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Support to Reforms – Environmental Governance, Beirut, Lebanon

EuropeAid/134306/D/SER/LB

Use of Treated Wastewater for Lebanon

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Overall comments for follow up

This report was discussed on 23 October 2015 with the following persons:

- Olfat Hamdan, MoE
- Nour Masri, MoE/UNDP/ERLM
- Lamia Mansour, MoE/EU/StREG

It was agreed to focus the report on wastewater reuse and delete the available sections related to sludge (which was reflected in the current version of this report).

The following comments were also raised by the participants and need further follow up:

- The report should highlight that only wastewater resulting from secondary wastewater treatment and above should be considered for reuse
- The report should take into account the need to update the ELVs for industrial wastewater discharge into the network
- The participants flagged that the Ministry of Agriculture had issued a ministerial decision allowing farmers to use wastewater in agriculture without refering to the type of produce nor the level of treatment of the wastewater...

Other comments provided by Nour Masri were left in this report for future follow up.

1. INTRODUCTION

1.1 Objective of the Report

Over the last few years serious concerns have been raised in Lebanon that the use of wastewater in agriculture is leading to harmful environmental and health issues.

In particular fears have been expressed that because the wastewater and sludge used may not always be adequately treated, contamination is occurring to the

- Soil; and especially to the
- Crops;

by bacteria, intestinal worm eggs and viruses from faecal matter, by organic substances (notably pesticides) and by heavy metals.

In particular the article (with some editing) stated that

- '*…Scientists and researchers say that fruit and vegetables grown in Lebanon have excessive levels of pesticides and fertilizers due to raw sewage irrigation. Unsafe agricultural and handling practices abound, and leave fruit and vegetables laced with contamination by the time they reach the (dinner) plate'*
- *The Bekka Valley is Lebanon's agricultural heartland. Crops are feed from the Litani River, the main source of irrigation. However recent years have seen the Litani increasingly polluted with industrial dumping, hospital waste and raw sewage'*

This was one of the main reasons why MoE requested the StREG Project to:

- Summarise controls on the use of treated wastewater on land and in agriculture;
- Review previous studies about the reuse of treated wastewater on land and in agriculture in Lebanon; and
- Propose appropriate standards to meet the present concerns in Lebanon;
- Undertake a case study on the reuse of treated wastewater on land and in agriculture in the Bekka Valley.

1.2 Scope

The present report covers the following:

- Background to the Reuse of Treated Wastewater on Land and in Agriculture;
- Main sources of pollutants in wastewater and methods of controlling them;
- Standards for the use of treated wastewater on land and in agriculture;
- Previous studies on the reuse of wastewater in Lebanon;
- Review of the recent FAO proposed standards for use of treated wastewater on land and in agriculture for Lebanon with a comparison of the standards used in EU Member States, in USA and in Saudi Arabia;
- Proposed modified FAO proposed standards for Lebanon;
- Possible timetable for implementation of proposed modified FAO standards in Lebanon;
- Treatment methods of wastewater so that treated wastewater produced can be used safely on land and in agriculture;
- Case study of the reuse of (treated) wastewater in the Bekka Valley.

2. BACKGROUND TO THE REUSE OF WASTEWATER

The reuse of treated wastewater on land and in agriculture is important in a great many countries around the world since it provides additional water for irrigation (which is often in short supply) as well as nutrients to aid crop growth.

As such it has a significant socio-economic impact in many arid and semi-arid areas. It does also provide an economically valuable alternative compared to just discharging the wastewaste (together with any pollutants and nutrients) into the receiving environment such as local rivers or to the sea, with the resultant pollution problems such as eutrophication.

However, the practice is not without risk (and especially if the wastewater is not properly treated) and controls need to be placed on both the quantity and quality of the wastewater and sludge used in order to avoid harm to the environment or to people (ranging from the farmers to the consumers of the crops produced).

In particular, controls need to be introduced to limit the amount of the following groups of substances in the wastewater and sludge used and also for the irrigation practice employed:

Bacterial pathogens

- These are divided into two broad groups; i.e. those that
  - Result in illness in most individuals ranging from diarrhea to kidney failure;
  - Are opportunistic, and only cause illness in sensitive peoples;
- Opportunistic bacterial pathogens are believed to associate with biofilm growth in water distribution systems;
- All pathogens require an entry into the water system, either as the result of source water contamination or as the result of a failure in the distribution system.

Viruses

- There are more than 100 viruses from 13 families that are capable of transmission via the contamination of drinking water;
- Viruses (as well as bacteria) are easily transmitted by the faecal-oral pathway. Others are also transmitted by person-to-person spread and by respiratory inhalation contact with infected surfaces.

Parasites

- There are a wide range of protozoal parasitic organisms in wastewater that can health issues in humans such as:
  - **Cryptosporidium** which can cause flu-like symptoms, watery diarrhea, loss of appetite, substantial loss of weight, nausea;
  - **Ascaris** for which the disease caused is mostly asymptomatic or accompanied by inflammation, fever, diarrhea;
  - **Helminths** (commonly known as **parasitic worms).** These are worm-like organisms living in and feeding on living hosts;.

Heavy metals

- There are a wide range of heavy metals in wastewater mostly due to dicharges from Industrial Establishments, for example. Cadmium, Chromium, Lead and Zinc. Some of these can be phytotoxic and affect the growth of some crops;

- In addition studies[1] have shown that certain vegetables can take up heavy metals from contaminated water used for irrigation and these could affect the consumer. In particular the research found that concentrations of nickel and chromium increased in potatoes and onions (but not in carrots), when irrigated with water containing contaminant levels similar to those found in industrial wastewater.

Organic Compounds

- Substances such as solvents and pesticides in the wastewater discharged in the public sewer from Industrial Establishments and from agricultural run-off.

The World Health Organization (WHO) drew up the first Guidelines for the use of treated waterwater in agricuture in 1989 and these are shown below.

Table 1: WHO 1989 Guidelines for using treated wastewater in agriculture[2]

Category	Reuse conditions	Exposed group	Intestinal nematodes[b] (arithmetic mean no. of eggs per litre[c])	Faecal coliforms (geometric mean no. per 100ml[c])	Wastewater treatment expected to achieve the required microbiological guideline
A	Irrigation of crops likely to be eaten uncooked, sports fields, public parks[d]	Workers, consumers, public	⩽ 1	⩽ 1000	A series of stabilization ponds designed to achieve the microbiological quality indicated, or equivalent treatment
B	Irrigation of cereal crops, industrial crops, fodder crops, pasture and trees[e]	Workers	⩽1	No standard recommended	Retention in stabilization ponds for 8–10 days or equivalent helminth and faecal coliform removal
C	Localized irrigation of crops in category B if exposure to workers and the public does not occur	None	Not applicable	Not applicable	Pretreatment as required by irrigation technology but not less than primary sedimentation

[a] In specific cases, local epidemiological, sociocultural and environmental factors should be taken into account and the guidelines modified accordingly.

[b] *Ascaris* and *Trichuris* species and hookworms.

[c] During the irrigation period.

[d] A more stringent guideline limit (⩽ 200 faecal coliforms/100 ml) is appropriate for public lawns, such as hotel lawns, with which the public may come into direct contact.

[e] In the case of fruit trees, irrigation should cease two weeks before fruit is picked, and no fruit should be picked off the ground. Sprinkler irrigation should not be used.

Many other Guidelines for the use of wastewater in agriculture involving a plethera of potential pollutants have been proposed since the WHO guidelines were first published.

[1] EC Science for Environmental Policy 11 July 2013 Issue 336

[2] Taken from Guidelines for the Microbiological quality of treated waste water used in agriculture: recommendations for revising WHO Guidelines Ursula J. Blumenthal et alia (Bulletin of WHO 2000, **78**,((9)

Even so the basic principles of the original WHO Guidelines and especially for intestinal worm eggs and bacteria from faecal matter have been maintained throughout.

It is apparent from these Guidelines that before the wastewater can be used on land and in agriculture, it needs to be treated first and used in an appropriate manner. This will require a number of controls being introduced and covering such issues as:

- Probably at least secondary treatment of the wastewater to destroy the bacterial component and to reduce the organic content;
- Prevention of many of the pollutants, notably heavy metals, being discharged from Industrial Establishments into the public sewer, or to rivers from which the irrigation water is obtained;
- Quality (ELVs) and quantity of wastewater and used which will depend on the choice of the wastewater treatment system used;
- Minimization of human exposure by using the proper irrigation practice to protect both farmers and consumers of the crops grown;
- Surveillance measures for the quality of soils, surface and groundwaters and harvested crops to monitor the effects of the use of wastewater.

In addition to mitigating possible health effects associated with the use of wastewater in agriculture, good irrigation practices will also have to be followed to ensure a full crop yield and to minimize risks to the environment since as mentioned above several heavy metals can be phytotoxic.

Furthermore irrigation practices will also depend on local conditions, including climate, physical and chemical soil properties, drainage conditions and salt tolerances of the crops to be grown.

This is particularly important since crops need different nutrients at different stages of their growth – nitrogen for leaf growth and potassium for flower development - and this variation can be difficult to achieve with treated wastwater which is often of a similar composition throughout the year.

3. MAIN SOURCES OF POLLUTANTS IN WASTEWATER AND POSSIBLE CONTROLS

3.1. Overall account

As mentioned in Section 2 above the pollutants in wastewater can be divided into three main Groups. These are:

- Pathogenic organisms (e.g. bacteria, viruses, intestinal nematodes) mainly from human and animal faecal matter;
- Heavy metals mainly from industry and household products;
- Organic compounds (e.g. solvents and pesticides) mainly from industry, agriculture and from household products.

Since the sources of the pollutants in these different Groups are usually different and can require different controls and treatment methods, it is best to consider them separately. A general description of the respective sources of the pollutant discharged to the public sewer, likely pollutants discharged to the public sewer and of possible means of controls is given below. Further details on the range of controls and treatment methods annotated for the case of Lebanon is given in Section 7 of this report.

3.1.1. Pathogenic organisms

Source of Pollutant	Likely Pollutants discharged to public sewer	Possible Means of Controls
• **Domestic**	• **From human faeces** containing bacteria, viruses and intestinal nematodes	1. Ensure at least secondary treatment at MWWTP[3] 2. Possible tertiary treatment involving Cl_2 or O_3
• **Agriculture**	• **From Animal faeces** discharged either illegally or in storm water run-off containing bacteria, viruses, intestinal nematodes and Cryptosporidium	3. Ensure stormwater discharges do not enter the public sewer 4. Ensure at least secondary treatment at MWWTP **5.** Possible tertiary treatment involving Cl_2 or O_3

[3] Municipal Wastewater Water Treament Plant (MWWTP)

3.1.2. Heavy metals and Organic compounds from Industry

Source of Wastewater	Likely Pollutants	Possible Means of Controls
Industrial effluents	• Heavy metals; • pH value changers; • Nitrogen (ammoniacal, nitrate and organic); • COD; • Phosphorus; • Boron; • Suspended solids; • Organic substances from industrial sources, e.g. solvents; • Organic micro-pollutants such as pesticides, pharmaceuticals, endocrine disruptors	6. Permitting industry to minimise effluents 7. Require Industrial Establishment to treat wastewater on site that cannot be treated in the Municipal WWTP 8. Notify operator of Municipal Wastewater Treatment Plant (MWWTP) the volume and composition of discharges to the sewer. 9. Charge for treatment of effluents

3.1.3. Heavy metals and Organic compounds from domestic discharges

Source of Wastewater	Likely Pollutants	Possible Means of Controls
Domestic Discharges	• Heavy metals; • Nitrogen (ammoniacal, nitrate and organic); • COD; • Phosphorus; • Boron; • Grease and fats; • Organic and inorganic substances from household products; • Organic micro-pollutants such as pesticides, pharmaceuticals, endocrine disruptors;	10. Controls on formulation of household products 11. May need to modify operation of MWWTP

3.1.4. Other sources of pollutants

Source of Wastewater	Likely Pollutants	Possible Means of Controls
Storm water run-off	• Heavy metals; • Nitrogen (ammoniacal, nitrate and organic);	12. Construction of storm water holding basins 13. Bypass MWWTP and

	• Phosphorus; • Faecal matter; • Suspended solids;	discharge storm water into rivers or to the sea.
Agricultural runoff	• Heavy metals • Nitrates • Pesticides	14. Apply wastewater in a controlled manner

3.1.5. Possible actions to deal with pollutants

Possible Actions at MWWTP		
Operation of MWWTP	• Treatment of wastewater • Production of sludge	15. Set ELVs for WWTP Discharges 16. Set Conditions in Permit for MWWTP to achieve ELVs
Use of treated wastewater and sludge	• Discharge of treated wastewater to river, land, agriculture or to sea	17. Set ELVs and operational requirements for discharge to: 18. Rivers 19. Sea 20. Use on Land 21. Protection of groundwater 22. Use in Agriculture
If wastewater not properly treated may cause problems due to:	• Pathogenic organisms (bacteria, helminths, viruses); • Heavy metals (industrial and domestic sources); • pH value; • Nitrogen (ammoniacal, nitrate and organic); • Phosphorus; • Boron; • Grease and fats; • Faecal matter; • Dissolved solids; • Suspended solids; • Organic substances from industrial sources, e.g. solvents; • Organic micro-pollutants such as pesticides, pharmaceuticals, endocrine disruptors.	23. Will need tighter controls of use if the Wastewater is not properly treated

4. STANDARDS FOR THE USE OF TREATED WASTEWASTE ON LAND AND IN AGRICULTURE

4.1. Summary of standards

For the present report a summary of the various standards used for the use of treated wastewater used throughout Europe, USA and the Kingdom of Saudi Arabia has been prepared. This was based on the following Guidelines and Standards;

- WHO Guidelines (reference 2 above);
- Relevant EU Directives[4] which included those on
  - Urban Wastewater;
  - Quality of Water to Support Fish life;
  - Bathing Waters;
  - Quality of Water to Support Shellfish;
  - Pollution caused by certain dangerous substances discharged to the aquatic environment;
- USEPA and some Individual States of the USA[5];
- Kingdom of Saudi Arabia for Irrigation Water[6].

The overall outcome of the various standards is given in

- Appendix 1: Use of Treated Wastewater on Land and in Agriculture;
- Appendix 2: Irrigation Water for Saudi Arabia.

These standards can be used as a direct comparison for the standards proposed for Lebanon (see Section 5 onwards).

Commented [NM1]: Is there any particular reason why we've singled out Saudi Arabia? Their WW treatment capabilities differ greatly from Lebanon.
Maybe introduce the rationale behind this choice.

[4] UWWT Directive concerning urban waste water treatment (91 /271 /EEC) of 21 May 1991

Fish Directive on the quality of fresh waters needing protection or improvement in order to support fish life (2006/44/EC) of 6 September 2006

Bathing Waters Directive concerning the management of bathing water quality and repealing Directive (2006/7/EC) of 15 February 2006

Shellfish Directive on the quality required of shellfish waters (2006/113/EC) of 12 December 2006,

Dangerous Substances on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community (76/464/EEC) of 4 May 1976

[5] Standards are set for each US State and so ranges are given for most parameters in Appendix 1

[6] Irrigation water quality standards at point of discharge to irrigation system and use points. Royal Commission Environmental Regulations Saudi Arabia – 2010; RCER – 2010, Volume 1, Regulations and Standards

5. PREVIOUS STUDIES FOR LEBANON FOR RE-USE OF TREATED WASTEWATER

5.1. Background

A number of earlier studies on the proposed standards for the reuse of wastewater in Lebanon have been undertaken. These include:

- UN FAO[7] Project UTF/LEB/019/LEB on Wastewater Reuse and Sludge Valorisation and Reuse (2010) which included
  - Proposition for Lebanese Wastewater Reuse Guidelines; (see Appendix 1 of the draft Report)
  - Proposition for Lebanese Guidelines on Sewage Sludge Use in Agriculture (see Appendix 2 of the draft Report)
- ENEA[8] Report on Safe Reuse of Treated Wastewater in Agriculture in Lebanon (2014). This also deals with measures to improve the quality of the Litani River which is used as the main source of irrigation water for the Bekka Valley (see Section < >).

5.2. Outline of Present Situation in Countries such as Lebanon

The Executive Summary of the ENEA Report on Safe Reuse of Treated Wastewater in Agriculture in Lebanon (reference 6 above) gives the following (edited) outline:

- *Approximately, 70% of the world's water is used for agricultural irrigation. As such the reuse of treated municipal wastewater for purposes such as landscape and agricultural irrigation reduces the amount of water that needs to be extracted from natural resources as well as reducing the discharge of wastewater to the environment;*
- *As such treated municipal wastewater is a valuable water source for recycling and reuse in the **Mediterranean countries such as Lebanon** and other arid and semi-arid regions which are facing increasing water shortages;*
- *There are several constraints to water reuse however such as:*
  - *Health problems, such as water-borne diseases and skin irritations, may arise where people come into contact with reclaimed water or produce that was grown using reclaimed water treatment;*
  - *In some cases, water reuse is not economically feasible because of the requirement for an additional distribution system;*
  - *Water reuse may be rejected for cultural or religious reasons in some societies;*
- *Wastewater irrigation is different from freshwater irrigation however and, consequently, calls for a specifically adapted management practices, if environmental and soil degradation is to be prevented and/or sustainable high crop yields are to be realised.*

5.3. Standards proposed by FAO

[7] United Nations Food and Agriculture Organisation (FAO)

[8] Italian Ministry of Foreign Affairs and Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA)

The proposed FAO standards for the re-use of treated wastewater and of sludge (reference 6) are also included respectively in Appendices 1 and 5.

5.4. Comparison of Standards

The authors of the present report undertook an in-depth review of the standards for the Reuse of Wastewater on Land and in Agriculture proposed by the FAO. They concluded that the respective FAO studies for Lebanon are broadly similar those used for other regimes.

Even so the FAO standards usually were the strictest or at least proposed the lower end of the range for some parameters. This is probably because these proposed standards are more related to the growth of food crops where protection of the farmers and the consumers of the crops produced are paramount.

As such the authors of the present report understood that the FAO Standards would be difficult to achieve at least in the short-term and standards less onerous should be proposed, assuming that they are consistent with protecting the environment and people from the use of wastewater on land and for agriculture.

5.5. MoE's response to FAO proposed standards

MoE has also previously reviewed the FAO proposed standards for the use of treated wastewater and of sludge and subsequently decided to reject them for a number of reasons but mainly;

1) **For use of wastewater** since the proposed standards:
   - Do not include the justification for the selection of the proposed guidelines for Lebanon. In fact there is a lack of scientific research at the national level to determine the factors to be taken into account during the development of the guidelines;
   - Were based on preventing the use of treated water on crops that are eaten raw. However, it should also seek to prevent its use for crops that grow in the soil and that may still come into contact with treated wastewater;
   - Did not distinguish the areas that are directly exposed to the public and customized according to age group (for example, below the age of fifteen and above the age of fifteen) and set limits on the basis of bacteriological indicators. When unable to do so, the stricter values should be taken into account;
   - Do not identify the quality of treated wastewater with respect to heavy metals, but only for limited indicators and omitted a number of them that pose a threat to public health (e.g. lead, cadmium ...), knowing that these indicators are particularly important for the case of Lebanon where industrial effluents are also discharged into the sewage networks;
   - Identifies the quality of agricultural crops for heavy metals, but the protocol measurements and analysis took into account only the evaluation of the quality of wastewater inflows and outflows of wastewater without referring to assess the quality of agricultural crops;
   - Do not specify the distances that should separate the irrigated areas by treated wastewater from other nearby sites that may be highly exposed to this treated water (for example, residential buildings, public roads, surface water, wells, etc.);
   - Do not emphasize that the issuance of any regulation on the re-use of treated water for irrigation should be in the form of guidelines subjected to a trial period and not a strict standard.

2) **For the use of sludge since:**

- It was agreed on the need to consider the master plan prepared in 2002 on the treatment of sludge from wastewater treatment plants, before issuing any legislation regarding the guidelines for re-use sludge on agricultural land;
- Emphasis on the content of a number of letters sent by the Ministry of Environment in 2001, which indicates that the adoption of the options of using sludge on agricultural land is associated with environmental risks on soil, groundwater and surface water, as well as the damage caused to human health and crops, in case the required quality standards were not met, and therefore, this option should be based on standards based on field trials, in order to determine the quality of the wastewater of some sites.

5.6. Proposed standards by the authors for Lebanon

The authors of the present report fully understand the reservations expressed by MoE above as to why they have not yet issued Guidelines for the use of treated wastewater and sludge.

However the time needed to obtain all of the background information listed above will delay the introduction of the Guidelines by many years. During which time, harm to the environment and to the public (even causing deaths) is likely to continue to occur.

Thus as an example of the need for urgent action, a study[9] of the incidence of intestinal parasites **among presumably healthy individuals** in Lebanon undertaken in 2004 revealed that the prevalence of intestinal parasites was 12.4% with the most common parasites identified as Escherichia coli (3.8%), Giardia lamblia (3.1%) and Entamoeba histolytica (2.3%).

The abstract of this Study further concluded with the statement that the ....data presented shows the need to improve hygienic conditions to contain the problem of intestinal infections with parasites in Lebanon....'

Accordingly various approaches were considered by the authors of this report to deal with the issues against the background of

- The proposed FAO standards were prepared specifically for Lebanon by FAO – probably the world leaders as regards crop nutrients requirements. As such they must always be born in mind;
- Even so to require Lebanon to meet the FAO standards when they are stricter than those proposed by other regulatory systems seems unreasonable;
- Until the wastewater and sludge used in Lebanon is properly treated, harm to the environment and to the public is likely to occur and so speed of action is important.

The conclusion reached was that since Lebanon is at the beginning of the process to fully regulate the use of treated wastewater used on land and in agriculture, it seems reasonable at this stage to

[9] Intestinal parasites among presumably healthy individuals in Lebanon, Bassem R. Saab, Umaya Musharrafieh, Nabil T. Nassar, , Mustafa Khogali, , George F. Araj. Saudi Med J 2004; Vol. 25 (1): 34-37,.

- **Consider the FAO standards as aspirational and something to strive for to achieve in the next 20-30 years;**
- **In the meantime to**
  - **Accept modified FAO standards (see below) which should be achieved in a shorter period of time (perhaps over the next 10 years);**
  - **Implement a step-wise approach to achieve these modified FAO standards as soon as possible to protect the environment and public health;**
  - **Reflect the differences in controls needed and the potential harm caused by the biological, organic and heavy metal components of the wastewater discharged the public sewer and used on land and for agriculture.**

Details of the proposed Modified FAO standards are given in Section 6 below.

6. PROPOSED MODIFIED FAO STANDARDS

For these it is proposed that Modified FAO standards for the use of wastewater on land and in agriculture should be set for Lebanon which:

- Are limited to the most critical parameters. If shown necessary additional parameters can always be added – it is always best to start with the smallest number of parameters possible;
- Are based on the proposed FAO standards; but should be
  - Less strict where the proposed FAO Standards are more strict than those set for other regulatory regimes (mainly those used in the EU and in the USA);
  - Set at the lower end where a range of values are given in these other regulatory regimes;
  - Never weaker than those set by other regulatory regimes;
  - Accepted where no standards are given for the other regulatory regimes;
- Reflect the different sources and controls measures needed for
  - Bacterial;
  - Organic; and
  - Heavy metal components of the wastewater used discharged to the public sewer.
- Allow extended periods of time for Lebanon to achieve the proposed modified FAO standards set.

On that basis, proposed Modified FAO Standards have been prepared for the use of waste on land and in agriculture and these are set out in Tables 2 and 3 below.

The Modified FAO standards have been given in order of importance to protect the environment and people.

Those parameters with a proposed lower value than the proposed FAO standards are shown in red.

Commented [NM2]: Maybe also include a geographical restriction based on the geographical distribution of industries whose effluents can be used and also, for sludge, based on the economics of logistics (end-use, geographical destination, type of crops, etc.)

Maybe also exclude the reuse of treatment wastewater and use of sludge from specific industries, where known and possible. Especially when it comes to heavy metal charged effluents.

Table 2: Proposed modified FAO standards for use of wastewater on land and for agriculture

Parameter	Use Category (see Appendix 3 for details)		
	I	II	III
Faecal Coliforms (MPN/l)	<200	<500	<1000
Helminths ova per litre	<1	<1	<1
BOD_5 (mg/l)	50	100	100
COD (mg/l)	125	250	250
TSS (mg/l)	60	200	200
pH	6-9	6-9	6-9
Cl_2 residual (mg/l)	500	750	1000
N-NO3 (mg/l)	<5	5-30	30-50
Arsenic (mg/l)	0.1	0.3	0.5
Boron (mg/l)	0.75	1.25	2.0
Cadmium (mg/l)	0.01	0.03	0.05
Chromium (mg/l)	0.01	0.01	0.05
Cu (mg/l)	0.01	0.02	0.03
Nickel (mg/l)	0.01	0.02	0.02
Total Zn (mg/l)	2	2	5

Commented [NM3]: Comment for both table 2 and 3: Clarify why some values are in red.

7. CONTROL METHODS FOR DEALING WITH WASTEWATER DISCHARGED TO THE PUBLIC SEWER IN LEBANON

7.1. Key stakeholders

A wide range of stakeholders are involved with the controls on the reuse of treated wastewater on land and in agriculture. The most important of these are listed in Table 1 below. It will necessary for the involvement to be coordinated probably by establishing

- An Overall Coordinating Committee established under **Law 444/2002 on Protection of the Environment** with the Chair probably held by MoE; and
- A series of Memoranda of Understanding (MoU) between the various stakeholders to ensure that they act in a concerted manner.

Table 1: Key stakeholders dealing with Reuse of Wastewater

Ministries	Agriculture and Land use Sector	Water and Food supply
• **Ministry of Environment**	• **Farmers**	• **Wholesale and retail outlets for agricultural products**
• **Ministry of Industry**	• **Farmer's Associations**	• **Drinking water providers (groundwater sources)**
• **Ministry of Agriculture**	• **Farm workers**	• **General public (includes consumers of water and agricultural products, and those potentially affected by irrigation/spreading practices).**
• **Ministry of Public Health**	**Chamber of Commerce, Industry & Agriculture of Zahlé & the Bekaa**	
• **Ministry of Energy and Water and particularly managers of the MWWTP[10]**		
• **Ministry of Interior and Municipalities**		

Commented [NM4]: Could be expanded... to be discussed with Olfat.

Commented [NM5]: If we are considering the Bekaa geographical area only.
Otherwise, we need to expand to other CCIA also.

[10] (M)WWTP is (Municipal) Wastewater Treatment Plant

7.2. Controls

Using the same numbering system as that used for sections 3.1.1 – 3.1.5 above, each of the possible controls for limiting the pollutants in the treated wastewater used on land and in agriculture are considered below:

7.2.1. Pathogenic organisms (Controls 1-5)

There are few controls available on the amount of pathogenic organisms (mainly from human faeces) discharged to the public sewer.

The main controls to limit pathogenic organisms in the treated wastewater are

- **Control 1** Ensure at least secondary treatment at MWWTP;[11] and
- **Control 2** Possible tertiary treatment involving Cl_2 or O_3;

As regards the pathogenic organisms from animal faeces the recommended treatment methods are

- **Control 3:** Ensure stormwater discharges do not enter the public sewer; and as for pathogenic from human faeces:
- **Control 4:** Ensure at least secondary treatment at MWWTP;
- **Control 5:** Possible tertiary treatment involving Cl_2 or O_3.

7.2.2. Industrial effluents (Controls 6-9)

Permit all Industrial Establishment **issued under Decree 8018 /2002[12]** which will require the Operator to

- Take all reasonable measures (including installing an on-site WWTP to minimise the discharges of wastewater to the public sewer and particularly those substances that can cause serious pollution to the environment or harm to humans **(Control 6);**
- Treat wastewater on site that cannot be treated normally by the Municipal WWTP (MWWTP) **(Control 7).**
- Notify the Operator of the MWWTP regarding details of the quantity and composition of the wastewater discharged to the sewer **(Control 8).** This will enable the Operator of the MWWTP to be able to manage more effectively the treatment of the wastewater received;

The costs of treatment of this wastewater discharged to the public sewer should be recovered from the Operator of the Industrial Establishment **(Control 9)** discharging the wastewater and used to off-set the cost of running the MWWTP **(see Figure 3 below).**

At present the costs of the treatment of wastewater discharged to the public sewer from an Industrial Establishment in Lebanon are not normally recovered from the Operator. This means that there is little or no incentive for the Operator to reduce either the quantity or the quality (composition) of the wastewater discharged.

Commented [NM6]: Maybe here exclude a certain type of industries based on the geographical area we are considering. If we are sticking to Bekaa alone considering the type of industries in the area... the business plan of the Quaraoun can help.

Commented [NM7]: Could... rather tahn should. Simply because as far as i know there are no effluents permits being prepared currently.

Maybe use this report to voice the importance and imminent need to move on this file.

[11] Municipal Wastewater Water Treament Plant (MWWTP)

[12] Decree 8018 (21/06/2002) on Procedures and permitting requirements to establish/operate industrial establishments

Charging the Operator for the treatment of the wastewater discharged (probably under **Law 444/2002**[13] which includes Polluter Pays Principle – Polluters Pays for Pollution Prevention and Control) – could be a powerful means of reducing the pollutant load discharged to the public sewer.

This can mean that it cheaper for the Operator to treat the wastewater on site rather than to discharge it to the public sewer. This is often the best solution since it is usually more effective to treat a smaller quantity of wastewater with a higher concentration of pollutant rather than a much larger quantity of wastewater (due to the addition of other wastewaters to the public sewer) with the resultant lower concentration of pollutants.

In many countries the cost of treating the wastewater is assessed on the basis of the amount discharged and the composition of the wastewater. Often this is done using a formula which links the charges to the respective cost of treating the various components in the wastewater.

One such system is the Mogden formula used in the UK. This is set out in Figure 3 below and shows how the charges payable by the Operator of the Industrial Establishment for treatment of the wastewater discharged are a combination of respective costs of treatment of the various components in the wastewater.

Figure 3: UK Mogden formula for charging for treatment of wastewater[14]

Charge per unit of effluent = R + [(V + Bv) or M] + B(Ot/Os) + S(St/Ss)

Where

R = reception and conveyance charge [price charged/m^3]

V = primary treatment (volumetric) charge [price charged/m^3]

Bv = additional volume charge if there is biological treatment [price charged /m^3]

M = treatment and disposal charge where effluent goes to sea outfall [price charged /m^3]

B = biological oxidation of settled sewage charge [price charged /kg]

Ot = Chemical oxygen demand (COD) of effluent after one hour quiescent settlement at pH 7

Os = Chemical oxygen demand (COD) of crude sewage one hour quiescent settlement

S = treatment and disposal of primary sewage sludge charge [price charged /kg]

St = total suspended solids of effluent at pH 7 [mg/litre]

Ss = total suspended solids of crude sewage [mg/litre]

The respective price charged per unit of pollution will be set at the beginning of each year in consultation with industry for the Operator of MWWTP to recover its costs for treatment of the wastewater.

[13] Law 444/2002 on the Protection of the Environment

[14] UK Water Services Regulatory Authority

7.2.3. Household Discharges (Control 10 and 11)

These controls should be considered for the longer term

Control 10 involves the reformulation of household and garden products to remove / substitute any chemicals that could affect the operation of the MWWTP particularly by killing the bacteria used to break down the organic material present in the wastewater. These chemicals include such examples as Dichloro-phenols and Dichloro-benzenes used in toilets blocks, boron in detergents and pesticides in garden chemicals.

This Control will take a long time to achieve and is probably one for the future. Nevertheless discussions should be held with the manufacturers of these household products to advise them of the need to reformulate their products, since the use of these chemicals in household products will have to be phased out over a specified period of time – perhaps within the next 5-10 years.

It may also be possible to amend the operation of the MWWTP to deal with these Chemicals **(Control 11),** though this is unlikely to be successful since the purpose of many of the chemical in domestic products is to kill bacteria which lie at the heart of the operation of the MWWTP.

Some of these domestic products may be imported from other countries and that could make their removal / substitution more difficult. In this case it would be necessary to introduce amended import controls on these products and to require the importers to demonstrate that they had complied with these amended import restrictions.

7.2.4. Stormwater Run-off (Controls 12 and 13)

These Controls deal with storm water run-off which during periods of heavy rain can amount to many times the normal flow of wastewater. If this volume of storm water is allowed to enter the sewer, it can scour out the bacteria from the MWWTP facility and also cause pollution of the receiving river or of the sea. It can then take several days for the bacteria in the WWTP to grow sufficiently so that normal treatment of the wastewater in the MWWTP will resume.

There are two standard methods to deal with storm water run-off:

- Construction of storm water run-off holding basins **(Control 12);** The rainwater held in these holding basins could always be used later for irrigation purposes;
- Bypass of MWWTP and to discharge storm water run-off directly into a river or to the sea **(Control 13).**

Control 12 can be expensive and obviously depends on the likely quantity of stormwater that needs to be stored, whereas **Control 13** is generally much cheaper. It does however pose the potentially risk of polluting the river or the area of the sea into which the stormwater run-off is discharged. But that may be preferable to have the MWWTP effectively out of action for several days whilst the bacterial population re-grow after being scoured out following a surge of storm-water.

Control 14 requires that treated wastewater and sludge should be applied so as to minimise effects from storm-runoff. Details of good irrigation practice is given in Appendix b

Such controls could be introduced Law 444/2002 on Protection of the Environment – for example under Section 5 Prevention of Natural Resources Degradation

7.2.5. MWWTP Operation (Controls 15 and 16)

Emission Limit Values (ELVs) need to be set that the Operator of the MWWTP has to achieve before the treated wastewater and the sludge produced can be discharged **(Controls 15 and 16).** These ELVs will need to be set to reflect the use of the treated wastewater and sludge following discharge from the MWWTP.

Commented [NM8]: As part of StREG inspection and Enforcement component.

Also to achieve these ELVs the operation of the MWWTP will need to be adjusted according to the effluent loading - Industrial Discharges (**Controls 6 - 9**), Domestic Effluents **(Controls 10 and 11)** and the Use the Wastewater and Sludge will be put to (**Controls 17 - 22**).

7.2.6. Use of wastewater (Controls 17-22)

Commented [NM9]: Restrict geographically as well, taking into account t space and land availability

Guidelines on the use of treated wastewater on land and in agriculture will need to be established. In particular these will need to establish the maximum loading of wastewater allowable according to the use, taking into account soil type, land use, crop grown and stage of the crop growth **(Controls 17-22).**

Special care will also be needed to ensure that the use of treated (and particularly untreated) wastewater on land and for agriculture to ensure that any run-off does not cause pollution to the groundwater and especially if that is used for drinking water purposes.

This is especially important for countries such as Lebanon[15] where

- More than two thirds of the country (about 6,900 km^2) have Karst features such as landscape underlain by limestone which has been eroded by dissolution, producing ridges, towers, fissures, sinkholes and other characteristic landforms;[16]
- There are at least 15 aquifers in Lebanon of which 14 are in Karstified carbonate strata.

It is important to note that protection of the sea from the discharge of wastewater is already included in **MoE Decision 8/1 (2001).** However protection of the land from the use of sludge is not included in this MoE Decision.

Commented [NM10]: Protection of surface water is also relevant in this case and not only of the sea. It is also included in decision 8/1 of 2001.

7.2.7. Additional Controls (Control 23)

If the wastewater has not been properly treated in the MWWTP, then tighter Guidelines on their use of the partially treated wastewater will be needed.

7.3. Good irrigation practice

In addition to all the controls outlined above it is vital that a good irrigation practice is adopted to ensure that maximum benefit for the crops is achieved whilst minimum harm is caused to the public and to the public. Brief details on good irrigation practice is given below.

7.3.1. Water quantity

[15] Karst and Hydrogeology of Lebanon, H S Edgell , Carbonates and Evaporites September 1997, Volume 12, Issue 2, pp 220 -235

[16] Definition given by Wikipedia

The amount of water available for irrigation will ultimately determine what types of crops can be grown what types of irrigation techniques can be used. Most water applied to crops is lost by evapotranspiration from the plant surface. Therefore, the water required by the crops is usually equal to the amount of water lost by evapotranspiration. The evapotranspiration requirement is largely dependent on crops climatic factors thus can be estimated based on local meteorological data.

FAO has developed a computer program (CROPWAT) to help farmers determine crop water requirements based on climatic factors[17]. The appropriate quantity of water to use will need to be adjusted for the amount of rainfall, leaching requirements, application losses other factors.

7.3.2. Water quality

Apart from the microbiological component in wastewater that is reduced during the treatment processes, wastewaters generally contain chemical elements that cannot be eliminated by a traditional secondary treatment. The FAO Guidelines for conventional irrigation water quality gives in Table 3 below some concentration limits to consider.

Often, the limits on concentrations of many chemicals in the irrigation water will be determined by crop requirements not by health concerns. The nutrients in wastewater (i.e. nitrogen, potassium, phosphorus, zinc, boron sulphur) should be present in the right concentrations, or they can damage the crops /or the environment.

For example, wastewater often contains high concentrations of nitrogen. Although plants require nitrogen for growth, excessive nitrogen can cause overstimulation of growth, delayed maturity or poor-quality produce. Plants require different amounts of nitrogen based on their growth stage.

In the first stages of growth, plants may require high quantities of nitrogen (in the earliest stages of growth, plants require lots of nitrogen, but may be too small to usefully assimilate all that is applied), but in the later flowering fruiting stages, they may require less. In some cases, nitrogen levels will need to be adjusted by blending water supplies if conventional water is available.

This is also an important consideration to reduce leaching of nitrate into groundwater supplies, which would pose a potential health risk to consumers of the drinking-water.

Table 4: Water quality for irrigation

Commented [NM11]: Source?

[17] (Pescod, 1992). CROPWAT is available at http://www.fao.org/landandwater/aglw/cropwat.stm

Parameter		Units	Degree of restriction on use		
			None	Slight to moderate	Severe
Salinity EC_w [a]		dS/m	<0.7	0.7-3.0	>3.0
TDS		mg/l	<450	450-2000	>2000
TSS		mg/l	<50	50-100	>100
SAR [b]	0-3	meq/l	>0.7 EC_w	0.7-0.2 EC_w	<0.2 EC_w
SAR	3-6	meq/l	>1.2 EC_w	1.2-0.3 EC_w	<0.3 EC_w
SAR	6-12	meq/l	>1.9 EC_w	1.9-0.5 EC_w	<0.5 EC_w
SAR	12-20	meq/l	>2.9 EC_w	2.9-1.3 EC_w	<1.3 EC_w
SAR	20-40	meq/l	>5.0 EC_w	5.0-2.9 EC_w	<2.9 EC_w
Sodium (Na^+)	Sprinkler irrigation	meq/l	<3	>3	
Sodium (Na^+)	Surface irrigation	meq/l	<3	3-9	>9
Chloride (Cl^-)	Sprinkler irrigation	meq/l	<3	>3	
Chloride (Cl^-)	Surface irrigation	meq/l	<4	4-10	>10
Chlorine (Cl_2)	Total residual	mg/l	<1	1-5	>5
Bicarbonate (HCO_3^-)		mg/l	<90	90-500	>500
Boron (B)		mg/l	<0.7	0.7-3.0	>3.0
Hydrogen sulfide (H_2S)		mg/l	<0.5	0.5-2.0	>2.0
Iron (Fe)	Drip irrigation	mg/l	<0.1	0.1-1.5	>1.5
Manganese	Drip irrigation	mg/l	<0.1	0.1-1.5	>1.5
(Mn)					
Total nitrogen (TN)		mg/l	<5	5-30	>30
pH		Normal range 6.5-8			
Trace elements (see Table 3)					

TDS, total dissolved solids; TSS, total suspended solids
Sources: Ayers & Westcot (1985); Pescod (1992); Asano & Levine (1998).
[a] EC_w means electrical conductivity in deciSiemens per metre at 25 °C.
[b] SAR means sodium adsorption ratio ($[meq/l]^{1/2}$)

8. WASTEWATER TREATMENT PLANTS

8.1. Main concerns

As mentioned above, wastewater unless properly treated (at least to secondary treatment standard) poses risks to the environment and to human health since it may contain:

- Excreta-related pathogens (viruses, bacteria, protozoan and multicellular parasites);
- Skin irritants and toxic chemicals like heavy metals;
- Pesticides and pesticide residues;
- Endocrine disruptors that can generate serious problems in the environment and for the public.

As such the overall objectives for treatment of the wastewater so that it (and the associated sludge produced) can be used on land and in agriculture are to ensure that it is done in a safe manner regarding:

- Human health;
- Nuisance (flies, odours);
- Animal health (agricultural and other);
- Crop quality;
- Groundwater quality, especially for drinking water resources;
- Surface water quality (especially if used for drinking water resources);
- Soil quality (long-term) – heavy metals, salinization, blinding by grease and fats, micro-biological diversity.

For this the primary risk factors that have to be taken into account include;

- Pathogenic organisms (bacteria, helminths, viruses);
- Heavy metals (industrial and domestic sources);
- pH value;
- Nitrogen (ammoniacal, nitrate and organic);
- Phosphorus;
- Boron;
- Grease and fats;
- Faecal matter;
- Dissolved solids and the sodium, calcium, magnesium balance;
- Suspended solids;
- Organic substances from industrial sources, e.g. solvents;
- Organic micro-pollutants such as pesticides, pharmaceuticals, endocrine disruptors;
- Odour;
- Problems with flies, mosquitos and vermin.

It is for these reasons that most standards (see Appendices of this report) for the re-use of wastewater relate to the use of TREATED waste waster[18] in agriculture and often prohibit the waste of UNTREATED wastewater for this purpose.

[18] Obviously if the wastewater is untreated, then no sludge would be formed to be used on land or in agriculture

8.2. Treatment of Wastewater

For most proposed standards for the reuse of treated wastewater on land and in agriculture, the term **TREATED** usually means a combination of:

- **Primary treatment** which consists of temporarily holding the wastewater in a basin where heavy solids can settle to the bottom while oil, grease and lighter solids float to the surface;
- The settled and floating materials are removed and the remaining liquid may be discharged or usually subjected to secondary treatment;
- After further digestion the settled matter is termed **Sewage Sludge**.

- **Secondary treatment** involves treating the dissolved and suspended biological matter with naturally occurring micro-organisms;
- Secondary treatment may require a separation process to remove the micro-organisms from the treated water **(which are usually feed into the Sludge Digester)** prior to discharge or tertiary treatment.

And for more developed systems:

- **Tertiary treatment** which is anything more intensive than primary and secondary treatment in order to allow the re-use of the treated wastewater into more sensitive or fragile ecosystems (estuaries, low-flow rivers);
- Here the treated water may be disinfected chemically or physically (for example, by lagoons and microfiltration) prior to discharge into a stream, river, bay, lagoon or wetland, or it can be used for the irrigation of a golf course, green way or park.

During these various treatment steps the organic compounds in the wastewater (unless broken down by bacterial action) and the dissolved compounds usually remains in the treated wastewater whilst the heavy metal compounds tend to be concentrated in the resultant sludge.

It is for that reason different standards need to be set for the use of treated wastewater and for sludge on land or in agriculture and will involve a combination of regulations, monitoring programmes and stakeholder guidelines.

Even so the demand for wastewater for use in irrigation in agriculture can be so great in some countries that farmers will still endeavour to use it whether it has been treated or not, regardless of the risk. This is often done illegally by breaking into the discharge pipe from the MWWTP.

Such activities have has to be taken into account when setting the standards for the use of treated wastewater and for sludge on land or in agriculture, and particularly when enforcing them.

9. STATUS OF WASTEWATER TREATMENT PLANTS IN LEBANON

The status of Lebanon's treatment plants are set out in the Table 2 below. This was taken from Chapter 3 of the 2010 State of the Environment Report. Although it needs updating it nevertheless gives some picture of the present position. Depending on the loading those treatment plants where the Process is given as **AS** (Activated Sludge), **B** (Biofiltration), **EAAS (**Extended Aeration Activated Sludge) may be able to meet the required standards for treated wastewater (shown in green) whereas those where the process is given as **TF** Trickling Filter or **PT** Pre Treatment probably will not be able to do so (shown in pink).

Table 2: Status of Lebanon's treatment plants (2010)[19]

Location (RWE)	*Population Served*	*Capacity m^3/d*	*Process*	*Status*
Main Coastal STPs				
Ghadir (BML)	250,000	50,000	PT	Operating. An expansion planned to add 850,000 people.
Jbail (BML)	50,000	9,000	B	STP complete. Networks completion in 2011
Jieh (BML)	88,000	11,900	B	Complete
Tabarja (BML)	505,000	70,000	B	Planned
Bourj Hammoud (BML)	2,200,000	330,000	PT	Planned
Saida (Sth L)	390,000	55,000	PT	Operational
Sour (Sth L)	200,000	45,000	AS	Under construction
Batroun (Nth L)	30,000	4,100	EAAS	Complete. Networks under construction
Chekka (Nth L)	15,600	1,750	EAAS	Complete. Networks under construction
Tripoli (Nth L)	1,000,000	135,000	AS	Complete. Operational mid 2011.
Abdeh (Nth L)	185,000	30,000	AS	Planned
Main Inland STPs				
Barouk (BML)	12,000	1,000	AS	Planned
Nabeh al Safa(BML)	30,000	3,000	AS	Planned
Hrajel (BML)	37,000	6,000	AS	Planned

[19] CDR, 2010 (Main Coastal and Main Inland) and WB, 2010 (Litani Basin)

Nabatieh(Sth L)	100,000	9,000	EAAS	Complete. Awaiting completion of network.
Litani Basin (Bekaa)				
Baalbeck	89,000	12,000	AS	Complete. Awaiting completion of network
Zahleh	120,000	18,000	TF	Ongoing
Joub Janine	77,000	10,500	EAAS	Ongoing
Saghbine	4,100	530	EAAS	Ongoing
Labwa	53,000	7,000	AS	Planned
Majdel Anjar	275,000	44,500	AS	Planned
Tibnin el Tahta	100,000	25,000	AS	Planned
Aitanit	37,500	5,000	TF	Operational
Fourzol	7,400	1,000	TF	Operational
Chmistar	13,200	1,800	TF	Ongoing
Ablah	14,630	2,000	TF	Ongoing

AS Activated Sludge, **B** Biofiltration, **EAAS** Extended Aeration Activated Sludge, **TF** Trickling Filter, **PT** Pre Treatment

10. OVERALL TIMETABLE FOR IMPLEMENTATION OF STANDARDS

Commented [NM12]: Maybe use a different format for easier/clearer presentation.

TIME	ACTIONS	CONTROL (SEE FIGURE 2)
	DURING YEAR 1	

	• Lead Ministry/Ministries enter into dialogue with Farmers and with Farming Associations to inform them that
	  • Guidelines to control the use of treated wastewater on land and in agriculture need to be prepared;
	  • These Guidelines will be introduced WITHIN THE NEXT 2 YEARS;
	  • Requirements of the Guidelines will have to be met WITHIN 3 YEARS OF INTRODUCTION.
		14, 15, 16 &17

	• Lead Ministry/Ministries enter into dialogue with Operators of Industrial Establishments informing them that as part of their existing Operational Permit (or new Operational Permit to be issued if they do not have one)
	  • Conditions will be added WITHIN THE NEXT 2 YEARS which will have to be met WITHIN 3 YEARS OF INTRODUCTION requiring the Operators to
	  • Minimise the amount of wastewater discharged to the sewer and especially of the amount of polluting substances in the wastewater;
	  • Notify the Operator of the WWTP of the likely quantity and quality of the wastewater discharged;
	  • Pay for treatment of the wastewater discharged according to the quantity and quality of the wastewater.
		1, 2, 3 & 4

	• Lead Ministry/Ministries enter into dialogue with Industrial Establishments producing household products informing them informing them as part of their existing Operational Permit (or new Operational Permit to be issued if they do not have one) to notify them that
	  • Conditions will be added WITHIN THE NEXT 2 YEARS which will have to be met WITHIN 3 YEARS OF INTRODUCTION requiring the Operators to
	  • Advise the Operators of WWTPs of any substances used in their products that may be discharged into the sewer that could affect the operation of the WWTP;
	  • To phase out these substances from their products
		5

	WITHIN 5 YEARS OF INTRODUCTION (in many cases this will entail the reformulation of their products).	

	• **Lead Ministry/Ministries enter into dialogue with Operators of WWTPs informing them that**
	  • **WWTPs will be permitted WITHIN 2 YEARS and those permits will set ELVs for treated wastewater used on land and in agriculture before it is discharged;**
	  • **These ELVs will have to be met WITHIN 3 YEARS OF INTRODUCTION;**
	  • **Operators of Industrial Establishments discharging wastewater to the sewer will have to notify them WITHIN THE NEXT 5 YEARS of the quantity and quality of the wastewater discharged;**
	  • **Operators of the Industrial Establishments discharging wastewater will WITHIN THE NEXT 5 YEARS begin to pay for treatment of the wastewater to the Operator of the WWTP;**
	  • **The Permit will also require the Operator of the WWTP to review within the NEXT 5 YEARS the possibility of**
	  • **Building holding tanks for stormwater run-off; or**
	  • **Installing a stormwater bypass.**
		6 & 7
		8 & 9

	• **Lead Ministry/Ministries enter into dialogue with Ministry / Ministries responsible for protection of rivers and the sea from possible harm caused by the reuse of treated wastewater on land and in agriculture with the aim of** • **Introducing controls within NEXT 2 YEARS to prevent harm happening. These controls will need to be met WITHIN 3 YEARS OF INTRODUCTION.**	**11,12 &13**
	• **Arrange public meeting and for publications to be prepared ensuring that the public are made aware of the issues related to the use of treated wastewater on land and in agriculture and of the measures to be introduced to minimise the possible harm;**	**All**
	WITHIN NEXT 2 YEARS	
	• **Lead Ministry/Ministries with farmers and with farming associations develop and introduce Guidelines for the use of treated wastewater on land and in agriculture;** • **Requirements of the Guidelines will have to be met WITHIN 3 YEARS OF INTRODUCTION.**	**14, 15, 16 &17**
	• **Lead Ministry/Ministries develop and introduce Conditions into existing Permit (or new Permit to be issued if they do not have one) for Industrial Establishments requiring the Operator to**	**1, 2, 3 & 4**

	• **Minimise the amount of wastewater discharged to the sewer and especially the amount of polluting substances in the wastewater discharged;** • **Notify the Operator of the WWTP of the likely quantity and quality of the wastewater discharged;** • **Pay for treatment of the wastewater discharged according to the quantity and quality of the wastewater.** • **Requirements of the Conditions will have to be met <u>WITHIN 3 YEARS OF INTRODUCTION.</u>**	

	• **Lead Ministry/Ministries develop and introduce Conditions as part of their existing Operational Permit (or new Operational Permit to be issued if they do not have one) of Industry producing household products requiring them to**
	  • **Notify the Operators of WWTPs <u>WITHIN 3 YEARS OF INTRODUCTION</u> of any substances used in their products that may be discharged into the sewer that could affect the operation of the WWTP;**
	  • **Phase out these substances from their products <u>WITHIN 5 YEARS OF INTRODUCTION</u>**
		5

	• **Lead Ministry/Ministries develop and introduce Conditions as part of their existing Operational Permit (or new Operational Permit to be issued if they do not have one) of WWTP requiring them <u>WITHIN 3 YEARS OF INTRODUCTION</u> to**
	  • **Meet the ELVs for treated wastewater used on land and in agriculture before it is discharged;**
	  • **Review the possibility of**
	  • **Building holding tanks for stormwater run-off; or**
	  • **Installing a stormwater bypass.**
		6 & 7
		8 & 9

	• **Lead Ministry/Ministries with Ministry / Ministries responsible for protection of rivers and the sea from possible harm caused by the reuse of treated wastewater on land and in agriculture, develop and introduce controls to prevent this harm happening.** • **These Controls will need to be met <u>WITHIN 3 YEARS OF INTRODUCTION</u>.**	**11,12 &13**
	• **Prepare a review of the progress on the measures introduced to protect the environment and human health from the reuse of treated wastewater on land and in agriculture.** • **Advise on possible changes**	**All**
	WITHIN 3 YEARS OF INTRODUCTION AND THEN ANNUALLY	
	• **Inspect farms to ensure Guidelines for the use of treated**	**14, 15, 16**

	wastewater on land and in agriculture are being met;	**&17**

	• **Inspect Industrial Establishments to ensure that the Conditions in their permit are being met to**
	  • **Minimise the amount of wastewater discharged to the sewer and especially the amount of polluting substances in the wastewater discharged;**
	  • **Notify the Operator of the WWTP of the likely quantity and quality of the wastewater discharged;**
	  • **Begin to pay for treatment of the wastewater discharged according to the quantity and quality of the wastewater.**
		1, 2,3 & 4

	• **Inspect Industrial Establishments producing household products to ensure that the Conditions in their permit are being met to**
	  • **Notify the Operators of WWTPs of any substances used in their products that may be discharged into the sewer that could affect the operation of the WWTP;**
	  • **Phasing out these substances from their products (to be completed <u>WITHIN 5 YEARS OF INTRODUCTION);</u>**
		5

	• **Inspect WWTPs to ensure that the Conditions in their permit are being met to**
	  • **To achieve the ELVs for treated wastewater used on land and in agriculture before it is discharged;**
	  • **Review the possibility of**
	  • **Building holding tanks for stormwater run-off; or**
	  • **Installing a stormwater bypass.**
		5 & 7
		8 & 9

	• **Inspect rivers and the sea to assess possible harm caused by the reuse of treated wastewater on land and in agriculture**	**11,12 &13**

	• **Prepare a review of the progress on the measures introduced to protect the environment and human health from the reuse of treated wastewater on land and in agriculture;**
	• **Advise on possible changes;**
	• **Review and implement the best option of**
	  • **Building holding tanks for stormwater run-off; or**
	  • **Installing a stormwater bypass.**
		All

11. APPENDICES

11.1. Reuse of wastewater

Appendix 1: Standards for Use of Treated Wastewaters in Agriculture including FAO standards for overall use of Wastewater

Appendix 2: Irrigation water quality standards at point of discharge to irrigation system and use points. Royal Commission Environmental Regulations Saudi Arabia – 2010; RCER – 2010, Volume 1, Regulations and Standards

Appendix 3: FAO Proposed Wastewater Reuse Guidelines for Lebanon

11.1.1. Appendix 1: standards for use of treated wastewater in agriculture

Limit values mg/kg dry solids (assuming secondary treatment)

Parameter	UWWTD	Fish	Bathing Waters	Shellfish	Dangerous Substances	US EPA	FAO
E ~~Coli~~Coli	No	No	500-1000	<300	No	<250	See App. 2
Int. Cocci	No	No	200-400	No	No	<250	
Virus	No	No	No	No	No	No	
Helminth	No	No	No	No	No	No	
BOD5 (mg/L)	25	3	**No**	No	No	5-30	
COD (mg/L)	125		**No**	No	No	5-30	
TSS (mg/L)	35/60	25	**No**	>30%	No	5-30	
pH	No	6-9	No	7-9	No	No	
Temp (°C)	No	21.5	No	>2°C	No	No	
DO (mg/L)	No	No	No	>80%	No	No	
Cl_2 residual (mg/L)	No	No	No	No	No	No	
Total N (mg/L)	15 to 10	No	No	No	No	<10	
Total P (mg/L)	2 to 1	No	No	No	No	No	
NH_3 (mg/L)	No	0.04	No	No	No	1-4	
Nitrite (mg/L)	No	0.01	No	No	No	No	
Total Zn (mg/L)	No	0.3	No	No	No	No	
Total Cu (mg/L)	No	0.04	No	No	No	No	

11.1.2. Appendix 2: irrigation water quality standards at point of discharge to irrigation system and use points in Saudi Arabia

Royal Commission Environmental Regulations Saudi Arabia – 2010; RCER – 2010, Volume 1, Regulations and Standards

TABLE 3D
IRRIGATION WATER QUALITY STANDARDS[1]
AT THE POINT OF DISCHARGE TO IRRIGATION SYSTEM AND USE POINTS

PARAMETER[2]	UNITS	Maximum Allowable	Monthly Average
PHYSICAL			
Floating Particles	mg/m^2	Nil	-
Total Suspended Solids	mg/l	10	10
Total Dissolved Solids	mg/l	2000	1750
Turbidity[3]	N.T.U.	5	2
CHEMICAL			
Aluminum	mg/l	5	-
Ammonia, Total as N	mg/l	5	-
Arsenic	mg/l	0.1	-
Barium	mg/l	1	-
Beryllium	mg/l	0.1	-
BOD_5	mg/l	10	-
Boron	mg/l	0.75	-
Cadmium	mg/l	0.01	-
COD	mg/l	50	-
Chloride	mg/l	1000	500
Chlorine Residual[4]	mg/l	0.5 (min)	-
Chromium	mg/l	0.01	-
Cobalt	mg/l	0.05	-
Copper	mg/l	0.2	-
Cyanide	mg/l	0.05	-
Dissolved Oxygen[5]	mg/l	2.0 (min.)	-
Fluoride[6]	mg/l	15	5
Iron	mg/l	5	-
Lead	mg/l	0.5	0.1
Lithium	mg/l	2.5	-
Manganese	mg/l	0.2	0.02
Mercury	mg/l	0.001	-
Molybdenum	mg/l	0.01	-
Nickel	mg/l	0.02	-
Nitrate	mg/l	10	-
Oil and Grease	mg/l	Nil	-
pH	pH units	6 - 8.4	-
Phenols	mg/l	0.002	-
Phosphorus, total as P	mg/l	30	20
Selenium	mg/l	0.02	-
Silver	mg/l	0.5	-
Sodium	mg/l	1000	500
Sodium Adsorption Ratio (SAR)	SAR units	20	10
Sulfate	mg/l	600	-
Sulfide	mg/l	0.1	0.05
Total Kjeldahl Nitrogen	mg/l	60	35
Total Organic Carbon	mg/l	40	-
Vanadium	mg/l	0.1	-
Zinc	mg/l	2	-

BACTERIOLOGICAL			
Total Coliform [7]	MPN/100 ml	23	2.2[8]
Fecal Coliform	MPN/100 ml	1	-
PARASITOLOGICAL			
Nematodes (eggs)	No./1000 ml	1	-
Protozoan Cysts	No./10 ml	1	-
Platyhelminths-flatworms	No./10 ml	1	-

Notes:

1) Adopted from Ministry of Municipality and Rural Affairs (MOMRA) Standards
2) For any parameters not identified, specific standards will be determined on a case-by-case basis
3) Maximum turbidity not to be exceeded more than 5% of the time in the 24-hour period.
4) Free chlorine residual after 30 minutes of contact: 0.5 (min) at the production
5) Dissolved oxygen level is a minimum concentration requirement
6) Fluoride levels assume well-drained sandy soil for irrigation which will not be used for forage
7) Reclaimed water shall at all times be adequately disinfected, oxidized, clarified and filtered.
8) The wastewater shall be considered disinfected if the median number of coliform organisms in the effluent does not exceed 2.2 total coliform MPN per 100 ml, as determined from the results of the last seven days for which analyses have been completed, AND if the number of coliform does not exceed 23 total coliform per 100 ml in any sample.

11.1.3. Appendix 3: FAO Proposed Wastewater Reuse Guidelines for Lebanon

Parameter	Use Category		
	I	II	III
Faecal Coliforms	<200	<1000	None required
Helminths ova in 1litre	<1	<1	<1
BOD_5 (mg/l)	25	100	100
COD (mg/l)	125	250	250
TSS (mg/l)	60	200	200
pH	6-9	6-9	6-9
Cl_2 residual (mg/l)	0.5-2	0.5-2	0.5-2
N-NO3 (mg/l)	<5	5-30	>30

Category I:
a) Fruit trees crops that are eaten cooked
b) Parks, public gardens, lawns, and golf courses other areas with direct public exposure
c) In case of stabilisation pounds, the TSS limit value is 100 mg/l.

Expected wastewater treatment to meet the criteria:
- **Secondary treatment + filtration + disinfection**

Category II
d) Fruit trees;
e) Lawns, wooded areas, other areas with limited public access, road sides outside urban areas;
f) Landscape impoundments: ponds, water bodies ornamental streams, where public contact with water is not allowed.

Expected wastewater treatment to meet the criteria:
- **Secondary treatment + filtration + disinfection or**
- **Secondary treatment + either storage or well-designed series of maturation ponds or infiltration percolation**

Category III
g) Irrigation of cereals oleaginous seeds, fibre, and seed crops;
h) Crops for canning industry, industrial crops;
i) Fruit trees (except sprinkler-irrigated);

j) Plant nurseries, ornamental nurseries, wooden areas, green areas with no access for the public.

Expected wastewater treatment to meet the criteria:

- **Secondary treatment + a few days' storage or Oxidation pond systems.**