Wastewater Reuse Regulations In Saudi Arabia

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Saudi Aramco

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Outline

• Introduction

• Saudi Government Wastewater Reuse Regulations
  ▪ Background
  ▪ The Regulation of “Treated Sanitary Wastewater and Its Reuse”
  ▪ MOMRA ROIs
  ▪ MOWE ROI
  ▪ Council of Ministers Decision 228

• Comparison between MOWE ROI and California Title 22

• Saudi Aramco Wastewater Reuse Regulations

• Conclusions and Recommendations
Saudi Aramco wastewater reuse activities started since 1980s.

Saudi Aramco Daily Wastewater Generations:
- Sanitary Wastewater: 21 million gallons
- Industrial Wastewater: 24 million gallons

Saudi Aramco Reuse:
- Sanitary Wastewater: ~72% (>90% after projects completion)
- Industrial Wastewater: ~15%

More than 15 MBR Projects

Saudi Aramco Reuse Applications:
- Landscape Irrigation
- Agriculture Reuse
- Industrial Reuse
- Percolation Ponds
Saudi Government Wastewater Reuse Regulations

Background ...

Royal Decree No. M/6
“Treated Sanitary Wastewater and Its Reuse Regulations”
Published in Um Alqura Newspaper (Issue # 3797)

Council of Ministers Decision No. 228
Water Conservation – Grey Water

May 2000

Council of Ministers Decision No. 228
Water Conservation – Grey Water

June 2002

MOMRA Decision No. 16820
Three Rules of Implementations (ROIs)
Tow of the ROIs indicate that the ROI is valid until January 2005

October 2005

Ministry of Water and Electricity
Rules of Implementations for the Regulations of Treated Sanitary Wastewater and Its Reuse
Valid for five (5) years

Published on Website
Thirty four (34) articles.

Article no. 1: Objective is to provide reliable standards to reuse wastewater for:

• Agriculture irrigation
• Landscape irrigation
• Recreational places
• Future groundwater recharge
• Cooling
• Industrial purposes (Article no. 18 excludes food industries)

Article no. 1: non-conventional water resource.
Article 3: Large complexes shall install treatment plants of their own

Reuse Threshold

Article 3: Rules of implementation shall determine the size of such complexes and technical conditions

Quality

- Article 6: Rules of implementation shall determine the contaminants concentration in treated wastewater.
- Article 17: Treated wastewater for recreational activities shall be tertiary treated.
- Article 21: Treated wastewater for direct injection shall conforms to technically recognized standards.
ROI: Sanitary WWTPs of Large Complexes

Reuse Threshold

Article 2.1.1: Water Consumption > 120 m3/day (residential units > 60)

Quality

• Article 2.1.8: Treated wastewater for landscape irrigation and agriculture purposes shall be tertiary quality.

• Article 2.1.17: Treated wastewater shall be reused for “irrigation” and toilets water flushing systems.

• Article 3.1.3: Tertiary treatment followed by disinfection
  • BOD5: 10 mg/L, TSS: 10 mg/L
  • Total Coliform < 2.2 MPN/100 ml
• No limits for other pollutants such as NH3 and heavy metals
MOWE Rules of Implementation

Reuse Applications:

• Ag Irrigation (restricted and non-restricted)
• Landscape Irrigation
• Fisheries
• Injection into Groundwater Aquifers
• Industries
• Recreational Purposes

Article 5.5.1 requires Large Complexes:

• Install WWTPs, and
• Make wastewater suitable for reuse

Article 5.5.2 requires Large Complexes:

• Reuse, or
• Dispose of the treated wastewater
Article 1.15: Wastewater generation of more than 500 m$^3$/day (population > 2000)

MOMRA, ~ 100 m$^3$/day → MOWE, 500 m$^3$/day

Large Complexes Wastewater Reuse
MOWE Rules of Implementation

MOWE ROI includes 8 tables:

- Table-2: Limits for secondary treated wastewater
- Table-3: Limits for tertiary treated wastewater
- Table-4: Extra limits for restricted irrigation water
- Table-5: Extra limits for non-restricted irrigation water

### Parameters regulated by Table-2: Secondary Treated Wastewater

<table>
<thead>
<tr>
<th>Floatables</th>
<th>TSS</th>
<th>pH</th>
<th>BOD5</th>
<th>O&amp;G</th>
<th>Phenol</th>
<th>Turbidity</th>
<th>NO3</th>
<th>NH3</th>
<th>Al</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fecal Coliform</td>
<td>As</td>
<td>Be</td>
<td>B</td>
<td>Cd</td>
<td>Zn</td>
<td>Cr</td>
<td>Co</td>
<td>Cu</td>
<td>F</td>
</tr>
<tr>
<td>Free Chlorine</td>
<td>Fe</td>
<td>Pb</td>
<td>Li</td>
<td>Mn</td>
<td>Hg</td>
<td>Mo</td>
<td>Ni</td>
<td>Se</td>
<td>V</td>
</tr>
</tbody>
</table>

### Parameters regulated by Table-3: Tertiary Treated Wastewater

In addition to the thirty (30) parameters included in Table-2, Table 3 includes one more parameter: number of intestinal worms eggs.
### MOWE Rules of Implementation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Table-2 limits</th>
<th>Table-3 limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSS (mg/L)</td>
<td>40</td>
<td>10, monthly avg. 15, weekly avg.</td>
</tr>
<tr>
<td>BOD5 (mg/L)</td>
<td>40</td>
<td>10, monthly avg. 15, weekly avg.</td>
</tr>
<tr>
<td>Fecal Coliform (MPN/100 ml)</td>
<td>1000</td>
<td>2.2, in a week 23, any time</td>
</tr>
<tr>
<td># of intestinal eggs</td>
<td>N/A</td>
<td>1 viable egg per liter</td>
</tr>
</tbody>
</table>

**Table-4: limits for restricted irrigation water (agriculture)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>TDS (mg/L)</td>
<td>2500</td>
</tr>
<tr>
<td># of intestinal worms eggs</td>
<td>1 viable egg per liter</td>
</tr>
</tbody>
</table>

**Table-5: limits for unrestricted irrigation water (agriculture)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>TDS (mg/L)</td>
<td>2500</td>
</tr>
</tbody>
</table>
MOWE Rules of Implementation

**Quality – Agriculture Reuse**

Para 6.2 (Unrestricted Irrigation): WW shall meet Table-3 and Table-5.

Para 6.3 (Restricted Irrigation): WW shall meet Table-2 and Table-4.

**Quality – Urban Irrigation**

Para 7.2 (Unrestricted Access Areas): WW shall meet Table-3.

Para 7.3 (Restricted Access Areas): WW shall meet Table-2.

Para 7.4 (toilets flush water, streets and pavements washings, and firefighting): WW shall meet Table-3.
**MOWE Rules of Implementation**

**Quality – Groundwater Recharge**

Para 10: No Specific Requirements – Approach MOWE for Permit.

**Quality – Industrial Reuse**

Para 11.1: No Specific Requirements – Approach Ministry of Industry and Commerce (MOIC) for Permit.

Para 11.2: MOIC will identify the water quality in accordance to intended use.

Para 11.3: Treated WW is not allowed in food industry.

**Quality – Recreational Reuse**

Para 12: No Specific Requirements – Approach MOWE for Permit.
Grey Water Reuse

Consists of 7 Sections

Section 3, Para 1 requires the implementation of 2 sewer networks for water reuse for new installations

- Exceptions: hospitals and health centers

Section 3, Para 2 requires MOWE to inform existing facilities of the importance of water reuse.
How MOWE ROI are compared to California Title 22 Reuse Regulations?

**California Title 22** is the state of California Water Recycling Criteria issued by the California Department of Health Services. This is a well-know and internationally recognized criteria used in the wastewater reuse field.

<table>
<thead>
<tr>
<th>MOWE ROI – Treated Wastewater for Unrestricted Irrigation</th>
<th>California Title 22 – Recycled Water for Irrigation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Applications:</strong></td>
<td><strong>Applications:</strong></td>
</tr>
<tr>
<td>• All food crops without exceptions</td>
<td>• Food crops, including all edible root crops</td>
</tr>
<tr>
<td>• Public parks</td>
<td>• Parks and playgrounds</td>
</tr>
<tr>
<td>• Children playgrounds</td>
<td>• School yards</td>
</tr>
<tr>
<td>• Areas patronized by public</td>
<td>• Recreational landscaping</td>
</tr>
<tr>
<td></td>
<td>• Unrestricted access golf courses</td>
</tr>
<tr>
<td>MOWE ROI – Treated Wastewater for Unrestricted Irrigation</td>
<td>California Title 22 – Recycled Water for Irrigation</td>
</tr>
<tr>
<td>----------------------------------------------------------</td>
<td>---------------------------------------------------</td>
</tr>
</tbody>
</table>
| Wastewater shall be tertiary treated and shall meet pollutants limits in Table-3 and Table-5. Tertiary treated wastewater means:  
  • Biologically treated  
  • Filtered  
  • Disinfected | Wastewater shall be a “disinfected tertiary recycled water”; which means:  
  • Oxidized  
  • Filtered  
  • Disinfected |
| Filtered | Filtered |
| Wastewater shall meet specific turbidity limit.  
No specific design parameters. | Wastewater that meets the criteria in a or b:  
a. Coagulated and passed through natural or media filters pursuant to specific filtration rates (gallons/min/ft²) and turbidity limits.  
b. Passed through membrane filters pursuant to specific turbidity limits. |
| Disinfected  
Wastewater shall meet specific fecal coliform limit. | Disinfected  
Wastewater shall meet:  
a. Specific CT value or inactivation percentage.  
b. Specific total coliform limits. |
Saudi Aramco has 2 documents that govern wastewater reuse:

- SAES-A-104
- Section 2 of the SASC
Para 8.3: Water Consumption > 120 m3/day (Approx. 100 m3/day WW)

SAES-A-104, Table-1 and Table 16: Unrestricted Irrigation Parameters

<table>
<thead>
<tr>
<th>Floatables</th>
<th>O&amp;G</th>
<th>pH</th>
<th>TSS</th>
<th>TDS</th>
<th>Al</th>
<th>NH3-N</th>
<th>As</th>
<th>Be</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorides</td>
<td>B</td>
<td>Ba</td>
<td>Cd</td>
<td>Free Cl2</td>
<td>Cr</td>
<td>Co</td>
<td>Cu</td>
<td>Cn</td>
</tr>
<tr>
<td>Phenols</td>
<td>TOC</td>
<td>Fe</td>
<td>Pb</td>
<td>Mn</td>
<td>Hg</td>
<td>Ni</td>
<td>NO3-N</td>
<td>Se</td>
</tr>
<tr>
<td>COD</td>
<td>SO4</td>
<td>V</td>
<td>Zn</td>
<td>BOD5</td>
<td>Viable oocysts or cysts</td>
<td>Enteric animal viruses</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- F, Li, and Mo are included in Table-3 of MOWE ROI but not in SAES-A-104
- Enteric animal viruses, Ba and Cn are included in SAES-A-104 but not in Table-3 of MOWE ROI
Para 13.2.1 (a): Wastewater for unrestricted irrigation shall be oxidized, coagulated, flocculated, and clarified, then disinfected.

- Total Coliform: 2.2/100 ml in seven days (23/100 ml 30-day period)

Para 9.5.2.1 specifies filtration rate (gallons/min./ft²)

Para 10.2.1 specifies Chlorination CT and Conc. requirements

MBR shall obtain California Title 22 Certificate
Conclusions and Remarks

- Saudi Aramco considers wastewater as an asset not a waste.

- Sanitary WW reuse is very well established (> 72% reused) and > 90% of the generated sanitary WW will be reused when the ongoing projects are completed.

- Saudi Aramco is developing a patent that will provide a cost effective method to treat the hard-to-treat industrial wastewater.

- Saudi Aramco Water Conservation Team.

- Saudi Aramco needs to assess its reuse effluents for Li, F, and Mo specified in the MOWE Rules of Implementation. Also, include in the standards.

- California Title 22, MOMRA ROI, Saudi Aramco: **Total Coliform.** MOWE ROI: **Fecal Coliform.**

- MOWE ROI needs to re-visit the Large Complexes 500 cubic meters per day reuse threshold and should consider the use of 100 m3/day.

- MOWE ROI to include design parameters.
Thank You ...
Golf Course Irrigation
Agriculture Reuse
Riyadh Refinery
Redshanks (Tringa totanus) and flamingos (Phoenicopterus ruber) feed at depths that suit their long legs.

An Isabeline snipe (Lymnocryptes isabellina) perches on one of the reed mats that form dense stands in Lake Lambada.

A moorhen (Gallinula chloropus) feeds for berries among the reeds. Little crakes (Porzana parva) probe shallow water.
**Definitions – Large Complexes**

**Large complexes (MOMRA)**
These are government or private residential, commercial or joint complexes that perform specific activities. They include, but are not limited to, buildings of ministries, universities, military and civilian colleges, airports, companies and the like.

**Large complexes (MOWE)**
Residential, industrial, commercial or joint clusters, military cities, university campuses, or any installation which perform private or public activities, be they government or private, whose inhabitants exceed 2000 persons or whose flow is in excess of 500 cubic meter a day.
Definitions – Restricted and Unrestricted

**Restricted Irrigation:**
Irrigation of all plants to the exception of fresh produce, root crops, and plants whose fruits may come into contact with the treated water, whether they are eaten raw or cooked.

**Unrestricted Irrigation:**
Irrigation of all types of crops with no exceptions.