

WADI AMMAN: SOCIAL + ENVIRONMENTAL INFRASTRUCTURE

by

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A REPORT

Submitted in partial fulfillment of the requirements for the degree

MASTER OF LANDSCAPE ARCHITECTURE

Department of Landscape Architecture
College of Architecture, Planning and Design

KANSAS STATE UNIVERSITY
Manhattan, Kansas

2009

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Abstract

Over the past 90 years Amman's population has increased approximately 400 times from 5,000 inhabitants to over two million (Al Rawashdeh and Bassam 2006). As Amman's population grows, so does their demand for clean water. The climate of Amman has produced only an average 595.5 mm (24.5 in) of rain per year from 1976 – 2005 (Jordan Meteorological Department, 2009). In addition to the need for more water, Amman is also confronted with congested traffic, deteriorating air quality and lack of public open space (figure 0.3).

Implementation of green or sustainable infrastructure in new urban development projects will aid in supporting the projected growth of Jordan's capital city. Living machines, ephemeral water features and eco-roofs are ways of improving water quality. The flat roofs of old and new Amman architecture create opportunities for the implementation of eco-roofs with minimal amounts of effort. Ephemeral water features within open space creates a dynamic environment throughout the year. Landscaped parks and plazas will be a fusion of the rich history, culture, and place contributing to the city's movement towards sustainability.

Further study of the interaction between green infrastructure and pedestrian experience in Amman will determine what is possible in future urban development projects.

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Wadi Amman:
social + environmental
INFRASTRUCTURE



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Kansas State University
Masters of Landscape Architecture

Wadi Amman

ENVISIONING SOCIAL + ENVIRONMENTAL INFRASTRUCTURE

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Acknowledgments

I would like to acknowledge and extend my gratitude to the following persons and groups who have made the completion of this Master's Thesis Project possible:

Tim Keane, Primary Professor, for always making himself available to share his vast knowledge about hydrology and providing direction when needed. Most of all I would like to thank him for his support and trust, giving me the freedom to explore through this Master's Thesis process.

Blake Belanger, Secondary Professor, for his unique and refreshing take on how to approach projects. His insightful thoughts and words provided new ways of thinking about how to present ideas to the reader.

Stephanie Rolley for instilling a desire to learn, providing guidance, and creating courses which pushed for more from myself and the profession of landscape architecture.

The SWA Group, for providing a challenging project requiring innovative design to inspire creative thinking throughout the entire journey.

Kinder Baumgardner, Principal at SWA, for his continuous support and guidance.

Jessica Bacorn, Staff at SWA, for her assistance and consistent contact as the project moved forward.

To Kelly Sullivan who was so patient with my late nights, I want to thank her for her faithful support.

Most especially to my family Tom, Pat, Maggie & Scott.

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Abstract ::

Over the past 90 years Amman's population has increased approximately 400 times from 5,000 inhabitants to over two million (Al Rawashdeh and Bassam 2006). As Amman's population grows, so does their demand for clean water. The climate of Amman has produced only an average 595.5 mm (24.5 in) of rain per year from 1976 – 2005 (Jordan Meteorological Department, 2009). In addition to the need for more water, Amman is also confronted with congested traffic, deteriorating air quality and lack of public open space (figure 0.3).

Implementation of green or sustainable infrastructure in new urban development projects will aid in supporting the projected growth of Jordan's capital city. Living machines, ephemeral water features and eco-roofs are ways of improving water quality. The flat roofs of old and new Amman architecture create opportunities for the implementation of eco-roofs with minimal amounts of effort. Ephemeral water features within open space creates a dynamic environment throughout the year. Landscaped parks and plazas will be a fusion of the rich history, culture, and place contributing to the city's movement towards sustainability.

Further study of the interaction between green infrastructure and pedestrian experience in Amman will determine what is possible in future urban development projects.

Landscaped parks and plazas are to be a fusion of the rich history, culture and place contributing to the city's movement towards sustainability.



figure 0.3 | Amman Hillside

Thesis ::

An infrastructure plan utilizing modern water collection technology coupled with historically proven Middle Eastern collection techniques has the potential to create a conceptual design shaped around the progression of water through the site; resulting in landscaped parks and public plazas that celebrate water while providing ties to the country's rich history, culture, and place.

Introduction :: Key Issues & Background

Historic cities, such as Amman, are looking for ways to maintain their rich social and physical history while designing for the future. With their rapid population growth, Amman is quickly surpassing their ability to provide open space and generate clean water for all of its inhabitants. Like other large cities, Amman is trying to establish sufficient public transportation opportunities within their new developments. The ultimate goal being that the public transportation systems would be a catalyst for new pedestrian life within the city.

“The concept of mixed use is not new to Amman; it’s what makes the old parts of the city so special. In many ways the wonderful street life of old Amman is what gives the city our soul.”

Mayor Omar Maani

Amman is active in becoming more sustainable. The Greater Amman Municipality (GAM) recognizes the potential value of high density mixed use residential developments. Implementation of planned mixed use residential would be environmentally, socially and economically beneficial to Amman. These developments lend themselves to creating enjoyable pedestrian environments, less dependency on individual motor vehicles, and additional employment for a growing population. New mixed use residential developments can reduce traffic, and allow public transit to travel relatively unobstructed through less congested routes. Incorporating mixed use will not jeopardize the social or physical history according to Mayor Maani who stated, ‘the concept of mixed use is not new to Amman; it’s what makes the old parts of the city so special. In many ways the wonderful street life of old Amman is what gives the city our soul’ (Press 2007).

Amman has recently shown interest in incorporating green design systems into their city. Since Amman gets only around 595.5 mm (24.5 in.), of rain per year (Jordan Meteorological Department, 2009) it is critical that the systems that are in place harvest or infiltrate the water to the best of their ability. Living machines, ephemeral water features, and green roofs are ways of improving water quality. The flat roofs of old and new Amman architecture create opportunities for the implementation of green roof systems with minimal effort. Water features within open space create a dynamic environment throughout the year, while filtering collected water back into the ground or collection system.

Section One :: Location

1

LOCATION

Context ::

Located between Saudi Arabia and Israel (figure 1.01), Amman (figure 1.02), the capital city of Jordan rises and falls over the mountains into the horizon. Four kilometers of dry river bed are designated for creation of a new urban strip at the heart of the city of Amman (figure 1.03). The new development is cradled by hills that give the site a sense of enclosure and security. Since the site was once the Seil River, the water that eroded the rock from the hills also created a reasonably flat site. The site lends itself to a mixed use residential development, creating a pedestrian corridor coupled with public transportation.

The project is located in a 50 square mile watershed at the base of the hills (figure 6.12). The site can collect large amounts of water during a storm using water features, cisterns and other systems that detain/retain the runoff, allowing Amman to use the harvested water for secondary use. Along with the collection of rain water, redeveloping the project site allows for other systems within the infrastructure (such as living machines for large buildings). Recycling waste water from buildings and circulating it back as gray water will save Amman a tremendous amount of water and capital.

Located at the west end of the project site is Hashemite Plaza joined by a Roman amphitheater (figure 1.04). The amphitheater is a well known tourist attraction and should be celebrated. Just North of Hashemite Plaza is Jabal Al qala'a. Al'qala'a, a Roman citadel, is elevated well above the dry Seil River bed and is considered a coveted piece of architectural history. The plateau that the citadel is constructed upon yields stunning panoramic views through Roman ruins out to the City of Amman (figure 2.01). Directly North near the center of the site is the Raghadan Royal Palaces compound. Construction of the palaces began in 1925 and is still the current residence of the Royal Highnesses Prince El Hassan and Princess Sarvath (The Royal Palaces 2008). At the far east end of the project site is the Hedjaz Train Station. The railway was designed to be a direct connection between multiple Arabian cities to Mecca. The track was never completed and stops 400km short of the Holy City (Hejaz Railway 2008). The Hedjaz Train Station could potentially serve as a hub for public transit.

There are two major roads that border the site and one which bisects it. The road to the North is Al-Jaish Highway. The road to the South is King Abdullah 1 Road, and the road that crosses the site is Al-Istiqlal. The site is very accessible to both vehicular and pedestrian traffic.

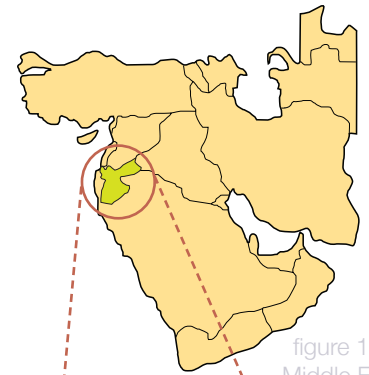


figure 1.01
Middle East

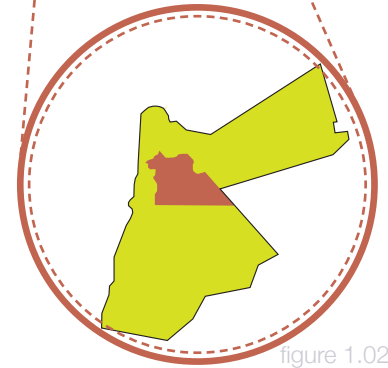


figure 1.02
Jordan

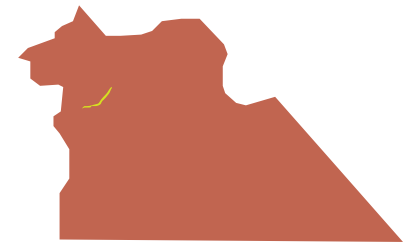


figure 1.03
Site in Amman

LOCATION



- 1 Jabal Al qala'a (Citadel)
- 2 Roman Amphitheater
- 3 Hashemite Plaza
- 4 Raghadan Royal Palaces
- 5 Hedjaz Train Station

figure 1.04 | Site Context

Districts ::

The site is divided into three districts. Bisecting roads begin to set up a framework for the division of the project site. Each district provides similar programmatic elements such as retail, residential, office and open space. Through programming and recurrent landscape, the districts are a cohesive corridor providing an exciting pedestrian experience. What makes the project unique is what the existing site has to offer within each district.

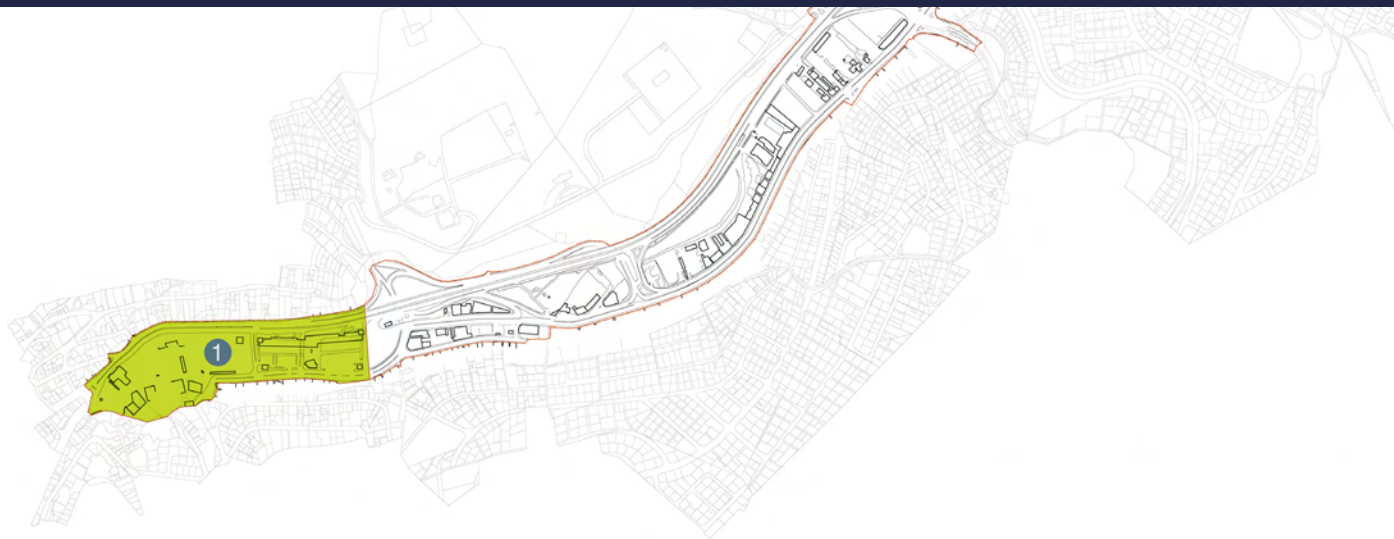
The names of each district are set forth by the Greater Amman Municipality (GAM).

Wadi Philadelphia (District 1) provides impressive cultural and historic landmarks to the City of Amman (figure 1.05). The Roman Amphitheater, Hashemite Square, and the Odeum are all distinctive features that should be maintained and celebrated through the design of the site. Wadi Philadelphia will repurpose and retrofit specific cultural buildings to better accommodate the design. Old City Hall, now a library, will be maintained in its existing location as it provides historic and social value to the site. The design for Hashemite Square is based on a current GAM revitalization plan. Wadi Philadelphia has great potential to be a desirable tourist location due to the rich history within the district.

Wadi Ragadan (District 2) will act as the primary mixed use development with around forty percent of the district dedicated to residential units (figure 1.06). To accommodate the residential space requirements, in addition to the need for office and retail space, Wadi Ragadan is the densest of all three districts. Located between district one and district three allows Wadi Ragadan to act as the heart of the project creating a strong transition zone between districts one and three.

Wadi Mahatta (District 3) will be designed as the Light Rapid Transit Hub for Amman (figure 1.07). Mixed use will allow residents to access transit options with ease as they pass by buildings of mixed use retail and commercial. Wadi Mahatta will act as the gateway from the east, indicating the entrance into downtown Amman.

Wadi Philadelphia figure 1.05



Wadi Ragadan figure 1.06



Wadi Mahatta figure 1.07



Section Two :: Goals

2

Goals ::

Project

- G1 Create a distinctive design that maintains and strengthens the integrity of place.
- G2 Create a pedestrian friendly corridor that addresses the need for public transportation within a dense urban site.
- G3 Provide a cost effective design.

Educational

- G4 Improve the understanding of water harvesting / recycling systems potential within arid landscapes.
- G5 Discover new creative sustainable design solutions.

Personal

- G6 Gather a deeper knowledge and appreciation for Arab culture, their rich history and beliefs.
- G7 Strengthen relationship with SWA Group.



Create a distinctive design that maintains and strengthens the integrity of place.

Discover new creative sustainable design solutions.

Gather a deeper knowledge and appreciation for Arab culture, their rich history and beliefs.

Section Three :: Dilemma

3

Dilemma to Address ::

Over the past 90 years Amman's population has increased approximately 400 times from 5,000 inhabitants to over two million (Al Rawashdeh and Bassam 2006). This rapid population boom is due in large part to Jordan's immigration policy — allowing immigrants from neighboring countries to cross their border during times of crisis (Al Rawashdeh and Bassam 2006).

As Amman's population grows, so does the demand for clean water. With specific organizations delegated to looking for solutions for this increasing problem, it is imperative that designers lead the way by implementing creative sustainable solutions for this dense, arid urban environment.

Amman is also confronted with congested city traffic (figure 3.01), deteriorating air quality (figure 3.02) and a lack of public open space (figure 3.03). Although Amman's density is 246.3 person/km.sq (The Hashemite Kingdom of Jordan 2003), vehicular traffic is still an issue primarily due to the terrain upon which the city has been established. Amman's mountainous terrain does not lend itself to pedestrian traffic.

Congested City Traffic figure 3.01



Increased Population & Deteriorating Air Quality figure 3.02



Lack Of Public Open Space figure 3.03



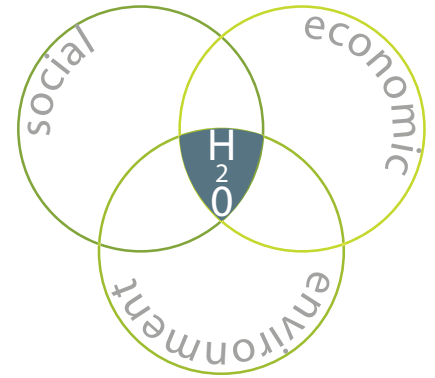
Section Four :: Process

4

Process ::

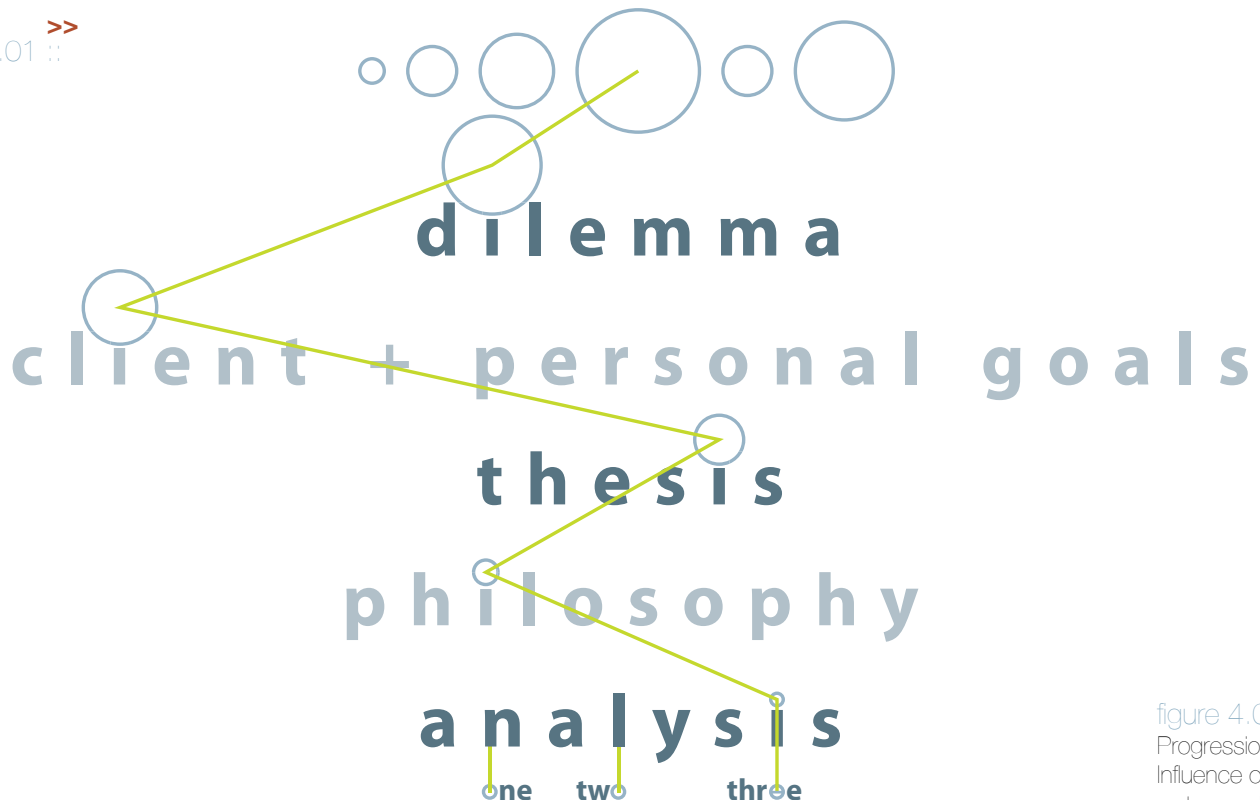
Process for the project begins with issues on hand for the City of Amman. Multiple problems are presented, most connected, and the solution to one will be the beginning of the solution to another. Blue circles along the top graphically represent issues presented to the site (figure 4.01). As a selected issue is passed through each phase of the path the circle decreases in size representing steps towards lessening the problem and finding a resolution. The words “one,” “two” and “three” below the term “analysis,” represent three different scales of examination (regional, city, and site specific).

There are three essentials to the design of a successful site. It is important to identify and understand how social, economic and environmental aspects of the project should interact with one another (figure 4.02). Water is positioned where the three circles overlap, representing water as the cohesive element that unites these important aspects of life. Water is the catalyst for the interactions on site. The progression of water will guide design decisions for the site, setting up the potential for rewarding interactions between society, economics, and the environment (figure 4.03).



^
figure 4. 02 ::
Design
Essentials

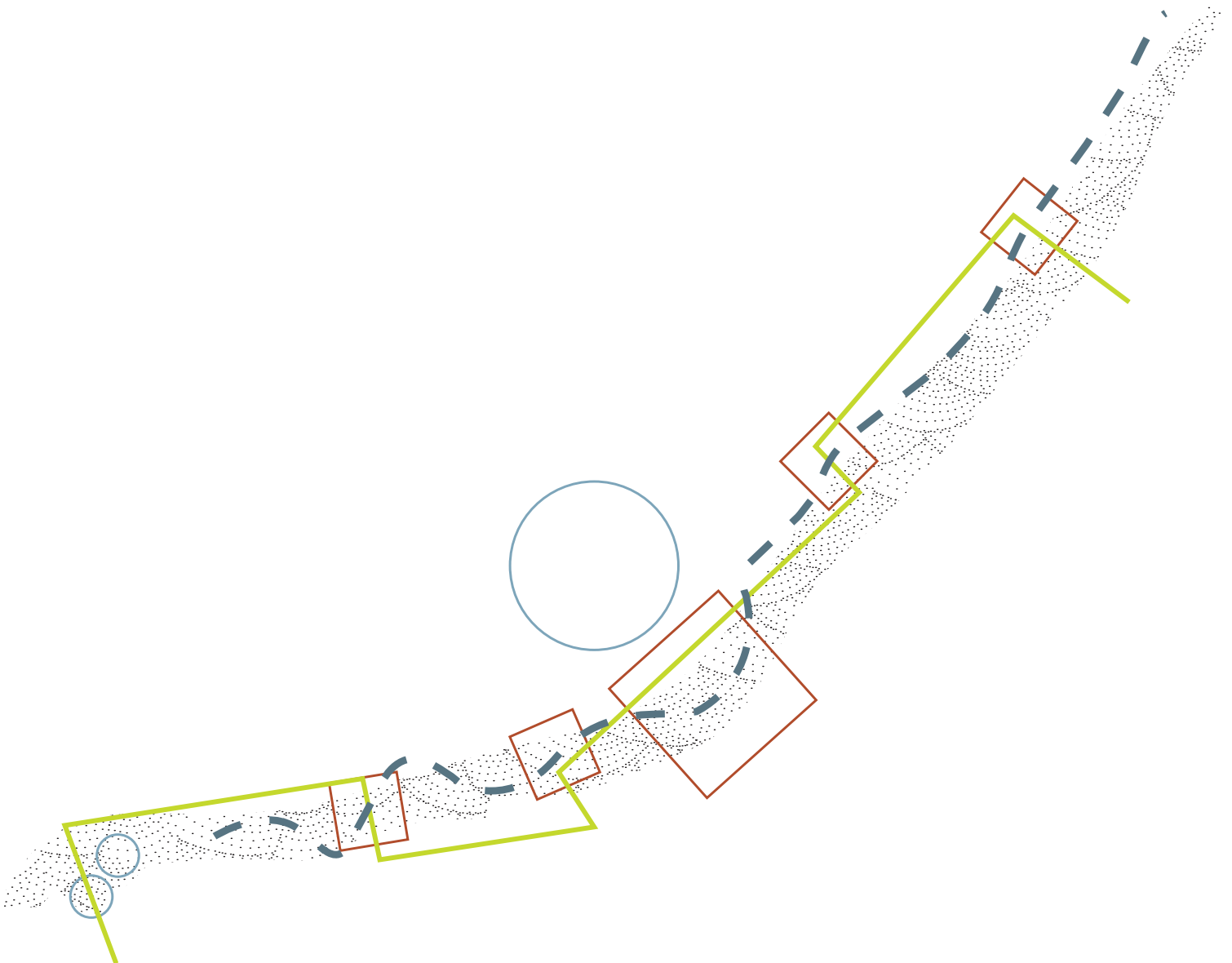
>>
figure 4.01 ::
Process



>>
figure 4.03 ::
Progression:
Influence of
water on design.



The progression of water will guide design decisions for the site, setting up potential for rewarding interactions between society, economics, and the environment.



Section Five :: Case Studies

5

CASE STUDIES

CASE STUDY

Humeima ::



BACKGROUND ::

Humeima was a small trading post showing signs of an urban focus located in the southern deserts of Jordan (figures 5.01 and 5.02). The use of hydraulic systems to manage water and precipitation, allowed “the community...to enjoy a settled existence based on agriculture, stock-raising, and passing caravans.” Humeima was inhabited from 80 B.C. till its abandonment in 750 A.D (Schram 2007).

The success of the site’s location was primarily due to “the settlement...located at the conflux of several run-off fields that provide a reliable supply and manageable amount of water to two public reservoirs and numerous private, domestic cisterns.” (Schram 2007)

A 1986-87 survey located 51 cisterns surrounding the site and 11 located within the settlement (figure 5.03). It should be noted that most of the housing was located around the larger cisterns 67 and 68, probably built by a municipal authority



^ figure 5.01 ::
Humeima
Location Map

<< figure 5.05 ::
Nabataean
Cistern

>> figure 5.06 ::
Rainwater
Aqueduct



<< figure 5.02 ::
Humeima
Landscape

(Schram 2007). Many houses also utilized private cisterns located closer to their homes (figure 5.04). Along with the location of cisterns the survey also located 4 springs, 1 aqueduct, 1 dam, 2 sets of wadi barriers, 2 reservoirs, and 6 sets of terrace or stone piles (Nydahl 2002).

cisterns ::

Cisterns were either cut in to the bedrock or built from blocks (figure 5.05). Most of the cisterns were roofed with stone slabs to slow down evaporation. One author described a cistern as “a perfect cube cistern, with corners that formed perfect right angles. They sometimes added perfectly made stone support pillars with accurately spaced, combed, oblique stone dressing. Onto this prepared surface they plastered cement composed of water-resistant plaster of unmatched quality” (Nabataea 2002).



aqueduct ::

The aqueduct begins at ‘Ain al-Qanah (elevation 1425 m) and spans 18.901 km to two reservoirs in the settlement at the elevation of 995 m. The aqueduct is located at ground level utilizing low bridges when necessary (figure 5.06). “The aqueduct consists of a heavy rubble foundation wall that supports long stone conduit blocks framed by rubble packing set in mortar. The conduit blocks are made of yellow marl or white sandstone depending on the region; the material was quarried locally. On the upper edges of the conduit blocks, fist size rubble was set in a hard mortar and smoothed over with stucco/plaster on the interior. The whole structure was topped with flat slabs of limestone.” (Nydahl 2002)

dams ::

Dams were constructed in and around the slopes of the wadi hills to collect excess runoff. Dams were constructed of stacked stone covered with the same smooth, hard mortar found in the aqueduct and cisterns (figure 5.07 and 5.08).

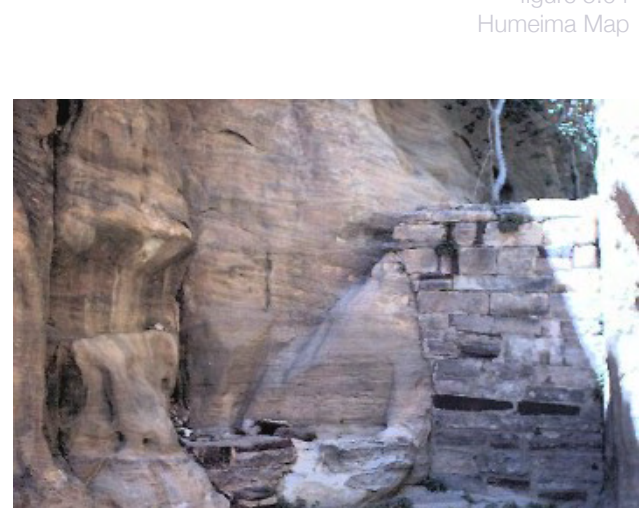
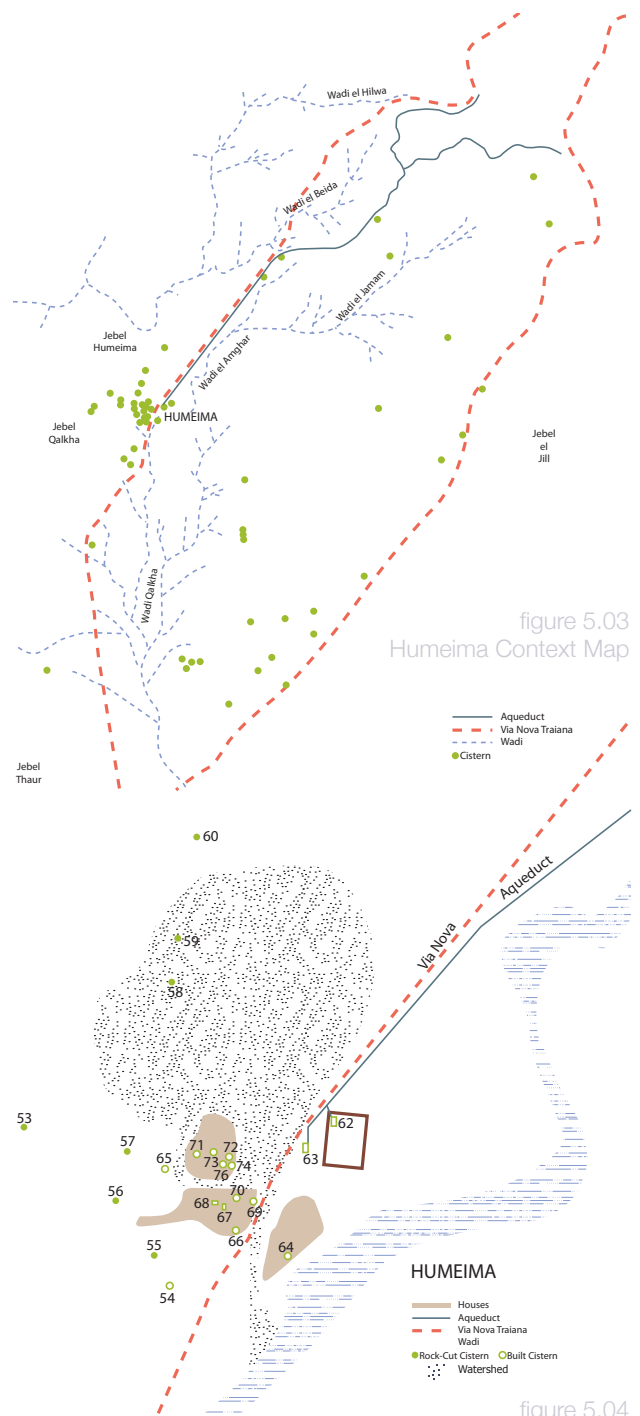


figure 5.07 Nabataean Dam

CASE STUDIES

terraces ::

Terraces were carved into the steep wadi slopes to protect and collect precious topsoil from runoff allowing for the planting of crops (figure 5.09). This was a way to transform otherwise uninhabitable land into an investment for the settlement. Wetter terraced topsoil might have been used to produce olives and grapes, while dryer terraces might have been used to grow wheat (Watson, Burnett and Wahlin 1998)

wadi barriers ::

The intended purpose of wadi barriers is to “serve to slow runoff in the channel of the wadi and to impede the movement of soil down the wadi bottom” (Watson, Burnett and Wahlin 1998). Along with erosion control the wadi barriers also protected structures and agriculture from flash flooding during the rainy seasons.

reservoirs ::

There are two reservoirs located within the settlement, one is Roman and the other is Nabatean (figure 5.10). The Roman reservoir had the capacity to hold around 1250 cubic meters of water and is located inside a rectangular fort. The Nabatean reservoir had a capacity of around 800 cubic meters. The reservoirs were lined with white sandy plaster for waterproofing (Schram 2007).

It happens too often that a new, modern technology is introduced and pushes a historically proven technique aside. Amman has experienced this to some extent as they are no longer collecting and treating their own water but rather are provided water by the government through pipes and trucks. When working with water most systems are site specific, understanding the strengths and weaknesses of past techniques will provide an improved strategy towards harvesting water for Amman.

Constructed Dam Within Hills figure 5.08



Terraces Supporting Vegetation in Desert figure 5.09



Empty Reservoir figure 5.10



CASE STUDIES

figure 5.13 ::
Eco-Roof Study
Locations



CASE STUDY

Eco-Roof ::

HISTORY ::

Dating back to 500 B.C., one of the first documented green roofs was designed at the Hanging Gardens of Babylon. Buildings materials such as stone, wood, soil and sod promote the creation of ecological habitats. As earthen materials were used in places like Scandinavia, naturally, vegetative growth would establish itself providing habitat for insects, birds and micro organisms (Henderson 2003).

The builders' material choice was not determined by what would be beneficial to the environment, but rather, what would be most beneficial to them in terms of protection against the elements. Stripped sod from near grass meadows was placed upon birch bark, used for waterproofing, for better building insulation (Dunnet and Kingsbury 2008).

Europe, Germany in particular, began to appreciate values that the green roof concept had to offer. During WWII Britain used green roofs on military airfield hangers for camouflage (Getter and Rowe 2006, 1276). In the 1970's a German Landscape Architect by the name of Hans Luz stated that green roofs should become part of the urban fabric as a strategy to improve the quality of cities (Dunnet and Kingsbury 2008). In 1975, The Landscape Research, Development



& Construction Society was founded to provide green roof standards and technology (Metropolismag 2006).

The term green roof is commonly associated with any roof that is environmentally responsible, from 'cool' roofs to solar panels; accordingly the term eco-roof has been defined for specific roofs with vegetation (Dunnet and Kingsbury 2008).

figure 5.12 ::
Abstract Eco-Roof

Today the benefits of green roofs are better known and include their ability to improve flow rate and quality of stormwater runoff, conserve energy (figure 5.11), decrease urban heat island effect, increase biodiversity and habitat, and mitigate air and noise pollution.

AVERAGE TEMPERATURE / PRECIPITATION

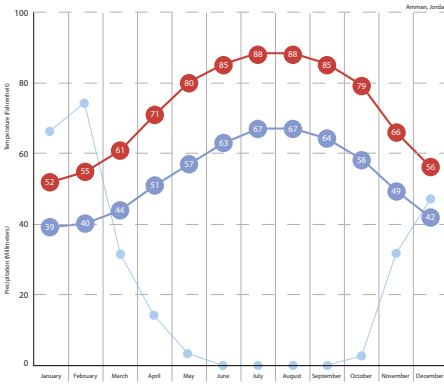


figure 5.14 :: Amman

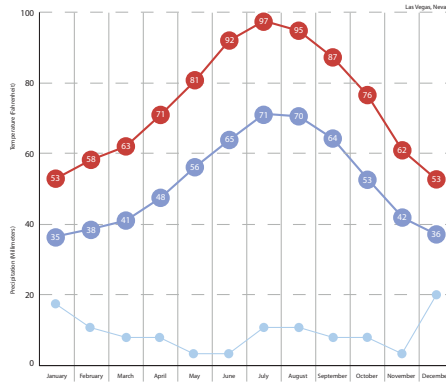


figure 5.15 :: Las Vegas

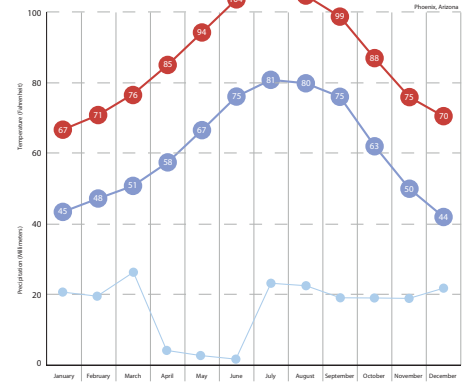


figure 5.16 :: Phoenix

PHYSICAL STRUCTURE (figure 5.12)

VEGETATION

Shallow-rooting grasses requiring little to no maintenance.

PLANTING MEDIUM

Often confused with soil, planting medium is normally a light weight, engineered, expanded clay with high mineral content.

FILTER LAYER

Holds soil medium in place while allowing flow of water. The filter layer can also act as a root barrier when treated with a root inhibitor.

DRAIN LAYER

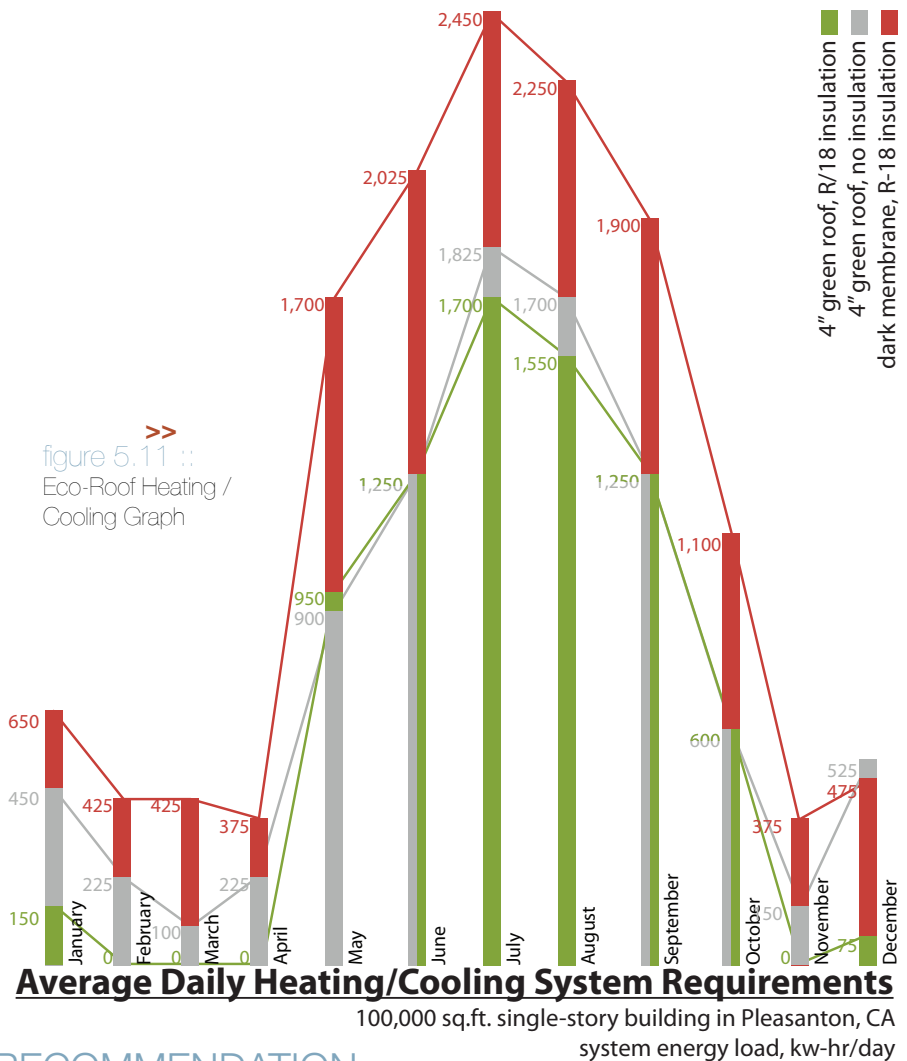
Usually around 20mm (0.8in.) thick, the drain layers allows for excess water to access the buildings' drainage system.

PROTECTIVE LAYER

Lightweight concrete, rigid insulation, plastic sheet or copper foil can aid in protecting the structural integrity of the building.

INSULATION

In hot climates roof insulation may not be required due to the efficiency of thermal protection provided by the vegetation, planting medium and drain layer.



RECOMMENDATION

After reviewing the use of eco-roofs in arid climates through the study of specific locations (figure 5.13) with similar temperature and precipitation rates (figures 5.14, 5.15 and 5.16), it was determined that this system is less than an optimum solution for the stated design goals of this thesis.

CASE STUDIES

figure 5.18 ::
Living Machine
Study Locations



CASE STUDY

Living Machine ::

BACKGROUND ::

The Living Machine was originally designed by Dr. John Todd to utilize ecologically-based components that treat and process waste water. The Living Machine has also been referred to as the “Advanced Ecologically Engineered System.” Based upon the same processes that occur in a natural wetland, The Living Machine has evolved into two types of systems, the Tidal Flow Wetland Living Machine and the Hybrid Wetland living Machine.

The Tidal Flow Wetland System was developed to produce more dependable results treating wastewater in a smaller footprint than conventional constructed wastewater treatment systems. The Tidal Flow Wetland System has four to six tidal flow cells that are alternately flooded and drained to attain desired

treatment level of wastewater. This process allows for aerobic treatment. The cells are watertight, covered with engineered media and planted with vegetation. Wastewater is kept below grade making the process odor free while also preventing any undesired animal and human interaction with wastewater (www.worrellwater.com 2007).

Hybrid Wetland System is the newest generation of Living Machine combining the Tidal Flow Wetland System with exterior horizontal wetlands. The system only requires two tidal flow cells, rather than the four to six that the Tidal Flow Wetland requires. The tidal flow cells still utilize the fill-and-drain process after receiving the wastewater from the initial treatment of an exterior wetland.

Both systems require less energy and cost (figure 5.17) than current wastewater treatment systems. The layout and plant selection of these systems is site specific. Living Machines, Inc. of Taos, New Mexico

now designs The Living Machine and markets it as a wastewater treatment system capable of achieving tertiary treatment; reduce emissions of greenhouse gases, which are an environmentally friendly, cost-effective competitor to conventional systems (www.worrellwater.com 2007).

In areas where water is in short supply, such as Amman, Living Machine Systems create opportunity to treat contaminated water for reuse in tertiary situations such as toilet flushing and irrigation applications. Living Machines offer lower energy costs than sludge systems, are aesthetically pleasing, environmentally friendly and improve public awareness through visual interaction and education.

Like the eco-roof case study, the advantages of Living Machines were documented through the study of existing Tidal Flow Wetland Systems within specific locations dependent on the systems scale and purpose (figure 5.18).

primary tank ::
flow equalization,
solid setting, and
filtering effluent.



tidal wetland cell ::
aggregate-filled with emergent plants for
nitrification.



disinfection ::
located in
mechanical room
and may include
ultraviolet, ozone,
or chlorination.



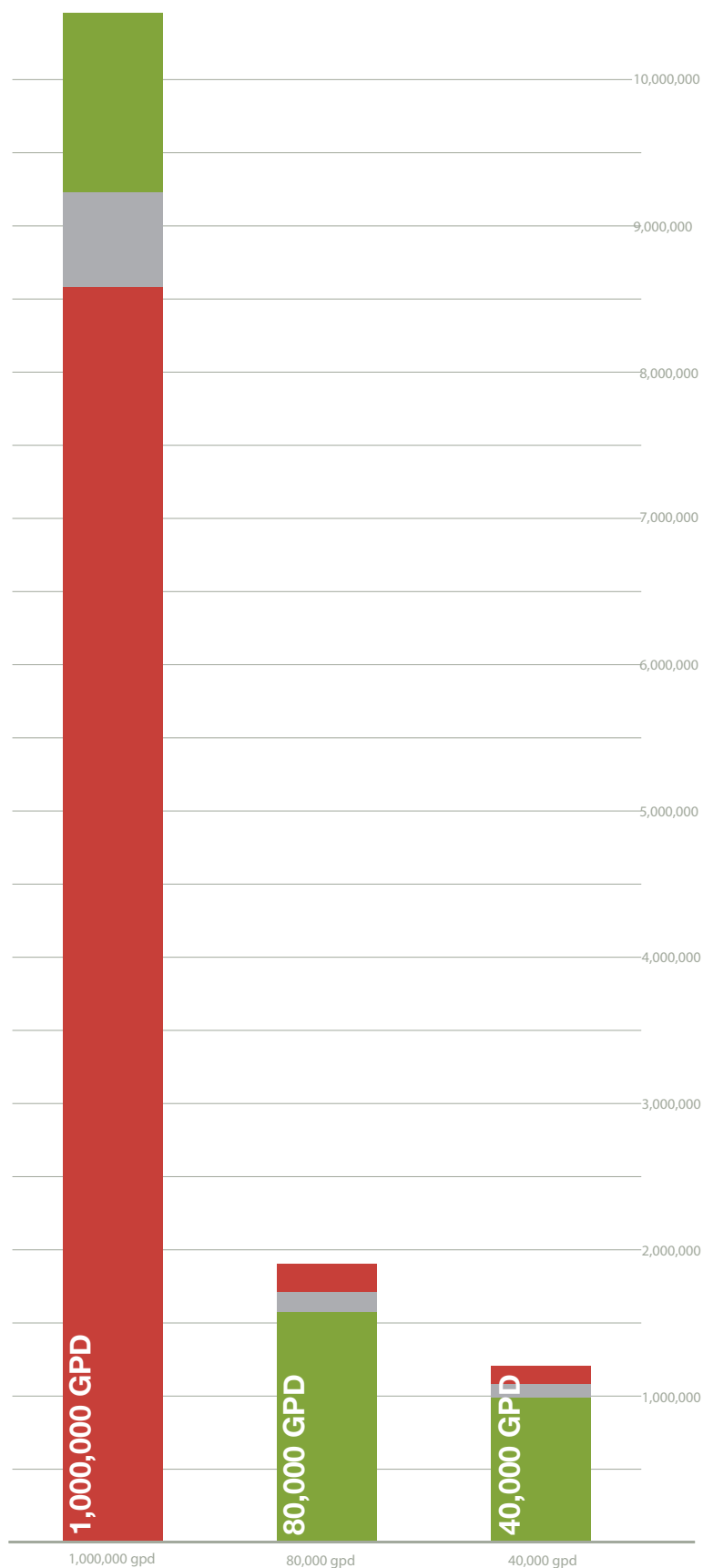
reuse storage tank & system ::
pressure tank for nonpotable reuse,
water supply for toilet flushing, disposal
or landscape irrigation, and subsurface
disposal.



figure 5.19 | Abstract Living Machine

Cost (U.S. Dollars) vs. Gallons per Day (gpd)

- "Living Machine" without greenhouse
- "Living Machine" with greenhouse
- Conventional System



BASIC PROCESS

Principle components (figure 5.19) adapted from Worrel Water Technologies, 2007::

COLLECTION SYSTEM

All wastewater from programmed sources are captured by a designed collection infrastructure intended to transport wastewater to the primary treatment system.

PRIMARY TREATMENT

Large solids, settling and floatable wastes, grit and other inorganic material are removed and treated in an interceptor tank to reduce risk of clogging. Upon separation of solids, wastewater is pumped to secondary treatment.

SECONDARY TREATMENT

Removal of total suspended solids (TSS) and dissolved organic constituents (biological oxygen demand, BOD). The wastewater is treated to remove TSS, BOD, nitrogen and phosphorus to lower levels. Further treatment maybe employed in disinfection step.

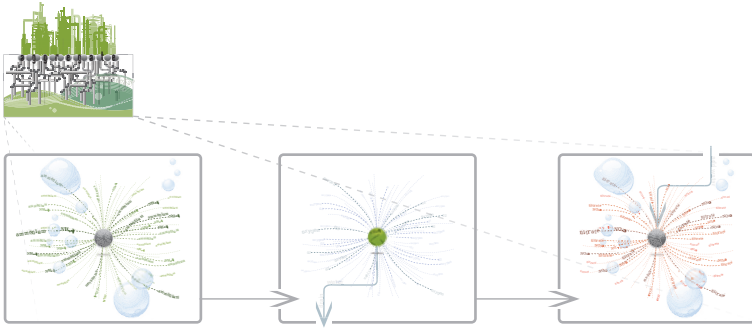
DISINFECTION

Additional pathogen removal can be accomplished through the use of chemical or physical based disinfection technologies.

REUSE OR DISPOSAL

Treated effluent is contained and reused for approved purposes.

figure 5.17 Cost: Living Machine vs. Conventional System



CASE STUDY

Living Machine ::

TIDAL WETLAND CELL PROCESS

Detailed Filtration Process (figure 5.20) adapted from Worrel Water Technologies, 2007:

STEP ONE

The tidal wetland cell is flooded with water. Ammonium ions (NH_4^+) in the water adsorb to aggregate surfaces.

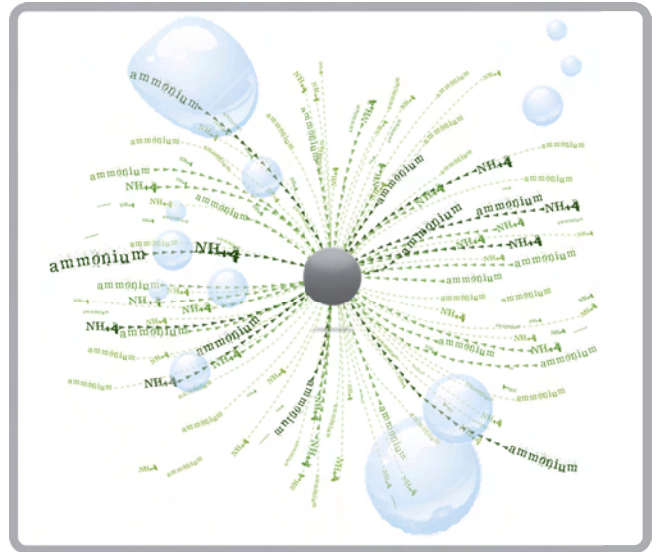
STEP TWO

The tidal wetland cell is drained of water. Adsorbed ammonium ions nitrify as oxygen saturates thin biofilms.

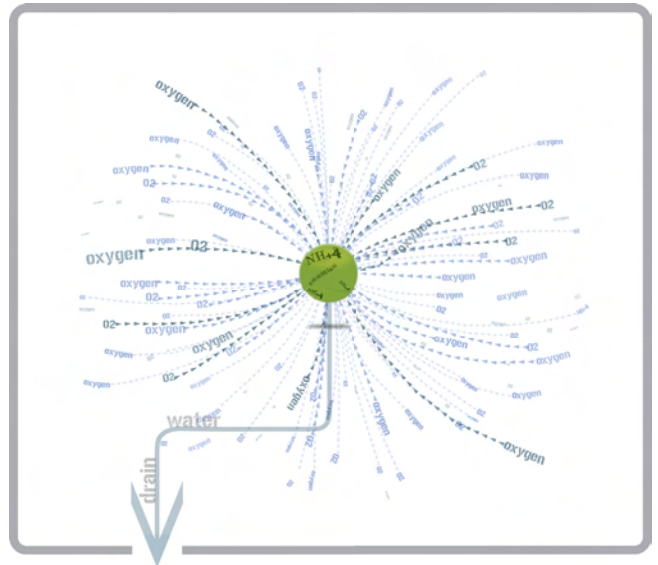
STEP THREE

The tidal wetland cell is once again flooded with water. Nitrated ions (NO_3^-) desorb into water and are denitrified by bacterial action and absorbed into the roots of vegetation.

STEP ONE



STEP TWO



STEP THREE

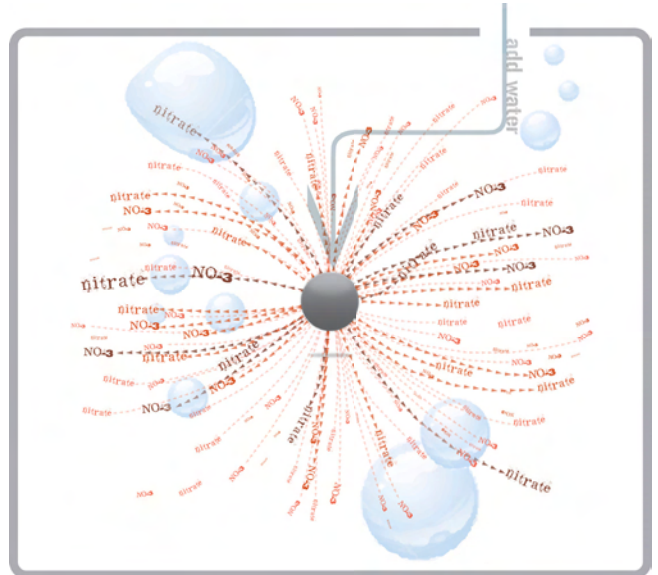


figure 5.20 ::
Detailed Filtration
Process

figure 5.23 ::
AC Recover
Study Locations



- San Antonio Texas
- Houston Texas
- Gulf Breeze Florida
- Atlanta Georgia
- Wauseon Ohio
- Dubai UAE
- Sydney Australia

CASE STUDY

AC Condensate Recovery ::

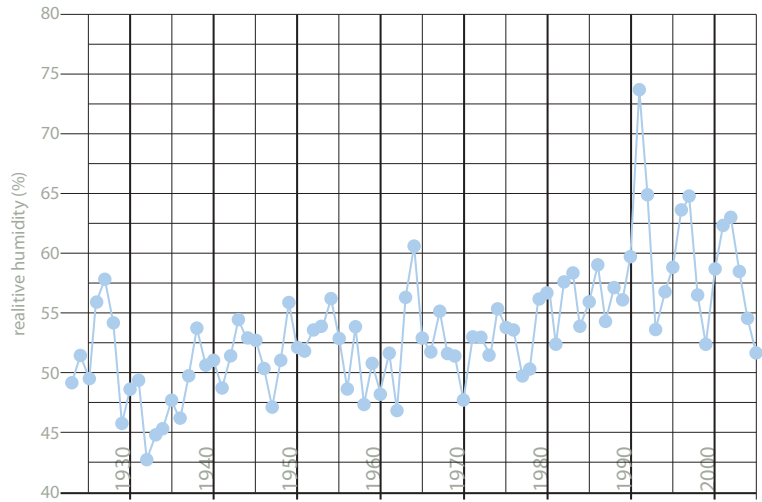
SIGNIFICANCE ::

Amman’s warmer climate requires that air conditioning must be utilized thorough extended periods of the year to maintain comfort levels within buildings. It might be feasible that the coil condensate collected from the entering air could have prospective uses ranging from irrigation to replacing evaporated water in cooling towers and water features (figure 5.21). The system works most efficiently with buildings that require large amounts of outdoor air to satisfy ventilation requirements (Friedman 2003).

ISSUES ::

- Distilled water won’t have important primary nutrients (Nitrogen & Phosphorus) Collected condensation will lack nutrients and have bacteria issues
- Dry climate may not produce sufficient volumes of water (figure 5.22).
- Possibility of salt content in water collected

figure 5.22 ::
Relative Humidity at Amman Airport (1923-2005)



RECOMMENDATION

After reviewing the use of AC Condensate Recovery in arid climates (5.23) it was determined that this system is less than an optimum solution for the stated design goals of this thesis.

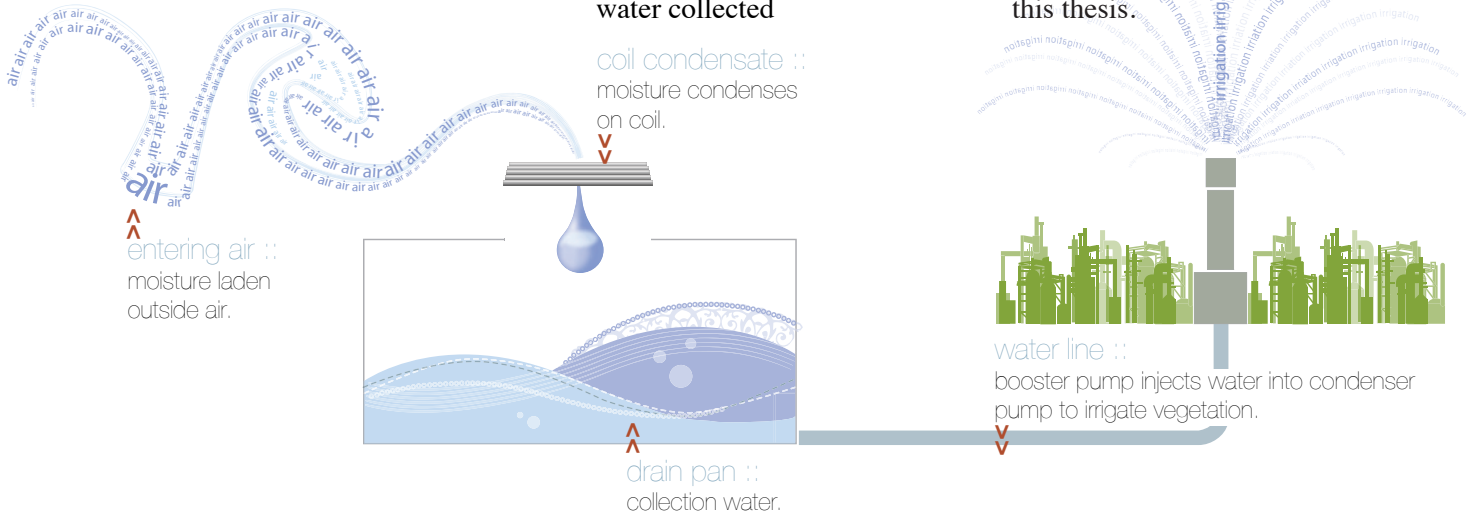


figure 5.21 Abstract AC Condensate Recovery Diagram

Section Six :: Inventory & Analysis

6



Regional Scale ::

figure 6.01

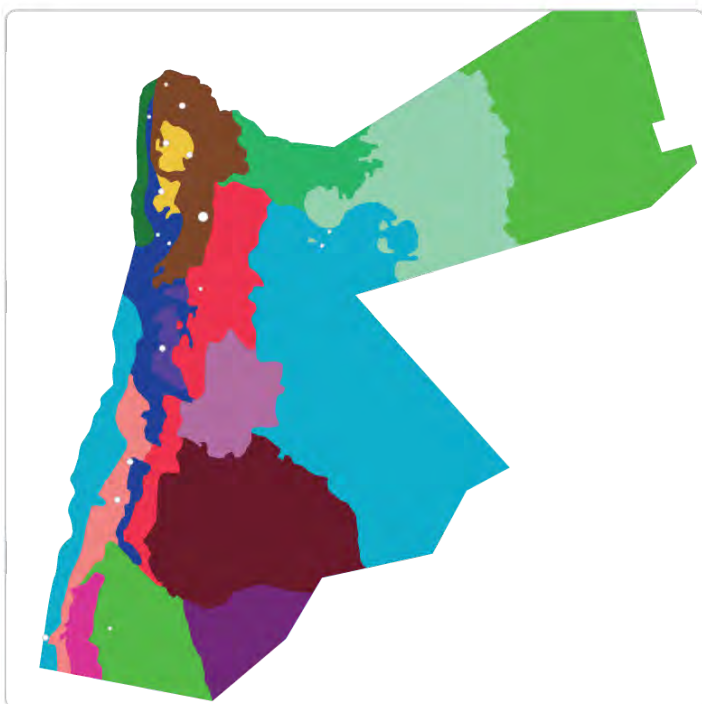


figure 6.02

SOILS MAP

Jordan has eighteen different soil types. At a regional scale Amman is located within the Northern Highlands Dissected Limestone land region. There are 16 total soil map units within this land region (figure 6.02).

Altitude Range: Sea-level to 1050m

Range in Precipitation: 250mm to 500mm

Natural Vegetation: Mixed woodland and tall unforested grasslands to the east. (University of Arizona 2008)

WATER RESOURCES MAP

Increasing population demands more potable water which leads to over pumping in the winter. Major fluctuation in the groundwater level can be attributed to human activity (figure 6.03).



figure 6.03

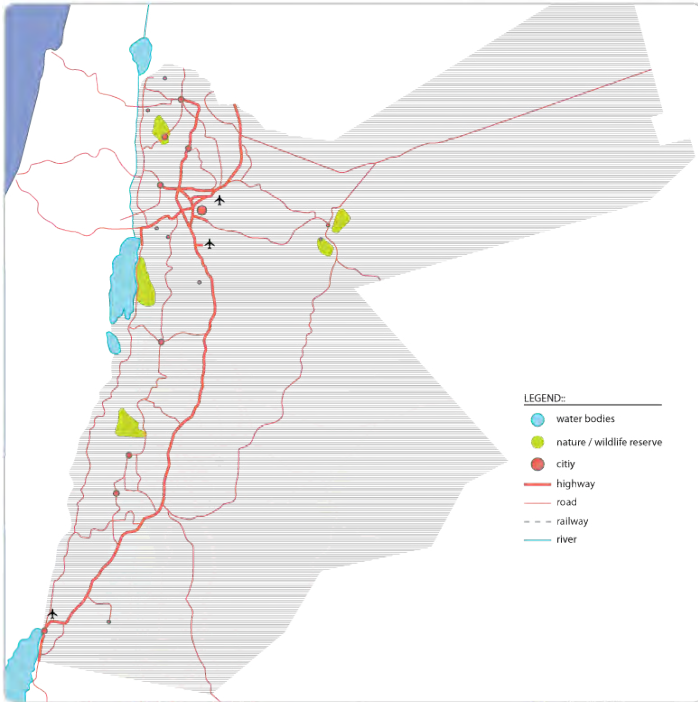


figure 6.04

CIRCULATION PATTERN

Based on existing infrastructure, all major modes of transportation (highway and rail) pass through or near the capital city making Amman an accessible destination from anywhere in Jordan. International access is possible through the use of the Queen International Airport south of Amman. To the north is Marka Airport (figure 6.04).

SURROUNDING CONTEXT

Amman is one of the largest cities to the east. Zarqa is north east, As-Salt is north west, and Aqaba is at the southern tip of Jordan (figure 6.05). All surrounding cities have rich histories. The Dead Sea (figure 6.06) is located only 35 minutes to the southwest. One of Jordan's most notable cities is Petra (figure 6.07). Located south of Amman, Petra is carved into the cliffs and has been titled one of the seven wonders of the world. Another tourist attraction is Wadi Rum (figure 6.08). The impressive desert landscape draws visitors from all over the world.

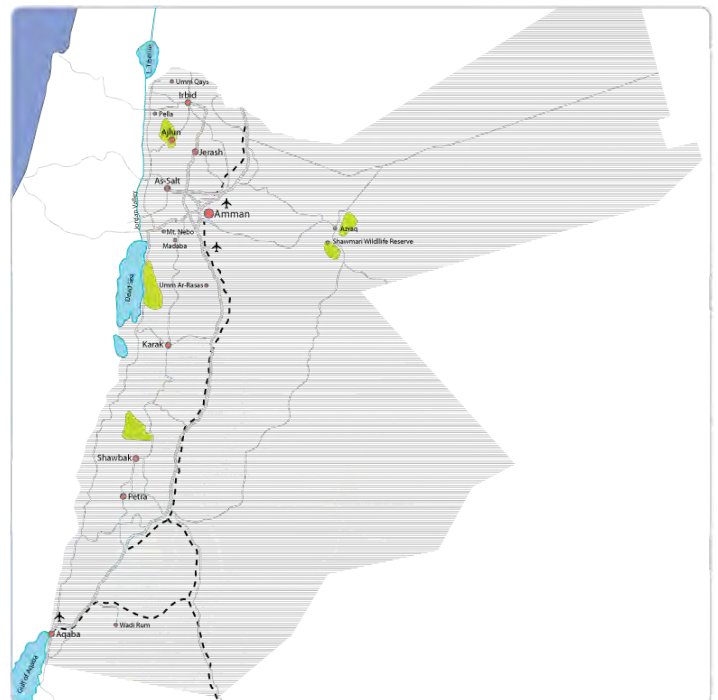
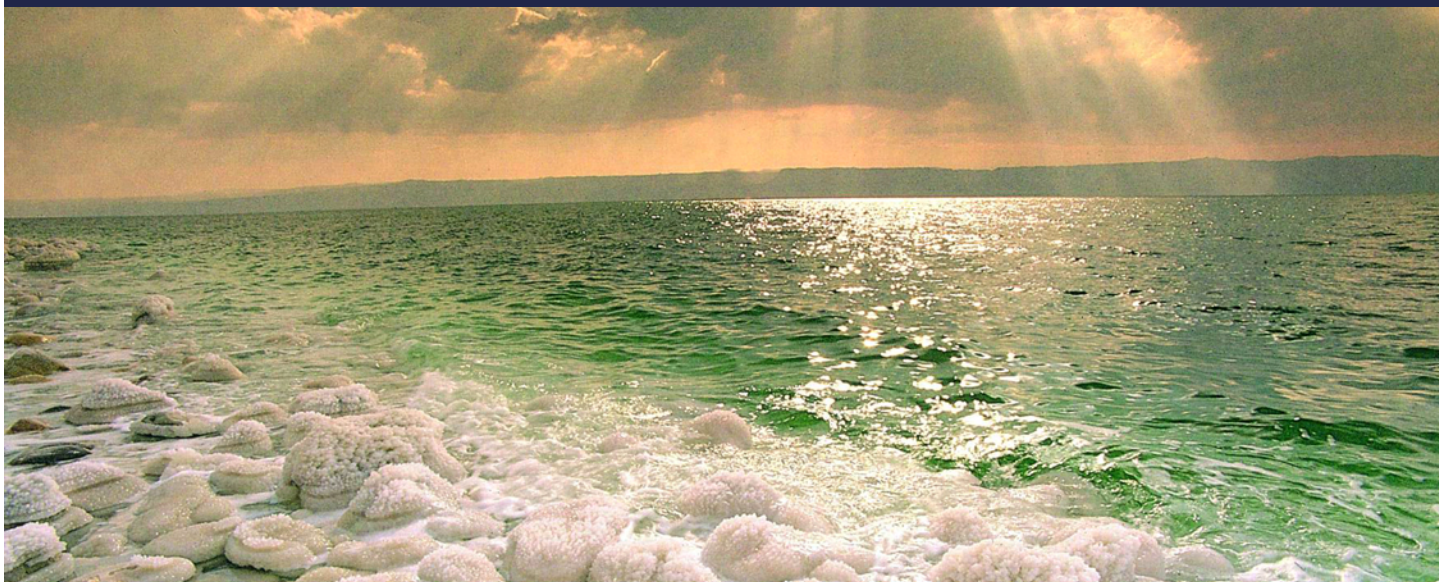


figure 6.05

Dead Sea

figure 6.06



The Monastery at Petra, Jordan

figure 6.07



Wadi Rum

figure 6.08





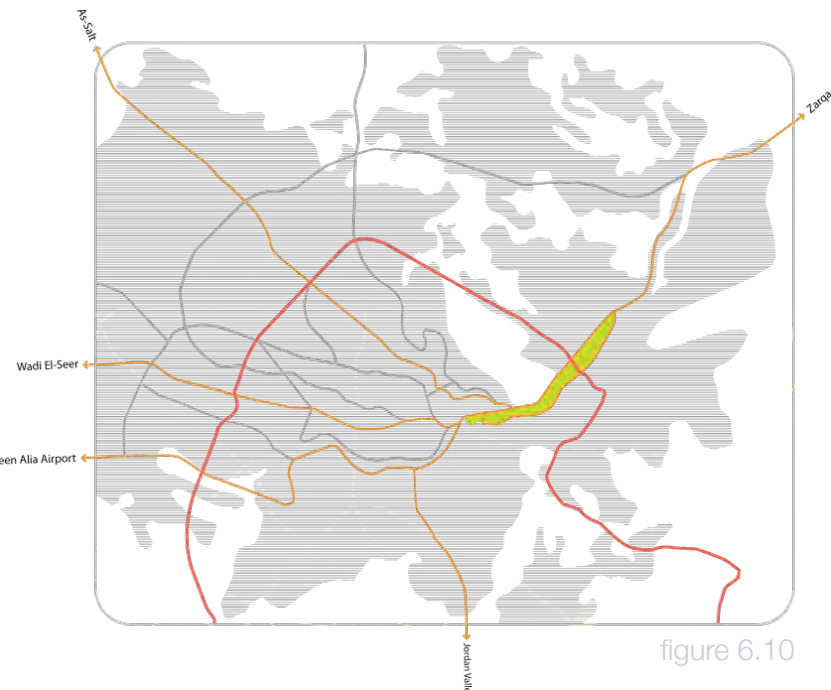


figure 6.10

CIRCULATION PATTERN

The existing primary circulation pattern divides the site into two sections. Secondary circulation runs along the northern and southern boundaries providing excellent vehicular access to the project (figure 6.10).

SURROUNDING CONTEXT

Located in the center of Old Downtown Amman the site is south of the Royal Palace Compound. To the west is the Al-Balad Downtown Market. The site acts as an entry gate into Amman from the east (figure 6.11).

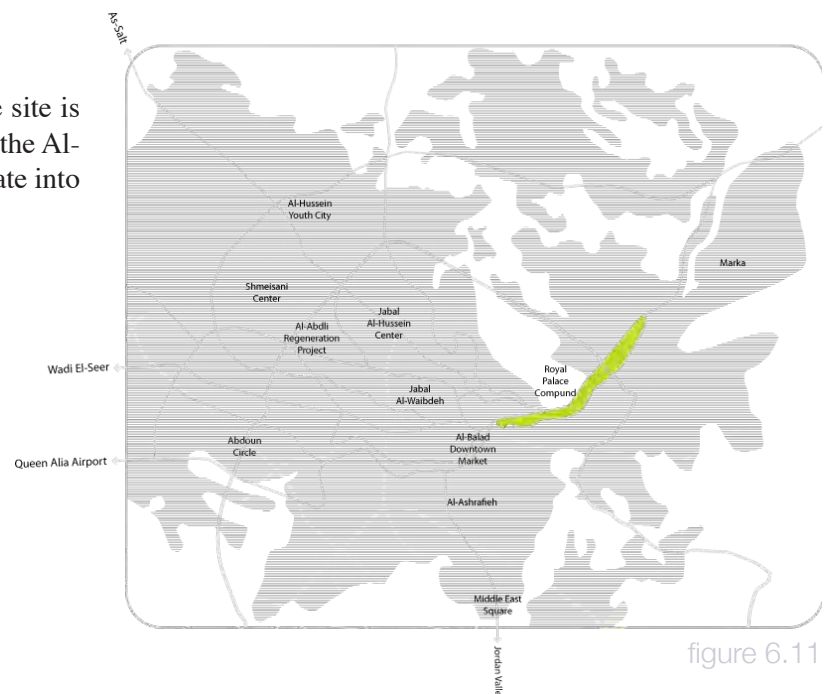


figure 6.11

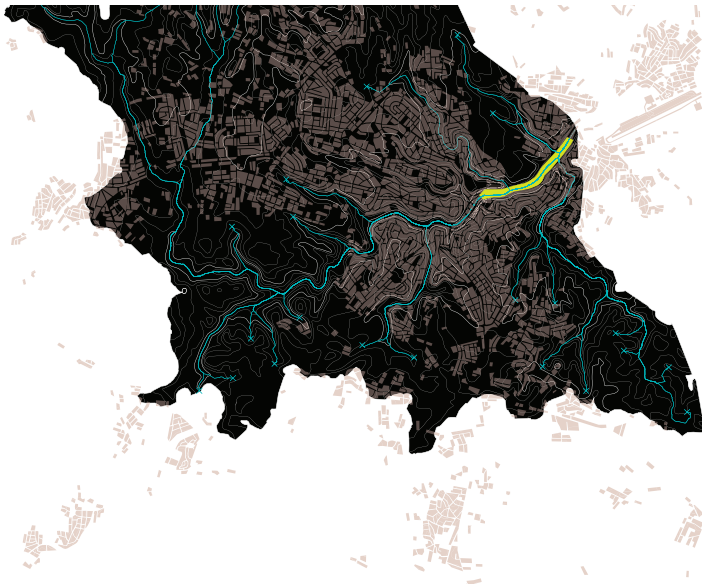


figure 6.12

WATERSHED

Amman is located at the beginning of a large watershed, with the site is located near the outlet of the watershed. The watershed is 31,771 acres (50 sq. mi.) in size (figure 6.12).

TOPOGRAPHY

Topography plays a large role in Amman. The city has very few flat locations, making this particular site unique. The natural process of erosion has provided flat land in the middle of Old Downtown Amman (figure 6.13).

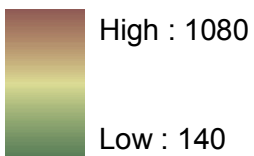
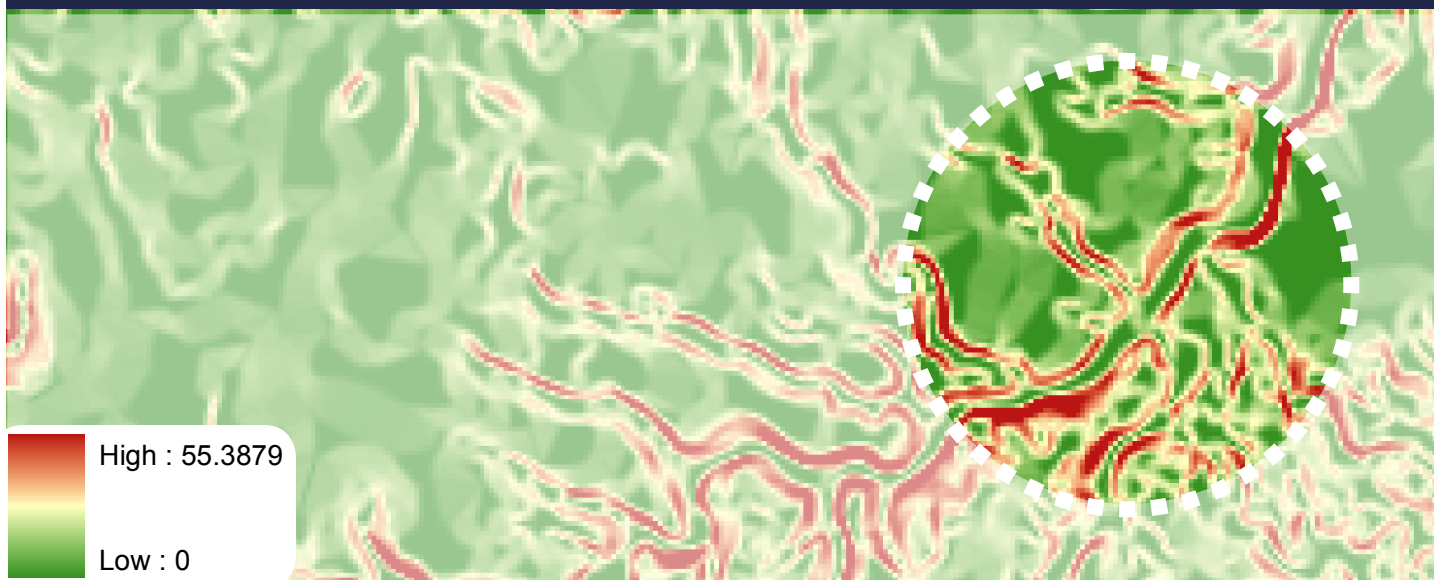


figure 6.13

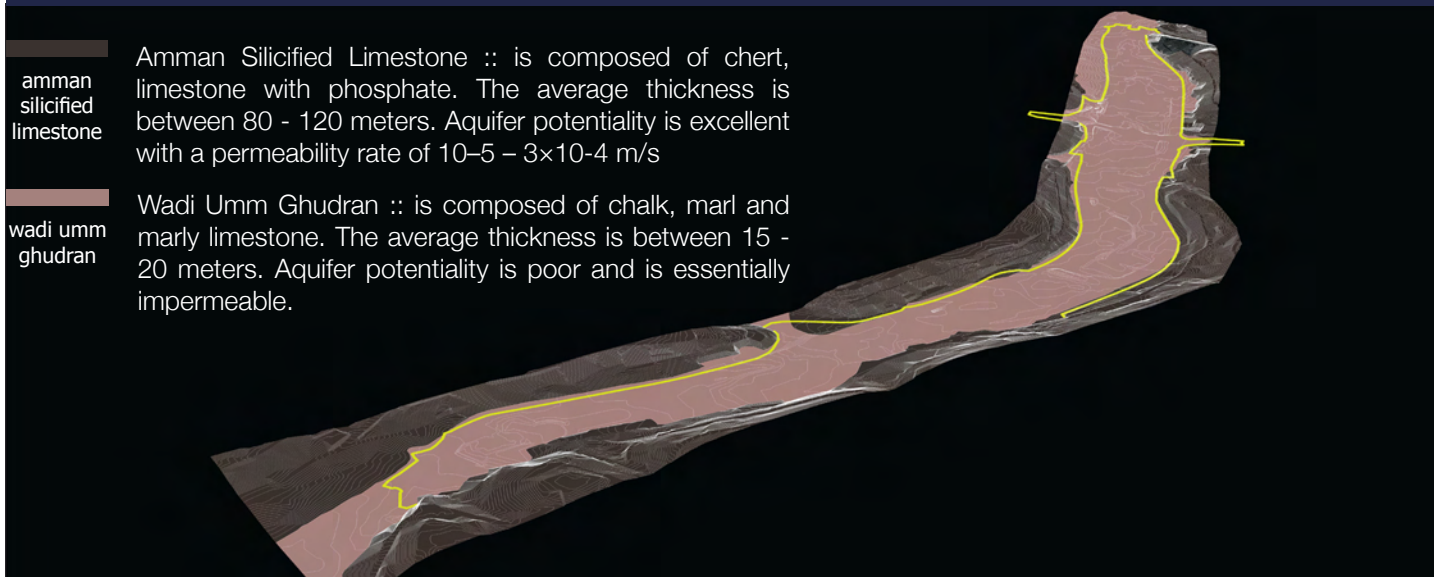
Slope

figure 6.14



Soils

figure 6.15



Weather Averages (1976 - 2005) | Adapted from Jordan Meteorological Department

figure 6.16

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg. High °C (°F)	3.2 (38)	6.5 (44)	12.0 (54)	18.7 (66)	23.6 (74)	25.5 (78)	27.1 (81)	29.1 (84)	25.5 (78)	20.5 (69)	13.7 (57)	9.2 (49)
Avg. Low °C (°F)	-3.9 (25)	-1.5 (29)	3.6 (38)	5.2 (41)	9.2 (49)	14.5 (58)	19.7 (67)	18.4 (65)	13.6 (56)	8.5 (47)	5.3 (42)	1.5 (35)
Avg. Rainfall mm (in.)	171.9 (6.7)	99.7 (3.9)	76.0 (2.9)	45.3 (1.7)	14.1 (0.5)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	36.3 (1.4)	55.2 (2.1)	97.0 (3.8)



CIRCULATION PATTERN

The diagram defines areas that are suitable (green) for pedestrian activity when considering vehicular noise pollution and traffic. Vehicular noise pollution was determined by locating vehicular access points, major intersections, and vehicular traffic volume by road type. A factor that is omitted is the effect of building height acting as a buffer for interior spaces (figure 6.18).

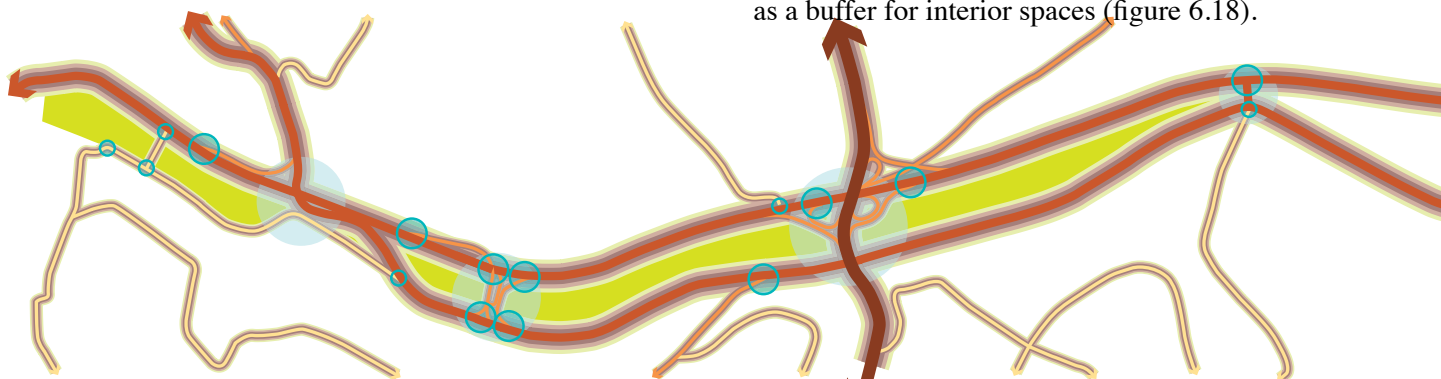


figure 6.18

DETAILED SOIL MAP

Grain distribution of clay, silt, gravel, and sand make up the dry wadi bed. The diagram to the right shows the suitability of soils based on grain size distribution, specifically analyzing the percentage of clay in specific locations throughout the site. Dot size relates to the percent of clay. The smaller the dot the higher the suitability for implementation of green infrastructure (figure 6.19).

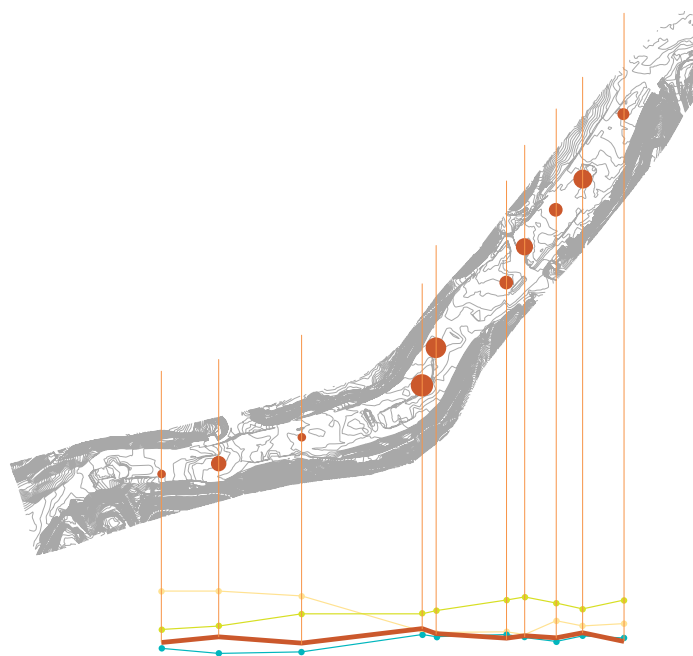
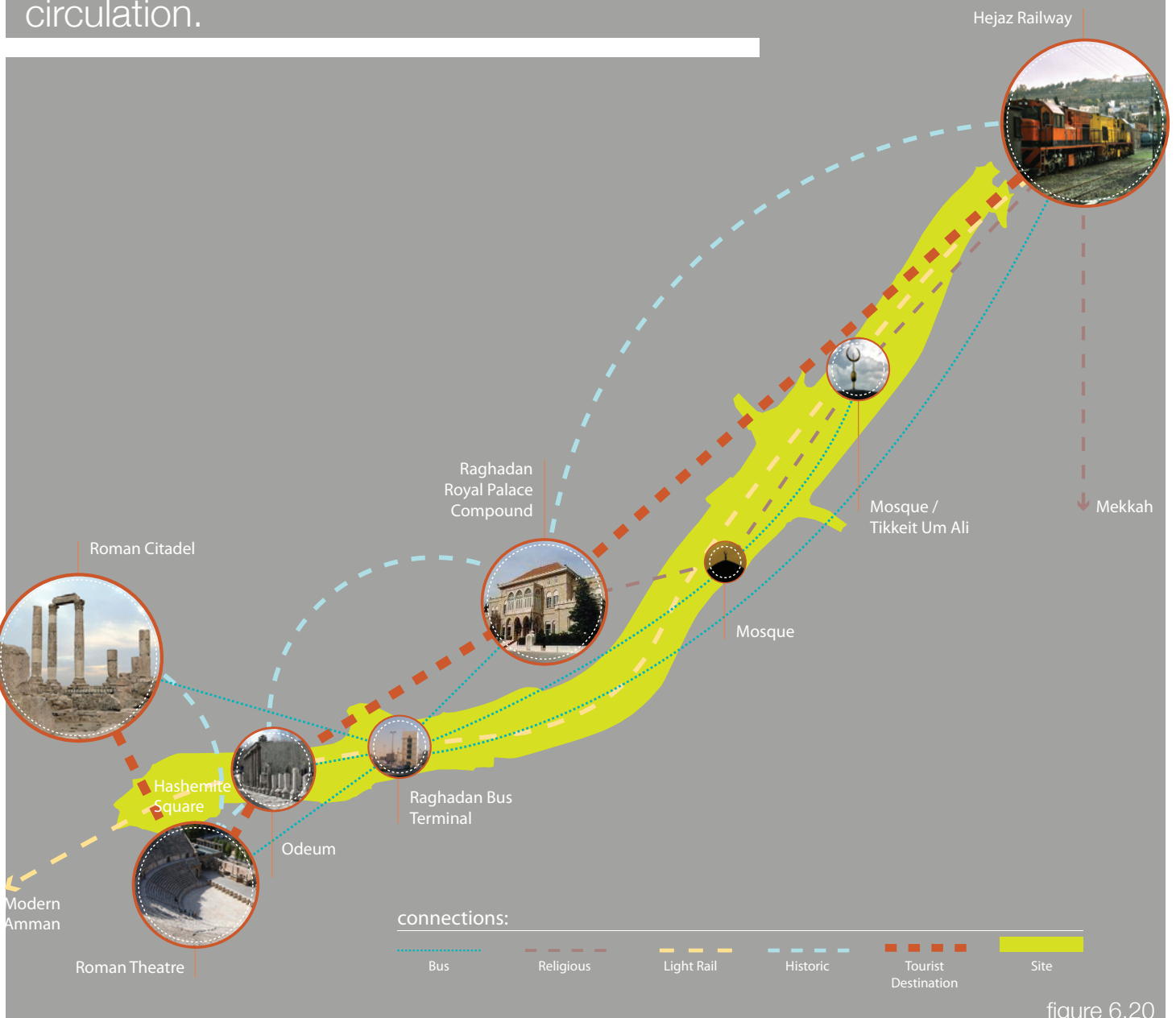


figure 6.19

This diagram shows the potential for existing landmarks located adjacent to, and on the site providing a frame work for the shaping of pedestrian and public transportation circulation.



Connections :: Bus, Light Rail, Religious, Historic, Tourist Destination

The proposed development is bursting with rich archaeological landmarks (figure 6.20). The western quarter of the site provides a glimpse to the past when Amman was the Roman city of Philadelphia. Just north, the Roman Citadel rises above the site providing breath taking panoramic views over Downtown Amman (figure 6.23). South of the Citadel three tiers are carved away from one of many hills to create a beautiful Roman Theatre with the ability to seat 6,000 individuals. On occasion the theatre is still used as a gathering point for celebrations and plays. The theatre looks out over the Hashemite Square which acts as a transition space to the Odeum (figure 6.24). Probably built first, this smaller theatre can seat around 500 individuals.

Located near the middle of the site to the north, an unusual green buffer elevates along the highway. The large open space within Amman's dense urban city fabric defines the boundary of the Raghadan Royal Palace Compound. This historical complex boasts beautiful architecture and is still the home of the royal family.

Offsite at the northeast quarter of the site is the historic Hejaz Railway. The railways original purpose was to establish connections between existing cities with the terminus being the holy city of Mecca.

IEWS + TOPOGRAPHY

Amman's hillside landscape provides opportunities to strengthen views outward towards existing landmarks (figure 6.21). From the slopes, it provides views into designed spaces showcasing the project to the rising hills around it. Most views are near the west end of the site. There is a 26 meter change in elevation from the surrounding context to the site. Although there are steep slopes, the fact that the project site is located in a dry riverbed lends itself to pedestrian traffic and markets (figure 6.25).

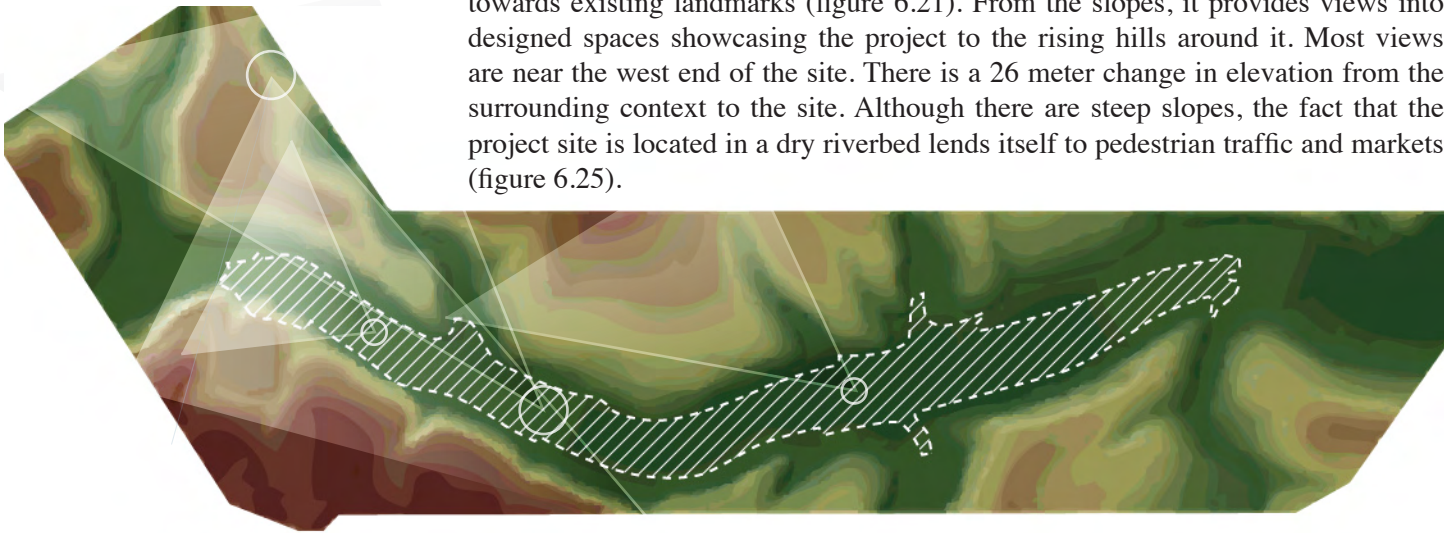


figure 6.21

PLANTING

The selection of trees was determined by two set factors that all tree species must meet with the addition of one or more other specified factors. For a tree to be considered for selection it was a necessity that it withstand clay soils and drought (CSBE 2009). Upon passing the first two factors (clay soils & drought tolerance) the tree then was required to provide at least one of the following: shade, flower producing, or native / cultural value (figure 6.22).

	<i>Callistemon viminalis</i>	<i>Casuarina equisetifolia</i>	<i>Elaeagnus angustifolia</i>	<i>Ficus microphylla nitida</i>	<i>Lagerstroemia indica</i>	<i>Melia azedarach</i>	<i>Pinus halepensis</i>	<i>Quercus coccifera</i>	<i>Schinus molle</i>	<i>Sophora japonica</i>	<i>Ulmus glabra</i>
shade		+	+	+		+	+	+	+	+	+
flowers	+		+		+	+				+	
native / cultural			+				+	+			

figure 6.22

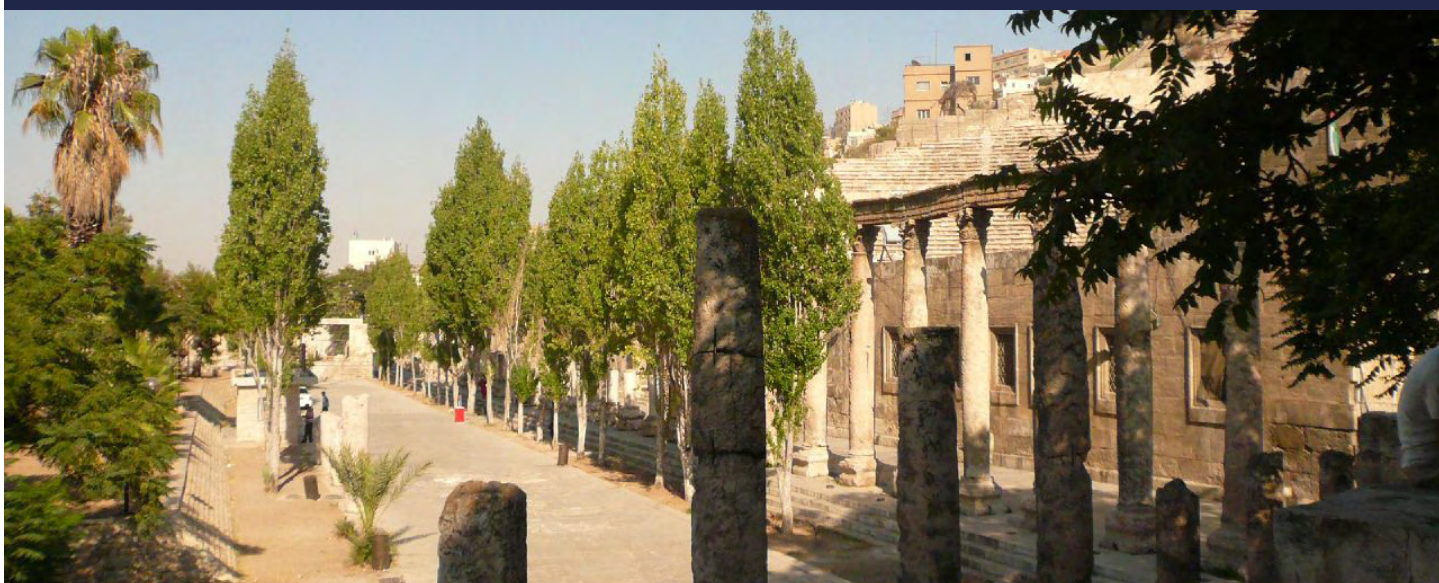
View from Citadel to Old Downtown Amman

figure 6.23



Hashemite Square

figure 6.24



Amman Market

figure 6.25



Analysis Conclusions ::

Amman is an arid environment that receives little rain each year (figure 6.26). It is located over an underground aquifer that fluctuates with the seasons. The stress on this aquifer is largely due to the water requirements of the swiftly expanding population of the city above. Amman, however, is located within a 50 square mile watershed with the watershed's outlet point being close to the east end of the subject project site. There is more than 26 meters of grade change from the project's low point to the top of the adjacent hills. Steep slopes surrounding the site, some in excess of 55 degrees (figure 6.14), act as a funnel directing all runoff from down the slope into the project site.

Steep slopes are the result of the limestone hills that slowly have eroded over time. The river bed soil type is classified as wadi umm ghudran which is highly impermeable making it a very poor aquifer potentiality, meaning that it is very impermeable. Further analysis to the project site revealed four to five locations on site where the soil contained far less clay than the surrounding context, allowing for a better chance of permeability. Soils located outside the boundaries of the site are considered some of the best in Jordan, being noted for their ability to sustain mixed woodland and tall un-forested grasslands.

The soil types in the surrounding region lend themselves to a potentially broader plant template. Plants that should be utilized are ones that are clay soil and drought tolerant so as to thrive in the conditions found in the old river bed. In addition, the plants should have aesthetic and/or cultural value as well as providing shade to enhance the pedestrian experience throughout the site.

Jordan's rich history, culture and unparalleled landscape make Amman a desirable location for tourist. Visitors to the site will come from all over the world due to the location of Amman which provide easy access to anywhere within Jordan from the Capital City. All major vehicular circulation paths come through, or touch, the edges of Amman. The historic city of Petra, one of the Seven Wonders of the World, is located to the south and is easily accessed from Amman. The Dead Sea, located to the southwest is only a thirty minute drive from the city limits.

The project site contains the remnants of the historical city of the original Roman settlement, Philadelphia. The west edge of the site is adjacent to an existing roman amphitheater, the Odeum, and Hashemite Plaza (figure 6.27). A strong, unimpeded connection between the site and the historical elements will act as a gateway into and out of the project site.

The existing conditions of the circulation on and adjacent to the site provide great potential for access and visibility into the project site. A major highway runs along the northern edge

of the site with multiple exit ramps for vehicles to loop around to the southern road and access the project site.

Due to the narrowness of the site, providing only pedestrian access to the interior would provide for a safer, more satisfying pedestrian experience (figure 6.28). The implementation of public transportation could further enhance the experience through the site. The west end of the site is near the historic Hejaz Railway, which being located at the far west boundary of Old Downtown Amman, should be considered for the potential of being the transportation hub heading east through the site and into New Downtown Amman.

All the above regional, city and site scale factors are considered throughout the entire design process. The design will determine ways to relieve stress on the aquifer through the implementation of a strategic landscape and site design treatments and will include the use of gray water systems for use in the proposed buildings within the project site.

Regional Landscape figure 6.26



City Landscape figure 6.27



Site Landscape figure 6.28



Section Seven :: Program

7

Program ::

The Middle East faces a number of major issues, such as, rapid population growth, diminishing natural resources, congested traffic, and lack of potable water. The location of this project provides opportunity to act as a catalyst site, responding to current problems and providing a blue print for improving the quality of life in arid communities with limited natural resources.

The program will address potential design solutions to Amman's largest problem, lack of water. The implementation of strategically placed systems in combination with understanding and addressing social factors will result in a successful range of alternatives to the stated problem.

Systems located at ground level should be simple and natural, seamlessly integrated into the social fabric of spaces. Ground level harvested water should be celebrated, and experienced by pedestrians. Creating a participatory landscape that can be experienced on a daily basis will naturally bring life and activity to the site.

Introducing shade will aid in cooling the hot summer air and invite pedestrians to relax and enjoy the landscape. The shifting organic shapes created by the shade structures throughout the day coupled by strategic water features create the potential for a dynamic landscape that is always changing. The surroundings of a large pedestrian pathway will change with the seasons, guiding pedestrians through the rich history that the site rests upon.

PROGRAM

GOALS TO ADDRESS

- Public Transportation
- Designed Pedestrian Network
- Provide Parks
- Provide Open Space
- Reuse of Stormwater
- Pedestrian Access to Water
- Pedestrian Connectivity
- Accessibility
- Preserve Cultural Heritage

PROGRAM GOALS

There are three different organizational goals involved with the project. All primary goals defined by each organization are shown. Larger words represent the importance placed on a particular topic by an organization. The “goals to be addressed” section combines similar goals between organizations in gray. In addition to similar goals, certain organization specific goals are deemed important to the project and are present in the common goals section (figure 7.01).



figure 7.01 Program Goals

Section Eight :: Design

8

Design ::

Water is an enchanting element of design. It has the ability to captivate awareness in various forms. Motionless or moving. Rising towards the sky or falling towards the ground. People are innately attracted to water. It provides nourishment to life, and historically a key necessity around which settlements occur.

The Seil River once surged through Amman, carving away at the arid limestone hills. Romans who settled in the flat river valley utilized fertile soil and proximity of water to grow their crops. Over time the river diminished as the surrounding city continued to grow.

The project site is long passed the old days of growing crops, and is now planted with Roman landmarks, mosques and auto repair shops. The hills are no longer shaped by the flow of water, but rather the curves of highways and roads. Water that would once have flooded the valley is now directed into drains. Rapid increases in population density without proper planning further stresses existing infrastructure. The hills of Amman are covered with analogous architecture that rolls off into the distance. New constructed buildings continue to displace open space with impervious surfaces increasing runoff velocities towards the project site.

Historically the flat roofs of Amman were used to harvest water that would be retained in cisterns. Fewer people are using this proven technique and instead rely on the city to provide water to them. To deliver all the water required by the city causes massive fluctuations in the water table as underground aquifers are pumped. Office, retail and large residential buildings should be utilizing gray water as a viable source of water for restrooms and irrigation use. Gray water should not be used for water features in order to protect pedestrian health. This poses a constraint when determining how to provide for water expressions throughout the site. A study of historic islamic water features, such as Alhambra, was executed to better understand how water has historically been expressed in arid climates. It was determined that the most common expression of an islamic water feature was through the use of a runnel that was narrow and deep. This specific type of water expression minimized the surface area of the water with a depth that would not rapidly evaporate. At Alhambra there is the more common narrow water feature, but there are also two larger reflecting pools. The findings at Alhambra provide evidence that there are specific situations that would allow for large reflecting pools to be considered based on the importance of the space they were located within.

Water is a scarce and precious resource. As this resource is depleted the people of Amman are looking for solutions as to how they can continue to live in this arid environment.

The project responds to the current issues that Amman faces with respect to historical uses of water and the culture that depends upon it (figure 8.01). The design concept looks at the progression of water and how it could shape a conceptual master plan to create a vibrant pedestrian corridor while maintaining the importance of utilizing water strategically.

Establishing a walkable pedestrian environment, highlighting historic landmarks on and off site, and employing strategies towards sustainability with a focus on water are the guiding principles found throughout the design.

The location along a dry river bed provides the opportunity to take advantage of the naturally flat passageway within a city that is otherwise hills. To strengthen the vision of developing a walkable pedestrian corridor, vehicular access will be limited to the southern boundary of the site along King Abdullah Road. No vehicles will be permitted into the corridor providing increase safety to pedestrian movement while allowing for an uninterrupted landscape to connect the three districts.

The pedestrian experience is further enhanced with directed views to historical elements on and off site through the use of landscape features. Strengthened views yield more visible site lines through the addition of planting directing the pedestrian's eye through the site. In addition to strengthening views, planting has the ability to aid in the implementation



figure 8.01

of sustainable strategies. Treatment of water at the point of entry on site will allow plants to collect large debris before the water reaches the collection point for water harvesting.

Water conservation is key, and the strategic use of water is imperative to the design. Water collected using architecturally conscious building designs will be filtered and held in cisterns on site (figure 8.02). In addition to water harvesting, the amount of sun that Amman experiences suggest that the use of solar voltaic cells placed on roofs can provide renewable power and move the city towards a more sustainable model.

The design begins with the historic Seil River. The symbolic Seil River moves up and down through the landscape, represented by a wall, inlaid and drops below grade as a runnel. The references to the Seil River glides through the landscape of the site tying each zone to the next.

Turf mirrors the motion of the Seil River representing the life that the river brought to this arid environment. As vegetation moves further from the wall the bands of vegetation changes into a xeriscape acting as the transition zone to the compacted sand. The vegetative banding is not all the same width as it moves through the corridor. The forms that the vegetation takes are expressive of the forces that flowing water would exert by pushing larger sediment to the banks of the Seil River (figure 8.03). The banding represents the natural evolution of a river bed. The planting

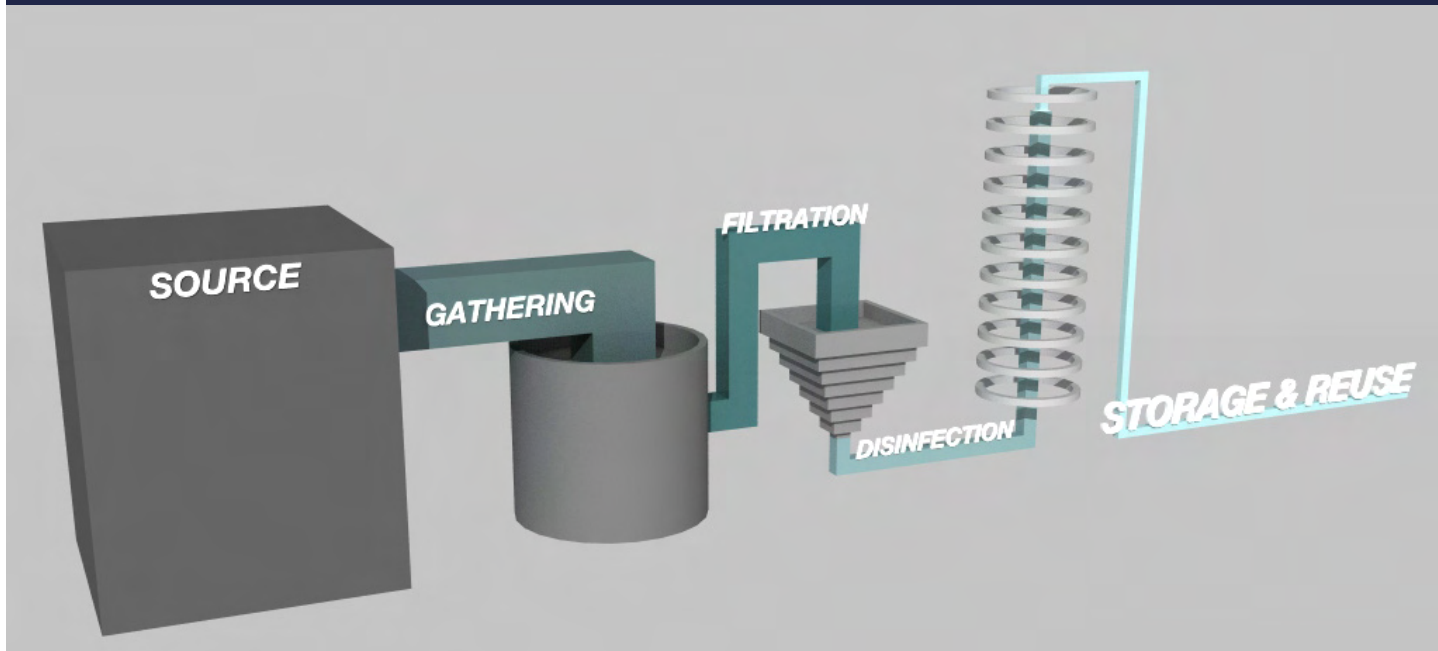
is representative of how a river would sort grain sizes from fine mud, sand, gravel to larger boulders. The greater forces along the cutbank of a river are represented by larger planting with a larger variety of plant types representing the affects of turbulence. Inner sections of a curve designate the location of deposits of smaller sediments.

Compact sand will be used for circulation in addition to providing opportunities for program elements within the corridor. In Amman it is common for markets to be on the streets and for people to gather outside a mosque before or during prayer. These spaces have the ability to accommodate programs from small everyday activity to large weekly events such as lively markets.

Within the conceptual master plan three sites were further explored as prototypes for the project (figure 8.04). The site locations are specific to research of surrounding topography, with specific consideration of infiltration points through soil analysis, and cultural relevant existing structures on site. The designs are comprised of components that act as building blocks for each space. These components address the ecological, social, and aesthetic functions of the design with the goal of multiple individual components being applied through the entire corridor.

Gray Water Diagram

figure 8.02



Plants + Textures

figure 8.03

Planting is inspired by a river's ability to move and sort sediment. Larger debris is pressed against the outside edge of the river. Layering of plants and textures will provide a more enhanced pedestrian experience.



Conceptual Master Plan ::

WADI PHILADELPHIA

WADI RAGADAN

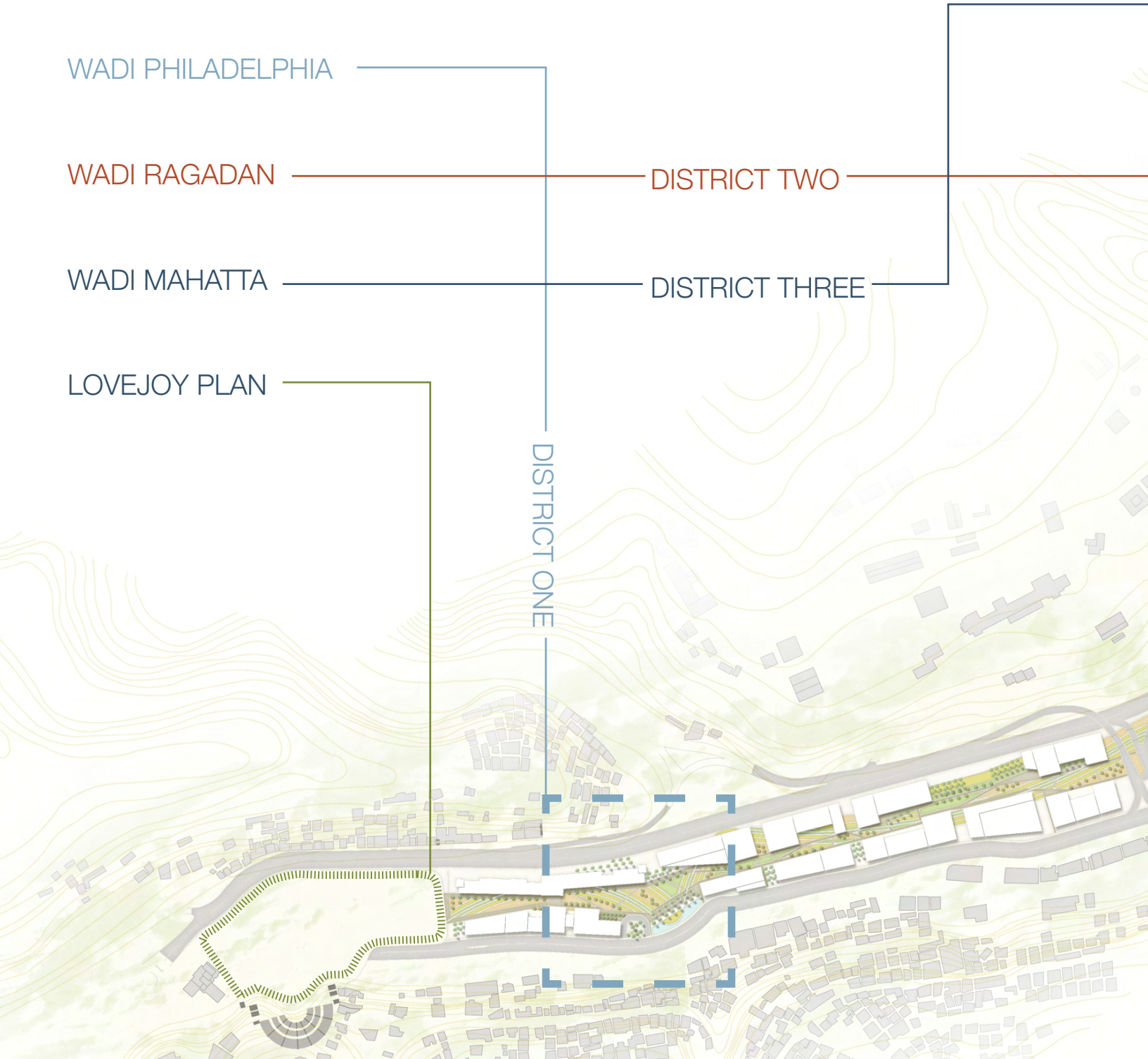
WADI MAHATTA

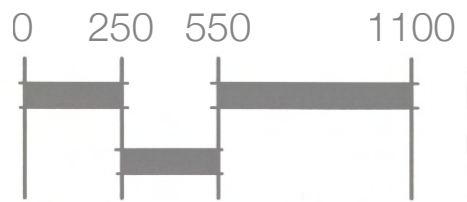
LOVEJOY PLAN

DISTRICT TWO

DISTRICT THREE

DISTRICT ONE





SCALE 1" = 550'

figure 8.04 | Conceptual Master Plan

Wadi Philadelphia ::

Within Wadi Philadelphia (District 1) there is minimal turf in an effort to reduce water requirements (figure 8.06). The project is set in a dry riverbed with steep slopes rising quickly at the site's edges (figure 8.05). This area is the primary drop-off for the two hotels and the main access to the Lovejoy design for the Hashemite Plaza. The water feature located near King Abdullah Road announces the presence of the drop-off area and entrance to the site. The Seil River wall cuts through the fountain allowing for signage to be posted facing King Abdullah Road and for planting to provide a backdrop resulting in less water required for this specific water feature (figure 8.07). To reduce exposed surface area of the water feature, recycled glass is incorporated into the fountain design. The entrance fountain also utilizes recycled glass to help minimize the surface area of the water.



LOCATION MAP



figure 8.05 | Wadi Philadelphia Section

figure 8.06



figure 8.07 | Wadi Philadelphia

Wadi Philadelphia ::

DESIGN COMPONENTS



BUILDING TYPOLOGY

Image represents materials and architectural style of hotel structures (figure 8.08).

ECOLOGICAL FUNCTION

GRAY WATER

Wadi Philadelphia focuses on the reuse of gray water within retail structures. Smaller structures will share a filtration system and holding tank for the reason that their individual water use is lower than an office or residential structure. Gray water systems will reduce the demand for city water, reducing cost for the retailer and stress on aquifers.

WATER HARVESTING

Wadi Philadelphia focuses on the potential for small retail structures to capture water from rooftops to be collected in cisterns for reuse.

INFILTRATION

Water infiltrates the turf, vegetative strips, and permeable paving. Permeable paving can be utilized under trees where heavy pedestrian traffic is expected.

WATER FEATURE

Medium size water feature can be minimized through the integration of planting and recycled glass. (Reference Figure 8.09)

SOLAR COLLECTION

Photovoltaic cells are located on roofs to aid in renewable energy production.

NATIVE MATERIALS

Materials are native to the region reducing green house gases due to shorter transit distances for delivery.

SOCIAL FUNCTION

GATEWAY

Wadi Philadelphia is the main pedestrian entrance from the project into Hashemite Plaza. Large programmable hardscape plazas have the ability to withstand heavy pedestrian traffic. (Reference figure 8.09)

SHADE

Shade plays an important role in Amman. Tree canopies cover gathering spaces that provide seating. Shade over compact sand can provide a more soothing experience for public markets and outdoor events.

LAWN

Wadi Philadelphia uses an intermediate amount of lawn, more than Wadi Ragadan but less than Wadi Mahatta. The amount of lawn allows for passive recreation and smaller lawn games such as bocce ball. (Reference Figure 8.09)

RETAIL

Retail attracts residents, locals and tourist from on and off site to shop, dine and gather. Wide sidewalks accommodate pedestrian traffic comfortably. (Reference Figure 8.09)

MARKET

Markets are common in Amman. Compacted sand and permeable paving allow for vendors to setup off the primary pathways and attract large groups of people. (Reference Figures 8.09)

AESTHETIC FUNCTION

APPROACH

Visible signage and way-finding elements are utilized through the use of the water feature and Seil River wall signage. Both announce the vehicular access to the site along King Abdullah Road.

SHADE

Canopies are used for comfort from the heat but also as a design element that changes with the sun creating dynamic patterns on the ground at the pedestrian level.

LAWN

Green lawn contrasts against compact sand and xeriscaped plants giving a subtle hint of an oasis. (Reference Figure 8.09)

WATER FEATURE

Water is utilized as a way-finding element and cools the walkway to the east hotel. (Reference Figure 8.09)

PLANTING

Planting types relate to place and culture. The banding of plants through the center of the corridor pull pedestrians through the space. (Reference Figure 8.09)

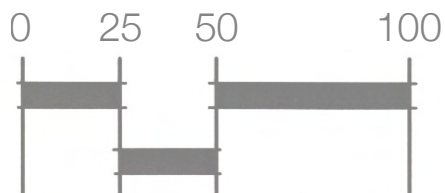
NATIVE MATERIALS

Materials are native to the region increasing the sense of place and culture.

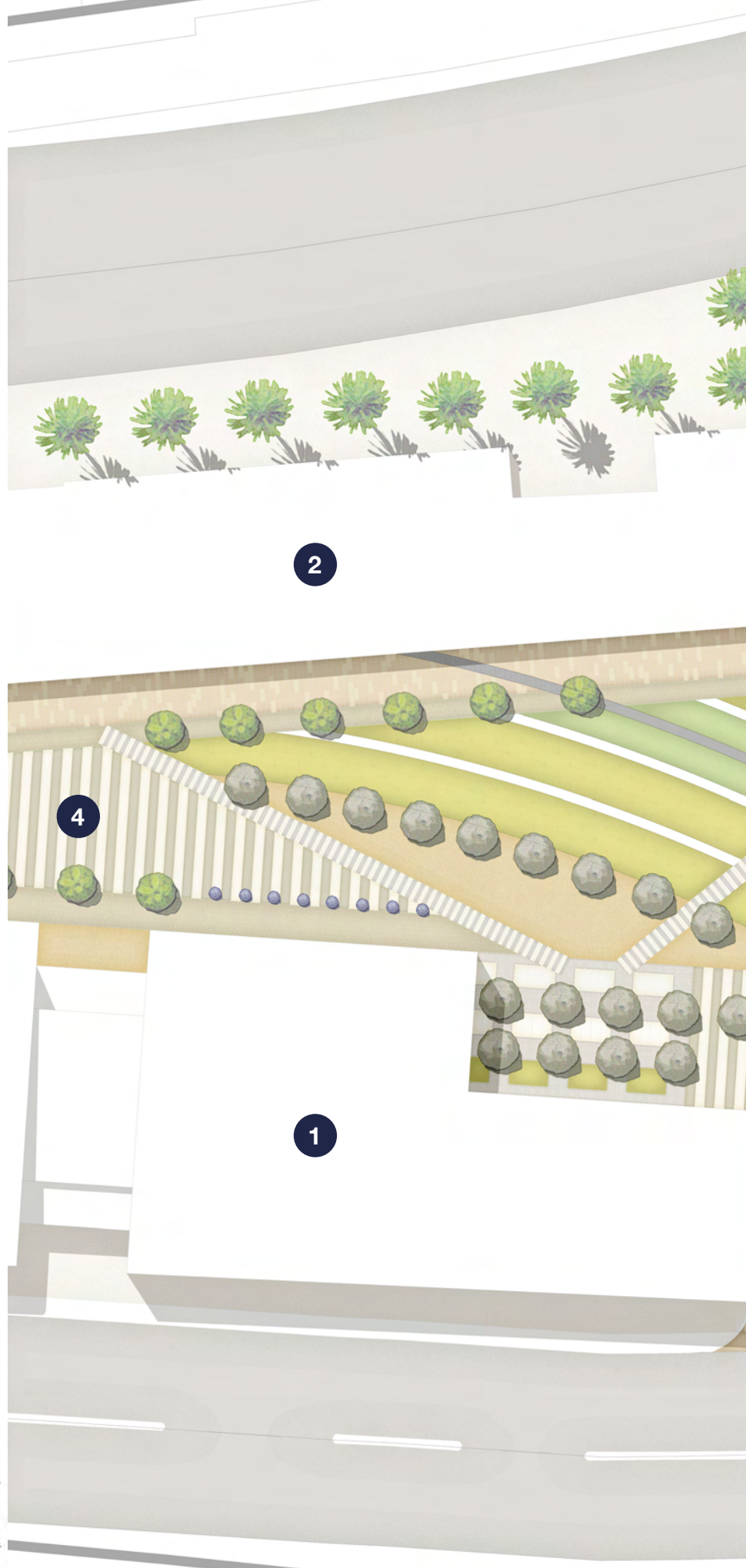
Wadi Philadelphia ::

DESIGN COMPONENTS

- 1 Hotel Structure
- 2 Raghadan Bus Terminal ::
Converted to Retail
- 3 Entrance Water Feature
- 4 Gateway to Hashemite Plaza
- 5 Symbolic Seil River Wall
- 6 Lawn
- 7 Market Space
- 8 Xeriscape Planting
- 9 Al-Jaish Highway
- 10 King Abdullah 1 Road



SCALE 1" = 50'



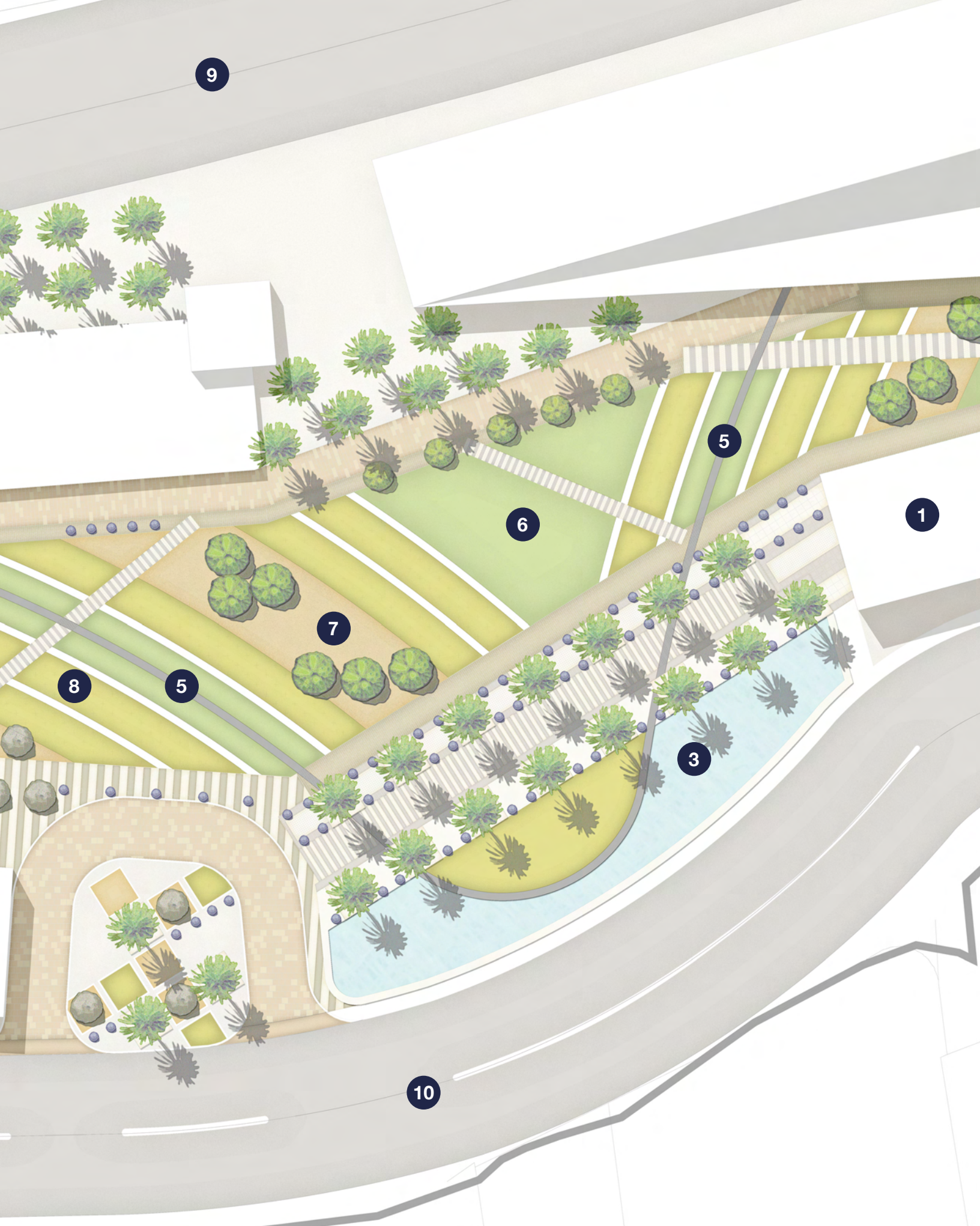


figure 8.09 | Wadi Philadelphia Plan





figure 8.10 | Wadi Philadelphia Perspective

Wadi Ragadan ::

Population density is at its highest at the east end of Wadi Ragadan (District 2) (figure 8.11). The tallest buildings on site inhabit this district. Along the north walk is an abstract representation of a Wadi. The first and third spaces are depressed below grade. The space between them is at grade. Overhead tree branches provide protective cover from the sweltering Amman sun. The paving design is representative of the pattern that is created within the wind-blown wadi sand. There are runnels of water that reflect the more historic Islamic water features that cut through the space creating smaller, more defined private spaces. The runnels represent the movement of water through a wadi. Runnel walls cut into steps illustrating the impressive power and lack of control people have over water. Integrated seat walls allow people to sit next to the soothing sound of flowing water (figure 8.12).

A plaza space is located to the east, allowing heavy pedestrian traffic while still maintaining views towards the royal palace to the north. The hardscaped plaza is balanced by a large bosque of trees that elevates above grade to help bring the scale of the buildings to a more comfortable pedestrian height. Under the trees, the ground surface is compacted sand. There are benches, tables, and chairs located under the tree canopy for people to escape the hot Amman sun.

LOCATION MAP



figure 8.11



figure 8.12 | Wadi Ragadan

Wadi Ragadan ::



BUILDING TYPOLOGY
Image represents materials and architectural style of office structures (figure 8.13).

ECOLOGICAL FUNCTION

GRAY WATER

Wadi Ragadan focuses on gray water reuse within office structures. Large structures will have a complementary sized filtration system and holding tank based on the buildings square-footage. Once cleansed the water will be pumped to toilets and irrigation systems as needed.

WATER HARVESTING

Wadi Ragadan focuses on water harvesting from surrounding conditions. The water will be filtered upon entering the site through the use of vegetative strips. Runoff will filter through taller grasses, slowing the velocity and catching large debris. Once filtered, the water flows into a drain and is directed to a cistern.

INFILTRATION

Water infiltrates through vegetative strips and permeable paving. Permeable paving is utilized in the three larger plaza spaces. The use of hardscape and compacted sand reduce the water needs of the district to almost zero. (Reference on Figure 8.14)

WATER FEATURE

Water features are narrow and deep to reduce surface area and evaporation. (Reference on Figure 8.14)

SOLAR COLLECTION

Photovoltaic cells are located on roofs to aid in renewable energy production.

NATIVE MATERIALS

Materials are native to the region reducing green house gases during shorter transit distances for delivery.

SOCIAL FUNCTION

OFFICE

Large hardscape plazas should be utilized when dealing with heavy pedestrian traffic. In addition to hardscape, compacted sand will also be suitable in less trafficked areas such as under bosques of trees. (Reference Figure 8.14)

SHADE

Tree canopies cover gathering spaces that provide seating areas. Shade over compacted sand and permeable paving can provide more refreshing spaces for public markets and outdoor events.

LAWN

There is no pedestrian accessible lawn within Wadia Ragadan. Open plaza space allows for very flexible programming without concern for the impact of pedestrian traffic on lawns.

WATER FEATURE

Certain water features are elevated into seat walls while others are depressed into the paving as runnels creating more defined spaces so a group can gather and enjoy the sound of trickling water. (Reference Figure 8.14)

RETAIL

Retail attracts business men and women, residents, and locals from on and off site to shop, dine and gather. (Reference Figure 8.14)

MARKET

Large open hardscaped plazas facilitate weekend markets for people to shop for local produce. Compacted sand along the edges of walkways create space for markets while still allowing for fluid pedestrian movement. (Reference Figure 8.14)

AESTHETIC FUNCTION

APPROACH

The approach from the east opens up views to a heavy planted slope that is part of the Royal Palace Compound. Large plazas have the ability to direct views with the aid of planting and framing.

SHADE

The contrast from shade and sun on the ground has the ability to further define spaces beyond a change in material. Canopies are used for comfort from the heat but also as a design element that changes with the sun creating dynamic patterns on the ground at the pedestrian level.

LAWN

Strategic use of lawn adds significance to key elements as the eye is drawn to the unfamiliar color and texture of planting and hardscape.

WATER FEATURE

Spaces are divided and sub-divided by the runnels of water creating a variety of scales of pedestrian gathering spaces that could accommodate a group of ten to a single person. The sound of water refreshes and cools spaces. (Reference on Figure 8.14)

PLANTING

Planting types relate to place and culture. The banding of plants through the center of the corridor pull pedestrians through the space.

NATIVE MATERIALS

Materials are native to the region increasing the sense of place and culture.



figure 8.14 | Wadi Ragadan Plan

SCALE 1" = 100'



Wadi Ragadan :: DESIGN COMPONENTS

- 1 Office Structure
- 2 Infiltration Point
- 3 Runnel Water Feature
- 4 Bosque
- 5 Retail / Dinning
- 6 Market Space

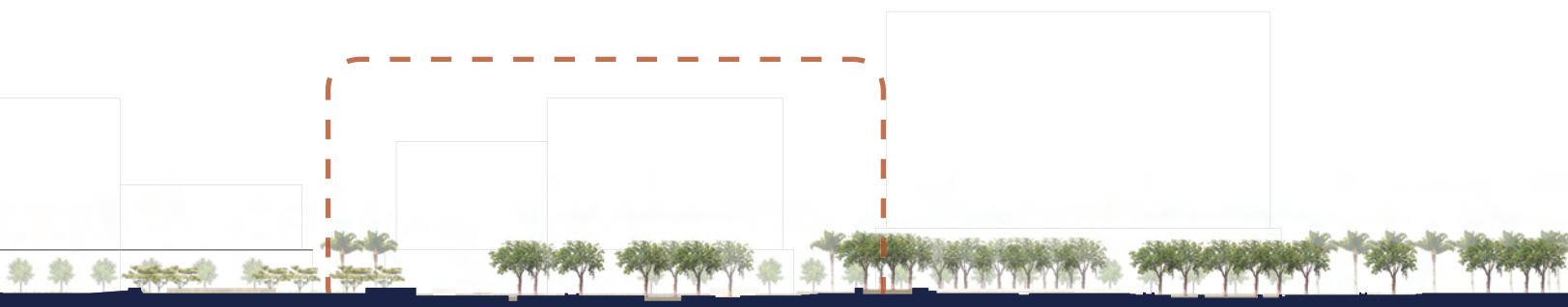


figure 8.15 | Wadi Ragadan Section





figure 8.16 | Wadi Ragadan Perspective

DISTRICT THREE

Wadi Mahatta ::

Wadi Mahatta (District 3) (figure 8.17) contains an existing mosque. The cultural value of the existing mosque and the amount of pedestrians traffic that will visit this area make it an exception and allows for more importance to be placed on a water expression. Along with the reflecting pool there is more turf in this zone. Turf will be used for passive and active recreation. (As stated earlier there is a scarcity of open spaces within Amman.) The flat open space will allow children a place to kick a soccer ball, play tag, or fly a kite. The space provides opportunities for passive recreation on an open lawn for individuals to enjoy during cooler days in Amman.

A small gathering space near the mosque is shaded with inviting low ornamental trees that provide changing colors with the seasons. Limestone benches provide seating acting as a gathering place for family and friends to go to and from the mosque or surrender to their innate desire to be near water (figure 8.18).

LOCATION MAP



figure 8.17

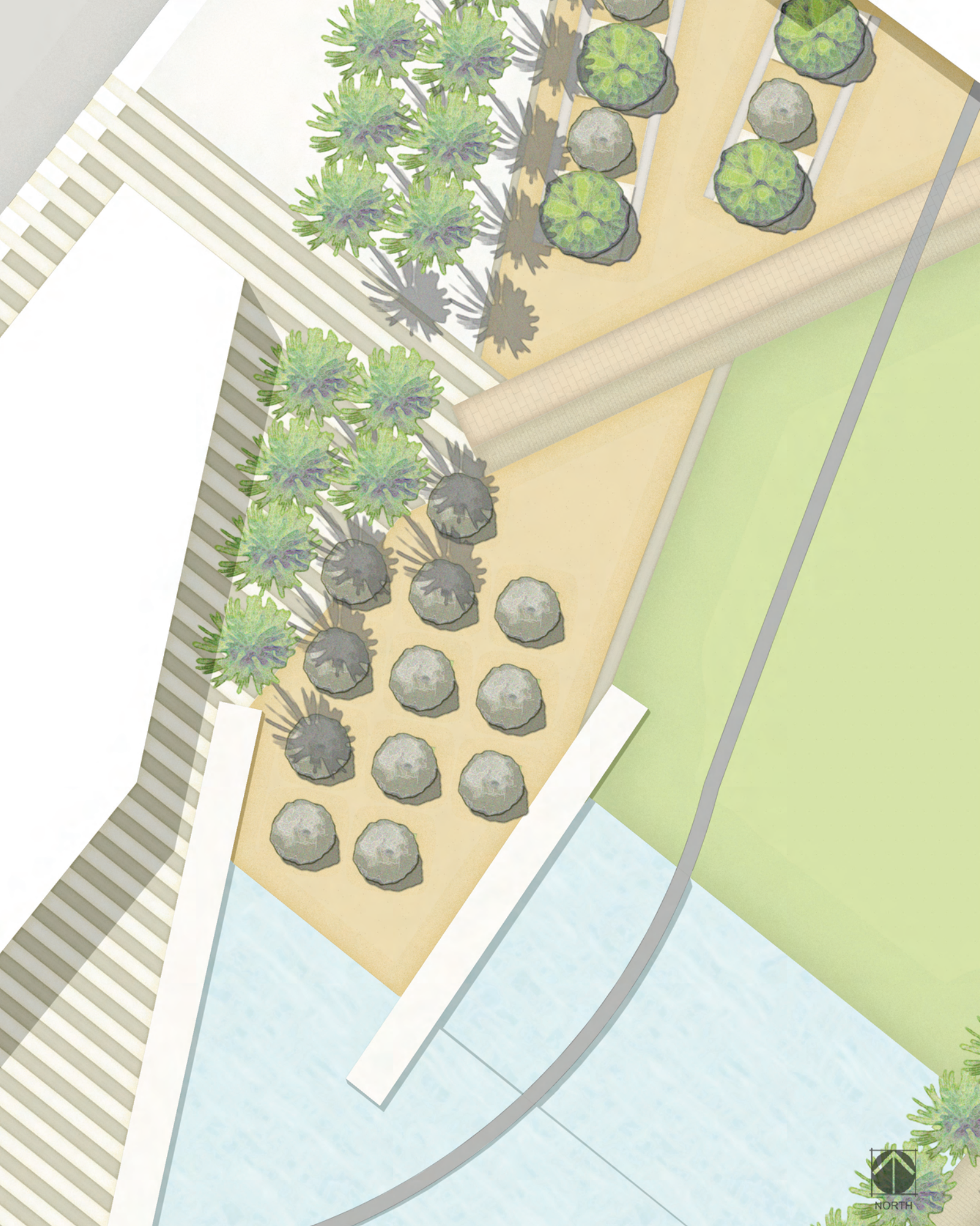


figure 8.18 | Wadi Mahatta

Wadi Mahatta ::

DESIGN COMPONENTS



BUILDING TYPOLOGY

Image represents materials and architectural style of residential structures (figure 8.19).

ECOLOGICAL FUNCTION

GRAY WATER

Wadi Mahatta focuses on the reuse of gray water within residential structures. Medium sized structures will have their own filtration systems to handle large amounts of water from the use of sinks, showers and bathtubs. Treated water will irrigate smaller areas while most of the water will be reused for residents.

WATER HARVESTING

Water harvesting within Wadi Mahatta focuses on the residential buildings collecting rainwater from rooftops and cisterns.

INFILTRATION

Water can infiltrate the turf, vegetative strips, and permeable paving. Permeable paving can be utilized under trees where heavy pedestrian traffic is expected. (Reference Figure 8.20)

WATER FEATURE

Large water features are reserved for important spaces that will have consistent pedestrian traffic. (Reference Figure 8.20)

SOLAR COLLECTION

Photovoltaic cells are located on roofs to aid in renewable energy production.

NATIVE MATERIALS

Materials are native to the region reducing green house gases as a result of shorter transit distances for delivery.

SOCIAL FUNCTION

MOSQUE

The mosques is one of the most important elements on site. It brings people together at specific times of the day when they come to pray. Large hardscape plazas should be utilized when dealing with heavy pedestrian traffic. In addition to hardscape, compacted sand will also be suitable in less trafficked areas such as under bosques of trees. (Reference Figure 8.20)

SHADE

Trees canopies cover gathering spaces that provide seating areas. Shade over compacted sand and permeable paving can provide more refreshing spaces for public markets and outdoor events.

LAWN

Large lawn should be utilized where corridors widen to allow for active recreation or larger public venues such as outdoor movies. Narrow sites are less suitable for large expanses of lawn as it limits the program elements. (Reference Figure 8.20)

RETAIL

Retail attracts business men and women, residents, and locals from on and off site to shop, dine and gather. (Reference Figure 8.20)

MARKET

Mosques will occasionally host markets and outdoor venues allowing local, residents, tourist, and business men and women to enjoy public markets. (Reference Figure 8.20)

AESTHETIC FUNCTION

APPROACH

Plazas create view corridors through the use of planting and paving patterns that draw the eye to the water features and facades of important architecture.

SHADE

The contrast from shade and sun on the ground has the ability to further define spaces beyond a change in material. Canopies are used to provide comfort from the heat but also as a design element that changes with the sun creating dynamic patterns on the ground at the pedestrian level.

LAWN

Unfamiliar landscape can intrigue pedestrians and draw them into a district. Additionally, open space on flat land should be utilized for passive and active recreation. (Reference Figure 8.20)

WATER FEATURE

Large water features add a calmness to spaces. It is capable of drawing pedestrians into a district. Reflections are an added element of beauty. (Reference Figure 8.20)

PLANTING

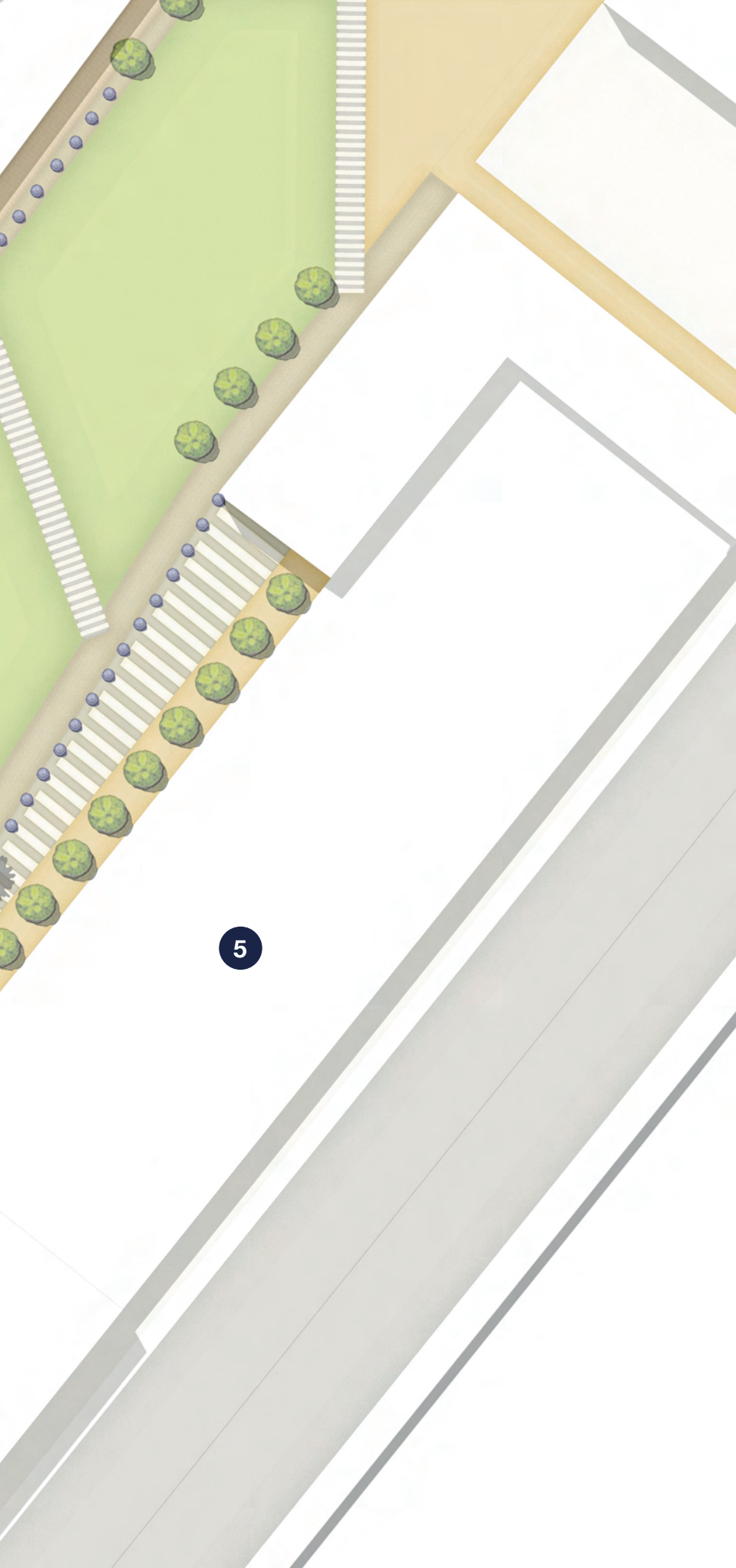
Planting types relate to place and culture. The banding of plants through the center of the corridor pull pedestrians through the space.

NATIVE MATERIALS

Materials are native to the region increasing the sense of place and culture.

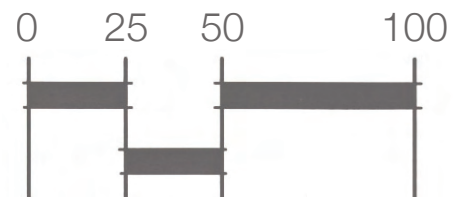


figure 8.20 | Wadi Mahatta Plan



Wadi Mahatta :: DESIGN COMPONENTS

- 1 Existing Mosque
- 2 Infiltration Point
- 3 Water Feature
- 4 Lawn
- 5 Retail / Mixed Use
- 6 Market Space



SCALE 1" = 50'





figure 8.21 | Wadi Mahatta Perspective

Conclusion ::

Amman's population has grown to over two million people in the past 90 years, creating a much higher demand on the finite water resources available in the region. The design considers the implementation of methods to moderate this demand resulting in a reduction in water usage within the landscape while still providing an enjoyable pedestrian experience that celebrates the site's rich history and its connection to this life giving resource.

The project creates a distinctive design utilizing the symbolic progression of the Seil River as the inspiration behind the landscape's design. Two of the three zone's (District 1 & District 2) success can be linked to their strategic reduction in the use of water to irrigate minimal areas of turf throughout the landscape. Wadi Ragadan is the most successful site when dealing with water consumption, for the reason that it uses hardscape rather than softscape to minimize turf areas and thus water usage. Additionally, Wadi Ragadan's water features protect against evaporation through the use of deep, narrow runnels, reducing the surface area of proposed water features. All three sites utilize water collection techniques such as cisterns and gray water reuse. Systems such as eco-roofs and ac condensate recovery were not integrated into the design solutions for this specific site. While eco-roofs would reduce heating and cooling loads they would require the introduction of irrigation watering systems into their design to sustain plant materials in Amman's hot arid climate. AC condensate water collection is less than optimal for plant health since the process of condensing water removes a number of nutrients required by plants for their healthy development. Photovoltaics should be incorporated into the design and would provide a successful source of renewable energy for Amman. Native plants and construction materials within the project strengthen and respect the sense of place imparted by the design.

The design provides a pedestrian friendly corridor through landscaped parks and plazas enhancing the potential for social activity and interaction. The landscape design directs views to important elements and helps to define circulation patterns in an effort to draw people through the site. The conceptual master plan provides for new opportunities for shopping, dining, housing, worship and the creation of additional usable public open spaces.

The overall project does not solve Amman's primary issue of diminishing water resources. It does, however, provide a blueprint for others to study, implement and improve upon as the City of Amman begins to come to terms with the fact that it will need to incorporate new, as well as historic, systems into future building and landscapes if they are to continue to live in harmony with their existing environment as they continue to grow and urbanize the region.

Appendix ::
TIMELINE | LITERATURE MAP

9

KEY ::

- project description + intent
- literature review
- process
- precedent study
- inventory + analysis
- program
- final document + committee meeting
- goals + objectives
- storyboard
- document design
- mid crit
- final document draft
- final document

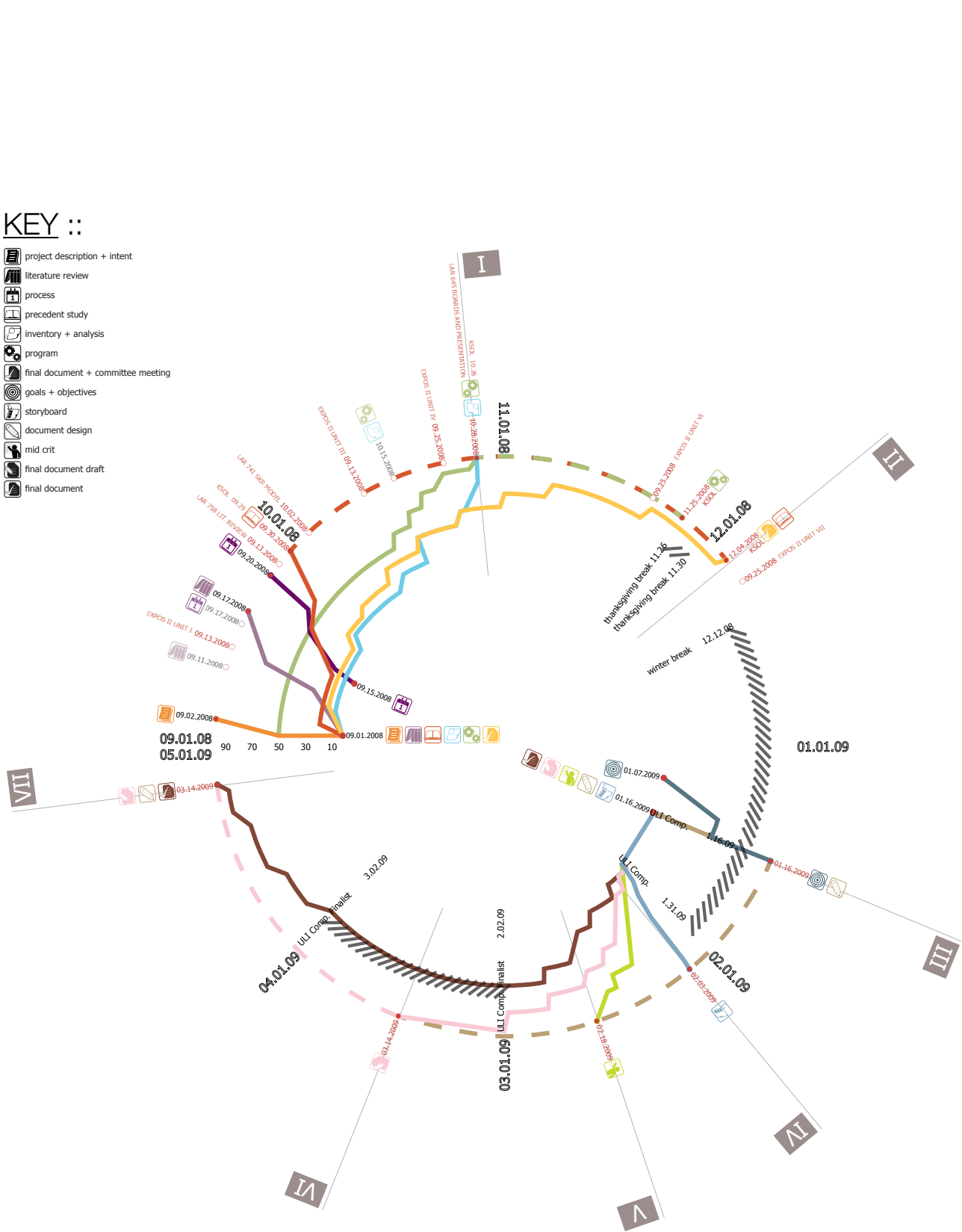


figure 9.01 Project Timeline

Project Timeline ::

Each task that has been assigned for project programming is represented by a specific color and icon. Through time as the tasks are completed they are spun to the outside of the circle. Each line represents a rough percentage of completion to that date as the task steps its way out to one hundred percent completion. Dash lines represent the continuation of a task past the assigned due date (figure 9.01).

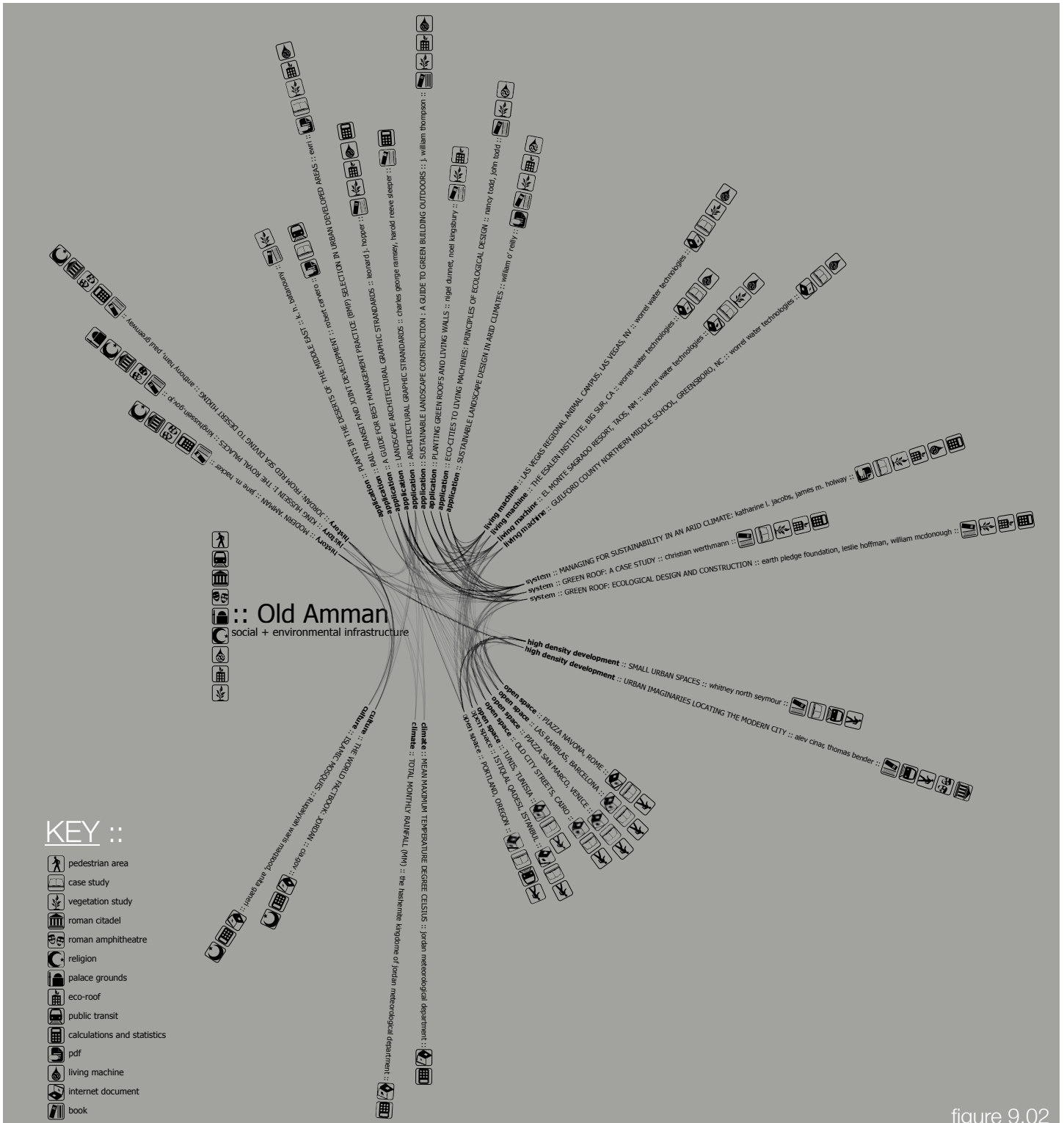


figure 9.02

Literature Map ::

The literature map is divided into eight different categories: history, application, living machines, systems, high density development, open space, climate and culture. The title of the literature and the author are located directly after the category that the source is assigned to (figure 9.02). The next level of information are the icons which define the literature type (book, internet, or pdf) and what information can be found within the text.

Lines in the middle of the diagram use the icons to represent basic connections between the sources. The darker the line, the more the sources have in common. If there are no shared icons there is no line.

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10

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