GE Power & Water
Water & Process Technologies

# GCC Reuse Regulations

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# GCC Reuse Regulations

# UAE (Abu Dhabi, Dubai)

# Abu Dhabi - Definition of application / purpose

## A1 Approved-reuse-activities - Reclaimed Water

A1.1.1 Subject to review by the Panel and approval by the Bureau.

Table A1.1(A): Approved-reuse-activities - Reclaimed Water

| Approved-end-use | Public health standards | Irrigation standards | Special criteria |
|---|---|---|---|
| Irrigation of urban areas | P I | Required | |
| Unrestricted irrigation of agricultural areas | P II | Required | |
| Restricted irrigation of agricultural and forestry areas | P III | Required | |
| Irrigation of domestic gardens | P I | Not applicable | |
| Toilet Flushing | P I | Not applicable | |
| Fountains and water features | P I | Not applicable | *Legionella* |
| Air conditioning processes | P I | Not applicable | *Legionella* |
| Street cleaning and dust suppression | P II | Not applicable | |
| Vehicle washing | P II | Not applicable | |
| Concrete manufacture | P II | Not applicable | |
| Fire fighting | P I | Not applicable | *Legionella* |

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# Legislation - Abu Dhabi

## Definition of standard of Quality: (i) Health (I, II, III) – (ii) Irrigation/Metals – (iii) Legionella

Table A2.1(A) Microbiological public health standards - Reclaimed Water

| Parameter | Unit | Assessment criteria | Public health standards | | |
|---|---|---|---|---|---|
| | | | P I | P II | P III |
| Faecal Coliforms | CFU/100ml | MAC | < 100 | < 1000 | - |
| Intestinal Enterococci | CFU/100ml | MAC | < 40 | <200 | - |
| Helminth Ova | Number / l | MAC | < 0.1 | < 1 | < 1 |

Table A2.1(B): General characteristics public health standards - Reclaimed Water

| Parameter | Unit | Assessment criteria | Public health standards | | |
|---|---|---|---|---|---|
| | | | P I | P II | P III |
| pH | | Average | 6 to 8 | 6 to 8 | 6 to 8 |
| BOD5 (ATU) | mg/l | MAC | 10 | 10 | 20 |
| Total Suspended Solids | mg/l | MAC | 10 | 20 | 30 |
| Turbidity | NTU | MAC | 5 | 10 | n/a |
| Residual Chlorine | mg/l | Average | 0.5 to 1 | 0.5 to 1 | n/a |
| Dissolved Oxygen | mg/l | Average | ≥ 1 | ≥ 1 | ≥ 1 |

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# Legislation - Dubai

## Definition/restriction of application and purpose

**Minimum Standards of Treatment.**

2. ***For unrestricted irrigation***: ***(Class A waters)*** All sewage effluents shall be treated to secondary standard, sand filtered and chlorinated. The maximum E Coli level in the final effluent shall be less than 10 per 100 ml.
**For restricted irrigation** ***( Class B waters )*** the effluent shall be secondary treated and E Coli level must be reduced to 1000 per 100 ml.

| Irrigation Method | Permissible water class |
|---|---|
| Drip irrigation on to trees and bushes. | A or B |
| Low mist hand spray Class | A or B |
| Spray irrigation in parks and green spaces that are closed to the public or after the hours of use, subject to a 2 hour break before public use begins. | A or B |
| Unlimited spray irrigation of public areas with precautions to reduce mist formation. | A only. |

Wastewater irrigation points shall be regularly tested for bacteria including legionella. Especially where spray irrigation is practiced. Any branch of the network where legionella is detected or where bacterial levels are elevated must be isolated and treated.

Chlorination is not an adequate disinfectant for legionella and slime borne organisms. As a guide chlorine-dioxide or any material or product of equivalent effectiveness shall be used.

# Legislation – Dubai

Definition of the limits for irrigation and distinction between drip and spray

Limits are high compared to other regions

**Table 1 – Dubai Wastewater Discharge Limits**

| INDICATORS | | *Maximum Allowable Limits for Discharge to | | |
|---|---|---|---|---|
| | | Sewerage System | Land as for Irrigation | |
| *Physico-Chemical* | *Units* | | Drip | Spray |
| Biochemical Oxygen Demand | mg/l | 1,000 | 20 | 10 |
| Chemical Oxygen Demand | mg/l | 3,000 | 100 | 50 |
| Chlorides | mg/l | | 500 | 350 |
| Chlorine – residual | mg/l | 10 | Not less than 0.5 mg/l after 30 min contact time | |
| Cyanides as CN | mg/l | 1 | 0.05 | 0.05 |
| Detergents | mg/l | 30 | | |
| Fluorides | mg/l | | 1 | 1 |
| Nitrogen, ammoniacal | mg/l | 40 | 5 | 1 |
| Nitrogen, organic (Kjeldhal) | mg/l | | 10 | 5 |
| Nitrogen, total | mg/l | | 50 | 30 |
| Oil & Grease – Emulsified | mg/l | 150 | | |
| Oil & Grease – Free oil | mg/l | 50 | 5 | 5 |
| pH (range) | units | 6 – 10 | 6.0 – 8.0 | 6.0 – 8.0 |
| Pesticides, non-chlorinated | mg/l | 5 | | |
| Phenols | mg/l | 50 | 0.1 | 0.1 |
| Phosphorous (P) | mg/l | 30 | 20 | 20 |
| Sulfates, total | mg/l | 500 | 200 | 200 |
| Sulfides as S | mg/l | 10 | 0.05 | 0.05 |
| Surfactants | mg/l | | | |
| Suspended Solids (SS) | mg/l | 500 | 50 | 10 |
| Temperature | °C | 45 or > 5 of ambient | | |
| Total Dissolved Solids (TDS) | mg/l | 3,000 | 1,500 | 1,000 |

| | | *Maximum Allowable Limits for Discharge to | | |
|---|---|---|---|---|
| | | Sewerage System | Land as for Irrigation | |
| | | | Drip | Spray |
| ***Metals*** | | | | |
| Total Metals | mg/l | 10 | | |
| Aluminum (Al) | mg/l | | 2 | 2 |
| Arsenic (As) | mg/l | 0.50 | 0.05 | 0.05 |
| Barium (Ba) | mg/l | | 1 | 1 |
| Beryllium (Be) | mg/l | | 0.1 | 0.1 |
| Boron (B) | mg/l | 2.0 | 2.0 | 2.0 |
| Cadmium (Cd) | mg/l | 0.3 | 0.01 | 0.01 |
| Chromium (Cr) | mg/l | 1.0 | 0.1 | 0.1 |
| Cobalt | mg/l | | 0.1 | 0.1 |
| Copper (Cu) | mg/l | 1.0 | 0.2 | 0.2 |
| Iron (Fe) | mg/l | | 2.0 | 2.0 |
| Lead (Pb) | mg/l | 1.0 | 0.5 | 0.5 |
| Magnesium (mg) | mg/l | | 100 | 100 |
| Manganese (Mn) | mg/l | 1.0 | 0.2 | 0.2 |
| Mercury (Hg) | mg/l | 0.01 | 0.001 | 0.001 |
| Molybdenum (Mo) | mg/l | | 0.01 | 0.01 |
| Nickel (Ni) | mg/l | 1.0 | 0.2 | 0.2 |
| Selenium (Se) | mg/l | | 0.02 | 0.02 |
| Silver (Ag) | mg/l | 1.0 | | |
| Sodium (Na) | mg/l | | 500 | 200 |
| Zinc (Zn) | mg/l | 2.0 | 0.5 | 0.2 |
| ***Bacteriological*** | | | | |
| Fecal Coliforms | MPN/100 ml. | 500 | 20 | |

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# Oman (Muscat)

# Definition of application / purpose

**TABLE 3 : WASTEWATER RE-USE -AREAS OF APPLICATION OFSTANDARDS A AND B (TABLE 1 )**

| | A | B |
|---|---|---|
| | ( See Table 1 ) | |
| CROPS | Vegetables likely to be eaten raw.<br>Fruit likely to be eaten raw and within 2 weeks of any irrigation. | Vegetables to be cooked or processed Fruit if no irrigation within 2 weeks of cropping<br>Fodder, cereal and seed crops |
| GRASS and ORNAMENTAL AREAS | Public parks, Hotel Lawns Recreational areas.<br><br>Areas with public access. Lakes with public contact. (except places which may be used for praying and hand washing) | Pastures.<br><br>Areas with no public access. |
| AQUIFER RECHARGE | All controlled aquifer recharge | |
| METHOD OF IRRIGATION | Spray or any other method of aerial irrigation not permitted in areas with public access unless with timing control | |
| ANY OTHER RE-USE APPLICATIONS | Subject to the approval of the Ministry | |

# Legislation - OMAN

## Definition of standard of Quality – A & B

| PARAMETER | STANDARDS (See Table 3) | |
|---|---|---|
| | A | B |
| Biochemical Oxygen Demand (BOD) (5d@20°C) | 15 | 20 |
| Chemical Oxygen Demand (COD) | 150 | 200 |
| Suspended Solids (SS) | 15 | 30 |
| Total Dissolved Solids (TDS) | 1500 | 2000 |
| Electrical Conductivity (E C) (micro S. / cm) | 2000 | 2700 |
| Sodium Absorption Ratio (SAR) *(The effect of Sodium on soil absorption)* | 10 | 10 |
| pH (within range) | 6-9 | 6-9 |
| Aluminum (as Al) | 5 | 5 |
| Arsenic (as As) | 0.100 | 0.100 |
| Barium (as Ba) | 1 | 2 |
| Beryllium (as Be) | 0.100 | 0.300 |
| Boron (as B) | 0.500 | 1 |
| Cadmium (as Cd) | 0.010 | 0.010 |
| Chloride (as Cl) | 650 | 650 |
| Chromium (total as Cr) | 0.050 | 0.050 |
| Cobalt (as Co) | 0.050 | 0.050 |
| Copper (as Cu) | 0.500 | 1 |
| Cyanide (total as CN) | 0.050 | 0.100 |
| Fluoride (as F) | 1 | 2 |
| Iron (total as Fe) | 1 | 5 |
| Lead (as Pb) | 0.100 | 0.200 |
| Lithium (as Li) | 0.070 | 0.070 |
| Magnesium (as Mg) | 150 | 150 |
| Manganese (as Mn) | 0.100 | 0.500 |
| Mercury (as Hg) | 0.001 | 0.001 |
| Molybdenum (as Mo) | 0.010 | 0.050 |
| Nickel (as Ni) | 0.100 | 0.100 |
| Nitrogen: Ammoniacal (as N) | 5 | 10 |
| : Nitrate (as $NO_3$) | 50 | 50 |
| : Organic (Kjeldahl) (as N) | 5 | 10 |
| Oil and Grease (total extractable) | 0500 | 0.500 |
| Phenols (total) | 0.001 | 0.002 |
| Phosphorus (total as P) | 30 | 30 |
| Selenium (as Se) | 0.020 | 0.020 |
| Silver (as Ag) | 0.010 | 0.010 |
| Sodium (as Na) | 200 | 300 |
| Sulfate (as $SO_4$) | 400 | 400 |
| Sulfide (total as S) | 0.100 | 0.100 |
| Vanadium (as V) | 0.100 | 0.100 |
| Zinc (as Zn) | 5 | 5 |
| Fecal Coliform Bacteria (per 100ml) | 200 | 1000 |
| Viable Nematode Ova (per litre) | <1 | <1 |

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# Saudi Arabia

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# SAES – A – 104 (MOMRA)

**Table 1 – Effluent Discharge Limitations [1]**

| | | MOMRA Limits for Wastewater | | Yanbu Royal Commission Limit [4] | | |
|---|---|---|---|---|---|---|
| | PME[2] | Unrestricted Irrigation | Pretreatment Limitations | Monthly Mean | Maximum | Pretreatment Limitations |
| **Physical -Chemical Pollutants mg/L[3]** | | | | | | |
| Floatable | None | None | None | None | None | |
| pH Units | 6-9 | 6-8.4 | 6-9 | 6-9 | 6-9 | 5-9 |
| Total Suspended Solids (TSS) | 15 mg/L | 10 mg/L | 600 mg/L | 25 mg/L | 40 mg/L | 500 mg/L |
| TDS | | 2000 | | | | |
| Temperature(°C) | | | 30-50 | | | 50 |
| Turbidity [5] | 75 NTU | | | 8 NTU | 15 NTU | |
| Dissolved Oxygen | - | | | 5 mg/L min. | 2 mg/L min. | |
| Salinity | - | | | + 1 ppt | + 2 ppt | |
| Non-Organic Pollutants | mg/L (30 day mean) | | | mg/L | mg/L | |
| Total Chlorine (residual) [6] | 0.5 | | | <0.2 | 0.3 | 400 |
| Free Chlorine | | 0.2 | | | | |
| Chlorides (Cl-) | | 100 | | | | |
| Nitrates ($NO_3$-N) | | 10 | | 1.0 | 10 | |
| Phosphorus (total as P) | | | | 1.0 | 2.0 | 2.0 |
| Phosphates (total, as P) [6] | 1.0 | | | | | |

| Organic Pollutants | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L |
|---|---|---|---|---|---|---|
| **Biochemical Oxygen Demand ($BOD_5$)** | 25 | 10 | 500 | 15 | 25 | 800 |
| **Chemical Oxygen Demand (COD)** | 150 | 50 | 1000 | 75 | 150 | 1500 |
| **Total Organic Carbon (TOC)** | 50 | 40 | 1000 | 50 | 150 | 400 |
| **Total Kjeldahl Nitrogen (TKN)** | 5 | | | 10 | 5 | |
| **Total Chlorinated Hydrocarbons** | 0.1 | | 0.5 | 0.1 | 0.5 | |
| **Oil & Grease** [8] | 8 | None | 100 | 8 | 15 | 100 |
| **Phenols** | 0.1 | 0.002 | 5 | 0.1 | 1.0 | 25 |
| **Biological Pollutants** | MPN/100 mL [8] | | | MPN/100 mL | MPN/100 mL | |
| **Total Coliform** | 1000 (30-day geometric mean) | | | 1000 | 2400 | |

# Bahrain

# Bahrain – Recent PPP Effluent Quality

| Parameter | Unit | Value |
|---|---|---|
| pH | - | 6.5-9 |
| Turbidity | NTU | 2 / 0.2* |
| O&G | mg/l | 5 |
| TSS | mg/l | 10 |
| COD | mg/l | 40 |
| BOD | mg/l | 10 |
| NH4-N | mg/l | 1 |
| NO3-N | mg/l | 10 |
| TKN | mg/l | 5 |
| $P_{tot}$ | mg/l | 1 |
| Faecal Coliform | | <1,000/100ml |
| Helminth eggs | | <1/1,000ml |

*(*) value for MBR technology*

# Qatar

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# Qatar – MOE Standards for TSE

## 4.0 MOE- STANDARDS FOR TREATED WASTE WATER

| Parameter | Symbol | Unit | Limits | |
|---|---|---|---|---|
| | | | For Irrigation | For Landscape |
| **1. Physical Test** | | | | |
| Total Dissolved Solids | TDS | mg/L | 2000 | 2000 |
| Total Suspended solids | TSS | mg/L | 50 | - |
| pH | pH | mg/L | 6-9 | 6-9 |
| Floating Particles | | mg/L | Nil | Nil |
| **2. Inorganic Matters** | | | | |
| Ammonia as N | $NH_4^+$ | mg/L | 15 | 15 |
| Chloride | $Cl_2$ | mg/L | 0.1 | 0.1 |
| Cyanide (Total) | CN | mg/L | Nil | 0.2 |
| Dissolved Oxygen | DO | mg/L | >2 | >2 |
| Fluoride | F | mg/L | 15 | 15 |
| Phosphate as P | $PO_4^{-3}$ | mg/L | 30 | 30 |
| Sulphate | $SO_4^{-2}$ | mg/L | 400 | 400 |
| Sulfide | $S^{-2}$ | mg/L | 0.1 | 0.1 |
| Biochemical Oxygen Demand | $BOD_5$ | mg/L | 10 | 50 |
| Total Kjeldahl Nitrogen as N | N | mg/L | 35 | 35 |
| Chemical Oxygen Demand | COD | mg/L | 150 | 150 |
| **3. Trace Metals** | | | | |
| **4. Organic Matters** | | | | |
| Oil & Grease | O&G | mg/L | 10 | 10 |
| Phenols | Ph | mg/L | 0.5 | 0.5 |
| Total Organic Carbon | TOC | mg/L | 75 | 75 |
| **5. Biological Tests** | | | | |
| Total Coliform | | MPN/100 ml | 2.2 | 2.3 |
| Egg parasites | | mg/L | <1 | <1 |
| Worm parasites | | mg/L | Nil | Nil |
| Toxicity Evaluation | | mg/L | Each case independent | |

# Key Parameter Summary

# Helminth Ova

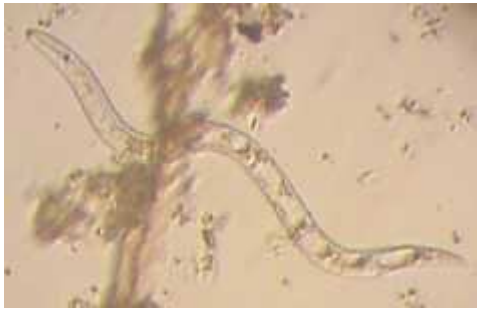
Definition: *Parasitic worms or helminths are unlike external parasites such as lice and fleas, that live inside their host. They live and feed off living hosts, receiving nourishment and protection while disrupting their hosts' nutrient absorption, causing weakness and disease. They can live inside humans as well as other animals. Approximately 3 billion people globally are infected with helminths.*

*Because of their high mobility and lower standards of hygiene, school-age children and immunocompromised people are particularly vulnerable to these parasites*

GCC Countries with restrictions

UAE, Bahrain, Qatar

# Nematodes



Nematodes are one of the most diverse of all animals. Nematode species are very difficult to distinguish; over 28,000 have been described, of which over 16,000 are parasitic.

Nematodes have successfully adapted to nearly every ecosystem from marine to fresh water. Their many parasitic forms include pathogens in most plants and animals (including humans).

## GCC countries with restrictions

## Oman, Qatar

# Coliforms

Coliforms include genera that originate in feces -"Fecal Coliforms" (e.g. *Escherichia*) as well as genera not of fecal origin - "non-Fecal Coliforms." (e.g. *Enterobacter*, *Klebsiella*, *Citrobacter*). The assay is intended to be an indicator of fecal contamination; more specifically of *E. coli* which is an indicator microorganism for other pathogens that may be present in feces. Presence of fecal coliforms in water may not be directly harmful, and does not necessarily indicate the presence of feces.[1]

# GCC Countries with restrictions

## UAE, Oman, KSA, Bahrain, Qatar

# Key Water Quality Values in GCC

Bahrain

Turbidity < 2 NTU

Helminth Ova < 1 ct / 100 L

Oman

Feacal Coliforms < 100 cfu / 100 mL

Nematodes < 1 ct / L

UAE (Abu Dhabi)

Feacal Coliforms < 100 cfu / 100 mL

Helminth Ova < 1 ct / 100 L

# European & North American Legislation

# EU Bathing Water Quality

| EU BATHING WATER QUALITY - DIRECTIVE 2006/7/EC | | | | |
|---|---|---|---|---|
| INLAND WATERS | | | | |
| Parameter | Quality | | | Method |
| | Excellent | Good | Sufficient | |
| Intestinal Enterococci (cfu/100ml | 200 | 400 | 330 | ISO 7899-1 ISO 7899-2 |
| Escherichia Coli (cfu/100 ml) | 500 | 1000 | 900 | ISO9308-1 ISO9308-3 |
| Compliance | 95%ile | 95%ile | 90 %ile | |
| COASTAL AND TRANSITIONAL WATERS | | | | |
| Parameter | Quality | | | Method |
| | Excellent | Good | Sufficient | |
| Intestinal Enterococci (cfu/100ml | 100 | 200 | 185 | ISO 7899-1 ISO 7899-2 |
| Escherichia Coli (cfu/100 ml) | 250 | 500 | 500 | ISO9308-1 ISO9308-3 |
| Compliance | 95%ile | 95%ile | 90 %ile | |

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# EC Practice – Water recycle

Spain Italy and France are large users of water for agricultural irrigation and are the main users of reclaimed water

Power Industry special case, boiler water make up

Industrial re-use commonly uses filtration and RO

# EC Recycle Standards

Italy and Spain leading the way

Proposed standards

7 tiers of microbiological standards

4 tiers chemical standards

Reflects increasing levels of potential for human contact

# CDPH - Title 22 Recycled Water

Several quality definitions

- Disinfected secondary-2.2 recycled wastewater
- Disinfected secondary-23 recycled wastewater

(2.2 and 23 refer to micro quality - coliform MPN/100ml

- Disinfected tertiary water

(Disinfected with chlorine 450 mg mins/litre or total 5 log removal of MS-2 or polio virus)

- Filtered wastewater – 2 different criteria

# CDPH - Title 22 Recycled Water

Filtered wastewater

Media filtration criteria

- <2 NTU 24 hour average
- <5 NTU 24 hour 95%ile
- <10 NTU 24 hour MAC

# CDPH - Title 22 Recycled Water

Filtered wastewater

Membrane filtration criteria

- <0.2 NTU 24 hour 95%ile
- <0.5 NTU 24 hour MAC

# CDPH - Title 22 Recycled Water

Re-use criteria

Surface irrigation including edible crops eaten raw or where human contact is possible

- Disinfected tertiary water
- <2 NTU effluent at all times
- Media filters influent turbidity monitoring

Other uses may use secondary-2.2 or 23 recycled wastewater, depending on use (includes crops where edible portion is not contacted)

# Filtration Technologies

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# Conventional Technologies

Sand Filters

Disc Filters

Can meet average turbidity around 1 NTU (50, 95 and 100%ile guarantees may vary with supplier)

UF

Typical quality better then 0.2 NTU

# ZeeWeed = *Consistent* High Quality Effluent

| Achievable ZeeWeed Treatment Results | |
|---|---|
| $BOD_5$ | < 2 mg/L |
| TSS | < 2 mg/L |
| $NH_3$-N | < 0.05 mg/L |
| TN | < 3 mg/L* |
| TP | < 0.05 mg/L* |
| Turbidity | < 0.2 NTU |
| Fecal Coliform | < 2.2 CFU/100 mL** |
| SDI | < 3 |

- With appropriate biological design
- ** After disinfection – CDPH 60301.230 disinfected tertiary recycled water

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# ReUse Options

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# Wastewater Reuse Options

- Irrigation
  - currently major use of TSE
  - high water quality very important
  - further polishing not required
- Agriculture
  - huge potential use of TSE
  - high water quality critical
  - further polishing not required
- Industrial / District Cooling
  - use of TSE reduces demand on potable water demand
  - high water quality is value added to customers
  - polishing required (EDR/RO) in larger scale or site by site

# Wastewater Reuse Options

- Groundwater Recharge
  - high water quality very important
  - further polishing is required
- Environmental
  - River flow augmentation
  - high water quality may be critical
  - further polishing may not be required
- Recreational
  - Lakes, ponds, golf course irrigation
  - high water quality important
  - Further polishing may not be required