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Regional meeting to review guidelines on available treatment technologies for urban wastewater and sludge, industrial pre-treatment, and environmental standards and available desalination treatment technologies

Ankara, 22-23 November 2022

Agenda item 4: Pre-treatment standards for industrial sectors

Regional guideline on pre-treatment standards and applicable BATs for industrial sectors eligible to discharge to urban wastewater collection systems

UNEP/MAP
Athens, 2022

Note by the Secretariat

Following the adoption by COP 22 (Antalya, Türkiye 7-10 December 2021) of Decision IG.25/8 on the Regional Plans on Urban Wastewater Treatment and Sewage Sludge Management as well as the Decision IG.25/19 on UNEP/MAP's Programme of Work and Budget, the Secretariat/MED POL Programme was requested under Output 1.2, Activity 1.2.1 to prepare technical guidelines to support implementation of the measures in the Regional Plans on available pre-treatment methods for industrial sectors eligible to discharge to collection systems.

The current guideline on "on pre-treatment standards and applicable BATs for industrial sectors eligible to discharge to urban wastewater collection systems" provides the knowhow to operators of wastewater treatment plants and industrial facilities as well as regulators on means by which protection of collection systems and wastewater treatment plants can be achieved from the undesired effects of direct discharges from "light" industrial facilities and the collective discharges of pre-treated wastewater from Organized Industrial Zones in line with the requirement of the Regional Plan for Urban Wastewater Treatment. The ultimate aim of this Guideline is to ensure the efficient functioning of urban wastewater treatment plants by addressing the undesired influx of contaminants and hazardous substances which could hinder the beneficial use of the sewage sludge as fertilizer/soil conditioner as well as the use for energy recovery as proposed by the Regional Plan on Sewage Sludge Management.

In this context, the current Guideline provides information on the feasibility of pre-treatment of industrial effluents, permitting requirement, monitoring of pre-treated effluents as well as application of BAT and implementation of BEP for the pre-treatment of industrial effluents to be applied on-site as well as off-site industrial facilities. The Guideline targets operators of industrial facilities and urban wastewater treatment plants. It addresses industries connecting directly to urban wastewater treatment plants as well as those situated in organized industrial zones which are connected to a central industrial wastewater treatment plant.

This document is presented to the Regional Meeting to review Guidelines on Available Treatment Technologies for Urban Wastewater and Sludge, Industrial Effluents Pre-treatment, and Environmental Standards and Available Desalination Treatment Technologies for their review with the aim of submission to the MED POL Focal Points Meeting, planned to be held in May 2023, for their approval.

Table of Contents

Pages

List of Abbreviations / Acronyms

BAT	Best Available Techniques
BEP	Best Environmental Practices
BOD5	Biochemical Oxygen Demand
BREF	BAT Reference Documents
COD	Chemical Oxygen Demand
COP	Conference of the Parties
EIPPCB	European IPPC (Integrated Pollution Prevention and Control) Bureau
ELV	Emission Limit Value
FAO	Food and Agriculture Organization
IPPC	Integrated Pollution Prevention and Control
LBS	Land Based Sources
MED POL	Mediterranean Pollution Control and Assessment Programme
N	Nitrogen
NBB	National Baseline Budget of Pollutants
OIZ	Organized Industrial Zones
P	Phosphorus
p.e.	Population Equivalent
PRTR	Pollutants Release and Transfer Register
SME	Small & Medium Enterprises
SS	Suspended Solids
TDS	Total Dissolved Solids
TS	Total Solids
UNEP/MAP	United Nations Environment Programme /Mediterranean Action Plan
UO	Unit Operation
UWWTP	Urban Wastewater Treatment Plant
WWTP	Wastewater Treatment Plant

1. Introduction

1. This guideline is prepared under Article 7 of the Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources (LBS Protocol), which stipulates that "the Parties shall progressively formulate and adopt, in cooperation with the competent international organizations, common guidelines and, as appropriate, standards or criteria dealing with (1.b) special requirements for effluents necessitating separate treatment; and (1.e) specific requirements concerning the quantities of the substances listed in annexes I and II discharged, their concentration in effluents and methods of discharging them."

2. In this context, in accordance with Article 15 of the LBS Protocol, the Regional Plan on Urban Wastewater Treatment (referred to hereafter as the Regional Plan) which was adopted by COP 22 (Antalya, Türkiye 7-10 December 2021) entered into force on 26 July 2022. In its Article V.III pertaining to measures on industrial wastewater discharge, Paragraphs 15 and 16, the Regional Plan stipulates:

> *By 2025 at the latest, the Contracting Parties shall ensure that the competent authority or appropriate body adopt emission limit values appropriate to the nature of industry discharging industrial effluents to collecting systems connected to urban WWTPs.*
>
> *By 2035 at the latest, the Contracting Parties shall ensure that industrial wastewater discharged into collecting systems and urban WWTPs shall meet, as a minimum, the emission limit values set in Appendix I.C.*

3. In Article VI of the Regional Plan, addressing aspects related to facilitating the effective implementation of the measures, Paragraph 18 stipulates that "the Contracting Parties collaborate in preparing and implementing common technical guidelines."

4. It is in the framework of Article 7 of the LBS Protocol, as well as Articles V and VI of the Regional Plan that the "Regional Guidelines on Pre-treatment Standards and Applicable BATs for Industrial Sectors Eligible to Discharge to Urban Wastewater Collection Systems" is prepared. Three key objectives are intended from this Guideline. These are iterated in Article IV of the Regional Plan under Paragraph 5, Clause (iv) which states:

> *Industrial wastewater entering collecting systems and WWTPs are subject to pre-treatment, if necessary, in order to:*
>
> *a) protect the collecting systems and the treatment plant;*
> *b) ensure that the operation of the WWTP and the treatment of the sludge are not impeded; and*
> *c) ensure that discharge effluents do not adversely affect the Mediterranean marine environment, particularly for priority substances, contaminants of emerging concern which are harmful to the receiving waters and cannot be treated in urban WWTPs.*

5. To achieve these objectives, the current Guideline aims to provide relevant information and knowledge on application of BAT and implementation of BEP to enable industrial facilities to meet the pre-treatment effluent standards which set the emission limit values (ELVs) for discharge of industrial wastewater into collecting systems and urban wastewater treatment plants as stipulated in the Regional Plan on Urban Wastewater Treatment (Appendix I.C) [reproduced in this guideline in Annex I].

6. The Guideline also supports the regulatory authorities on establishing monitoring programmes for industrial discharges and for setting permitting requirements for industrial facilities, as well as identifying "light industries" which are eligible to discharge safely to collecting systems without causing perturbance to the influent of Urban WWTPs. Moreover, the current Guideline provides the regulatory authorities information on managing Organized Industrial Zone (OIZs) which are discharging to collecting systems. OIZs have been introduced to the amended Annex I of the LBS Protocol, which was adopted by COP22 (Antalya, Türkiye, 7-10 December 2021).

7. This Guideline is organized in four sections:
   a. Feasibility of pre-treatment of industrial effluents. This section is intended to assist operators of industrial facilities to assess the pre-treatment option which is most economically viable and technically feasible and affordable for meeting effluent standards for discharge of industrial wastewater into collecting systems and urban wastewater treatment plants.
   b. Permitting requirements for industries to discharge pre-treated wastewater. This section provides information to both industry owners and operators of urban wastewater treatment plants on aspects related to applying, reviewing and granting permits to discharge further to pre-treatment of industrial effluents.
   c. Monitoring of effluents from industrial facilities. This section provides the knowhow to industry operators for designing the monitoring programme to better assess the performance of industrial pre-treatment facilities prior to any discharge of hazardous and other pollutants into urban collecting systems that would result in the malfunctioning of the urban wastewater treatment plants.
   d. Best Available Techniques (BAT)/Best Environmental Practices (BEP) for the pre-treatment of industrial effluents to be applied on-site as well as off-site (end-of-pipe techniques) taking into account the particular conditions in the Mediterranean Region in order to meet standards for discharge of industrial wastewater into collecting systems and urban wastewater treatment plants.

2. Feasibility for pre-treatment of industrial effluents

8. Although all industrial facilities can theoretically be connected to urban wastewater treatment plants, there are specific technical and economic constraints which make the installation of pre-treatment facilities economically unaffordable to meet the relevant requirements that prescribe a level of pre-treatment up to raw municipal wastewater composition. This is particularly relevant to the removal of hazardous substances that require the application of complex techniques associated with high investment/operational costs that cannot easily be covered especially by SMEs. Several factors come into play where pre-treatment can be feasible for a particular industrial process. These include effluent composition and related type of industrial process; pollution loads and related size of the industrial operation; and discharge of industrial effluents directly to a municipal sewage network or further to treatment in a centralized industrial wastewater treatment plant situated in an Organized Industrial Zone (OIZ).

2.1 Effluent composition and type of industrial process

9. In principle, industries which do not require extensive pre-treatment of their effluents are those which discharge pollutants which do not adversely affect the operation of urban wastewater treatment plants. The pollutants are mostly of organic nature like those discharged from human/urban activities. These include total solids (TS), total dissolved solids (TDS), suspended solids (SS), nitrogen (N), phosphorus (P), chloride, alkalinity ($CaCO_3$), grease and BOD5. These industries do not discharge significant loads or high concentrations of harmful substances such as heavy metals, phenols, cyanides, etc.; therefore, they are best characterized as “light industries.”

10. On the other hand, industries such as metal processing (e.g. electroplating, accumulators manufacture, copper smelting etc.), which are common in the Mediterranean Region, cannot discharge their effluents into urban wastewater treatment plants. A quick glance at the adopted emission limit values for discharge of industrial wastewater into collecting systems and urban wastewater treatment plants as stipulated in Appendix I.C of the Regional Plan for Urban Wastewater Treatment (reproduced in Annex I of this guideline) show that heavy metals standards (ELV) are stricter than those prescribed in most Mediterranean Countries. As a result, pre-treatment is not economically feasible, and consequently metal industries are not characterized as “light industries.”

11. Typical examples of light industries from the Mediterranean can be inferred from the list of industrial sectors and subsectors listed under the National Baseline Budget (NBB) Classification System which applies to all Mediterranean Countries.[1] A correlation to this list can be also deduced for the sectors and subsectors under the European Pollution Release and Transfer Register (E-PRTR) Classification System.[2] A common list of light industries correlating both NBB and E-PRTR is presented in Table 1.

Table 1: Light industries according to correlation between NBB/E-PRTR Classification

NBB Classification		**E-PRTR Classification**	
Sector	Sub-sector	Sector	Sub-sector
4. Farming of animals	11. Farming of animals (cattle, sheep, swine, poultry) and slaughterhouses 12. Farming of special animals (rabbits, goats, horses, asses, mules and hinnies, other)	7. Intensive livestock production and aquaculture	(a) Installations for the intensive rearing of poultry or pigs (b) Intensive aquaculture
5. Food packing	13. Animal feeds 14. Animal raw materials, vegetable raw materials 15. Dairy industry 16. Manufacture of beer 17. Manufacture of non-alcoholic beverages 18. Manufacture of olive oil 19. Manufacture of other vegetable oils (other than olive oil) 20. Manufacture of sugar beet 21. Manufacture of wines and spirits 22. Other prepared foods 23. Preserving fruit and vegetables	8. Animal and vegetable products from the food and beverage sector	(a) Slaughterhouses (b) Treatment and processing intended for the production of food and beverage products from: (i) Animal raw materials (other than milk) (ii) Vegetable raw materials (c) Treatment and processing of milk
6. Port Services	76. Gasoline Loading 77. Port handling (cargo)		
21. Building and repairing of ships and boats	8. Drydocks 9. Shipyards		

[1] UNEP/MED WG.473/12: Introduction to Pollutant Release and Transfer Register (PRTR) and Guidelines for Reporting MEDPOL PRTR Implementation Guide - Appendix X (Istanbul 29-31.5.2019)
[2] EU Regulation No 166/2006 (establishment of E-PRTR)

NBB Classification		**E-PRTR Classification**	
Sector	Sub-sector	Sector	Sub-sector
8. Agriculture	1. Growing of cereals (wheat, rice, maize, soybeans, other) 2. Growing of fruit and vegetables 3. Horticultural specialties, nurseries 4. Industrial crops (cotton, tobacco, sugar cane, sugar beet, potatoes, other) 5. Manufacture of wines		
13. Aquaculture	6. Fish breeding 7. Fish processing		
14. Management of urban solid waste	24. Waste dumps	5. Waste and wastewater management	(b) Installations for the incineration of non-hazardous waste (c) Installations for the disposal of non-hazardous waste (e) Installations for the disposal or recycling of animal carcasses and animal waste
25. Waste incineration and management of its residues	97. Urban waste incineration plants		
26. Waste management activities	98. Refuse collection, depollution and similar activities		
31. Treatment of sewage sludge	94. Compost production		
18. Manufacture of other inorganic chemicals	48. Industrial gases 49. Manufacture of ceramic products 50. Manufacture of glass and glass products	3. Mineral industry	g) Installations for the manufacture of ceramic products by firing, in particular roofing tiles, bricks, refractory bricks, tiles, stoneware or porcelain
20. Tourism	85. Hotel, food and beverage services 86. Recreational activities		

12. As can be seen, light industries may include food/drinks processing sectors (animal and vegetable products from the food and beverage sector, milk processing, beer/wine production etc.), farming of animals, agricultural activities etc. Infrastructural installations such as waste management and recreational activities (tourism) are sectors which can also be connected to urban wastewater treatment plants.

2.2 Pollution load and size of the industrial operation

13. Another factor enabling the connection to urban wastewater treatment plants is the production size of the industrial facility. In principle, industrial plants with moderate amounts of discharged wastewater that do not adversely affect the equilibrium of the biological/aerobic processes in urban wastewater treatment plant can be characterized as "light industries," and as such, they can discharge to collecting systems further to pre-treatment of their effluents.

14. Large industrial facilities discharging heavy loads of pollutants, even though they do not contain contaminants such as heavy metals in their wastewater effluent, are not considered "light industries," and hence may not be feasible from an economic perspective for pre-treatment.

15. Industrial facilities discharging small quantities of contaminants (e.g. manufacture of glass, ceramic products, etc.), regardless of their size, may be allowed to discharge their industrial effluents into urban wastewater treatment plants provided their effluents undergo pre-treatment and do not contain significant amounts of contaminants.

16. A "rule of thumb" about the size of industries allowed to discharge to urban wastewater treatment plants can be inferred from the EU Directive 91/271/EEC (the Wastewater Directive). Further to Article 13 of the Directive, a threshold value of 4,000 population equivalents (p.e.) for discharge of biodegradable effluents directly into water recipients i.e. sea, lake, river (and not to WWTP) is indicated. This limit value corresponds to a biochemical oxygen demand (BOD5) of 240 kg/day.[3] Consequently, it can be inferred that industries with less than 240 kg of daily discharge of BOD5 can be considered potentially suitable, size wise, to be connected to urban wastewater treatment plants.

17. In this regard, it should be noted that permissible loads and concentrations limits are defined by the operator of the urban wastewater treatment plant as prescribed in its relevant regulations. These regulations differ from one plant to another depending on the size and type of operation of the wastewater treatment plant as well as the environmental conditions of the final water recipient (sea, lake, river).

2.3 Organized Industrial Zones (OIZ)

18. In the Mediterranean Region, the concept of Organized Industrial Zones (OIZ) has been adopted in recent years where centralized treatment installations undertake the pre-treatment of effluents before their discharge to urban wastewater treatment plants; and in some cases, directly to water recipients further to full treatment of effluents. The OIZs have been included and agreed the updated LBS Annex I (A), Sector of Activity, which were adopted by COP 22 (Antalya, Türkiye 7-10 December 2021). Specialized OIZ have been also introduced for specific industrial sectors (e.g. tanneries) where the industrial wastewater treatment plant is developed to undertake a "tailor made" treatment of specific industrial effluents.

19. In both cases of specialized and general OIZ, the wastewater treatment plant operators ask for specific pre-treatment requirements from individual industries to be connected with the wastewater treatment plant, especially when new facilities want to join the OIZ. These requirements are typically stipulated in the permitting process (explained in the next section) and are necessary in order to safeguard the plant's efficient operation, particularly when a biological treatment unit is foreseen as the central treatment unit of the OIZ and there are fears of its malfunctioning due to overloads of pollutants such as heavy metals.

20. Pre-treatment standards for OIZ wastewater treatment plants have been averaged from several country standards in the Mediterranean. These are presented in Table 2 along with a comparison with the standards for connecting to urban wastewater treatment plants as stipulated in the Regional Plan (reproduced in Annex I). As can be seen, permissible concentrations of heavy metals are generally stricter if an industry discharges its effluents directly to an urban wastewater treatment plant.

[3] Calculated based on 60 g/day per p.e.

Therefore, it is advisable when decisions about the establishment of OIZ are taken to re-allocate metal processing industries to an OIZ where the relevant pre-treatment standards can be easily met.

21. Further to the data shown in Table 2, it can be inferred that pre-treatment of industrial effluents in Organized Industrial Zones is more feasible and easier to manage in comparison with individual pre-treatment facilities of industrial installations. Within an OIZ setting, meeting of effluents pre-treatment standards is much less complicated and less costly in comparison with individual pre-treatment units discharging industrial wastewater to municipal collecting system.

Table 2: Pre-treatment standards for discharge to wastewater treatment plants in OIZ in comparison to direct discharge to urban wastewater treatment plants

Parameter	**Pre-treatment standards from OIZ regulations** [4]	**Standards for discharge of industrial wastewater into collecting systems and urban wastewater treatment plants**
Aluminium – Al (mg/l)	10	25
Arsenic – As (mg/l)	0.5 - 3	0.1
Beryllium - Be (mg/l)	30	0.5
BOD5 (mg/l)	350 – 500	500 (1/4 of the COD concentration)
Cadmium – Cd (mg/l)	0.5 - 2	0.1
Chromium – Cr^{3+} (mg/l)	2	-
Chromium – Cr^{6+} (mg/l)	0.5	0.5
Cobalt - Co (mg/l)	10	1
COD (mg/l)	1000 – 1200	2000
Copper – Cu (mg/l)	1 - 5	0.5 - 1
Cyanide (mg/l)	3 – 10	0.2 - 0.5
Detergents (mg/l)	50	-
Fluoride – F (mg/l)	6	-
Lead – Pb (mg/l)	5	0.5
Manganese – Mn (mg/l)	10 – 20	1
Mercury – Hg (mg/l)	0.01 – 0.2	0.05
Mineral Oil (mg/l)	15	20
Molybdenum – Mo (mg/l)	10	0.15
Nickel – Ni (mg/l)	5 – 10	0.5
Nitrite NO_2–N (mg/l)	4	-
Nitrates NO_3–N (mg/l)	20	-
Oil & Grease (mg/l)	40 - 100	-
pH	6 - 9	6 - 10
Phenols (mg/l)	5 – 10	3
Phosphates – P total (mg/l)	10	-
Sulfites SO_3 (mg/l)	1	-
Sulfates SO_4 (mg/l)	1,500 – 1700	-
Suspended solids (SS) (mg/l)	350 – 500	-
Temperature (°C)	35 – 50	40
Total dissolved solids (TDS) (mg/l)	3000	3500
Total N (mg/l)	100	15 - 30

22. In this regard, it must be noted that effluents from OIZ treatment plant have to meet the same pre-treatment standards as the individual industries when connected to urban wastewater treatment plants. And in case of direct discharge into a water recipient, the effluents from an OIZ treatment plant should be subject to full treatment.

23. In conclusion, the pre-treatment or full treatment of industrial effluents within an OIZ provides clear advantages to individual treatment installations, namely:

[4] Examples from regulations of OIZ WWTP in Mediterranean countries

a. Temperature and pH adjustment are facilitated due to mixing of various effluents which can also lower the concentration of pollution loads originating from similar industrial activities (dilution effect);
b. More effective use of equipment and chemicals; thus, allowing the decrease of the operating costs;
c. In case of biological treatment, the WWTP operations within an OIZ offer better balance, mixing of flows and aerobic conditions which can be more effectively controlled/monitored compared to individual facilities;
d. Sludge treatment can be better managed by centralized installations
e. It is more cost effective and
f. Easier to monitor the compliance;

3. Permitting requirements for industries to be connected to wastewater treatment plants

24. In principle, all industrial installations must possess an environmental permit issued by national or regional regulatory authorities where all details about their operation, effluents characteristics, pre-treatment/ treatment requirements and installations are clearly described. In this section, focus is provided on permitting for discharge of *pre-treated effluents* to urban sewer networks, urban wastewater treatment plants or industrial wastewater treatment plants within organized industrial zones.

3.1 Applying for a permit by an industrial facility

25. In order to be allowed to discharge its effluents, an industry has to prove that it meets the pre-treatment requirements set by the relevant treatment plants operators. The fulfilment of these requirements can be part of the overall environmental permit of the industry or a “stand alone” document according to the regulations of the treatment plants operator.

26. An application for a permit to discharge can refer to a *new* facility which wishes to be connected or an existing industrial installation which must submit a *renewal/revision* application after a certain period of time, and/or if changes are made to the production process affecting the wastewater composition and/or quantity.

27. The application serves on the one hand to allow the treatment plant operator to become acquainted with the production process and the associated types/quantities of pollutants to be discharged. It also allows the industrial facility operator to design the subsequent monitoring programme with a focus on the crucial parameters to be monitored and reported on associated with the industry’s operation.

28. The application for a permit should be prepared by the industrial operator and submitted to the regulatory authorities before connection to collation system leading to the urban wastewater treatment plant. It is recommended that the operator of the industrial facility provides as part of the permit application the following information:

a. The industry’s production process (raw materials, products, use of water/energy) – average production and peaks.
b. Detailed assessment of sources of wastewaters generation.
c. Types and quantities of wastewaters from each source.
d. Pre-treatment technologies to be applied to meet the pre-treatment standards for connection to the WWTP and fate of any solid wastes (e.g. sludge) resulting from pre-treatment.
e. Description of the effluent well (equipped with water meters for checking the effluent quantities) at the point of discharge into the wastewater treatment plant.
f. Statements about:
    i. Separation of the industrial from the municipal wastewaters generated in the facility (to be mixed after the effluent well).

ii. Frequency of measurements of the wastewater composition.
iii. Segregation of wastewater streams (except in cases of pre-treatment requirements, e.g. neutralization) before discharge to the treatment plant.
iv. Measures in place to prevent dilution of wastewaters.
v. Segregation of collected stormwaters and their diversion away from the treatment plant.
vi. Actions taken to ensure that substances such as radioactive materials, substances with autoignition potential and explosives, carbon disulfate, formaldehyde, trichlorethylene) are not contained in the effluent wastewater.

3.2 Reviewing and granting permits to discharge

29. In order to assess which industries can be connected to the treatment plant's collection network and associated risks, it is recommended that the urban wastewater treatment plant (or OIZ treatment plant) operator undertakes the following:

a. An inventory of industrial facilities connected/requesting permission to connect to the treatment plant. The inventory should focus on the types of expected effluents (i.e. which industrial processes discharge pollutants which can adversely affect the plant's operation); the size of the industries (i.e. with a focus on larger units); and associated risks on the operation of the treatment plant (i.e. focus on critical parameters). The inventory would give the treatment plant operator an insight into the overall situation of discharged effluent, providing a comprehensive overview of influent wastewater classification to be treated. This ensures the optimization of the working conditions of the treatment plant, as well as setting the upper limits of pollutants loads that the plant can safely treat.
b. Review of discharge permits with a focus on submitted/approved permits and the relevant registers (maintained by the authorities and the industries associations). This review would help to highlight "free riders" (i.e. industries which operate and/or are connected to the sewage network without the relevant permits).
c. Field visits to selected (high risk) industrial facilities to review records of samples taken by the industrial facility, and in their absence or in case of doubt of results, to undertake on the spot counter-samples. Sampling should focus on the crucial parameters to be emitted by the industry and which can affect the operation of the wastewater treatment plant. To avoid misunderstandings and controversies, sampling should be performed in the presence of representatives from the industrial facility. Sampling and analysis should be conducted by a certified independent chemical laboratory.

30. It must be noted that an urban wastewater treatment plant operator has a more difficult task to assess the industries to be connected to the plant than the operator of a treatment plant set in OIZ. In an OIZ setting, the number of industries connected to the treatment plant is limited. In case of urban wastewater treatment plants connected to public sewage systems of urban agglomerations, several industrial facilities and SMEs are also connected. These are typically spread over a large catchment area discharging their effluents to the treatment plant; sometimes without a prior notice.

31. An industrial facility may be denied connection by treatment plant operators if, in their opinion, the respective effluents can cause a deterioration of the environmental status of the receiving water body and/or, adversely affect the smooth operation of the wastewater treatment plant.

32. On the other hand, some industrial facilities including light industries, may be waived the requirement to apply for a permit to discharge or to undertake pre-treatment of their industrial effluents under the following conditions:

a. No harmful substances are contained in their effluents such as heavy metals, phenols, cyanides and the other substances listed in Table 1 (except BOD5, SS, TDS);
b. Wastewater generation from the industrial facility is in the range of 2 to 4 m3/day.
c. Discharged wastewater is of similar characteristic to the urban wastewaters (i.e. small/medium BOD5/COD/SS loads).

d. Industries dealing with final finishing or packing of products (i.e. no generic production process).
e. Commercial activities such as car washing, clothes cleaning/dry-cleaning etc.

4. Monitoring of effluents from industrial facilities

33. A programme for monitoring of critical pollutants discharged in pre-treated effluents from industrial facilities should be established by the facility operator to safeguard in part the smooth operation of the wastewater treatment plants. The programme should include the parameters to be monitored and the frequency for sampling

34. The monitoring programme is one of the permitting requirements between the industrial facility and the regulatory authorities; as such, it is case specific. The key pollutants discharged further to pre-treatment of industrial effluents should be specified in the permit between the industrial facility and the treatment plant operator, as well as the frequency of their monitoring. In any case, industry specific parameters (e.g. $Cr^{3+/6+}$ from tanneries) should be part of the monitoring programme.

4.1 Parameters for monitoring

35. Appendix I.C of the Regional Plan for Urban Wastewater Treatment provides guidance on potential parameters for monitoring in industrial wastewater at the point of discharge to collecting systems and urban wastewater treatment plants.

36. With regards to light industries, for which pre-treatment is economically feasible, the following potential parameters presented in Table 3 should be monitored.

Table 3: Potential parameters for monitoring in industrial wastewater at the point of discharge to collecting systems leading to urban wastewater treatment plants[5]

Industrial Activity	Parameters for monitoring
Domestic and communal wastewater (function halls, restaurants, shopping malls, Hotels etc.);	BOD, COD, pH, TSS, Total Oil & Grease, Cl, Na, Boron, Detergents
Food Sector - Animal and vegetable products	COD, pH, TSS, Total Oil & Grease, Heavy Metals, Cl, Na, Total N, Total P, Polyphenols, Phenols
Food Sector - Meat industry & Fish processing	BOD, COD, pH, TSS, Total Oil & Grease, Cl, Na, Total N, Total P, Polyphenols, Phenols
Laundry Facilities	COD, pH, VSS, TSS, Cl, Na, Boron, Total Hydrocarbons, Detergents
Gas stations	COD, pH, Mineral Oil, BTEX, MTBE
Agriculture: chicken farms, pig farms, fish farms, etc.	COD, pH, TSS, Cl, Na, Total N, Total N, Boron
Waste and wastewater management	BOD, COD, pH, VSS, TSS, Mineral Oil, Total oil & Grease, Heavy Metals, Total N, Total P, Cl, BOD, Total Hydrocarbons, Toxicity to fish eggs (T_{egg})

37. The monitoring programme should ensure that sufficient data and information is generated to detect any malfunctioning in the pre-treatment installations in order to avoid any penalties imposed in the permit by the treatment plants operators.

[5] Data obtained from Appendix I.C of the Regional Plan for Urban Wastewater Treatment

38. It is the responsibility of the industrial facility to carry out the monitoring programme on the quality of the discharged effluents and to report back to the treatment plant authorities. Usually, industrial facilities are required to maintain a composite sampling register which covers the working period of the installation. The register should be made available to the controlling authorities (treatment plant operator and governmental inspection authorities) at request.

39. The industrial facility should maintain its own effluent well where samples can be taken. All wells have to be equipped with flow meters to check the compliance of the wastewater quantities with the issued permits.

4.2 Frequency of sampling

40. Appendix III of the Regional Plan for Urban Wastewater Treatment provides guidance on monitoring frequencies of pollutants discharged from industrial facilities to collecting systems.

41. In principle, monitoring frequencies need to be selected in a manner to characterize the effluent quality and to detect events of noncompliance, considering the need for data and, as appropriate, the potential cost.

42. Monitoring frequency should be determined on a case-by-case basis, considering the variability of the concentration of various parameters. A highly variable discharge should require more frequent monitoring than a discharge that is relatively consistent over time (particularly in terms of flow and pollutant concentration). Start-up/first year of operation and sudden increase of pollutants' concentrations in the treatment facility would warrant increased frequency.

43. Frequency requirements may be on the other hand reduced based on a demonstration of excellent performance. Facilities can demonstrate good performance by meeting a set of compliance and enforcement criteria and demonstrating their ability to discharge pollutants below the necessary levels consistently.

44. A minimum sampling frequency for the discharge effluents may be introduced in accordance with Table 4.

Table 4: Recommended sampling frequency per year for industrial wastewater at the point of discharge to the collection systems leading to urban WWTP[6]

Industrial Activities	Sampling frequency/year
Domestic and communal wastewater (function halls, restaurants, shopping malls, hotels etc.)	4
Food Sector - Animal and vegetable products	4
Food Sector - Meat industry & Fish processing	4
Laundry Facilities	4
Gas stations	4
Agriculture: chicken farms, pig farms, fish farms, etc.	4
Waste and wastewater management	Waste – 4 Hazardous waste - 6

45. All samples taken from the effluent well should be counter checked by the treatment plant operator and should be analyzed by accredited independent laboratories to avoid disputes over the results.

[6] Data obtained from Appendix III of the Regional Plan for Urban Wastewater Treatment

5. Best Available Techniques (BAT)/Best Environmental Practices (BEP) for the pre-treatment of industrial effluents

46. Best Available Techniques (BAT) and Best Environmental Practices (BEP) included in this section apply mainly for the particular conditions in the Mediterranean. They are developed based on experiences acquired and documented from other regions while taking into consideration the financial implications for investing in environmental protection.

47. There are two types of Best Available Techniques (BAT) and Best Environmental Practices (BEP) which can be considered for the efficient treatment of industrial wastewaters with the aim to meet pre-treatment standards set by WWTP operators:

a. On-site techniques
b. End-of-pipe (off-site) technologies.

5.1 On-site techniques

48. On-site techniques are meant mainly for simple methods to be applied within the industrial facility aiming at the reduction of water consumption in the production process and the rational use of raw materials and water. This would result in less generated wastewater quantities and smaller pollution loads; thus, easier and more cost-effective pre-treatment options (i.e. end-of-pipe techniques).

49. On-site techniques evolve from a detailed knowledge of the production process and can be defined further to analysis and assessment of each process Unit Operation (UO) through a mass balance sheet as shown in Figure 1. This analysis would allow the identification of those production steps in which extensive use of water and/or of raw materials and chemicals occurs and hence their reduction.

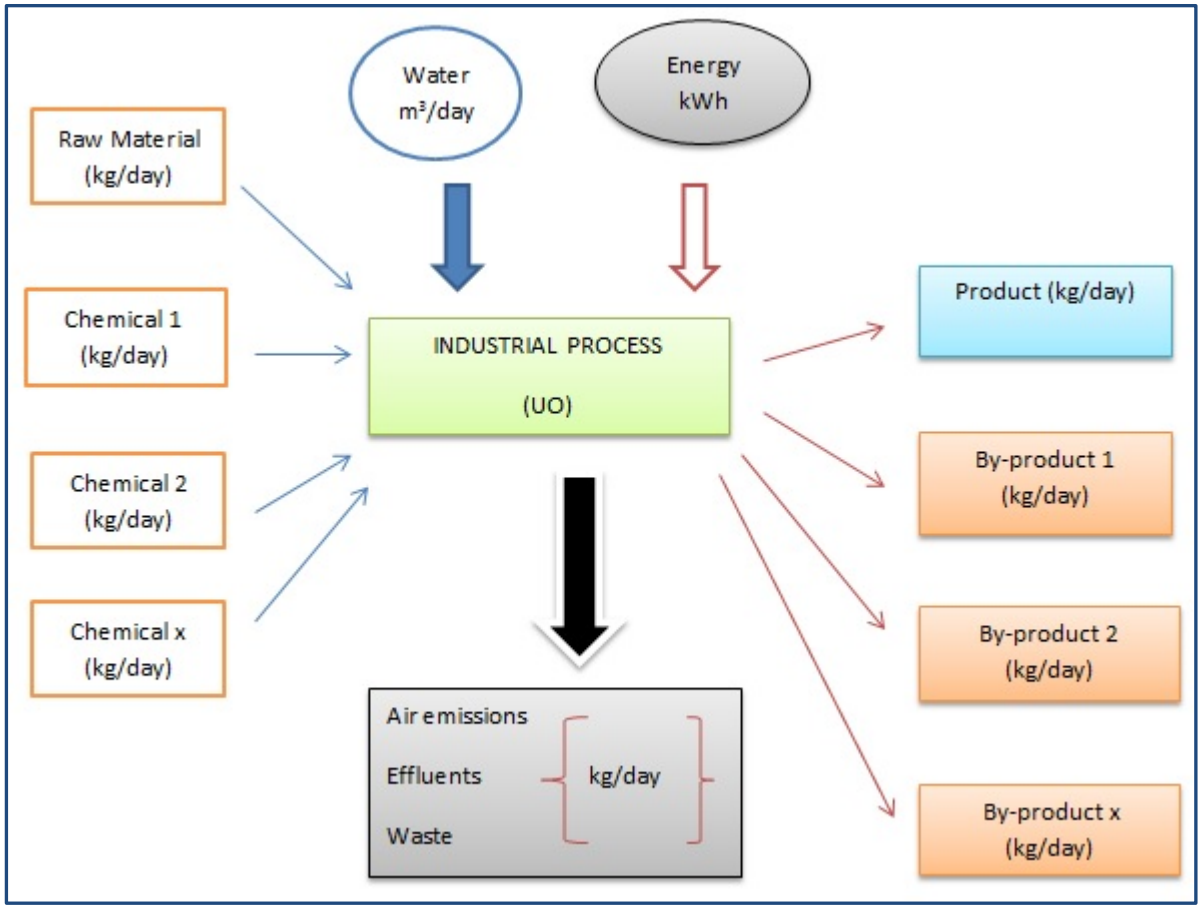

Figure 1: Mass balance sheet for a process unit operation

50. On-site techniques are sector specific, i.e. they refer to those UOs which are applicable in a specific sector (e.g. food processing industry); however, there are some general patterns which are universally applicable in industrial sectors; for example, re-use/recycling of process/cooling waters. These techniques are typically simple mostly focusing on good housekeeping practices.

51. The following list of BAT/BEP on-site techniques are mostly derived from the European experience as reflected in the BAT Reference Documents (BREF) prepared by the European Integrated Pollution and Prevention Control Bureau (EIPPCB). The IPPCB collects and evaluates BAT/BEP applicable not only in European countries but also worldwide.

5.1.1 Segregation of wastewater streams

52. Ideally, a full segregation of the various wastewater streams originating from a single industrial facility has to be envisaged in order to allow a better performance of treatment interventions on case-by-case basis. The streams for which separate drainage systems have to be installed are:

a. Stormwater;
b. Cooling water;
c. Sanitary wastewater;
d. Wastewater containing organic (biodegradable) pollutants; and
e. Wastewater containing inorganic pollutants (e.g. heavy metals).

53. This segregation allows for a targeted treatment at the lowest possible cost whereas some streams such as sanitary wastewater and wastewater with biodegradable components can be directly discharged into the wastewater treatment plant.

54. Buffering facilities for the organic and inorganic wastewaters allow for the equalization of peak flows as well as of variations in flow and levels of concentrations on a daily/weekly basis.

5.1.2 Counter-current extraction/washing of raw materials and/or products

55. Multiple batch washings are usually applied in sectors such as food processing where the raw materials are repeatedly washed. A counter-current extraction (i.e. initial washing with waters from previous washings) allows the drainage of concentrated wastewaters which can be more effectively treated as depicted in Figure 2.

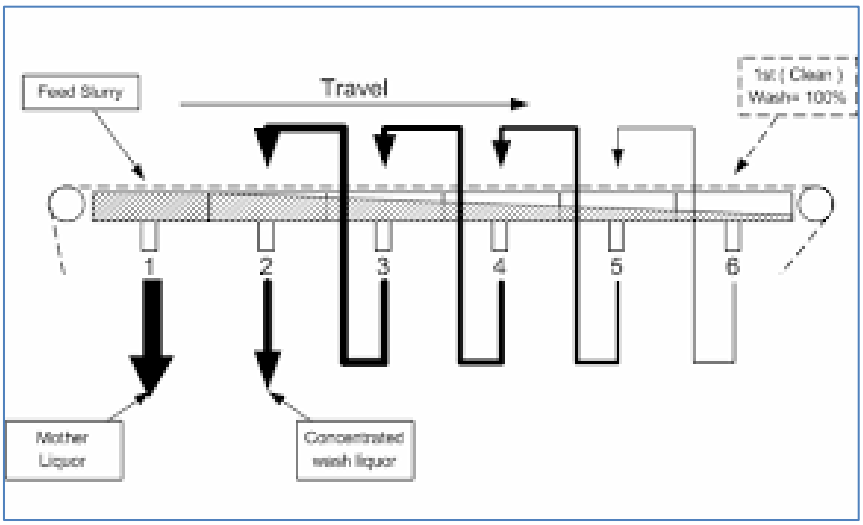

Figure 2: Counter-current washing[7]

[7] BREF Food, Drink, Milk industries (also Tables 6, 7, 8)

5.1.3 Multiple use/recirculation of water

56. Waters from equipment washing, distillates from the production, open circuit cooling waters, waters from air cleaning can be re-introduced in the production process provided that their composition does not negatively affect the production process. It is a simple good housekeeping technique; thus, allowing the reduction of the overall water consumption.

5.1.4 Dry transport of solid materials

57. The avoidance of the use of water for the transport of various solid materials especially in the food processing industry is a good housekeeping method for the reduction of wastewaters quantities. Some indicative examples are tabulated in Table 5.

Table 5: Good housekeeping methods (dry transport) for the reduction of wastewaters quantities from food industries

Industrial food process	**Method for the reduction of wastewaters quantities**
Meat processing	- Bones and fat from deboning and trimming meat materials by a conveyor belt
Slaughterhouses	By-products and waste from the slaughter and animal by-products treatment processes can be transported as dry as possible
Fish processing	- Skins are removed from drums by vacuum instead of water, - Fine mesh conveyor belts are used to collect wastes and separate them from the wastewater, - Removal of offal by vacuum or by using conveyors after filleting and eviscerating.
Fruit/vegetable processing	- Dry transport of peels and cutting residues

5.1.5 Installation of grates, fat traps, screens

58. Where high solids quantities are generated during the production process (e.g. in slaughterhouses, fruit/vegetables processing), the coverage of the floor drains with screens, fat traps and fine mesh grates allows the separation of considerable amounts of solid materials from the rinse waters; thus, preventing them to enter the wastewater collection system and consequently reducing BOD5, COD and suspended solids (SS) loads.

5.1.6 Segregation/re-use of secondary raw materials/by-products

59. Off-specification products, trimmings, fats and other products can be separately collected (and not flushed into the wastewater collection system) by installing some simple devices such as splash protectors, screens, pumps and troughs especially in the food processing sector. The collected materials can be re-used mostly as animal feeders but also for other purposes. Some indicative examples are tabulated in Table 6.

Table 6: Examples for segregation/re-use of secondary raw materials/by-products from food industries

Industry	**Method for the reduction of wastewaters quantities**
Dairy industry	- Draining of yoghurt and first rinses of buttermilk and residual fat in butter churning (stirring) operations, for use in other processes, e.g. for low fat spreads and whey, - Leaked and spilt materials for animal feeders.
Fruit/vegetable processing	- Peel, cores and cutting residues, apple and tomato pomace and citrus pulp pellets separated by screens/filters and used as animal feeders

5.1.7 Pressure cleaning

60. The use of pressure for cleaning floors and equipment results in considerable savings in water use and consequently to reduced quantities and pollution loads of the wastewaters.

5.1.8 Dry cleaning

61. Dry cleaning can be used to remove much residual material as possible from vessels, equipment and installations before they are wet cleaned. This can be applied both during and at the end of the working period. All spillages can be cleaned up for example by shoveling or vacuuming spilt material prior to wet cleaning.

5.1.9 Sector specific BAT/BEP

62. There are various techniques which are sector specific and can lead to beneficiary results concerning wastewater generation. Their main characteristics are the recovery of substances at source thus allowing reduced pollution loads in the wastewaters. Some examples of simple methods are given in Table 7.

Table 7: Various techniques for reduction of wastewater generation from various industries [8]

Sector	Process	Details
Dairy	Improved preliminary milk filtration and clarification	By improving the preliminary milk filtration and clarification processes, the deposits in the centrifugal separators are minimized, leading to a reduction of the frequency of cleaning
	Whey recovery	Sweet whey is collected and re-used in the process of cheese making or in other processes to make by-products, e.g. for protein recovery, as animal feed, as a food supplement and as baby food. Reduction of up to 50% of BOD5 and of approx. 80% of fat can be achieved
	Minimization of the production of acid whey	Wastewaters containing acid whey cause low pH levels in the wastewaters. Its separation after curd (yoghurt) formation by draining the acid whey from the top of the platforms of the salting vats leads to a minimization of the acid whey content of the wastewaters
	Continuous pasteurisers	The use of continuous pasteurizers instead of batch pasteurizers allows reduced wastewater generation
	Component filling	Milk products (e.g. with different fat content) can be diversified as late as possible, preferably immediately prior to filling by using different pipelines with skimmed milk and milk with standardized fat content. Component filling also reduces the need for in-line storage tanks and the corresponding cleaning requirements
Breweries	Recovery of yeast after fermentation	After fermentation, brewers' yeast is separated and stored in tanks to be used as animal feed, re-used in the fermentation process, used for pharmaceutical purposes, sent to anaerobic WWTPs for biogas production or disposed of as waste
Wineries	Recovery of filter material	The filter material (bentonite, diatomaceous earth) can be collected to prevent it from being washed into the wastewater drainage. It can be treated for re-use

[8] BREF Food, Drink, Milk industries, BREF Tanneries

Sector	Process	Details
Bottle cleaning in the drinks sector	Re-use of bottle cleaning solutions	To save caustic soda and fresh water and to avoid unnecessary wastewater loads, the contents of the bottle cleaning bath are settled and filtered at the end of the production period. The cleaning solution is pumped from the bottle cleaning equipment to a sedimentation tank. This tank also serves as a temporary storage unit. The settled particles are drawn off with a filtration unit. The water is then available again to be used for cleaning at the beginning of the next production period
Fruit/ vegetables processing	Dry caustic peeling	The material is dipped in a 10 % caustic solution heated to 80 to 120 oC to soften the skin, which is then removed by rubber discs or rollers. This reduces water consumption and produces a concentrated caustic paste for disposal
Oils/fats processing	Two-phase extraction of olive oil	In traditional olive processing, i.e. the three-phase production, the extraction of the olive seeds has resulted in three streams, i.e. oily, aqueous and solid. The wastewater is highly polluted. In the two-phase extraction, the decanter centrifuges are modified so that the crushed (mixed) olives are separated into two-phases, the oil phase and a solid phase. This technique does not require the addition of water to the olive mixture. Water is saved in the extraction part of the two-phase process. The amount of wastewater and its contaminant load is also reduced
Tanneries	Partial substitution of chromium	20 – 35 % of the fresh chrome input can be substituted by recovered chrome from the wastewater by re-dissolving chrome containing sediments with sulphuric acid and feeding again the chrome tanning process
	Partial substitution of ammonium	Ammonium salts can be partially substituted with CO2 and/or weak organic acids in the deliming/bating process
	Re-use of pickling liquors	n the pickling process liquors can be repeatedly recirculated before being flushed into the drainage system
	Reduction of water consumption during soaking	It is possible to re-use some process liquors such as the water at the end of the bating process, which is used to rinse and cool the pelts prior to the pickling operation. This water could be used for the dirt soak to reduce water consumption
	High exhaustion chrome tanning	In conventional tanning 2 – 5 kg/t raw bovine hides (8 - 12 kg/t dry goat- and sheepskins) of chrome salts are released via the spent liquors. With high-exhaustion chrome tanning this quantity can be reduced to 0.05 – 0.1 kg / t raw bovine hide. Leaching of chrome from the tanned leather can be reduced by ensuring good fixation, e.g. use of syntans at the end of the process

5.2 Off-site (end-of-pipe) techniques

63. End-of-pipe (off-site) technologies consist of more complex treatment methods which can also be applied within the industrial facility as well as at centralized level, i.e. as central treatment units in an OIZ. They are common for any type of industrial wastewaters and can be used either for segregated streams as well as for combined wastewaters.

64. Usually a combination of on-site and end-of-pipe technologies is recommended to achieve the best possible results. On-site techniques allow the reduction of wastewater quantities at source and a more flexible adaptation to production changes whereas the centralized off-site installations allow the mixing of different waste streams (temperature and pH adjustment) and a better use of equipment and chemicals. It must however be noted that, if the relevant pre-treatment standards cannot be met by the on-site techniques (which is the usual case), some simple end-of-pipe techniques should also be applied on single facility level on top of the on-site techniques.

65. Concerning “light” industries i.e. those with mainly biodegradable pollutants, on-site techniques are more applicable by allowing the reduction of wastewater quantities and loads at source, whereas end-of-pipe methods aim mainly at the removal of heavy metals and other hazardous substances.

66. These are well known methods which can be installed either at the facilities’ premises (for medium/large industries) or can form the pre-treatment stage in an OIZ treatment plant before the final biological treatment. These are described below.

5.2.1 Neutralization/ equalization

67. For small industries, neutralization/equalization followed by appropriate pre-treatment are more economically feasible before wastewater enters the treatment plan. Since effluent wastewater should be neither acidic nor alkaline (pH = 6.5 – 9), mixing of various wastewater streams and further addition of chemical agents achieve a neutral composition. In order to avoid oversizing of tanks, only acid and alkaline wastewater streams should be led to the neutralization tank whereas neutral streams can bypass this step. The neutralization tank also acts as an equalization step so that the consumption of neutralizing agents (sodium hydroxide, calcium hydroxide, sulphuric acid, hydrochloric acid) can be held to a minimum.

5.2.2 Coagulation/flocculation/sedimentation

68. If simple gravity sedimentation does not remove an adequate portion of the solids contained in industrial wastewater, then the addition of chemicals is an effective solution allowing the destabilization of colloidal and small suspended particles (dyes, organic solids, clay, heavy metals, phosphorous) and their agglomeration into flocs which easily settle as sludge at the bottom of the tank. The settled sludge must be treated as hazardous waste. Inorganic coagulants (lime, ferric sulphate, polyaluminium chloride) and/or a polymer are commonly used.

5.2.3 Flotation

69. In this process, liquid-solid separation is induced by dissolving pressurized gas (air) into the treatment unit. The gas is released as micro-bubbles that rise to the surface, capturing the solids on the way. The sludge bed formed on the surface of the tank is withdrawn by scrapers or overflow and must be subsequently treated as hazardous waste.

70. Flotation is a more costly method (energy costs) compared to simple sedimentation and is usually applied when the suspended solids have poor settling characteristics. It also helps to remove dissolved fats and grease.

5.2.4 Lamella separation

71. Settleable solids are separated from the liquid phase by a series of inclined plates. The advantage of lamella separation over traditional sedimentation is a reduced space requirement due to the increased effective settling area of the plates. Lamellas can also operate with high flow rates. Fine screening, grit and grease removal prior to this process might be needed.

5.2.5 Sludge management

72. Solids generated from various industries (e.g. meat processing, slaughterhouses, fruits/vegetables/oils processing). Sludge should be collected in separate containers. They can be disposed-off with municipal solid wastes if they do not contain hazardous substances.

73. When chemicals are used in end-of-pipe pre-treatment (e.g. coagulation/flocculation/ sedimentation), the settled sludge can be dried on-site (if space is available) and disposed-off together with the sludge from an OIZ treatment plant (if similar techniques are applied). This may require sludge drying and conditioning in order to reduce the moisture and the overall sludge volume for disposal in designated locations by local authorities.

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Annex I

Emission limit values for discharge of industrial wastewater into collecting systems leading to urban wastewater treatment plants[9]

[9] Appendix I.C of the Regional Plan on Urban Wastewater Treatment (Decision IG.25/8, COP22)

Emission limit values for discharge of industrial wastewater into collecting systems leading to urban wastewater treatment plants[10]

Parameter	Unit	Emission Limit Values (ELV)
Adsorbable organically bound halogens (AOX)	mg/l	1
Aluminium - Al	mg/l	25
Arsenic - As	mg/l	0.1
Benzene	mg/l	0.05
Beryllium - Be	mg/l	0.5
BOD5	mg/l	500 (1/4 of the COD concentration)
Cadmium - Cd	mg/l	0.1
Chloride - Cl	mg/l	430
Chlorine	mg/l	0.5
Chromium – Cr^{6+}	mg/l	0.5
Cobalt - Co	mg/l	1
COD	mg/l	2000
Copper - Cu	mg/l	0.5 - 1
Cyanide	mg/l	0.2 - 0.5
Fluoride – F	mg/l	6
Lead - Pb	mg/l	0.5
Lithium - Li	mg/l	0.3
Manganese - Mn	mg/l	1
Mercury - Hg	mg/l	0.05
Mineral Oil	mg/l	20
Molybdenum - Mo	mg/l	0.15
Nickel - Ni	mg/l	0.5
Phenols	mg/l	3
pH		6 - 10
Polyphenols	mg/l	100
Selenium - Se	mg/l	0.05
Sodium - Na	mg/l	230
Total Dissolved Solids (TDS)	mg/l	3,500
Total Oil &Grease	mg/l	250
Total Phosphorous - (TP)	mg/l	30
Temperature	^{o}C	40
Tin - Sn	mg/l	2
Total Hydrocarbons	mg/l	20
Total Nitrogen - (TN)	mg/l	15 - 30
Total Suspended Solids (TSS)	mg/l	1,000

[10] Appendix I.C of the Regional Plan on Urban Wastewater Treatment (Decision IG.25/8, COP22)