8-2016

Mutualism: Experience of Instantaneous, Generational, and Geological Time on Heimaey Island

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To the Graduate Council:

I am submitting herewith a thesis written by Jessica Ryann Porter entitled "Mutualism: Experience of Instantaneous, Generational, and Geological Time on Heimaey Island." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Architecture, with a major in Architecture.

Tracy Moir-McClean, Major Professor

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Vice Provost and Dean of the Graduate School

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Mutualism:
Experience of Instantaneous, Generational, and Geological Time on Heimaey Island

A Thesis Presented for the
Master of Architecture
Degree
The University of Tennessee, Knoxville

Jessica Ryann Porter
August 2016

DEDICATION

Thank you Mamsi, Dad, and Brutter for always believing in me.

And to my future cats, Sheldon Cooper and Hermione, for keeping me motivated.

ACKNOWLEDGEMENTS

My gratitude and thanks to:

James Rose and Jason Young for their invaluable insight and criticism.

Tracy Moir-McClean, for her role as my thesis advisor. Your instrumental wisdom is appreciated immensely.

ABSTRACT

Iceland's Heimaey Island's population is approximately 4400 people (Vestmannaeyjar). The island's main industries are fishing and tourism, which depend on the harbor on the island's northeast side (Iceland: Westman Islands). Keeping the harbor accessible is essential to these industries. Because the harbor was almost lost during the 1973 volcanic eruption, proactive measures must be taken to protect the harbor from future eruptions.

For the purpose of this thesis, an architecture has been designed that creates a mutualistic relationship between humanity, architecture, lichens, and lava flows that is experienced over three scales of time by humanity. The concepts of instantaneous time, generational time, and geological time are reflected within the investigation. Instantaneous time is experienced in three ways. The first is visual, providing an immediate, improved view of the island for visitors. The second is through observation of the metabolic processes of lichens living on the architectural and landform surfaces. At every moment, lichens change color, activity, incrementally improving air quality, filtering excess particulates, removing carbon dioxide and adding oxygen to the atmosphere. The third is the moment of eruption, which transforms architecture, landscape and human experience in a single instant.

Generational time is human in scale - experienced through repeated experiences and memories of architecture and landform over the course of a human lifetime. Generational time is reflected in two ways. The first is in the slow growth of lichens on the lava rock and architecture. Lichens only propagate a fraction of an inch each per year, so seeing growth will take many years (Hale 79). The

second is in the weathering and wear of the soft lava rock used to construct architecture, landform and pavements.

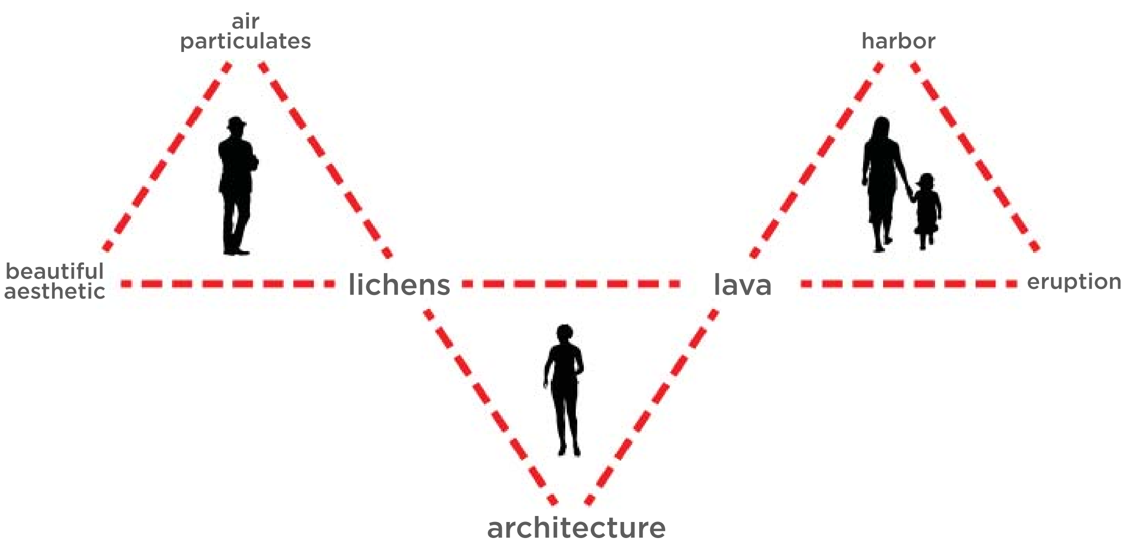
Geological time exceeds generational time. The next eruption of Eldfell will occur within the next 500 years (20-25 generations). The architecture and landform are designed to endure in place, passing between generations perhaps maintained or perhaps as ruins, and then implode when breached, thereby slowing and diverting lava flows to protect most importantly the harbor and secondarily, the town.

THESIS STATEMENT

Designing an impermanent architecture and landform for human experience of controllable and uncontrollable events and scales of time. This architecture and landform is supported over time through relationships of mutualism between humanity, biotic life, and geological process on landform and constructed surfaces.

Relationships

Mutualism- a symbiotic relationship where all parties benefit



The architecture is designed to provide a microclimate.
The lichens are planted.
The thriving plants bloom.
The active plants feed off the particulates in the air.

The architecture is designed to divert.
The harbor needs to be protected.
The new volcano erupts.
The lava flows.
The architecture diverts.

Figure 0.00 Relationships of Mutualism
Source: Author

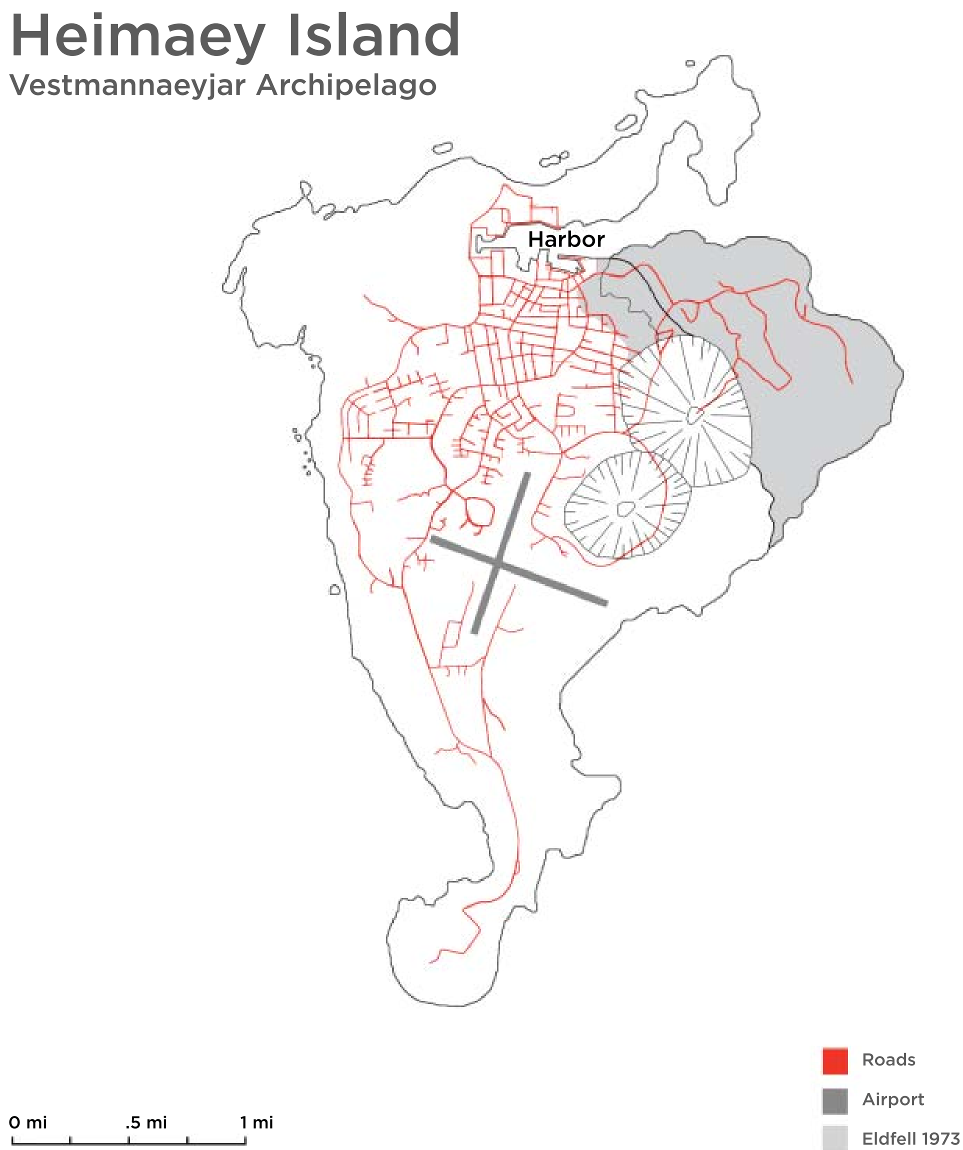
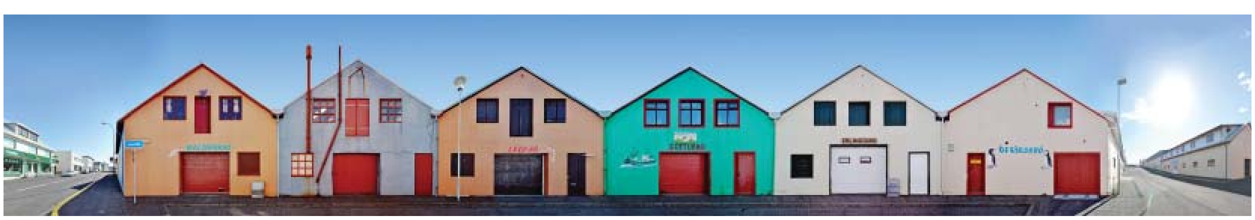


Figure 0.01 Heimaey Island Map
Source: Author; Map Based off of: ArcGIS



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Source: http://icelandmag.visir.is/article/thjodhatid-vestmannaeyjar-islands-party-weekend-away

At 2 a.m. on January 23, 1973, a volcano unexpectedly erupted on Iceland's Heimaey Island. Luckily, because of a storm the day before, the fishing fleets stayed in the harbor that night (Williams & Moore 7). This stroke of luck meant that evacuating the 5300 inhabitants was possible in the middle of the night (Williams & Moore 11). A 1.25 mile fissure ripped open overnight, leaving a great scar on the island's northeast side. (Figure 1.02) This new volcano Eldfell, meaning "Fire Mountain," grew to a towering height of over 700 feet during February. (Figure 1.03) By March, the lava flows had destroyed a third of the town, including approximately 400 homes (Williams & Moore 12). (Figure 1.04)

Protecting the harbor became a top priority as the flows crept dangerously towards it. (Figure 1.10) A seawater pumping system was imported from the United States. (Figure 1.05) To divert the lava away from the harbor, the large seawater pumping system's infrastructure spanned the island's northeast side and extended onto the fleets of boats. (Figures 1.06 - 1.09) Pumping cool seawater onto the flows diverted them eastward and kept the mouth of the harbor navigable. This was one of the first major attempts to manipulate lava in history (Jonsson). After the flows subsided in April of 1973, Heimaey Island harnessed the cooling lava flows' energy by building a geothermal infrastructure that delivered hot water and electricity to the island over the next decade (Williams & Moore 8).

Figure 1.02 Eldfell Fissure
Source: http://eldheimar.is/en/

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Source: http://eldheimar.is/en/

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Source: http://eldheimar.is/en/

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Source: http://pubs.usgs.gov/of/1997/of97-724/water.html

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Source: http://pubs.usgs.gov/of/1997/of97-724/32html/lavaoperations.html

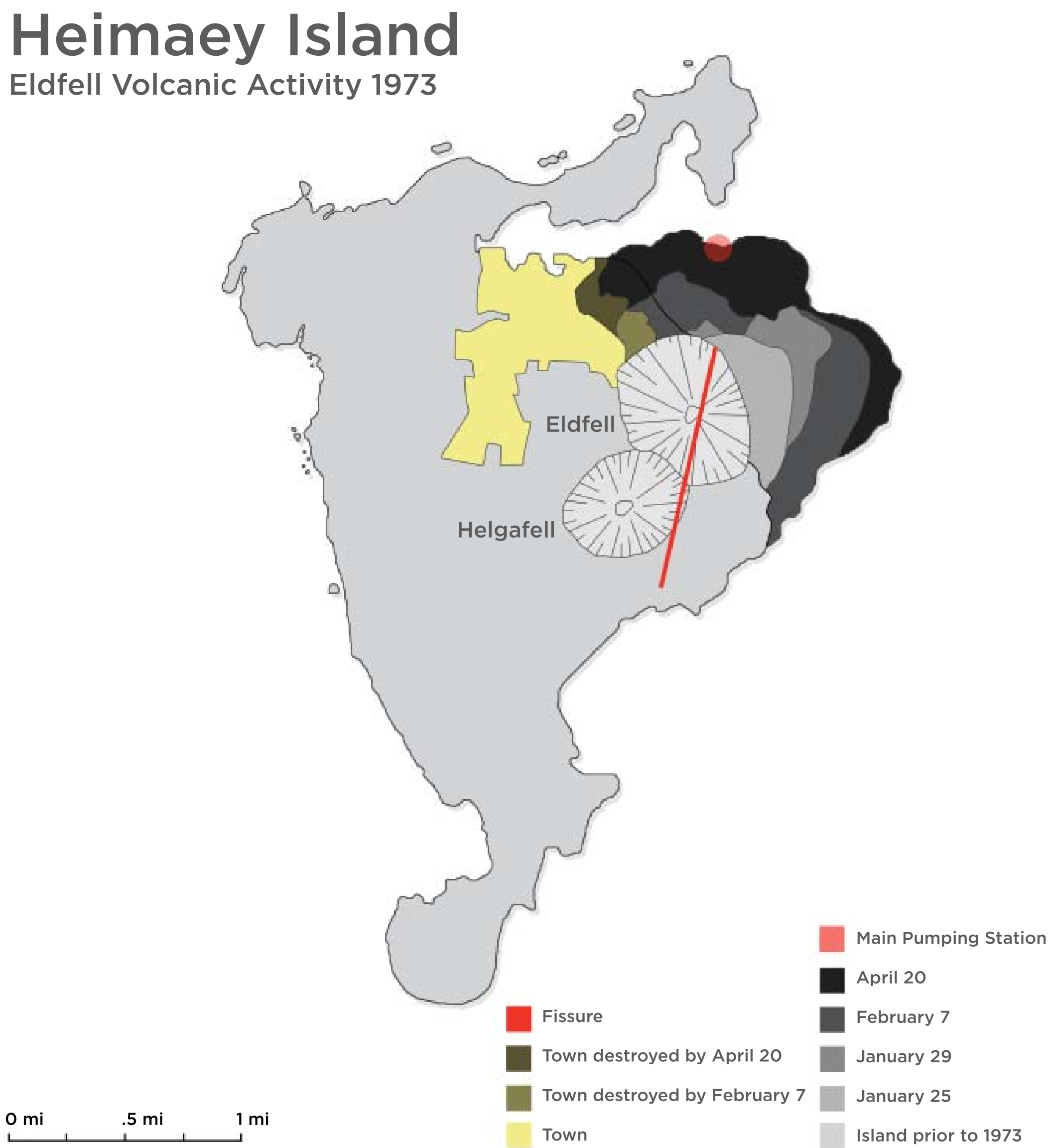

Figure 1.10 Map of Heimaey Island 1973 Eruption Lava Flows
Source: Author; Map Based off of: ArcGIS & p. 6 Williams & Moore

2. LICHENS

Air pollution is creating a catastrophic domino effect on our ecosystems (Blong 120). The six common air pollutants in earth's atmosphere are ground-level ozone, particulate matter, carbon monoxide, nitrogen oxides, sulfur dioxide, and lead (EPA's Six Criteria Pollutants). These pollutants are affecting the earth's health, thereby hurting dependent species, including humans (Marti 152). As professionals who manage environmental design and construction, architects look for strategies to remediate the atmospheric balance in unexpected ways. Although air pollution does not have a quick fix, small positive adjustments in building practices can have a significant impact on the environment. Trees are often added to remediate landscapes because they filter particulates, add oxygen, and sequester carbon.

However, trees have a difficult time growing in Iceland because of the low sunlight levels. The few trees that do manage to grow in these less-than-ideal conditions are stunted and weak (Howerton). In contrast, lichens thrive in Iceland because of their ability to grow in extreme conditions by turning off their metabolic processes and becoming dormant for periods of time (Purvis 19). The dominant lichen species in Iceland have adapted to volcanic rock surfaces like those found on Heimaey. If architectural and landform structures are designed to create micro-habitats where lichen thrive, this can increase both the volume of lichen in the landscape and the mutualistic services lichen provide to humanity. Thus, a lichen-covered landform and architecture provide a method that can not only generate air-quality data, including hazardous ozone depletion, but also purify the atmosphere and filter acid rain (Purvis 70 & 76). As a further advantage, lichens, visually-pleasing organisms, add to a building's aesthetics.

A lichen, which is a mini-ecosystem, is the combination of a fungus, a mycobiont, and a photosynthetic partner, a photobiont. A photobiont contains chlorophyll and can be either a green algae or a cyanobacterium, formerly called a green-blue algae (Hale 1). The lichen is a thallus, an individual plant that lacks differentiation into distinct stem, leaves, and roots (Hale 13). (Figure 2.00)

Although lichens are comprised of both fungi and algae, they are identified only by their fungi. A fungus can pair with different types of algae and still have the same identity, even if the different algae has given it a different appearance. For example, a fungus paired with a green algae photobiont has the same identifying name as the same fungus paired with a cyanobacteria photobiont. These types of lichen with the same fungus but different algae are called photomorphs (Purvis 15). (Figures 2.02 & 2.03) The same lichen in different geographical locations or different stages of their life cycles may contain different photobionts. Lichen fungi can also pair with more than one type of algae in one surface's vicinity (Purvis 10). (Figure 2.01) The algae play a major part in determining what a lichen looks like, how it functions, and where it grows (Purvis 13). Environmental factors, such as climate, light, and humidity, determine which photobiont is present in a lichen (Purvis 24).

The lichens chosen for this study are the sunburst and the map lichen. (Figures 2.04 & 2.05) These two lichens will thrive on Heimaey Island because they are native to Southern Iceland and can grow on igneous rocks, also known as lava rocks (Hansen 53). With the presence of multiple photomorphs, more than two lichens will appear to be growing on the architecture.


Figure 2.00 Lichen Thallus
Source: http://www.kindofcurious.com/2010/05/these-lichen-are-likin-my-fence.html

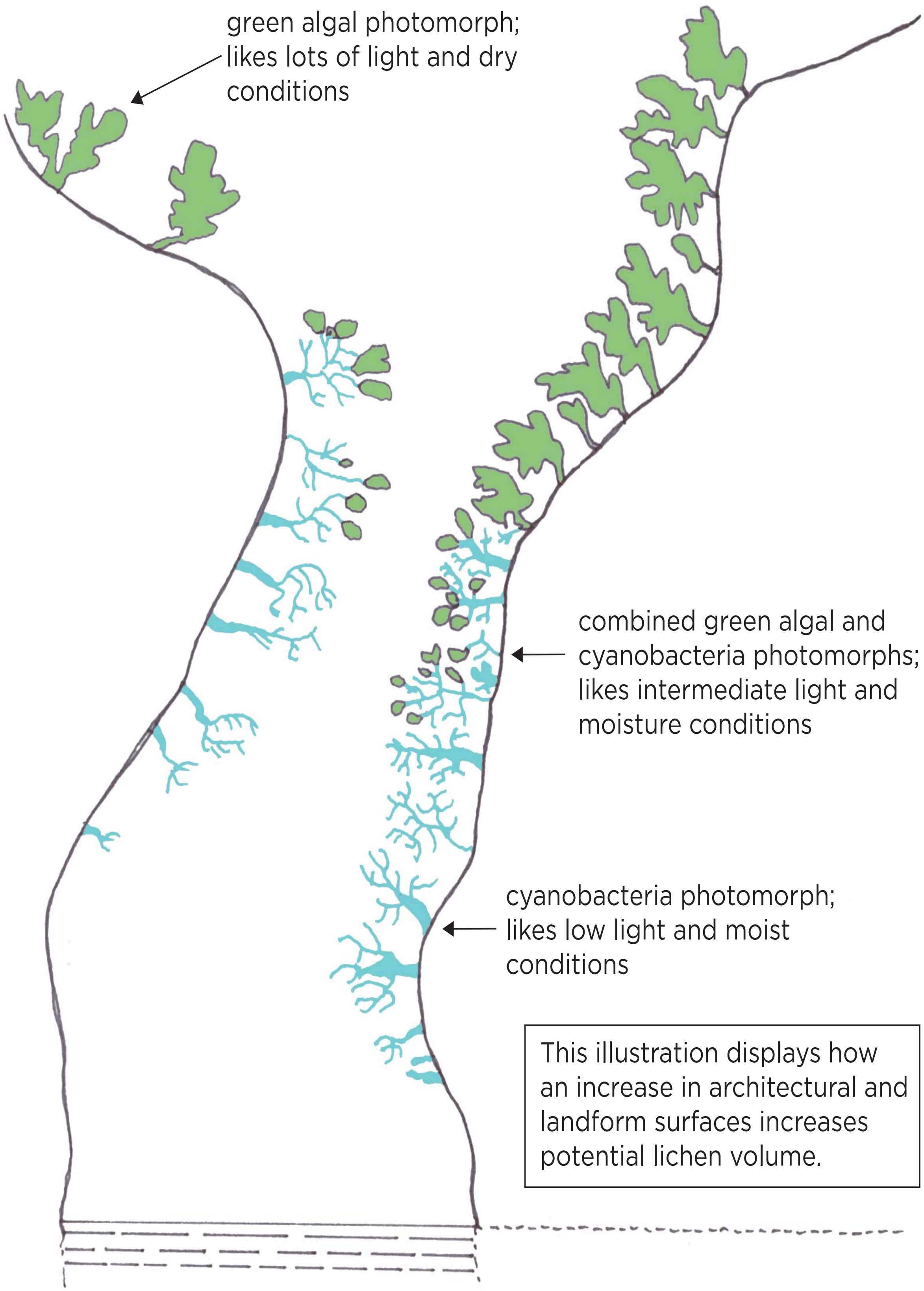

Figure 2.01 Lichen Substrate
Source: Author; Based off of: p. 13 Purvis

Figure 2.02 Lichen Photomorph A
Source: p. 15 Purvis

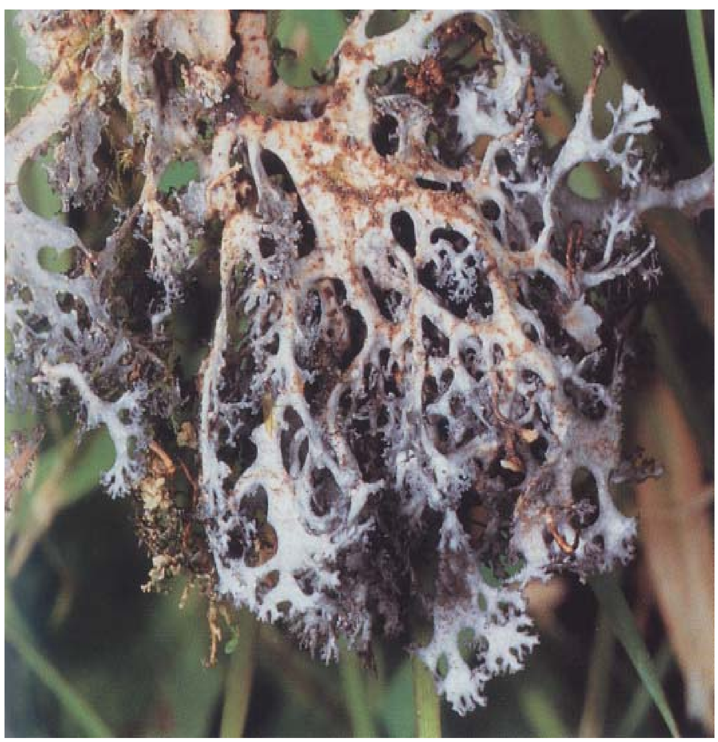

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Figure 2.04 Map Lichen
Source: https://www.flickr.com/photos/26426438@N00/371160360

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Source: http://mushroomobserver.org/observer/observation_search?page=3&pattern=Xanthoria+elegans

3. LANDFORM VOCABULARY

alas • cliff • crater • cuesta • dale • dell • escarpment • glen • gully • hill • knoll • mountain • plain • plateau • ridge • rock shelter • scarp • terracettes • vale • valley • valley shoulder • watershed • **fissure** • arch • barrier bar • barrier island • bay • gulf • beach • beach ridge • boondock • cape • cave • coast • coral reef • cove • delta • dune system • estuary • fjord • **headland** • isthmus • island • archipelago • atoll • lagoon • machair • notch • ocean • Ocean ridge & oceanic trench • peninsula • ria • salt marsh • sea • sound • spit • stack • stump • **tombolo** • wave cut platform • arroyo • bar • bayou • Carolina Bay • basin • gully • island • lake • levee • marsh • meander • oasis • lake • pond • pool • riffle • river • spring • stream • stream terrace • swamp • vale • waterfall • arête • **berm** • cirque • crevasse • corrie • dirt cone • drumlin • drumlin field • esker • fjord • U-shaped valley • glacial horn • glacier • hanging valley • inselberg • kame • kame delta • kettle • moraine • mountain & mountain range • outwash fan • outwash plain • pingo • stream terrace • tunnel valley • valley • **caldera** • cinder cone • geyser • lava dome • lava flow • mid-ocean ridge • oceanic trench • vent • **folding lava** • volcanic island • volcano • shield volcano • stratovolcano • Butte • canyon • lavaka • limestone pavement • rock formations • tea table (Nagel)

fissure

noun \'fiSHər\

: a long, narrow opening or line of breakage made by cracking or splitting, especially in rock or earth

headland

noun \'hed-lənd\

: a narrow area of land that sticks out into the sea

Figure 3.00 Fissure Definition
Source: http://gudmann.photoshelter.com/image/I0000Jz3iKC4294s & http://google.com

Figure 3.01 Headland Definition
Source: https://bantryblog.wordpress.com/2012/02/16/shot-head/ & http://google.com

tombolo

noun \tom-buh-loh\

: a narrow sand or gravel bar linking a small island with another island or the mainland

berm

noun \bərm\

: an artificial ridge or embankment or a small hill or wall of dirt or sand; the shoulder of a road

Figure 3.02 Tombolo Definition
Source: https://www.ana-cooljapan.com/destinations/kagawa/shodoshima
& Merriam-Webster

Figure 3.03 Berm Definition
Source: https://www.pinterest.com/pin/431571576761675016/
& Merriam-Webster

caldera

noun \kal-’der-ə\

: a volcanic crater that has a diameter many times that of the vent and is formed by collapse of the central part of a volcano or by explosions of extraordinary violence

Figure 3.04 Caldera Definition
Source: http://whenonearth.net/live-inside-active-volcano-aogashima-island/
& Merriam-Webster

folding lava

noun \’fōl-di’ ‘lä-və\

: fluid-like molten rock folding over itself due to its viscosity

Figure 3.05 Folding Lava Definition
Source: http://www.earthshots.org/
& http://n-e-r-v-o-u-s.com/blog/?p=3243

4. SITE & LANDFORM

Heimaey Island is located off the Southern coast of Iceland in the Vestmannaeyjar Archipelago, which consists of approximately eighteen islands and numerous skerries or smaller formations (Vestmannaeyjar). (Figures 4.00 & 4.01) Active submarine volcanos are still forming new islands in this area (Iceland: Westman Islands).

A few glaciers remain in Iceland. (Figure 4.02) Both subglacial and submarine volcanos release a plume of ash into the atmosphere, affecting the surrounding areas as it gathers in the air and falls back to earth (Thordarson & Hoskuldsson 115-116). Lichens are useful organisms when this ash is in their vicinity because through their natural metabolic processes, they filter the particulates out of the air and the groundwater flowing across them (Purvis 25 & 80).

The volcanic system that formed the land mass of Iceland has a main ridge, or plate boundary, called the Mid-Atlantic Ridge (Sigmundsson 5). Rather than being one straight line across the landscape, this ridge contains many overlapping segments, called active rifts or volcanic zones, which are frequently straining, moving, and consequently erupting. Areas called fracture zones connect these moving segments (Thordarson & Hoskuldsson 6). (Figure 4.03)

Before the 1973 eruption, Heimaey Island was 4.3 square miles and had a wide harbor mouth. (Figure 4.04) After the eruption, Heimaey Island gained 0.89 square miles of igneous rock along the harbor coast making the island 5.19 square miles (Williams & Moore 6). Because of the new coastline, the resulting entrance into the harbor is much more sheltered and narrow. (Figure 4.05)

Hot spot tracing can be achieved by marking past volcanic eruptions' locations on a map (Thordarson & Hoskuldsson 4). (Figure 4.06) By mapping these locations, predictions can be made as to where the hot spot has shifted, pinpointing the next volcanic eruption's location (Thordarson & Hoskuldsson 10-11). Iceland, an island located on the submarine Mid-Atlantic Ridge, was formed when the North American Tectonic Plate moved north and the Eurasian Tectonic Plate moved southeast on the bottom of the Atlantic Ocean. The tectonic plates' separating movement created a void that was filled by molten lava sucked from deep within the earth, thus creating Iceland. This plate movement causes frequent volcanic activity along the ridge (Thordarson & Hoskuldsson 12).

Iceland

Vestmannaeyjar Archipelago
Heimaey Island

Figure 4.00 Map of Heimaey in Iceland
Source: Author; Map Based off of: https://mmillericeland.wordpress.com/

Heimaey Island

Site

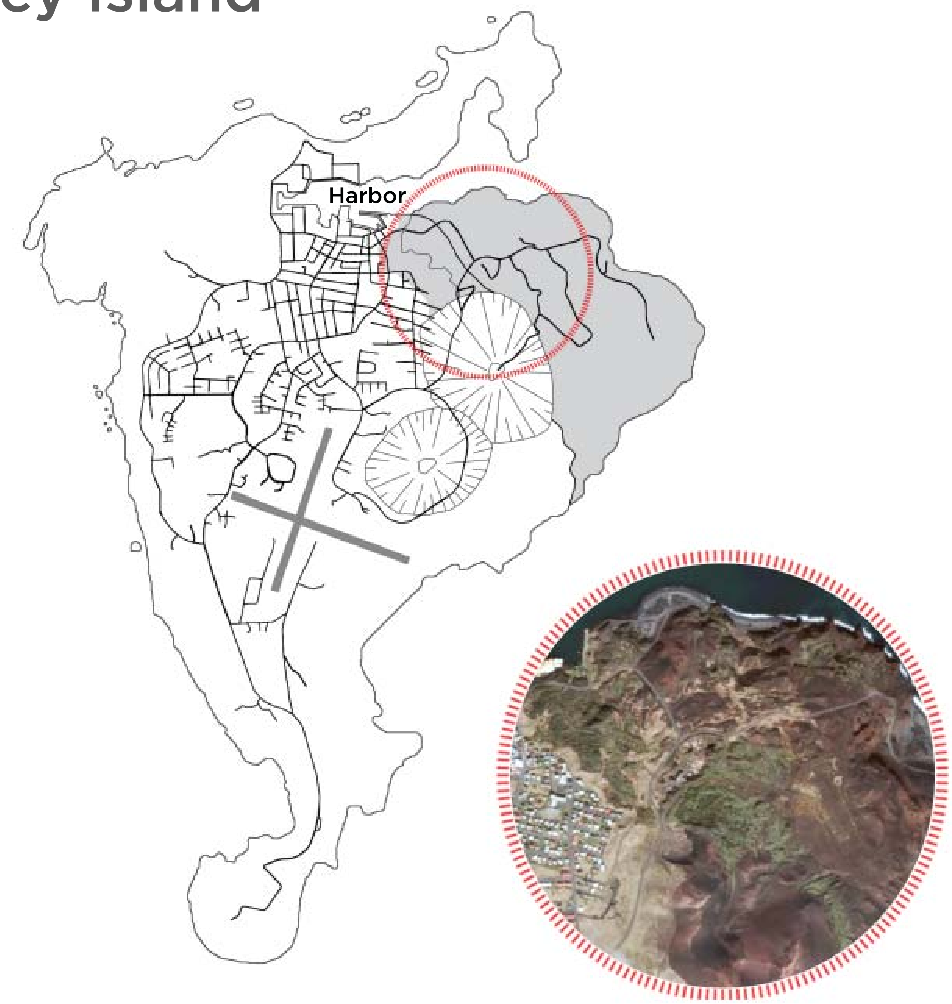

Figure 4.01 Site on Heimaey Island
Source: Author; Map Based off of: ArcGIS

Iceland
Glacier Systems

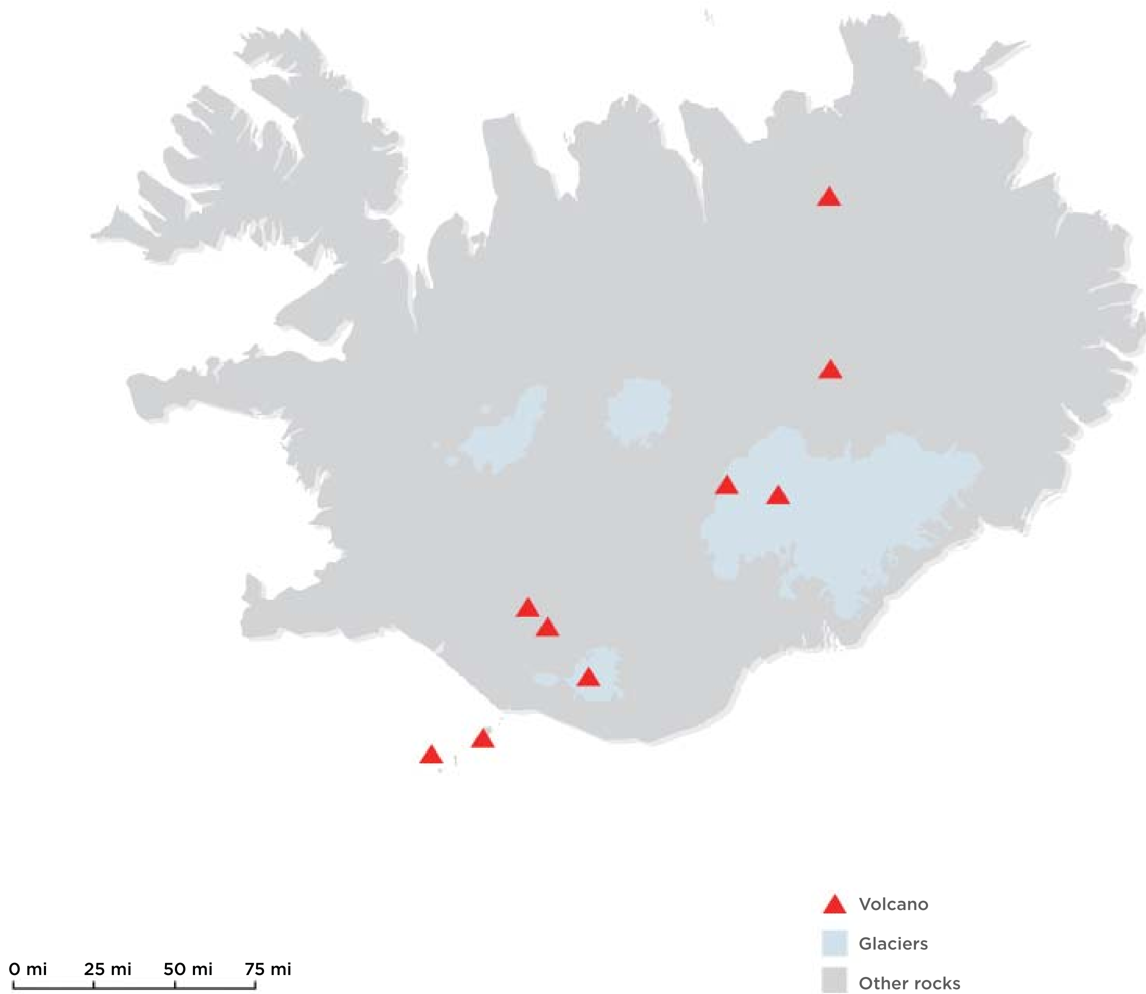

Figure 4.02 Glacier Systems in Iceland
Source: Author; Map Based off of: https://mmillericeland.wordpress.com/

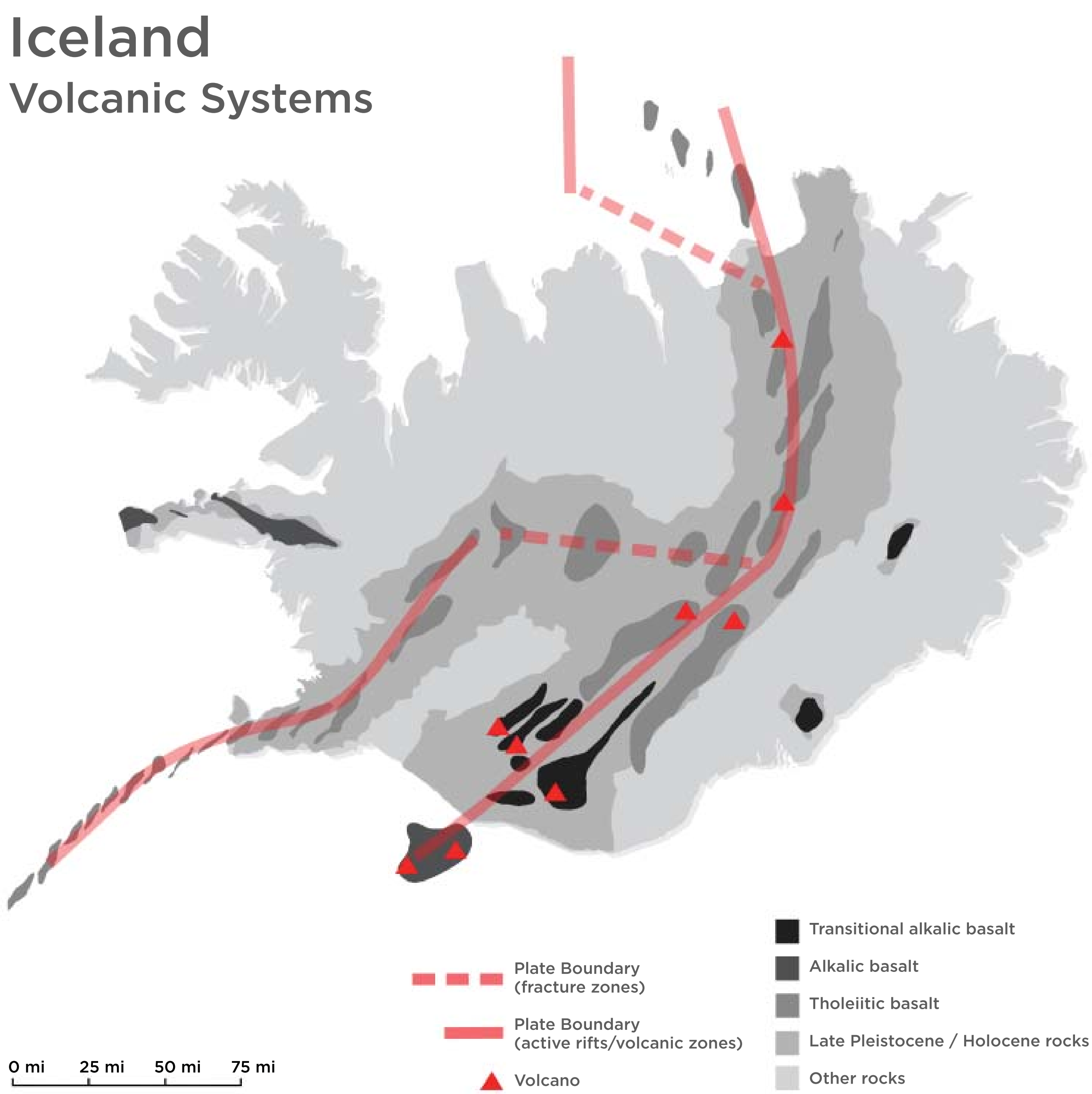

Figure 4.03 Volcanic Systems in Iceland
Source: Author; Map Based off of: https://mmillericeland.wordpress.com/ & p. 5 Thordarson & Hoskuldsson

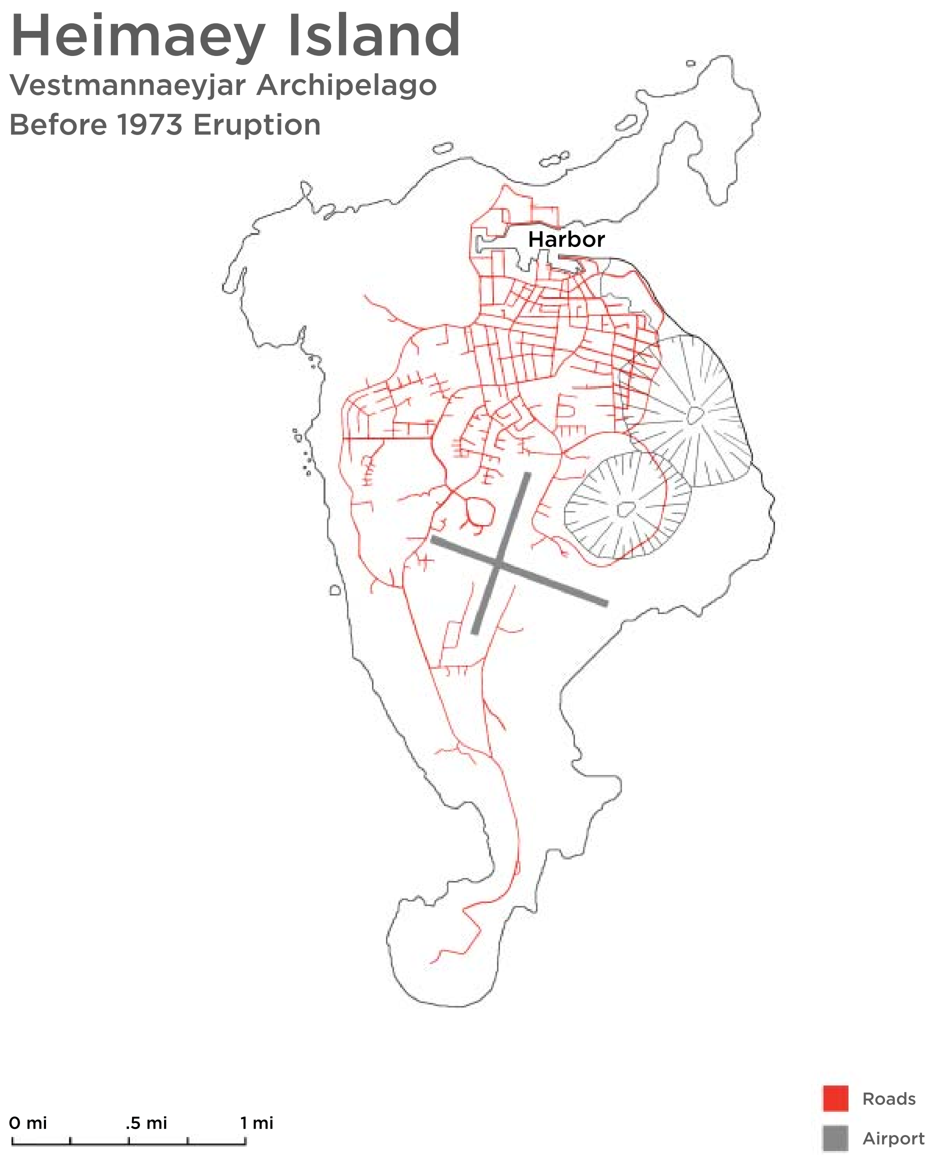

Figure 4.04 Map of Heimaey Island Before the 1973 Eruption
Source: Author; Map Based off of: ArcGIS & p. 18 Williams & Moore

Figure 4.05 Map of Heimaey Island Topography Post 1973 Eruption
Source: Author; Map Based off of: ArcGIS

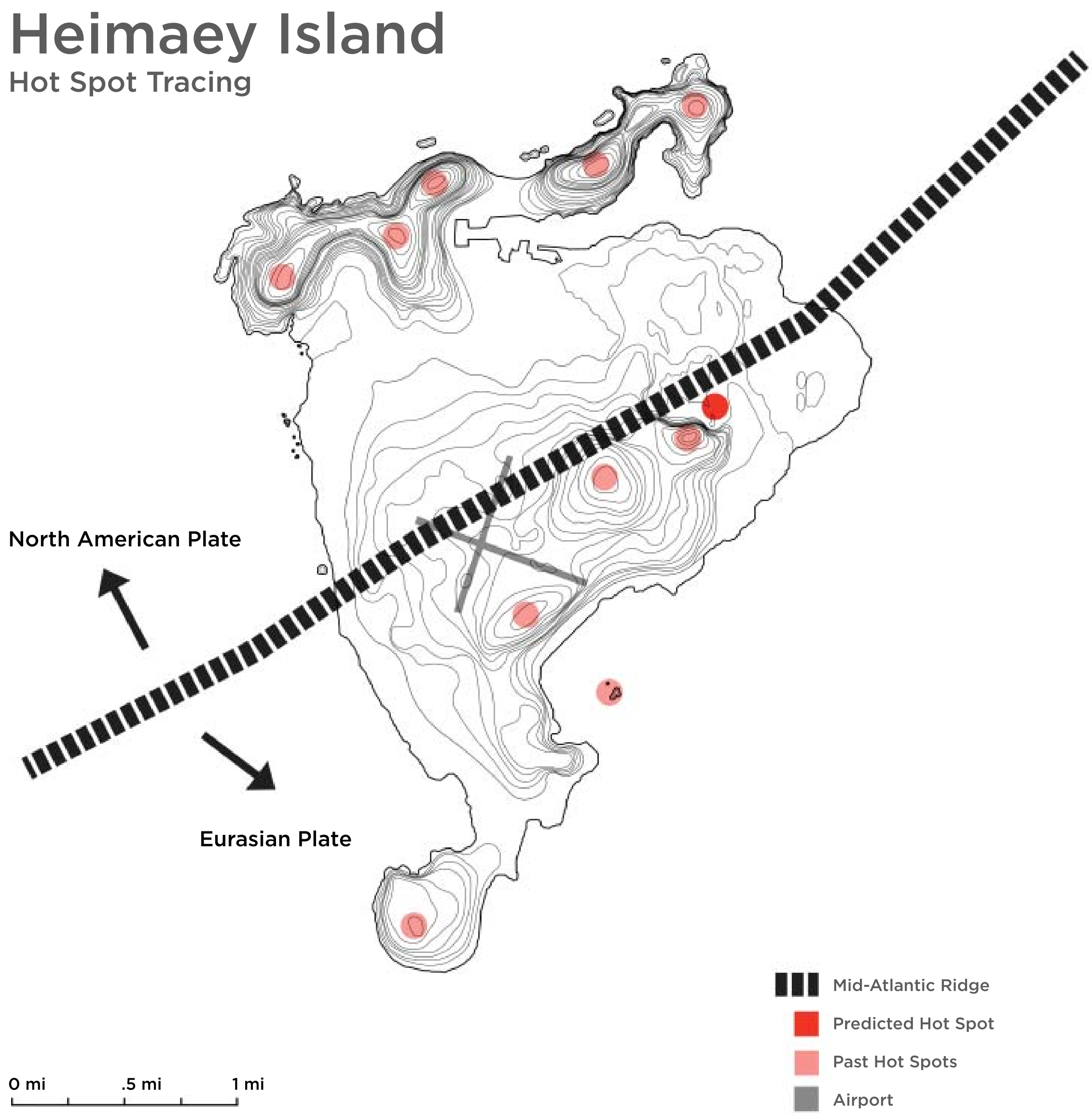

Figure 4.06 Heimaey Island Hot Spot Tracing
Source: Author; Map Based off of: ArcGIS

5. CIRCUMSTANCE EXPLORATION

I studied the island and site by using Rhino software and the CNC mill to create an accurate physical model of the topography. I vacuum-formed this model to create three plastic duplicates, which I used to test future eruptions' lava flow paths by pouring molten wax on the predicted eruption spot. (Figure 5.00) By studying the hot spot tracing, I predicted the eruption spot. On each of the three plastic models, I designed a different type of lava-diversion wall to test how the wax would react to three types of diversion walls: the V-diversion wall, the line-diversion wall, and the S-diversion wall. Although the wax reacted to the three walls uniquely, it had very similar reactions to the topography. After filling a depression next to the predicted eruption spot, the wax began traveling northeast. Once it hit the water line, it clung to the existing coastline as it expanded outward into the ocean.

Cutting into the earth and creating a ditch behind it, the V-diversion wall protects a single point. Its weaknesses are on either side of the V where the lava is channeled. It would be strengthened if many of them were close together in a line. (Figure 5.01)

The line-diversion wall is a series of low walls. A single low wall would be weak, but having numerous walls one after another that are designed to fail slowly is a strong design. (Figure 5.02)

The S-diversion wall is one long solid wall that is strong and that directs lava flows with its curve. This is a very strong lava-diversion design but is aesthetically weak. (Figure 5.03)

Figure 5.00 Wax Test Pours
Source: Author

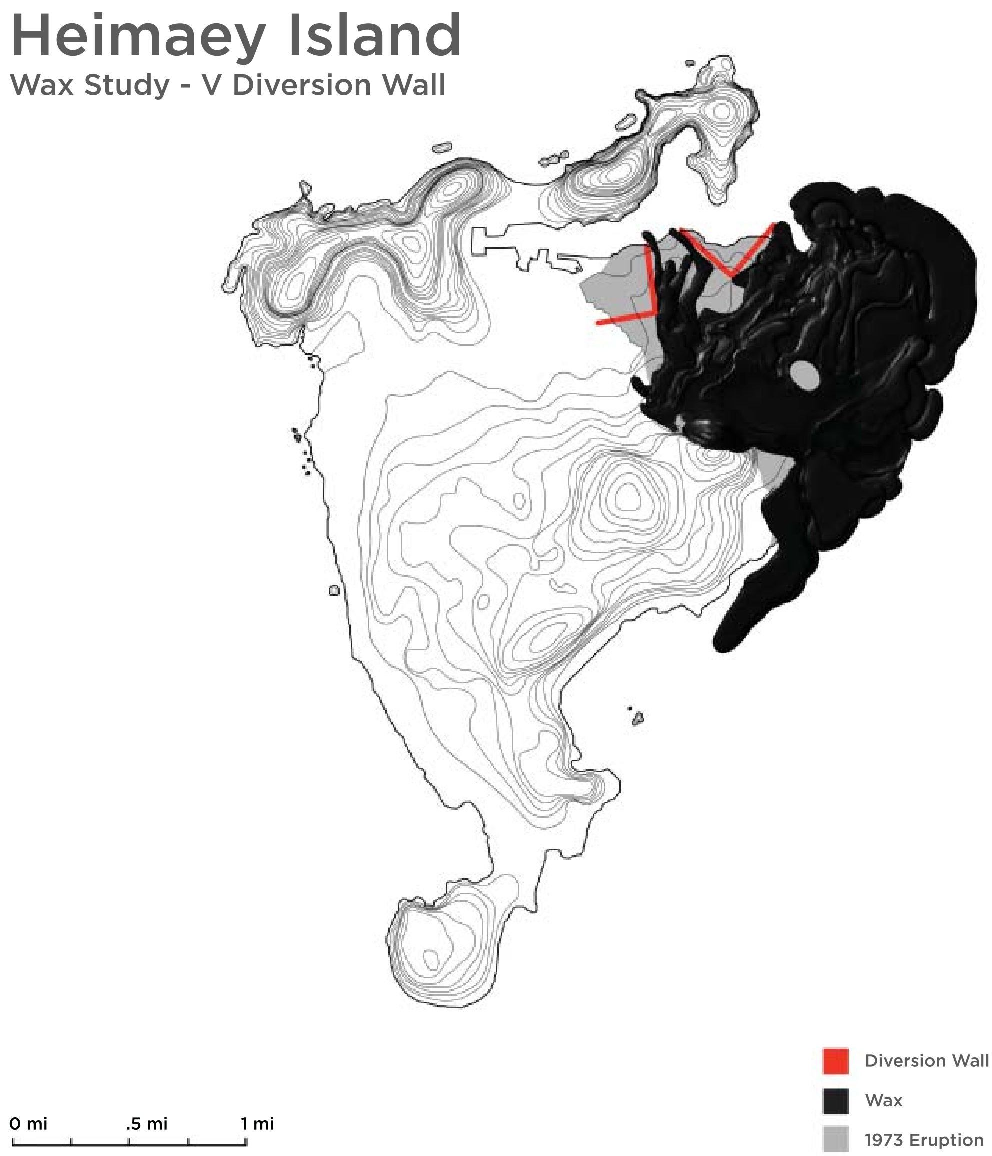

Figure 5.01 Wax Study - V Diversion Wall
Source: Author; Map Based off of: ArcGIS

Figure 5.02 Wax Study - Line Diversion Wall
Source: Author; Map Based off of: ArcGIS

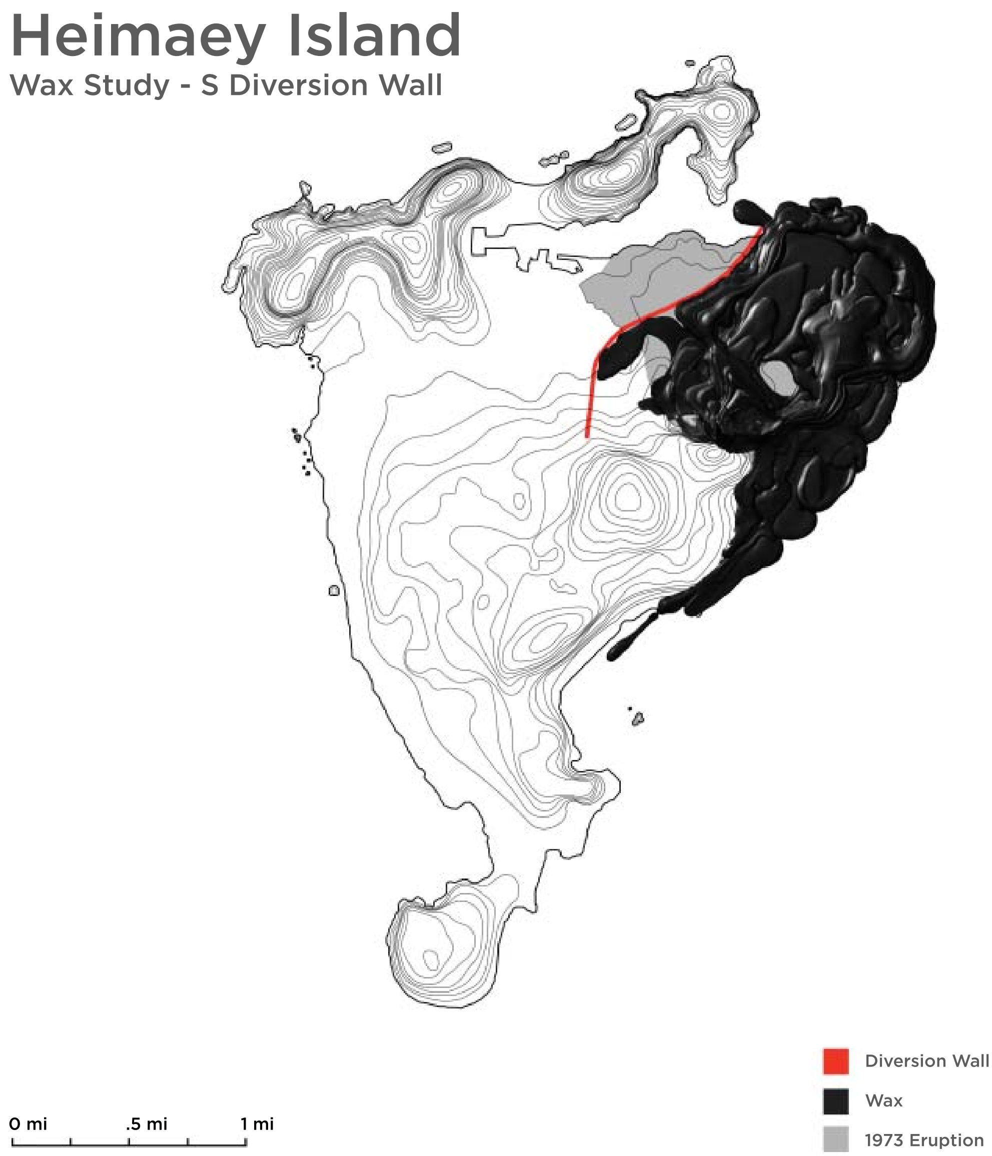

Figure 5.03 Wax Study - S Diversion Wall
Source: Author; Map Based off of: ArcGIS

The sun study of Heimaey Island is unique in that the island goes through a long period of extended sunshine followed by a period of minimal sunshine throughout the year. The Rhino software showed that the sun's radial angles also have extremes. (Figure 5.04) During June, July, and August, the sun shines approximately 300 radial degrees around the island throughout the day, with daylight lasting up to 21 hours. During December, January, and February, however, the sun shines approximately 45 radial degrees and no direct sunlight reaches the site, just ambient lighting for as few as five hours. (Figure 5.05)

Sun Study	Sunrise	Morning	Mid Day	Evening	Sunset
January	11:00 am	12:00 pm	2:00 pm	3:00 pm	4:00 pm
February	10:00 am	11:30 am	2:00 pm	3:30 pm	5:30 pm
March	8:30 am	11:00 am	2:00 pm	4:00 pm	7:00 pm
April	7:00 am	9:30 am	2:00 pm	5:30 pm	8:30 pm
May	5:00 am	8:30 am	2:00 pm	6:30 pm	10:00 pm
June	3:30 am	7:00 am	2:00 pm	8:00 pm	11:30 pm
July	3:00 am	6:00 am	2:00 pm	9:00 pm	12:00 am
August	4:30 am	8:00 am	2:00 pm	7:00 pm	10:30 pm
September	6:00 am	9:30 am	2:00 pm	5:30 pm	8:30 pm
October	7:30 am	10:30 am	2:00 pm	4:30 pm	7:00 pm
November	9:00 am	11:30 am	2:00 pm	3:30 pm	5:00 pm
December	10:30 am	12:00 pm	2:00 pm	3:00 pm	4:00 pm

Figure 5.04 Heimaey Island Sun Study
Source: Author

Heimaey Island

Sun Study

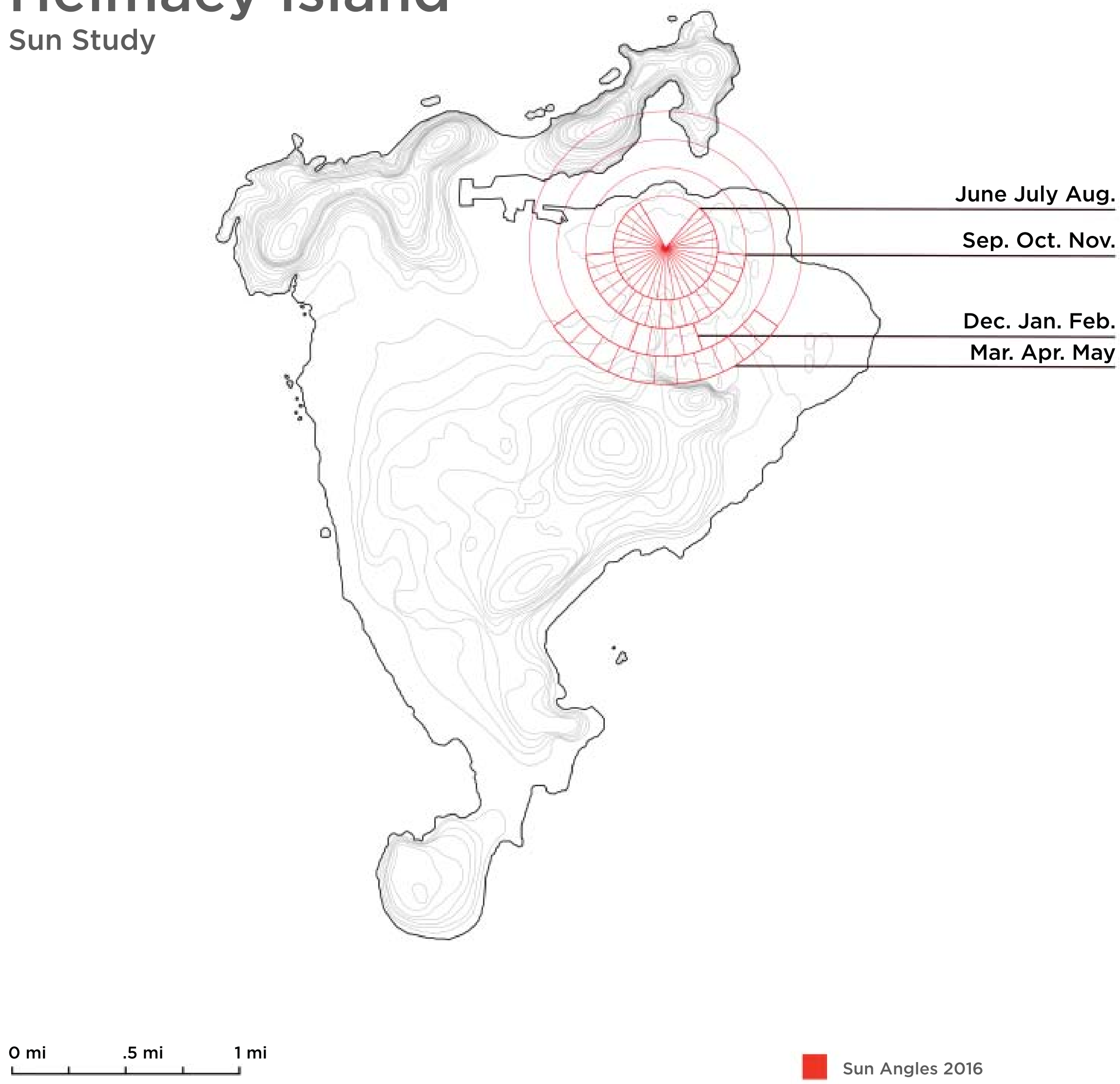

Figure 5.05 Heimaey Island Sun Direction
Source: Author; Map Based off of: ArcGIS

6. PROPOSAL

When designing the architecture and landform for the volcanic site, I considered the lichens, the existing lava rock, and the predicted eruption. My mile-diameter landscape's core design focuses on geological time. (Figure 6.00 & 6.01) The mile-long, gently curving road runs along a natural ridge on the topography. The road is the datum around which the rest of the site is organized. (Figure 6.02) The western third of the road is on grade because it is low-risk. The middle third is ten feet below grade because it is on the ridge's highest point. The eastern third of the road is a ten-foot berm because the coastline is the lowest point and the highest risk area for the harbor during a future eruption. North of the road, the town can be expanded onto the past lava flows. The town has been unable to expand because this land is unprotected from future eruptions. Although a last resort in diverting the lava, the road creates enough protection for the extended town to have sufficient time to evacuate safely.

An additional lava diversion has been designed in the high-risk area where the eastern mogul field meets the coast. Experimentally, I found that the lava will push outward into the ocean but will also cling to the coast as it finds its natural outflow route. Continuing onto the designed tombolo and island, the road ends in a roundabout. The tombolo, a narrow strip of land that the road and the black sand beach occupy, is as an additional barrier to protect the harbor when the lava reaches the ocean. (Figure 6.07) On the designed island is a marina, boardwalk, and observation tower at the top of the hill. The marina is important because it gives the villas and the town an additional evacuation route. The triangular observation tower has a central courtyard. Each façade of the triangle is directed towards an important view. The main façade faces the predicted eruption point. The other façades face the mouth of the harbor and the surrounding islands, which have breathtaking views. This observation tower will be a key shelter where scientists can observe, track, and photograph the next eruption.

My thesis centers on the premise that man's manipulation of Nature is only achievable when man lives by the words of Francis Bacon, a Renaissance scientist: "Nature to be commanded must be obeyed." My design is a lava-diversion system that will manipulate Nature when the next eruption occurs within the next 500 years. I designed a new landform called a lava mogul field that will slow the lava flows. (Figure 6.08) Lava moguls are triangular-shaped, cut-fill structures made of gabion volcanic rock. (Figure 6.13) The lava mogul field is a combination of the V- and line-diversion walls. (Figure 6.09) The lava moguls are paired with a permanent seawater pumping system, which will divert the lava away from the harbor and the town, just as the pumping system did in 1973. As the lava flow breaches the lava mogul's raised triangular half, it will then fill the back half of the lava mogul, which is a recessed void. (Figure 6.10) This slowly failing lava diversion system, which considers Nature and her destructive and viscous element, lava, is key. The design's strength is that the moguls are repeated one after another, creating a mogul field. Thus, when the first line of moguls is breached, the lava must travel out of the void to breach the second line of moguls. (Figure 6.11) Although an eruption cannot be prevented, the architecture's design can help divert the flow and minimize damage. The lava mogul system is safe because it is designed to fail slowly in succession and prevent a catastrophic event.

The lava flow's force was considered when the moguls were designed. The gabion structure depends on gravity, friction, and an adequately-sized foundation to be functional during an eruption. (Figure 6.14) A small foundation at the mogul's nose paired with a larger foundation at the mogul's back will prevent the mogul not only from being picked up and carried with the lava flow but also from crumbling backwards. Although stacked and tied off, the gabion cages mainly rely on friction and their weight to remain structural.

The lava moguls are positioned and sized according to the amount of risk and the shape and height of the topography on which they are built. (Figure 6.03) Northwest of the predicted eruption spot is an 840,000 square foot depression in the topography that will fill with lava first. The lava's next path will be through the saddle in the topography to the east. This saddle will direct most of the lava northeast towards a small bay on the coast, just south of the harbor's mouth. This area where the lava meets the ocean is a critical point because the lava will then follow the coastline to the harbor. West of this critical point are a medium-risk mid-section and a low-risk western section. (Figure 6.15)

The western field of moguls is five feet above ground and descends five feet into the moguls' individual gulches. This location is considered a low-risk area because of the higher elevation topography and because the moguls protect the town.

The middle field of moguls is ten feet above ground and descends ten feet into the moguls' individual gulches. This location is considered a medium-risk area because of the gradually eastern-sloping topography and because the flowing lava will find a lower elevation to breach.

The eastern field of moguls is twenty feet above ground and descends twenty feet into the moguls' individual gulches. This location is considered a high-risk area because of its low topography and its proximity to the coast and the harbor's mouth. The lava flows will converge on this lower elevation in the natural bay next to the harbor's mouth.

The seawater pumping system paired with the lava moguls will be successful in re-directing the lava, which is a highly viscous material that moves in a very unique manner. (Figure 6.04) According to Gansecki and Hon, "Lava flows inflate like a balloon. The outside crust moves up as lava continues to fill the inside of the flow" (2014). A flow can inflate to a towering height of over fifteen feet. Topography is drastically changed when a second flow runs over a past flow. Only solid materials that can withstand high heat can endure a lava flow. Currently, when a lava flow is aiming towards wooden power poles, a gabion cage is placed around them and filled with rock. An earth berm is then created around the base. This method has preserved power structures (Gansecki & Hon), thus proving that a gabion/berm combination will divert a lava flow.

The lava moguls' shape is ideal for lichen growth during the long periods of sun on Heimaey Island. Receiving sunlight from approximately 300 radial degrees throughout a summer day, the lava moguls provide areas of full sun on their berms and shadowy, cool areas in their gulches. This diversity of sunlight allows multiple variations of photomorphs from the map and sunburst lichens to grow, creating a diverse and colorful microclimate. The stacked gabions that are filled with lava rock will create small niches in which the multiple photomorphs can grow. (Figure 6.12) On the moguls where recreational activities such as climbing or biking occur, an additional layer of lava-rock aggregate concrete can be applied to create the smooth surface needed.

The site's primary program involves lava diversion and lichen microclimates. This lava-diversion system adds to the tourism industry on Heimaey Island. Designed as large lava moguls, three villa complexes are incorporated into the program to bolster the tourism infrastructure. (Figure 6.06) Positioned between the lava mogul field and the road, the villas are woven into the back of their respective lava mogul field. Made of lava-rock aggregate concrete, each villa is an elongated parallelogram (approximately 14' x 25') and is recessed three feet below grade. (Figures 6.17 & 6.19)

These villas' purpose during the next eruption within 500 years is to catch and contain the lava flow, thereby protecting the harbor and the town. The villas alternate facing forward and backward with the entrance being down a slope on the back of each villa. (Figures 6.16 & 6.18) Being recessed three feet into the ground, the floor plane forces an exaggerated perspective of the surrounding landforms during months of high sunlight levels and of the sky's beautiful light display, the aurora borealis, during months of low light levels. (Figure 6.23)

One unique design element in the villas is the roof design. After the next eruption, the roof will become the new floor plane if lava flows reach as high as predicted. (Figure 6.20 & 6.21) As a result, the roof shape will be another lava mogul, which will continue diverting lava until the mogul is completely buried. (Figure 6.22)

The path to the villas starts at a reception area on the landscape's west side in the 5' moguls, meanders through the 10' moguls, and ends amongst the towering 20' moguls where the villas are located. (Figure 6.05) Between the villa complexes are a series of small parks. To the east of the villas is a boardwalk, which provides access to the black sand beach. Amongst the moguls where the ridge is at its highest is a terrace system with another lookout point providing tourists with an optimal view of the entire mogul landscape. These terraces are also perfect for observing the next eruption; however, this point is less protected than the observation tower at the end of the tombolo making the terraces a secondary location.

Figure 6.00 Site Timeline
Source: Author

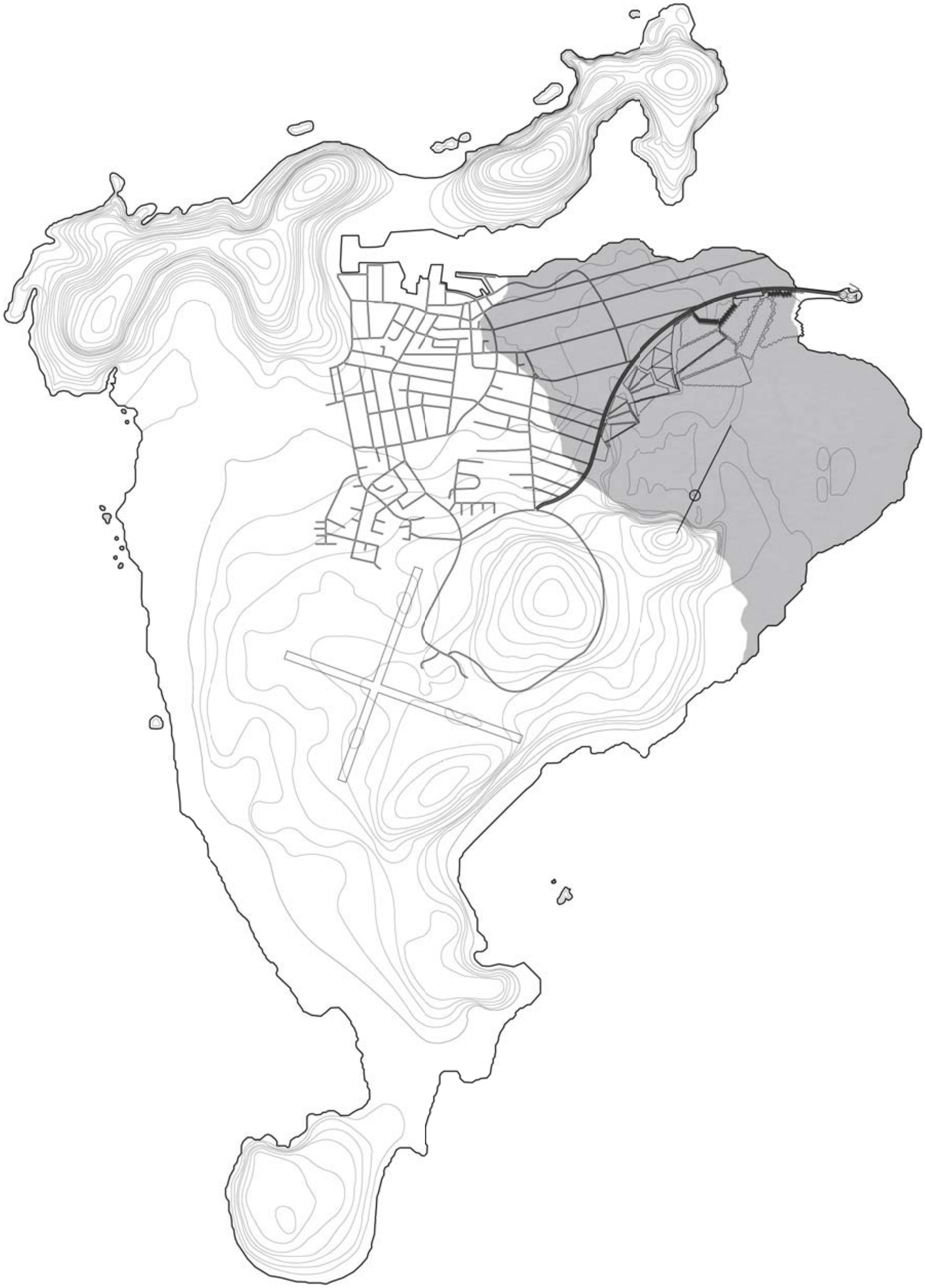

Figure 6.01 Plan - Island Scale
Source: Author; Map Based off of: ArcGIS

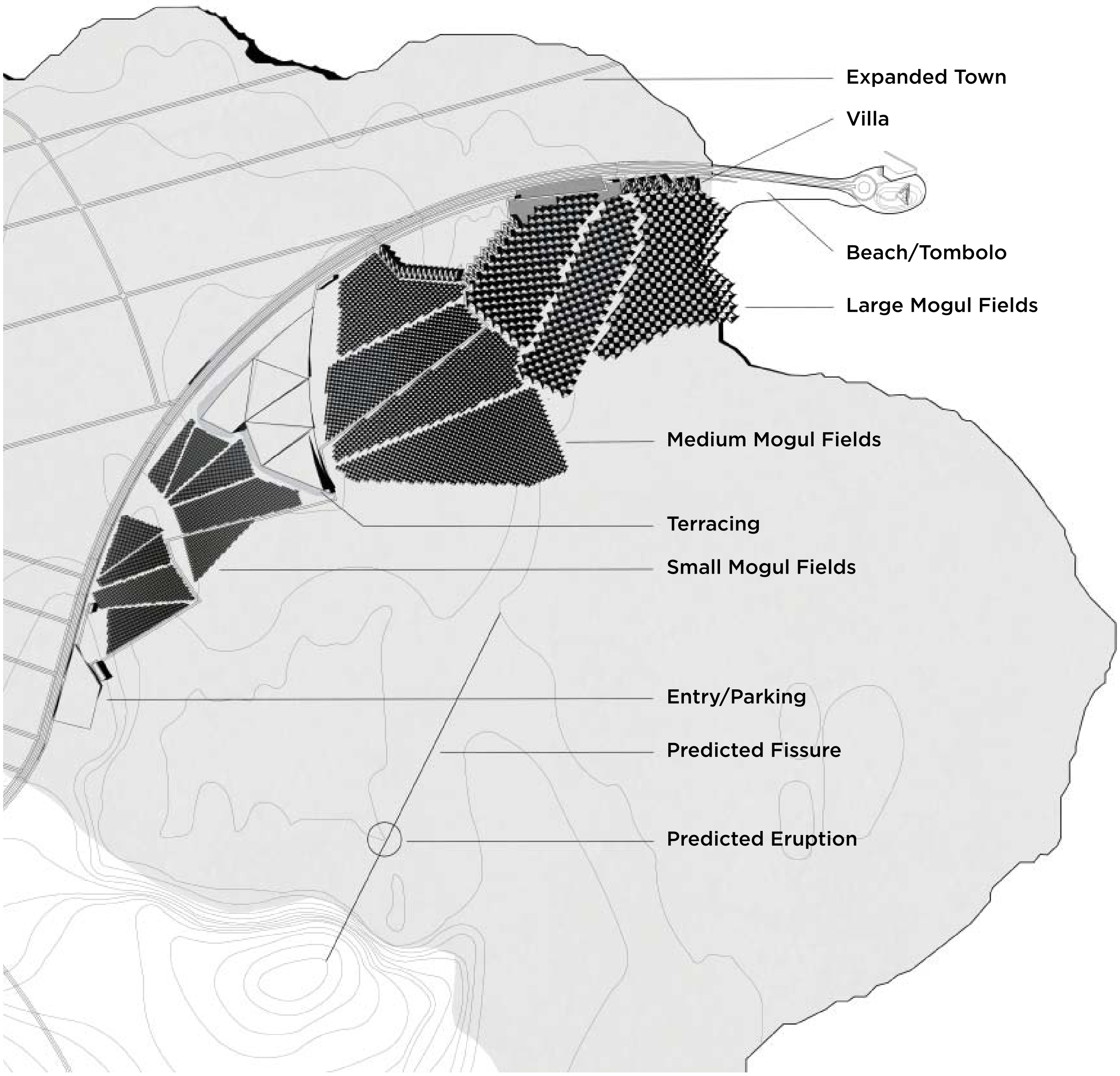

Figure 6.02 Plan - Site Scale
Source: Author; Map Based off of: ArcGIS

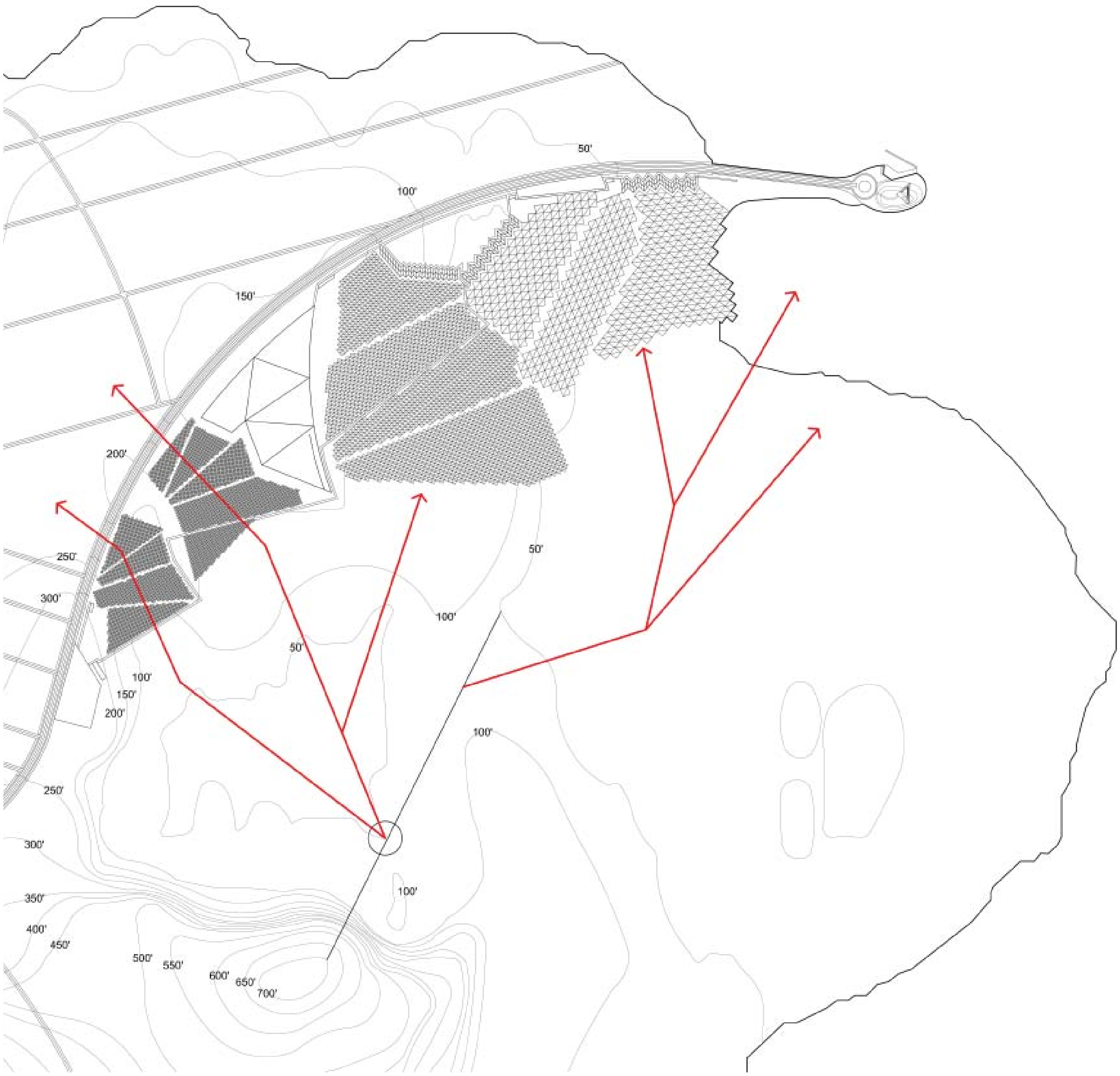

Figure 6.03 Predicted Eruption Lava Flows Plan
Source: Author; Map Based off of: ArcGIS

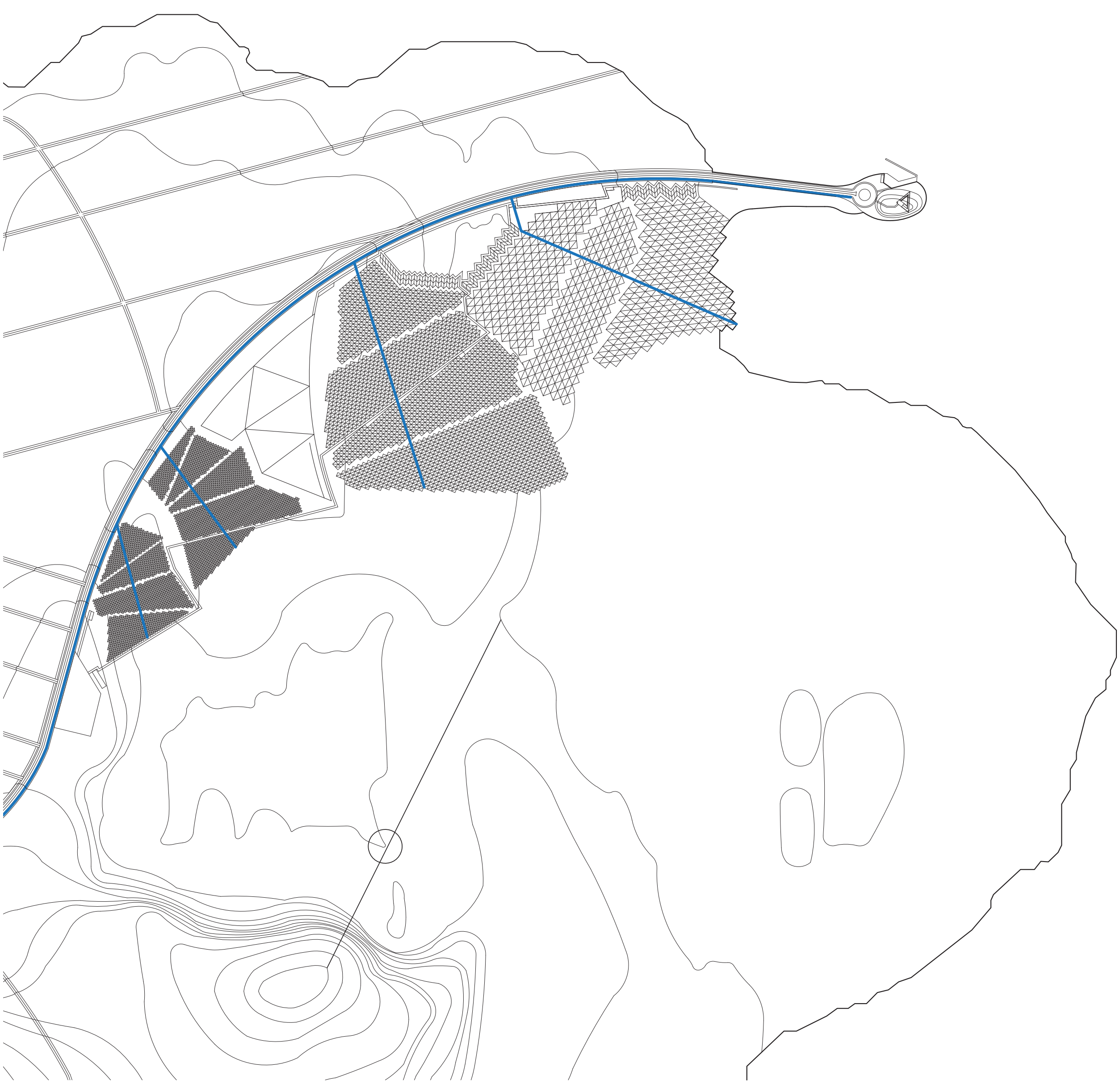

Figure 6.04 Sea-Water Pumping System Plan
Source: Author; Map Based off of: ArcGIS

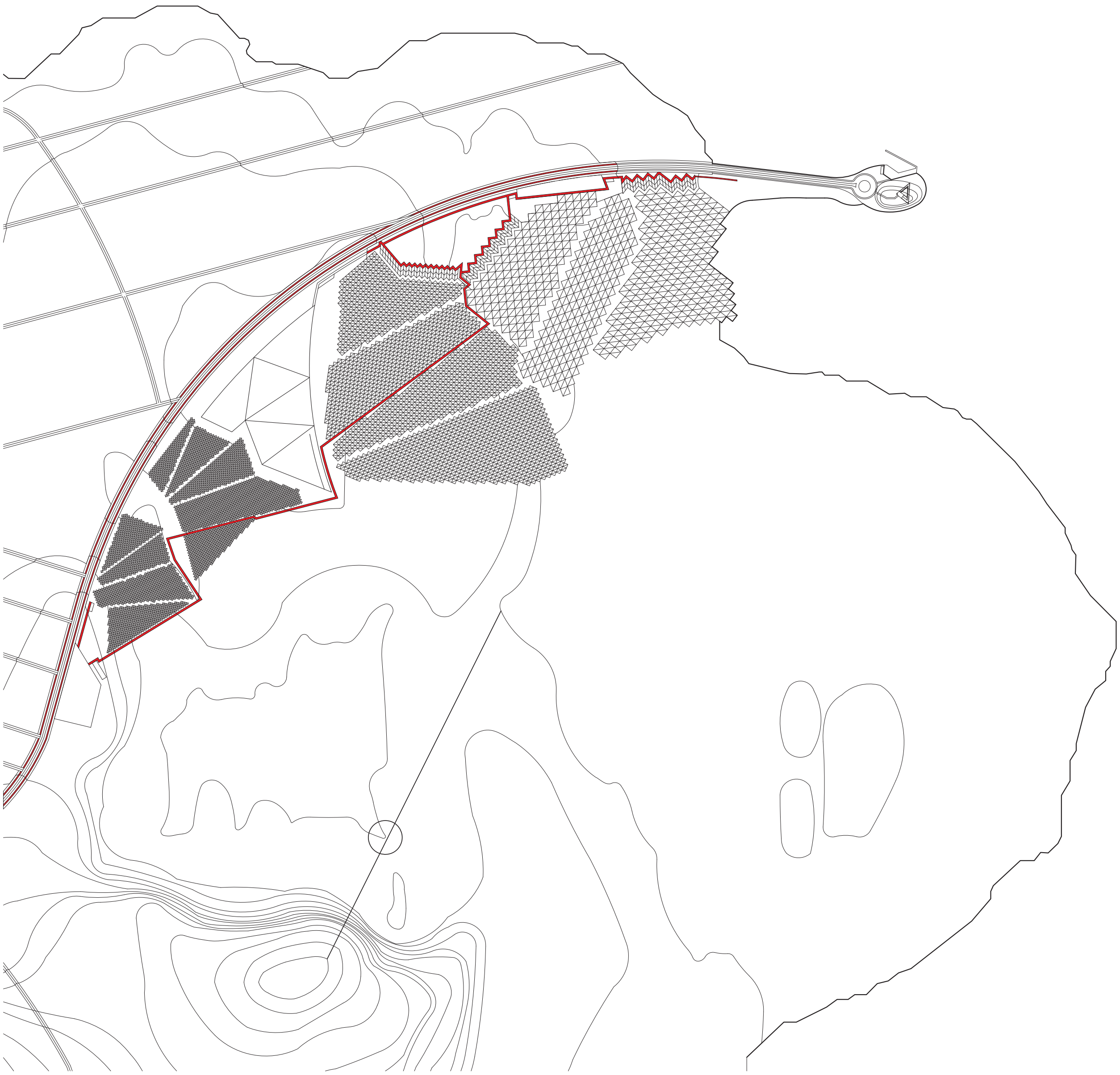

Figure 6.05 Paths Plan
Source: Author; Map Based off of: ArcGIS

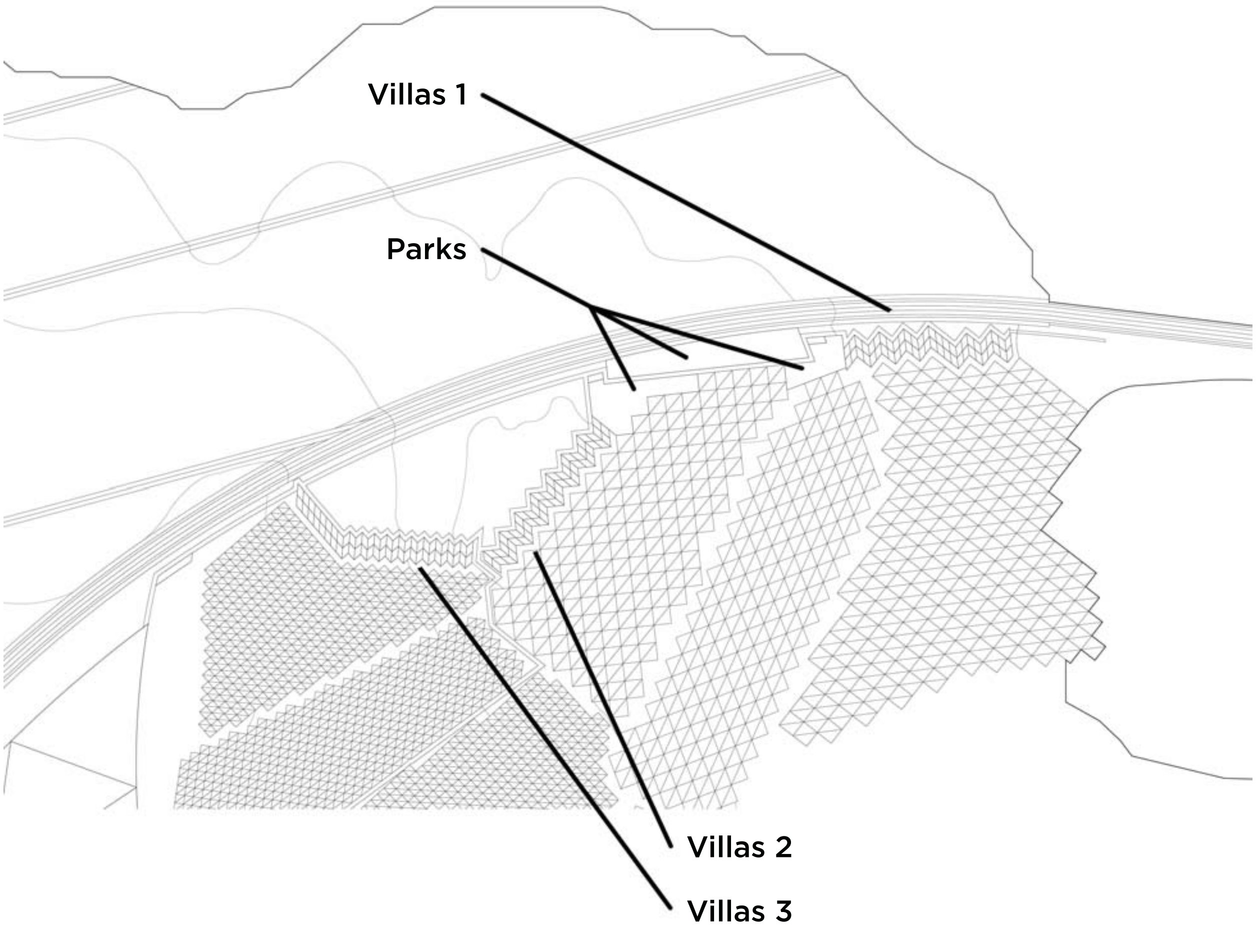

Figure 6.06 Plan - Villas Scale
Source: Author; Map Based off of: ArcGIS

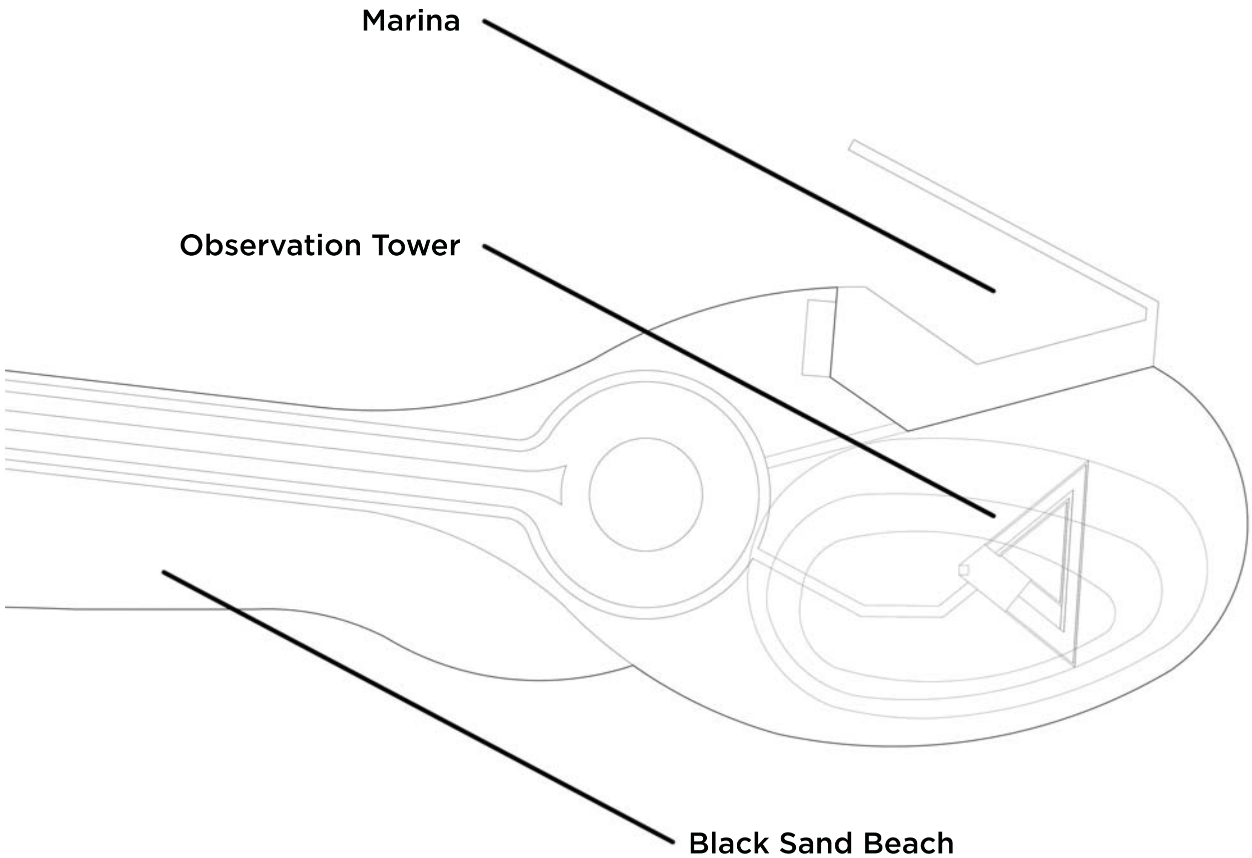

Figure 6.07 Plan - Tombolo Scale
Source: Author

lava moguls

noun \’lä-və ’mōgəls\
: a cut fill structure made of gabion volcanic rock that is triangular shaped; meant to slow the process of lava paired with a permanent sea-water pumping system

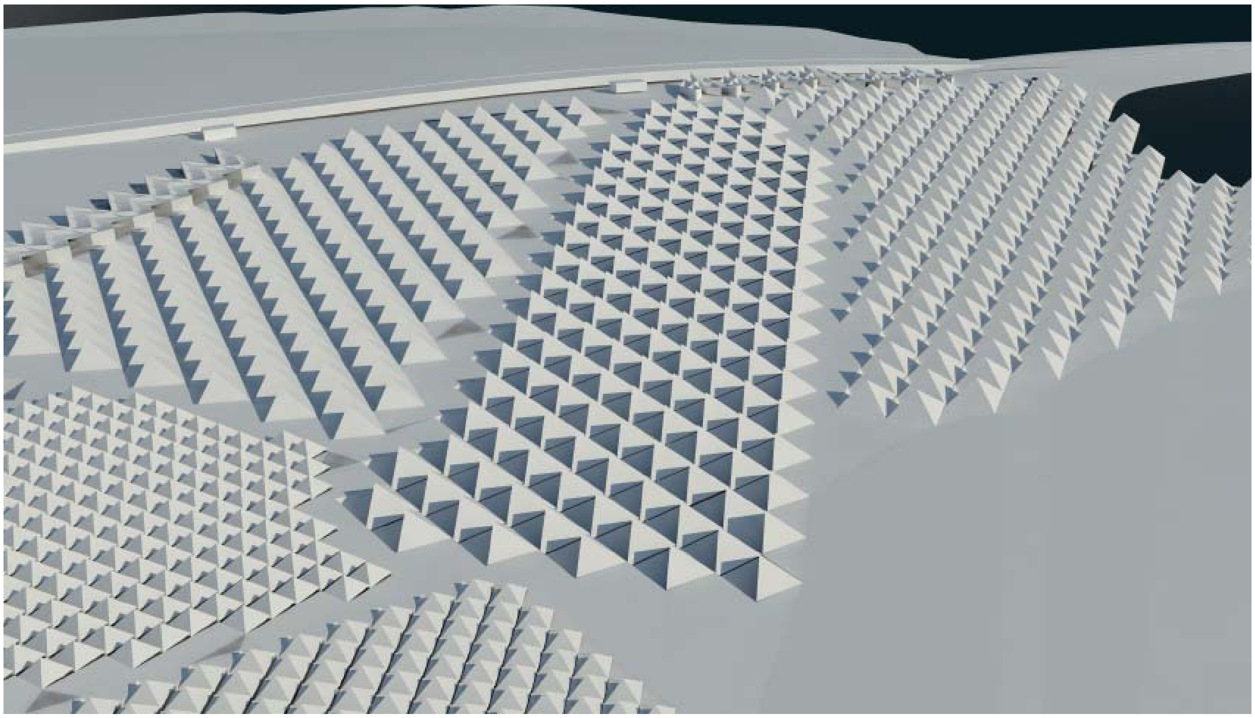

Figure 6.08 Lava Moguls Landform
Source: Author

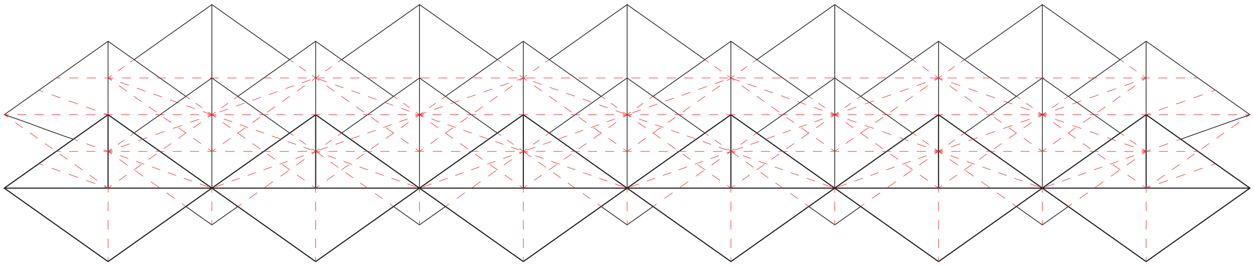

Figure 6.09 Lava Moguls Elevation
Source: Author

Figure 6.10 Testing the Lava Moguls
Source: Author

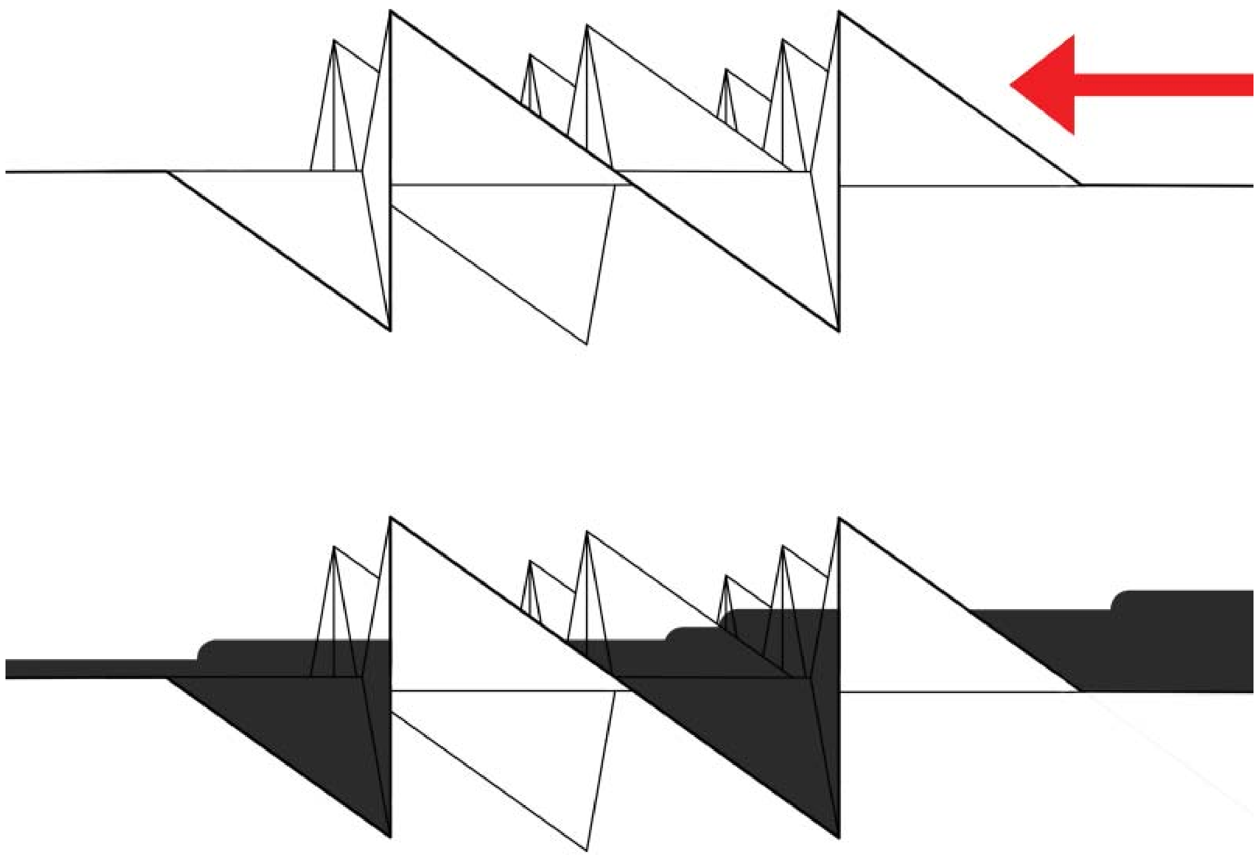

Figure 6.11 Lava Moguls Before and After Future Eruption
Source: Author

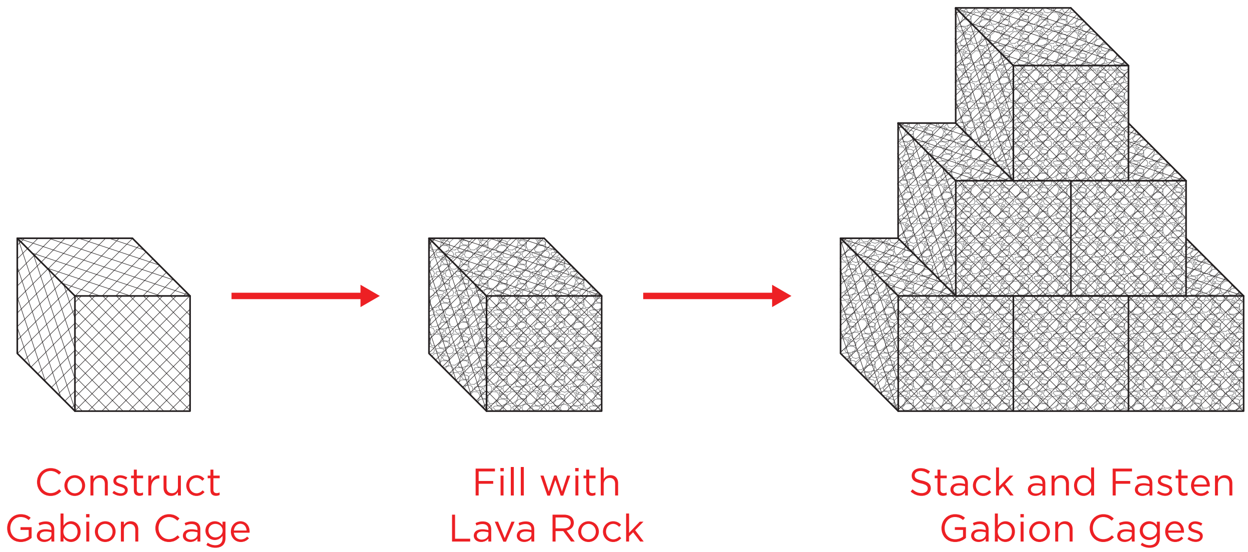

Figure 6.12 Gabion Construction
Source: Author

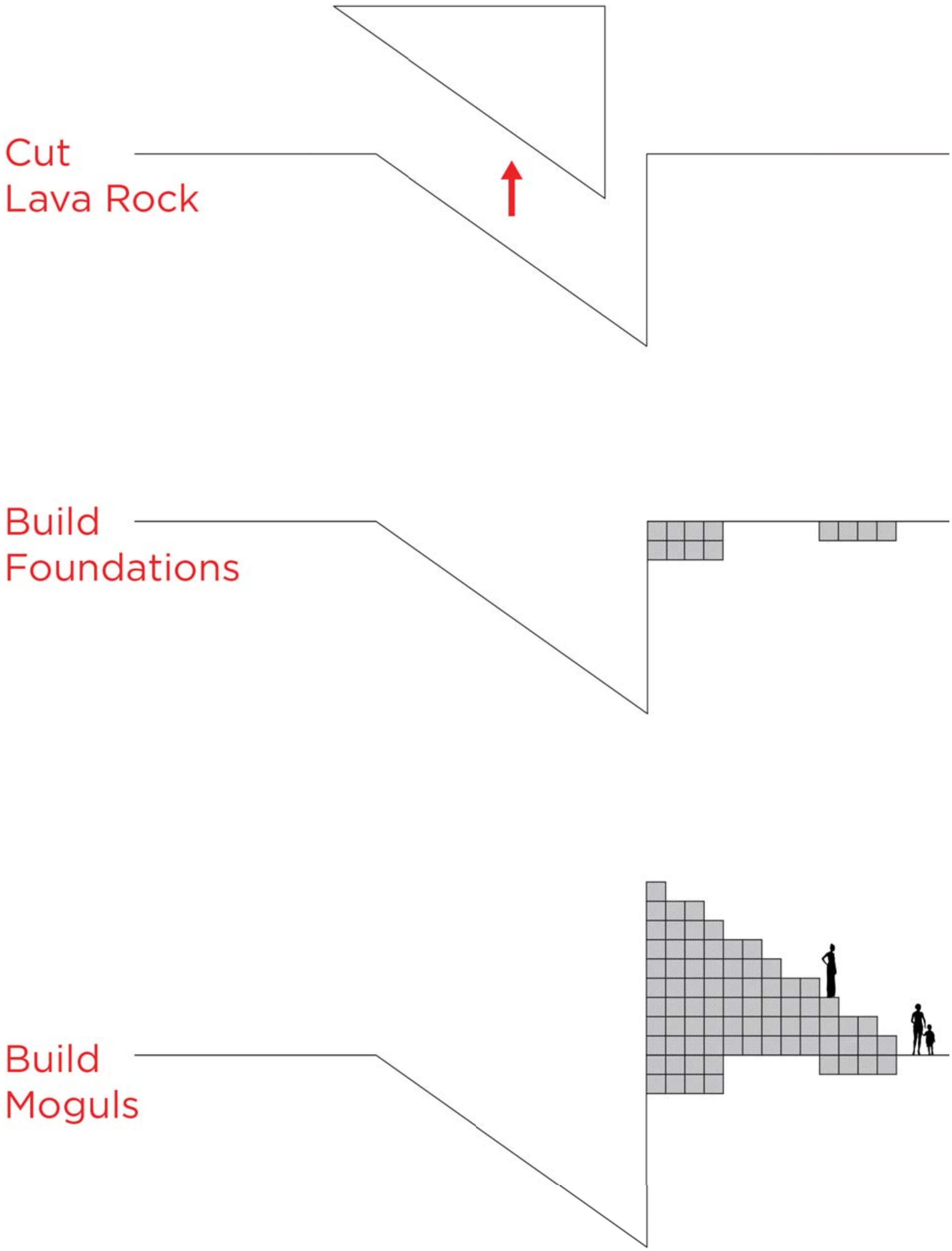

Figure 6.13 Lava Moguls Construction
Source: Author

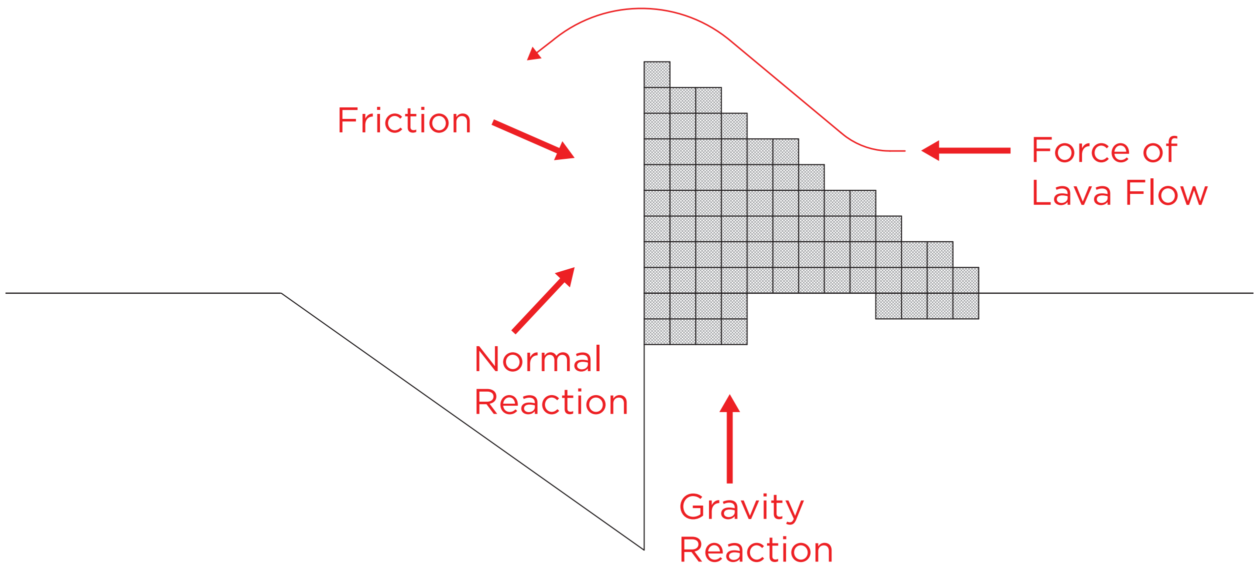

Figure 6.14 Forces on Lava Moguls
Source: Author

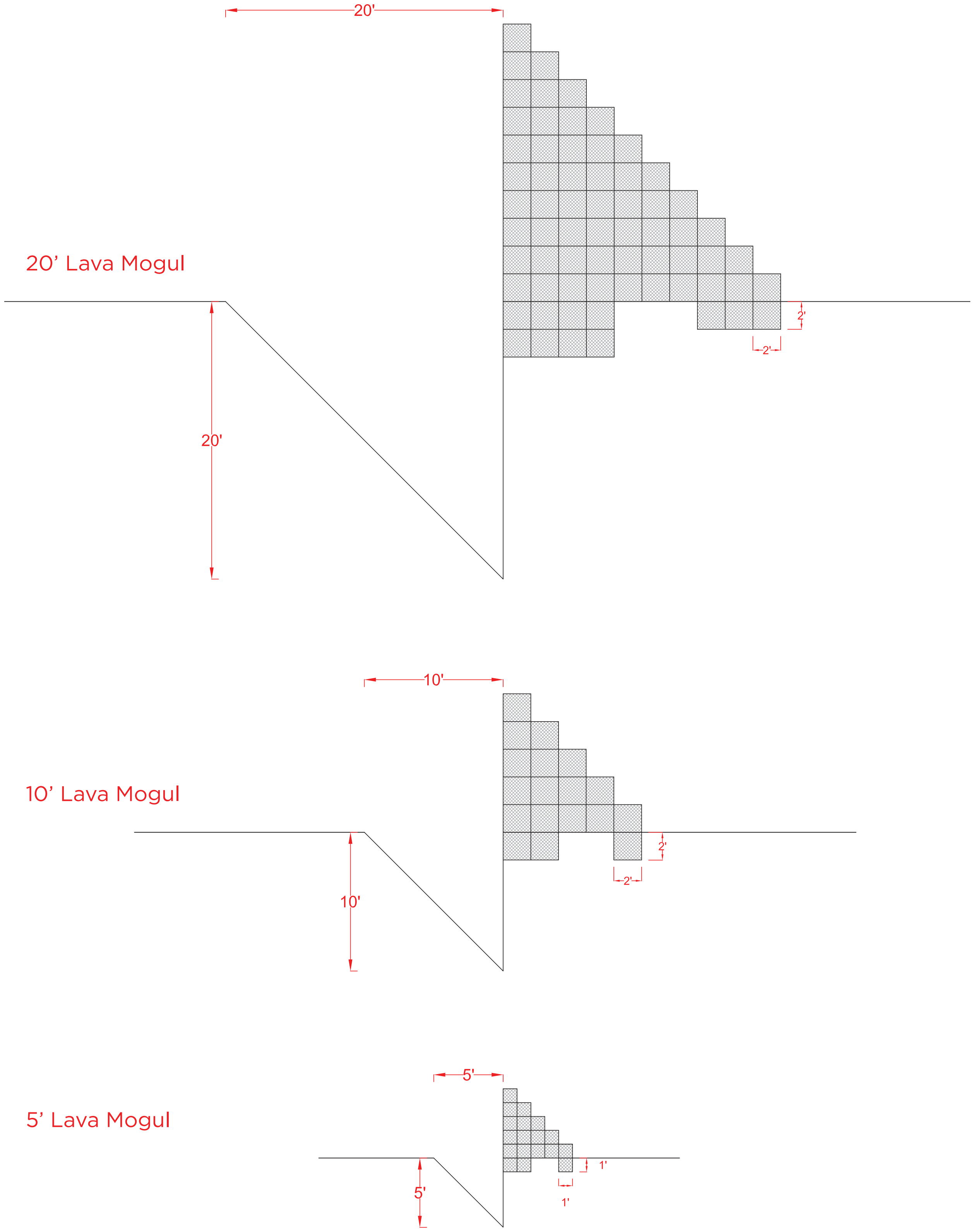

Figure 6.15 Lava Mogul Sizes
Source: Author

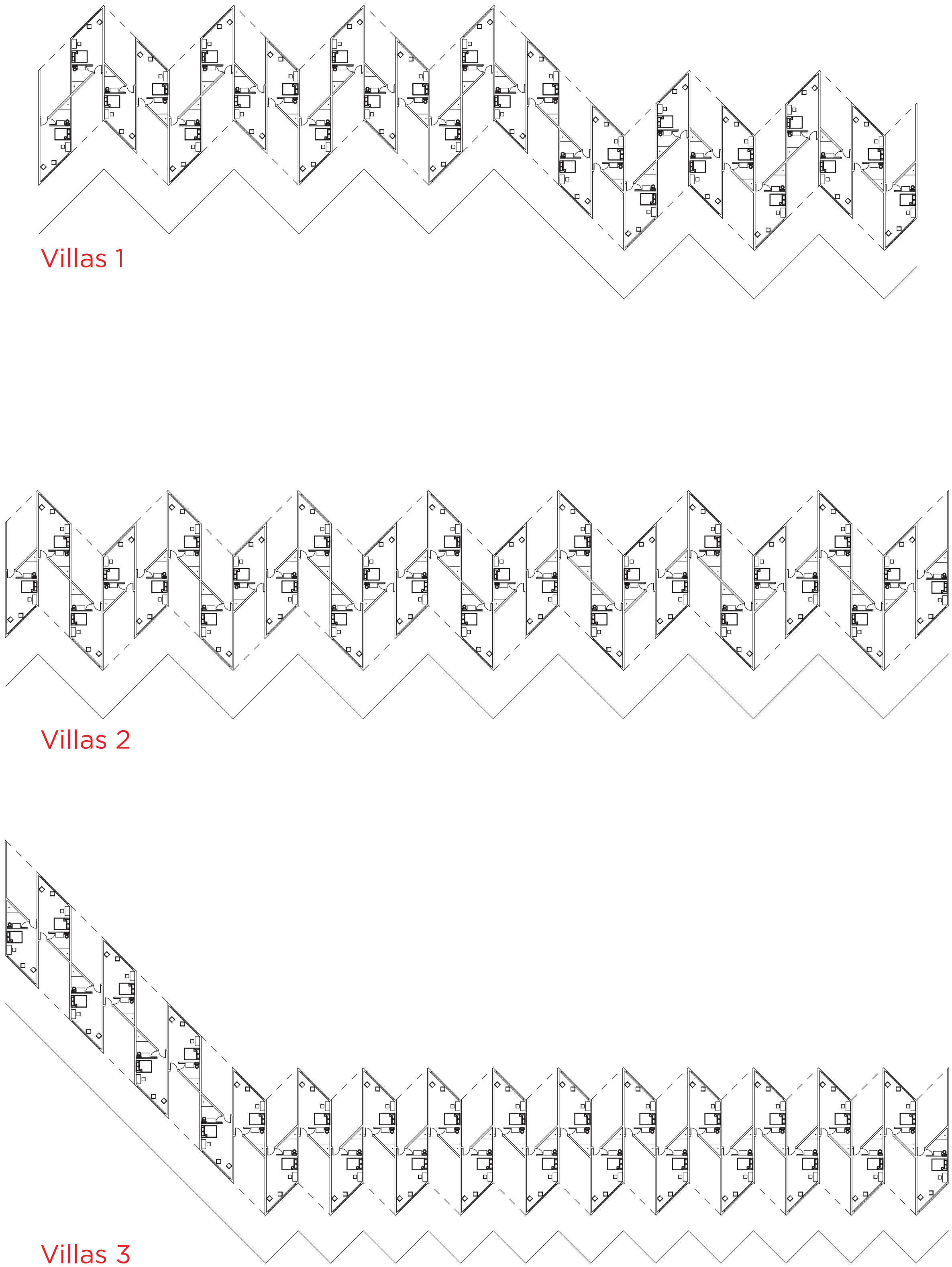

Figure 6.16 Villa Complexes' Plans
Source: Author

Figure 6.17 Villa Plan
Source: Author

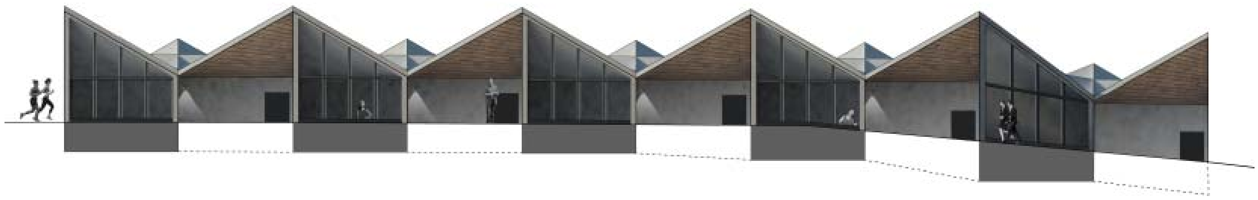

Figure 6.18 Villa Complex Elevation
Source: Author

Figure 6.19 Villa Elevation
Source: Author

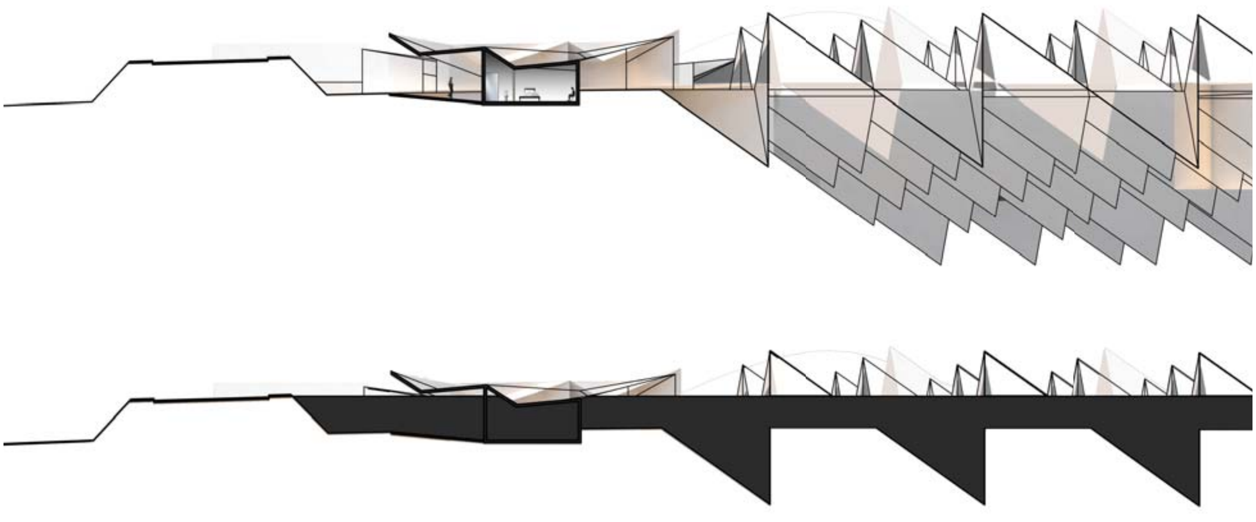

Figure 6.20 Site Sections Before and After Future Eruption
Source: Author

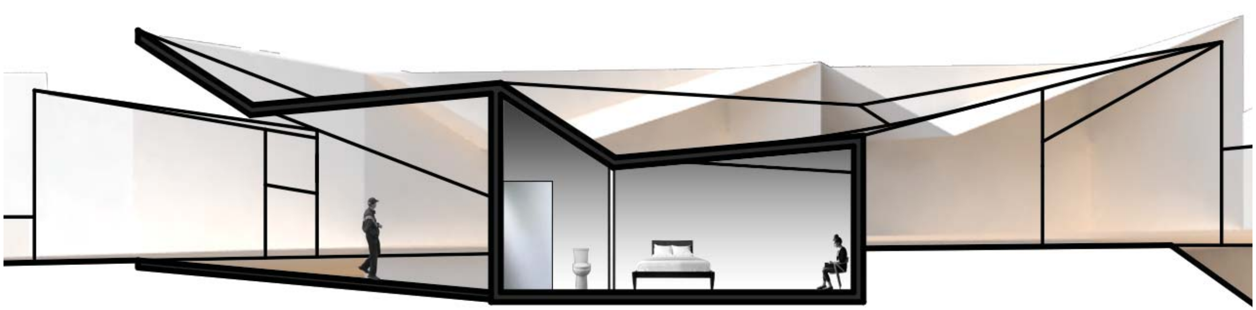

Figure 6.21 Villa Section Before Future Eruption
Source: Author

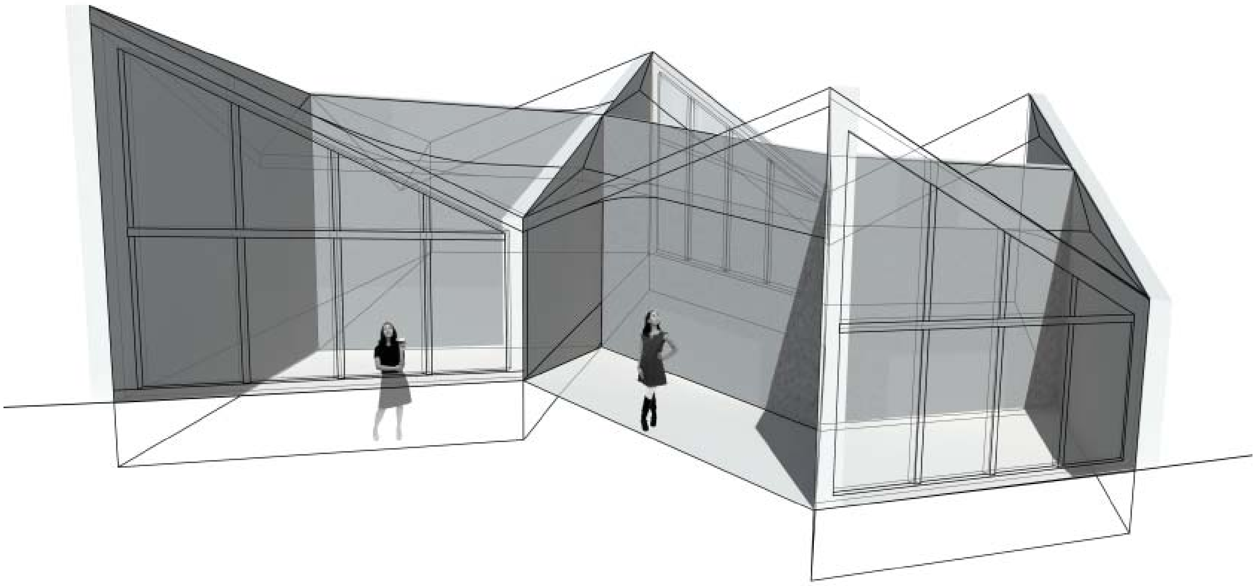

Figure 6.22 Villa Axon
Source: Author

Figure 6.23 Villa Interior Perspective
Source: Author

Figure 6.24 Climbing the 10' Lava Moguls Perspective - Year 2026
Source: Author

Figure 6.25 Climbing the 10' Lava Moguls Perspective - Year 2216
Source: Author

Figure 6.26 Climbing the 10’ Lava Moguls Perspective - Year 2516
Source: Author

Figure 6.27 Black Sand Beach Perspective - Year 2026
Source: Author

Figure 6.28 Black Sand Beach Perspective - Year 2216
Source: Author

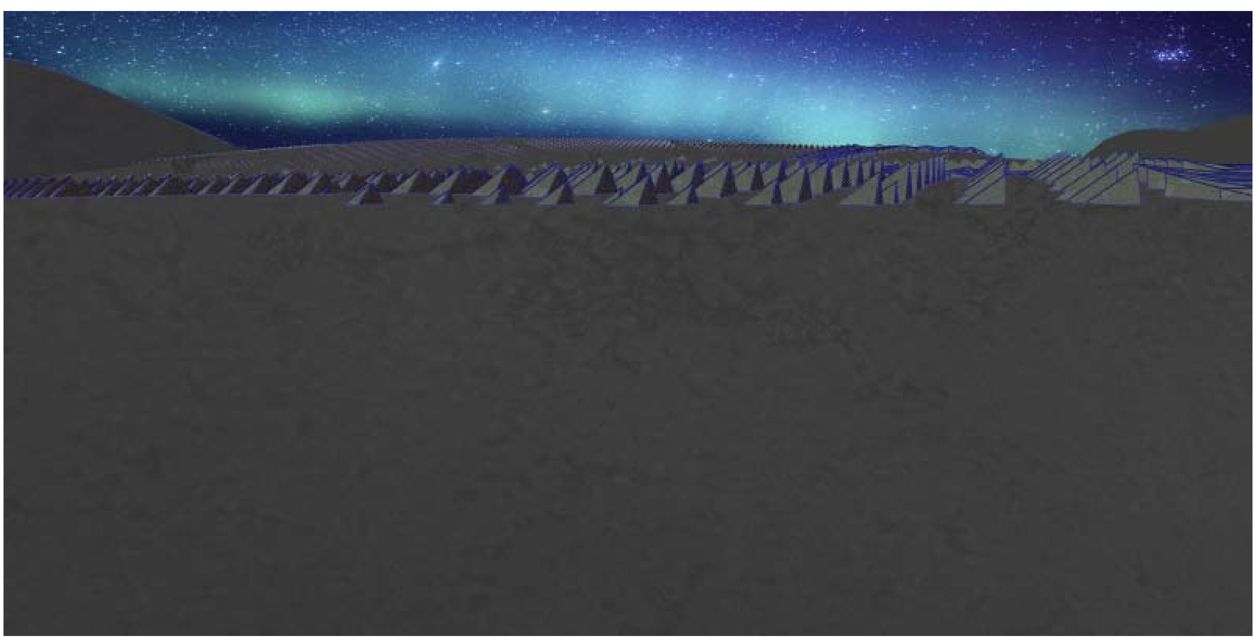

Figure 6.29 Black Sand Beach Perspective - Year 2516
Source: Author

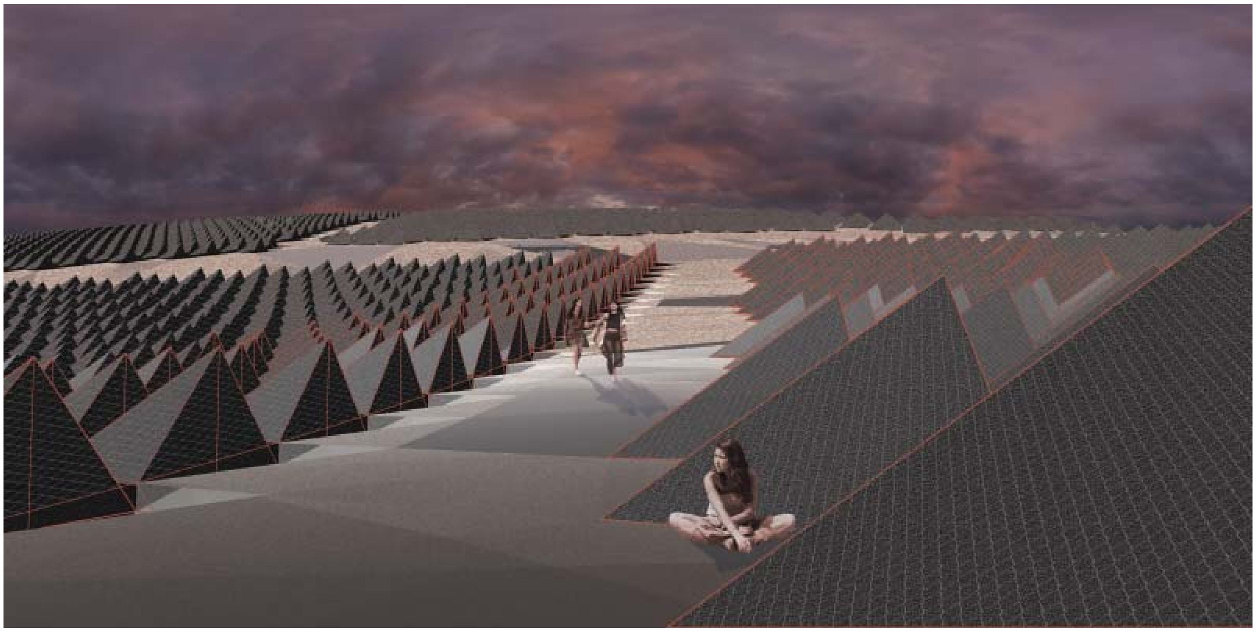

Figure 6.30 In the 5’ Lava Mogul Fields Perspective - Year 2026
Source: Author

Figure 6.31 In the 5’ Lava Mogul Fields Perspective - Year 2216
Source: Author

Figure 6.32 In the 5’ Lava Mogul Fields Perspective - Year 2516
Source: Author

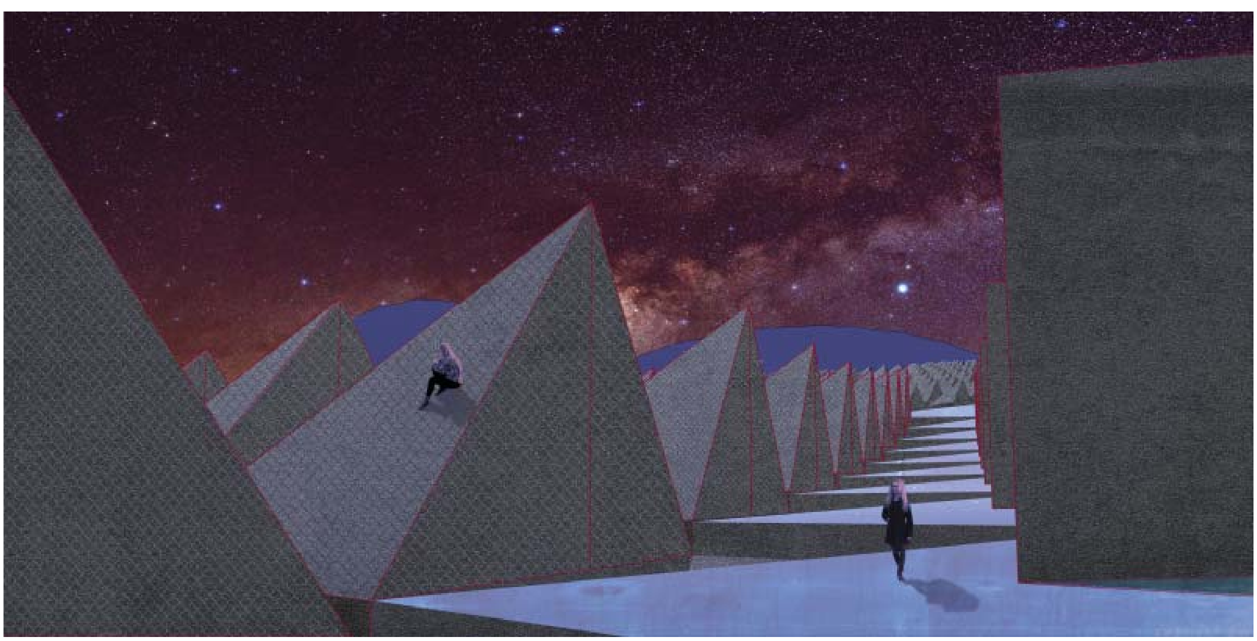

Figure 6.33 20’ Lava Moguls and Villas Perspective - Year 2026
Source: Author

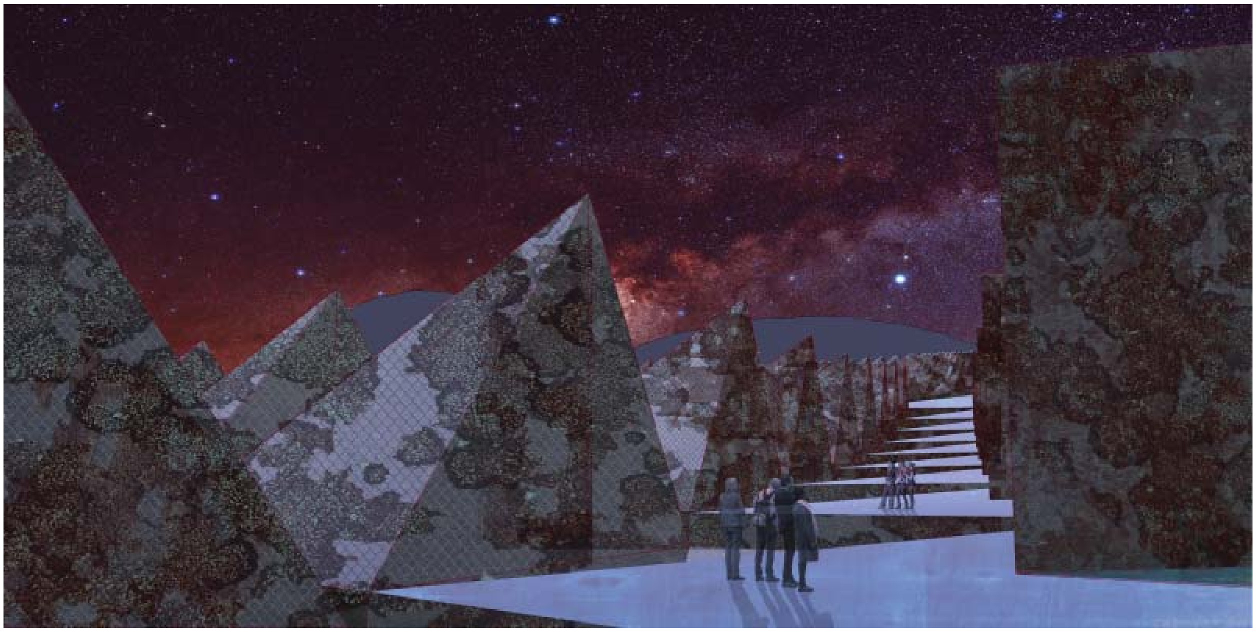

Figure 6.34 20’ Lava Moguls and Villas Perspective - Year 2216
Source: Author

Figure 6.35 20’ Lava Moguls and Villas Perspective - Year 2516
Source: Author

7. CONCLUSION

My goal in this thesis was to explore and broaden awareness of proactive, planned, slowly acting architectural interventions. For the purpose of this thesis, I designed an impermanent architecture and landforms for the human experience of controllable and uncontrollable events and scales of time through relationships of mutualism. The architecture, landforms, and humans are mutually dependent on the lichens, lava, and eruptions. The air quality humans rely on is supported by the slow metabolic processes of lichens that exchange carbon dioxide for oxygen. Last-minute efforts for lava diversion are common in human history after an eruption has already begun; but these reactionary attempts are typically unprepared, disorganized, and frantic, thus creating a safety hazard. However, as my thesis shows, a proactive system can be designed that serves humanity in the instant moment of an inhalation of oxygen, a generational experience of time in a landscape, and an anticipation of geologic eruption generations in the future. On Heimaey Island, proactive measures are needed to protect the harbor from future eruptions. This geological need has provided a circumstance in which to investigate and propose architectural and landform interventions that are designed to endure, then fail. Experience, event, and form in this proposed intervention are at once instantaneous, generational, geologic and impermanent. As a result, if my lava moguls and lichen concepts were implemented in other volcanic scenarios, mankind could be safer and healthier.

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VITA

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