PT PLN (PERSERO)

ENERGY TRANSITION AND SUSTAINABILITY DIVISION

Waste Water and Water Quality
MANAGEMENT GUIDELINE

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Key Abbreviation

AOI	:	Area of Influence
BOD	:	Biological Oxygen Demand
COD	:	Chemical Oxygen Demand
E&S	:	Environmental and Social
EHS	:	Environmental, Health and Safety
ESF	:	Environmental and Social Framework
ESMP	:	Environmental and Social Management Plan
ESMS	:	Environmental and Social Management System
ESS	:	Environmental and Social Standard
FGD	:	Fluid Gas Desulfurization
GHG	:	Greenhouse Gas
GIIP	:	Good International Industry Practice
IA	:	Impact Assessment
IFC	:	International Finance Corporation
PS	:	Performance Standard
PV	:	Photovoltaic
SVOC	:	Semi Volatile Organic Compound
TDS	:	Total Dissolved Solid
TPH	:	Total Petroleum Hydrocarbon
TSS	:	Total Suspended Solid
USEPA	:	United State Environmental Protection Agency
VOC	:	Volatile Organic Compound
WBG	:	World Bank Group

1 Introduction

PLN is committed to avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from PLN's project activities to water bodies (in the context of this management guideline, water[1] consists of surface water, groundwater, and seawater).

This management guideline applies to new project development, expansion of an ongoing project, and for changes to the operation of PLN's facilities. This management guideline is developed to be consistent with the E&S principles as described in the ESMS Manual and based on international good practices such as the World Bank's Environmental and Social Standards (ESS) 3, WBG Environmental, Health, and Safety (EHS) Guidelines, IFC Performance Standard (PS) 3, and other documents as listed in **Section 13** of this management guideline.

This management guideline applies to any PLN's project or activity that involves release or introduction of substances to water resources through wastewater discharge or stormwater. This guideline is developed to provide detailed guidance in managing wastewater and water quality, where by implementing the management guideline PLN could meet the following objectives:

- To avoid wastewater discharge from the activity when possible;
- When avoidance is not feasible, to reduce volume of the wastewater discharge;
- To control wastewater quality by treatment prior to discharge;
- To ensure that wastewater that is discharged from project sites shall be in compliance with the national laws and regulations or the international standards, whichever is more stringent;
- To ensure that PLN's projects and facilities do not introduce unacceptable contaminants or significant impacts on quality of receiving waters in their surroundings.
- Minimal or no grievances arise from the community regarding air pollution from the Project.

2 Disclaimer

This management guideline will not be taken as a standard, regulation, or manual and is not described to the detail level of a work instruction. If a more relevant or updated standard, regulation, or manual is available and requires revision of this Management Guideline, then such revision will be made. If any revision is made; references, rationales and amended sections will be clearly defined. Additionally, if a detailed work instruction or project-level procedure is required, such documents will be developed.

To be able to serve its purpose, this management guideline should be reviewed, implemented, and enforced by PLN staff with relevant authorities and competencies specified in the ESMS Manual Section 3. Any changes to this management guideline may trigger the need to revise the associated procedures and other guidelines that connected with this guideline. Any

[1] Water in this Management Guideline includes surface water, seawater, and groundwater and does not include natural form of water beyond those type of water, e.g., fossil water, ice, steam, etc.

update, deviation, or suggestion of this guideline will be followed up in alignment with the provision of Chapter 9 of the ESMS Manual (Management of Change).

3 Management Approach

The management of wastewater impact is a risk-based approach, which means that the management activities will be proportional to risk or impact. The base activities of a risk-based approach are identifying potential impact due to wastewater discharge and assessing the significance level of those impact, and based this identification – assessment process, the management effort and activities will be determined proportional with the significance level of the impacts.

For example, a small – scale solar PV power plant will produce less complex of wastewater (less domestic wastewater and no specific contaminant parameters from the panel cleansing process) compare to geothermal power plant (that has a larger number of personnel on site and a more complex contaminant parameter from process wastewater). Thus, the small – scale solar PV plant may only need a small bio-septic tank, while the geothermal plant may need a complete Wastewater Treatment Plant

PLN will avoid discharge of wastewater to the extent possible, and when avoidance is not feasible, minimize and control the concentration of contaminants and mass flow of their discharges using the performance levels and measures specified in national law or the international standards, whichever is most stringent. This applies to the discharges of aqueous water streams due to routine, non-routine, and accidental circumstances with the potential local, regional, and transboundary impacts.

PLN should consider alternatives and implement technically and financially feasible, energy efficient, and cost-effective options to avoid or minimize project-related water discharges during the design, construction, and operation of the project.

In the context of wastewater and water quality management, the project and facilities should:

- Understand the quality, quantity, frequency, and sources of liquid effluents in its installations. This includes knowledge about the locations, routes and integrity of internal drainage systems and discharge points.
- Plan and implement segregation of liquid effluents at source and by applying industrial, utility, sanitary, and stormwater categories, in order to limit the volume of water requiring specialized treatment. Characteristics of individual streams may also be used for source segregation.
- Identify opportunities to prevent or reduce wastewater pollution through such measures as recycle and reuse within their facility, input substitution, or process modification (e.g., change of technology or operating conditions/modes).
- Assess the compliance of wastewater discharges with the applicable: (i) discharge standard (if the wastewater is discharged to the environment, either to surface water or groundwater), and (ii) water quality standard for a specific reuse (e.g., if the wastewater reuse for agricultural purposes), and (iii) international standards, relevant to the project.

4 Process Overview

To achieve the objectives of each step of the E&S safeguard process, the wastewater and water quality management will implement the following process:

- Identification of potential impacts from wastewater generation and discharge;
- Assessment of the identified impacts;
- Planning for mitigation measures; and
- Monitoring and review of the implementation of mitigation measures.

All the above process is conducted within the Impact Assessment (IA) process as required by the ESMS manual, which includes the screening process and categorization, scoping, a baseline study, analysing and assessing impact, defining mitigation measures and management and monitoring strategies. In every step of the IA process, the mitigation hierarchy will be taken into consideration.

5 Screening and Categorization

5.1 Screening of potential wastewater and water quality impact

The screening stage is a key step for an initial identification of impacts related to wastewater and the quality of receiving waters from a project, which conducted at an early stage of a project's lifecycle. The objective of screening in the context of management of wastewater and the quality of receiving waters is to identify potential major wastewater impacts of a proposed project/activity. Screening of potential wastewater impacts serves as the basis for scoping (see **Section 6**) and will contribute in calculating the likely E&S effect of a project when determining project category (see ESMS Manual Chapter 5.3).

Screening is based on professional judgement and the information available at the time. Project screening and categorization process is conducted at the earliest possible stage in every project lifecycle; therefore, it is probable that the data used for identification is not widely available and not very detailed at that stage. Whenever possible the data collection and the initial identification of impact shall be conducted concurrently with or part of the pre-feasibility and feasibility studies, and in collaboration with preparers of the feasibility assessments.

The identification of impacts of wastewater will include of the following information:

- The source of impact.
  Wastewater from project or facilities can be generated from man activities and natural water (i.e., precipitation) that come to the site. Each activity may generate and discharge different types of wastewaters, for examples wastewater from utility operations, process wastewater, wastewater from utilities operation, stormwater, sanitary (domestic) wastewater at construction sites, etc.;
- Wastewater quality; and
- The receptors of the impact (e.g., receiving waters, communities that utilizing the receiving waters, water biota, etc).

Initial identification of the potential impacts of wastewater is based on information of the project type and nature, the activities planned in general, and the proposed location in general. Information that needs to be obtained are the following but is not limited to:

- Type of project (e.g., transmission line, types of power plant, distribution line, etc.)
- Technology used in general (e.g., types of solar panel, etc.)
- Project phases (e.g., construction, operation, decommissioning)
- Location characteristic in general, (e.g., administrative boundaries, watershed, climate & weather in general, topography in general, presence of receiving waters in and around project area, etc.)
- Timing of the activities (e.g., during wet season, dry season).

Types of projects, technology that will be applied, in each of the project phases could give information on typical sources of wastewater, types of pollutant generated and rough estimation of the amount of wastewater produced. The location characteristic can provide estimation on the amount of wastewater from stormwater, the tendency of water flow direction, presence of receiving waters and its quality, etc. Numerous sources can be used to obtain information above, for examples spatial map, land use map, online database (e.g., climate components), remote sensing data, public reports, including interviews and site visits.

5.2 Source of wastewater

The following is description of types of sources of wastewater that can be used as reference in the process of identifying potential impact of wastewater.

Process Wastewater

- Cooling water, produced mostly in thermoelectric power plants that boil water to create steam to spin turbines. Once steam has passed through a turbine, it must be condensed into water before it can be reused to produce more electricity. To cool the steam, water withdrawn from nearby water bodies such as rivers, lakes, or oceans is used. After this process water becomes heated and contaminated with various impurities, including suspended solids, biocides and chemicals. (UCSUSA, 2010)
- Boiler blowdown wastewater, generated from boiler blowdown process to control boiler water parameters within prescribed limits to minimize scale, corrosion, carryover, and other specific problems. Blowdown is also used to remove suspended solids present in the system. These solids are caused by feedwater contamination, by internal chemical treatment precipitates, or by exceeding the solubility limits of otherwise soluble salts. (Veolia, 2023)
- Flue Gas Desulfurization (FGD) wastewater is generated in power plants equipped with flue gas desulfurization systems to reduce sulphur dioxide emissions. FGD systems use chemical processes to remove sulphur dioxide from flue gases before they are released into the atmosphere. The wastewater produced during this process contains various pollutants, including heavy metals, suspended solids, and dissolved chemicals.
- Ash pond effluent is generated in coal-fired power plants that produce ash as a byproduct of combustion. The ash is collected in ash ponds or impoundments, where it settles out from the water before being discharged. However, some amount of ash particles can still be present in the effluent, along with other contaminants such as heavy metals and trace elements.

Wastewater from Utilities Operation

- Excess water from dewatering/pumping activities from the Project's construction activities, or from springs or streams at any type of projects.
- Oil-contaminated water from equipment, e.g., turbine at hydropower projects.
- Petroleum, solvent, or paint-contaminated water from workshops, vehicle/equipment washing station, fuelling station, parking lots, work locations, etc., including run-off from these areas.

Stormwater

- Run-off from precipitation, primarily during construction activities but also during operation. Example of potentially significant stormwater impacts during operation phase usually notable in solar PV projects where the water discharged may contain high level of sediments due to erosion.

Sanitary (domestic) Wastewater

- Sanitary wastewater from domestic activities of workforce during construction and operation phase.
- Household wastewater ("grey" water) during construction and operation.

5.3 Preliminary assessment of wastewater impacts

Once relevant information and potential wastewater impacts have been assembled, a preliminary assessment will be conducted to assess the significance of the identified potential impacts. The significance of the potential wastewater impacts is measured by assessing the probability and the consequence level, using reference criteria for probability and consequence as provided in Appendix 4 of the ESMS Manual, criteria for Resource Efficiency, Pollution and Emissions of Greenhouse Gases (GHG).

The significance of wastewater impacts will contribute to calculating the Likely E&S effect of a project when determining the project's category. The potential wastewater impacts assessed will likely consist of several impacts, for examples impact of domestic wastewater discharge, impact of contaminated run-off from the project's area, etc., where each of these impacts will have its own impact significance. However, in the context of determining project category, the risk category will follow the highest risk significance.

The results of the screening and categorization process are preliminary in nature and will be expanded and expanded and revisited as part of the Impact Assessment, when more information about the nature and the scope of a project becomes available or when project definition and circumstances change (e.g., screening of subprojects identified during project implementation, change of project design or components, etc.). This is in line with an adaptive risk management approach.

6 Scoping of Wastewater Impact

Scoping aims to deepen the understanding of the potential wastewater impacts (in condition that they have been identified during Project Screening and Categorization), to clearly define what is within the scope of the assessment (activities, risks/impacts, affected area), and develop a suitable methodology and a sampling strategy for the wastewater Impact Assessment that ensues.

At the scoping stage, the identification of impacts of wastewater will be further broadened and deepened. Identification of the potential impacts of wastewater are derived, based on the project's description. However, more information about the project is usually available, detailed and more defined, compared to the information available during the project screening and categorization stage. All impacts identified from the project screening and categorization stage will still be included in the list of a project's potential impacts.

The scoping will include, but not limited to:

a. Understanding project activities, project description and project alternatives.

   At this stage of the project, information regarding the project is available in a more comprehensive manner, such as the project's phases, the technology to be applied, the site design, etc., including some alternatives of project components design. An understanding of the project activities and description will be needed to identify potential interaction between the project and receptors in the Area of Influence (see point c).

b. Identify potential wastewater impact

   Identification of potential wastewater impact in the scoping stage is basically an iteration of identifying potential impact in the screening stage. However, usually more information about the project is available, detailed and more defined (although some alternatives of design and/or project locations may still be considered, but not in a broad range of selection), compared to the information available during the project screening and categorization process. Therefore, the identification of impacts from wastewater is further developed in this scoping process.

   Identification of wastewater impacts is based on the project's description, activities that produce wastewater or contaminated water, and how it interacts with the receptors.

   During the identification of potential impacts, permits or licenses required that are related with activities that produce wastewater shall be also identified. Identification of permitting and licensing requirements will provide information on management actions that may need to be conducted when developing mitigation measures plan.

c. Identify area of influence (AOI) for wastewater impact.

   The project activities will impact spatial (area) and temporal (time) dimensions. Based on the potential wastewater impacts that have been identified (both in the screening process and developed in this scoping process), the area of influence for wastewater impacts will be determined. The extent of the AOI for wastewater impact will consider the extent of the direct and indirect impact and location characteristics, such as receiving waters and their sensitivity. The extent of the direct impacts may be determined based on reference to similar project or activities, standards related with wastewater (e.g., distance for wastewater monitoring, etc.) or other justified studies. Location characteristics, especially the characteristics of the receiving waters such as water hydraulics, existing quality, etc., will be the main factors to determine the AOI, for example receiving waters with heavy discharge may transport the contaminants from the wastewater discharge for long distances; or tributary rivers may contribute to dilution of contaminants from wastewater discharge, thus the impact due to increment of pollutants can be significantly reduced in short distances.

It should be noted that the AOI determined in the scoping process may be revised and adjusted when new information gathered throughout the impact assessment process (e.g., new information on existing baseline condition from the baseline survey result) or circumstances change (e.g., changes in project's design).

d. Identify sensitive receptors

Wastewater impacts that related to or may affect the sensitive receptors need to be identified in order to determine which wastewater impacts may need to be focused and analysed in more depth. Sensitive receptors include water ecosystems, communities, and receiving waters and their habitats.

e. Identify existing environment conditions and social issues related to wastewater

Existing environmental conditions and social issues related to wastewater that can be exacerbated by the project will be identified. For example, the receiving water body is currently utilized by the community for daily life and has a poor quality where the discharge of wastewater from the project may decrease the water quality further. This kind of environmental conditions and social issues need to be considered when analysing the potential impacts, also as a basis for planning appropriate wastewater management plan.

f. Define methodology for impact analysis

In analysing the potential wastewater impacts, there are methods that can be used, including quantitative, semi-quantitative, and qualitative methods. As much as feasible, the wastewater impact assessment is carried out quantitatively. In general, the methodology for wastewater impact assessment consists of, but not limited to:

- Primary and secondary data collection
  The primary and secondary data collection will be conducted as part of the baseline study (see **Section 7**).

- Modelling
  In order to have a reliable quantitative data, some pollutant dispersion from wastewater discharged may need to be modelled. The output of erosion modelling (if any) will also become input for calculating the consequence of wastewater discharge during impact significance assessment (see **Section 8.2**). The wastewater discharge modelling will be conducted using appropriate software program, taking into consideration the characteristics of the pollutant and the characteristics of receiving waters.

g. Identify baseline data requirements

Baseline data that needs to be collected will be identified, based on the previous activities in the scoping, i.e., the potential impacts that have been identified, the AOI defined, and methodology for impact analysis that has been defined (including the requirements to conduct modelling), etc. Input from stakeholder engagement that has been conducted as part of the impact assessment process as a whole, especially related to wastewater, will be taken into consideration in determining baseline data that may require to be collected.

7 Baseline Study

A baseline study will include collection of primary and secondary data collection and analysis of data collected. The primary and secondary data that shall be collected is utilized to understand the receiving waters' conditions in the Project's AOI before the implementation of the Project and as input for modelling process.

The data to be collected will consider the characteristics of potential wastewater impacts that have been identified, the location characteristics (including the potential receptors), and other data required to conduct modelling that has been defined (if modelling is deemed necessary based on scoping practice)..

Primary data collection may consist of field observations, receiving waters sampling and wastewater discharge sampling (if available), laboratory analysis, and interviews. Secondary data collection may include available water studies that have been conducted earlier in the AOI, wastewater studies, and supporting data to analyse the receiving waters condition and potential wastewater impacts.

7.1 Primary data collection

In designing the primary data collection program, the methodology used considers the following:

- Data collection, methods, equipment are valid, reliable and consistent, i.e., will be conducted in accordance with the national law and regulation or the international standard, whichever is more stringent and technically feasible to be applied.
- Sampling of receiving waters needs to represent the seasonal conditions (wet and dry seasons), by considering the timing of the activities and proportionate with the potential significance of the impacts.

When wastewater impact potentially occurs, the baseline information will also be utilized for monitoring purposes, therefor the quality of receiving waters should be undertaken to assess background levels of various water quality parameters, especially the concerned parameters in the wastewater quality, in order to differentiate between existing ambient conditions and project-related impacts. The sampling program should align with other environmental sampling program, especially related with water, and should consider the following, but is not limited to:

- Discharge points of wastewater from the project location to the receiving waters. Sampling should be at least be taken at an upstream of the discharge point, at the discharge point, and downstream of the discharge point.
- Land slope and the direction of storm water flow;
- The characteristics of the receiving waters (debit, direction, river flow, quality, etc.,).
- Seasonal (dry and wet season) sampling should be conducted at least once in each season planned.
- Aquatic habitats in the receiving waters.

- Other activities (community, other plant, etc) near the receiving waters or known to also discharging their wastewater to the same water bodies.

Parameters of the receiving waters to be measured should, follow the applicable laws and regulations or the international standard[2] (whichever is more stringent and technically feasible to be applied) regarding water quality, and will take into regard the specific regulations or standard applicable for the receiving waters (if any, e.g., local regulation, water use designation[3]) and specific wastewater quality (if any, e.g., cooling water discharge). Other parameters that should be added are the specific water contaminants that are contained in the wastewater discharged that have not been regulated in the national laws and regulations (if any). Additionally, the standards to be referred to, including the parameters planned to be sampled and the associated threshold will be identified based on scoping result, by taking into account the potential significance of the impacts.

7.2 Secondary data collection

As previously described, secondary data collection includes studies that have been previously conducted in the AOI and supporting data to analyse the receiving waters condition and the potential of wastewater discharge into the waters. Supporting data may include the following but not limited to hydrological data, delineation of watershed and water basin, land use, etc. It should be noted that for modelling purposes, there might be some specific requirements and other data components needs to be collected, depending on the modelling type and software defined.

7.3 Baseline data analysis

Data from the sampling program will be analysed to describe the condition of receiving waters. The parameters measured and analysed will be compared with the applicable standard (national regulation and relevant international standard, whichever more stringent and technically feasible).

8 Analyse and Assess Potential Wastewater Impact

8.1 Prediction of impact and impact mapping

All available information and data collected during the scoping process and from the result of baseline study will be analysed to determine what could potentially happen to receptors as a consequence of the project and its associated activities. From the potentially significant interactions identified in the scoping process, the impacts to the various receptors are described and evaluated. It is to be noted that impact assessment is not an isolated process, there may be additional information obtained which may change the impact profile, where this impact has not previously identified during the scoping process, including secondary impact on other receptors that requires an assessment of the interaction of impacts that may intensify their scale and significance.

[2] International standard reference for ambient water quality: US EPA Water quality criteria (https://www.epa.gov/wqc)

[3] International standard reference for receiving water with specific designation (e.g., drinking water, recreation, etc.): WHO guidelines (https://www.who.int/publications/who-guidelines)

Once all the impacts have been collated, they will be grouped based on phase of the project where they will potentially occur and the correlation between impacts (including impact other than wastewater impact) will be mapped. This will give a clear picture of what impacts may influence other impacts and any interaction between the identified impacts that will enable identification of possible indirect and cumulative impacts.

8.2 Significance of impact

After the identified potential impacts are defined and mapped, they will be assessed for their significance using the same method as in the preliminary assessment stage using a risk matrix method. However, at this stage more reliable data is available, including that from impact modelling that will give more quantitative reliable information, specifically related to the significance of the impact and other impact consequence factors (if available). The significance of impact will be assessed based on the probability of the impact to occur and the extent of its consequences if it occurs. The consequence of the impact will take into account the following factors:

- Type of impact (direct, indirect, and cumulative)
- Duration of impact (short, medium, or long term)
- Extent or size of the affected area
- Reversibility of impact (reversible or permanent)
- Sensitivity of receptor (vulnerability)

It is important to note that in determining the impact significance, embedded controls (i.e., physical or procedural controls that are included in Project Description) are taken into account in estimating the raw significance. An example of an embedded control is if a wastewater treatment plant is designed to be installed prior discharge to the receiving waters.

Once the significance of an impact has been defined, the next step is to evaluate what mitigation and enhancement measures are warranted (see **Section 9**). The main objective of developing mitigation measures is to reduce the significance of an impact by reducing the consequence and/or lowering the likelihood. Re-evaluation of impact significance value needs to be conducted once mitigation measures are developed. The significance of the residual impact will be assessed with the same risk matrix, taking into account the application of mitigation measures. For example, land clearing of 1 ha during the construction period (approximately 1 year) may cause water run-off that carrying erosion sediments to the river to the south of the project area. This impact is assessed as an impact with 'medium' consequence and 'very high' likelihood; thus, the impact significance is 'high'.

All the impacts that have been assessed will be managed, through mitigation measures (See **Section 9**) that have been defined and will be monitored (see **Section 10**). The management and monitoring strategies will need to be developed to reduce the impact significance, prevent an impact to escalate, and to improve the E&S performance of a project. The management and monitoring strategies will be conducted through developing a Wastewater Management Plan (See **Section 11**).

9 Mitigation Measures

9.1 General Principles

In project and activities where wastewater generation cannot be avoided, wastewater will be managed. Mitigation measures for impacts from wastewater will be undertaken by following three main principles (WBG EHS Guideline, 2007) as follow:

a. Water Conservation

Wastewater volume is normally correlated with the amount of water consumed for the project or activity. Conserving water intake for the project or activity will reduce volume of wastewater to be discharged.

Water Efficiency Management Guideline will be followed in attempt to conserve water intake for project or activity.

b. Wastewater Treatment

Wastewater treatment will be undertaken, where practical, to speed up the natural processes by which water is purified. Wastewater treatment may have two stages i.e., primary and secondary (or sometimes are combined). In the primary stage, solids are allowed to settle and removed from wastewater, while in the secondary stage biological or chemical processes are used to further purify wastewater. (USEPA, 1998)

Wastewater treatment can consist of physical treatment, chemically treatment, biological treatment, sedimentation, etc., subject to the targeted parameter to be managed. Types of treatment that will be selected will targeting the quality of parameters that meet the applicable standard for reuse or discharge and will prevent adverse impact on receiving waters. If needed, application of wastewater treatment techniques may further reduce the load of contaminants prior to discharge, taking into consideration potential impacts of cross-media transfer of contaminants during treatment (e.g., from water to air or land). Example of Wastewater Treatment Approach is provided in **Table 7-1**

When wastewater treatment is required prior to discharge, the level of treatment should be based on:

- Whether wastewater is being discharged to a sanitary sewer system, or to surface waters;
- National and local standards as reflected in permit requirements and sewer system capacity to convey and treat wastewater if discharge is to a sanitary sewer;
- Assimilative capacity of the receiving waters for the load of contaminant being discharged wastewater if discharge is to surface water;
- Intended use of the receiving water body (e.g., as a source of drinking water, recreation, irrigation, navigation, or other);
- Presence of sensitive receptors (e.g., endangered species) or habitats;
- Good International Industry Practice (GIIP) for the relevant industry sector.

Table 7-1 Example of Wastewater Treatment Approach *(WBG EHS Guideline, 2007)*

Pollutant/Parameter	Control Options/Principle	Common End of Pipe Control Technology
pH	Chemical, Equalization	Acid/Base addition, Flow equalization
Oil and Grease TPH	Phase separation	Dissolved Air Floatation, oil water separator, grease trap
TSS - Settleable	Settling, Size Exclusion	Sedimentation basin, clarifier, centrifuge, screens
TSS - Non-Settleable	Floatation, Filtration - traditional and tangential	Dissolved air floatation, Multimedia filter, sand filter, fabric filter, ultrafiltration, microfiltration
Hi BOD (>2 Kg/m³)	Biological - Anaerobic	Suspended growth, attached growth, hybrid
Lo BOD (<2 Kg/m³)	Biological - Aerobic, Facultative	Suspended growth, attached growth, hybrid
COD - Non-Biodegradable	Oxidation, Adsorption, Size Exclusion	Chemical oxidation, Thermal oxidation, Activated Carbon, Membranes
Metals Particulate and Soluble	Coagulation, flocculation, precipitation, size exclusion	Flash mix with settling, filtration traditional and tangential
Inorganics / Non-metals	Coagulation, flocculation, precipitation, size exclusion, Oxidation, Adsorption	Flash mix with settling, filtration traditional and tangential, Chemical oxidation, Thermal oxidation, Activated Carbon, Reverse Osmosis, Evaporation
Organics - VOCs and SVOCs	Biological - Aerobic, Anaerobic, Facultative; Adsorption, Oxidation	Biological: Suspended growth, attached growth, hybrid; Chemical oxidation, Thermal oxidation, Activated Carbon
Emissions - Odors and VOCs	Capture - Active or Passive; Biological; Adsorption, Oxidation	Biological: Attached growth; Chemical oxidation, Thermal oxidation, Activated Carbon
Nutrients	Biological Nutrient Removal, Chemical, Physical, Adsorption	Aerobic/Anoxic biological treatment, chemical hydrolysis and air stripping, chlorination, ion exchange
Colour	Biological - Aerobic, Anaerobic, Facultative; Adsorption, Oxidation	Biological Aerobic, Chemical oxidation, Activated Carbon
Temperature	Evaporative Cooling	Surface Aerators, Flow Equalization
TDS	Concentration, Size Exclusion	Evaporation, crystallization, Reverse Osmosis
Active Ingredients/Emerging Contaminants	Adsorption, Oxidation, Size Exclusion, Concentration	Chemical oxidation, Thermal oxidation, Activated Carbon, Ion Exchange, Reverse Osmosis, Evaporation, Crystallization
Radionuclides	Adsorption, Size Exclusion, Concentration	Ion Exchange, Reverse Osmosis, Evaporation, Crystallization
Pathogens	Disinfection, Sterilization	Chlorine, Ozone, Peroxide, UV, Thermal
Toxicity	Adsorption, Oxidation, Size Exclusion, Concentration	Chemical oxidation, Thermal oxidation, Activated Carbon, Evaporation, crystallization, Reverse Osmosis

c. Wastewater Monitoring.

A wastewater quality monitoring program is to be conducted with adequate resources and management oversight. Details on wastewater monitoring is further described in **Section 10**.

9.2 Mitigation Keys

Based on the above principles, the following mitigation keys are provided below, subject to the type of wastewater (WBG EHS Guideline, 2007), whichever applicable and proportionate with the impact significance:

Process Wastewater:

- Treatment technology, including design and equipment, will be selected based on the wastewater characteristics. Operation and maintenance of such technology will be conducted adequately by technically competent and well-trained resources.
- The design and operation of the selected wastewater treatment technologies will avoid uncontrolled air emissions of volatile chemicals from wastewaters.
- Residuals from industrial wastewater treatment operations will be disposed in compliance with local regulatory requirements (*Annex 47 of Indonesian Ministry of Environmental and Forestry (MOEF)'s Regulation No 5 of 2014 on Wastewater Threshold*).

Wastewater from Utilities Operations:

- Implementation of principles of water conservation, particularly on cooling system, as provided in Water Efficiency Guideline of this ESMS.
- Use of heat recovery methods (also energy efficiency improvements) or other cooling methods to reduce the temperature of heated water prior to discharge to ensure the discharge water temperature does not result in an increase greater than 3°C of ambient temperature at the edge of a scientifically established mixing zone which takes into account ambient water quality, receiving water use, potential receptors and assimilative capacity among other considerations.
- Minimizing use of antifouling and corrosion inhibiting chemicals by ensuring appropriate depth of water intake and use of screens. Least hazardous alternatives will be used with regards to toxicity, biodegradability, bioavailability, and bioaccumulation potential. Dose applied will accord with local regulatory requirements and manufacturer recommendations.
- Testing for residual biocides and other pollutants of concern will be conducted to determine the need for dose adjustments or treatment of cooling water prior to discharge.

Stormwater:

- Stormwater will be separated from process and sanitary wastewater streams in order to reduce the volume of wastewater to be treated prior to discharge.
- Surface runoff from process areas or potential sources of contamination will be prevented.
- Where this approach is not practical, runoff from process and storage areas will be segregated from potentially less contaminated runoff.
- Runoff from areas without potential sources of contamination will be minimized (e.g., by minimizing the area of impermeable surfaces) and the peak discharge rate will be reduced (e.g., by using vegetated swales and retention ponds).

- Where stormwater treatment is deemed necessary to protect the quality of receiving water bodies, priority will be given to manage and treat the first flush of stormwater runoff
  where the majority of potential contaminants tend to be present.
- When water quality criteria allow, stormwater will be managed as a resource, either for groundwater recharge or for meeting water needs at the facility;
- Oil water separators and grease traps will be installed and maintained as appropriate at refuelling facilities, workshops, parking areas, fuel storage and containment areas.
- Sludge from stormwater catchments or collection and treatment systems may contain elevated levels of pollutants and will be disposed in compliance with local regulatory Requirements. In the absence of which, disposal will be consistent with protection of public health and safety, and conservation and long-term sustainability of water and land resources.

Sanitary Wastewater:

- Wastewater stream will be segregated to ensure compatibility with selected treatment option (e.g., septic system which can only accept domestic sewage);
- Segregation and pretreatment of oil and grease-containing effluents (e.g., use of a grease trap) will be undertaken prior to discharge into sewer systems;
- If sewage from the industrial facility is to be discharged to surface water, treatment to meet national or local standards for sanitary wastewater discharges (refer to *Minister of Environment and Forestry's Regulation No. P.68/MENLHK/SETJEN/KUM.1/8/2016 concerning Domestic Wastewater Threshold*) or applicable international standard, whichever more stringent and technically feasible. Additionally, the standards to be referred to, including the parameters planned to be sampled and the associated threshold will be identified based on impact analysis and assessment result, by taking into account the significance of the impacts. Reference of international indicative guideline values applicable to sanitary wastewater discharges shown in **Table 7-2**;
- If sewage from the industrial facility is to be discharged to either a septic system, or where land is used as part of the treatment system, treatment to meet applicable national or local standards for sanitary wastewater discharges will be conducted. Final Polishing (tertiary treatment) in bioretention basins or SUDS systems may be considered.
- Whenever feasible, sanitary wastewater can be recycled then reused for other purposes, for example watering plants, or re-injected into the water basin. The reuse and recycle method, as well as re-injection of treated water coincides with water conservation measures (see Water Conservation Management Guideline).
- Sludge from sanitary wastewater treatment systems will be disposed in compliance with local regulatory requirements. In the absence of which, disposal will be consistent with protection of public health and safety, and conservation and long-term sustainability of water and land resources.

Table 7-2 Indicative Values for Treated Sanitary Sewage Discharge *(WBG EHS Guideline, 2007)*

Pollutants	Units	Guideline Value

pH	pH	6 - 9
BOD	mg/l	30
COD	mg/l	125
Total nitrogen	mg/l	10
Total phosphorus	mg/l	2
Oil and grease	mg/l	10
Total suspended solids	mg/l	50
Total coliform bacteria	MPN[a] / 100 ml	400

Notes:
a. MPN = Most Probable Number

10 Monitoring

Monitoring and review process serves as a tool to improve the performance of wastewater and water quality management. As part of the wastewater and water quality management, monitoring consists of periodical monitoring as part of the overall management activities (i.e., mitigation measures planned) and review of the management plan.

10.1 Management activity monitoring

Each of the mitigation measures that are planned should be monitored to ensure that management activities are carried out according to plan, ensure that project activities do not violate the provisions that have been regulated and determined, as well as early detection of an increase in abnormal water pollution. The monitoring plan will be developed based on the mitigation measures that has been set, and will be commensurate with the significance level of impact based on the impact analysis and assessment result.

In developing a monitoring plan for activities planned in the management plan, the following items should be taken into account, but not limited to:

- Parameters to be monitored.
  Parameters to be monitored are the performance indicators that have been determined when developing management plan. The parameters selected for monitoring will be indicative of the pollutants of concern from the process and will include parameters that are regulated under compliance requirements. As previously discussed, the parameters are dependent on the wastewater quality and ambient water quality of the receiving water, both based on national standards and/or relevant international standards, whichever is more stringent and technically feasible.

- Baseline calculation
  Before a project is developed, baseline of receiving bodies of water in the vicinity of the site will be undertaken to assess background levels of key pollutants, in order to differentiate between existing ambient conditions and project-related impacts. This should also include the applicable standards (compliance to regulatory and/or international standards), the results of monitoring of receiving water bodies will also be compared to the baseline condition prior the project commencement in order to analyse the project impact to the receiving water bodies quality. It is common to set a project-based maxima

that are less than the standard limits as trigger values for review, if the process exceeds its anticipated controlled levels.

- Monitoring type and frequency
  The frequency of monitoring will depend various factors, which includes the duration of impact, magnitude of impact, the sensitivity or limit of the receptor, etc. Longer periods of impact, larger magnitudes of impact, more sensitive receptor and the poor condition of the receiving bodies of water, will require more intense monitoring, likewise. There may also be seasonal considerations. The frequency of several parameters that are required to be monitored in the permit, if any, must comply with the provisions in the permit, at minimum.

  Wastewater monitoring will take into consideration the discharge characteristics from the process over time. Monitoring of discharges from processes with batch manufacturing or seasonal process variations will take into consideration of time-dependent variations in discharges and, therefore, is more complex than monitoring of continuous discharges. Effluents from highly variable processes may need to be sampled more frequently or through composite methods. Collecting samples or, if automated equipment permits, composite samples may offer more insight on average concentrations of pollutants over a 24-hour period. Composite samplers may not be appropriate where analytes of concern are short-lived (e.g., quickly degraded or volatile). It may also be necessary to schedule a special sampling event, triggered by an incident in plant operation of a community grievance.

- Monitoring locations:
  The monitoring locations will be selected with the objective to obtain representative monitoring data. Effluent sampling stations may be located at the final discharge, as well as at strategic upstream points prior to merging of different discharges. Process discharges will not be diluted prior or after treatment with the objective of meeting the discharge or ambient water quality standards. If required, monitoring can be carried out at the upstream of wastewater treatment process as early identification of abnormal condition and to control the effectiveness of the wastewater treatment process. Where possible the sampling locations used during baseline data collection will be used.

  For monitoring at the receiving waters, the monitoring conducted at the upstream of the wastewater discharge point, at the discharge point, and downstream of the discharge point. The monitoring locations at the receiving bodies of water needs to take into account the hydraulic features of the body of water.

- Sampling and analysis methods
  Monitoring programs should apply national or international methods for sample collection, preservation, and analysis. Sampling should be conducted by, or under, the supervision of trained individuals. Analysis should be conducted by entities permitted or certified for this purpose. Sampling and analysis Quality Assurance/Quality Control (QA/QC) plans should be applied and documented to ensure that data quality is adequate for the intended data use (e.g., method detection limits are below levels of concern). Monitoring reports should include QA/QC documentation. Chain of custody for collected samples should be established.

- Instruments that will be used for monitoring, including calibration requirements.
  The method and instrument to be used will comply with applicable regulation (if any), and will follow the best practice as technically feasible.

- The resources
  The monitoring will determine the minimum required qualifications of persons who will conduct the monitoring and inspection. At some cases, public participation in monitoring can be a requirement or a strategy in a management. If public monitoring determined to be applied, then it should be regulated and the requirements of the public that will participate should be determined.

10.2 Management plan review

Wastewater Management Plan is a living document and have to be referred to every stage along the project cycle. The target and approach established in the plan should be reviewed, modified, or renewed as from time to time as deemed necessary to find the best possible result.

The following are items that need to be determined related to management plan review:

- Schedule for regular review. The management plan should be reviewed regularly. If the phase will be more than one year, then the regular review shall be conducted annually in minimum.
- The parties that responsible for conducting the review, making an amendment, and the party approving the result of the review.
- Special reviews may be scheduled if there are changes to the wastewater treatment, discharge or if monitoring events show that discharge criteria are exceeded.

11 Wastewater Management Plan

Mitigation measures of potential impact from wastewater and the monitoring plan will be defined in detail within the Wastewater Management Plan. The Plan will be developed during Impact Assessment process of the project as part of the Project's ESMP, or to be a stand-alone document. It shall be modified, updated, and detailed as necessary so the wastewater management can be improved.

A Wastewater Management Plan will be developed consisting of the following components:

11.1 Component 1: Objective(s)

The objective of Wastewater and Water Quality is to ensure that PLN can reduce the significance level of impacts from generated wastewater based on the Impact Assessment.

11.2 Component 2: Source of Impact and Wastewater Balance

The Wastewater Management Plan should detail the following:

- Each equipment or facility that generates wastewater hence control measure is needed;
- Characteristics of wastewater;
- Potential receptors for each source;
- Wastewater balance calculation and diagram of entire wastewater stream; and

- Target parameters for discharges and receiving waters.

11.3 Component 3: Impact management activities

This is the core of the management plan where all mitigation measures for mitigating the wastewater impacts will be described. For specific project activities that require permits for its implementation, any requirements of the permit related to the management effort for the impact source should be included in the management plan.

The activities planned should also consider other plans that are related (if any), such as Water Efficiency Management Plan, Occupational Health Safety Management Plan, Community Health Safety and Security Management Plan, Stakeholder Management Plan, etc.

The Plan should also require that stakeholders that may be impacted to be consulted. The Plan must provide for timely handling of complaints/concerns received through the formal grievance mechanism or otherwise, including identifying the person or persons responsible for dealing with such issues.

11.4 Component 4: Performance Indicator

Every mitigation measure or management activity planned should have a measurable indicator of success as a tool to determine achievement targets and control the implementation of the management activity. Management indicators are determined shall be measurable, wherever possible to be quantitative in nature and can be measured with applicable tools. The indicators of success are based on specific water quality parameters regulated in a discharge permit (which based on applicable national laws), ambient water quality in the receiving body of water and other water quality standard as related with intended use of the water (e.g., water quality for specific reuse), which are based on national and/or international standards whichever is more stringent and technically feasible.

11.5 Component 5: Institutional *Responsibility*

The management plan must identify and describe the responsibilities of all parties (PLN, contractor or other relevant third parties) and competent authorities. The management plan must also identify the roles and responsibilities of individual positions within these organizations, including person or persons that are responsible for follow-up and take action on grievances related to wastewater that are submitted through the formal grievance mechanism

11.6 Component 6: Implementation Schedule

The management plan should detail an implementation schedule of management activities, taking into account the planned timing of construction and other project activities, including any permit or license that should be obtain prior activity's commencing.

11.7 Component 7: Cost Estimates

The management plan should include cost estimates for implementation of each activity or set of activities, including any up-front investment costs and long-term recurrent costs.

11.8 Component 8: Monitoring, Recordkeeping and Reporting

The management plan must call for inspection/monitoring of wastewater control activities (see Section 8). in order to ensure compliance with the applicable national laws and regulations or the international standard, as set in the management plan objectives. The monitoring plan in the management plan should specify:

- The wastewater monitoring activities and locations. In general, this should be the upstream and downstream of the wastewater stream, this includes monitoring water quality of the receiving bodies of water as control point.
- Parameters to be monitored;
- The frequency of inspection and monitoring;
- Regulatory/permit criteria and any specific requirement imposed on the project by government (as applicable);
- Instruments that will be used for monitoring, including calibration requirements;
- The required qualifications of persons who will conduct the monitoring and inspection, and of any members of the public who may participate in monitoring;
- Records that must be kept and the person responsible for keeping the records;
- Reports that will be prepared, to whom the reports are to be submitted for review, and the length of time records will be kept. This will include summary reports at intervals and to which institutional should be submitted.

For Project activity or management activity that requires permit in its implementation, the monitoring plan must facilitate the requirements in the permit, for examples parameters to be monitored, the frequency, etc.

11.9 Component 9: Management Plan Review

The management plan should determine and state the schedule of management plan review (see **Section 10.2**). Regular review of the management plan and the party responsible for conducting a review, making an amendment and the party approving the results of the review and the changes made (if any) must be stated in the management plan.

12 Procedure

In carrying out Wastewater Management Plan activities, procedures can be developed as necessary (e.g., wastewater monitoring procedure, sludge treatment procedure, etc.). The procedures required are highly dependent on the nature of the project and the impact and mitigation measure determined, although some procedures may be more general thus can be used for various projects (e.g., water quality sampling procedure).

In general, there are several key items that need to be included in the procedures to be developed as follow, but not limited to:

- Procedure Information, which includes procedure title, identification number, number of pages.
- Purpose. The procedure should provide information on the objective of the procedure.
- Scope. The procedure should inform the boundary of the procedure, aspects or parties that are covered under the procedure, and limitation to the procedure.

- Definition. The procedure should define the terms used in the procedure.
- Responsibilities. The procedure should identify and state the parties that will be responsible to follow the procedure, supervise the implementation of the procedure, provide training of the procedure, and parties that will regularly review and update the procedure.
- Work instructions. The procedure should list, in a simple and clear manners, the specific steps that will be taken to implement the procedure.
- Reference documents. The procedure should list the relevant documents that support, utilized as the basis or provide additional information for the procedure, including rules and regulation that to be complied.
- Records. The procedure should provide information of the required documented outcomes of the procedures. Format for required records will be provided under the procedure, as necessary.
- Approving authority. The procedure should provide information on party that is responsible for approving the procedures.
- Issue date. The procedure should provide information on time of procedure issuance.
- Revision date. The procedure should provide information on time of procedure reviewed and revised (Procedures should be continually updated and improved).
- Other Environmental & Social components, if applicable. The procedure should include other environmental and social component, if applicable, related with the activities in the procedure. Example: PPE required for the activities must be clearly stated in the procedure.

13 References

- Act No. 11 Year 2020 on Omnibus Law
- Government Regulation No. 22 Year 2021 on Implementation of Environmental Protection and Management
- Ministry of Environment and Forestry Regulation No. 68 Year 2016 regarding Domestic Wastewater Standard
- World Bank Environmental and Social Framework (ESF), Environmental and Social Standard (ESS) 3: Resource Efficiency and Pollution Prevention and Management
- World Bank Environmental and Social Framework (ESF) Guidance Note, Environmental and Social Standard (ESS) 3: Resource Efficiency and Pollution Prevention and Management
- WBG Environmental, Health, and Safety (EHS) Guidelines, 2007.
- IFC PS 3: Resource Efficiency and Pollution Prevention, 2012
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