WATER CONSERVING GARDEN

Prepared for ‘Aqaba Special Economic Zone Authority

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Badia Research and Development Program

US AGENCY FOR INTERNATIONAL DEVELOPMENT

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It is He who produces
Gardens, with trellises
And without, and dates,
And tilth with produce
Of all kinds,
Eat of their fruit
In their season, but render
The dues that are proper
On the day that the harvest
Is gathered. But waste not
By excess: for God
Loves not the wasters.

Quran vi, 141

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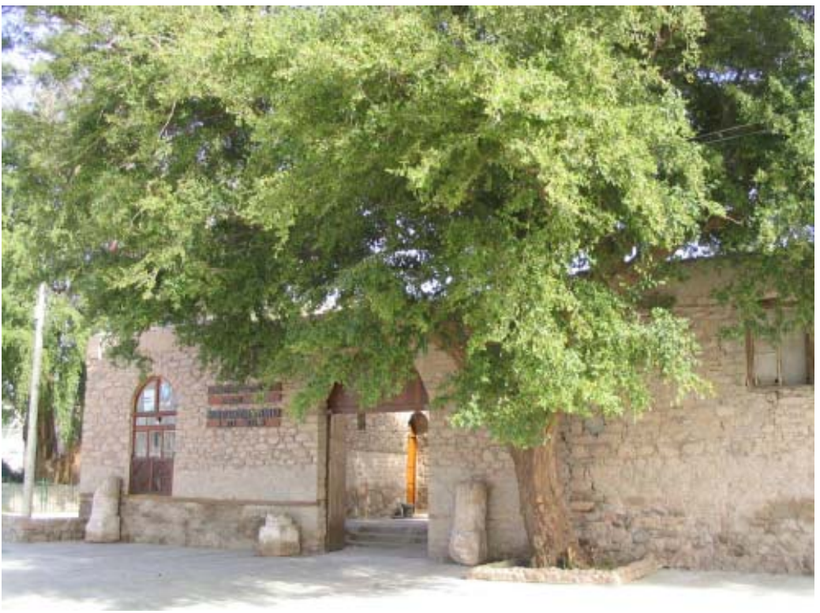


ABSTRACT

The idea of developing a demonstration garden in a public space for Jordan was conceived in response to the need for the nation to conserve resources, particularly water. The goal of the Water Conserving Garden is to demonstrate low water-use strategies in landscapes through the appropriate selection of design elements, including plant materials and the use of reclaimed water resources.

The first portion of the document includes information about the principles of Xeriscape or water-conservative landscape design. The standard accepted principles have been tailored to correspond directly to the specific needs of 'Aqaba. The second part of this report presents the detailed proposal for the design of the Water Conserving Garden. The Water Conserving Garden explicitly utilizes current water-conserving design practices and can serve as a model for the development of future open spaces in Jordan. Every effort was made throughout the design to appropriately respond to the needs of the environment, culture and economics of the region.

This technical report seeks to be a resource for Jordanian developers, architects, landscape architects, engineers, conservation specialists and public works personnel involved in the future of Jordan's open spaces. 'Aqaba specifically is experiencing a rapid rate of development, and thoughtful planning and design are essential to the health of its natural environment, the success of the city as a whole and the quality of life for residents and visitors of the town.

The project was initiated by the Sustainable Development of Drylands Project of the International Arid Lands Consortium at the University of Arizona. The Jordanian partnering institutions include the Badia Research and Development Program, Higher Council of Science and Technology and the 'Aqaba Special Economic Zone Authority (ASEZA). Support has also been provided by the US Agency for International Development.

INTRODUCTION

Given the critical status of water resources in Jordan, active conservation is an essential practice which needs to pervade every aspect of life throughout the country. Landscape design and planning is a significant area where water-efficient strategies will profoundly impact the future of water resources within Jordan.

Although investment in landscape may initially appear costly, the benefits of green spaces in arid environments are innumerable. Several of the advantages of enhanced landscapes can be summarized within the following categories based on the sustaining characteristics: *economics, environmental, and social*.

Economically, studies have found increased property values, tourism rates and willingness of businesses to invest in areas with attractive landscapes. Economic savings can also be directly gained through the reduction of energy needed to heat and cool buildings with landscape enhancements.

Environmental benefits are manifold as well. Vegetation within the urban context has been shown to significantly mitigate the urban heat island effect.[1] Additionally, trees and shrubs function as filters which remediate harmful pollutants of air and water quality. Regarding noise, while actual decibel level has not found to be significantly reduced by vegetative barriers, analysts agree that the psychological impact or perception of noise is reduced in the presence of plant screens and buffers. Loss of soil or erosion is often an issue of concern in arid environments. The roots of plants effectively hold soil and thus significantly reduce erosion.

A major **social** benefit of enhanced landscapes includes the improvement of overall quality of life. Natural elements infused into the urban environment provide an environment to which people can retreat and relax from the chaos of everyday life in the urban setting. Also, daily contact with natural elements instills environmental awareness in people. Familiarity with one's natural surroundings is the most effective way to generate concern leading to a conservation ethic. Environmental education is the best hope for the future conservation of natural resources.

A common sustainable practice applied to created landscapes in arid regions is termed "Xeriscape." The term Xeriscape was first used in 1981 in the state of Colorado.[2] The word was derived from the Greek word *xeros* meaning 'dry' and the suffix to the word land*scape*. Currently, Xeriscape is identified with meaning quality, creative, low-maintenance, water-efficient landscapes. Xeriscape has been shown to result in savings related to water-usage, installation costs, and labor investments.

Following is a discussion of the principles of this sustainable practice as well as the application of the strategies to the Water Conserving Garden of 'Aqaba.

[1] Urban heat island effect is the well-documented and widely accepted phenomenon of elevated ambient temperatures found in urban environments due to the replacement of soft natural areas with a dense fabric of hard and reflective paved surfaces.

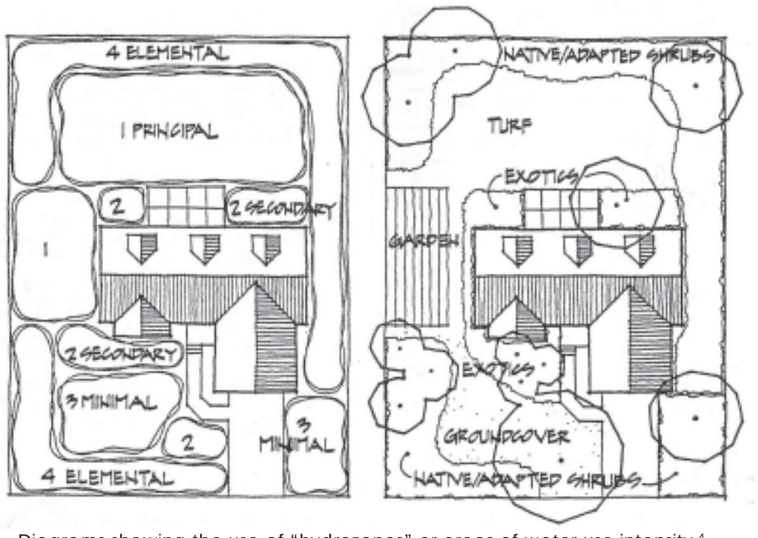
[2] The term "Xeriscape," was coined by the Denver Water Department in 1981 to help make water conserving landscape practices an easily recognized concept.

PRINCIPLES OF XERISCAPE DESIGN

There are seven principles of Xeriscape design. The following categories have been modified slightly from the original seven in order to specifically relate to the issues and needs of Jordan:

1) Planning and design
2) Plant selection
3) Wise use of turf
4) Soil & mulches
5) Alternatives sources of water
6) Maintenance
7) Efficient irrigation

Images used by Denver Water to demonstrate that "Xeriscape" does not mean solely cacti and rocks. A well designed water-conserving landscape can be interesting, colorful and easy to care for.[3]



Diagrams showing the use of "hydrozones" or areas of water use intensity.[4]

Planning and Design

Essential to water conservative design is the manner in which a landscape design is planned. The use of "hydrozones" is highly recommended. Hydrozones are specific areas which differ in the degree of water used. The amount of water used in each zone should follow the intensity of activity for that area. There are three basic categories of hydrozones: elemental, secondary and principal. The elemental zone is the area of least activity and thus water use. This area can also be referred to as the desert zone and most often includes native or desert adapted vegetation, very little supplemental water and is usually located along the periphery of a site. Next is the secondary zone. This is frequently the area of transition, an area where pedestrians pass but do not necessarily spend a significant amount of time. Last is the principal hydrozone or area of highest use and accordingly the most water use. This last zone is also referred to as the oasis.

Desert or Elemental Zone

Transition or Secondary Zone

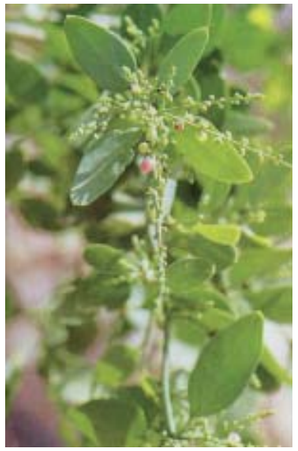
Oasis or Principal Zone

[3] www.water.denver.co.gov
[4] Low 4 Program, Pima County Cooperative Extension Water Resources Research Center. *The Seven Principles of Xeriscape - pamphlet.*

Plant Selection

The specific species of plants chosen will also significantly impact the success of a design. Plants naturally found in Jordan and nearby regions are adapted to the low water and full sun conditions and thus will require less care and water than exotic species not naturally found in arid environments. Examples of native plants found in Jordan (in order of appearance below) include: *Raetama raetam, Lupine spp., Salvadora persica, Asphodelus aestivus, Salvia lanigera and Lotus lanuginosus.*

When selecting plants, it is also important to consider the size of the plant once mature. Underestimating plant size will require extensive maintenance in terms of pruning. Knowledge and proper placement of species based on sun or shade requirements will also reduce future maintenance. If a plant is placed in a location which mimics its natural environment, then it has a stronger probability of thriving.



Wise Use of Turfgrass

Turf, or grass, is one of the most demanding elements that can be found in the landscape. Because it requires frequent application of water and fertilizer as well as labor investment, it is best to reduce the quantity of turf in a xeriscape design. The sensible use of turf is recommended. In other words, turf is only appropriate in actively used areas such as: schools, sports fields and places where the benefits, such as cooling, can be effectively gained. Narrow medians along roads and parking areas are particularly inappropriate for turf, as these areas are the most difficult to efficiently irrigate and they are infrequently utilized as sitting areas.

The image to the right demonstrates the inappropriate use of turf. Pedestrians infrequently use this area and also the narrow patch of grass is difficult to irrigate efficiently. The image above, however, shows an alternative road median planted with native vegetation and displaying a variety of forms and textures. At the same time, the landscape in the image above requires much less maintenance and water.

Soil and Mulch

The soil of arid regions, and particularly ‘Aqaba, present a challenge to landscape design. Being predominately composed of sand, the soils of ‘Aqaba are very poor at retaining water. Mulches are organic or inorganic materials which can be added to the soil or soil surface in order to improve its properties. The benefits of mulches include: improved retention of soil moisture, the addition of nutrients, prevention of erosion and dust, reduction of weeds, reduction of maintenance and also the mitigation of reflective heat.

Several mulch possibilities exist for ‘Aqaba. First, rock, gravel and touf (volcanic rock) are available in Jordan. The addition of a layer of these inorganic materials would help to cool soil temperatures and thus reduce evaporation of moisture. Furthermore, a layer of the material on top of the soil would reduce erosion and dust, thereby helping air quality. In order to gain the above benefits, the city of Tucson, Arizona, requires a 2 inch layer of decomposed granite as a surface cover for all new landscape projects. Arid nations throughout the Middle East should all be similarly using crushed rock materials in their landscapes to gain these benefits. Given a supply of granite, volcanic rock or similar material, the export of inorganic mulch materials could become a significant export commodity for Jordan.

Compost is another option for ‘Aqaba. Compost is a rich organic material made from ordinary household kitchen scraps. In order to facilitate decomposition, the material should be kept in a shady location and periodically mixed as air is necessary for the health of the microbes decomposing the material.

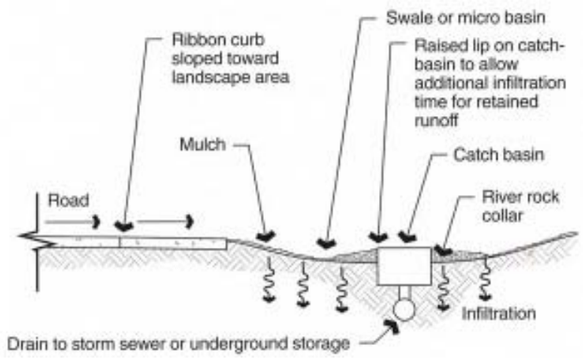
Co-polymers or hydrogels are also an effective way to enhance the moisture-retaining properties of soil. Co-polymers are a lightweight spongelike substance - the same technology as used in baby diapers. After the power is added to the soil, it absorbs water at a rate of 100 times its own weight. It slowly releases the water when the soil is dry. In the past, landscape application of co-polymers was thought to be cost prohibitive. However, increasing demand for landscape application is making its use more feasible.

Lastly, while wood chips are not usually appropriate in desert environments, due to material scarcity, their use may be feasible for projects where trees are selected for removal from the site.

Alternative Sources of Water

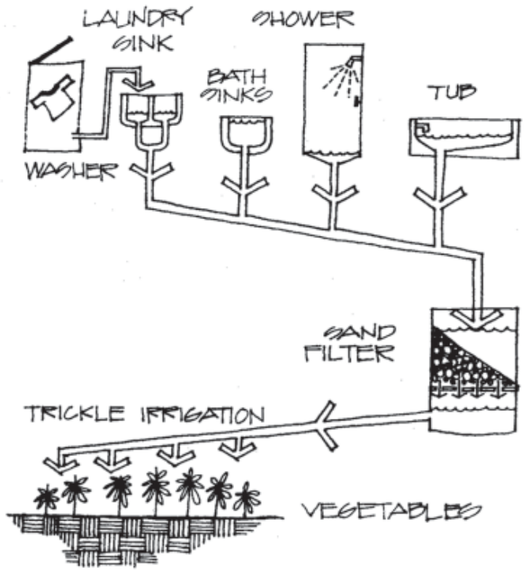
Given the restricted natural water resources in arid regions, the use of alternative sources of water is increasingly essential. Possible alternative sources of water include: water harvesting, the use of graywater and also reclaimed water resources.

Water harvesting typically refers to the collection or control of rainwater. It can occur either actively or passively. Active water harvesting is the collection and storage of water that naturally falls as rain. Collecting rainwater from roofs or large paved surfaces can result in large quantities of high quality water in regions with reliable rainfall. Given that rainfall is so scarce in ‘Aqaba, active water harvesting is not deemed relevant in the case of the Water Conserving Garden.



Passive water harvesting is the directional control of available water resources. This includes the creation of berms and swales in order to retain water in desirable locations such as in areas where it can be utilized by plants. Grading our hard surfaces to have gentle slopes, ensures that any available water (i.e. from irrigation or cleaning) be made available to plants instead of merely succumbing to evaporation.

Graywater is water which has been used at least once, but is still safe to be applied for landscape application. Common sources of graywater include bathroom sinks, bath tub, shower or laundry. Water from the kitchen, due to its bacterial content, is not to be considered graywater. Both filtration and storage are optional but not necessary with graywater.



A drinking fountain demonstrating a simple application of graywater. Tohono Chul Park - Tucson, Arizona.

Reclaimed water is another reliable alternative source of water. It is water that has been cleaned by a wastewater treatment center and it is considered ideal for landscape applications. 8% of Tucson, Arizona's water needs are met with reclaimed water. The primary users include: golf courses, schools and public parks. Purple color is the international convention for pipes and tubes carrying reclaimed water. Signs, such as the one pictured to the right, are mandatory when reclaimed water is in use.

Constructed wetlands offer an advanced and thoughtful means of treating wastewater. Such facilities serve multiple functions in addition to effectively treating wastewater. At the same time, they provide wildlife habitat and lush green spaces for people to enjoy. Some constructed wetlands serve as popular bird-watching facilities. Given 'Aqaba's unique location at the intersection of three continents, bird migratory routes are especially prominent and thus a wildlife viewing center would inevitably be a successful international tourist destination.

Sweetwater Wetlands, a wastewater treatment facility and popular recreation area in Tucson, Arizona.

Efficient Irrigation

Irrigation is yet another significant aspect of water conservative landscape design. First, it is essential to know the water needs of each plant and to water accordingly. Also, watering slowly will provide time for water to percolate into the soil thereby reducing the amount of run-off to unintended areas. Next, watering during the cooler times of the day such as the evenings or early morning hours will help to reduce water loss from evaporation. It is also very important to consider seasonal changes and to adjust irrigation timers accordingly. A common mistake is setting an irrigation system to summer season water requiements and not adjusting to decreased water needs that occur in the winter.

Water wasted by inefficient irrigation practices.

Remember to adjust timers seasonally.

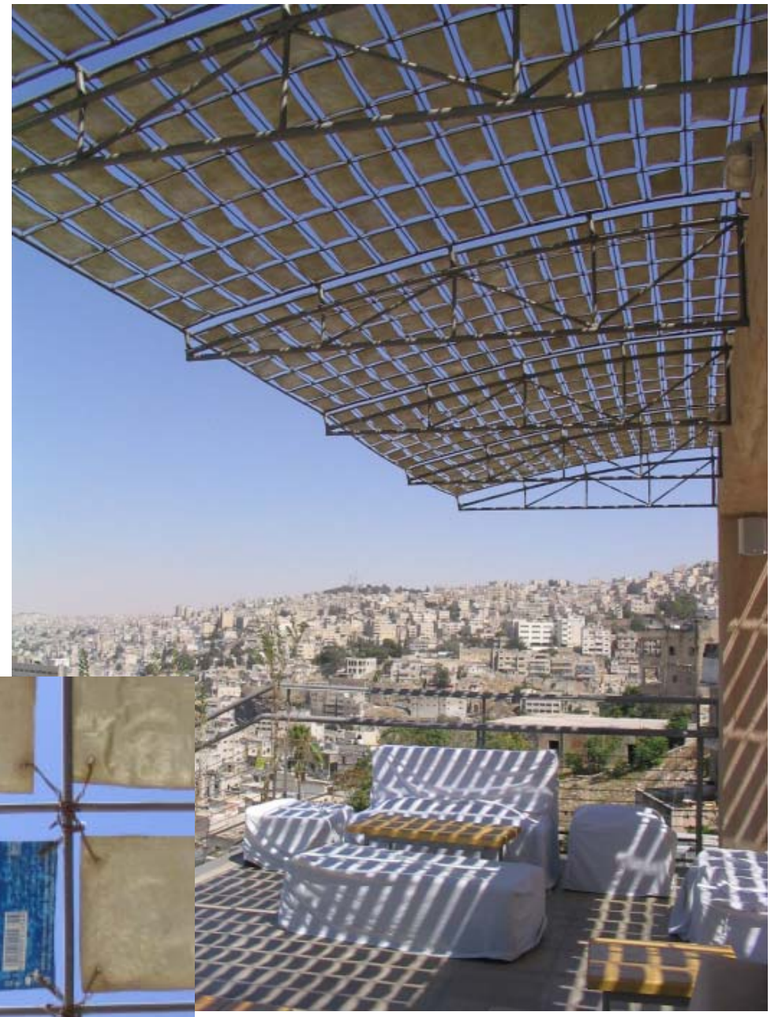
Maintenance

Regular care is an essential aspect of any landscape design. However, a design based on the principles of xeriscape will help to reduce the amount of water, fertilizer, pruning, weeding, pest management and replanting required. At the same time, a successful xeriscape design requires *an informed personnel.* If our maintenance staff, landscape designers and planners are not informed of water efficient strategies, then even the most conservatively designed garden or park will not achieve the desired benefits.

The above seven principles represent the core of water efficient landscape design. They serve as the foundation upon which the design of the Water Conserving Garden is based.

Adaptive Reuse

An essential aspect of resource conservative design solutions is the use of creative thinking. Considering our surroundings with imagination and a wilingness to work with new methods is paramount to advances in design. Current sustainable design approaches commonly incorporate the idea of *adaptive reuse*. Adaptive reuse is the utilization of discarded elements or materials already found on site. Not only does this method save landfills from unnecessary burden, the reuse of materials can also be a positive way to comment on one's culture, respect the history of a site and/or reveal a positive environmental ethic.



The creative use of discarded soda cans in the construction of a ramada structure at the RSCN Nature Center in Amman by Jordanian architect Ammar Khammash.

Conservation in Islam

The idea of water conservation in the landscape is not a novel concept. Furthermore, water conservative design is not only familiar to Islamic garden design, but rather has historically been an essential element. Traditional Islamic garden style includes the respectful use of water, sunken gardens, transitional indoor/outdoor spaces and attention to microclimates. We find further evidence of the significance of conservative practices in the following hadith:

> *The Prophet told his companion, Sa'ad, that he was using an excessive amount of water to make ablution...saying, 'do not waste [water]'. Sa'ad then asked whether there could ever be wastage if water was used for the purpose of wudu. The Prophet's reply was, 'Yes. Even if you are by a flowing river.'*[5]

Future design efforts in Jordan should strongly heed the lessons of the past. Respecting one's history is unquestionably the best way to ensure enduring, successful and sustainable open space designs while maintaining a strong sense of identity and culture for the nation.

[5] Musnad, ii, 22; Ibn Maja, "Tahara," 48, no. 425; I, 147 (translation by Ibrahim Ozdemir)


SUNGOLD
SOYA OIL
PALM OLEIN
زيت صويا
PALMOLE
SUNGOLD
SOYA OIL
PALM OLEIN

WATER CONSERVING GARDEN

The goal of the Water Conserving Garden is: *to create a variety of outdoor spaces which effectively communicate low water-use strategies to the residents and visitors of 'Aqaba.*

The garden seeks to impact the future of water availability on two levels: first, through the process of education and second, by directly augmenting the available water supply through the use of reclaimed water resources. Furthermore, the principles and strategies of the garden should serve as a model to be followed in the development and renovation of future green spaces in 'Aqaba, Jordan and arid regions worldwide.

Simultaneously, the garden redesign also needs to satisfy the daily needs of its preexisting user base - the local residents who already enjoy the park.

Several objectives were established during the preliminary stages of design development in order to meet the goals of the project. These can be classified into one of two categories: educational or functional.

EDUCATIONAL ELEMENTS

- Alternative sources of water - reclaimed, gray, harvested
- Low water-use plants - natives and exotics
- A variety of hardscape materials
- Efficient irrigation system
- Landscape design strategies
- Interpretive information

FUNCTIONAL ELEMENTS

- Orientation area
- Clear circulation
- Large group gathering space
- Workshop space
- Child play area
- Youth recreational area
- Safety considerations
- Local materials

The Water Conserving Garden explicitly utilizes the latest water-conserving design practices. Additionally, every effort was made throughout the design to appropriately respond to the needs of the environment, culture and economics of the region.

SITE ANALYSIS

The Water Conserving Garden is located in the town of ‘Aqaba which rests within the Sudanian desert of the Middle East. Rainfall in the region is extremely low with an average of less than 50 mm per year being recorded. The average winter temperature is 20 C while the average during the summer months is 38 C.

‘Aqaba is a major coastal town making it significant to the nation of Jordan in terms of both trade and tourism. The coral reef system associated with the Gulf of ‘Aqaba is yet another reason why application of water to the landscape needs to be restrained. Additional nutrients in the sea would lead to detrimental impacts on reef health.

The site of the Water Conserving Garden is advantageous in being near both hotel and commercial districts and thus is easily accessible by visitors. Also, three schools can be found nearby as well as a mosque, technical training center and commercial building containing several small shops.

In general, the existing site is fairly well utilized by the local residential community, despite its somewhat neglected state. Plantings in some areas are overgrown to the point that visitors complain about too much shade. Also crime is a concern, resulting in an enclosing wall and five gates that are locked at night. Unfortunately, this barrier proves to be largely ineffective. Current thought on designing “defensible spaces” advocates for the removal of walls, fences and other barriers. Today, it is widely believed that the most effective way to secure our public spaces is to leave them open allowing for visual access to the site.

The site is mainly accessed by pedestrian traffic. Pedestrian corridors line each edge of the garden. The two gates closest to the Haia Center are open during the day, furthering facilitating the neglect of the Western portion of the garden. The majority of vehicular traffic can be found on the street to the north of the garden.

‘Aqaba is located within the Sudanian desert at the Southwestern tip of Jordan.

‘Aqaba is Jordan’s only coastal town, resting on the edge of the Gulf of ‘Aqaba.

The site of the Water Conserving Garden is located near the main hotel and commcial districts.

The boundaries of the Water Conserving Garden.

External Context

The diagram on the next page shows relevant external circulation. Of the roads surrounding the site, only one carries two-way traffic. Although it is residential in scale, this is the busiest street associated with the site. The northwestern edge of the site is particularly active as it is near the neighborhood mosque and women's technical training center. The neighborhood has three schools with one situated directly to the north of the site. Unfortunately, direct access to the park is denied by a long tall wall. The residential buildings surrounding the site on the remaining three sides are two to three stories tall.

In addition to the wall surrounding the garden, walls also enclose the apartment buildings making the pedestrian corridors unfriendly and uninteresting. The walls act as barriers to the park and prevent access.

The commercial area may be included as part of a future renovation plan. Its new design will reflect that of the park building emphasizing the relationship between the two.

Internal Conditions

The park itself primarily serves residents of the associated neighborhood. The park is largely in a neglected state with users requesting updates that will make it safe as well as visually appealing. The Haia Center is the main focus of the park. It contains a children's library as well as offices for park staff. The park is currently staffed by six individuals: two administrators, one librarian, two maintenance personnel and one security guard.

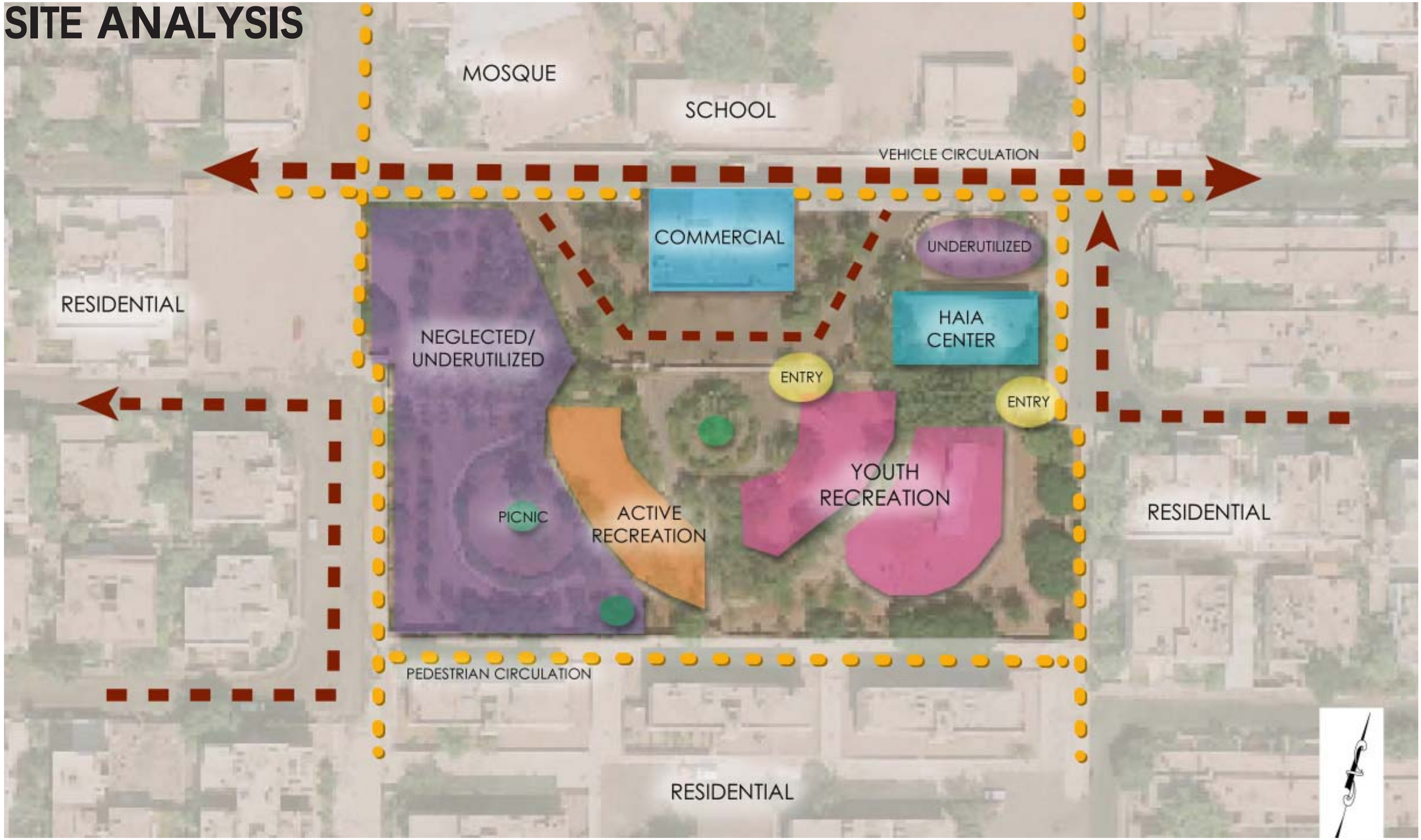
The most successful areas of the park are the child play area, the impromptu youth sports area, and the turf areas for sitting. The child play area consists of outdated play equipment which many adults consider unsafe. A shade structure in the middle of the play area, appears possibly unstable and is avoided by most park users. Seating at the edge of the play area is frequently used by the adults as they supervise their children. The youth sports area is an irregular shaped patch of dirt which is frequently utilized for soccer. Many of the young boys expressed a strong desire to have a field with regulation standards. A recreational field is an appropriate area to demonstrate the use of turfgrass and reclaimed water. There is also a black top area for basketball, which is a second priority to soccer. Any hard smooth surface could be used to explain water harvesting (i.e. as an analogy to a street, driveway, roof or other hard surface).

The turf areas are popular for sitting and picnic areas. While turf is not a low water-using plant material, it is extremely popular with the public. It is difficult to imagine a successful design in the region without the use of turf areas. Also, it is acceptable among water conservationists to incorporate turf into areas where it will be utilized (picnic spaces, child play areas). Thus, small thoughtfully sized patches, which effectively explain the appropriate use of turf, are suitable. Lastly, the western portion of the park is largely dark, underutilized and undermaintained. Programmed activity in this section would help to activate this area.

Existing wall of the Haia Garden and adjacent residential building.

The existing signage announcing the Haia Garden is indicative of its present state.

SITE ANALYSIS



User Surveys

Currently, the site functions as the Princess Haia Garden and is well utilized by neighborhood residents. Interviews were conducted in January of 2004 to determine both the priorities and concerns of the users of the garden. An effort was made to obtain the input of men and women of all ages. While the purpose of the survey was not quantitative in nature, a clear qualitative perspective of the opportunities and constraints associated with the existing garden was obtained. A sample survey, developed in conjunction with ASEZA, can be found in Appendix A. The most popular aspects of the garden include the children's play area, the sports field and the picnic areas. Many park users expressed a desire for a computer room with internet access as a part of the renovation plan. Visitors to the park were generally concerned by the overgrown and neglected portions of the garden those being the Western portion of the park and the area to the North of the Haia Center.

Left - Eager survey participants. Above - the popular soccer area. Below - a safe play area for young children is a high priority for park users.

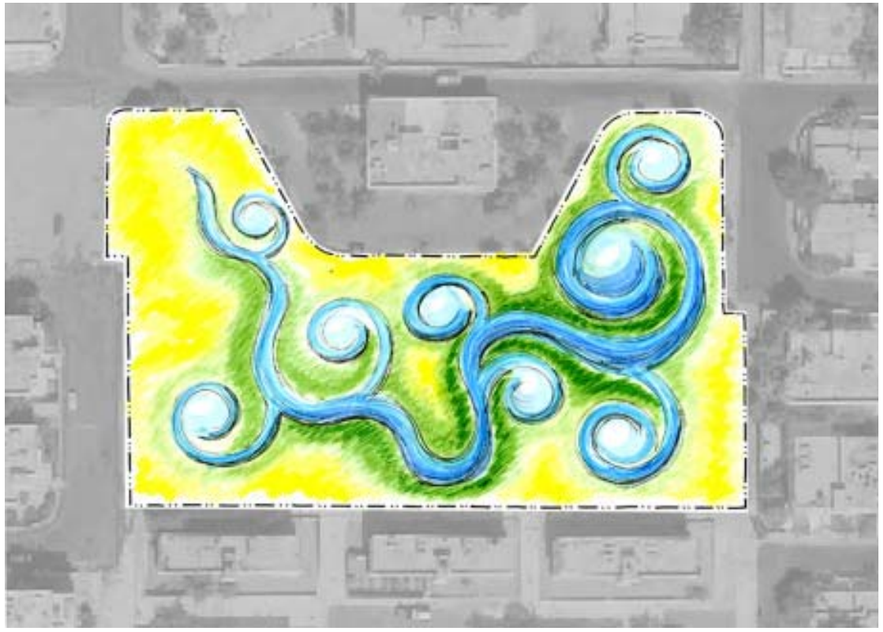
The areas of turfgrass are popular for sitting and picnics.

A demonstration of the ineffectiveness of the locked gates and wall surrounding the park.

The image below shows the overgrown Western portion of the Haia Garden. Some areas of the park are so dense with vegetation, that users complain about the lack of sun in the winter.

An inventory of the existing vegetation was performed in January of 2004 (see Appendix B). Mature plants are an asset to any landscape installation. This is especially true in arid environments due to the need for shade. An effort was made to retain the existing poinciana trees (*Delonix regia*), a large mature sidra (*Zizyphus spina-christi*), two of the large existing ficus trees (*Ficus nitida*) and most of the date palms (*Phoenix dactylifera*). Plants selected for removal included the green wattle (*Acacia dealbata*), oleander (*Nerium oleander*) and the existing shrubs. The acacia dealbata was not considered a desirable species due to its tendency to easily reseed and thus require an intensive maintenance investment. An effort should be made to relocate the trees selected for removal or to reincorporate them into the site of the Water Conserving Garden as mulch.

CONCEPT - The Wadi of Knowledge

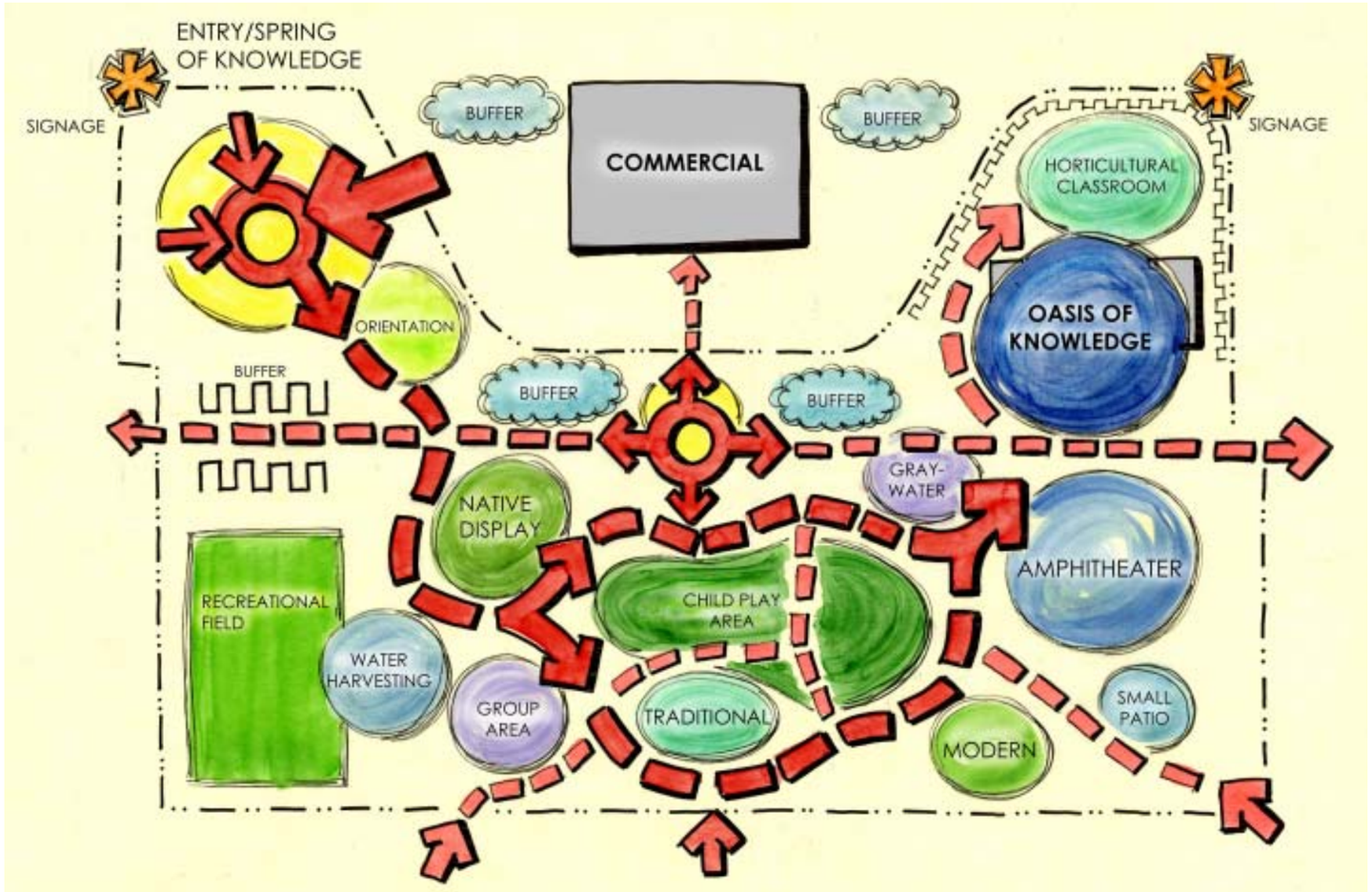


The main ideas behind the forms and circulation of the redesign originate from the concept that the garden should emulate the feeling of a wadi - a "Wadi of Knowledge." The garden should primarily consist of a river-like pathway with nodes of learning opportunities. The coolness and movement of a river should be expressed in the selection of both hard and soft materials. The first principal of xeriscape is followed in that the river flows from an area of low water use intensity (the desert), through transitional areas, and culminates in the principle water use zone or the oasis. The concept is an appropriate one given that the principal purpose for the garden is water education.

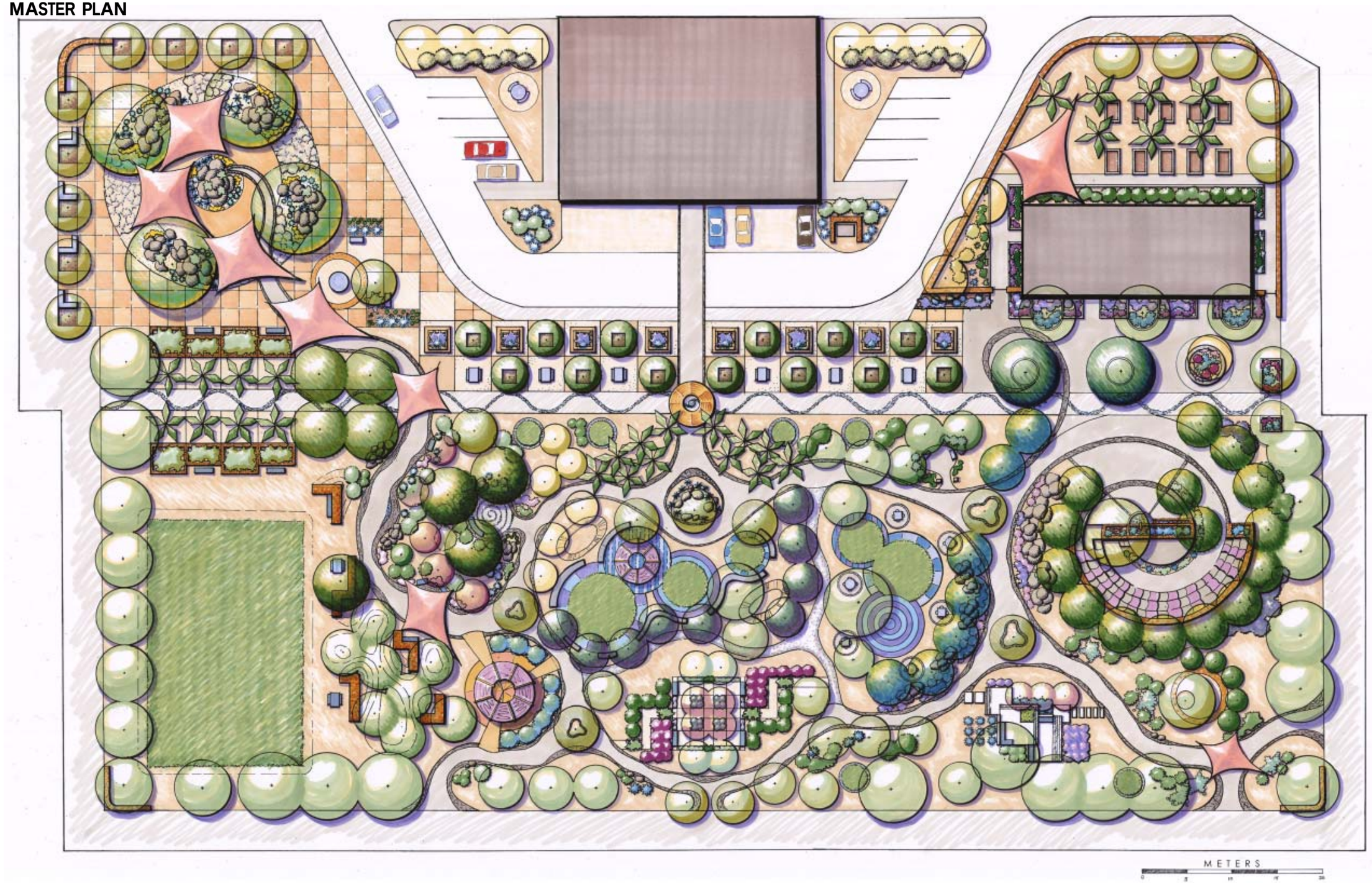
Circulation and Functional Areas

The circulation plan of the garden begins in the low water-use desert area and culminates in the Oasis of Knowledge. The path between the two contains various nodes conveying different water conservation practices. The Western portion of the site is activated by the recreational field and the newly positioned main entry. Distinct garden nodes include a native garden, a traditional/formal display, water harvesting and graywater areas. The final oasis includes an amphitheater, the learning center and an outdoor horticultural classroom. Overall, the site will have a permeable boundary allowing access from many directions.

The pathway progresses chronologically from natural spaces associated with the area's nomadic past, to the traditional garden and the idea of cultivation, to the modern display and finally terminating at the oasis of knowledge or the future of water conservative landscape design.



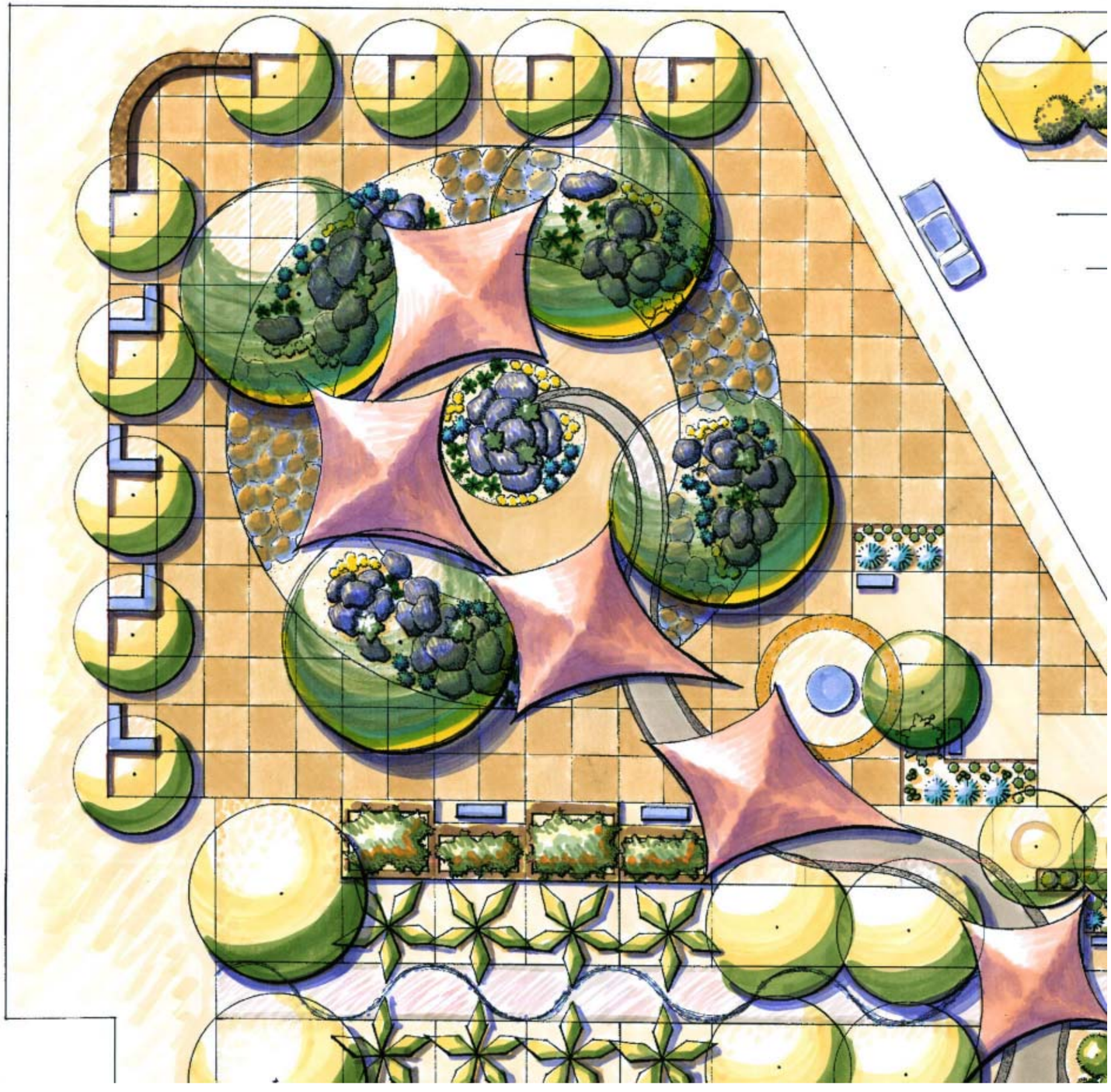
MASTER PLAN



MASTER PLAN

WATER CONSERVING GARDEN

IALC / BRDP / USAID



THE SPRING OF KNOWLEDGE

The main entry, or Spring of Knowledge, serves as an orientation plaza as well as a space for decompression from the busy urban environment. It is strategically located in order to benefit from the densest traffic area. The new location expands the entry garden to the edge of the most prominent road, thereby heightening its visibility.

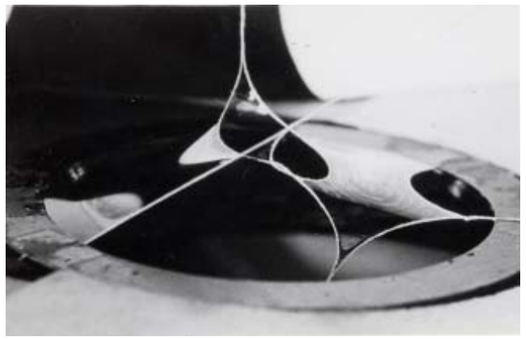
Overall, the entry aims to be an expression of the beginning of a wadi and thus attempts to recall a natural spring found in the desert environment. Springs in the desert are often associated with groups of rocks, placed in order to accentuate their presence. Similarly, the spring in the design, is celebrated with several groupings of large decorative natural boulders. Low water-use plant species are intermittently mixed amongst the boulders. The groups of stone should be large enough in scale that they offer seating opportunities as well.

The regular grid pattern of the ground plane mimics the regular forms of 'Aqaba's urban block system. A row of carob trees (*Ceratonia siliqua*) on the North and Western sides provide welcomed shade. The Western side also offers four seating options in the form of concrete-capped gabions. The Northwest corner is an appropriate area for signage announcing the garden. In this case, we are recommending a rammed earth structure with street-facing lettering.

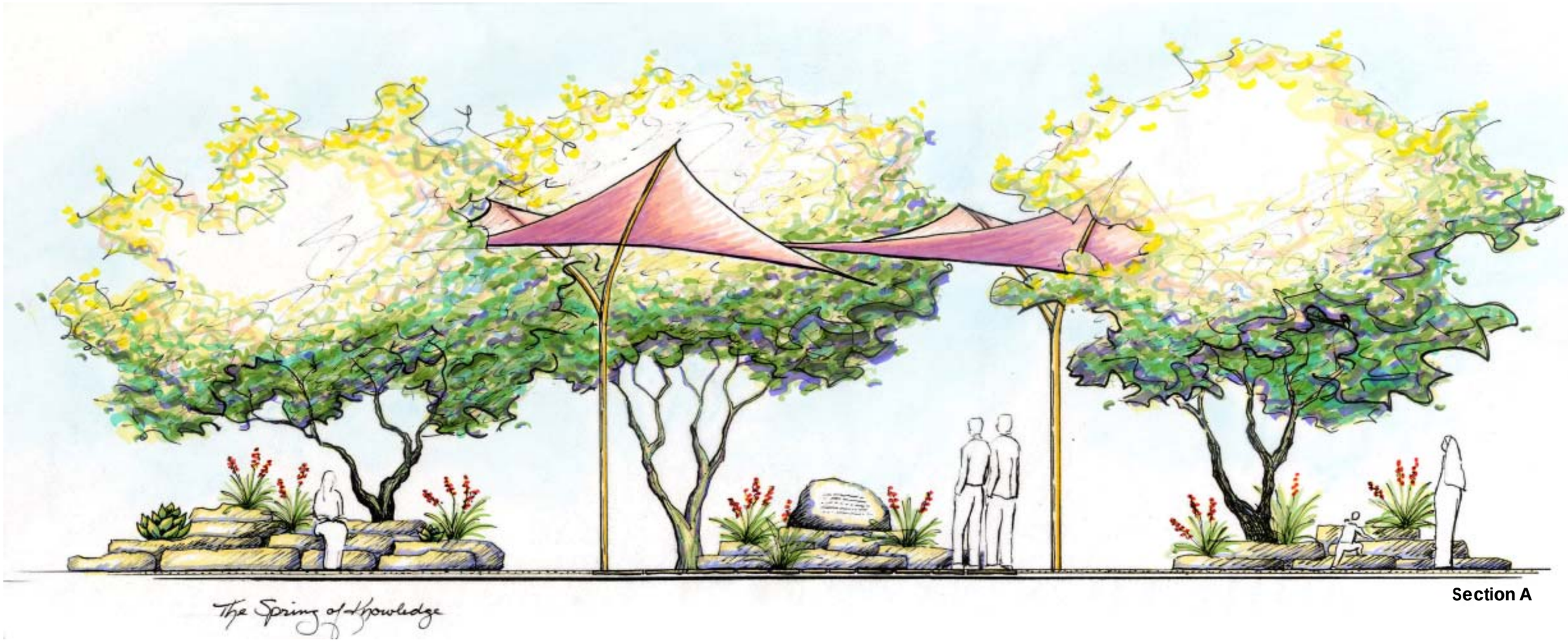
Proceeding to the center of the entry area, the visitor passes over a circular boundary, marked by changes in the paving material. Here more natural materials (native stone and decomposed granite) emphasize the idea of stepping from the urban environment into the natural world. The circle is further marked by four striking palo verde trees.

The very center of the circle contains a central grouping of stones. We are proposing to position one large prominent stone and engrave it with the hadith referred to above. This message, from a much respected authority, will welcome the visitor to the garden while conveying the overall message of the critical need for water conservation (see Section A).

A winding pathway emerges from the central grouping, clearly leading the visitor on their journey through the Water Conserving Garden.



A second element frequently found in association with springs, are the tents of the Bedouin communities. A subtle reference is made to this phenomenon through the use of tensile shade structures. Fabric tension structures provide a reliable source of shade while also yielding eye-catching forms and colors. Recent advances in fabrics, including teflon-coating, ensure long life-spans of the structures.



Section A

NATIVE PLANT GARDEN

The native plant garden focuses on the native plants of the region while also exhibiting natural or organic planting design patterns. Because the area is composed exclusively of vegetation native to Jordan, it naturally will be the lowest water-use area for the garden.

The location of the native plant display is appropriate in that it is located in close proximity to a large existing Sidra tree (*Zizyphus spina-christi*). A small seating area with local stone materials offers a small shaded area where visitors can enjoy a closer view of the plants as they relax. Each of the plant species pictured to the right are naturally occuring in Jordan.

Capparis spinosa

Zizyphus spina-christi

Colutea istria

An example of a naturalistic seating area utilizing native plants, organic forms and local materials at the Desert Botanical Garden in Phoenix, Arizona.

RECREATIONAL FIELD

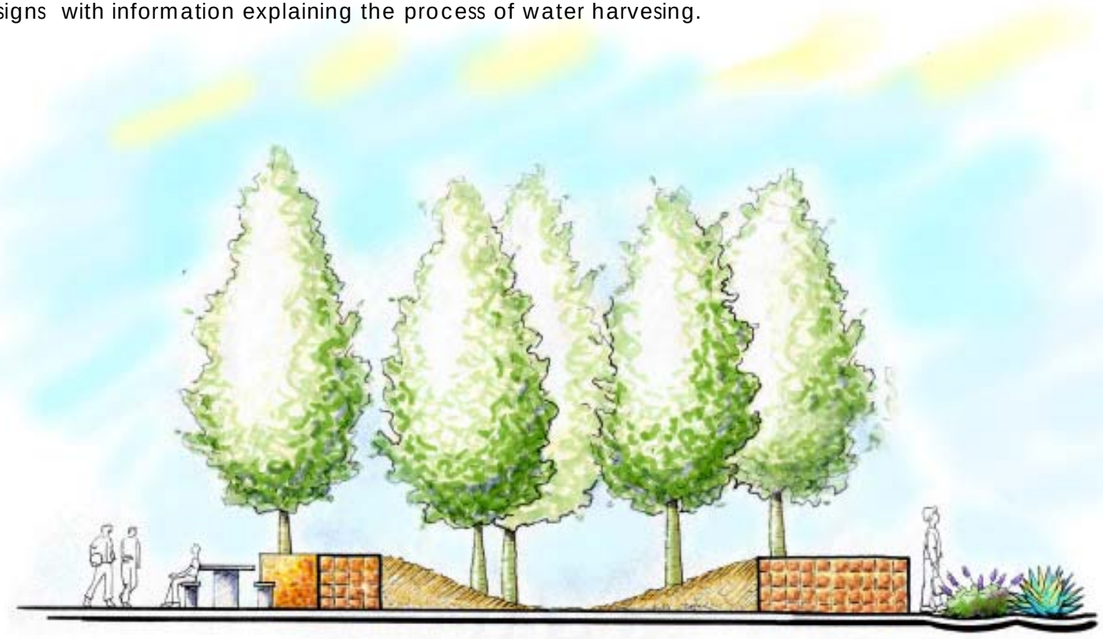
The recreational field will be a demonstration in water conservative design in several aspects. First, it is an example of an appropriate use of turfgrass. Also, the playing field should be sunken so that it occurs 0.25 M below grade in order to ensure that all irrigation water is retained on the field. The field is sized to regulation dimensions, however it is scaled to ¼ the size of a professional field. Picnic tables and seating elements are available for spectators.

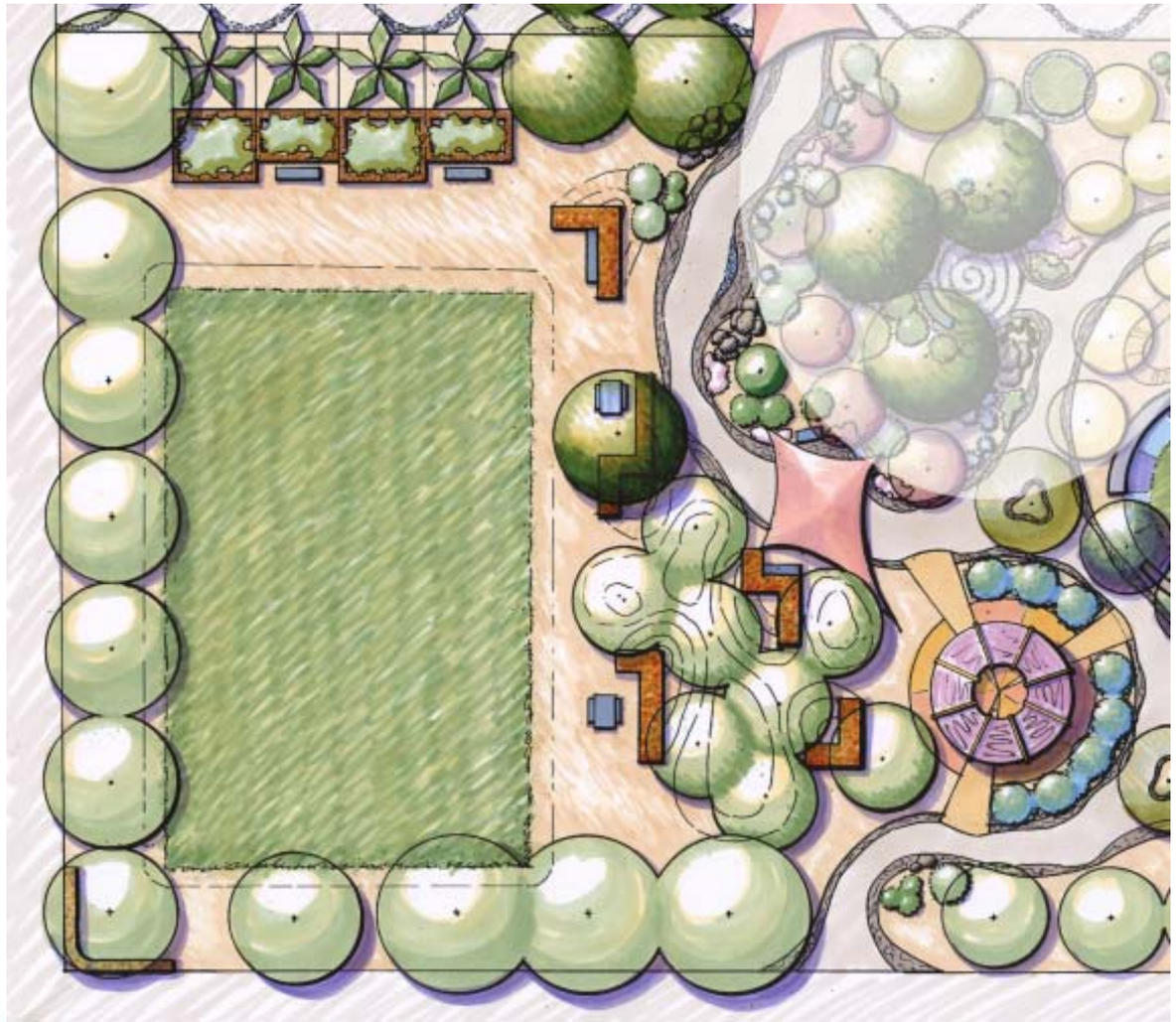
The field is intentionally placed in the Southwestern portion of the garden in order to activate this currently underutilized area. This location is further appropriate in that it minimizes the interaction of the active play area with the quieter experience occurring throughout the other areas of the garden.

WATER HARVESTING

An area of gabions further buffers the recreational field from the main wadi pathway while demonstrating the principles of water harvesting. Gabions have been used extensively throughout history for the retention of soil and the minimization of erosion. Because they are frequently associated with watercourses, gabions are appropriate in a design attempting to recall the features of a wadi.

The soil between the gabions should be bermed to demonstrate their retaining properties thereby creating swales where water will collect (see Section B). Bottle trees (*Brachychiton populneus*) should be planted in the swales. Bottle trees, although within a different family, resemble poplar trees often found in association with riverways, thus accentuating the feeling of a watercourse. The ramada area to the east of the water harvesting area would be an appropriate place to install signs with information explaining the process of water harvesing.





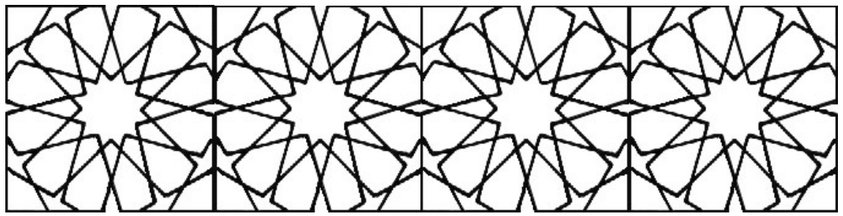
Section B
A section describes the berming of the soil between gabions and the creation of a swale. In addition to a water collecting swale, the gabions create nooks for seating opportunities. Further to the right is the ramada with interpretive information.

A detail of the rock material creating gabion structures.

Gabions as they are traditionally used for soil stabilization along a roadway in Jordan.

A gabion with a concrete cap creates an attractive seating element at the University of Arizona in Tucson.

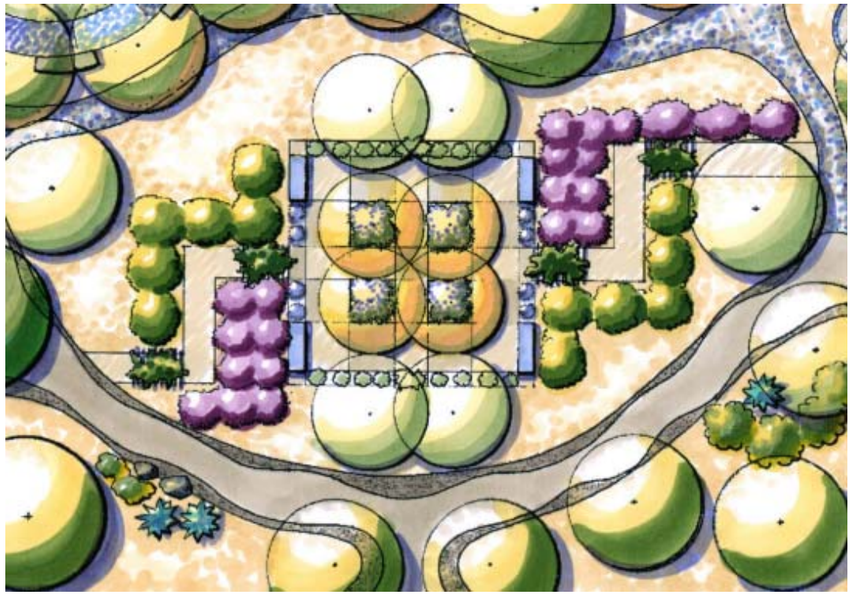
An attractive climbing structure for a flowering vine.



FORMAL/TRADITIONAL GARDEN

The formal or traditional garden is based on historic Islamic garden design elements which evoke a sense of order and harmony. These elements include symmetry, repetitive geometric patterns, the chahar bagh form or quartered garden, the transition from dark to light and classic fragrant plant materials.

Entering the garden, one passes through a series of fragrant and colorful plantings. Trellis structures covered with the native honeysuckle vine (*Lonicera etrusca*) provide shaded portals through which the visitor must pass before emerging into the lightness of the “interior” garden. The form of the garden resembles interior patio spaces traditionally found within historic palaces of the Islamic world in that it is enclosed on all sides by vegetation. At the same time, the plants chosen are of sufficiently low heights so that visual access, and thus safety, is maintained. Detailed tile work should be worked into the seating elements. Interlocking pavers, with repetitive geometric patterns, are recommended for the hardscape. The center of the garden maintains the classic chahar bagh form and is accentuated by four prominent pomegranate trees (*Punica granatum)* in depressed planting beds.



YOUTH PLAY AREA

The youth play area is an element much desired by the current users of the garden. The youth of today is a critical component to the future of water and environmental conservation. Thus, it is essential that nature and the ideas of water conservation are instilled within children at an early age.

The Western portion of the play area is partially enclosed by an undulating seating structure thereby creating a safe semi-enclosed environment for young children. The Eastern part of the play area includes the option of tables for picnic opportunities and additional parental supervision.

The youth play area serves as a model for future gardens in several aspects. First, it demonstrates an area where the use of turfgrass is appropriate. Also, the soft play area is extended through the use of an alternative soft play surface. Recycled rubber is a material that is available in many colors and shapes while offering a comfortable area for children to play. Flowering trees are strategically located along the Southern side of the play areas in order to optimize the amount of shade provided. A ramada structure with a fabric covering further provides shade and may be used specifically to reduce heat load on play structures.

The informal pathway through the play area would be an appropriate area to demonstrate a new hardscape material. Glass is a new contemporary material which is increasingly being found in the landscape. Either in the form of smooth beads or crushed and tumbled to soften edges, the material is laid in concrete and is safe to walk on with bare feet. The reflective properties of glass offer a new, intriguing, sustainable material. Considering its availability in Jordan, glass may be an exciting option to consider for future projects.

SECONDARY ENTRY AND AXIAL PATHWAY

The secondary entry and axial pathway provide a strong connection between the park and the adjacent commercial area. Planters of CMU construction with granite facing abstractly represent the granite mountains of 'Aqaba. The planters provide a buffer between the garden and vehicular traffic while creating opportunities for seating areas. The planters should be 0.75 M in height with an additional 0.5 M level surrounding as seating. The planters are an ideal location for the experimental application of hydrogel.

Near the axial pathway, alternating spaces provide picnic areas with comfortable table elements. Similarly, squares on the ground plane should alternate between colored concrete and stabilized decomposed granite. Decomposed granite material is an attractive alternative to more reflective surfaces.

The axial pathway is punctuated by a steel ramada structure enclosing a modest water element. Water features within arid environments should be deliberately designed. All fountains should recirculate their water. The presence of the water should be emphasized through accentuated sound. In this particular water feature, this is accomplished by placing rounded rocks in the catch basin which give the water secondary surfaces to splash on while echoing the sound in different directions. Appropriate catch basins are two times as wide as the feature is tall in order to recapture every drop of water. All water elements in the landscape should be shaded in order to reduce the amount of water lost to evaporation. Also, beautiful water features can be designed which demonstrate a restrained or modest use of water. This conservative approach heightens the visitor's awareness of the scarcity and sacredness of water in the desert environment.

Callistemon viminalis

Dasyliron wheeleri

Section C

The view of the secondary entry from the commercial area. The axial pathway is lined with bottlebrush trees (*Callistemon viminalis*). Also, a secondary row of the native date palm (*Phoenix dactylifera*), occurs on the South side of the pathway. The native palms are an extension of the native plant display and are reminiscent of the palm oases which were once common throughout 'Aqaba.

An appropriate water feature.

Decorative ramada detail of river rock.

A durable steel ramada structure appropriate for the desert environment.

Section D

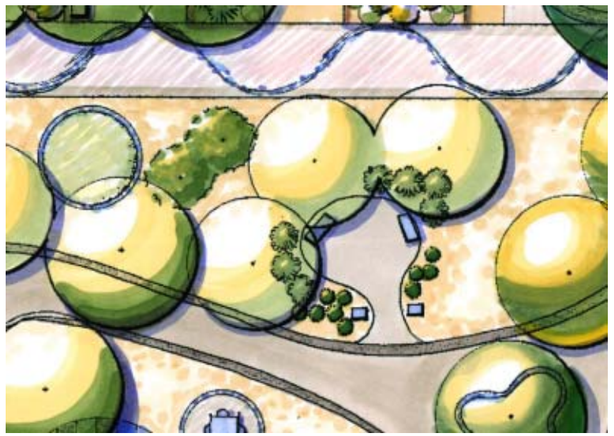
A view across the axial pathway shows the suggested welcome ramada structure. Also, a raised pathway connecting to the commercial area would help to create a safe pedestrian environment. The design of the planters has changed so that they are more regular in location and size. Also, in the latest version of the plan, the planters only occur in one row instead of two.

WADI PATHWAY

The pathway leading through the garden should emulate the experience of traveling through a wadi. The proposal is to have denser quantities of plants along the pathway, as one would find in nature near a watercourse. The selected plants, including purple fountain grass (*Pennisetum cupreum var. purpureum*) and the Mexican palo verde tree (*Parkinsonia aculeata*) have a flowing movement to them. The pathway will gently curve throughout the park and be punctuated by groupings of local stone. The greatest density of stones is found on the approach to the amphitheater. The rocks serve to buffer direct access to the amphitheater thereby prolonging one's anticipation of arrival. The majority of the pathway should be of a local stone material with an edge detail of travertine. Nodes of interest with interpretive materials should be marked with insets of round river rock.

Section E

The entire pathway should possess a gentle crown ensuring that any water on the surface is not allowed to evaporate but rather is conveyed to the planting areas to the sides. Microbasins should follow the length of the path to further ensure that available water (from cleaning, irrigation or rainfall) is directed towards the plants.



GRAYWATER

A small node off of the main pathway is the graywater information area. This area should contain a drinking fountain, with potable water, where excess water is allowed to flow to nearby plantings. A hand-washing station, also with potable water, would offer a second opportunity for the demonstration of graywater usage. Handwashing is recommended after direct contact with reclaimed water and thus should be incorporated into the site. Interpretive information should relate the processes observed in the park to the potential use of graywater in the home.

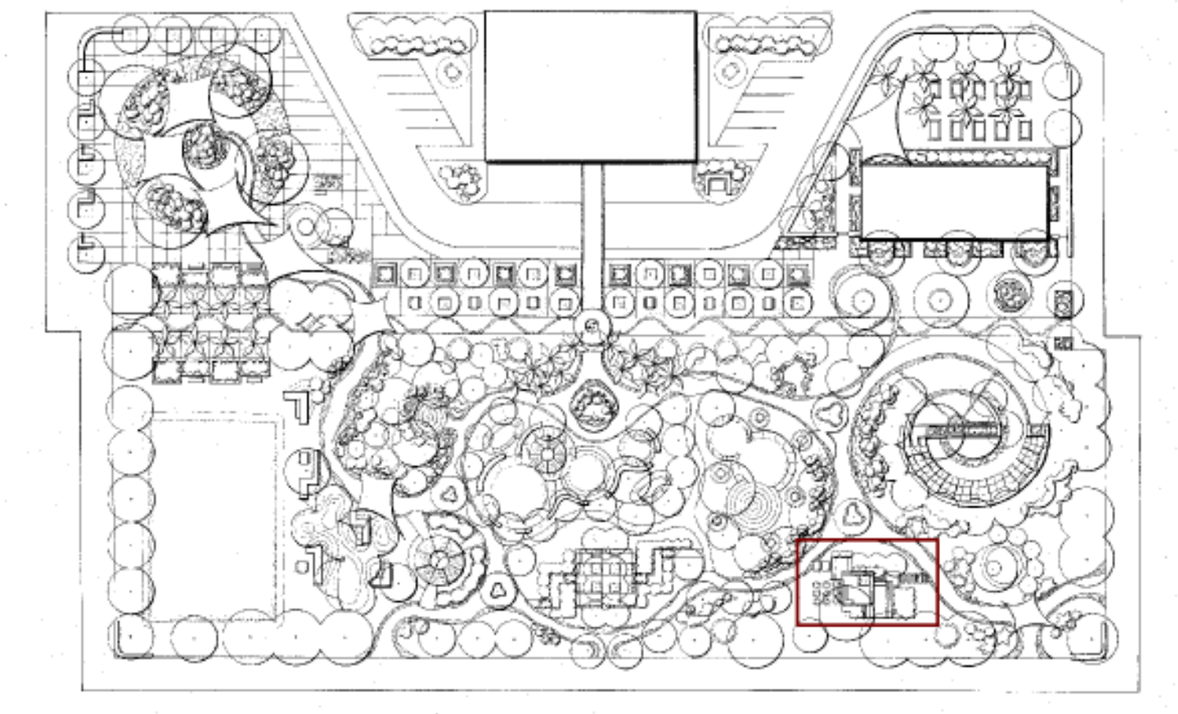
A circular area of turf is also observed in this plan view. Such spaces offer picnic opportunities. Whenever possible, installations of turf should be shaded in order to reduce evaporative water loss.

The images above and below effectively convey the form of a wadi. Similar materials are suggested for the Water Conserving Garden. However, the river is to be the main pedestrian pathway and accordingly should flow with people, not actual water.

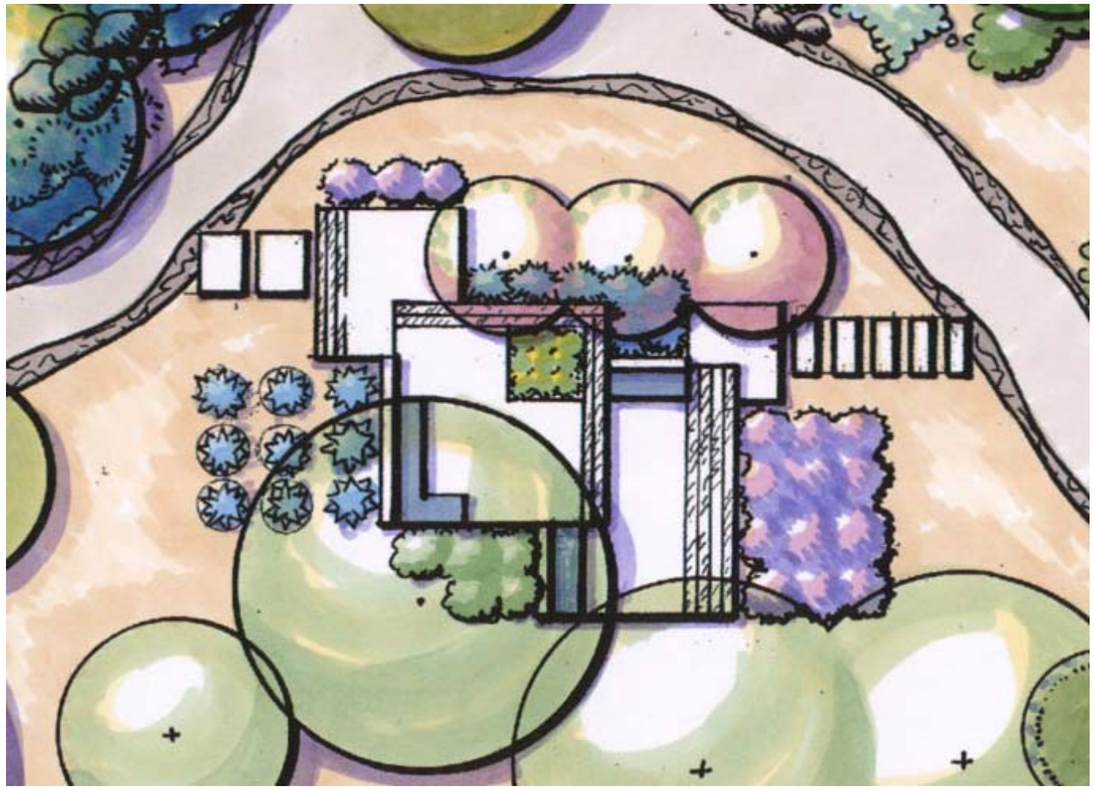
MODERN GARDEN

The next area is a display of modern garden design. It emphasizes clean geometric forms, repetitive patterns, the use of asymmetrical balance and sculptural plant elements. Specific plants utilized include *Agave palmeri, Phormium tenax* and *Albizia julibrissim*. The garden is composed of several different levels of rectilinear concrete pads with seating opportunities and geometric details. The concrete areas represent another opportunity for the introduction of tumbled and embedded glass.

The modern garden further introduces the idea of adaptive reuse. Adaptive reuse is an old idea which is gaining popularity in landscape design today. It is the practice of finding a new use or function for an old material. Adaptive reuse is very sustainable in that it often takes into consideration the reuse of materials already found on site. Much of what is found in landfills today is discarded construction materials. Thus, finding a new use for existing materials instead of simply throwing them away is a very sustainable practice. It is further advantageous in that the reused material decreases our dependence on new materials as well as their shipment to the site. Adaptive reuse is also a respectful way to highlight the former identity of a place. Numerous people spent their childhoods at the Haia Garden and it is desirable to retain a remnant of that history.



The modern garden is located in the Southeastern portion of the site. This location allows for a comfortable distance between individual garden areas and also helps to create a logical sequence through the garden. The pathway progresses chronologically from natural spaces associated with the area's nomadic past, to the traditional garden associated with cultivation, on to the modern garden display and finally to the oasis of knowledge or the future of water conservative landscape design.



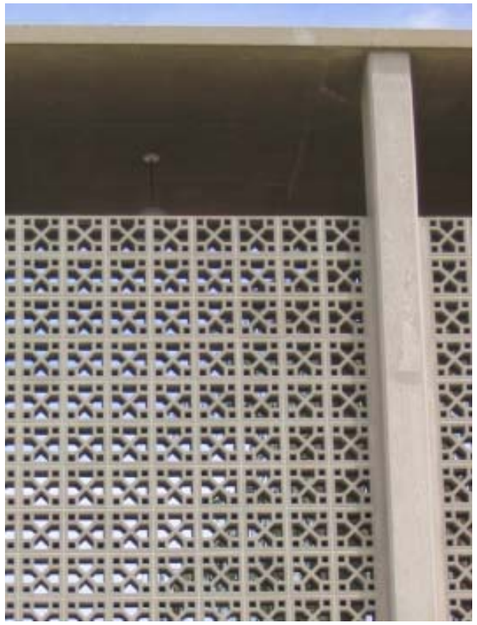
Two views of embedded glass along a pedestrain boardwalk in Santa Monica, California.

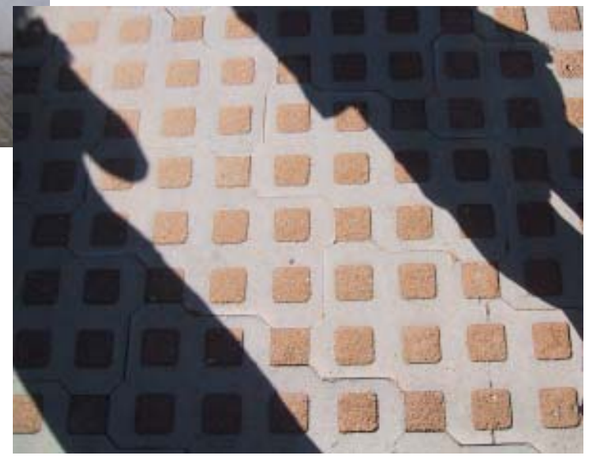
The design proposes the removal of the existing concrete wall surrounding the garden. The wall is inlaid with detailed concrete lattice work. The design proposes salvaging these lattice blocks and reworking them into details of the modern garden. One proposed reuse of them is as a decorative detail on the concrete ground plane. Utilizing this form on the ground also demonstrates another water conservative strategy. The pores of the lattice should be filled with soil thereby reducing the amount of reflective heat generated in the area. Similar porous pavers are also desirable in areas with higher rainfall as a means of reducing the amount of run-off from a site. A second proposed use of the lattice block is to build semi-transparent sections of walls throughout the modern garden area. These function to effectively divide the space while maintaining visual access important to the overall safety of the site.

Section F
A section through the modern garden area showing seating opportunities and lattice wall dividers. A silk-floss tree (*Albizia julibrissim*) provides the garden with shade.

Existing wall with concrete lattice work provides an opportunity for "adaptive reuse."

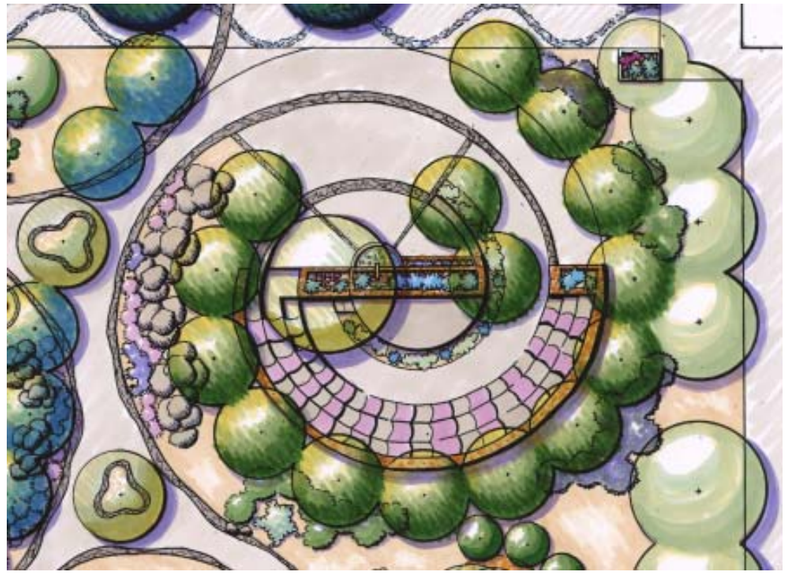
A wall of concrete lattice pieces creates a semi-transparent screen.





Permeable pavers with stabilized soil in a parking lot - Phoenix, Arizona.

Another example of glass embedded in a concrete walkway at the University of Arizona, in Tucson.

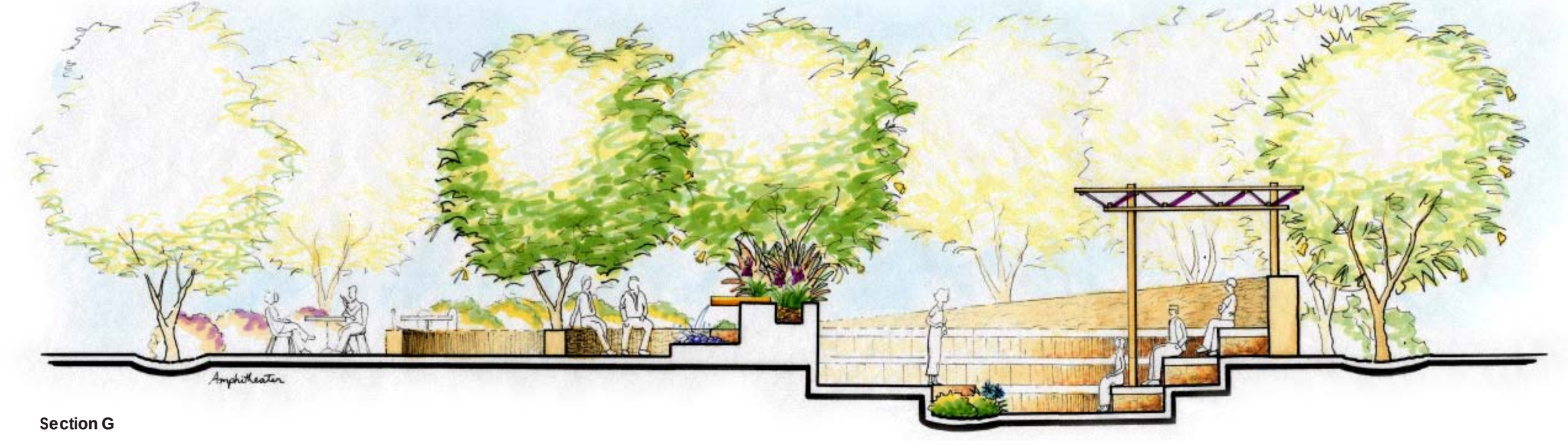


AMPHITHEATER OF KNOWLEDGE

The amphitheater of knowledge is a part of the principal water use zone and thus exhibits the atmosphere of an oasis. Plantings are more lush in nature, a water feature is present and shade and seating elements are ample. The amphitheater should primarily be a workshop and lecture space. It may also serve as a gathering space for community events.

The amphitheater should be graded so that it functions as a water harvesting display as well. The ramp leading down to the lower level of the amphitheater should be sloped so that excess water will drain to a planting area at the base of the stage.

The amphitheater rows should be constructed of gabions with concrete caps. A stone masonry wall surrounding the outer limits of the amphitheater will help to mitigate noise from outside sources. A fabric ramada structure is proposed to cover the seating area of the amphitheater.



Section G

The upper plaza has a modest water element emerging from a gabion backdrop. A conservative stream of water should flow from a metal trough into a semi-circular catch basin, two times as wide as the water source is high. The gabions should be constructed so that they additionally function as planters. A row of vegetation will help to buffer the upper plaza from the activity of the amphitheater just behind. The water feature is to be shaded by a carob tree. Travertine covered seating elements partially enclose the upper plaza.

Section H

OASIS OF KNOWLEDGE

The existing Haia Center will function as the Oasis of Knowledge. The Oasis of Knowledge should serve as a education center where people can learn more about water efficient landscape practices as well as water and resource conservation in general. Plantings associated with the building, including several large existing trees, will create a lush oasis environment.

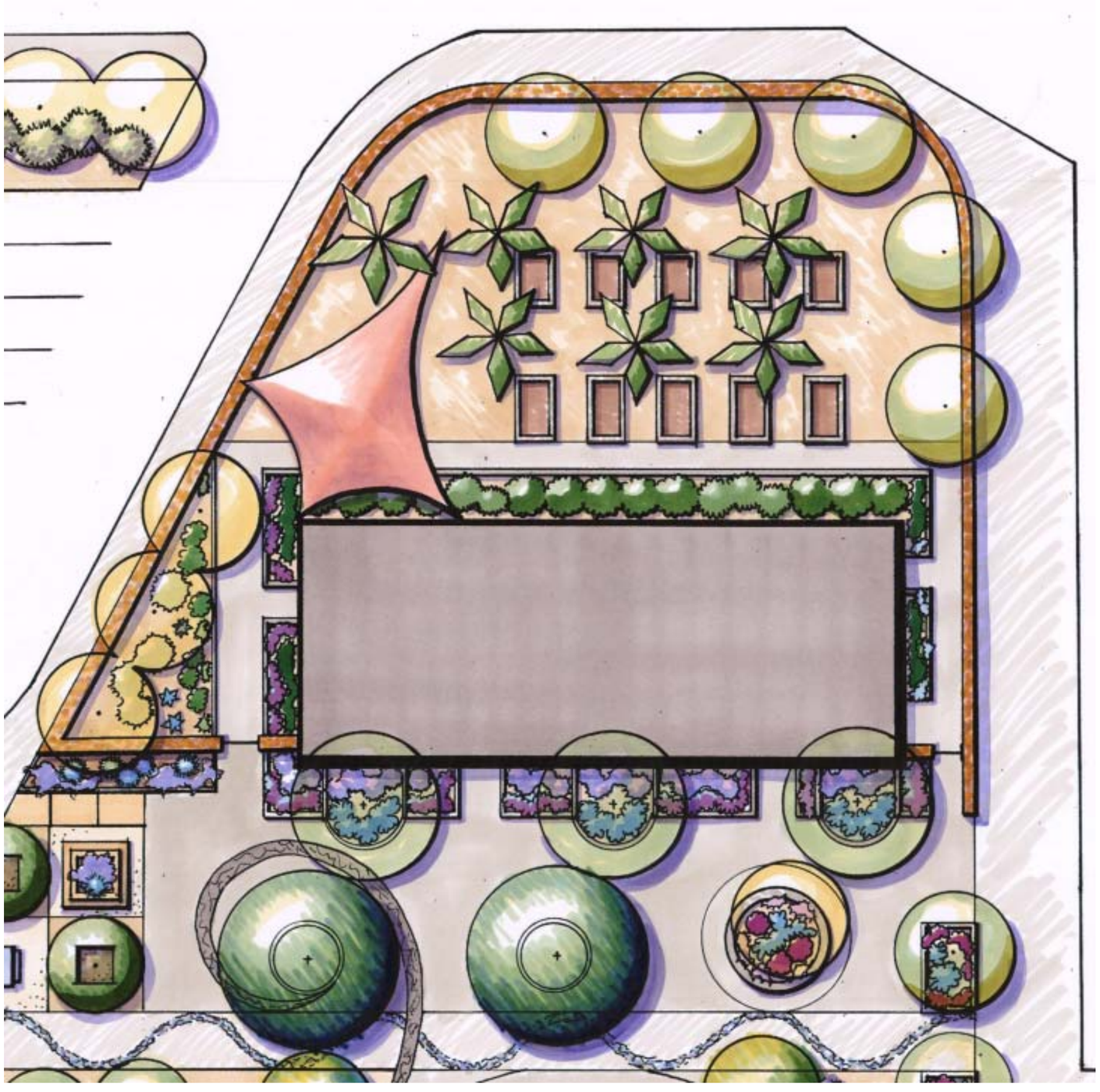
Passive solar heating and cooling is utilized through the incorporation of deciduous trees on the West side of the building. In the summer, these trees (*Robinia psuedoacacia*) will shade the structure thereby decreasing heat load. In the winter, the leaves will drop from the trees, allowing the sun's rays to warm the building.

Delonix regia

Agapanthus orientalis

Raetama raetam

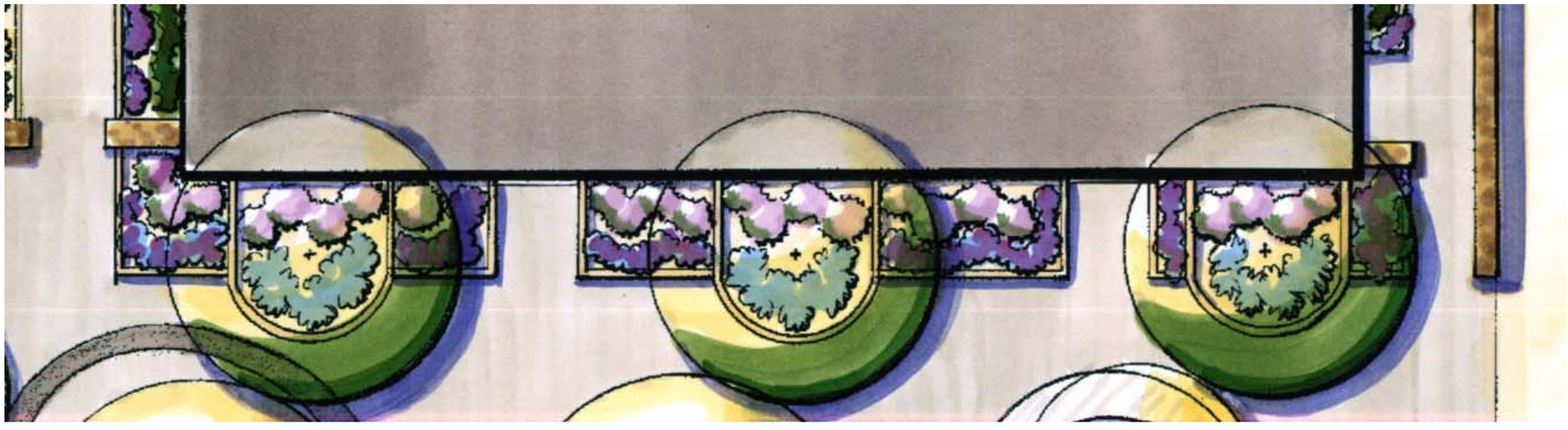
Artemesia arborescens



The planter in front of the building has been modified from the architectural remodel plans in order to preserve the existing Poinciana trees (*Delonix regia*). Instead of continuous raised planters, variations in planter heights are recommended in order to preserve the trees.

Section I

Optional iron gate detail.



HORTICULTURAL CLASSROOM

The currently underutilized space to the North of the Oasis of Knowledge will be activated by the addition of an outdoor horticultural classroom. The horticultural classroom will serve as an applied learning area where visitors would be able to learn first hand about water conservative gardening methods, irrigation and plant care. Several schools in the area could take an active part in the daily maintenance of this area of the garden.

Raised beds are recommended for the main planting area. Raised beds provide a comfortable way for people to come into close contact with plant materials while preventing soil compaction. The beds should be at seating level (0.5 M in height) and of concrete construction.

The horticultural classroom is also an appropriate area for collecting and processing compost from the community. Common food scraps collected from the kitchen could be collected in large bins. The material will naturally decompose over time yielding a rich dark medium that can be reworked into the soil throughout the garden. In order to facilitate decomposition, compost bins should be shaded as well as constructed with sufficient permeability as to allow for air exchange. Decomposition will also occur at a faster rate if the material is periodically rotated within its bin.

The upper and lower images show two different kinds of compost bins. The image to the right is of raised garden beds.

Plant materials selected for the north side of the building demonstrate the need to plant according to each species requirements. It is essential to plant species that are tolerant of shade in such areas such as: *Plttosporum tobira and Mrytus communis.* Most arid adapted plants will prefer a sunny location.

A historic rammed earth structure in Morocco.

Experimental blocks of rammed earth with color additives.

The outdoor classroom is an enclosed area, surrounded by a two meter high wall of rammed earth construction. Rammed earth is a very sustainable construction material. Rammed earth is composed of soil collected from the construction site. Thus the cost of importing material to the site is reduced. The soil is mixed with a minimal amount of cement, which acts as a binding agent. The material is loaded into forms in the shape of the desired structure. Approximately 8 inches of material are loaded and then repeatedly tamped down until it is compacted to a height of 5 inches. Another layer is added and tamped, repeating the process until the desired height of the wall is met. The process of tamping, or ramming, is analogous to the geologic processes which create large scale stratified layers of stone and earth. This stratified result and the use of the local material, are the fundamental aspects of the beauty of rammed earth.

A rammed earth wall being constructed by University of Arizona architecture students - Tucson, Arizona.

A home built of rammed earth.

NEXT STEPS - INTERPRETATION

Given that the main goal of the Water Conserving Garden is education, it is essential that the design include interpretive materials. The basic techniques of water conservation utilized throughout the park need to be explained. At the same time, the interpretative information needs to also go beyond what is directly observed in the garden. The general public should be able to understand the conservation strategies in terms of their application in the home or in the development of future outdoor spaces. The information should be conveyed in a clear and concise manner that is comprehensible and appealing to park visitors of all ages and backgrounds.

Interpretive materials can be found in many different forms, the most common of which include: signs, booklets, brochures or pamphlets. Interpretation can also be experiential in the form of a lecture or guide who offers verbal explanations. Some of the most effective interpretation comes in the form of active participation. Ideally, the Amphitheater of Knowledge and the Outdoor Horticultural Classroom will become forums where such workshops will occur.

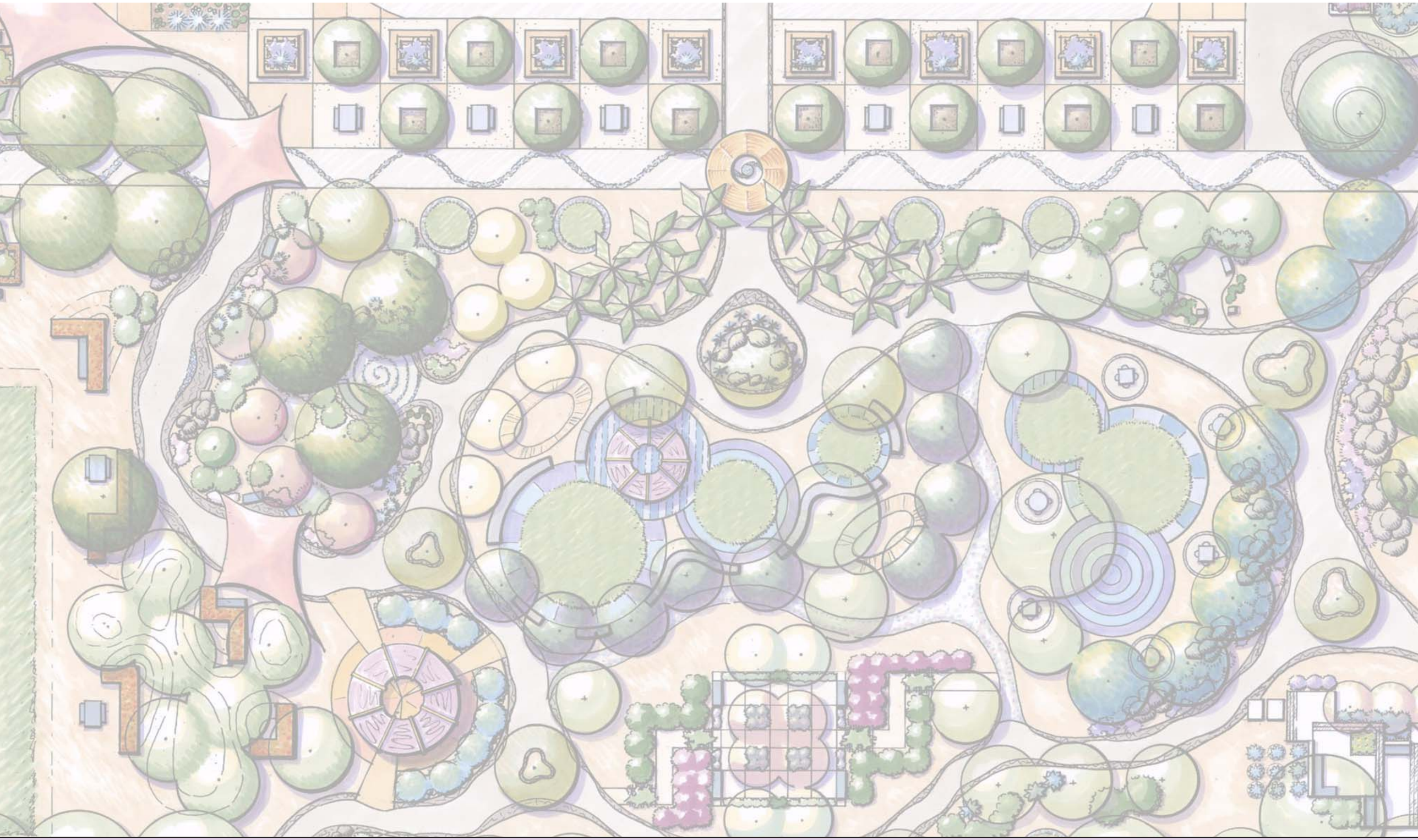
The development of interpretive materials will depend on the redefined functions of the Haia Center. If space within the Center is allocated for water conservation information, we envision interpretive materials largely in the form of booklets and pamphlets. However, if space is not dedicated within the building, then all information should be housed within the realm of the garden itself. In this case, a stronger emphasis will be put on the design of outdoor signs.

Either way, a unique identity or recognizable design language should be developed for the interpretive materials. A design language is conveyed in the form of a consistently used icon, text style, color palette and/or materials used.

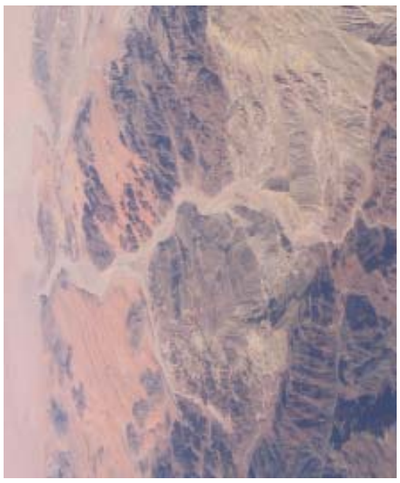
Any outdoor signage needs to be durable against the climatic elements and also resistant to vandalism. Spaces associated with points of information should be shaded and comfortable so that the experience of reading the information is an enjoyable one. Nodes of information along the main wadi pathway should provide enough space so that one group of visitors may comfortably pass while another is reading.

In addition to conveying information about water conservation, information throughout the park should be effective in terms of orienting and directing the visitor (way-finding). Ideally, this experience begins before the visitor ever reaches the site. The presence of the park should be evident from the main streets of Al-'Istiqlal and Al-Husayn bin'Ali. Once the visitor nears the site, its location should again be clearly noted from signage fronting the road of Al-Mutanabi. The orientation plaza itself should be recognizable as an entry area and drop-off point. Early in the stages of one's visit to the Water Conserving Garden, they should have a clear understanding of the garden's purpose.

Main themes which should be explained in the interpretive information include: water harvesting, reclaimed water, graywater, low water-use native plants and exotics, proper irrigation methods and water conservative design strategies.



APPENDICES

Public Survey

This survey is being conducted by a collaboration of The University of Arizona and the Aqaba Special Economic Zone, in an effort to better understand the needs and desires of the people of Aqaba, as they relate to public gardens.

- How frequently do you come to this garden?
- How many people came with you to the garden today?
- What is your favorite specific area in this garden?
- What is your favorite activity or thing to do while at this garden?
- If you could add something to this garden what would it be?
- What is your least favorite element of the garden?
- Would you prefer separate areas for different groups (men, women, children, family areas)?
- Do you primarily visit this garden, or do you go to other gardens and parks in Aqaba?
- Do you have a garden at home? If yes, what kind of plants do you have?
- Would you like to learn more information about plant materials?
- Do you think the idea of water conservation is important for Jordan? Are you interested to learn more about water conservation?
- Do you make efforts to conserve water at home? If yes, can you tell us more about what you specifically do to save water?

Thank you for your participation.

The following survey was conducted with the generous assistance of Muhandisa Deema Diab of ASEZA's Planning and Development Department, during the week of January 4, 2004.

APPENDIX B
VEGETATION SURVEY
Conducted the week of January 4, 2004

key	*scientific name*	common name	size (m)	exposure*	water**	growth***	native range	notes	qty
AA	*Arbutus andrachne*	strawberry tree	3x3	1.5	1	2	native	smooth orange-red bark, fruits resemble strawberries	6
AD	*Acacia dealbata*	green wattle	8x6	1	1	1	Australia	evergreen, common, short lived	0
AJ	*Albizia julibrissin*	silk tree	6x6	1.5	2	1	native	deciduous, pink flrs, filtered shade	1
BP	*Brachychiton populneus*	bottle tree	10-15x6	1	1	2	Australia	park & street tree	8
CFi	*Cassia fistula*	golden shower tree	6x4.5	1.5	1	1.5	India	endures salt, evergreen, yellow fragrant flrs	3
CFl	*Cercidium floridum*	blue palo verde	9x9	1	1	2	US	deciduous, unique green trunk	4
CL	*Chilopsis linearis*	desert willow	8x8	1	2	1.5	US	long-lasting bloom, low maintenance, decid	8
CSe	*Cordia sebestena*	geiger tree	5x4	1	1	2	US	salt tol, dark orange flrs, evergreen	4
CE	*Ceratonia siliqua*	carob	8x8	1	1	3	Mediterranean	evergreen, good street tree	20
CSm	*Cercis siliquastrum*	redbud	6x5	1.5	1	1	native	purple-red flrs, deciduous	4
CV	*Callistemon viminalis*	weeping bottlebrush	6x5	1	2	2	Australia	evergreen, bright red flrs, tropical effect	13
DR	*Delonix regia*	flame tree	10x10	1	1	1	Madagascar	deciduous, brilliant red flrs	3
FC	*Ficus carica*	edible fig	6x6	1.5	2	2	Mediterranean	deciduous, Mediterranean, edible fruit	0
LI	*Lagerstroemia indica*	crape myrtle	5x4	1.5	2	2	China	salty water	3
LN	*Laurus nobilis*	Grecian laurel	6x4	1.5	2	3	Mediterranean	traditional formal tree, accepts clipping well, aromatic evergreen culinary herb	4
MO	*Moringa oleifera (Peregrina)*	moringa	5x4	1	1	unk	Red Sea, Arabia, N. Africa	seeds traditionally used for water treatment (Sudan)	3
OE	*Olea europaea*	olive	6x6	1	1	2	Mediterranean	med native, good for streets or parks, evergreen	9
PA	*Parkinsonia aculeata*	Mexican palo verde	6x6	1	1	1	N. America	branches, filtered shade, bright yellow flowers, leaf	7
PD	*Phoenix dactylifera*	date palm	25x7	1	3	2.5	N. Africa & W. Asia	classic symbol of desert oasis, edible fruit, formal,	12
PI	*Pistacia atlantica*	Mt Atlas pistacia	10x10	1	1	3	Mediterranean	decid, great for parks, streets, public spaces, low maintenance, almost evergreen	4
PG	*Punica granatum*	pomegranate	5x5	1	2	2	native	frt+flr, fall color, decid	5
RP	*Robinia pseudoacacia*	black locust	8x5	1	1	1	US	decid, hardy, fragrant flrs	5
SJ	*Sophora japonica*	Japanese pagoda tree	6x6	1.5	1	2	China & Korea	excellent for parks & streets	9
SP	*Salvadora persica*	siwak/salvadora	5x3	1	1	2	native	historically stems chewed on for dental hygiene, red berries attractive to birds	4
TP	*Thevetia peruviana*	yellow oleander	6x5	1	4	1	Tropical America	lasting large colorful flrs, tropical effect, evergreen/poisonous	15
VA	*Vitex agnus-castus*	monk's pepper tree	5x5	1	2	1	S. Europe	purple flrs, decid	0
ZS	*Ziziphus spina-christi*	jujuba, "sidra"	8x6	1	1	2.5	native	decid, low maintenance, fall color, edible fruit, great shade tree	3
Notes									
* Exposure: 1 = full sun, 2 = part shade, 3 = shade									
** Water Requirements (after plant establishment): 1 = 1x/month, 2 = 2x/month, 3 = 1x/week, 4 = 2x/week									
*** Growth rate: 1 = fast, 2 = moderate, 3 = slow									

key	*scientific name*	common name	size (m)	exposure*	water**	growth***	native range	notes	qty
AAs	*Artemisia arborescens*	sagebrush	1x0.5	1	1		Mediterranean	silver lvs, yellow flrs	40
AH	*Atriplex halimus*	salt bush	2x3	1	1	1.5	Mediterranean	salt tolerant	3
AOr	*Agapanthus orientalis*	Lily of the Nile	0.5x0.4	1.5	4	2	Africa	evergreen, blue flowers	32
BD	*Buddleia davidii*	butterful bush	1-2x1	1	4	1	China	deciduous, white/violet or pink flrs	49
BT	*Berberis thunbergii*	Japanese barberry	1x1	1.5	3	2	Japan	crimson lvs	57
CC	*Cistus creticus*	pink rock rose	1	1	1		native	evergreen, (salt tolerant)	26
CG	*Caesalpinia gilliesii*	yellow bird of paradise	3x1.5	1	1	1	Argentina/Uruguay	seeds poisonous, prefers well-drained soil, great for revegetation	11
Cl	*Colutea istria*		2x2	1	1		native	decid/karakash, yellow flrs, inflated pods	4
CM	*Carissa macrocarpa*	Natal plum	1x1	1.5	2	1.5	S. Africa	edible fruit, accepts shearing well, prefers well-drained soils, spines	16
CN	*Cestrum nocturnum*	night jessamine	2x2	2	4	1.5	Indies	white flrs w/ powerful scent at night	0
CP	*Caesalpinia pulcherrima*	red bird of paradise	3x2	1.5	1	1	Indies & Mexico	mass plantings, orange-red flr display, prickles, semi-evergreen (cut back in late winter - rapidly regrows)	10
CSa	*Cistus salviifolius*	white rock rose	0.6x0.75	1	1		native	evergreen, white flrs	0
CSp	*Capparis spinosa*	capper	1-1.5	1	1		native	silver lvs, white flrs	9
CW	*Cassia wislizeni*	shrubby senna	1x1	1	2	2	US	yellow flrs	14
EH/M	*hierosolymitana*	spurge	0.2-0.4		1		native	evergreen	12
GA	*Globularia arabica*	Arabian globularia	0.15-0.4	1	1		native	pink flrs	12
KU	*Kniphofia uvaria*	torch lily	0.7x0.5	1	2	1	S. Africa	evergreen perrenial, yel/orange flr.	10
LA	*Lavandula angustifolia*	lavender	0.8x0.8	1	4	2	Mediterranean	aromatic herb	16
LF	*Leucophyllum frutescens*	Texas sage	2.5x2.5	1	1	2.5	Mexico & US	screen, good for parks, tolerates shearing, evergreen,	11
LLe	*Leonotis leonurus*	lion's ear	0.7x0.7	1.5	4	1	Africa	decid shrub, orange flrs	23
LS	*Lycium shawii*	wolfberry	1-2	1	1		native	natural to saline environments	4
LW	*Lawsonia inermis*	henna	4-4	1.5	1	2	old world	evergreen, fragrant	2
MC	*Myrtus communis*	true mrytle	2.5x1.5	1.5	2	2	Mediterranean	dense, evergreen, formal hedge, aromatic lvs	23
ON	*Ononis natrix*	sticky restharrow	0.6	1	1		native	evergreen shrub, yellow flrs	8
PL	*Plumbago auriculata*	cape plumbago	3x3	1	3	1	S. Africa	blue flrs, fewer flrs with trimming	8
PTe	*Phormium tenax*	flax	1.5x1	1	3	2	New Zealand	dramatic grass-like perennial	27
PTo	*Pittosporum tobira*	Japanese mock	2.5x2	2	3	2	China/Japan	evergreen shrub, yellow flrs	11
RO	*Rosmarinus officinalis*	rosemary	1x0.7	1	2	1	Mediterranean	evergreen, fragrant culinary herb, attracts bees,	22
RR	*Retama raetam*	white broom	2x2	1	1		native		11
SCi	*Senecio cineraria*	dusty miller	0.7x0.5	1	2	1	Mediterranean	silver lvs, yellow flrs	50
SCo	*Salvia coccinea*	scarlet salvia	1x0.7	1.5	4	1	C. America	red flrs	0
SCs	*Santolina chamaecyparissus*	lavender cotton	0.3x0.4	1	1	2	Spain & N. Africa	evergreen, aromatic silver lvs, yel flrs	9
SV	*Salsola vermiculata*	saltwort	1x1	1	1		native		0
TC	*Tecomaria capensis*	cape honeysuckle	2x1.5	1.5	2	1	S. Africa	evergreen vine or shrub, lasting orange flrs, salt	8
TF	*Teucrium fruticans*	bush germander	1x1	1	2	2	Mediterranean	evergreen, silver lvs, violet flrs, needs good dainage	31
TS	*Tecoma stans*	Mexican yellow bells	4x5	1	1	1	Mexico & Indies	evergreen, yellow flrs	0

APPENDIX E

WATER CONSERVING GARDEN

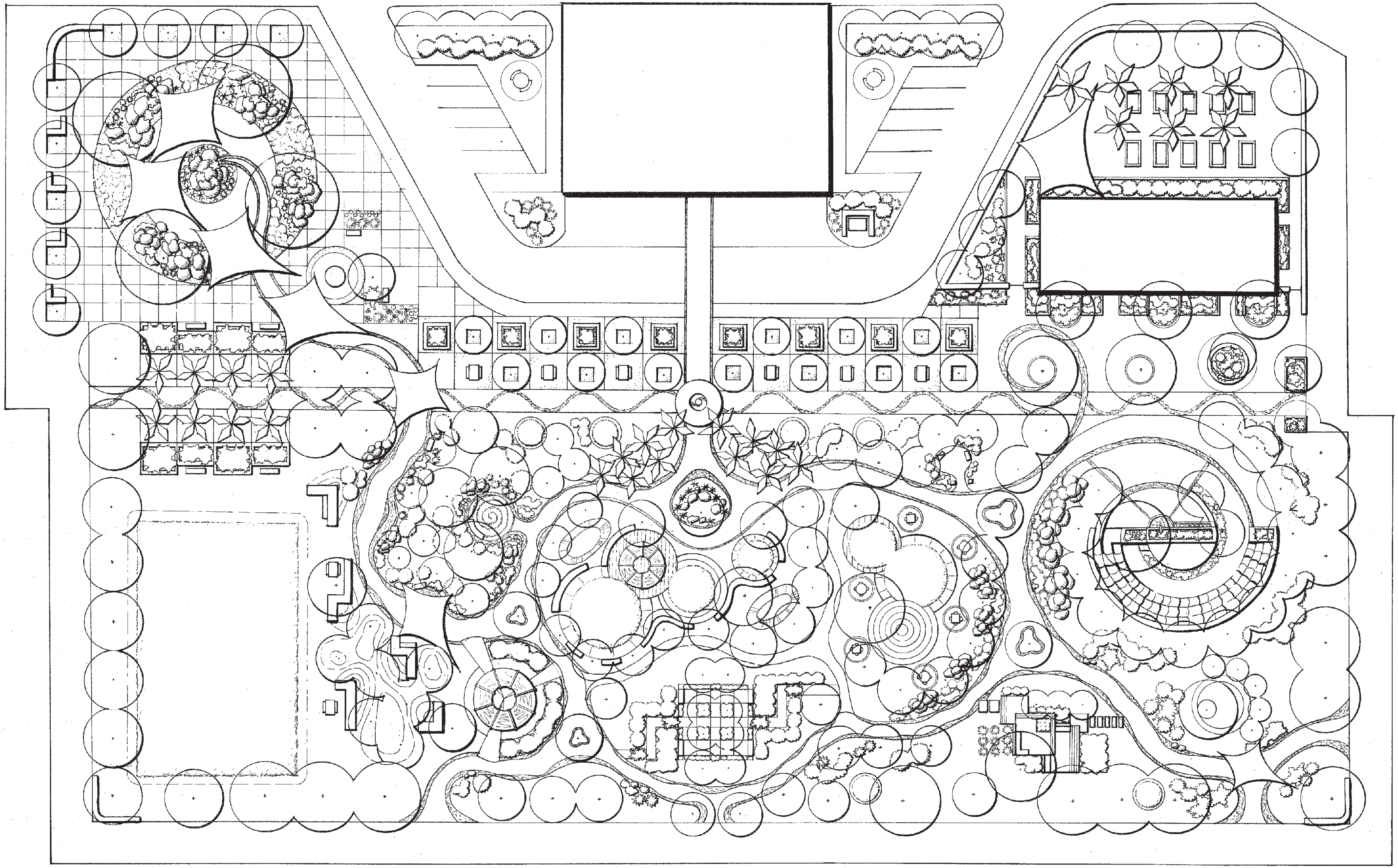
OTHERS - Unique Growth Forms

key	*scientific name*	common name	size (m)	exposure*	water**	growth***	native range	notes	qty
AAe	*Asphodelus aestivus*	asphodel	0.6x1.2	1	1	2	native	per bulb	18
AAt	*Agave attenuata*	century plant	1-1.5x1	2.5	2	2.5	S. Mexico & C. America	thornless, soft gray-green lvs	33
AN	*Aloe nobilis*	aloe	0.2x0.3	1.5	1	2	Africa	succulent/orange flrs	15
AO	*Adenium obesum*	desert rose	1x1	1.5	2	2	Central Africa	evergreen, great in containers, tolerates high soil temps	3
AP	*Agave palmeri*	Palmer's agave	1.5x1	1.5	1	2	Mexico & US	great in containers,	9
AV	*Agave vilmoriniana*	octopus agave	1x1.5	1.5	2	3	Mexico	sculptural lvs, short lived, less available	5
CB	*Cactus-barrel*	barrel cactus	0.3x0.4	1.5	1	3	US	succulent w/ bold form, low maintenance, spines	19
CC	*Cactus-columnar*	columnar cactus	0.3x1	1.5	1	3	S. America	succulent, low maintenance, spines	5
CD	*Cynodon dactylon*	turf	gcover	1.5	4	1	Africa	turf grass, high maintenance	690 sq m
CR	*Campsis radicans*	trumpet creeper	8x8	1	1	1	Eastern US	self-climbing, decid vine, large orange flrs	0
DF	*Drosanthemum floribundum*	rosea ice plant	0.4x0.5	1.5	2	2	S. Africa	pink flr, gcover, succulent, prefers coastal climate, great for slopes/erosion control	100
DS	*Dasylirion sp.*	desert spoon	1x1	1.5	1	2	Central Mexico	bold accent	19
EI	*Echeveria imbricata*		0.1x0.2	1.5	2	2	unknown	succulent, silver flrs, winter interest	0
HP	*Hesperaloe parviflora*	red yucca	1x1	1.5	1	2.5	Mexico	succulent, pink flrs, low maintenance	40
IS	*Iris sp.*	iris	0.4x0.2	1.5	3	1	native	purple or violet flrs	13
KS	*Kalanchoe sp.*		0.4x0.4	2.5	2	2	unknown	silver leaf/succulent	37
LE	*Lonicera etrusca*	Italian honeysuckle	0.5x4	1.5	2	1	native	evergreen vine, yellow flowers	4
OF	*Opuntia ficus-indica*	India fig	2x2	1	1	3	unknown	evergreen succulent, edible fruit, container plant, spineless	6
PS	*Pennisetum setaceum var 'Cupreum'*	red fountain grass	1x1	1.5	1	1	Africa	perennial ornamental grass, red lvs, erosion control, cut back foliage in fall or winter	25
VV	*Vitis vinifera*	grape vine	6	1	1	1	native	decid vine, edible fruits	2
YA	*Yucca aloifolia*	Spanish bayonet	4x1.5	1.5	1	2	US & Caribbean	salt tolerant, container plant, succulent, low maintenance, terminal spines	3
Notes									
* Exposure: 1 = full sun, 2 = part shade, 3 = shade									
** Water Requirements (after plant establishment): 1 = 1x/month, 2 = 2x/month, 3 = 1x/week, 4 = 2x/week									
*** Growth rate: 1 = fast, 2 = moderate, 3 = slow									

Note: Plants specified as 0 quantity refer to low water-use species that will be considered for incorporation into the Water Conserving Garden in the event that substitutions are required.

APPENDIX F

MASTER PLAN - September 2004



WATER CONSERVING GARDEN

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