MATERIALSCAPE:
THE TRANSFORMATION AND REVITALIZATION OF
AN ABANDONED LIMESTONE QUARRY INTO
AN EDUCATIONAL AND RECREATIONAL PUBLIC PARK

A CREATIVE PROJECT
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MASTER OF LANDSCAPE ARCHITECTURE

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THE TRANSFORMATION AND REVITALIZATION OF AN ABANDONED LIMESTONE/GRANITE QUARRY IN SOUTHERN INDIANAPOLIS INTO AN EDUCATIONAL AND RECREATIONAL PUBLIC PARK
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ABSTRACT

MaterialScape layers a 65-acre educational park of material consumption on an abandoned quarry in Indianapolis, IN., where material extraction was and still is a major component of Indiana’s cultural and economic history.

The project aims to create an immersive and engaging learning experience for the visitors through the visualization and the representation of the consumption of six essential materials (water, stone, coal, steel, gasoline, and salt) in landscape architecture’s design language. It addresses sustainability not only through environmentally low-impact development of the quarry site but also through emphasizing cultural sustainability by integrating innovative and rich educational programs.

As a future landmark destination, the project has the potential to bring multiple benefits to the west Indianapolis community where the site is located, including raising land value and strengthening public space networks and more importantly, creating a sense of belonging and honor.
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01_BACKGROUND

I. Introduction
II. Problem statement
III. Assumptions and delimitations
IV. Process and methodology
why quarries?

The MaterialScape project draws inspiration from the photography works by Edward Burtynsky, who has made poetic portraits of the manufactured or the post-industrial landscapes that possess the visual uniqueness and emotional impacts: quarries, oil farms, factories and so on. Behind those beautiful but disconcerting pictures lie the conflict between raw materials extraction activities and the calling for an uncompromised natural environment. Quarries, in this sense, highly symbolize human’s enduring efforts of materials extraction to support their living environment: the construction materials for buildings, houses, roads—everywhere.

As human’s footprint expands on earth, it results in countless open wounds to the landscape: highly manufactured, altered and deserted land of collapsed ecological system, exposed stones, and little vegetation cover. Here is a list of negative environmental impacts from mining activities:

• Habitat/Biodiversity Loss: Mining activities in the pits or quarries require the removal of almost all natural vegetation, topsoil and subsoil to reach the aggregate underneath. It not only leads to a loss of existing animal wildlife but also results in a massive loss of biodiversity as plants and aquatic habitats have been destroyed.

• Natural Drainage destruction: Pits and quarries disrupt the existing movement of surface water and groundwater.

• Water pollution: the interruption of natural water recharge can lead to reduced quantity and quality of drinking water for residents and wildlife near or downstream from a quarry site.

Also, the hazardous substances most likely to be present at quarry sites are “fuels for heavy equipment, detonators, explosive charges, detonation cord, various metals, and nitrate fertilizers used for large fragmentation charges” (EPA, 2009).

However, at the same time, those abandoned mine lands possess such topographical uniqueness and cultural significance to the foundation of human being’s life, which could turn into innovating design opportunities.
Why Indiana?

Indiana is geologically rich in mineral resources. According to the National Mining Association’s statistics in 2012, Indiana’s home to 293 mining operations. Throughout the past two hundred years, Industrial material extraction and consumption have been the primary engine of Indiana’s economic development. Among the diverse material resources that have been mined in Indiana like coal, natural gas, and petroleum, stone resources are the icon of Indiana for one-third of the mining activities here were of stone and aggregates production, according to the Indiana Geological Survey in 2007.

Specifically, Indiana limestone, as a high-profile and enduring dimension stone, is unique to the southern part of the Indiana. In the history of Architecture of the United State, Indiana limestone has been used to build up some of the national’s iconic buildings, such as the Empire State Building in New York City, the Pentagon in Virginia and the National Cathedral in Washington D.C. For decades, Hoosiers took pride in the mining and crafting trade of the Indiana limestone.

In this sense, Indiana has a rich cultural background and social connection to the mining industry, which echoes the project’s ambition to address the aftermath of post-mining land and to reconnect/return those lands to the urban fabric.

II__ Problem Statement

The MaterialScape project explores possible design solutions to reclaim and transform an abandoned limestone quarry in the Indianapolis urban area into an educational park. The project visualizes and demonstrates the consumption of six essential raw materials of everyone’s lifetime: water, stone, coal, gasoline, steel and salt, and addresses cultural sustainability in sculptural and aesthetical appealing landscape settings.

The project will address the following sub-questions.

- Cultural sustainability in the landscape: How to create a public park that sustains the site’s cultural significance in material consumption through sculptural, aesthetical appealing landscape elements as well as educational and demonstrative site programs?
- Material consumption and representation: How much raw material does each person consume in his or her life and how to demonstrate the quantity and quality of each material through a park design?
- Adaptive reuse of landscape: How to best reuse and preserve the existing quarry terrain as well as reclaiming the materials or resources left on site?
III. ASSUMPTIONS, DELIMITATIONS AND DEFINITION OF TERMS

_Assumptions_

• The creative project will be developed after the reclamation process of vegetation, soil formation and drainage system on the site, and the concentration of the project is not on the ecological reclamation process.

• The community around the site is supportive to the redevelopment of the quarry site. And the landowner is agreeable to the overall project proposal.

• There are no specified budget limits to the project, but the project will consider applying budget reduction procedures during the design process.

_Delimitations_

For the creative project, the following delimitations have been noted.

• It’s not the intention of the project to ensure the success of construction and reclamation efforts.

• It’s not the purpose of the project to develop a quarry adaptive reuse prototype that fits into all quarry sites.

_Definition of terms_

**Material Consumption**

The consumption of materials characterizes the expenditure in specific terms (per unit of production) of material resources (fundamental and auxiliary materials, fuel, energy, and depreciation of fixed assets) needed for production. Each year the Mineral Information Institute calculates the annual and lifetime consumption of mineral and energy resources from information provided by the U.S. Geological Survey and other sources to show the dependence that Americans have on the mining industry.

**Landscape Interpretation**

Interpretation facilitates a connection between the visitor and the site resource. A meaningful link is forged through a dynamic combination of spatial experience, visual and sensational cognition that conveys relevant themes and information.

**Quarry Reclamation**

Restoration of mined land to original contour, use, or condition. Also describes the return of land to alternative uses that may, under certain circumstances, be different from those prior to mining.

**Culture Sustainability**

For a given landscape understood as a space and a place, social and cultural criteria encompass objects and structures, such as historical remains and habitat for people, and values such as the sense of place, local culture, and traditions (Axelsson, Robert et al., 2013).
IV_ PROCESS AND METHODOLOGY

The project’s research starts with the literature review, which is a synthesis of existing theories that are related to the quarry redevelopment as well as an answer to the questions from the problem statement. From the literature review, the overall concept of the project is formed.

The literature review is followed by case studies of existing practices in the field of landscape architecture regarding quarry reclamation strategies, cultural representation, and educational landscape design. The case studies further contribute to the site’s programming and concept development.

Other methodologies such as site observation and 3D modeling and visualization are used to facilitate the design process.

1_ LITERATURE REVIEW

The literature review explores the body of literature and research articles around three topics: theories of culture and aesthetics in sustainable landscape design; material consumption study and legacy of material extractions/industrial mining activities in Indiana.

_Beyond ecological performance: culture and aesthetics in sustainable landscape design

The three pillars in sustainable landscape design are the principals of ecologic, economic and social sustainability. Along with the rise of environmentalism in the mid-1990s’ century, the intricate balance of the three elements has been broken.

In this sense, the sustainable ideology of technology in the aspect of ecological development has emerged as a dominant force to the landscape architecture field as James Corner and other landscape architects witnessed: “It is not unfair to say that contemporary theory and practice have all but lost their meta-physical and mythopoetic dimensions, promoting a landscape architecture of primarily prosaic and technical constructions”(Corner, 78). Professor Elizabeth K. Meyer of University of Virginia further explained,

“Sustainable development requires more than designed
landscapes that are created using sustainable technologies. Design is a cultural act, a product of culture made with the materials of nature, and embedded within and inflected by a particular social formation; it often employs principles of ecology, but it does more than that. It enables social routines and spatial practices, from daily promenades to commuting to work. It translates cultural values into memorable landscape forms and spaces that often challenge, expand, and alter our conception of beauty” (Elizabeth, 15).

In order to rebuild the balance among the three elements in sustainable landscape design, Corner argued about the important but ignored role of culture value to the landscape architecture’s practices, “Many fail to appreciate the role that landscape architecture plays in the constitution and embodiment of culture, forgetful of the designed landscape’s symbolic and revelatory powers, especially with regard to collective memory, culture orientation, and continuity” (Corner, 78).

Meyer further pointed out the importance of aesthetics in creating a cultural landscape,

“A beautiful landscape works on our psyche, affording the chance to ponder on a world outside ourselves. Through this experience, we are decentered, restored, renewed and reconnected to the biophysical world” (Elizabeth, 17).

Culturally rich and aesthetically appealing landscapes have the power to change people’s conscious, behavior and finally initiate social change.
Material consumption study

The study of material consumption is intended to:
1) identify the material types that are essential to everyone’s life;
2) calculate the quantity of each material’s consumption;
3) map the environmental footprint/impact from mining activities that resulted from that consumption;
4) visualize and represent the findings by applying visual elements into the physical world (see chapter_design).

[water]: 201,000,000 gallons

The project’s water consumption calculation is based on “Water Use Statistics” conducted by American Water Works Association in 2008:

“ The average American household uses nearly 70 gallons of water per person per day for bathing, cleaning, and other uses at home. Households with more efficient fixtures and no leaks could drop their use to 45 gallons per person per day “(Center for Sustainable Systems, 2014).

[stone]: 1,270,000 lbs.

According to NSSGA, there’s a surprising but solid fact about the huge demand of stone and aggregates: “Every American will need 1.37 million pounds of stone, sand and gravel in his or her life (NSSGA, 2008)”. The stone are mainly used as infrastructure construction industry, followed by chemical industry and manufacture industry.

The vast consumption of stone demanded large scale of stone evacuation. According to Indiana Geological Survey, there were 3651 stone or aggregate quarries on record in Indiana, including both active and abandoned mines (Indiana Geological Survey, 2015). In this sense, the stone consumption and related mining industry have yielded a massive environment footprint.
In Indiana, 49,297 acres of land are occupied by coal mining fields, including surface strip mines and underground mines. Without proper storage or processing, the by-products of coal production, often called tailings, can heavily pollute the ground water of the surrounding area if are not contained and processed correctly.

Indiana is home to over 45,000 gas wells and over 50,000 oil wells. Similar to the coal production, the leakage from gas and oil wells could lead to contamination of underground water or shallow aquifers.

There were 12 major steel production plants in Indiana, producing over 5000 tons of steel per day. The by-products and production process of steel could result in severe air, water, and soil pollution.

According to the Mineral Information Institute, “on average we use about 12 pounds per person a year in our food, but we are using more than 400 pounds per person every year for other uses, such as on our roads in the winter” (Mineral Information Institute, 2015). In this sense, a large portion of salt consumption comes from the wide usage of de-icers on highways.
Fig 01.02: diagram of essential material consumption, environmental footprints of resources mining.
Legacy of material extraction and mining industry in Indiana

The State of Indiana is geographically rich of mineral resources. In this sense, Indiana has a distinguish history and cultural significance in the material evacuation and mining industry.

There were a wide range of mineral resources and related mining industries, including but not limited to stone, coal, oil and gas. According to National Mining Association’s statistics in 2012, Indiana was home to 293 mining operations, providing direct employment to 16,200 people and another 29,940 people indirectly from mining activities, which occurring both in and outside the state, for a total of 46,140 jobs statewide.

Due to the geographical deposit condition, the stone resources in Indiana are mainly limestone. Native Americans were the first people to discover limestone in Indiana. The first quarry was started in 1827, and the quarried stone was produced for local use only prior to the building of railways in the 1850’s. By 1900, Indiana limestone represented 1/3 of the total U.S. dimension limestone industry, and increased to 80% by 1920. Part of reasons for this boom was the extensive fires in the cities of Chicago (1871) and Boston (1872) which increased the demand for Indiana Limestone.

Indiana limestone is renowned for its durability, consistency, and capacity to accept and retain fine detail. As a type of high-profile dimension stone, limestone played a significant role in the architecture building history in the United States. The Empire State Building, The Pentagon, The Chicago Tribune Building, as well as many university structures, state capitols, post offices, and churches are all constructed with this exceptional material.

There are a group of people who have dedicated their skills and professionalism to the limestone industry. They include sculptors, drill runners, stone polishers, forklift operators and union leaders. In Limestone Voices, the author recorded a touching story about those stone workers:

“When part of the Pentagon was destroyed after 9/11, an Indiana quarry went to work, mining 46 truckloads of limestone to be sent to the Washington site and enabling reconstruction to be completed ahead of schedule” (Ferrucci, 38).
Indiana is among the top ten coal producing states in the United States. Indiana coal was first discovered along the banks of the Wabash River in 1736. Organized mining and development of Indiana’s coal resources began in the 1830s and by 1918, its production exceeded 30 million tons.

There are two types of coal mines: underground (deep) mines, and surface (strip) mines. Before the 1940s, underground mining remained the primary mining method in Indiana. After World War II, surface mining began to dominate the coal production due to the advent of large-scale excavation equipment, which made surface mining more cost efficient. “Surface mining continues to be the primary method of coal removal in Indiana, with nearly 70 percent of the current production coming from surface mines” (Indiana Geography Survey, 2015).

Conditions for those who work in the coal mines, especially in the underground mines, are harsh and dangerous. Miners have to work long hours in the dark and wet environment “with a number of problems and hazards to deal with, such as water, ventilation, electric shock or exposure to the harmful gas” (the peel web, 2015).

Indiana’s oil and gas is produced from oil fields that are located dominantly in the southwestern and east-central portions of the state. There was a period beginning in 1876, called “Indiana Gas Boom” when America’s first giant oil field had been discovered in the Trenton Field of Indiana. Since then, active drilling and production of natural gas grew rapidly. Production reached a peak in 1956 at over 12 million barrels for the year (Grey, p 144). However, the wild, unregulated boom ultimately resulted in thousands of wells having been drilled. Back then, wasteful burning of the gas was not rare. To display and show off the abundance of the gas, some producers even lit a flambeau at the top of each well. “Some flambeaus had been burning for nearly two decades. Modern experts estimate that as much as 90% of the natural gas was wasted in flambeau displays” (Gray, p.189).

“As gas and oil production declined in northern Indiana during the early 1900s, new discoveries were being made in the southwestern part of the state known as the Illinois Basin” (Glass, p.31). The rise and fall of the Indiana’s gasoline production remained a lesson to warn us that even the most unlikely resources could run out if we keep wasting.
2_CASE STUDY

Case studies are a major part of the research methodology of the project. It explores diverse projects from different periods and locations with quarry reclamation, adaptive reuse, and cultural representation programs. Three case studies have been published: The ROM-Redesign Roma Quarry in Austria, The Eden Project in Cornwall, UK, and the Quarry Garden in Shanghai, China. The case study applies the same format that starts with an overview description and concepts narrative and follows with its design relevance to the MaterialScape project.

ROM-Redesign Roma Quarry, Austria

Overview

The ROM Project is a redesign of a Roman Quarry into a theatrical space for the St. Margarethen Opera Festival. The site was a former granite stone quarry that had left abandoned in the suburban St. Margarethen, Austria. Building elements are nestled into the quarry landscape, accentuating the particular ambiance of the quarry and affording visitors a very immediate and immersive experience of the theatrical spaces. The main open-air concert hall has an area of 7,000 square meters, with space for 4,670 people. It is accompanied by other social facilities, a children’s opera stage, and a restaurant and outdoor bar.
Concepts and design process

Instead of trying to cover up or hide the existing rough condition of the quarry site, the basic idea of the ROM design is to “extend the ambiance of the magnificent rock-face scenery to all parts of the theatrical arena so as to make it a more palpable and visually enveloping experience” (Archdaily, 2010). The vertical circulation consideration is a crucial component to the design. Elevated pathways connect the parking lots on the upper level of the quarry wall with the concert hall entrance on the bottom level.

Design Relevance

The ROM project achieves social significance by sustaining the site’s cultural identity: music and festivals. Concerts and operas are deep into every resident’s blood in the small town of Austria. Converting a passive space like an abandoned quarry into something dynamic and festival-like is a bold and brilliant move.

The ROM project provides an excellent example of the adaptive reuse of the quarry terrain that achieves functional feasible and aesthetic appeal at the same time. It embraces the unique quality of the quarry to enhance the auditory and visual experience of the festival. The natural enclosure of the quarry façade amplifies the auditory effect of the open-air concert hall. Meanwhile, the monumental rock-face creates dramatic visual effects that an opera or concert needs.
As for the design language as well as the development of the forms, the project creates a series of sculptural structures that have the following characteristics:

- **Preciseness**: clear and simple language of shapes
- **Reduction**: reflection on the essential
- **Contrast**: the contrastive color and texture application of the materials compared to the natural rock-face quarry walls.

**The Eden Project**, Cornish coast, UK

**Overview**

The Eden Project is a popular “ecological theater” park in the UK, home to the eight dome biomes in the world. It is located on a reclaimed brownfield site: a 40-acre china clay quarry on the Cornish coast, to the southwestern part of England. The design is “derived from the existing quarry, building upon its curved slopes, and its zigzag routes built for formal transportation purposes” (ASLA, 2014).
Concepts and design process

“The Eden Project is one of the UK’s top landmark Millennium Projects created to tell the fascinating story of man’s relationship with plants” (ASLA, 2014). The prime driver for the Eden project was to create the environment for growth using minimal amount of water and energy resources through climate and water control. A complex biome system has been developed to achieve those goals. Together with that, transportation, water, soil, energy, and material recycling systems have been designed to support the biomes. In a bigger picture, ‘Sustainability’ is a crucial theme for the project.

Design Relevance

[ On-site Water strategy ]
Water capture and reuse is a big issue at Eden. As a result of past mining activities, the underground water table is well above the floor level of the pit, which causes severe problems in the rainy seasons. The clay pit has copious water derived from rainfall in the pit area as well as groundwater and natural spring. A water strategy was devised with the civil engineers for a collection and disposal system, plus collection and distribution systems for ‘re-used’ water. “The water extracted from groundwater and springs is collected and stored in a large underground tank before being pumped into the water distribution system via a filtration and ultraviolet disinfection plant; water for toilet and urinal flushing is subjected to secondary disinfection by silver ionization treatment. Excess groundwater overflows into the site surface water disposal system” (The Arup Journal, 2001). The only water not provided from on-site natural sources is the potable water supply for drinking, cooking and showering.
[Material recycles programs and Soil manufacture technology]

The pit site has no topsoil or local mine waste to begin with. It was like trying to grow a garden on the moon. As a result, the production of soil has become an industrial process at the Eden Project. Several specific soil types are developed to meet the needs of construction and provide planting beds for plants. “Surplus sand and reject clay from two china-clay operations served as the basis, to which was added forestry bark as an organic component for interior soils and composted, domestic green-waste outside. This manufactured soil is now being marketed commercially” (The Arup Journal, 2001).

[Education, demonstration programs]

The Eden project is not only a single use botanical garden with a giant biome that are full of exotic plants from all over the world. Instead, building on its biome structures, there’s a rich and engaging experience that highlights the “sustainable education and demonstration” programs throughout the site. Below is a diagram showing how the site programs are organized and installed into a quarry site.
THE QUARRY GARDEN, Shanghai, China

Overview
Located in the center of Shanghai Chen Mountain Botanical Garden, the quarry garden covers an area of 4.26 hectares (10.53 acres). The site and natural scenery were severely damaged in the 1980s due to the quarry activities. One deep pool in the west quarry was a result of exploration and excavation into the ground. This project intended to restore the abandoned quarry ecologically and to recover the five classic sights of the “Chen Mountain Eight Sights” culturally, based on both the site condition and social context.

Concepts and design process
The main concept of the project is to transform the west quarry land into a delicate botanical garden, and embrace the memories of quarry history on the site. It has won the 2012 ASLA professional award as “a very honest project. It’s not trying to cover up what it is, and it’s an example of everything done right in reclaiming a quarry. As it seeps down and stains, it will be even more beautiful” (Quarry garden, ASLA, 2012).
Design Relevance

Similar to the site condition of the MaterialScape project, the most difficult challenge was the degraded ecological environment. The site was covered with almost no vegetation but barred rock, along with a significant degree of moisture and soil loss.

The Quarry Garden, as the core spots of Chen Mountain Botanical Garden, provided excellent opportunities for turning a piece of severely-damaged land into an environmental friendly public space. At the same time, the unique topography and spatial formation of the current quarry provides possibilities for designers to develop a piece of unusual landscape.

[ Restoring the ecology of quarry ]
The project involves strategies and attempts to build a new environment of quarry land through reshaping the landform and increasing land cover. As for exposed hills and rock walls, the designer manages to respect the trueness of rock-wall landscapes and exerts limited interventions to leave the rock wall evolving by itself under rain, sunshine and other natural conditions.

[ Natural and cultural experience for garden visitors ]
Applying the traditional Chinese garden method of “scenery borrowing”, the garden creates a dramatic route for visitors to climb the quarry hill and step deep down to the quarry hole lakeside. Meanwhile, the natural quarry scenery of raw rocks and steep hills can be admired by visitors intimately. The whole experience will strengthen their understanding of the Asian landscape and the past of mining industry.
3_OBSERVATION

The site observation includes activities of recording the site conditions and other information regarding the site, for example, site visiting, site sketching, photography and video, and behavior observation.

The objects of observations included but were not limited to the visual quality, sound, and smell; land cover and vegetation, topography, soil and drainage condition; entrance and transportation and the number of visitor’s. The observations took place in both sunny and rainy weathers in order to collect information and compare condition under different drainage situations. The length of each time of observation was 30 minutes.

4_3D MODELING

To have a better understanding of the complex terrain existing on the quarry site, it is a critical step to make 3D models in both physical and digital forms for the following analysis and design phase. The terrain data (DEM) were available from the online library of Indiana Geology Survey. A digital model was developed by importing data into ArcGIS and Rhinoceros 5. From the 3D model, a contour map was generated so as to create the physical model with cut boards and the laser cutter machine. The physical model was frequently used in the initial analysis and design conceptualization phase as an effective visual tool to communicate and present ideas with my project’s committee. The digital model was heavily relied on in the detail design phase for its accuracy and flexibility in producing detailing plans and visionary perspectives.
02 __ PROJECT SITE

V. site selection
VI. site description
VII. site analysis
VIII. site history and formation
IX. site opportunities
Site Selection

The final site of this project was selected out of seven potential quarry sites throughout Indiana, by comparing their advantages and disadvantages according to the following criteria:

- The site should have an urban context, to maximize the project’s social and culture value.
- The site should be an abandoned limestone quarry that has topographic uniqueness as a result of past mining activities.
- The size of the site should be manageable for a student creative project, which is around 30 acres.
- The site’s information is accessible for further research. Basic information includes GIS data, topographic map, drainage map, and soil map, etc.

![Site selection comparison diagram](image)

<table>
<thead>
<tr>
<th>SITE</th>
<th>Final selection</th>
<th>Potential quarry</th>
<th>Potential quarry</th>
<th>Potential quarry</th>
<th>Potential quarry</th>
<th>Potential quarry</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIZE (acres)</td>
<td>75</td>
<td>95</td>
<td>60</td>
<td>60</td>
<td>70</td>
<td>173.4</td>
</tr>
<tr>
<td>LOCATION</td>
<td>Bloomington</td>
<td>Indianapolis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RIELDS</td>
<td>45%</td>
<td>10%</td>
<td>30%</td>
<td>10%</td>
<td>25%</td>
<td>20%</td>
</tr>
<tr>
<td>Basic information</td>
<td>GIS data, topographic map, drainage map, and soil map, etc.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
VI_SITE DESCRIPTION

Location

The site, Blue Lake Quarry, is centrally located on the near West side of Indianapolis. It's about 8-minute drive (3.5 mi) from Indianapolis downtown.
The Blue Lake Quarry is a large void in a landscape that sits between the residential neighborhood of the West Indianapolis to its northwest and southwest. The site is inaccessible to the outsiders with a surrounding fence barrier, and its entrance is marked as “restricted” for public safety reasons. From the outside, people are unaware of the existence of the quarry lake. To its north, W Morris St connects the site with Highway I-70 and the east part of the West Indianapolis neighborhood, acting as the main entrance to the site. Multiple industrial parcels and other mixed-use development occupy its south side, where W. Minnesota St. connects the site directly to the urban core of Indianapolis, IN. The site’s surrounding neighborhoods are mostly low-income and rundown communities, which have a medium income below the state’s average.

The Eagle Creek defines the east site’s boundary with the Eagle Creek Greenway running on its levee. The quarry lake has a water outlet pointing to the Eagle Creek. In this sense, the quarry site has an ecological importance as it runs into the the Eagle Creek and later combines with the White River, which has an impact on the water quality of the downstream neighborhoods of southern Indianapolis.

The open space analysis is based on the site’s regional (west Indianapolis neighborhood) scale. It started with identifying diverse urban open spaces (public park, community park, greenway, etc.) with their service areas (under 0.25 mile/10 minutes walking radius). Further, layering on top a map of the residential population, it turned out that, in West Indianapolis Neighborhood, there is “an open space void” or an area of estimated 8000+ populations living without the proximity to open spaces and its relevant services.
circulation and entrances

The site’s boundary is defined by the surrounding fences and dense bushes (in pink dash-line). In this sense, the site is highly inaccessible to outsiders. However, there are three potential entrances to the site, one to the north onto W Morris St, one to the west onto S Tibbs Ave, and one to the south onto W Minnesota St. Based on the circulation data, the W Morris St provides better accessibility to downtown Indianapolis. As a result, the project proposes an entrance on W Morris St that creates better circulation convenience as well as attracts more visitors to the site.

waterbody and contamination

The site is currently owned by Blue Lake Development, LLC in Indianapolis, which is a landfill company. According to the local zoning record and environmental report, the property was a former Chrysler landfill facility.

The facility contains “hazardous waste” from “wastewater treatment plant sludge, containing cadmium, lead, and arsenic” (EPA, 2009). The known locations and remaining concentration of lead in the sludge are depicted and highlighted in the diagram below (yellow). The on-site monitors indicate...
the groundwater doesn't have any lead concentration while such concentration only exists in the soil.

As a result of the environmental restriction protocol, the future land-use type of the site is restricted from residential and commercial uses. Also, land removal and remediation processes are required to remove the remaining contaminations from the soil of the site, before the land is ready for any further development.

**Topography and Hydrology**

As a result of the past mining activities, the quarry site now features a dramatic landscape: an average 35-feet elevation change between the higher level of the quarry wall and gently sloping land on the lower level of quarry lake. The slope of the quarry wall ranges from 50 degree to 90 degree. Such man-made landscape terrain is rare in Indiana since most of northern and central Indiana is flat and open. The quarry walls also act as a natural barrier preventing people from going to the lower level from the site.
A series of section cuts throughout the site indicates the particular relationship between the surrounding communities and the Quarry Lake. Also, there is an underground connection between The Eagle Creek and the Quarry Lake, redirecting the overflow water from the creek to the lake.

Past mining activities disturbed the natural drainage system, resulting in severe erosion conditions of quarry walls from seasonal stormwater runoffs.

Fig 02_10. diagram of elevation series of the quarry site
To rediscover the hidden history of an abandoned quarry that is now on the bottom of 60 feet deep lake is an interesting and challenging journey. From the published records of local survey maps to the memories of residents, a timeline as well as a story of the site has been recovered.

The Blue Lake Quarry was opened in the 1930s, producing an average 10 tons of limestone gravel and sand per day, at its high period. During the quarrying operation, there was no lake on the site when the operation constantly pumping the water out of the quarry. As an estimation, the quarry once reached as deep as 60 feet deep.

The operation of the quarry lasted about 20 years before it ran out and finally closed around 1949. That was when the quarry lake began to form.

As time went by, the size of the quarry lake kept increasing. During the period, a levy was built up to prevent the Eagle Creek from flooding. Around 1998, the abandoned land was used as a landfill ground of Chrysler company, resulting in a certain degree of contamination of the soil of the site.

In 2011, a landfill company owned the blue lake property and began to infill the lake. As a result, the size of lake reduced dramatically to the current condition.

Fig 02.11 diagram of the size change of the quarry lake.
The formation of the site’s unique topography is a collective work of mining activities (evacuation) and natural process (absorption).

[ Evacuation ]
Operations of limestone mining and processing mainly include five stages: 1_blasting, 2_mining, 3_refining, 4_storage, 5_transportation. Steep quarry walls as high as 60 feet are formed as a result of the mining activities.

[ absorption ]
After the quarry operation ceased and pumping stopped, the quarry lake began to form. The sources of the incoming water include direct precipitation, surface runoffs, and underground water infiltration. Also, the landfill contributed to the rise of the lake water table.
IX_SITE OPPORTUNITIES

[ Re-connect ] accessibility

The current site is physically inaccessible both from the outside and within the site’s boundary. In this sense, the project will create a new entrance on the north of the site for both vehicles and pedestrians. Vertical structures will be installed to accommodate the elevation changes and provide accessibility among the complex quarry topography. Meanwhile, there are opportunities to rebuild the emotional connection between the site’s cultural value and residents’ memories and pride.

[ Re-claim ] eco-system services

The current site is a dysfunctional ecosystem, and has harmful effects on the surrounding environment. The introduction of bio-remediation measures will improve the soil and water qualities and recover vegetation communities of the barren land. In this sense, the once abandoned land could provide eco-system services to the surrounding communities.

[ Re-adapt ] low-impact development

The dramatic topography of the site is not a design obstacle to be solved but a design opportunity to be enhanced. All future development on the site will be designed to minimize the alternation of the existing topography as well as maximizing the visual and spatial experience of the site’s visitors.

[ Re-vitalize ] social impacts

The site has rich cultural background regarding its deep connection with the mining industry. It further tells the stories of the limestone mining, coal mining, steel refinery, and oil and gas milling history in Indiana. In creating a series of material-themed public landscapes of unique visual and spatial experiences, the project has the potential to to raise people’s awareness and increase reflection on the high price we paid for the material consumption to sustain our lifestyle.
03 DESIGN

X  design conceptualization
XI  client and site programs
XII  site design
XIII landscape nodes
The design concept was derived from the material consumption study. The study identified and quantified the top six materials (water, stone, coal, steel, gasoline, and salt) that were consumed most in everyone’s life. The study also revealed the massive environmental footprints and impacts from the past and current mining industries which responded to the ever-growing consumption needs of sustaining everyone’s lifestyle.

One of the ambitions of the project is to deliver this message about the material consumption to the public. The design will propose a sequence of landscape nodes, which each reflects and represents one material.

The representation and interpretation of the materials will cover the following aspects:

1. Consumption volume: the volume of a landscape structure will reflect the consumption volume of the material. For example, the volume of the existing lake on the site is roughly equal to the water consumption of a family throughout their lifetime. In this sense, the quarry lake is the natural representation of the water consumption.

2. Material acquisition: the process of how the material is produced or mined.

3. Material characters: the color, texture or other uniqueness of the material.

4. Cultural significance: the unique history or applications of the material.

The overall design proposal will create an attractive and immersive experience throughout the six landscape nodes, taking advantages of the site’s unique topography and atmosphere.
**XI_ CLIENT AND SITE PROGRAM**

**designated client group**

This site is designed to accommodate four user groups: residents of surrounding neighborhoods, residents of the Indianapolis metropolitan area, student groups of west Indianapolis neighborhoods and seasonal tourists. Each group is incorporated through multiple amenity programs and site features that overall allow for harmonious cohabitation within user groups.

**site program**

The site’s program is a collective work of fundamental programs from the case study and innovative programs from the material consumption study and site analysis. It’s developed into four categories or layers: the functional landscape, the productive landscape, the educational+ cultural landscape, and the dynamic landscape.

The **functional landscape** provides the fundamental infrastructures of being a public park, which includes a main parking lot, drop-off, entry plaza, a visitor center and so on. Also, to address the problem of storm water runoff on a quarry site, a wetland containing a sequence of storm water treatment features on the lake level is created to protect water quality.

<table>
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<tr>
<th>QUARRY TRANSFORMATION PROGRAM</th>
<th>quarry lake</th>
<th>quarry wall</th>
<th>land</th>
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<th>phrase II</th>
<th>phrase III</th>
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</table>

Fig 03_03. proposed site program

74 MaterialScape

Xiao Yang 75
quality in the lake from uncontrolled runoff. A typical Indiana prairie landscape is developed on the upper level of the quarry site in order to further stabilize the soil and rock structure from running off the quarry wall.

The **productive landscape** introduces food production and renewable energy production facilities. For example, solar panels on the quarry wall and windmills on the cliff top maximize land use efficiency by taking advantage of the existing terrain.

A key layer of site program is the **cultural and educational landscape**, where five material-themed landscape structures/landscape nodes are created. The aim is to visualize and educate visitors about essential material consumption during everyone’s lifespan: the consumption of stone, coal, steel, salt and gasoline. The visualization and representation of those material-themed landscapes are achieved by showing the volumes of particular material consumption in landscape architecture’s design languages.

The **dynamic landscape** is where diverse activities happen, and people gather and interact on a daily basis. It provides recreational and gathering spaces like outdoor theaters, dining places, water entertainment, trails, etc.

**Development phases**

The site development will be divided into three phases.

In phase I, all the functional landscape programs and most of the dynamic landscape programs will be implemented. The remediation process of the land will take about 10 to 15 years to complete. During the process, the productive landscape programs will produce a certain portion of the energy needs from the site’s development. The site will be partially open to the public.

In phase II, after the completion of land remediation, the food production programs will be safe to implement. The site will be entirely open to the public.

In phase III, the site will be able to provide environmental services to the surrounding communities such as providing stormwater storage and surcharge.
XII_ SITE DESIGN

The site design of the MaterialScape includes an overall masterplan and a bird’s eye view; a set of detail diagrams and plans of the focus nodes: [stone], [coal], [steel] and [salt]; and several perspectives of each of the focus nodes.

MASTER PLAN

The masterplan of the project is the collective design solution that integrates the site programs seamlessly with the existing topography and site conditions. The current terrain largely defines the overall layout of the plan.

As for the locations of the material-themed focus nodes, the decisions were made by matching the existing “spatial rooms” of the terrain with particular material’s volume and characters. For example, the location of the [coal] is a natural enclosure space that matches the volume of coal consumption. Other conditions from the site analysis may also contribute to the decision making of the locations, for example, the proximity to the entrance or the location’s elevation and views.

Visual connections between the different focus nodes served as guides and attractions to the site’s visitors. Vertically, stairs and ramps connect the upper level (on the quarry walls) to the bottom level (on the quarry lake).

LANDFORM + BIRD’S EYE VIEW

The current landform of the quarry largely determines the spatial experience of the new civic park. Rock walls stand 30 to 60 feet above the lake level, surrounding the central wetland and deep quarry lake. Five material-themed landscape nodes blend into existing terrain and were connected by a network of trails, ramps, and stairs.
- Functional Landscape -
  1. entry parking lot (50 spaces + 2 ADA accessible)
  2. drop-off and entry plaza
  3. [stone] information center
  4. wetland; stormwater infiltration system
  5. prairie land; soil / vegetation restoration
  6. quarry walk; ground/elevated trails for accessibility.

- Productive Landscape -
  7. solar wall; solar panel installation on quarry wall.
  8. terrace farm; food production to support 10 family.
  9. [oil+gas] wind energy production

- Educational + Cultural Landscape -
  3. [stone]; Indiana limestone heritage exhibition
  9. [oil+gas]; historical natural gas festival
  10. [coal]; art gallery and light installation
  11. [salt]; salt lake landscape; color coded habitats
  14. nature observation deck

- Dynamic Landscape -
  12. [steel]; outdoor theater + gathering place
  13. water recreation deck: swimming, diving, boating, etc.
XIII_ LANDSCAPE NODES

STONE

[stone] is the centerpiece structure of the park. Characterized by iconic “crystal-shaped” stone sculpture and stone gabion facades, the visitor center is located on the north edge of quarry wall, providing an excellent view of quarry lake.

[volume]: 5.48 million lbs of stone

[Development]: stone formation

The shape of the building as well as the stone sculpture derive from the formation of granite, limestone, and ore, under a 100x microscope. A semi-enclosed building compound of two stories forms the central courtyard.

[Functionality]: visitor center, education facility

The building functions as a visitor center of the public park as well as an education facility. It tells stories about the Indiana limestone heritage, material consumption in everyone’s life, and more importantly, about what to do to reduce the consumption and its impact on earth.

[detail features]

The entry plaza connects the drop-off station with the entrance of the visitor center.

The iconic stone sculpture stands throughout the building floors. It’s made of irregular limestone veneer walls with glass openings, allowing natural sunlight through.

The outdoor terrace overhangs from the top of quarry wall over the lake, creating a fantastic view of the lake and the
MaterialScape

Xiao Yang

Fig 03_08. detail diagram and perspective drawing of [stone]

5.48 billion lbs

consumption

formation

Indiana limestone is well known as the "National Building Stone". It’s quarried in southern Indiana (Bedford and Bloomington area) and considered to be prime building material for its extreme durability and capacity for carving.

In the stone building family, Indiana limestone is consumed by various types of gravel stones, the unique form and pattern is used to develop the building.

5.48 billion lbs

x 77 YEARS

landmark structure + vertical circulation between floors and roof gardens

Courtyard/Limestone fabrication

application + programs

material consumption education (GF)

formation study (stonework in frame)

limestone heritage exhibit (IF)

Information Center (PF)

Quarrying + Fabricating

Milling

cut into slabs with wire or belt saws

Finishing


cutting finish textures by hand(s) of cutters or carvers

cutters: stone craftsmen who shape stone into forms

carvers: skilled artisans who cut floral patterns or other artistic forms into stones
park. There are outdoor seating and dining areas further enriching the site’s program.

The **courtyard** exhibits different types of limestone products: dimension stone, limestone gravel, and sand. The visitors are able to physically touch and feel the subtle texture of the rocks.

The “quarry walk” is a network of elevated walkways attaching to the quarry wall. It enables visitors to experience the dramatic terrain, from the top of quarry wall to the lake’s water surface.

There are “**solar walls**” installed to the northeast side of the quarry wall, producing a certain portion of the energy to sustain the site’s maintenance consumption.

[ Indiana limestone legacy ]

Indiana limestone played a significant role in the architecture building history in the US. The Empire State Building, The Pentagon, the Chicago Tribune Building as well as many university structures, state capitols, post offices, and churches are all constructed of this fine material. Indiana limestone is renowned for its durability, consistency, and capacity to accept and retain fine detail.
_STONE : INFORMATION CENTER & MATERIAL CONSUMPTION EDUCATION_

Characterized by iconic crystal-shape stone sculpture and stone gabion facades, the information center provides a great view of quarry lake from cliff top.
Embodied as a part of the quarry’s enclosure topography, [coal] creates poetic art exhibition spaces and provides accessibility between quarry terrain’s upper level and lake level.

[Volume]: 2.57 million lbs of stone

[Development]: underground / surface coal mines

Underground mines and strip surface mines are the two typical coal mines. The working environment of those two kinds of coal mines showcases and represents a dramatic contrast between the darkness of underground and the brightness above the surface. In this sense, the [coal] proposes a “cap” structure onto a piece of semi-enclosed terrain, creating a dark room on the ground floor and a bright terrace on the second floor.

The oval shape of the structure derives from the original terrain. A 25-feet sculpture of coal acts as the centerpiece of the round-shape courtyard.

[Functionality]: art gallery, coal-theme exhibition

The dark room on the ground floor is ideal for showing light installations. The several coal-themed sculptures installed on the terrace floor tells the story of the dark coal mine history and harsh working conditions in the old “mine holes.” It is a metaphor that reminds us of the idea that we are living a lifestyle that is constantly requiring sacrifices from the environment and others.
Embodying as a part of quarry's enclosure topography, the coal: art gallery creates poetic exhibition spaces, provides accessibility between quarry terrain's upper level and lake level. Meanwhile, the volume of the structure visualizes and represents the coal consumption in everyone's life.
The coal sculpture is made of carbon-black coating surface with a hollow inside. The surface of the sculpture mimics the coal’s texture and color. Looking from a distance, the sculpture has a shape like an exotic but beautiful flower, sprouting out of dark coal mines.

The roof terrace provides open-air seating and dining areas. It’s also a spot for reflecting and observing from the rooftop to the courtyard.

The ramp stairs provides accessibility from the upper level of the quarry wall down to the level of the quarry lake, elegantly connecting the bright opening with the dark downstairs.
_COAL: ART GALLERY/ LIGHT INSTALLATION

The art gallery locates in a setting of coal mine hole, with dark background and intimate spacial experience. Light installations and fine art sculptures creates a interesting contrast to the raw and dark coal material/texture.
[ STEEL ]

[steel] is the primary gathering place for the park. The design installs corten steel elements on the site and reuses salvaged steel materials to demonstrate the quantity of steel consumption.

[ volume]: 333,824 lbs of steel

[ Development ]: terrain, sun orientation

The existing terrain largely defines the form of the [steel]. The design orientation of the theater’s seating faces north, to shelter the crowd from the direct afternoon sunlight. Tree canopies and water features are introduced to improve micro-climate and ensure a comfortable experience for the visitors.

[ Functionality ]: outdoor theater

The theater’s stage has a canopy structure that spreads into the quarry wall. A green roof enables the structure to merge into the surrounding environment. Opposite the stage, there is the sloping lawn with seating made of corten steel and wood. The sloping lawn is a flexible amenity where people can stroll, sit, or simply lay down and rest.

[ Functionality ]: quarry wall stabilizer and planting beds

To the east side of the [steel], a part of the quarry slope is not stable enough to withstand a severe flooding. The design solution is to install a sequence of corten steel plates: “planting beds” with vegetation growing on top of its soil and gravel filling. The root system of the plants will further stabilize those loose quarry wall.

[ detail features ]

The water feature of [steel] not only helps to adjust and to improve the micro-climate but also channel and store the storm runoff away from the quarry wall.

[ Steel ] reuses old rail tracks as parts of the paving patterns. Innovatively, the planting boxes have wheels that make them movable along the rail tracks.

Fig 03_13. detail diagram and perspective drawing of [steel]

Fig 03_14. perspective of [steel], looking towards north
By embodying the stage into the quarry wall, the sense of a gathering place is further enhanced by the enclosure topography of the quarry site.
_STEEL : OUTDOOR THEATER + GATHERING_

The consumption of the steel material is visualized with the corten steel site structures and furnitures (stage wall, retaining wall, benches) and the reuse of old railway tracks as planting bed and paving.
[Salt] creates a series of colorful and attractive saltwater ponds by controlling the sanity of the water. The color differences of the ponds result from both the variations in salinity and the algae content.

[ volume ]: 124392 lbs of salt

[ Development ]: water salinity

The different colors of the salt water ponds are defined by the dominant microorganisms that thrive in different ranges of salinity. The various micro-organisms communities further develop into different habitats. For example, the pink flamingo obtains their pink color by feeding on pink micro-organisms in the higher sanity water.

[ Functionality ]: water feature; education; natural habitat

The colorful water ponds attract the visitors’ attention and invite them to wonder about how those ponds are formed. It creates an opportunity to introduce a different perspective of understanding the habitat and environment: it is delicate and surprisingly beautiful, for one little factor (a small alternation of salinity) could lead to an entirely different outcome.
Evaporation of sea water is one way to obtain salt, which creates a unique and fascinating landscape that is characterized by colorful salt water ponds. These salt lake landscapes are defined by the dominant micro-organisms that thrive in diverse ranges of salinity.

124392 lbs

55% chemical industry
30% manufacturing industry
19% road anti-icer
5% edible salt

X 77 YEARS

color code habitats: algea to flamingo

pink flamingo
green algae
dunaliella
drime shrimp

(salinity) low medium high

landscape node / roadside flamingos
MaterialScape reimagines the destiny of an abandoned limestone quarry, revives the site from oblivion, and reconnects it with people’s memories. The new public park invites people to experience the uniqueness and splendor of the quarry terrain, tells the stories of material consumption and histories of resources mining, and reminds us to reflect on our lifestyle and its consequences. Through experiencing the elegant and poetic landscape, we learn about the essence of sustainability.

**REFERENCES**


