future park design and exploited as media that improves water quality rather than impairing it.

The second chapter will explore how water quality is an indicator of ecological health and particular challenges of low water quality in the Lake Calumet Area. Diminished water quality is a direct consequence of its anthropogenic strata, its layers of displaced fill and refuse. The paper then shifts into theory and concepts of waste. This section focuses on recent academic literature pertinent to the figurative and metaphorical discussions of waste in the landscape and presents information outlining the City of Chicago's agenda for dealing with Calumet's waste. The fourth chapter is a description of a conceptual landscape of strategic processes that challenges these concepts of waste and physical layers of strata by detoxifying earth and waterways and constructing new grounds for public space. Design in this thesis is a response to previously laid strata, biota, and associated ecological, social and industrial resources of the area. It shows that developing positive interactions between systems leads to restoring resiliency back into the social and environmental systems within the landscape. Rather than emitting pollution, the landscape can stabilize, neutralize, and metabolize pollution.

The thesis ends with reflections on the process and product and a re-examination of the park's design as it pertains to facing uncertainty and achieving practicality.

Chapter 1

WATER, LAND-USE CHANGE, AND POLLUTION

1.1 Location: geographic scale of the project

- *Calumet Region*: The Southern Region of Lake Michigan. Boundaries within Chicago and adjacent suburbs in Illinois and Northwestern Indiana. This region shares a common geological and ecological past and similarities in recent economic and social growth.
- *Calumet Complex*: Includes Lake Calumet and its associated local ecosystems and the industrial land surrounding it - namely the Calumet Industrial Corridor. The boundaries are Cottage Grove Avenue to the west and Avenue O to the east; the northern boundary is 99th Street and the southern boundary is 130th Street.

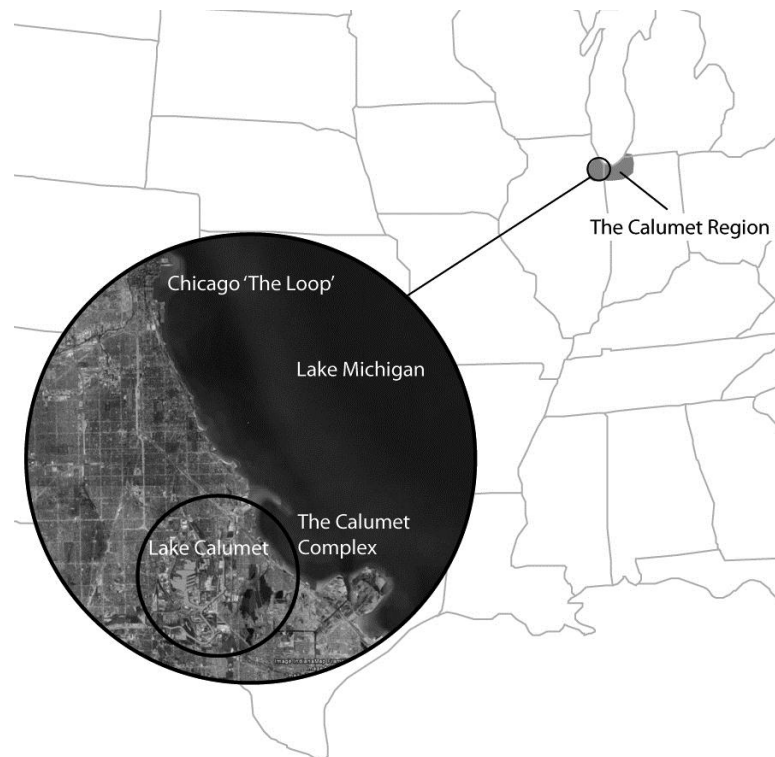


Figure 1.1: Location Map of the project scale. Highlighted are the scale difference between the Calumet Region, the Calumet Complex, and Lake Calumet; the latter two of which fall into this projects scope of design. Aerial photograph taken from Google Earth accessed on 6.6.

1.2 The evolution of a swamp to a city

Up to the mid to late 19th century the far south side of Chicago, within the Calumet Region, was a landscape comprised primarily of wetlands. Early reports describe it as a landscape with indistinct

boundaries due to rising and fluctuating water levels, often impassable due to its saturated soils. Today it is a local extension of the nation's 'rust belt.' This section will examine the formation and development of the Calumet region as more than a physical and political geography but as a stratification of materials, processes, and interactions. This information is critical to understanding and implementing future design decisions.

1.3 Strata: bedrock and soils

During numerous geologic eras from the Cambrian (570 million years ago, vertebrates began to evolve) to the Pennsylvanian (286 million years ago, just pre-dinosaur) the Calumet Region was largely underwater. The essential geology of this region comes from stratified layers of limestone that were deposited over this roughly 280 million year time frame. Much of the source for limestone is calcite; a mineral derived as a byproduct of ancient marine organisms. These primitive organisms used calcium as a building block to construct their protective shells. For millions of years these organisms collectively secreted massive quantities of minerals from the mineral rich oceans and thrived in the primitive developmental stage of the planet. When the organisms expired they sank to the bottom of the ocean and mixed with other sediments (sands, silts, and clays). Through the course of time the continuous cycles of life, death, and deposition formed these limestone layers that would become the bedrock for present day Illinois. These layers can be seen today as one drives east–west on Interstate I-80 across the well-known Thornton Quarry on the far South end of the metropolitan Chicago area (Illinois Department of Natural Resources, 2000). Here, this 280 plus million year old rock is mined and used as an aggregate material in concrete, cement, and as a base for many construction projects within the area.

1.4 Strata and biota: soils and plants

Pedogenesis is the process from which soils are created. Soils are a product of complex interactions between the atmosphere, biosphere, hydrosphere, and lithosphere. This process re-organizes and dissolves elements from within these spheres allowing new life to evolve (Chesworth 2008). In the Calumet Region this process largely began during the Holocene Epoch, which began roughly 10,000 years ago. Strata were once again defined by the interactions of biotic and abiotic forces.

Calumet soils are an amalgamation of materials that were deposited on top of the limestone bedrock by expanding and retreating glaciers (till) as well as deposited from Lake Michigan's fluctuating water levels (lucustrine). Additionally, many of the soils were windblown deposits (Loess) that settled after the glaciers began their retreat. More localized influences in soil types are caused by organisms (plants, invertebrates, soil micro fauna, etc.) that contribute larger quantities of organic material like peat, plant roots, and nutrient rich detritus to the soil layers (Illinois Department of Natural Resources, 2000).

Plant communities in the Calumet Region began to establish after the glaciers from the last ice age retreated. They largely organized according to their water and nutrient requirements; they also organized by their ability to adapt to changes and disturbances within the landscape, such as periodic flooding and drought conditions.

Many of the lowland areas typical in the Calumet region have frequently saturated soils, poor drainage, and high water tables. These conditions led them to develop into what are considered wetlands today. Wetlands can physically, and legally, be defined and identified by their very particular plants, soils, and hydrologic conditions (Lewis, 2001). Of importance to this research are the physical connections of these systems to the strata with which many co-evolved.

Diversity in wetland plant communities is further defined by the interactions of plants to their strata. Some plant communities developed in neutral to slightly acidic soils, others in more alkaline soils. This is a result of ground and surface water movement through strata which transports dissolved minerals to the associated plant communities.

Peat bogs are typical ecosystems that developed under neutral to slightly acid soils or similar types of conditions. They are a result of the accumulation of organic debris and slow anaerobic decomposition resulting in increased free hydrogen ion availability, or acidic conditions. In many cases these conditions cause nutrients to precipitate from suspension in water resulting in general deficiencies. Groundwater that is stored and transported in the bedrock and deeper soils underneath many of these systems is distinctly separated from the upper soil and vegetation layers above. Much of the water that feeds these systems comes from overland flow. As a consequence of being disconnected from deeper groundwater sources they are disconnected from a mineral supply - in the Calumet Region this mineral supply is mostly calcite. Many of these ecosystems support specialized, sometimes less common, plants. Common plant types in peat bogs include graminoids (grasses, sedges, and rushes), herbaceous plants, and shrubs.

Calcareous wetland fens are another type of wetland which evolved in systems quite different than bogs. These wetlands have upper soil layers that are connected to the subsurface layers which allows for water movement through their strata. Groundwater that passes through the bedrock strata carries dissolved trace amounts of calcite. Where this process occurs the results are neutral to alkaline soil types. Plant communities that evolved in these calcareous soils typically include graminoids, herbaceous plants, and some shrub species. Organic matter also accumulates in large quantities in this type of system as growth exceeds decomposition (Chadde 1998).

Wetland types such as marsh and swamp can be found in greater numbers in the Calumet region as well. Both have unique vegetation types but also generally less specialized and ambiguous hydrologic cycles.

Wetlands in all forms are rare in present day Illinois but especially rare are the particular types, locations, and quantity of wetlands in the Calumet Region. What are found in the region today are more extreme versions of these water and land relationship. In many instances they are either largely disconnected or hyper-connected by anthropogenic layers of material. Water that flows through this stratum today either is impeded or contaminated in some way.

1.5 Strata: slag

Much of Calumet's natural history is the result of the interactions of organic life (biota) with the region's geological history and surface stratum. In the Calumet Complex, like many highly urbanized landscapes, human influence has changed the landscape in ways that are not completely understood. For the purposes of understanding the Calumet Complex in its current state, its anthropogenic strata will be investigated.

When the central downtown area of Chicago re-organized during the turn of the century after the great fire of 1871, one initiative was to move industry out of the area in order for more civic development to take place. There are many logical reasons why industry and civility were separated during this post Victorian era of city planning. Smoke from industrial stacks turned buildings black, foul smells came from factories and processing plants, and garbage and waste products from these various industries was difficult to dispose of. Also of importance was that downtown property values were increasing as was the demand for more building resources. What was needed was a separate region dedicated solely to supplying such goods and materials - an industrial park. Enter the Calumet Region with Lake Calumet as its hub (Appleton 1927).

The early 1900's weren't the beginning of the steel age but more of a peak in its maturation in the United States. Chicago was quickly competing to become one of the most developed and dynamic cities in the country. Industrial technologies were advancing at a tremendous pace and mankind seemed completely in control of shaping its own destiny. This rapid advancement in technologies also gave humankind the ability to re-sculpt the surface of the earth in a way not seen in previous civilizations or geological eras (Moody 1916).

In the architectural world, buildings soon evolved into skyscrapers. These new structures required immense amounts of capital, energy, and iron to construct. At the time, several of the largest iron and steel manufacturers settled in and around the South side of Chicago around Lake Calumet and the shores of Lake Michigan. It was open land that was accessible by river and lakefront as well as railroad. Another ideal factor was that it had lands where excess materials left from the iron refining process could be easily disposed of. No one thought of Lake Calumet and its peripheral wetlands as valuable; they were, in a sense, disposable.

The process of refining iron uses extremely high temperatures to force iron particles to separate from their bonds with the rock substrate from which they were attached to form a more heterogeneous material. Iron content within iron ore is quite variable depending on its source. Iron ore is essentially a rock that contains high amounts of oxidized iron. Like many other rock materials it also contains silicates, phosphates, and other elements. These elements separate from the iron as it is exposed to extreme temperatures within the iron furnace. Part of the iron making processes requires the use of a type of flux to remove impurities and regulate its temperature while in a molten state.

One of the most important and widely available materials used as a flux in this process is limestone. Crushed limestone rock is incorporated during this smelting process which causes the impurities to bond to the calcium compounds. The iron is separated from the leftover excess material, which is then referred to as 'slag.' Refined iron from this process here is classified as pig iron and can be used for any number of products or further refined into steel.

Steel and iron mills began distributing slag to contractors to be used as aggregate for road and railroad base construction in the area. As industry gained momentum they produced excessive amounts of slag. These excess materials were deposited along with other trash and debris from outside sources such as fill from other excavations to extend the shorelines of Lake Calumet and Lake Michigan for new grounds to build more factories and manufacturing plants. The extent and concentration of slag deposits within the Calumet region is not entirely known; the best estimates come from the report *'Characterization of Fill Deposits in the Calumet Region of Northwestern Indiana and Northeastern*

Illinois Water-Resources Investigations Report 96-4126 U.S. Geological Survey & U.S. Environmental Protection Agency.' (Kay et.al. 1997). The numbers are staggering. They estimated that the fill covers roughly 60.2 square miles at various depths scattered throughout their study area. They estimate there is roughly 21,000,000,000.0 cubic feet of fill predominantly from the steel industry (Kay et.al. 1997).

The deposition of fill materials on the shores of Lake Calumet caused its measurable shape and size to change dramatically over time. Figure 1.2 represents the change of Lake Calumet from 1901 to 2000. These graphics are based on studies included in the Calumet Area Land Use Plan from the City of Chicago, Department of Planning and Development, December 2001 as well as historical USGS aerial photos.

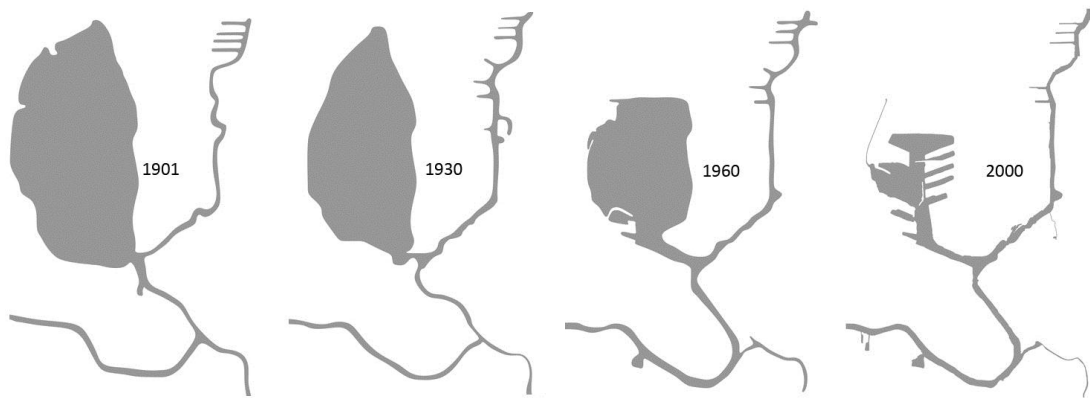


Figure 1.2: Represents Lake Calumet surface change in the years from 1901 to 2000. This graphic is adopted from the Calumet Area Land Use Plan from the City of Chicago, Department of Planning and Development, December 2001 as well as historical USGS aerial photos.

Over the course of time, industries expanded their operations and this tremendous project of landform engineering continued. Likewise local industries fed regional demand for refined materials. Both supply and demand took off at an exponential rate and as more and more iron was produced so was its slag. But this is not the only byproduct of the urbanized region that can be found in Calumet.

Other dominant waste features forming the present day topography of the Calumet Complex are its numerous landfills. Before any regulations existed on the fate and proper storage of trash, Calumet was seen as an ideal place for disposing human detritus. The same access to numerous forms of transportation that made Calumet an Ideal place to process and distribute materials also made it an ideal place to import and store them. Today, Calumet's topography is distinct because of these landfills; one of the highest points in the entire county is on top of one of these landfills.



Figure 1.3

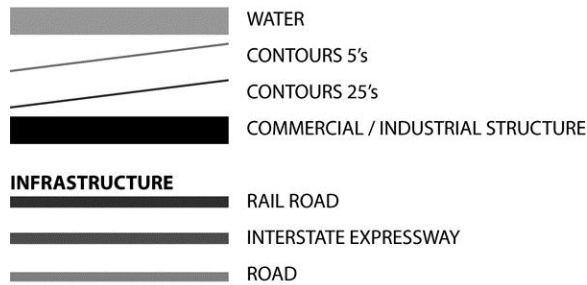


Figure 1.3 (previous page with key on the current page): Represents Lake Calumet surface topography and various industrial and infrastructural systems.

As a result, new strata were added the surface of the Calumet Region, this time human induced. In the case of the slag-filled soils of Calumet, the process of smelting iron caused the normally stable rock to become unstable again, and oxidized material to become unoxidized. In some ways this rock's geological clock has been reset (Chesworth 2008). The implications of these layers and their interactions with other layers will be discussed more in later chapters.

1.6 Hydrology / morphology

Like many urban areas throughout the world, Chicago is a highly engineered city. Much of its development through the years depended on substituting the uncertainties of human and ecological systems with the certainty and control gained through highly engineered systems of pipes, ditches, dams, pumping stations, and sewage treatment facilities. These artificial systems replaced the storage, conveyance, and treatment functions of wetlands, streams, and lakes. The driving force of landform alteration and development in the Calumet Complex took control of the region's hydrology and the hydrologic cycle.

Rivers and streams were dredged, widened, and channelized to make way for larger ships to navigate as well as provide docking areas to load and unload raw and finished materials. Much of the sediment generated from these river operations was deposited, along with slag and other general fill materials, on the shores of Lake Calumet and Lake Michigan to create more developable land.

The reworking of the hydrology of the Calumet region in its modern era is complex. Although the landscape is now controlled by engineered infrastructures, it used to rely on a wide range of ecosystem processes and relationships.

Today, water within the Chicago area generally flows out of the region through the Chicago Sanitary and Ship Canal to the Illinois River and eventually to the Mississippi River. This is much different than its historical hydrology. Because the Calumet Complex is flat and

connected to several waterway systems it used to flow in several directions. These directions depended on water and wind patterns. Historically, if there were large amounts of water flowing into Calumet Lake and the wind was blowing from a Southwesterly direction, water could flow out of Lake Calumet and into Lake Michigan. From there it may have even flowed through the Great Lakes into the St. Lawrence Seaway. If Lake Michigan's water levels were at normal levels and winds were calm it would flow out to the Illinois River.

There were many reasons why the hydrology was altered. One was the City of Chicago's safeguarding of Lake Michigan as its source of drinking water, which was at least partly due to the use of the Chicago River as a sewer for the disposal of human and industrial detritus. This conflict of interests led to the highly-noted reversal of the Chicago River. The idea was to prevent sewage from flowing back into Lake Michigan. Locks, dams, and canals were constructed at strategic locations along the river system so that a one-directional flow could be maintained.

Understanding the interactions between the strata and infrastructures are absolutely critical for future planning and development. The impacts to water quality as a consequence of this urbanization are just as important.

CHAPTER 2 WATER QUALITY

2.1 Impacts, issues, and concerns

While clean water is one of the simple necessities for healthy communities and ecosystems, in Calumet it is not being adequately fulfilled. Many of the ecosystem's functions have been altered by changes to site hydrology and chronic and acute forms of pollution. Pollutants such as bacterial contaminants, excessive amounts of nutrients, heavy metals, PCBs, sludge from sewage treatment plants and river dredging operations have permeated ground and surface waters and settled into soils and sediments along the river and lake bottoms (IDNR 2000, City of Chicago 2001). Heavy slag from the steel refineries has covered up once pliable soils with a solid substrate unable to sustain healthy plant communities. Water that passes through the layers of human-modified strata becomes laden with pollutants. In addition to these persisting toxins in the land and water, the vast majority of the region has been covered in an impermeable surface which alters storm events and drainage durations of low and peak flows.

This section will outline some of the more pertinent information that has come out of water quality surveys and studies and its strata/ biota relationships. The first sub-section discusses urban runoff, the second tackles groundwater sources.

2.2 Runoff

Many of the urban hydrological conditions of Calumet are fairly comparable to most urban systems. Calumet has a lot of impermeable surfaces and channelized control devices. However, in addition to normal urban conditions Calumet has a wide variety of industrialized land uses ranging from solid waste landfills to manufacturing to transportation which have countless effects on the water quality of the area. Each one of these land uses presents its own set of challenges in dealing with pollution - proving that there is no single treatment solution (City of Chicago 2001). Figure 2.1 indicates some of the more notable directions of surface water runoff used in this project.

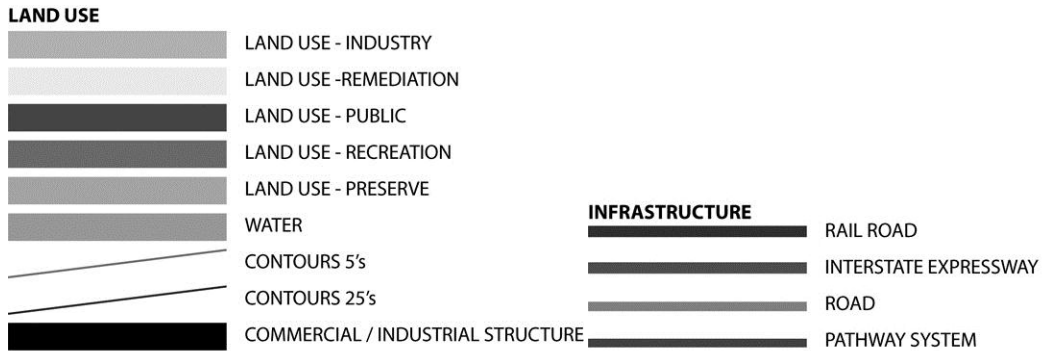
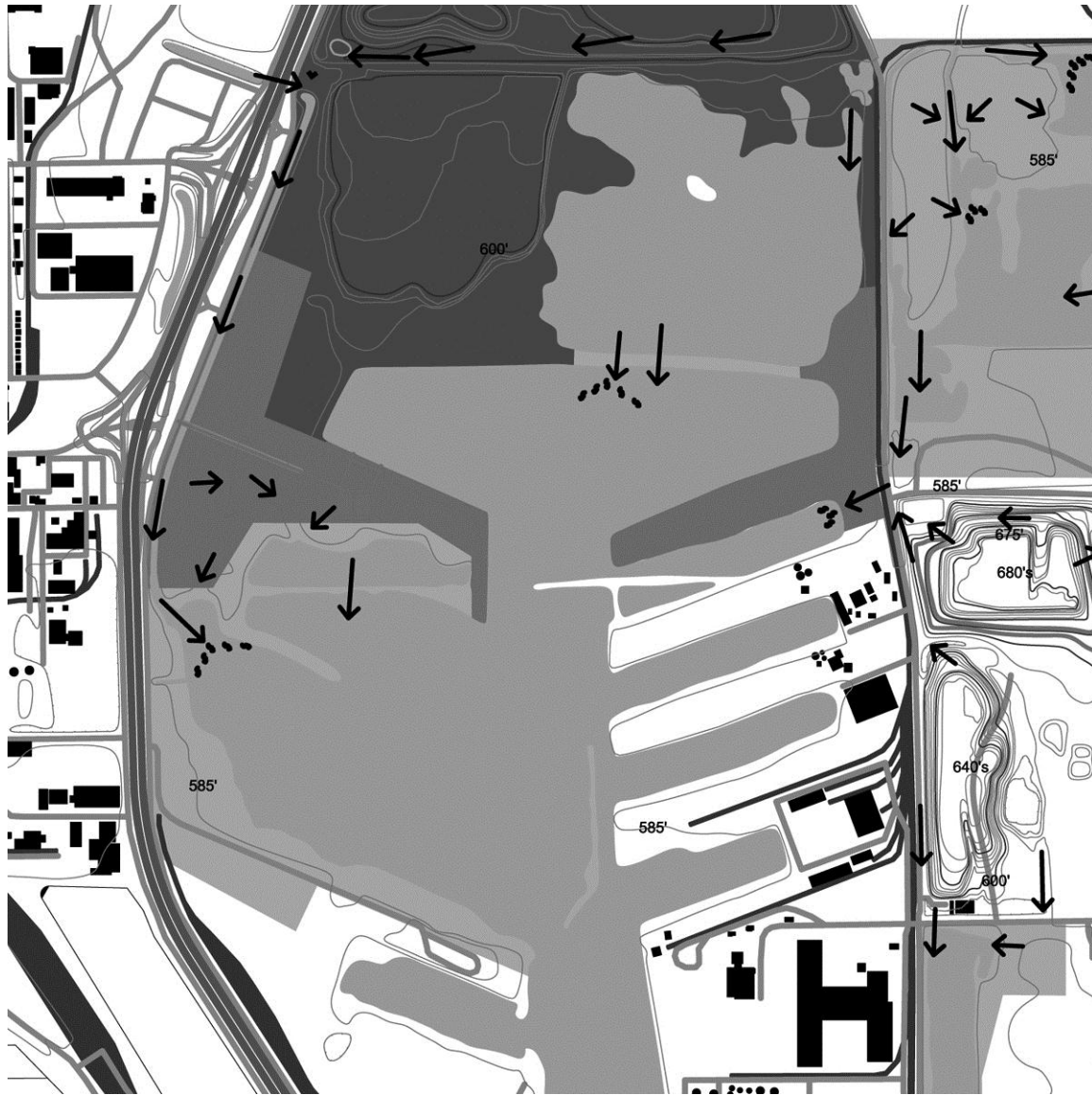


Figure 2.1: A section of the Calumet Complex with elevations and directions of known surface runoff flows. Map Key for the previous and all other maps within the design chapter.

Of all the contaminants that run off from the landfills into nearby wetlands and eventually Lake Calumet, of primary concern are nitrogen compounds (NH_4 , NH_3 , NO_4 , NO_3 , Norg.). Although other chemicals are present in surface waters, Nitrogen-based compounds have been found in higher concentrations (i.e. toxic) in groundwater and sediments sources. Although landfill leachate treatment is implemented in these facilities, nitrogen still finds its way into local ecosystems. This leads to a cycle of eutrophication and hypoxic local conditions. In Lake Calumet and its surrounding wetlands, plants, bacteria, and algae appear to be able to absorb and denitrify modest levels of nitrogen during the growing season. However, as spring temperatures rise autotrophic organisms grow at tremendous rates. They soon exceed their ecosystem support capacities and die. As these dying organisms sink to the bottom of the water bodies, they are consumed by bacteria that in turn remove large quantities of oxygen from the water. As this system enters into the winter seasons the nitrogenous compounds increase to very high numbers and restart the cycle once again (Fitzpatrick & Bhowmik 1990).



Figure 2.2: Landfill undergoing remediation in the Calumet Complex. In the foreground is a Leachate Treatment Pond. A constructed 'wetland' system largely used to de-nitrify polluted runoff. Photograph taken by the author.

Runoff from numerous impervious surfaces in the region raises other concerns. Pollutants from roadways include such chemicals as Nitrogen, Phosphorous, Lead, Iron, Cadmium, Chromium, Cyanide, Sodium, and Arsenic as well as other pesticides, compounds and particulates. These numerous chemicals and compounds affect normal chemical processes and interfere with the development of more balanced ecological systems. In addition to chemical contaminants, roadways also change the temperature of runoff, which interferes with the ecological process of aquatic life such as food and breeding cycles (Fitzpatrick & Bhowmik 1990, Metropolitan Water Reclamation District of Greater Chicago 2007, Mitsch & Gosselink 1993).

Much of the Calumet Complex relies on combined sewer systems to handle both sewage and storm water runoff. Under extreme storm events in past history the handling capacity of the system has been challenged, forcing sewage to rise to the surface and released into nearby streets and streams. Other reversals of these systems have forced water to enter Lake Michigan to prevent flooding from within the city (IDNR 2000, Metropolitan Water Reclamation District of Greater Chicago 2007).

Excess nutrients also increase bacterial counts in various *bacillus*, *colliform*, and *E- coli* bacteria species. Their presence indicates that other more harmful disease causing organisms and germs may live in these waters (Metropolitan Water Reclamation District of Greater Chicago 2007).

Recent projects such as the Tunnel and Reservoir Program and Surface Elevated Pool Aeration Projects have proven that large scale engineering projects can be used to benefit and improve both ecological and civic infrastructures within the Calumet Region.

In the 1970's, as the environmental era progressed, the Tunnel and Reservoir Project (T.A.R.P.) to mitigate the effects of storm water peak events began to utilize extensive underground tunnels to move and store large volumes of combined stormwater and sewage prior to its treatment. Hundreds of miles of tunnels, up to thirty foot in diameter, stretch underground from various sources ending at water treatment plants throughout the city and surrounding metropolitan areas. This program continues to this day, and every year additional tunnels are excavated and commissioned for use (Metropolitan Water Reclamation District of Greater Chicago 2007). Though this project remains completely invisible to most residents the benefits of reducing flooding are widely appreciated.

In the early 90's, Surface Elevated Pool Aeration Projects (SEPA) located along the Cal-Sag Channel were completed. This large scale engineering project has proven to be one of the most effective solutions in dealing with many of the urban industrial water quality problems found in the Calumet Region. Its process is simple: it increases the dissolved oxygen content of the water by constructing waterfalls along the river and canal corridors. To date, five separate SEPA stations are in operation alongside the Calumet River and Cal-Sag Channel (Metropolitan Water Reclamation District of Greater Chicago 2007). Figure 2.1 below shows more details of how they work.

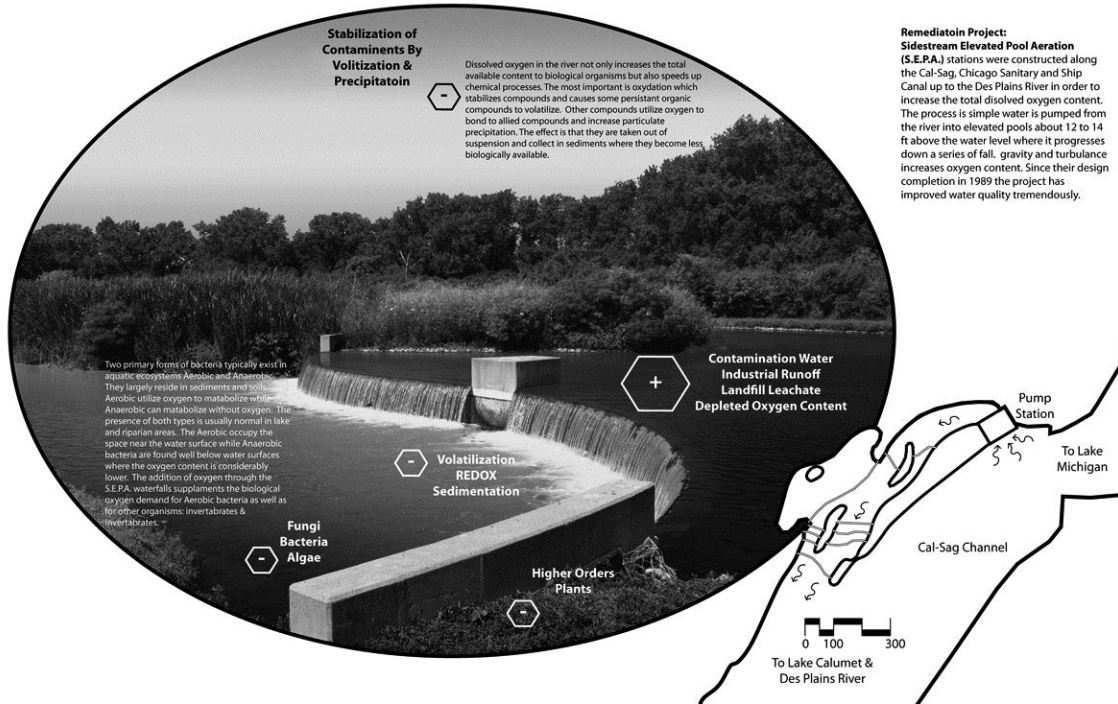


Figure 2.3: Represents the basic operating principals of increasing the dissolved oxygen content of river water using S.E.P.A. technology.



Figure 2.4: Photo Collage of the SEPA plant along the Cal-Sag Channel. Photograph taken by the author.

Other recent holistic approaches proposed by planners and landscape architects have consisted of promoting and utilizing rain gardens and bio-retention basins to intercept storm water before it enters the combined system (City of Chicago 2004).

2.3 Groundwater

Local scientific studies and surveys report that groundwater sources in Calumet are highly polluted. In general, almost any element can become hazardous at higher than normal levels (Chesworth 2008), and Calumet certainly has above average concentrations created and stored in its strata. Numerous compounds and ions including chloride, sodium, sulfate, organic carbon, cyanide, and a variety of heavy metals, volatile and semi-volatile organic compounds as well as others have been detected. See Kay et.al., 1997 Roadcap et.al. 2005 & 2006, Duwelius, et.al. 1993, Metropolitan Water Reclamation District of Greater Chicago 2007, etc. for specifics. Many of these compounds can be attributed to slowly weathering fill materials within the anthropogenic strata.

Roadcap (et.al. 2005) studied Lake Calumet and the effects of these slag fills on ground water quality. Their research found that some groundwater sources could have pH ratings as high as 12.8. This is due to the weathering calcium silicates and reduced compounds within the slag fills. As water passes through this stratum the groundwater slowly becomes a mineral solution. It picks up numerous dissolved forms of iron, manganese, as well as other metals and compounds. When the water then passes through the surface and enters the lake, usually via a seep or spring, the solution mixes with atmospheric CO₂ and causes many of these minerals to precipitate and form calcite on the lake bed surface. This process also causes the pH of the solution to return to more neutral levels (Roadcap et.al. 2005).

The interesting thing about these conditions is that as these slag soils are undergoing this weathering process they slowly become oxidized and more stable. The transition between ground and air facilitates this chemical stabilization process. Water solution laden with suspended pollutants combined with atmosphere yields a solution that precipitates its pollution into the strata. These processes of weathering, particle transport, and deposition are part of the process of soil formation. While there are elevated levels of pollutants and associated effects for ecosystem health, it is the beginning of a continuous process of new soil formation, and an ecological process to reabsorb some of the toxins into the strata. This process in many ways is very similar to the processes that created the limestone (Calcite) bedrock layers in much distant geological eras and the productive soils of recent geologic eras. The more intertwined the lithosphere, hydrosphere, and atmosphere are, the more effective this system is at stabilizing pollution transportation and soil formation.

In another study, Roadcap et.al. (2006) also discovered that although groundwater in these soils can have extremely high pH levels, life can still be found. While life here is in a very basic form, numerous *alkaliphilic b-Proteobacteria*, *Bacillus*, and *Clostridium* species of bacteria, their discovery is

proof that biological organisms are at work exploiting 'pollution' and participating in soil formation processes. These bacteria feed off chemical energy in the iron-oxidizing chemolithotrophic process. This particular study found that ecological relationships exist in places where previously never thought to exist. Other studies have found that the threshold of life existed at much less alkaline conditions, to the order of 2 pH levels less. The microbes and their associated enzymes gathered from this study show promise for future use of bioremediation in highly degraded landscapes such as those of the Calumet Complex (Roadcap et.al. 2006).

CHAPTER 3

LITERATURE AND PROJECT REVIEW

3.1 Concepts of waste and the Calumet Complex

This section will explore some of the theory relevant to the genre of landscape architecture capable of dealing with urban landscapes such as the Lake Calumet Complex. One of the key themes that will be explored here is waste. This will be considered both in the terms of the waste products that have been added as new strata on the earth's surface and the landscape itself as a waste product of urbanization. Much of this is examined through the lens of contemporary landscape architecture theory. Several recent publications have been reviewed for insights they might offer this design investigation. Additionally, information and research developed by the City of Chicago and other interested organizations to more productively engage local urban waste flows will be outlined in this section.

3.2 Waste in the landscape: traditions of waste

City planning ideals in Chicago in the late nineteenth and early twentieth century strongly clashed with its physical realities. While access to several river systems and a prime location on the Southwest tip of Lake Michigan made Chicago a strategic location for a city, its wetlands were not viewed as an ideal landscape type to be included in the cityscape. Human understanding of 'nature' at the time made future land transformation simple to justify. Wetlands were largely seen as 'wastelands', unusable land that humankind sought to tame and put into more productive use (Lewis 2001). The term 'waste,' throughout its use in Western history, is fairly ambiguous and often refers to the "unoccupied" or "desolate," giving this concept a more charged meaning that demands some type of reaction (Engler 2004).

During the last 150 years, Chicago, like so many other urban areas within the United States, has undergone tremendous urban and ecological change. As the demand for industry in the area expanded, pre-settlement ecosystems receded. The Calumet area was transformed from a vast assemblage of open waters (lakes, streams), fens, marshes, prairie, and forests to a landscape assembly of landfills, manufacturing facilities, steel and chemical factories and peripheral residential and commercial areas (City of Chicago 2001).

3.3 Contemporary views: waste

While industrialization grew quickly in the first quarter of the twentieth century and dominated much of the landscape in the Calumet Region, it receded at a similar rate from the middle to the end of the century. Today, Lake Calumet is part of the nation's "rust belt", which stretches from Chicago, North through Michigan and East to the Mid-Atlantic States. The rust belt is a region which contained high densities of iron and manufacturing industries that has gone into decline in the last quarter of the century. With the departure of heavy industry also came the slow departure of economic stability. While jobs were plentiful during the peak of industry, today, much of the Calumet area is in a state of decline ecologically, economically, and socially. Many industries have moved to greenfield sites or relocated their operations overseas. New industries are not returning to the area as the cost of redeveloping urban infill is tremendously expensive (there are many reasons for this including the cost of contaminated site clean-up and competitively cheap land in other areas) when compared with greenfield alternatives.

Much of the Calumet Complex transformed from a productive industrial landscape to a new form of post-industrial landscape which has been referred to by Alan Berger as 'Drosscape.' These landscapes are often comprised of degraded, highly polluted and industrially abused land. Various disciplines, from city planning to wildlife biology to landscape architecture, have been trying to understand the loss of industry and its implications for local economic and ecological systems, such as those found in Calumet. The following frames some of the more relevant contemporary landscape architectural theory on this topic of waste and its implications within this landscape.

Stim and Dross, Lars Lerup, 2005.

Dross is referenced in the English lexicon as an oxidized byproduct of molten metal as impurities migrate to the top during the process of its forging or casting. This material is usually skimmed off the top of the molten substance and set aside as a waste product. Lars Lerup makes it a point in the introduction of his essay on this topic to note dross as a waste product that comes out of the process of producing a valuable material. The landscape of waste is understood as an inevitable byproduct of more acceptable or productive forms of urbanization. In many ways Calumet is part of the City of Chicago's dross, a natural by-product of urbanization.

Lerup notes how the urban landscape can be studied and understood through its dross. Dross is a component of a city's 'mega-shape.' This refers to the overall complexity of a city where the center and periphery are more ambiguous in its relationship to the overall functioning city. He points out that there are two ways to read this 'mega-shape.' One is to look at them from the inside the other is to look at them from the outside. This is a simple exercise to examine the scale of the project and understand continuities within the mega-shape. The inside view leads to a focused understanding of the whole through an understanding of its fragmented parts while the outside view leads to an understanding of the whole through a broad examination of the mass. The outside view substitutes the inside view's detail for a glimpse of the big picture. This is a worthwhile perspective to remember for landscape architects and planners working in unfamiliar territories.

Often in a productive metropolitan area such as Chicago dross can simply be ignored or overlooked. Lerup offers us the concept of 'Stim,' short for stimulation, to explain how this could occur. Stimulation, in many cases a distractive force, is part of the process by which this dross landscape, figurative waste in the landscape, is ignored. Lerup suggests we find a new way to stimulate the dross itself.

Stimulation in this thesis means activating the area through landscape development and program. The dross of the Lake Calumet Complex is not just a metaphor for pollution but a component of the landscape. In practical terms, design must include reasons for the public to use and visit the area while providing for their safety. This will include strategies for experiencing the Complex and its dross from both inside and outside. Both of these vantages must provide for public safety from environmental contamination while offering unique visitor experiences. The outside views will separate the public from much of the source of the contamination and provide for landscape views of the Lake's ecological and industrial activities. These will eventually move many of the park's facilities into the lake while remediation strategies are directed at the lakes shoreline and perimeter. The inside views will allow the public an intimate view of the Lake's main component, water, with a more participatory perspective of remediation. Experimental spaces will take on the task of engaging the public visually while performing simple remediation procedures such as aerating water and moving it through biological filter media. These techniques will be further addressed in design descriptive chapters below.

Drosscape, Alan Berger, 2006.

Contemporary landscape thinkers such as Alan Berger are examining the idea of de-industrialized landscapes as a form of waste in hopes of developing new ways of returning these lands

to some form of productive use. In his book *Drosscape: Wasting Land in Urban America* Berger explores waste in the landscape and how it has amassed in our society in recent decades. Berger raises several interesting points on the subject of waste in the landscape. First, building upon Lerup's understanding of waste, Berger argues that it is a natural byproduct of growth and will always result from the process of urbanization. Second, he argues that in many cases waste can be more than a physical entity - it may also be a process such as a transition between uses; (Berger 2006). In Calumet much of the landscape has always been thought of as waste, from its early settlement times when the landscape was dominated by wetlands to its abandoned and polluted state today.

Berger classifies waste landscapes into six subcategories:

- Waste Landscapes of Dwelling (LODs)
- Waste Landscapes of Transition (LOTs)
- Waste Landscapes of Infrastructure (LINs)
- Waste Landscapes of Obsolescence (LOOs)
- Waste Landscapes of Exchange (LEXs)
- Waste Landscapes of Contamination (LOCOs)

This categorical approach is worth noting because each one of these subsystems has its own forms of waste processes but collectively are all part of the post-industrial urbanization process so typical of post-WWII United States. In addition to the physical composition that makes an urban area what it is, this section helps further conceptualize urbanization as a system of ongoing, dynamic processes. When its operating processes are halted because of any number of capital or resource limitations it often faults into a waste state. Theoretically categorizing waste landscapes allows them to be qualified and quantified for potential future uses. This shifts the landscape from a state lacking momentum or potential into a state seen as undergoing continuous processes and change that may eventually present new alternative future uses. Armed with this dynamic understanding, the designer can then speculate more freely on what this future use could be and how it might be brought about.

Waste as a descriptive term usually referenced the numerous landfills and garbage transfer stations in the Calumet Complex. However the city government and other interested parties are well aware of the landscape as a Waste Landscape of Transition (LOTs), a Waste Landscape of Infrastructure (LINs), a Waste Landscape of Obsolescence (LOOs), and a Waste

Landscape of Contamination (LOCs). Collectively these describe the Calumet Complex as a landscape that was once highly developed but is now rusting away and polluting its surrounding systems in the process. But this area has the potential to become something completely different. It has a highly developed existing infrastructure and is surrounded by a large population of potential users requiring a diversity of land uses including industry and recreation.

Designing America's Waste Landscapes, Mira Engler, 2004.

Engler's book begins with the bold statement: "Contrary to what many say, humans did not invent waste; nature did." According to landscape architect and academic, Mira Engler, waste production and its distribution are synonymous with life and growth. "Waste is a pervasive, essential, and constructive process of human society" (Engler 2004). Engler strives to remind (or teach) us that in fact waste is not just part of human society but also an important part of nonhuman ecosystems and processes as well.

Engler conducts a broad survey of what waste is and why it plays such a large role in shaping society. She explores many topics that deal with waste from the history of sanitation to the use of waste for artists working on the fringes of society to the sewage treatment plant as a garden of productivity and renewal. What is important for landscape architecture and design is to more fully understand the processes by which waste is integrated into society and the landscape.

Waste is a term with many ambiguous meanings and associated terms. Engler also points out that waste is more related to dirt than it is to soil. Soil is a media often thought to improve life - it is fertile and supports life. Dirt, on the other hand, is something thought to impede life, it is displaced and unkempt. Waste, she points out, is "dirty". Many people from the Chicago metropolitan region associate the Calumet landscape with a "dirty," gritty type of place. The Complex can be barren; in many places exposed rip rap covers railroads, lakes, and ditches making vegetation sparse and patchy. In other places space is bound by its barbed wire and 'weedy' margins. Most of its soils have been compacted, covered up or have waste products incorporated into them. This reality is very different than the imagery which is generally associated with soils that support life. Concepts of dirt and soils are very important to understanding, and ultimately, to directing future transformations of the Calumet Complex.



Figure 3.1: Photograph of grain silos on the Southwest portion of Lake Calumet. This today is largely vacant or has little active industry. Photograph taken by the author.

Waste produced by ‘nature’ provides and supports a system for life to exist. In the beginning of the Calumet Region’s geological history, dying micro-organisms were slowly deposited on a vast ocean floor. Their collective sedimentation over millions of years led to the formation of the bedrock which in turn provided support for the ecological and social systems of an earlier, post-settlement era. As modern human settlement re-sculpted this land, and a new layer of strata was quickly deposited that further framed life as we know it in the Calumet Complex today. This strata reacts with, and is integrated into, society and the landscape in a very different manner than the strata laid before it. These issues and parameters framed the challenge of this design thesis to find a new way to integrate this waste into contemporary and future landscapes of the Complex.



Figure 3.2: Photograph looking north of the Southwest corner of a superfund site within the Calumet Complex. A landfill mounds in the horizon. Photograph taken by the author.

3.4 Landscape as waste: the politics of reclamation

While there are many ways to interpret the term waste, what is of more importance for this thesis is the re-use and activation of the Calumet Complex's waste - conceptually, technically, and pragmatically - through design. To do so we must recognize the negative associations of waste, such as pollution, and also the potential for releasing latent ecological energy and capitalizing on new developable lands from what is perceived as mere waste.

The picture is not entirely bleak, and although Calumet is Chicago's representative of the rust belt there is still some ongoing industrial activity. The landscape is an amalgamation of vanished, idling, and active industry; though no economist or ecologist would categorize the Complex as a stable system.

Much of the information used in this thesis originates from the Calumet Initiative, a coalition made up of federal, state, city, private and public companies, and community interest groups which is working to revitalize the region. These numerous city departments, industries, and community groups are optimistic about the redevelopment of the Calumet area, and forward-looking in terms of implementing new strategies of reuse. As a result of this renewed interest there has been increased attention to developing and implementing numerous city plans, scientific and social research, and funding generation from various sources. The unifying ideal is that industry and nature can cohabitate the region under a new model of industrial and social cooperation.



Figure 3.3: Photograph of efforts from the Calumet Initiative to create new habitat in the margins of active industry. Photograph taken by the author.

The following section is a review of some of the more notable documents that came out of this renewed interest in the Calumet area. Understanding some of the Calumet Initiative's overarching goals and guidelines is crucial to constructing and implementing a framework for this design thesis.

Calumet Area Land Use Plan, City of Chicago, 2001.

This land use plan for the Calumet area was released in 2001. The purpose of this plan was to lay the foundation for renewal in the area and to lead future development in ways that balance economic, social, and ecological needs. The goals of the plan are:

- To improve the quality of life for the surrounding communities through improving economic and ecological qualities.
- To keep and improve the conditions and accessibility for businesses already there.
- To attract new forms of commerce and industry to the area.
- To protect and enhance the ecological conditions that make Calumet a unique ecological region, especially with regards to its habitat for rare and endangered species.

The plan begins by altering the land use plan and implementing new 'Action Objectives,' these are:

- To improve transportation and access to large developable tracts of land.
- To create a Calumet Open Space Reserve and improve connectivity to green spaces.
- To develop a new standard of design guidelines that improves the aesthetics of commercial and industrial properties as well as right-of-ways and open spaces. Special emphasis will be put on

'natural landscaping,' holistic stormwater and construction techniques and management, as well as to improve habitat for native flora and fauna.

The product that came out of this phase of land use implementation was an updated version of the land use plan. In 2005 this plan won an ASLA analysis and planning award of honor.

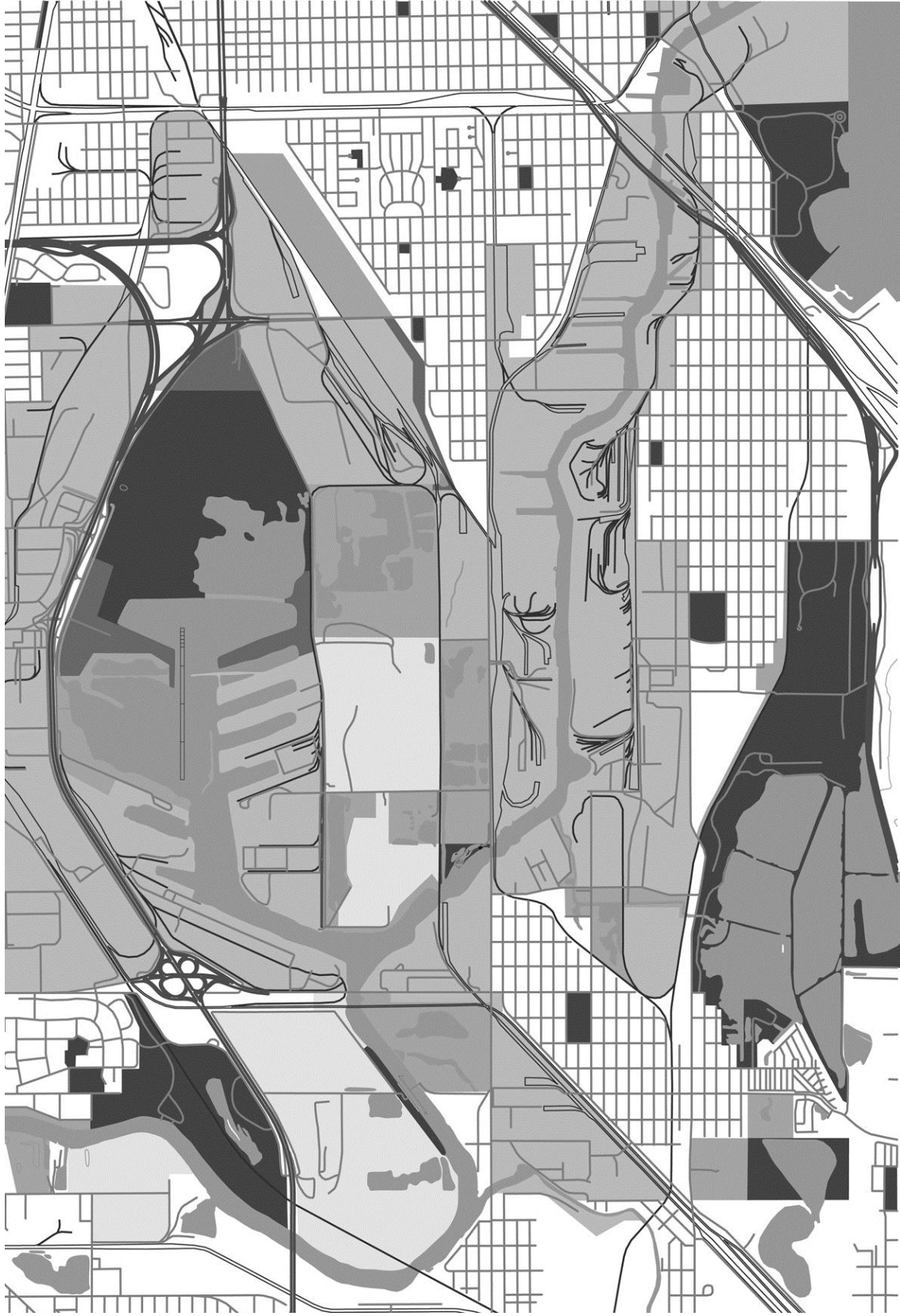


Figure 3.4







LAND USE	
	LAND USE - INDUSTRY
	LAND USE - REMEDIATION
	LAND USE - PUBLIC
	LAND USE - RECREATION
	LAND USE - PRESERVE
	WATER

Figure 3.4 (previous page): Represents the land use map of the Calumet Complex. This map is an adaptation of the City's original map found in the official Calumet Area Land Use Plan. The only adaptation this map made was to include the Calumet Sewage treatment plant, southwest of the Lake and West of the Bishop-Ford Expressway, as an industrial land use. The original plan discounted the plan in its map.

Calumet Area Ecological Management Strategy, City of Chicago, 2002.

While many engineering and scientific studies have been completed in the Calumet area throughout the years, including major biological, social, geological, and hydrological assessments, a comprehensive Ecosystem Management Strategy (EMS) had yet to be implemented. The study was an important phase of the Calumet Initiative. Its purpose is to preserve, improve, and create land of ecological importance in the area. To do this the EMS proposes guidelines that:

- Improve water, sediment, and soil quality.
- Achieve a better understanding of outside influence on water and air quality and their subsequent influences on local plants and animals.
- Maintain current populations of endangered and threatened species and improve the quality of their health and habitat.
- Enhance the sustainable coexistence of vital industry and healthy ecosystems
- Provide additional opportunities for citizens to interact with the natural features of the Calumet Area.

In addition to providing these guidelines this project began groundwork investigation of specific sites including Lake Calumet and some of its surrounding wetlands. The information gathered led to the investigation and development of specific hydrological data and recommendations for each site. The recommendations for Lake Calumet include: preserving aquatic habitat for species of concern, improving shorebird habitat, and the creation of opportunities for passive forms of recreation (i.e. walking, bird watching, etc.).

Calumet Area Design Guidelines, City of Chicago, 2004.

This was one of the first publications that steered the City's perspectives on functionality and aesthetics in the landscape away from more traditional or conventional, landscape ordinances. It was just as important for the whole City of Chicago as it was to the Calumet Region within the city limits. While conventional city guidelines suggested standard pavement blacktop surfaces and stormwater management strategies, this publication promoted permeable surfaces and alternative strategies such as rain gardens and bio-swales. While conventional guidelines suggest typical spacing and standards in street trees this publication suggests clusters. Since the publication was released, the city adopted and began accepting more alternatives to landscape management. While the implementation of such guidelines may take a while to catch on, this publication has changed the way that the city sees the landscape.

3.5 Integrating theoretical and political concerns

While contemporary landscape architecture theory offers an alternative lens through which to view and understand the urban landscape, its future design needs to be considered within practical and realistic guidelines. Chicago has already initiated many of these plans and set forth specific goals to make future development plausible. It may seem that these two discourses – the theoretical and the practical - would be in conflict with one another. However, both are necessary to integrate social, industrial, and ecological goals in a creative and meaningful way. Landscape theory speaks more to the creative side of design while planning literature dictates the necessary goals and guidelines needed in design.

In many ways these documents are part of larger landscape planning and design discussion. Chicago like many comparable cities is trying to improve its waste landscapes and attempting to reconcile its relationships with ecological systems. City planners recognize that the environment is an important component to developing the more ideal contemporary city. The way it is being accomplished and promoted is an important component for landscape planners and designers to consider and has been given attention by previous sources in this chapter. For instance, Lake Calumet may have always been thought of as a waste landscape and may be perceived this way well into the future. Waste is in many ways a condition of underutilization as much as it is one of overutilization to the point of exhaustion or contamination. Lerup and Berger have helped us identify these overlooked conditions within the city's overall composition. The City of Chicago has identified specific areas within their

boundaries that they believe are important and worth investing time and money in. Its planning guidelines are testament to this and more. In other historical-theoretical design thinking, Mira Engler offers several interesting comments that can inform future plans for reappropriating 'waste' landscapes. In its current state, the texture of Lake Calumet is more akin to dirt than it is to soil. Future designs need to consider the way users may come to perceive the landscape as productive and beneficial to society as opposed to a burden and nuisance. The City, with its control of codes and regulations, has provided alternative guidelines and standards that would allow for less traditional landscape designs in its Calumet Area Design Guidelines. In many ways, details such as the location and spacing of plantings and alternative systems for stormwater management are the first components that will allow dirt to become soil.

CHAPTER 4 DESIGN

4.1 Lake Calumet Complex Park

The human-built infrastructure that replaced the wetland dominated ecosystems in the Calumet Complex has been functioning for decades - it works, but not well. It is not a sustainable system and demonstrates few, if any, of the qualities that create resiliency seen in healthy ecosystems. Regardless of its functionality, the infrastructure around the Calumet Complex, like many around the country, has a limited lifespan and will need to be upgraded. While much of the Industrial Corridor is highly active there are many portions that are in decline. With this land being left for waste, how will it get used in the future? A growing concern for sustainable development, environmental stewardship, and demand for new places to recreate, provides an opportunity for the City of Chicago to speculate about how a new ecological infrastructure will look and function in its Lake Calumet Complex.

During the beginning of Calumet's period of industrialization the lake slowly began to be filled in with slag, dredging materials, and organic waste. At the surface and sub-surface these weathering materials began contributing to water and ecosystem pollution. Design in this thesis is a response to the previously laid strata and to the associated ecological, social and industrial resources of the area. Geological and natural histories of the region converge with theoretical concepts of waste to suggest re-use of the landscape in ways that have not existed before. This convergence of ideas makes new use out of the degraded surfaces and sub-surfaces of the Calumet Complex. The first task is to intervene on this system by introducing more heterogeneous, complex structures and process-driven ecosystem function enhancements. Deliberate and surgical manipulation of the landscape's infrastructures and strata will improve the resilient qualities of the ecosystem by increasing the system's ability to metabolize, neutralize, and stabilize excess nutrients, sediments, persistent organic pollutants, etc. Planning and design in this thesis follow principals set forth by the City of Chicago to regenerate local industrial, community, and ecosystem resources. This can be summed up in the following conceptual diagram (figure 4.1).

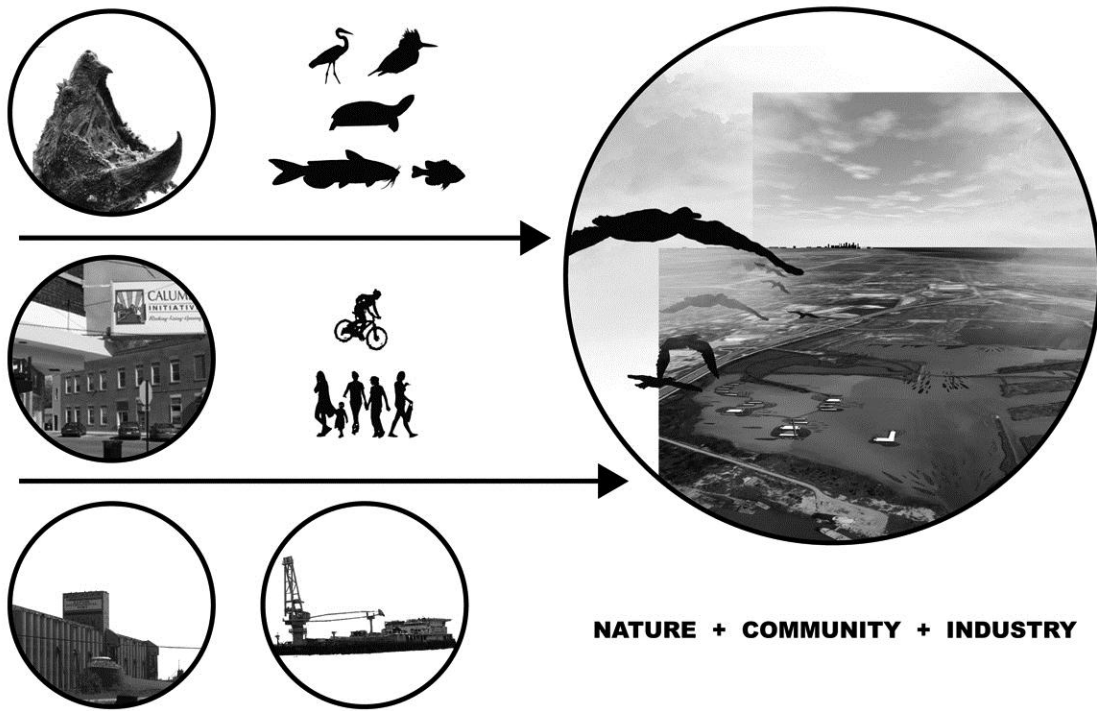


Figure 4.1: Represents the convergence of industrial, community, and ecosystem resources found within the Lake Calumet park design.

Tactics resting solely on ecological restoration are not practical for enhancing ecosystem functions of the Calumet Complex. However holistic principals can be used in making future decisions and to evaluate future remediation (Choi 2004 & 2007). Specific details such as recommended planting and materials lists are not included at this level of design since this design strategy is intended to serve as a framework for future evaluation and decision making at a systems level.

Inclusion of goals set forth by the City of Chicago's numerous plans such as the Calumet Area Design Guidelines (City of Chicago 2002) and the Calumet Ecological Management Strategy (City of Chicago 2004) have been considered in the formulation of this strategy. Goals adapted from research for this design are:

- Diminished water quality in the Calumet Region can largely be attributed to the strata through which it flows over and through. In order to improve this water quality its strata must be improved.
- Existing slag filled soils are young soils in an evolving soil formation process. Soil weathering, particle transport, and deposition are all part of this process of soil formation. This normally takes extended periods of time. In order to facilitate, or speed up this soil formation process, hybrid ecological and bioremediation systems will be integrated as part of a new ecological

infrastructure. Their application will lead to increased stability and less biologically available pollution transported through the hydrologic cycle.

- Pollution is transported by particulates suspended in water. These particulates should be directed to places where they can appropriately sediment and be used to build resilient soils.
- Passive recreation should not take place directly on shoreline stabilization and bioremediation areas but rather in places where they can be seen and enjoyed, from the lake.
- Mechanical filtration and aeration stations can serve as socially engaging and stimulating places as well as remediation structures.

This design is spread across several phases. Many of these phases have either a remediation or programming component or a combination of the two.

Remediation serves to integrate a new ecological infrastructure into the landscape. This infrastructure will fulfill the goals of improving the water quality, as well as meeting the ecosystem preservation, improvement, and creation goals set forth by the city. Meeting these goals will provide access opportunities and activities for visitors, nearby residents, and local ecologies. The techniques applied are based on simple methods to alleviate several pollution issues (i.e. urban runoff, decomposition, soils and landfill weathering process, etc.).

The programming or park components seek to reconnect people and revive interest in the Lake Calumet Complex; this will lead to future opportunities to mitigate some of the larger economic and social problems of the area. At various phases of the park's development the design goes beyond the shores of Lake Calumet and moves into central portions of the lake to create a unique and provocative space providing the visitor with a memorable experience. Improving water quality and ecosystem health will be the unifying themes.

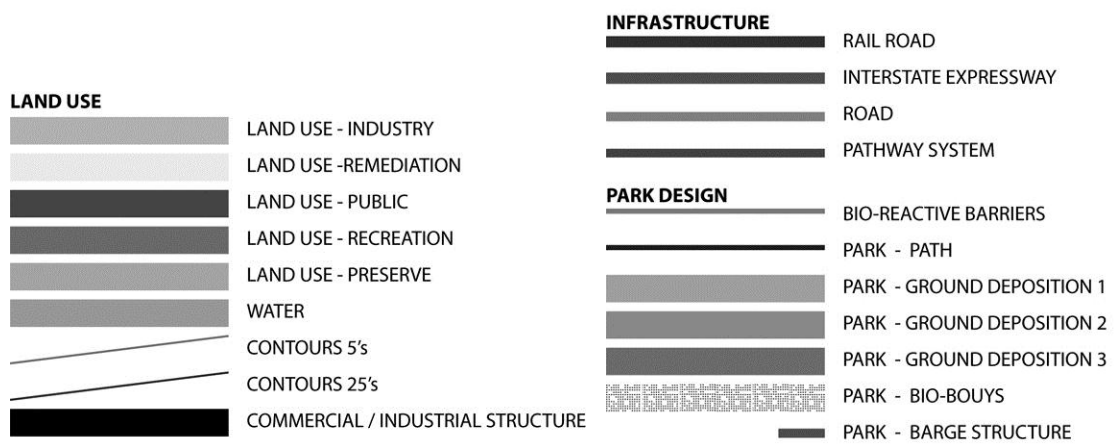


Figure 4.2: Overlay of proposed park design on aerial photograph.

4.2 Phase I: remediation begins

This framework begins by implementing remediation techniques within the lake's perimeter. The purpose of this tactic is to interrupt the weathering and transport phases of pollution by implanting more heterogeneous, complex structures and process-driven ecosystem enhancements. Since one or two of these techniques alone may not prove sufficient to restore resiliency to the ecosystem, choreographing many to work in conjunction and cooperation with one another may prove to be the best tactic.

Incorporating these techniques into a system has resulted in the design of bio-reactive barriers. Bio-reactive barriers are the first conceptual remediation system integrated into the framework of the future design of the Calumet Complex Park. In relation to the ecological goals, this directs efforts towards improving ecosystem functional rehabilitation rather than restoration. This system uses concepts of soil formation as a process to improve water quality by improving the strata groundwater flows over and through. This strategy integrates theoretical scientific research along with known and proven solutions by remediation experts. These barriers are a cross between reactive barriers with bioremediation techniques.

Reactive barriers are vertical trenches or pits dug into the earth contoured parallel to the local topography. Limiting elements, minerals, or compounds are mixed within the subsoil to bond to pollutants that are transported through the soil, usually in solution, making them biologically unavailable (US EPA 2001).

In the case of remediating Calumet's extremely alkaline groundwater the most basic and effective approach is to allow air to neutralize the problem. Roadcap (et.al. 2005) investigated the remediation of groundwater in slag filled soils of Lake Calumet. Their results recommended that air sparging, rather than CO₂ sparging, HCL, and dolomite applications, are the preferred technique. These techniques effectively reduce the toxicity of the water and prevent sediments that precipitated out of the solution from re-dissolving back into solution. This also proves to be one of the more cost effective methods. This concept further supports how atmosphere is a valuable component for stabilizing toxicity and building soils.

Many of these concepts of bioremediation and other in-situ remediation techniques utilize processes that reintroduce media and biota as supplemental inputs to the system. These serve to digest, buffer, and aid unavailable pollutants in the system. Although bioremediation techniques are relatively new to scientists, environmental engineers, and landscape architects, application of these techniques are appealing for the Calumet Complex as cost effective and

environmentally sound solutions (Westphal & Isebrands 2001). Recently mycoremediation, a bio-remediation technique that utilizes fungi, has shown a lot of promise. Leading contributors to this research come from the United Kingdom and the United States. One of these leaders in the US is mycologist and entrepreneur Paul Stamets. His research shows that fungi are capable of hyper-accumulating heavy metals, enzymatically digesting organic pollutants such as Poly Aromatic Hydrocarbons (PAH), and have numerous secondary ecosystem function improvements such as alleviating soil compaction, improve nutrient uptake to plants, and increase carbon content in soils. For normal healthy growth and maximum ecological benefit fungi require large quantities of carbon (from lignin and cellulose), stable moisture levels, and perhaps some supplemental nutrients depending on existing levels (Stamets 2005, Gald 2001).

Soils lacking adequate structure and texture have also shown improvement with the addition of the lacking amendments, i.e. organic matter (EPA 2007). Compost and other compostable materials are suitable for these purposes. With regards to plant succession on the surface, any addition of plants that are hardy enough to survive in the degraded conditions long enough to allow other plants to colonize at a later time would be welcome. As soil structure and texture conditions improve, more appropriate plant communities could re-colonize or be reintroduced to the site.

Application of this research begins by improving the soils of the area which will support higher plant and animal life. These bio-reactive barriers will employ the use of vertical filter strips, as used in reactive barriers, to increase ambient oxygen and carbon dioxide into the soil. Supplemental air can be discharged at low pressures into the barriers in key places using small compressors and tubing. The tubing can be laid into the barriers as they are being constructed with fairly conventional construction tools. Organic matter from recycled wood chips and compost will be added as a limiting resource and media to intercept and *sorb* pollutants allowing organisms such as fungi and bacteria to begin their process of hyper-accumulating and enzymatically digesting pollutants. Some wood chips will be inoculated with large quantities of fungi mycelium super-charging the system before it is positioned. As these organisms process the organic matter and pollutants they return carbon and nutrients back into the soil. This allows for other benefits such as increased aeration and added biological soil to follow in the maintenance of the soil formation process. As this system ages, plants that were not able to survive in the previous conditions because of the lack of stability and balance found in mature soils will begin to thrive. They in turn allow for additional ecologies to emerge and to participate in further bio-remediation processes. See figure 4.3 for additional description.

Soil Building Processes and Pollution Mitigation Utilizing Bioreactive Barriers in the Calumet Complex

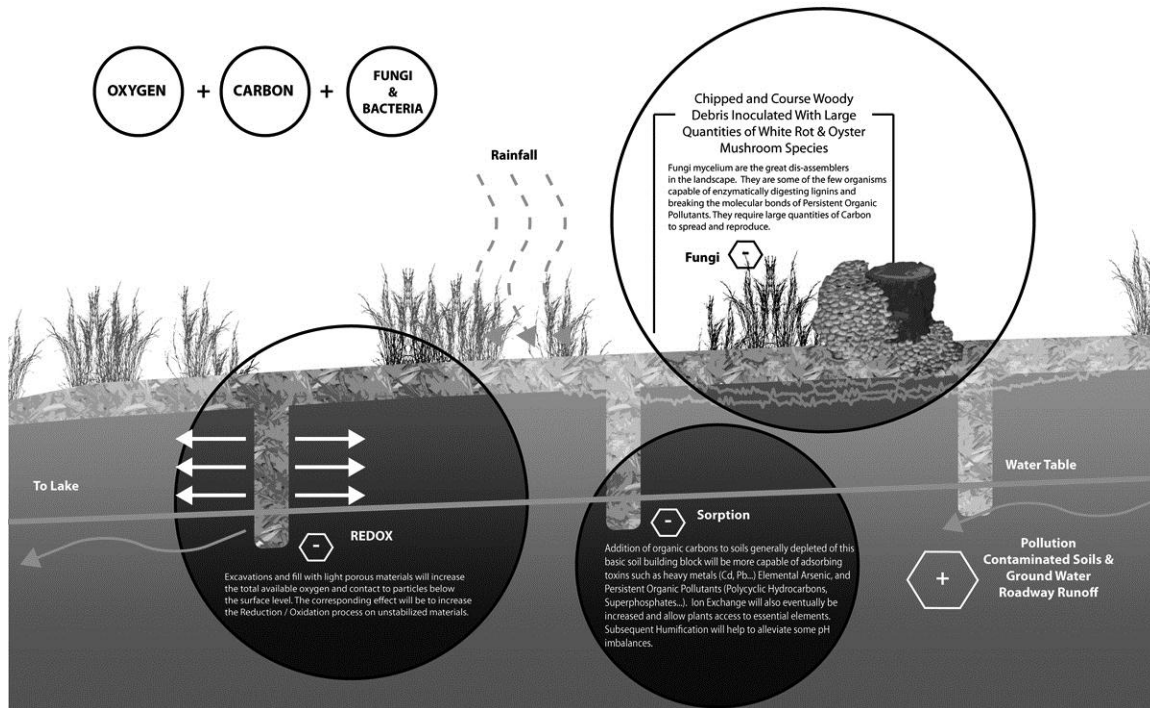
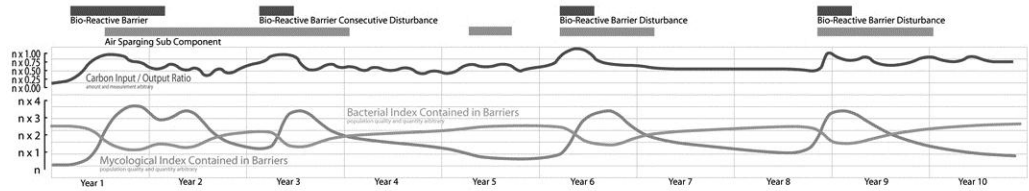


Figure 4.3: Bio-Reactive Barriers in relation to construction and bio-geochemical pathways.

The distribution and timing of the bio-reactive barrier's construction is just as important as their implementation. Their population dynamics cannot fully be predicted at this time, however, certain judgments can be made. Fungi are not expected to remain in place perpetually through time. Bacteria are expected to flux and interrelate with fungi populations. What will be intended is that a dynamic flux will occur over time in varying degrees and densities that will permit diversity in species and a diversity of effects, i.e. both enzymatically digesting pollutants as well as building new soils to take place. Figure 4.3 shows guidelines for how and where this should occur.

To further understand the timing of these prototypical structures figure 4.4 shows how they can be constructed over a period of several years.



- Phase I.**
Excavate Trenches.
 Surgical excavation using unobtrusive augers, trenchers, & back-hoe. Constructed around the lake perimeter, parallel to the surface contours, spaced between 10-20 ft apart. Air Sparging hose laid in the bottom of the trenches where the bottom of the trench is below typical water table levels and in critical areas (near seeps, low areas with higher base and surface flow).
- Phase II.**
Add Inoculated Wood Chips, Straw, & Course Woody Debris.
 Stratified layers of inoculated material and non-inoculated materials are to be used so that the fungal network stretches throughout the barrier system as much as possible. May require supplemental fertilizers. Constant aeration in critical areas and supplemented with additional inoculate during the growing season as needed.
- Phase III.**
Monitoring.
 Routine sampling for population levels, stabilization, competition, & efficacy.
- Phase IV.**
Complete Cycle Evaluation Repeat.
 After a number of years populations are expected to decline and replaced with other organisms and bacteria as part of a normal successional stage of development. To jump-start the system and process again a new set of trenches is to be excavated near the existing and the process repeated. In addition parent material (slag soils) should be oxidized in timed phases so that weathering can be controlled.

Locations.
 Lake Calumet Perimeter
 Upland Territories
 Including locations for future park programming.
 Trail Sides
 In select location so that it is a visible feature of the park development.
 *ORANGE LINES ON MAP INDICATE PLACEMENT

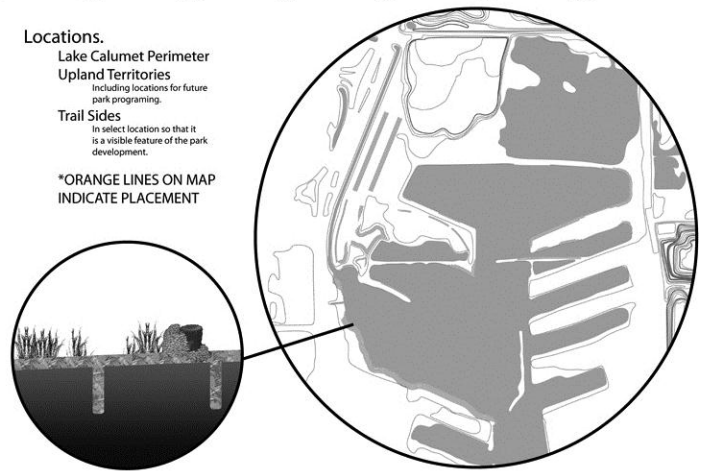


Figure 4.4: Bio-reactive barriers in relation to Lake Calumet and hypothetical population dynamics. This diagram shows how microbes are used for soil building and pollution mitigation in the Calumet Complex.

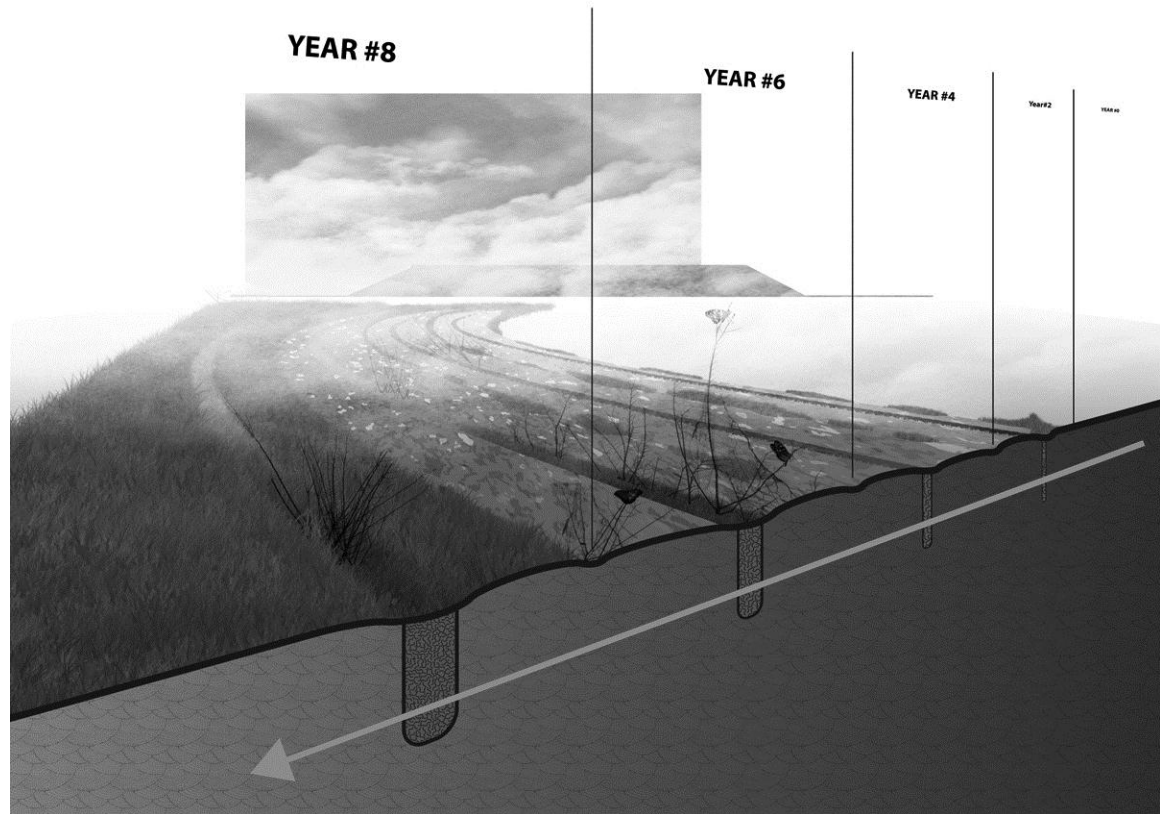


Figure 4.5: Bio-reactive barriers constructed parallel to each other over a number of years progressively allowing new colonies of life to increase the resiliency of the landscape.

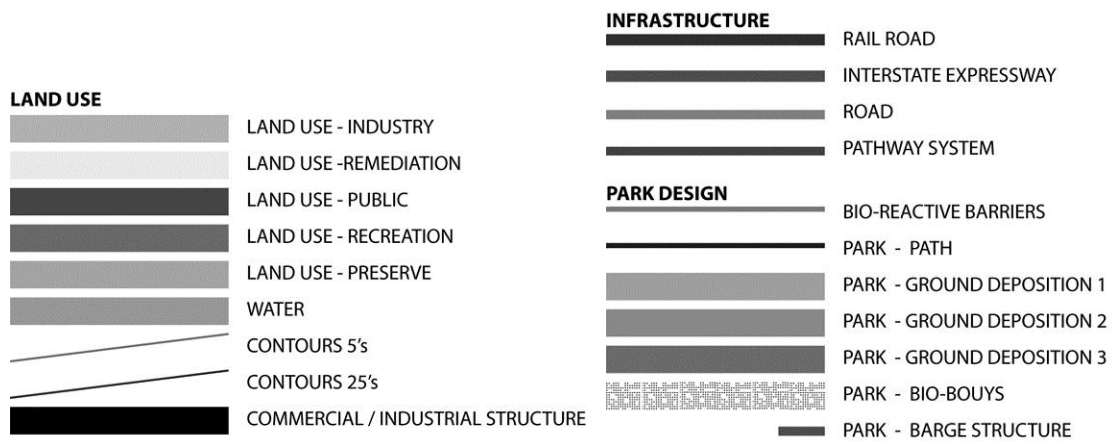
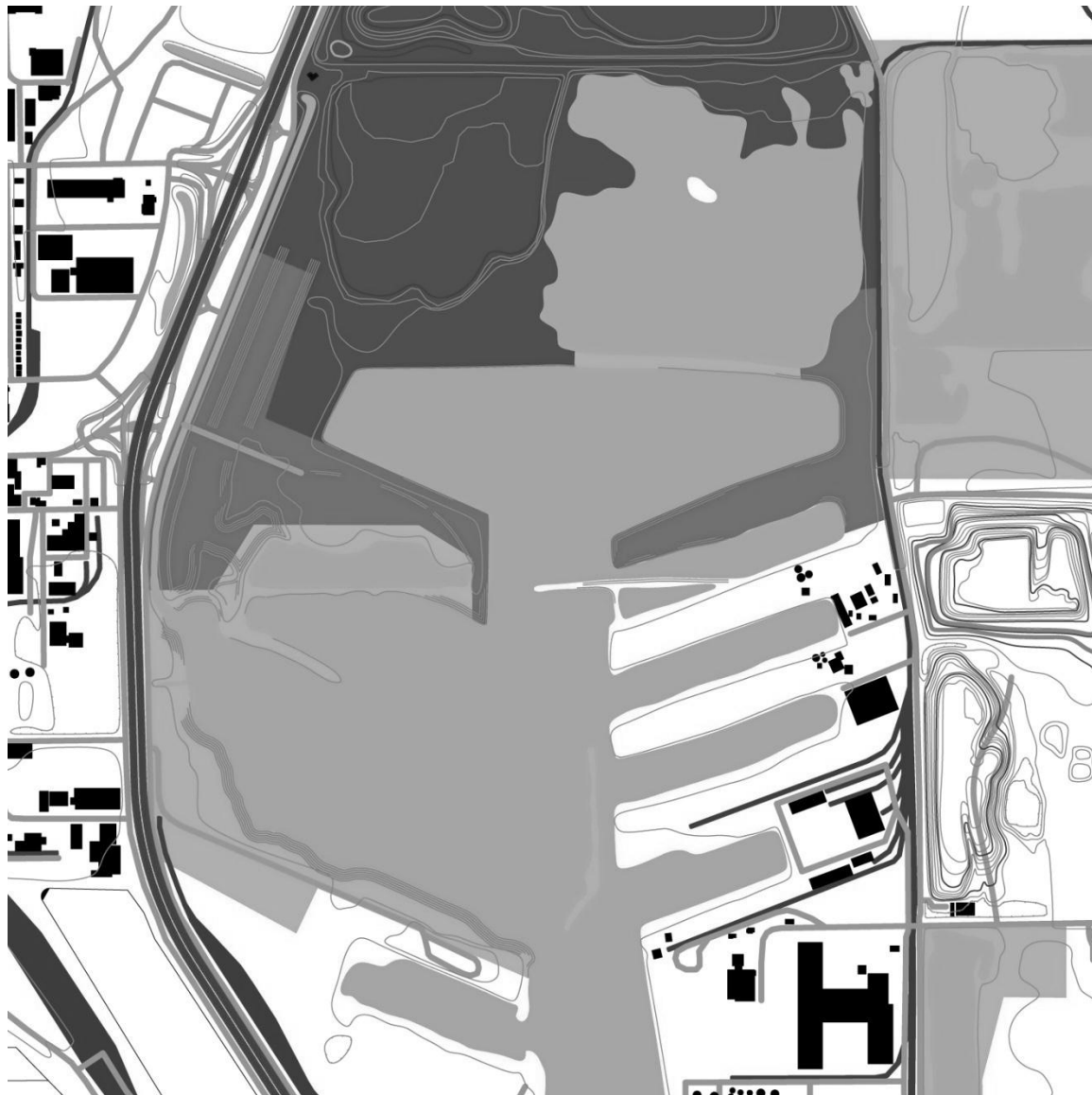


Figure 4.6: Additional location map of bio-reactive barriers.

4.3 Phase II: recreational opportunities emerge

This phase begins construction of the multi-use trail network, part of a plan envisioned by the Southeast Environmental Taskforce. This will connect the West end of Lake Calumet’s open space recreational areas with those on the east side. Some of the park’s land-based developments will also take place at this time. These will include facilities such as parking, trails, and boat ramps.

Much of this interest in the improvement and development of the Lake Calumet Complex would not exist if it were not for the efforts of very active local interest groups such as the Southeast Environmental Task Force. Their goals for the lake are to open its shores to public use, protect and restore habitat, and to connect communities across the Calumet region using trail systems (Southeast Environmental Task Force 2006).



Figure 4.7: Conceptual image of boat dock facilities constructed during this phase.

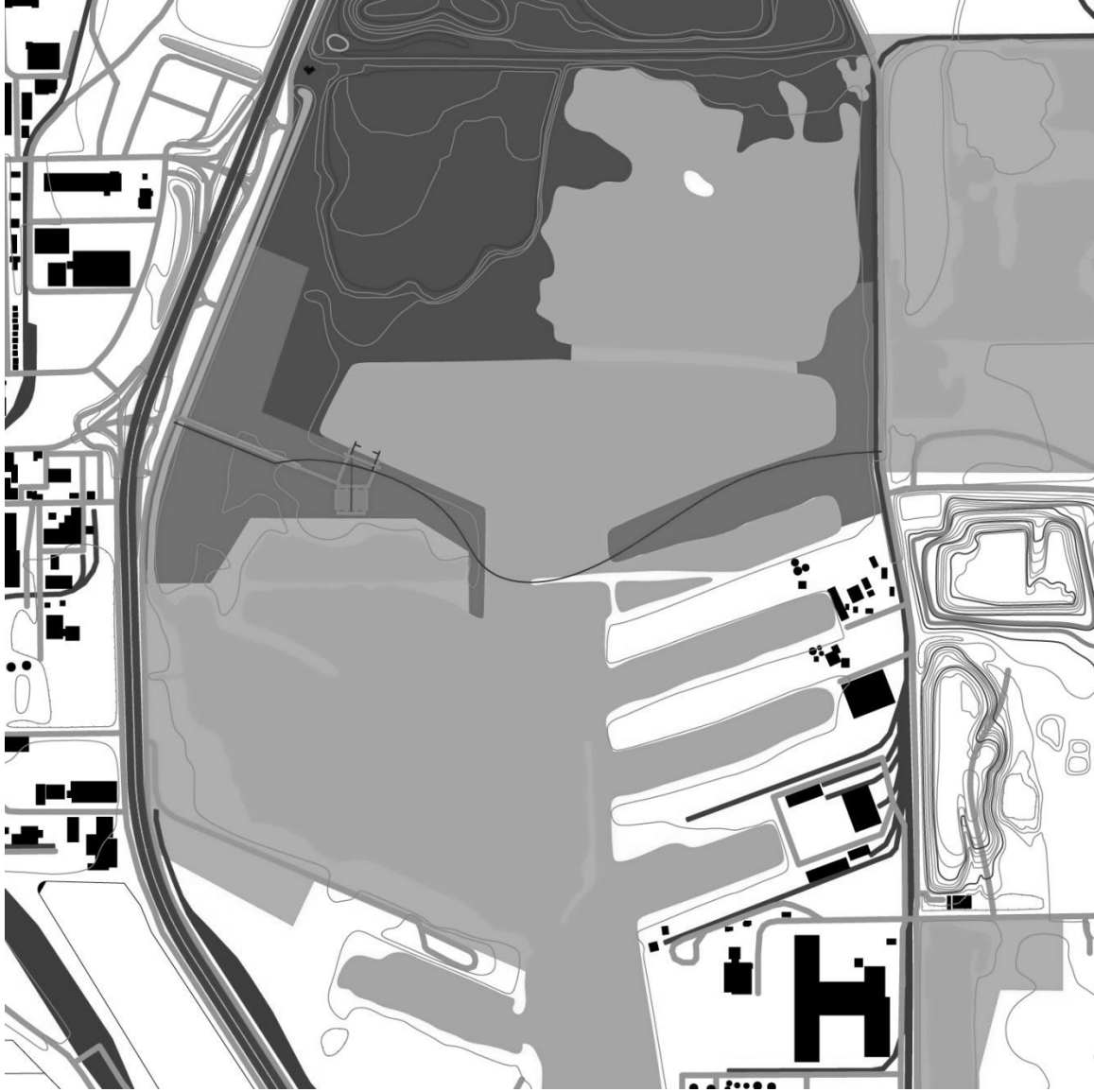


Figure 4.8: This map represents the placement of the multi-use trail network that connects the West and East sides of the Lake.

4.4 Phase III: recreational and ecosystem opportunities expand

This phase of the park's development goes beyond the shores of Lake Calumet and moves into what could potentially be a more interesting space for recreational experience. For years people have been speculating on the future of water by looking from the shores to the lake. Alternatively, by creating a platform from which to view a vast open system we can see the land from the water and see the land as part of the process of water. The purpose of fitting such a strategy into the park's overall goals is to create a hybridization between ecological and recreational systems that will stimulate the surrounding communities, industries, businesses, and other engaged parties to inspire innovation and development within the Complex.

Programming of the site is intended to create spaces that can be used as a recreational destination for the region as well as a conveniently located city park for local residents. Interested parties will organize, design, and develop a slice of real-estate that will filter or oxygenate a specified amount of water on a yearly basis. This real-estate will be contained on a mid-sized rake or box barge. Details of how the barge improves water quality will be under the judicious discretion of the members of the organizers. However, the style through which it is expressed is to be totally given over to the abilities and desires of the participants. A theme of improving water quality and ecosystem health will be the unifying objective. The collective parties, and their barges, will be located in strategic places on the lake so the ecosystem improvement objectives will be fulfilled. Their synergy will be a collection of floating experimental spaces, garden rooms, recreational facilities, and community assets that speak individually as well as collectively. Like the compilation of many differing individuals to a system 'Bio-Diversity,' this type of system is intended to profit from more rich and varied design. This is expected both for the benefit of local ecologies as well as community, business, and industry relationships.

A walkway elevated above the surface of the lake and barges will connect these structures back to the park's main land-based development. This walkway is intended to weave through the structures and surrounding ecosystems giving new access and views to this dynamic landscape. Figure 4.9 shows proposed locations for the barges and walkways. Several unique islands will also be separated from the walkway creating spaces only accessed by boat. These will have the potential to be used as rental facilities for boaters or even to locate concessions such as dining cars.

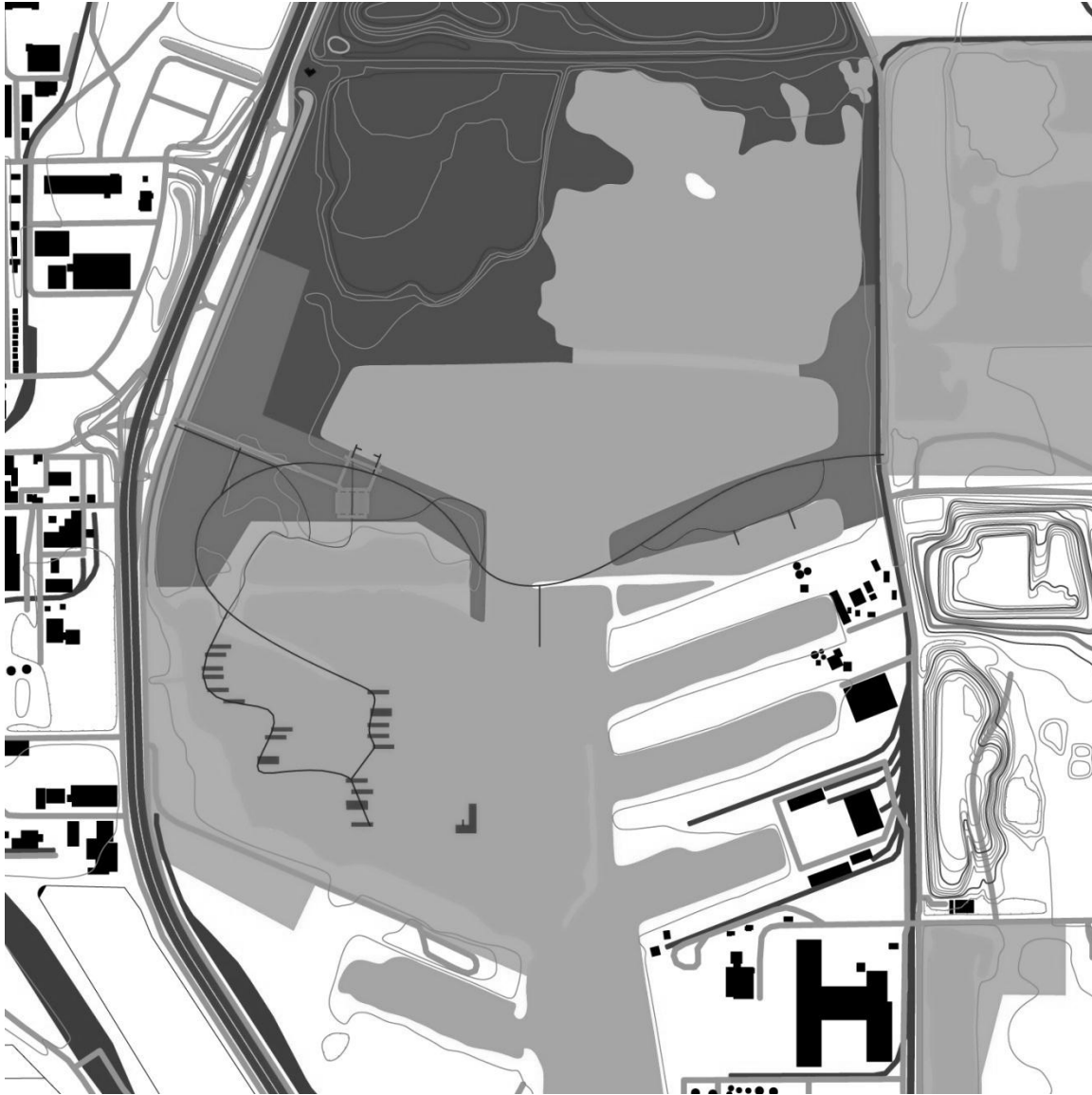


Figure 4.9: Location of barges and their connection to the park through the walkway system.

Design of the barges could serve any number of functions to meet social goals. Successfully integrating these socially stimulating aspects of the barges is an added value beyond the more functional aspects of the aforementioned ecological infrastructures. Figure 4.9 shows example barges that incorporate form and function. Experimental and challenging designs should be encouraged that utilize a wide range of materials and resources.

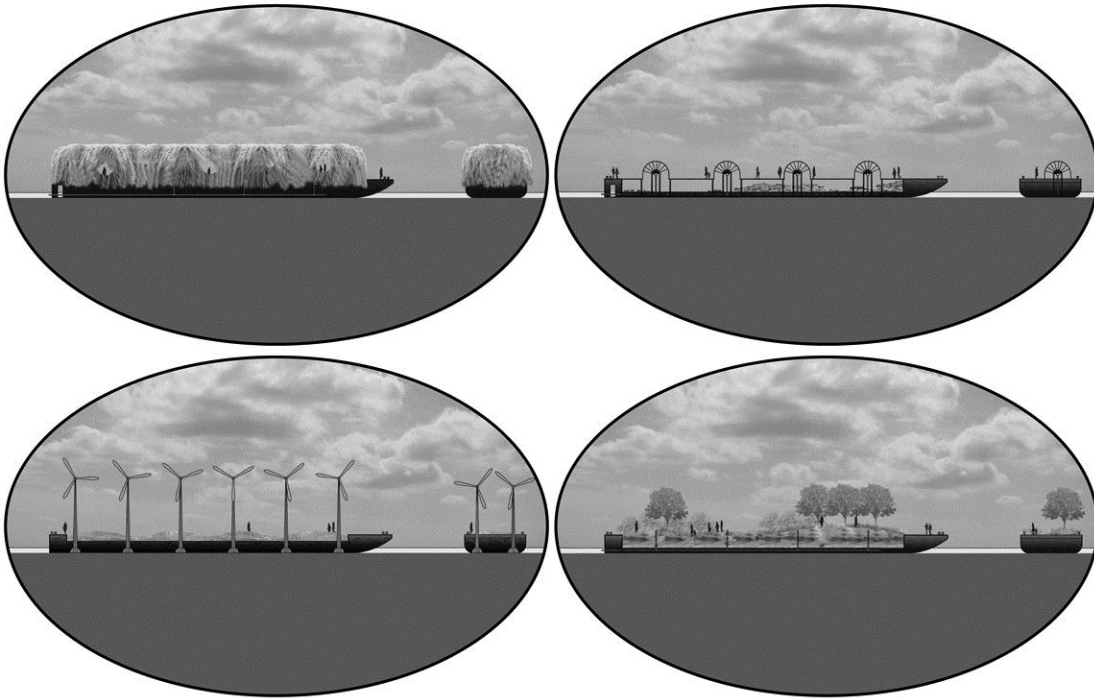


Figure 4.10: This image represents some potential barge designs that could come out of the open ended design process. While each may look and function differently they must perform a function of ecological improvement. Elements such as wind turbines and solar chimneys can power pumps and compressors aerating water and moving it through biologically charged filter media.

The barges can be partially assembled either on the lake itself or among the numerous vacant ports of the industrial and canal corridor. This land is already set up for this type of operation to take place with local rail, road, and barge access all around. Figure 4.9 shows several suitable locations for barge construction and staging.

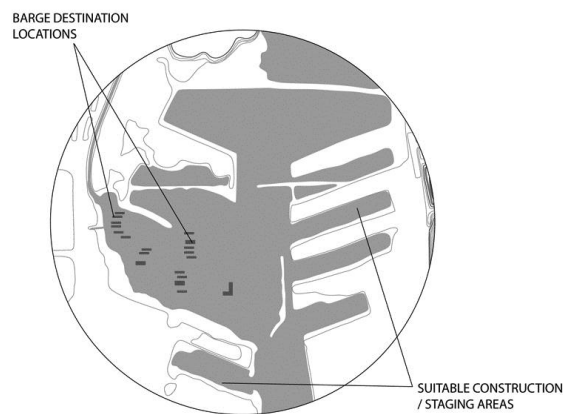


Figure 4.11: Barges can be staged and constructed in the numerous nearby docking ports.

This park concept challenges the distinctions between constructed and ecological systems. Ecological systems and urban infrastructure have much in common both in their components and processes. If we compare a typical modern waste treatment facility and its natural counterpart - a wetland - we find that both are capable of digesting waste products and do so using similar processes, but their ability to compress and concentrate treatment amounts operate at much different scales. Because space is limited and water quantities are high this park design will use the competitive advantage of constructed and hybrid systems over ecological systems to digest and treat polluted waters.

Wetlands are capable of handling as much product as a treatment plant but they need more land area to do so (Hey et al. 2005). Both waste treatment plants and wetlands utilize fluid mechanics to allow particulates to precipitate, bacteria to digest and break down chemicals, and oxygen or lack of oxygen at the correct time to help expedite the process. Treatment plants run at more stable, continuous rates while wetlands are subject to ecosystem fluctuations and complexities. Waste treatment plants are located at the terminal end of long chains of interlinked piping. Wetlands, by contrast, are spread throughout a larger area; they are the treatment plant and the pipe. As we have seen from previous research, wetlands can metabolize nitrogen at acceptable rates during the growing season and then quickly lose this ability during the non-growing season. When the growing season resumes one of the only devices that can restore oxygen back into the water is by using mechanical methods as found in the S.E.P.A. plants. This is a system working toward recovery by hybridizing ecological and artificial methods.

Research and applications by ecological engineer and entrepreneur John Todd has proven that floating hybrid 'Lake Restorer' systems can perform and enhance ecological functions and improve water quality. His research and designs have proven that mechanically assisted ecological systems can react with a highly polluted environment to accomplish water quality improvement goals (Todd et.al. 2003).

This design proposes to integrate similar ecological and hybrid mechanical filtration systems into the parks framework of development. This design does not focus on the specifics of how these systems will work as much as it does on the need to challenge others to adopt the innovative social and ecological potentials of such projective design thinking.

Water quality improvement goals that utilize mechanical filtration efforts should be directed by restoring simple ecological functions. Many more are possible, included below are goals of how to direct these ecological functions.

- Lake cooling - shading and cooling a microhabitat to buffer drastic water temperature fluctuations caused by urban runoff.
- Oxygenation - enhancing dissolved oxygen levels to benefit oxygen deprived aquatic habitats and improve chemical reactions such as chemical oxidation.
- Habitat Improvement - restoring the gradient for vertebrates & invertebrates.
- Detention - increase the residence time of water detention and treatment.

While these strategies all build upon simple, isolated methods the end result could create higher quality aquatic niches within the lake ecosystem.

4.5 Phase IV: ecosystem processes expand

As important as individual components are to the system they will be further enhanced if they work and function together. While the barges can remediate water quality issues so too can the spaces between them. While the barges can actively improve ecosystem functions the spaces between and around the barges will utilize more passive ecological methods. Soil building processes will again be used. To do this the spaces will be manipulated so that they reduce turbidity, increase sedimentation, and create pockets for plants and microbes that immobilize pollutants, metabolize others, increase oxygen, and provide new habitat for higher levels of organisms. Emphasis is on enhancing and creating habitat for organisms that increase the resiliency and complexity of the ecosystem. This phase of development can further be segmented into several sub-phases to take advantage of shifting resources and capital as well as changes and responses to these ecosystem fluctuations.

An important process of pollutant transport is through the movement of particulates found in suspension in water. This will be addressed by trapping and stabilizing sediments that transport pollution and adding the biological processes that allow for their *in situ* remediation. In addition, new ground will continuously be constructed re-establishing shoreline habitat and new hydrologic gradients that connect and bridge land and water.

Sedimentation spaces are constructed by driving stakes and pylons into the lake bed and using simple wattling techniques at regular and irregular intervals. Variation will be useful for the end result. Small permeable pockets of land will be constructed using soils generated from dredging operations, cut

and fill within the lake bed, recycled materials, and plant material. The emphasis is on setting up the operation to spawn its own development. Here the idea is that land formation is a process of sedimentation. Through the course of a number of years the lands will evolve and grow. New ecologies will form and will be enhanced within this phase of development.

Soil Deposition Processes and Pollution Mitigation in the Calumet Complex

Phase I.

Define Boundaries

Irregularly shaped landforms are allowed to evolve over time as sediment is directed into desired locations. Process begins by staking-out the loose shapes with vertical pliers. Then the area is filled with some content of suitable recycled materials (course woody debris i.e. old christmas trees, rip rap, fiber, etc...)

Phase II.

Monitoring.

The process is then allowed to progress on its own. The process can be repeated or enhanced as needed. New sections can be constructed as time and capital allow. The process showed be monitored to track its progress and efficacy. Seed and plant materials can be manipulated (removed, replaced, added) as the soils undergo their formation.

Locations.

Lake Calumet Barge Perimeters

*ORANGE SHAPES ON MAP INDICATE LOCATION, RED RECTANGLES INDICATE BARGES

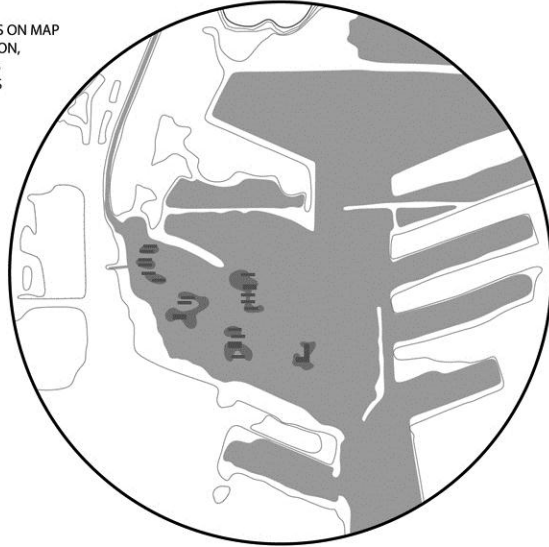
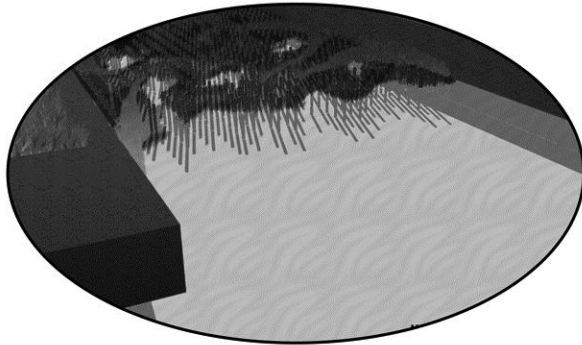


Figure 4.12: Location and description of sediment traps between barge structures.



Figure 4.13: Imagery of barges with evolving ecosystems and connecting boardwalks.

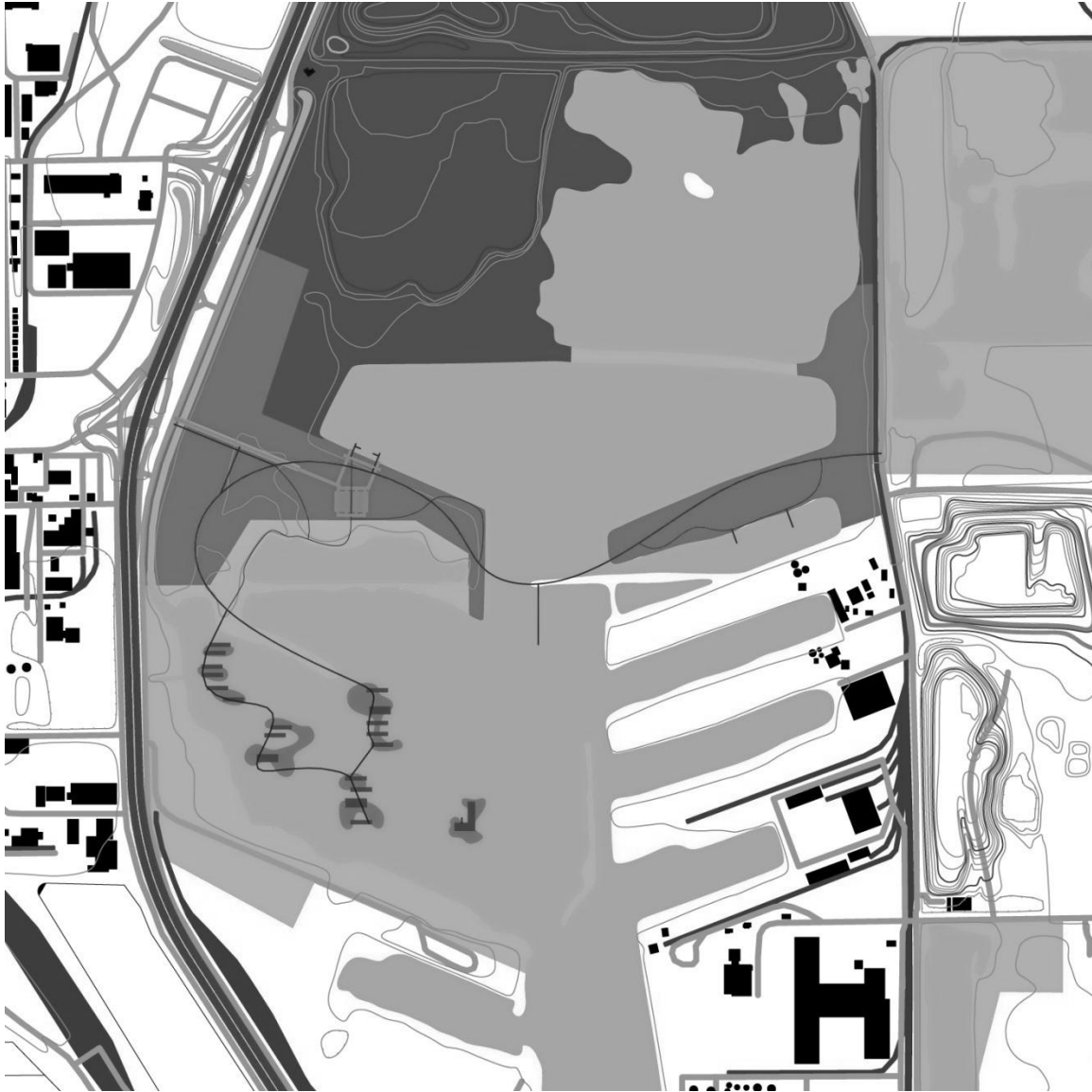


Figure 4.14: Location and park progression during phase IV.

4.6 Phase V: ecosystem processes refined

Additional systems will be added to the park during this time that help refine its aesthetic qualities and further promote the interplay between constructed and ecological systems. New, inventive structures and landforms will further facilitate these goals including the creation of Bio-Buoys as well as new island and shoreline habitat.

Bio-Buoys are additional structures that will be located within the complex to provide both architectural interest and ecological function. These Bio-Buoys are floating structures tethered to the lake's bottom. Their movement within the lake increases splashing thereby oxygenating water, dissipating waves, creating microhabitats, and serve as additional media for the growth of plants and microbes. Within the design a number of forms could exist, pictured in figure 5.13 is a grid pattern that will be broke into irregular segment more seen in figure 5.14.

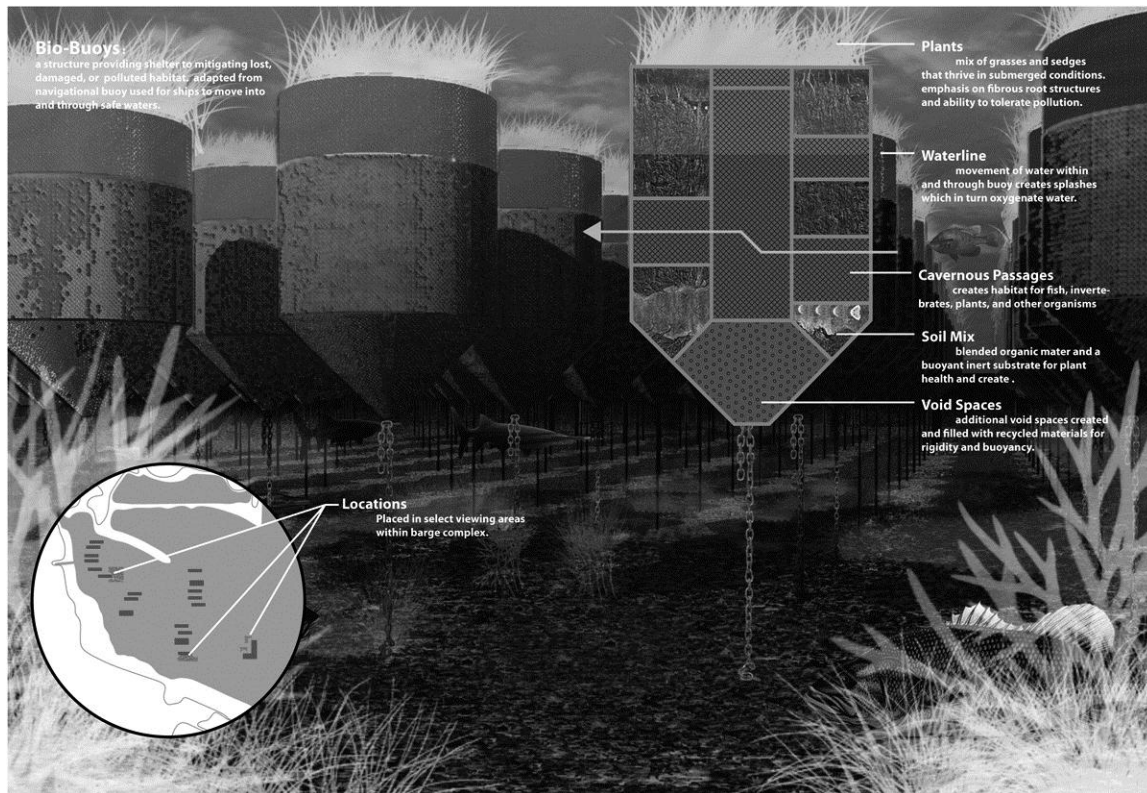


Figure 4.15: Design and location of Bio-Buoys within the park design.



Figure 4.16: Conceptual imagery of a view from the boardwalk and barge looking across the lake and nearby industry. Also in this frame is a view of the placement of a grouping of Bio-Buoys. These Buoys will be arranged in a broken grid pattern.

New grounds are also to be constructed during this phase that further reinforces sediment trapping processes. New soils and materials will be brought in from other sources to support and construct habitat. Topography will be manipulated to include more hammock island landforms.

Recent practices of remediating landfills within the Calumet Complex have been very successful in using imported soils from river dredging operations. These sediments were dredged from the Illinois river near Peoria, IL and transported by barge to remediate part of the Paxton I landfill (Marlin 2003). This operation proved that a quality soils can be reused in this site with fairly conventional techniques.

Shorelines and new islands will be constructed using similar methods and materials. Their use will enhance and eventually create a new hydraulic gradient between land and water.

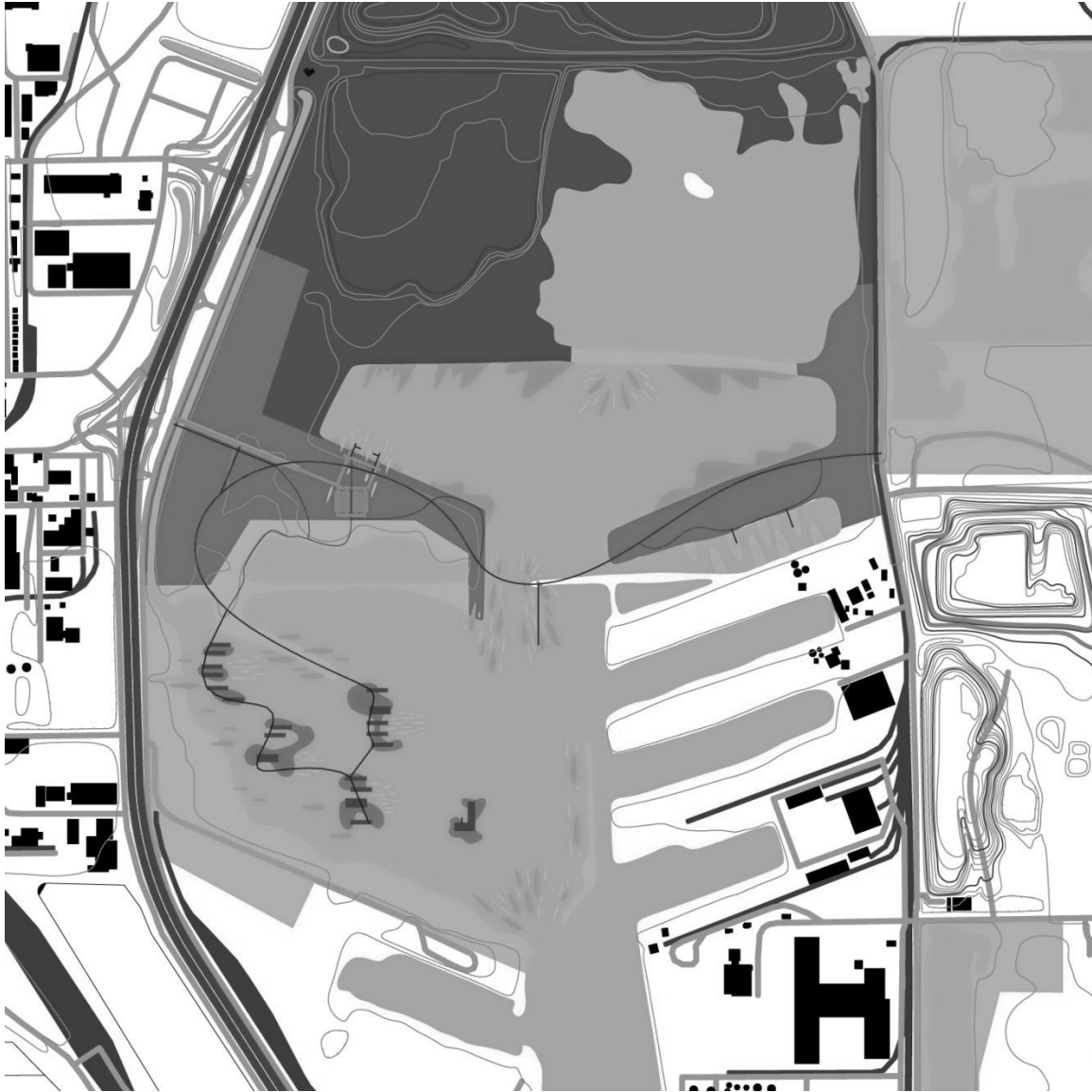


Figure 4.17: Location of evolving island structures within the park boundaries.



Figure 4.18: Conceptual image of a view of the lake from what it may look like in a small water craft.



Figure 4.19: Bird's Eye view of park with Downtown Chicago in the far horizon.

CHAPTER 5 CONCLUSIONS

5.1 Summary

For this design thesis, the industrial landscape of the Lake Calumet Complex has been used to investigate the idea that waste is a normal component of the ecological and urban fabric. Waste within this complex is a culmination of strata and used as staging grounds for various social, industrial, and ecological systems. This is supported by corresponding geological, ecological, and industrial eras that have deposited their layers of waste that contribute to its current landform. Adaptability of biological organisms to use this waste has made this region productive and prosperous in the past. The ability for present and future societies to reestablish this area as productive and prosperous will lie in their ability to investigate and repurpose such waste.

Water has been used as a primary focus in this thesis because it was crucial to the development of the area and its importance to society's need for a healthy community. Water quality within this landscape is one component that has been researched with additional improvements proposed to better serve ecological, economical, and social needs. The product of this research is the transformation of marginal land into a new park system that will use the improvement of water quality as a device to advance ecological, economic, and social systems of the area.

The design has been proposed to be completed in a series of phases directed at remediating the site, installing programming, or a combination of both. Remediation phases, designed to improve water quality, will also integrate a new ecological infrastructure into the landscape that will meet the ecosystem preservation, improvement, and creation goals set forth by the city. These goals will also provide access opportunities and activities for visitors and nearby residents.

The programming phases or park components seek to reconnect people and revive interest in the Lake Calumet Complex; this will lead to future opportunities to mitigate some of the larger economic and social problems of the area. At various phases of the park's development the design goes beyond the shores of Lake Calumet and moves into central portions of the lake to create what will be a unique and provocative space providing the visitor with memorable experiences.

In order for this thesis to serve the needs of future academic inquiry as well as make this project a plausible future scenario two additional topics must be considered. First, this thesis although rigorously researched and carefully designed, relies heavily on conceptual ideas and theories to draw its conclusions. There will always be a level of uncertainty until the efficacy of a project such as this can be

more carefully modeled or tested. Second, this thesis was researched and written from the perspective that Landscape Architecture is a valuable profession and discipline with much to offer urban developments such as the Lake Calumet Complex.

5.2 Implications: uncertainty

Although many of the ideas explored in this thesis are simple, practical methods, much of the design remains conceptual (as opposed to practically resolved). Information is limited and largely unexplored in the complex domain of ecological, industrial, and social system interaction. This section outlines some of the points that need attention for this type of project to be implemented.

Massive landscape changes have occurred to the Calumet region's landscape over time. Some changes have occurred over an extended period of time others over a relatively short period. The order for classifying time in the Calumet region in this thesis includes geological, pre-human, pre-settlement, settlement, industrialization, and post-industrialization. The proposed remediation techniques are modeled on processes and cycles that have occurred across several of these time frames. However, it is possible that remediation phases could equate to or go beyond these measurable time frames.

If the future is at all reflective of our past it is almost certain that our views will change. From settlement to post-industrialization periods we began with a waste landscape and have ended up with a waste landscape. There is always the chance that these long held beliefs of waste in the landscape will never change.

In this thesis waste is seen as naturally occurring materials and events across a time spectrum and looks for ways to digest, metabolize, and immobilize it. In respect to chemical processes and pollution mobilization and immobilization Calumet today has a stronger identity with its early geological past than it does with its pre-settlement times. For these reasons bio-remediation techniques make perfect sense, however we are just beginning to understand how to apply these techniques in the field.

Bio-remediation strategies such as the use of myco-remediation have been increasingly studied in recent years in laboratories and highly controlled environments. These strategies have not been fully tested in field situations. While variables such as nutrient requirements and production yields can be predicted, variables such as intra-species competition have yet to be fully understood in this way (Gald 2001, Stamets 2005).

To test the efficacy of some of these strategies test plots should be implemented in key areas. The City of Chicago and U.S. Forest Service are already testing some other bio-remediation strategies on the highly polluted Cluster Superfund site within the Calumet Complex (Westphal & Isebrands 2001).

5.3 Implications: future evaluation

If this project has been the least bit successful it will raise many questions and open a wide range of critiques for the landscape architectural community. Of much importance for future evaluations is how and why the profession of landscape architecture should be involved with re-designing the postindustrial landscape.

In considering who and what professions should be involved with designing post-industrial landscapes, landscape architecture is not solely privileged to this task but perhaps best involved as part of a multi-disciplinary team. As a profession that has the ability to analyze organize, and design across a variety of scales, landscape architecture is at the disposal of local and regional policymakers and representatives to help bridge the gap between the ecological and urban fabric with the needs of a progressive city. Perhaps landscape architecture can even bridge the gap between other professions that will necessarily be involved in such work.

Real efforts, as proposed in this design, would require engineers, biologists, mycologists, social scientists, outdoor educators, marketers, and many others in addition to landscape architects. The efforts currently underway in the Calumet Region outlined in previous chapters further reinforce this notion. In many ways the tools of development for tomorrow are not much different than they are today, we just need to find a new way to put them to use and for disciplines to interact. Additionally a much needed service to be provided by landscape architects could include the ability to write and organize a management plan for this type of landscape. Managing landscapes is largely about identifying or discovering what of value is living in the landscape and nurturing it. In the case of Calumet this could be the bacteria living off of the extreme alkaline chemical energy underground or a point in the landscape as a destination to local residents. A plan such as this would require constant monitoring as well as a way to provide feed-back to the design community. This information is, and has always been, useful to design all landscapes and avoid damage to what is already working.

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