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# Wastewater Reuse in Riyadh, an Integrated Approach

Riyadh, the capital of Saudi Arabia is located in one of the water scarcest regions in the world. Reuse of TSE (Treated Sewage Effluent) is meanwhile seen as an important water source not only for less demanding applications. The Arriyadh Development Authority has launched a Master Plan Study for Water Recycling to investigate reuse options integrated in the metropolitan possibilities.

## Situation in the Water Sector

Riyadh, the capital of the Kingdom of Saudi Arabia, has experienced a tremendous growth in the past decades. It covers today an area of more than 1,600 km<sup>2</sup> with a population of over 4.6 million compared to 150,000 in the 1960's.

Although water resources are scarce in Saudi Arabia, the area of Riyadh was originally rich in natural water. But it revealed soon, that resources become exhausted with the dramatic expansion of Riyadh city.

Water conservation and different methods for water savings have a long history in Riyadh. Water conservation kits are widely used and have been consequently promoted and distributed by the Ministry of Water and Electricity.

Even permits for new housing are tied to water conservation measures according to the Minister's announcement in 2007<sup>1</sup>.

Nevertheless, Riyadh's combined water and wastewater tariff is one of the lowest in the world with less than 0.03 US\$/m<sup>2</sup>,<sup>3</sup> and does not promote water demand management per se. It is expected that water tariffs for consumers will increase in an effort to support demand management and to encourage as well other measures underway to improve efficiency of the water supply system.

With the formation of the National Water Company in 2007 and the award of a

management contract for the water supply and waste water networks in Riyadh to France's Veolia Water, the ministry paved the way for such improvements.

## Potable Water Sources

Nowadays, the water supply of Riyadh depends on three water sources:

- Groundwater is exploited and supplies the capital by some major projects from two geological formations (Al Manjour formation and Al Waseea formation). However, water is saline and requires treatment and/or mixing with other sources.
- Desalinated water from Al Jubail, which is conducted to two big pipelines 460 km long to Riyadh.

Recently, treated sewage effluent became as well a significant source and substitutes remarkable amounts of fresh water. Effluent from the Manfuha wastewater treatment plant is reused for agricultural and industrial purposes. Presently, the quantity of reused water is 200,000 m<sup>3</sup>/day, which is nearly 25 % (!) of the daily water supply coming from the desalination plant in Al Jubail.

## Potential for Wastewater Reuse

Some wastewater treatment plants in Riyadh approach the end of their useful lifetime and in addition, the development of the capital requires additional treatment capacities. Thus, wastewater treatment is under restructuring resulting in a project-

ed total treatment capacity of 2,000,000 m<sup>3</sup>/day (Table 1). In fact, this denotes a huge potential for the reuse of TSE (Treated Sewage Effluent).

The Arriyadh Development Authority under the "High Commission for the Development of Arriyadh" initiated a comprehensive Master Plan for Water Recycling, exactly to study this potential for reuse and the different options. The Master Plan has been awarded to Fichtner Consulting Engineers from Germany, who started the assignment in January 2009. The study achieves to identify and investigate most feasible, integrated reuse options of the wastewater for the benefit of the metropolitan area of Riyadh.

## Master Plan for Water Recycling

The Master Plan started with a reconnaissance of the existing situation, wastewater projections and review of all available information. One of the most important outcomes of this phase is the projection of the available TSE and its chronological sequence.

An assessment of the social impact and, in particular, the acceptance of different reuse options shall cover as well the socio-cultural aspects beside the technical, economic and environmental aspects. Different options for wastewater reuse are then to be investigated and quantified in terms of potential demand.

## Agricultural Reuse

Reuse of TSE for irrigation has different requirements than prevailing for dis-

<sup>1</sup> Arab News, 24 January 2007, online edition

<sup>2</sup> WI-Global Water Intelligence, Edition September 2008

<sup>3</sup> Source: Arriyadh Development Authority, <http://www.ada.gov.sa>



**Table 1: Future Wastewater Treatment Plant Capacity for Riyadh**

Treatment Plant	Effluent Quality	Horizon	Capacity (m <sup>3</sup> /d)
Manfuha*	variable	to be abandoned	600.000
Al Hair	tertiary / unrestricted reuse	1 <sup>st</sup> phase 2011	1.200.000
Al Kharj	tertiary / unrestricted reuse	1 <sup>st</sup> phase 2007	400.000
Nazeem	tertiary / unrestricted reuse	2016	200.000
Banban	tertiary / unrestricted reuse	2016	200.000
Total			2.000.000

\*The Manfuha plant is not included, as the flow shall be diverted to the new treatment plants

charging the effluent to the environment. For reuse the water must meet higher minimum hygiene requirements, though BOD<sub>5</sub> standards could be lower, as the organic load will be degraded in agricultural soils. Nitrogen and phosphate are harmful to receiving water bodies and ammonium is toxic to fish. However, these compounds are nutrients that can substitute mineral fertilizers in irrigation applications. Unfortunately this is not well reflected in Saudi Arabia's environmental legislation and the standards for (restricted and unrestricted) reuse do not take into account these findings in particular for the nutrients. Marketability and acceptance of products need to be assessed. In Saudi Arabia more than 80 % of the water is consumed by the agricultural sector, hence the potential shall be predominant as well in Riyadh and its vicinity.

#### Industrial Reuse

In general, industrial reuse options comprise cleaning, washing, flushing and

cooling processes. Hygienic aspects are a prerequisite for reuse measures in this sector. In addition, constituents related to fouling, scaling and corrosion processes are of major importance for the practical feasibility of water reuse. In previous studies several industrial enterprises have been identified, which intended to reuse the water for cooling and de-dusting purposes, also for irrigation within their premises.

#### Landscape Irrigation

Landscape irrigation is assumed to be the most acceptable reuse option. The requirements and water quality standards are comparable to agricultural reuse. Landscape irrigation has certainly a potential in Riyadh for parks, the golf course and also Highway medians.

#### Groundwater Recharge

Groundwater replenishment or saltwater intrusion control are also possible options reusing the wastewater. Depending on geological and hydrogeological conditions,

this application will have the highest requirements to the treatment standards and quality of the TSE. Possible contamination of groundwater aquifers used as source for drinking water is under all circumstances to be avoided. Long and intricate preparatory studies may become necessary to prudently detail and investigate finally the feasibility of such measures.

#### Recreational/Environmental Reuse

In Riyadh the Wadi Hanifah (**Figure 1**)<sup>3</sup> plays a significant role for Riyadh. This valley is the major drainage of Riyadh city where 40 % of the city lies within the basin of this valley. Wadi Hanifah Basin is composed of more than 40 sub-valleys on both western and eastern sides and comprises as well most eminent recreational areas. It is reported that daily some 180,000 m<sup>3</sup> TSE are required to be further discharged to the Wadi to maintain its ecological balance.

Health concerns are also in future to be considered and besides potential toxic compounds in the wastewater, nitrogen and phosphorous must be attended to avoid eutrophication of the Wadi Hanifah.

#### Other, less conventional Reuse

These measures may comprise typical grey water options like WC flushing, etc. Hygienic standards and quality requirements for the technical feasibility are to be considered as well for this application. Broad application of this option may lead to high investment requirements for a parallel grey water network. A more concentrated approach on different spots may reveal to be interesting in the course of the study.

Evaluation of the different reuse options are the core module of the Master Plan and shall lead to prioritisation of measures. Most favourable measures are to be analysed techno-economically and pre-engineered in terms of their scope of works and investments.

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Fig. 1: Wadi Hanifah