

Wadi Hanifah Restoration Project

ARRIYADH DEVELOPMENT AUTHORITY I MORIYAMA & TESHIMA I BURO HAPPOLD I MARCH 2010



As recently as March 22nd, 2010, the United Nations Environmental Program released a report to coincide with World Water Day highlighting the dire consequences of "sick water" globally. The report states that "more people die from polluted water every year than from all forms of violence, including war… "

The UN Report states that an estimated two billion tons of waste water – including fertilizer run-off, sewage and industrial waste – is being discharged daily fueling the spread of disease and damaging ecosystems. It is estimated that 3.7% of all deaths globally are attributed to water-related diseases, translating into millions of deaths.

In the context of such stark reality, the Wadi Hanifah Restoration Project could not be of greater significance. We are honoured to present the Project in the following pages.

The Vision

The overall concept for Wadi Hanifah is of a 'Living Wadi' brought to health and sustainability and fully integrated into the life of Riyadh. The Vision sees Wadi Hanifah as clean, green, safe and healthy.



It transforms problems into opportunities, leading to a sustainable and productive setting, a continuous ribbon of naturalized parklands that interconnects the city and the Wadi, in which residential development, farming, recreation, cultural activities and tourism exist in harmony within an oasis that extends the full length of the City, and into the surrounding rural areas.









Bringing Environments Back From The Dead

Synopsis

Imagine ... an urban generated river flowing in the heart of a desert nation, the Kingdom of Saudi Arabia, within an ancient basin – the Wadi Hanifah. What would happen if this critical natural heritage resource died?

As recently as 2001, the river was so polluted from direct dumping of industrial and municipal waste water that animals and fish float dead in its waters. It was so damaged that an entire eco-system along its shores and within a 4500 sq km catchment area was close to extinction.

Now imagine that – through a completely natural yet groundbreaking processes of naturalization and bio-remediation – an inspired client and a team of planners, landscape architects and engineers, over a period of almost 10 years, succeeds in saving Wadi Hanifah. An eco-system is restored to its natural greatness and continues to be the sustainable source of life for the City that it once was.

The Arriyadh Development Authority as client, working closely with Canadian architecture and planning firm Moriyama & Teshima, in partnership with UK engineering firm Buro Happold, has achieved this very feat: through a visionary Master Plan, Restoration Program and ongoing enhancments. Wadi Hanifah is living and thriving once again today.

Photos:

1 / Map of Riyadh and the Wadi. 2 / Images of polluted waters before the Wadi Hanifah Restoration and Flooding Project was implemented. 3 / A restored Wadi. Wadi Hanifah is an outstanding example of recapturing urban wastewater and putting it to work transforming the city's relationship with its most significant natural feature, creating opportunities and benefits for its people. The Wadi Hanifah project is truly a project of global significance: it is a proven, measureable and tested vision and strategy with the capacity to restore degraded water and



ecological systems in urban environments. If Wadi Hanifah, its natural environment and 4500 sq km catchment area in the heart of a desert can be restored and successfully 'greened,' imagine the potentials of this comprehensive approach in locations around the world where humans and nature exist in conflict.







The following pages present the Wadi Hanifah Master Plan and Implemented Restoration Project, endeavoring to summarize a decade of complex environmental planning and design combined with the fundamentals of ground-breaking bio-remediation science that have produced, and continue to produce outstanding measureable outcomes:

- A river back from the dead;
- Urban waste water remediated so that it is safe for human contact;
- Large quantities of urban waste water are recycled back to the people of Riyadh for reuse;
- Developed an entirely unique bio-remediation facility that is already performing beyond expectations and at a capital cost of 1/3 of a mechanical treatment plant;
- An eco-system naturalized and restored, thereby 'greening' the desert with its indigenous flora and fauna;
- A city transformed, no longer turning its back to a polluted Wadi Hanifah;
- · Socio-cultural and economic benefits;
- People of Riyadh from all walks of life gathering together to enjoy public parks and open green spaces and parks along the Wadi for the first time in their lives;
- Real estate values along the Wadi soaring by ten-fold;
- An emerging collective pride and confidence that comes when people experience visible and tangible positive change in their environment and recognize the commitment of their leaders to a sustainable future; and
- Government and community commitment to responsible stewardship of the Wadi, and an array of environmental and educational programs that include the community.







The Site:

Riyadh (ar-Riyadh: meaning "The Gardens") is the capital and largest city of Saudi Arabia. It is also the capital of Riyadh Province, and belongs to the historical regions of Nejd and Al-Yamama. It is situated in the center of the Arabian Peninsula on a large plateau, and is home to 4,854,000 people, and the urban center of a region with a population of close to 6 million people.

The Study Area:

120 km stretch of Wadi Hanifah running through Riyadh; Catchment area of 4500 square kilometers.

Master Plan Period:

2001 to 2004 - Master Plan development, Restoration Designs, and design of Enhancements.

Construction / Implementation Period: 2004 to present.



Wadi Hanifah Quick Facts:

- 120 km in length
- 500,000 m3 dumping removed
- 10 million m2 cleaned wadi bed
- 2.5 million m3 in reprofiling cut and fill
- 40 side Wadis (10 major wadis)
- 9 major parks created
- 5 lakes created (25.1 hectares total surface area)
- 7.4 km pedestrian promenades
- 46.8 km of recreational trails created
- 30 toilet blocks designed and built
- 30,000 shade trees planted
- 6,000 planted date palms
- 50,000 shrubs planted
- 2,000 large Acacia transplanted
- Bio-remediation Facility consisting of 134 bio-remediation cells designed and built
 - 42.8 km of Wadi roads



- 2,000 parking spaces created
- 350,000 cubic metres of urban wastewater cleaned per day (2010)
- 1,200,000 cubic metres of urban wastewater cleaned per day expected in 2025
- 730 pieces of wayfinding and interpretive signage
- 2,500 light standards along walking trails and wadi roads
- 600 pieces of feature lighting







Summary of the Naturalization Strategy: Components and Process

Naturalization

One of the first steps in the naturalization process to bring the Wadi back to life was to clear the entire Wadi river-bed of dumping and debris. This was followed by extensive re-grading and floodprofiling measures including the relocation and installation of utilities and roadways. Once the Wadi bed had been cleared of dumping, re-graded and flood-proofed and the utilities and roads redeveloped, the next task was to begin the naturalization process that would lead to re-vegetating Wadi Hanifah with the same indigenous species of plants that once inhabited it. Following the identification of key species indigenous to Wadi Hanifah, the ADA and its contractors collected cuttings and seeds from some of the least damaged portions of the Wadi and began the process of growing thousands of trees, shrubs and grasses in the ADA greenhouses, a process we termed 'greening the desert'.

The new plants were installed in over 150 different designs of planting cells and constructed by the thousands within the Wadi bed along 70 km of its length. The planting cells were designed for the unique Wadi conditions. They consist of gravel-topped planting beds that become local nurseries which seed to propogate the greenery across the Wadi bed, thereby naturalizing the continuous open spaces. Within three years these planting cells have proven very effective and are transforming the bare earth of the Wadi bed into greenery for the people to enjoy.







Naturalized Desert Parklands

Rather than developing 'European style' parklands, the Master Plan recommended that the Wadi Hanifah be landscaped as Naturalized Desert Parklands that fit with and are indigenous to Riyadh's arid desert setting and ecology. This has resulted in a new landscape of desert greenery and limestone rock works that meld with the surroundings to become 70 km of naturalized desert parklands.











Wadi Parks

In keeping with the Master Plan vision, principles and recommendations, seven major Wadi parks have been completed and two more parks are under construction, including a large water park. The parks have been developed with visitor amenities and ample parking. Since picnicking is a Riyadh family recreational pasttime, all parks have been designed to accommodate hundreds of families. Three parks have a strong water focus, utilizing water cleaned by the bio-remediation facility. All of the parks are major people attractions. The response of the public has been absolutely overwhelming in their enthusiasm for the new parks. For the first time in decades the people of Riyadh are enjoying the Wadi and relaxing in green settings that bring families from all walks of life together.



Bio-remediation Facility

Simply put, clean water creates opportunities for wide-scale public use. By improving Wadi Hanifah water quality, the greater the potential is for regaining the Wadi environment as the most significant open space in Riyadh.

Bio-remediation is a general term applied to the use of natural biological functions for the remediation of a variety of environmental damages. It's nature's way of cleaning water. This naturally occurring process can be augmented in wastewater systems through the establishment of an ecologically efficient food web consisting of not only primary producers (algae and higher plants) but also consumer organisms (fish,birds, insects, etc).

This became the preferred methodology of cleaning the water because it enhanced the natural processes of the Wadi ecology, and was less costly than mechanical treatment. This has futher contributed to environmental quality of the Wadi, which in turn has greatly enhanced public perception and public use.

Within the dry weather flow channels of the Wadi Hanifah watershed, naturalized channel design provides continual bioremediation of toxicants, harmful bacteria, and excess nutrients (contaminants from urban and rural discharge) in the year-round flow.

The main Bio-remediation Facility is located north of the main highway interchange and incorporates a series of weirs, riffles, pools, aerating pumps, bioremediation cells, artificial periphyton & benthic substrates, and riparian planting. Together, the elements of this design have developed the appropriate aquatic and riparian conditions to assimilate contaminants and further remediate the water through a community of natural organisms that aggregate to form a food web.

While all principles utilized in the Bio-remediation Facility are proven, the design of the system integrates a hybrid of natural ecological principles and is the first of its kind in the world. This project is already successful in providing water treatment while creating a one-of-a-kind natural facility and open-space public attraction.











Bio-remediation Facility Objectives

The Bio-remediation Facility is designed as habitat and natural structures to support the biology that will do the work of cleaning the water.

The three main goals of bio-remediation are:

Reduction of fecal and total Coliform bacteria to safe levels;
 Elimination of bad odours; and

3. Prevent cumulative negative impacts of nutrient load through the Wadi.

The Bio-remediation Facility is the integral part of the Wadi Hanifah Restoration Project. The main treatment process of the water comprises 3 main functions that will take place in this area:

- 1. Aeration to kill the coloform bacteria in the water;
- 2. Development of a food chain to bio-accumulate excessive nutrients derived from urban sewage and wastewater; and
- 3. De-nitrifying (to metabolize nitrogenous compounds) to reduce odours emanating from the wastewater.

The four components of the Bioremediation Facility are designed to enhance the natural treatment process are:

- Biocells These are the basic units of the Bio-remediation Facility which are responsible for the bulk of nutrient assimilation. The whole facility consists of 3 biocell groups as follows: Group 2 (20 biocells), Group 3 (34 biocells) and Group 4 (80 biocells);
- Aeration System This provides sufficient levels of dissolved oxygen (DO) to the system killing coliform bacteria and creating favorable conditions to microbes, fish & other aquatic organisms;
- Artificial Periphtyon Benthic Substrates Provide substrates for biofilm / periphyton which is essential for bio-accumulating nutrients through the food chain; and
- **4.** Fish (Tilapia) Serving as the top of the food chain and controlling the growth of filamentous algae.





The Bioremediation Sampling Monitoring Program is designed to allow for water sample collection at strategic locations. The data collected is used to determine the treatment efficiency of individual biocells, groups of cells and of the entire facility. There are twenty-two (22) water quality parameters being analyzed in each location and grouped under four principal categories: General Variables; Organics; Nutrients; and Microbiology.

The long term purpose in collecting and analyzing data is to compare system performance to the Master Plan design objectives, in addition to developing long term bio-remediation operation and maintenance protocols.

A summary of water quality analyses is presented in the Nelson Environmental "Bioremediation and Surface Water Monitoring Report" dated February, 2010.

Bio-remediation Facility Performance

Based upon early testing and analyses – only five (5) months of data sets from August 2009 to February, 2010 – Nelson Environmental reported conclusive data in several key areas:

- Suspended solid removal rates are high (clear water).
- Ammonia removal rates are high.
- Fecal and total coliform removal rates are significant.
- System is functioning without odours from the water.
- Aquatic higher life forms (fish) are thriving in the Bio-remediation Facility.
- Emergance of a new level of preditors birds.
- In summary, the Bio-remediation Facility is performing beyond expectations.



Overall Achievements and Outcomes To Date:

The Wadi Hanifah Restoration Project is showing remarkable progress. It is rapidly taking shape as one of the worlds most distinguished park systems and will become Riyadh's Great City Park.

This remarkable progress has been made possible through the concerted teamwork of the ADA, Moriyama & Teshima and Buro Happold, ADA/Site Management, outside experts and the contractors - all working together. Although there is much work ahead to complete implementation of the Master Plan, the Restoration Projects in the main Wadi have been completed. The positive socio-cultural and measurable scientific outcomes are already evident and very impressive. The level of design is very high. A summary of outcomes and achievements follows:

- Flood proofed entire landscape along 70km stretch of Wadi Hanifah through combination of grading and channelization;
- Relocated all piped utilities (excepting heavy sewars) and removed all overhead utilities (relocated underground);
- Re-designed Wadi road system to reduce road widths, rationalize road system into single primary route into the Wadi;
- Implemented the channel system designed to biologically remediate wastewater as it flows along the channels;
- Completed construction of a major Bio-remediation Facility with 4 water quality experts on site collecting data and continually monitoring outcomes. Water quality Test Reports show extremely significant improvement in water quality;
- Designed and built 7 major public landmark parks (with two additional under construction) along the Wadi;
- 7. Designed and built 30 toilet blocks
- Designed and built 46.8 km +/- of walking trails running throughout entire park system;
- 9. Designed and built 7.4 km of pedestrian promenades
- Designed and built street lighting and trail lighting system for entire Wadi consisting of 2,500 fixtures + 600 feature lights;
- "Branded" the Wadi and produced 730 pieces of signage / wayfinding / interpretive signage (all now installed);
- Grown and planted 30,000 indigenous shade trees, 6,000 date palms, 50,000 shrubs and groundcovers, and transplanted 2,000 large native acacia trees;
- Designed and built over 2,000 lay-by and parking spaces along the length of the Wadi;
- The people of Riyadh have started using the Wadi parks and open spaces in large numbers as evidenced by the almost capacity crowds on weekends;
- 15. Technical and construction issues are systematically being resolved. The Wadi is becoming visibly green again and, as per the Nelson Environmental test results discussed above and presented in their Report, the water is being significantly cleaned;
- The Bio-remediation Facility is developing the biology that will do the work of cleaning the water. There is a tremendous

difference in quality between the water flowing into the Bioremediation and that flowing out and into the Wadi. Already the Bio-remediation Facility is performing beyond expectations;

- Maintenance and management of the Wadi is underway and will continue to enhance the entire length of the Wadi;
- Wadi Hanifah is becoming recognized in Saudi Arabia and around the world as a landmark initiative. Principles and techniques developed for the Wadi will have application in many places around the world;

Awards / Distinctions:

- Waterfront Center (USA) Top Honor Award: Wadi Hanifah Comprehensive Development Master Plan, Riyadh, Saudi Arabia, 2003
- Master Plan Presentation to United Nations Commission on Sustainable Development, April 2004
- "Highly Commended" award by the British Expertise
 Association, UK, 2006
- International Awards for Liveable Communities (LivCom)
 Community Sustainability Award "Natural Projects" Gold, 2007



Part Two: Historical Background and Project Chronology

The Historical Importance of Wadi Hanifah to the City of Arriyadh

The Wadi Hanifah watershed is the most significant natural resource in the Region. Wadi Hanifah, running through the center of Riyadh, is located in the heart of the Najd Plateau in the Kingdom of Saudi Arabia. The Wadi and its many sub-wadis form a unique 120 kilometre long ecological zone that descends from the Tuwaiq Escarpment in the northwest to the open desert southeast of Riyadh, a region comprising a 4500 square km catchment basin. The city's history – and its future – are inextricably linked to the existence and sustainability of Wadi Hanifah.

An oasis in the heart of the Arabian peninsula, the water, land and resources of the Wadi Hanifah watershed have historically provided sustenance for communities along its length. For centuries a balance prevailed between the Wadi and the people, between natural processes and human interventions. Stability existed because the inhabitants were completely dependent upon the Wadi for their survival and prosperity.

The First Saudi State strategically located its capital at Addiriyyah on the west bank of Wadi Hanifah, taking advantage of its water and arable lands. Subsequently Riyadh developed east of Wadi Hanifah as the new capital of the modern Saudi State. Until the rapid expansion of Riyadh, in particular up to the early 1970's, the city and the Wadi co-existed in harmony. Wadi Hanifah was used as a sustainable resource for water and food - a balance prevailed.

Wadi Hanifah Under Threat

From the early 1970's Riyadh expanded westward towards Wadi Hanifah, eventually spreading along its west bank. The Wadi was exploited to satisfy the increasing demand for water and to provide mineral resources to meet the massive construction needs arising from the rapid growth of the City. By the 1980's water resources in the Wadi could not cope with the demand, and water table levels dropped well below sustainable limits. To meet continued demand, Riyadh began to receive desalinated water piped from the Eastern Province. This brought with it a new problem: rising groundwater contaminated with raw sewage. As the natural drainage system for Riyadh, the Wadi was inappropriately used as a drainage channel for this urban generated waste water. Often standing water resulted along the wadi bed creating a public health hazard. Thus began the negative public perception of Wadi Hanifah as Riyadh's sewer and a serious health hazard.

Wadi Hanifah further deteriorated with the onset of widespread dumping and quarrying resulting in widespread environmental destruction.

For the next twenty-five years the City of Riyadh turned its back on Wadi Hanifah and its deterioration continued.

Actions Taken By the Arrivadh Development Authority to Restore the Wadi

Investigations into the serious consequences of development, groundwater levels and dumping in Wadi Hanifah began in the 1980's. This led the Arriyadh Development Authority to carry out technical and environmental studies in parallel with the development of a strategy for the Wadi. In addition to the groundwater studies and ongoing groundwater monitoring, the Arriyadh Development Authority undertook studies on water resources and flooding, as well as the historical and archaeological assets. These studies were used as the technical basis for the <u>Strategy for Wadi Hanifah</u>, which was adopted in 1994.

The Core Objectives of the 1994 Strategy for Wadi Hanifah:

The High Commission for the Development of Arrivadh enforced urgent measures to remove the sources of pollution and most of



the industrial activities along Wadi Hanifah. This included halting removal of soil and stopping dumping of waste. Additionally, the flood plain boundaries were defined and the placement of utilities and services was limited. Monitoring of the wadi environment, and issuance of guidelines and regulations were also carried out.

Despite attempts to improve the condition of Wadi Hanifah, the Wadi continued to deteriorate. The lack of a comprehensive plan made it difficult for authorities to improve and restore Wadi Hanifah to health and thereby to improve the quality of life for the people of Riyadh.

By 2001, when the flood plain boundaries were defined, it was evident that a comprehensive plan was an essential step forward to restore the Wadi. The following conditions had reached a critical state:

- Environmental degradation, loss of natural functioning and ecosystem productivity of the Wadi through unsustainable use of land, water, energy and other resources.
- Lack of special development controls for Wadi Hanifah and its environs.
- Illegal dumping of solid and liquid wastes.
- Development that had led to encroachments into the flood flow channel, and to changes of levels of the Wadi bed. These conditions negatively affected the Wadi's function as a natural drainage system, and its ability to deal with floods.
- Inadequate system of surface flow channels, which receive flow resulting from rising groundwater as well as discharge from the Manfouha Sewage Treatment Plant. The measures taken to that point had provided an interim response to the problem only, and required planning and co-ordination to address a broader range of issues.
- Uncontrolled discharges into the Wadi surface flow channel and/or its tributaries – for example from the abattoir, the tannery, and unauthorized discharges from sewage tankers.
- Health issues related to the quality of water in surface flow channels because of uncontrolled discharges.

- The general waste of a potentially valuable water recycling resource.
- Visual degradation, resulting from loss of natural environment, dumping, quarrying, lack of coordinated infrastructure installation, and lack of development controls.
- Uncoordinated use of the Wadi for trunk utilities, such as sanitary, potable water, irrigation mains, and use of the Wadi for overhead electrical distribution.

The 1994 Strategy was just the beginning of a long-term program for the preservation and proper use of the Wadi basin and its environs. The next step required a comprehensive development plan for Wadi Hanifah that reviewed the existing conditions, explored opportunities, and provided a vision, master plan and details for the development of priority projects. Based on two objectives:

1. The Environment; and

2. Quality of Life.

An over-riding concern for the plan would be the restoration of balance between needs of the Wadi ecosystem, and the needs, desires and expectations of the City of Riyadh with environmental sustainability the guiding principle.

The Wadi Hanifah Comprehensive Development Plan Commission / Terms of Reference

The Arrivadh Development Authority prepared the terms of reference for the Comprehensive Development Plan following the direction of the High Commission and defined the approach and content of Part 1, Part 2, and Part 3 of the assignment. Based on the Terms of Reference the Arrivadh Development Authority called for proposals and selected the Joint Venture Team of Moriyama & Teshima plus Buro Happold which began the Wadi Hanifah Comprehensive Development Plan on July 28, 2001.



The three part assignment consisted of :

Part 1, Introductory Appraisal: including review of existing studies, appraisal of existing data, evaluation of environmental, water quality and urban issues, development scenarios, together with the articulation of a short and long-term vision for the Wadi.

Part 2, Master Plan: including Environmental Plan, Water Resources Management Plan, and Land Use Plan, plus a defined program of Priority Projects, and 10 year Implementation Program.

Part 3, Staged Implementation Phase: including designs for Priority Projects related to water resources, transportation and utilities, programs and design options for environmental restoration and conservation, plus recreation and open spaces, guidelines and principles for urban development, infrastructure and engineering coordination, environmental and urban management, and financing principles. The capital construction works to implement the Master Plan were divided into two Parts, and 5 construction zones, which are described in detail below:

- The Wadi Hanifah Restoration Project being those construction works necessary to restore flood performance and water quality and to complete the Wadi Bed restoration; and
- 2. Wadi Hanifah Development Programme being those public infrastructure and public landscape capital construction works which, together with private sector investment projects, will build on the platform provided by the Wadi Hanifah Restoration Project to complete the implementation of the Wadi Hanifah Comprehensive Development Plan.

The Wadi Hanifah Restoration Project

The overall implementation process began by first meeting immediate existing demands along Wadi Hanifah before addressing future needs. This required restoring and protecting the environmental values of Wadi Hanifah and upgrading its functionality including:

- Cleaning the Wadi bed of dumping;
- Improving the flood performance of the channel by re-profiling and re-grading; and
- Improving the Wadi road network in relation to the proposed water restoration works, to better accommodate local access needs, connections to the Riyadh road network and to provide better performing and safer local Wadi roads.

The cleaning up of the Wadi is of course one of the critical parts of the project however just as important are the other measures designed to bring the Wadi back to the people of Riyadh.

Wadi Hanifah Development Programme:

This component of the Comprehensive Plan builds upon the Wadi Hanifah Restoration Project, and then continues with strategic public and private sector projects to more fully develop the environmental, cultural, recreational and water resources of the Wadi Hanifah by:

- Providing open spaces and parklands along the Wadi and extending them into surrounding residential areas;
- Developing the magnificent cultural resources of Wadi Hanifah, particularly at Addiriyyah, Hay Al Masani, the Old Dam and Old Al Hair;
- Re-establishing the natural landscape in the desert tablelands and rangelands of the desert catchment area above the Wadi bed, including construction of check dams;
- Providing private sector investments to renew the Seyah mixed use development area;
- Providing private sector investment opportunities for recreational and leisure facilities;
- Providing private sector investment opportunities for tourism development;
- Providing private sector investment for innovative agricultural development;
- 8. Constructing water recycling and treatment facilities, to meet future water needs in Riyadh.



Future Enhancements

All of the work realized to date is only the beginning of a continuing cultural and environmental process to sustain life and give meaning to Wadi Hanifah for future generations. There are a number of key initiatives that are important to realize its vision as a "Living Wadi". These include:

- Enhancement of <u>The Wadi Hanifah Directorate</u> to ensure the ongoing protection, management and enhancement of the Wadi Hanifah;
- Establishment of an educational an interpretative/information centre that will focus on the environmental and cultural stewardship of Wadi Hanifah and its ongoing importance to the city of Riyadh;
- Restoration and enhancement of the 10 main sub wadis and their linkage to Wadi Hanifah in a total watershed management program;
- The continuing development of Wadi Hanifah as the "Great City Park of Riyadh."
- Al Hair Lakes Tourist District
- Establishment of Wadi Reserve Zones (Al Hair Lakes, Wadi Laban, Al Hessiah)
- · Continuing water cleaning, recycling and reuse

A Global Precedent is Set

Wadi Hanifah Restoration Project is a bold vision being implemented in a world city that will enhance Riyadh as a model for sustainability in a world where "fresh" water is an increasingly scarce and precious commodity. By recycling and reusing 350,000 cubic metres per day of cleaned urban waste water from the City, it provides opportunities for the future as well as tangible economic benefits today. The Plan uses urban waste water to restore, green and re-connect this most significant environmental feature as public space in the capital city of 4.5 million people. The greening programs and projects throughout the watershed will make a significant contribution to the quality of life in Riyadh, while the people of Riyadh also gain access to 120 km of new open spaces and parklands. The ground-breaking vision, plan and implementation technologies have application globally for the protection and resurrection of other threatened environments.



