

## **11. MONITORING PLAN**

### **11.1 Introduction**

This section outlines the monitoring regime for the Project.

The Project Company plan will retain an EHS Manager within its organizational structure. One of the key responsibilities of the EHS Manager will be to ensure that the monitoring program is properly implemented.

Detailed Emergency Response Plan, Environmental and Social Management and Monitoring Plan, Community Impacts Monitoring Plan, Occupational Health and Safety Plans will be developed and implemented prior to commissioning and operation of the Plant.

### **11.2 Monitoring Categories**

The monitoring program can be split into categories namely:

Environmental Monitoring  
Socio-Economic Monitoring  
Operational and Management Performance Monitoring.

#### **11.2.1 Environmental Monitoring**

This environmental monitoring program will cover monitoring of the following parameters:

- Water resources
  - Freshwater intake and sediment
  - Groundwater
  - River-water outfall
  - Potable water
  - Cooling water
- Air emissions
- Noise levels
- Solid and hazardous waste
- Sewage treatment
- Incoming and outgoing chemicals
  
- Trucking and motorized machinery movements
- EHS workspace monitoring
- Safety records and adherence with site safety rules.

#### **Construction Phase Monitoring**

In the early phases (construction and operation start-up), the environmental monitoring program will cover all regulated parameters. Subsequently the list of parameters could be re-assessed according to their significance to the Plant and to the specific site conditions.

#### *Visual Inspection of Specific locations / activities*

Certain locations/ activities will require visual inspection to ensure that construction activities proceed in an environmentally sound manner. These include:

- Workers camp (which will be located inside the Project site boundary)
- Waste collection locations and wastewater storage tanks
- Storage locations.

#### Groundwater Monitoring

Weather conditions as well as sampling methodology usually influence sampling and analysis results. Samples taken by different methods or under different conditions may differ considerably, so that the analysis results are not comparable. In order to obtain reliable results, the samples will be taken under the same or very similar conditions and even if this requirement cannot be met, the conditions at the time of sampling shall be carefully recorded.

During the construction phase, ongoing visual inspection will be conducted at all storage areas, workshops, water collection and wastewater storage tanks, etc., to identify any incident and/or leak that could reach the groundwater. All analysis results shall be compared to baseline values, respectively to limits set by relevant legislation.

#### Potable Water

Potable water will be regularly monitored prior to the point of supply to the Plant's potable water supply network to ensure compliance with health standards. Quarterly monitoring shall take place during construction. Quarterly monitoring is required for the parameters presented in Table 11-5.

#### Air Emissions

During the construction phase, ambient air quality will be monitored quarterly by active sampling and measurements for PM10, SO<sub>2</sub>, CO, NO<sub>x</sub> and ammonia. For the purpose of comparison with baseline values, ammonia, SO<sub>2</sub> and NO<sub>2</sub> should also be measured by passive sampling once during construction activities. The measured concentrations shall comply with relevant legislation (Chapter 2 of this ESIA).

#### Noise Monitoring

Noise levels at the facility site during construction must comply with relevant legislation (Chapter 2 of the ESIA). At locations with ongoing pile-driving activities, noise levels will be checked regularly at least weekly. In areas with direct contact to equipment usage, noise levels will to be checked regularly at least quarterly. Ambient noise will be monitored twice a year at the facility boundaries and also at two locations the near closest habitation.

At these locations the noise level should be recorded by 24 hour noise measurement instruments using Type I sound level meter (Precision Grade) at least once per year.

#### Solids and Hazardous Waste Monitoring

A logbook will be kept and maintained to record the quantities of any excavated material wastes exported from the Project site, transportation routes and final reuse/disposal.

During the construction phase, waste should be handled in accordance with the waste

management plan outlined mentioned in Section 10.

Monitoring is required to ensure proper implementation of the management plan. Solid and hazardous waste quantities and destination must be documented.

#### Incoming and Outgoing Chemicals

A logbook will be kept and maintained for all incoming and outgoing hazardous chemicals. The logbook will be reviewed regularly to check the chemicals consumption. An inventory of material data sheets for all chemicals at the Project site will also be kept. Any new chemical proposed for purchase for the first time must be approved by site Environmental Officer prior to such purchase.

#### Trucking and Machinery Activities

During the construction phase, trucking and machinery will be continuously monitored to limit unnecessary/avoidable journeys. Dust mitigation measures should be applied during the construction phase. Any traffic accidents ISBL and OSBL will be recorded.

#### Workplace Monitoring

Records of all workplace accidents will be documented and archived. Routine employee medical check-up results, carried out periodically shall be documented. A baseline check-up of all employees (before they commence work) should be carried out.

#### Safety Monitoring

Safety records and monitoring of site safety rules.

### **Operation Phase Monitoring**

#### Groundwater Monitoring

Groundwater monitoring during the operation phase will form part of the continuous QA/QC procedures for the Plant subject to ongoing inspection. During the first year of operation phase, the groundwater will be sampled and analyzed quarterly for the parameters listed in Table 11-3 and the results compared with baseline values within the context of the limits set by relevant legislation. If after the first year, no major impacts are detected, the monitoring program may be modified and the number of monitoring parameters may be reduced.

#### River-water Outfall

During operation there will be three monitoring points for liquid wastes directed to the river-water outfall, as follows:

- **Storm water in the inspection sump** will be monitored continuously for volumetric flow rates, pH. The other parameters listed in Table 11-9 will be monitored quarterly.
- **Water from the equalization basin** will be monitored continuously for volumetric flow rates and pH and monthly/quarterly for the other parameters listed in Table 11-9.

- The frequency of monitoring and the parameter list for the **river-water outfall** are the same as for water from the equalization basin; monitoring intervals during the start-up phase should be more frequent than during the operation phase.

The monitoring results must comply with the relevant legislative criteria (Chapter 2 of this report).

### **Potable Water**

Potable water will be regularly monitored prior to the point of supply to the Plant's potable water supply network to ensure compliance with health standards. Quarterly monitoring will take place during the first year of operation, after which if no adverse results are found, the frequency and the parameters of monitoring can be reduced. Quarterly monitoring is required prior to the point of supply to the Plant's potable water supply network and at few points on the network (e.g. utility buildings, canteen, etc.) for the parameters presented in Table 11-5.

### Cooling Water

Cooling water will be monitored in order to ensure it meets quality assurance for design specifications.

### Air Emissions

The monitoring regime and parameters for ambient air quality during the operation phase are the same as during construction. Additionally, stacks and vents must be monitored during operation. Air emissions must be visually monitored for opacity at least once per day in order to detect any eventual equipment failure.

Emissions from stacks and vents should be monitored quarterly by active sampling and measurements of PM10, SO<sub>x</sub>, NO<sub>x</sub>, CO, CO<sub>2</sub> and volumetric flow rate. The location of the sampling points must be at the stack. Emissions from stacks and vents must comply with the relevant criteria for emissions (Chapter 2 of this report). If after the first year of operation, no major impacts are detected, the monitoring program may be modified.

Fugitive emissions are monitored as part of the QA/QC procedures and occupational health and safety requirements of the Plant.

### Noise Monitoring

Noise levels during operation of the facility must be monitored on a quarterly basis at the same locations and by the same method as during construction. Biannual noise measurements must take place for the first year of operation after which if no adverse impacts are noted, the monitoring frequency can be reduced. Limits set for noise levels by relevant legislation (Chapter 2 of this report) must be met.

### Solids and Hazardous Waste Monitoring

A logbook will be kept and maintained to record the amounts of wastes generated, transportation routes and final reuse/disposal. During the operational phase, waste should be handled according to the waste management plan referenced in Section 10. Monitoring is required to ensure proper implementation of the management plan. Solid and hazardous waste quantities and destination (final disposal) must be documented and kept, to ensure proper handling and disposal.

### Incoming and Outgoing Chemicals

A logbook will be kept and maintained for all incoming and outgoing hazardous chemicals. This book will be reviewed regularly to check the chemicals consumption. An inventory of material data sheets for all chemicals on the site must also be kept. Any new chemical proposed for purchase for the first time must be approved by site Environmental Officer prior to any such purchase.

### Trucking

During the operation phase, truck movements must be continuously monitored to limit avoidable journeys. All vehicle accidents should be recorded.

### Workplace Monitoring

In addition to the requirements listed above for noise monitoring inside the workplace, other important items will be included in the monitoring plan:

#### Occupational noise

Noise levels within the Plant must comply with relevant legislation for noise levels inside the workplace (refer to IFC occupational health and safety guidelines). Occupational noise levels inside workplaces must be monitored weekly using a Type II noise equipment. If no adverse impacts are noticed during the first six months of operation, the frequency for monitoring can be reduced.

### Air quality/ventilation inside the workplace

Precautions will be implemented to ensure no violation of relevant legislation (refer to IFC health and safety standards). Precautionary measures may include the following:

- Daily tuning of equipment
- Mechanical ventilation systems are to be maintained in good working order
- Point-source exhaust systems must have local indicators of correct functioning
- Re-circulation of contaminated air should be avoided
- Air inlet filters must be kept clean and free from dust and micro-organisms.

### Temperature inside the workplace

Temperatures inside the Plant area must be recorded and it must comply with relevant legislation (refer to IFC health and safety health and safety standards).

### Employees Health Condition/Accidents

A baseline check-up for all employees (before they start work) will be carried out. Follow-up medical check-up should be carried out periodically and the results must be documented. All accidents (minor and major) must be recorded and the records reviewed regularly.

### Safety Monitoring

Safety records and monitoring of plant safety rules.

### Emergency Response Plan Monitoring

The Emergency Response Plan (including the local community) will be monitored and tested frequently to ensure its effective in the event of an emergency.

### **11.2.2 Socio-Economic Monitoring**

The socio-economic impacts of the Project on the neighboring community (mainly positive) will be monitored. A basic socio-economic survey will be undertaken annually beginning during the first year of construction and continuing annually for first 2 years of operation and every 2-4 years.

Key parameters to be monitored will include change in income levels, job creation, internal transportation costs, etc. This socio-economic survey will be a mechanism to enable monitoring of benefits to the community.

### **11.2.3 Operational and Management Performance Monitoring**

This involves checking that all data are properly documented and interpreted. This will also ensure that corrective actions are properly followed up and implemented.

#### Documentation

The documentation system (logbooks, internal/external communication documentation, etc.) and the environmental register will be regularly checked (bi-monthly) and updated (daily).

#### Corrective/Preventative Action Results and Follow up

Forms shall be available for corrective action steps. Similarly, other forms will be made for corrective action follow-ups. Corrective action will be followed up regularly until they are finalized. Any such documentation system shall be structured so as to be ISO 9000: 2000 certification-capable whether or not it is in fact certified. Wherever possible, the documentation will be electronic.

## **11.3 Monitoring Work Plan**

This section describes the tasks required to fulfill the monitoring requirements.

### **11.3.1 List of Tasks**

- Review the monitoring plan
- Review site rules
- Review employee/contractor training and safety procedures
- Set a start date, adjust all following dates to fit the monitoring schedule
- Keep copies of the monitoring plan in areas relevant to sampling locations
- Review locations, monitoring parameter lists and activities (sampling, analysis, etc.)
- Clearly mark the monitoring locations on site plans
- Conduct (or supervise) the required sampling and analysis
- Record any site remarks observed, while sampling and analyzing
- Based on site remarks and data interpretation, determine non-conformances and requirements for corrective actions, if any
- In case non-conformances are detected, propose, document and follow up on corrective actions (weekly)
- For each monitoring round, prepare a report including:

- – Findings of the monitoring program and data interpretation.
- – Status of corrective and preventative actions.
- – Remarks and recommendations.
- – Monitoring activities and dates for the coming round
- During each monitoring round, examine previous monitoring results, and based on the
- parameter analyses levels, decide on any future additions or reductions in monitoring
- parameters and frequencies accordingly.

### 11.3.2 Monitoring Parameters

The monitoring parameters for water and sediment samples are listed in Tables 11-1 to 11-9.

**Table 11-1 Freshwater Quality Monitoring Parameters (Construction and Operation Phase)**

Temperature	COD	Colour
BOD	pH	Chlorine
Dissolved Oxygen	Oil and grease	TDS Ammonia

**Table 11.2 Groundwater Quality Monitoring Parameters (Construction and Operations Phase)**

Temperature	Iron	Faecal coliform
pH	Lead	Phenols

Dissolved Oxygen	Magnesium	Polychlorinated Biphenyls (PCBs)
Conductivity/total dissolved solids	Nickel	Monoaromatic Hydrocarbons (BTEX)
Turbidity	Zinc	Pesticides
Chloride	Mercury	Phosphate
BOD	Copper	Nitrate
COD	Total coliform	Nitrite
Cadmium	Sulphate Polynuclear	Aromatic Hydrocarbons (PAH)

**Table 11.3 Potable Water Quality Monitoring Parameters (Construction and Operation Phase)**

pH	Fluoride	Selenium
Temperature	Nitrite	Silver
Chlorine	Nitrate	Zinc
Colour	Sulphate	Cadmium
Dissolved oxygen	Aluminium	Chromium
Turbidity	Arsenic	Barium
TDS	Beryllium	Asbestos
Total hardness	Copper	Acrylamide
Calcium	Iron	Benzene
Protozoa	Lead	Benzo(a)pyrene
Total coliform	Manganese	Carbon tetrachloride
Chloride	Nickel	Chloride
Cyanide	Mercury	Pesticides
Faecal coliform	Trihalomethanes	

**Table 11.4 Effluent Outfall Monitoring Parameters (Operation Phase)**

pH	Temperature increase	Barium
TSS	Ammonia (as nitrogen)	Monoaromatic hydrocarbons (BTEX)
Urea	Conductivity / TDS	PAH
Colour	COD	Manganese
BOD	Sulphides	Silver
Turbidity	Phosphate	Cobalt
Oil and grease	Phenols	Pesticides
Nitrate	Nickel	Zinc
Flouride	Aluminium	Iron
Mercury	Lead	Cadmium
Chromium	Arsenic	Copper

### 11.3.3 Monitoring Summary

**Table 11.5 Monitoring Summary**

<b>Project Phase</b>	<b>Monitoring Category</b>	<b>Monitoring Regime</b>
<b>Construction Phase</b>	<b>Environmental</b>	Freshwater intake
		Two rounds down stream the construction location. Monitoring for parameters specified in Table 11-1.
		Groundwater
		Ongoing visual inspection. Bi-annual monitoring for parameters listed in Table 11-2.
		Potable water
		Quarterly monitoring for parameters presented in Table 11-3.
		Air emissions
		Quarterly monitoring by active sampling for five parameters and annually for passive sampling for three parameters.

**Table 11.5 Monitoring Summary (continued)**

Project Phase	Monitoring Category	Monitoring Regime
<b>Construction Phase</b>	<b>Environmental</b>	<p>Noise levels</p> <p>Bi-annual monitoring for ambient noise. Regular checks (at least quarterly) for areas with direct contact with equipment usage. Regular checks (at least weekly) during pile-driving works.</p>
		<p>Solids and hazardous waste</p> <p>Logbook kept and maintained.</p>
		<p>Incoming and outgoing chemicals</p> <p>Logbook kept and maintained.</p>
		<p>Trucking and motorized machinery</p> <p>Logbook kept and maintained.</p>
		<p>Workers and community safety (including incidents and accidents – fires, explosions, spills etc)</p> <p>Logbook kept and maintained.</p>

**Table 11.5 Monitoring Summary (continued)**

Project Phase	Monitoring Category	Mo	
Operation Phase	Environmental	Freshwater intake	Annually for the p
		Groundwater	Quarterly monito Table 11-2. If no major impac year, the monitor
		River-water outfall	Periodically moni Table 11-4.
		Potable water	Quarterly monito Table 11-3. If no major impac year, the monitor
		Air emissions	Quarterly monito stacks and vents. If no major impac year, the monitor

**Table 11.5 Monitoring Summary (continued)**

Project Phase	Monitoring Category	Monitoring Regime
<b>Operation Phase</b>	<b>Environmental</b>	Noise levels Quarterly monitoring. If no major impacts are detected after the first year, the monitoring program may be modified.
		Solid and hazardous waste Logbook kept and maintained.
		Incoming and outgoing chemicals Logbook kept and maintained.
		Trucking Logbook kept and maintained.
		Workers and community safety (including incidents and accidents - fires, explosions, spills etc) Logbook kept and maintained. Weekly monitoring for occupational noise. Constant monitoring of prevention measures - fires, spills and explosions.

**Table 11.5 Monitoring Summary (continued)**

Project Phase	Monitoring Category	Monitoring Regime		
Construction and Operation Phases	Socio-economic	Noise levels		Annual socio-economic survey and reporting.
	Operational and Management Performance	Solid waste	and	hazardous
Regular checks and documentation update. Regular follow-up with actions to correct any breaches.				