Republic of Lebanon
Ministry of Environment

GUIDELINES FOR CONCRETE BATCHING PLANTS

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List of Abbreviations

BOD	Biological Oxygen Demand
COD	Chemical Oxygen Demand
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
IEE	Initial Environmental Examination
MoE	Ministry of Environment
MoI	Ministry of Industry
ECC	Environmental Compliance Certificate
NA	Not Available
pH	Acidic and Basic Scale
DGUP	Directorate General for Urban Planning
CO	Carbon monoxide
NO2	Nitrogen dioxide
MoPH	Ministry of Public Health
VOCs	Volatile Organic Compounds
PM	Particulate Matter
PPE	Personal Protective Equipment
MoA	Ministry of Agriculture

I. National Legislation and Institutional Framework:

1. Introduction

Industrial establishments may cause environmental perturbations during construction and/or operation which will differ according to the practiced activities.

The decree law number 21/L dated 22/7/1932 defines rules and conditions related to classified establishments that require permits. In follow up to this decree law, Decree No. 4917 dated 24/3/1994 was issued to amend the classifications of establishments with hazardous activities or with impacts/harm on health. Decree 4917/94 categorize classified establishments in 3 groups depending on their location, size (production capacity) and potential impacts.

In 2001, industrial establishments were classified according to Decree No. 5243 dated 5/4/2001 listing all available industrial facilities in categories numbered from one to five taking into consideration its potential environmental impacts. The conditions, criteria and rules for the permitting of the industrial establishments were set in Decree No. 8018 dated 12/6/2002.

Category I: generates very dangerous impacts on the environment, surroundings and public health which requires moving it away from the households to prevent its impacts.

Category II: generates dangerous impacts on the environment, surroundings and public health but does not require moving it away from the households. However, it will not be given an investment permit unless mitigation measures are taken to prevent its impacts.

Category III: generates limited negative impacts on the environment, surroundings and public health and must be subjected to special conditions to avoid its limited impacts.

Category IV: generates minimal negative impacts on the environment, surroundings and public health and must be subjected to special conditions to avoid its minimal impacts.

Category V: does not generate any negative impact on the environment, surroundings and public health.

Table I-1: Definition of Industrial Establishments Categories (Decree No. 8018/2002)

Concrete Batching Plants are classified according to their production capacity. The classification is presented in table I-2, according to Decree No. 5243/2001. The separation distances are set as per Decree No. 8018/2002.

Concrete Batching Plants (ISIC code 2663)			
Production Capacity	**Classification**	**Classification criteria**	**Setback Distances**
Less than 50 tonnes/day	Category 3	• Establishments that lead to limited damages on the surrounding environment and public health. • These establishments must be subject to mitigation measures in order to reduce their impacts.	NA
More than 50 tonnes/day	Category 2	• Establishments that lead to damages on the surrounding environment and public health. • These institutions do not need the implementation of buffer distances if measures to mitigate their impacts are respected.	• If project area is located within a classified industrial land, refer to its correspondent legislative dictated by the General Directorate of Urban Planning (DGUP). • If the proposed plot is located within a non-classified area, the following requirements must be met: o Distance ≤1000m from any archaeological and natural areas protect by a specific and/or Urban Decree. o Distance ≤250m from main rivers (Aarka, AL Estwan, Al Bared, Abu Ali, Al Bouhsas, Al Jawz, Ibrahim, Beirut, Al Damour, Al Awali, Al Zahrani, Al Litani) o Distance ≤150m from winter drainage system. o Distance ≤1000m from hospitals, schools, nurseries or shelter plots limit. o Distance ≤1000m from the residential community of five or more houses. o Distance 1000m from coastal shoreline. o Distance ≤200 m from international highways boundaries. o Distance ≤100 m from international roads boundaries.

Table I-2: Concrete Batching Plant Classification System (according to Decree No. 5243/2001) and setback distances (according to Decree No. 8018/2002)

2. Environmental Assessment

Concrete batching is an activity of environmental significance; these activities require an establishment permit and an operation permit.

While there is no specific law related to batching plant establishments in Lebanon, the national principal legislation addressing pollution is the Environment Protection law 444/2002 that imposes the general environmental duty on industries undertaking an activity that affects or may affect the environment to take all reasonable and practicable measures to prevent or minimize any resulting environmental harm.

However, Concrete Batching plants should prepare an Initial Environmental Examination (IEE) report for the proposed project and submit it to the Ministry of Environment (MoE), as per Decree No. 8633/2012 "Fundamentals for Environmental Impact Assessment". In case the plant falls under a sensitive area as per annex 3 of the decree 8633/2012, the plant is subject to prepare an Environmental Impact Assessment (EIA) study.

3. Environmental Compliance Certificate

The Concrete Batching Plant should abide by the Decree No.8471/2012 on "Environmental Compliance for Establishments" and its related decisions. Applying for this certificate includes preparing an Environmental Audit with an Environmental Management Plan (EMP). Once environmental compliance is proven, after acquiring an operational permit, the facility will be awarded with an Environmental Compliance Certificate. The plant will be required to renew the Environmental Compliance Certificate (ECC) every three years based on a self-audit prepared by the industry.

Tables I-3 and I-4 indicate existing laws, decrees and decisions that are related to the environmental sector and responsibilities of the concerned ministries and governmental institutions.

Legislation	Date of Issue	Source	Subject
Law 444/2002	8/8/2002	MoE	Environmental Protection
Decree No. 8633/2012	9/8/2012	MoE	Environmental Impact Assessment Fundamentals
Decree No. 8471/2012	19/7/2012	MoE	Environmental Compliance for Establishment
Decision No. 8/1	30/1/2001	MoE	Standards and limits for air pollutants and liquid wastes discharged by classified facilities and wastewater treatment plants.
Decision No. 52/1	29/7/1996	MoE	Standards and limits for air, water and soil pollutants

Table I-3: Existing Laws, Decrees and Decisions related to the Environmental Sector

Institution	Responsibilities
Ministry of Industry (MoI)	- Issues the industrial permit based on the recommendation of the industrial permitting committee. - Heads the industrial permitting committee. - Conducts inspections to industrial establishments.
Ministry of Environment (MoE)	- Sets environmental conditions for pollution abatement. - Reviews and approves EIA and IEE studies.
Ministry of Public Health (MoPH)	- Checks the compliance of the industries conditions with necessary health related conditions.
Directorate General of Urban Planning (DGUP)	- Checks the compliance of the industries with necessary and applicable standards/regulations
Concerned Municipality	- Approves the issuance of the permit as a mandatory step[1].

Table I-4: The Responsibilities of the concerned ministries and governmental institutions

4. Permitting Procedure:

The following steps should be undertaken to acquire a construction or operation permit:

1. Submit file to the industrial permitting committee of the concerned Mohafaza. This committee is formed of members from different concerned ministries (Documents required are listed in Annex 2);
1. The file will be transferred to the concerned Municipality for their review and approval;
2. When approved by the Municipality, the file will be transferred to the concerned governmental authorities (MoI, MoE[2], MoPH, Urban Planning, Ministry of Agriculture);
3. After acquiring the feedback from all concerned governmental authorities, the industrial permitting committee will recommend the final decision to the Director General of the MoI who will transfer the file to the Minister of Industry with his recommendation;
4. The final decision is issued by the Minister of Industry.

[1] If the concerned municipal council decides to reject the permit application while the concerned authority of permitting insists on contradicting that decision, the application should be presented to CoM for final decision

[2] Environmental studies are required as defined previously in section 2.1 (Environmental Assessment)

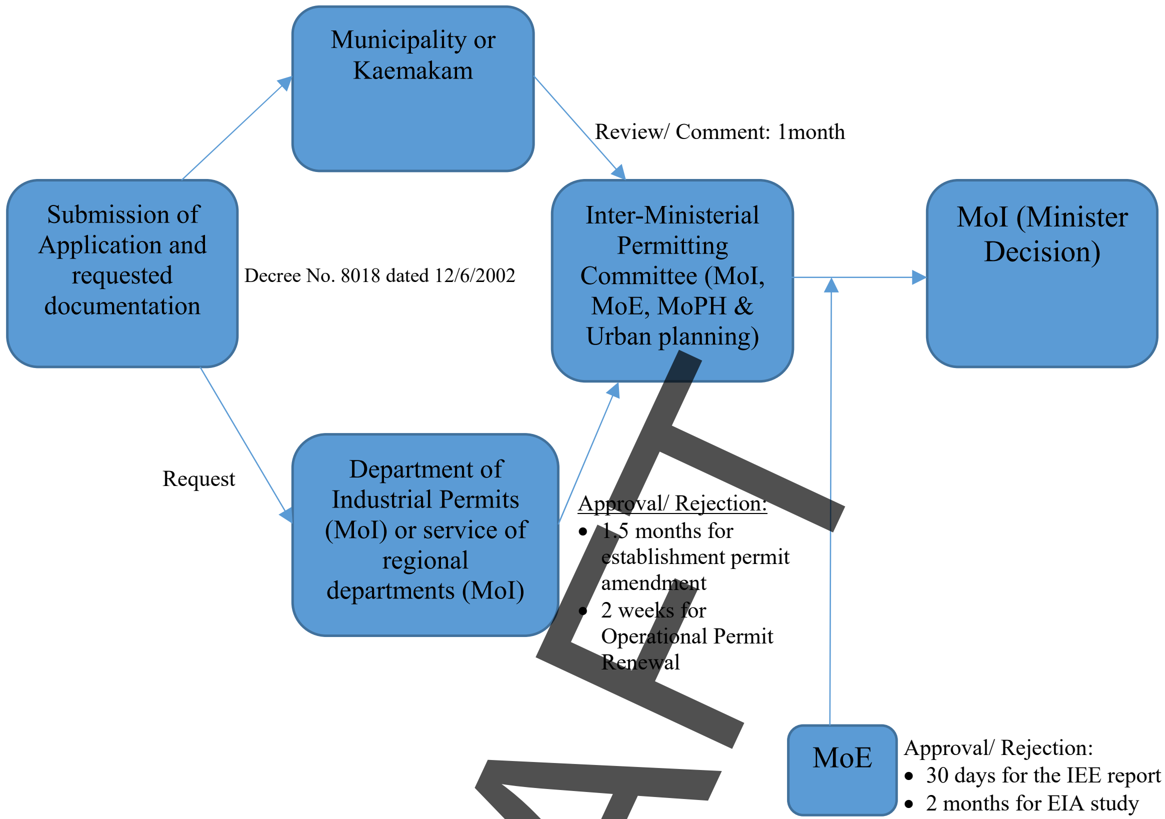


Figure I-1: Process for obtaining an industrial permit according to Decree No. 8018/2002 (Adapted from Policy Paper & Action Plan for Industrial Wastewater Management in Lebanon)

Type of Application	Purpose
Construction and Operation Permit	• Each industry is subject to apply for establishment and operation permit. • For categories 1,2, and 3, the industry is subject to an Establishment Permit followed by an Operational Permit
Construction Permit Renewal	• If the construction of the industry wasn't achieved during the previously specified time period.
Permit Addendum	Is mandatory in the following cases: • Expansion or change in the industrial process or classification of the industry • Addition of another industry

Table I-5: Permitting Applications

II. Production Process

Concrete is essentially composed of water, fine aggregates, coarse aggregates and cement. Supplementary cementitious admixtures (natural pozzolans, fly ash, ground granulated blast-furnace slag and silica fume) may be added to enhance specific desired characteristics such as: permeability, strength, color, or other concrete properties. Chemical supplements (usually present as liquid ingredients) may also be added such as accelerators, retarders, corrosion inhibitors, bonding agents, defamers and others. The purpose of the chemical admixtures is to entrain air, reduce water requirement for a required slump, retard or accelerate setting rare, enhance the flowability of concrete and perform other specific functions. Depending on the desired final product quality and proprieties, different proportions of raw materials can be set to fit the needed end-product composition (Dodge, 1955).

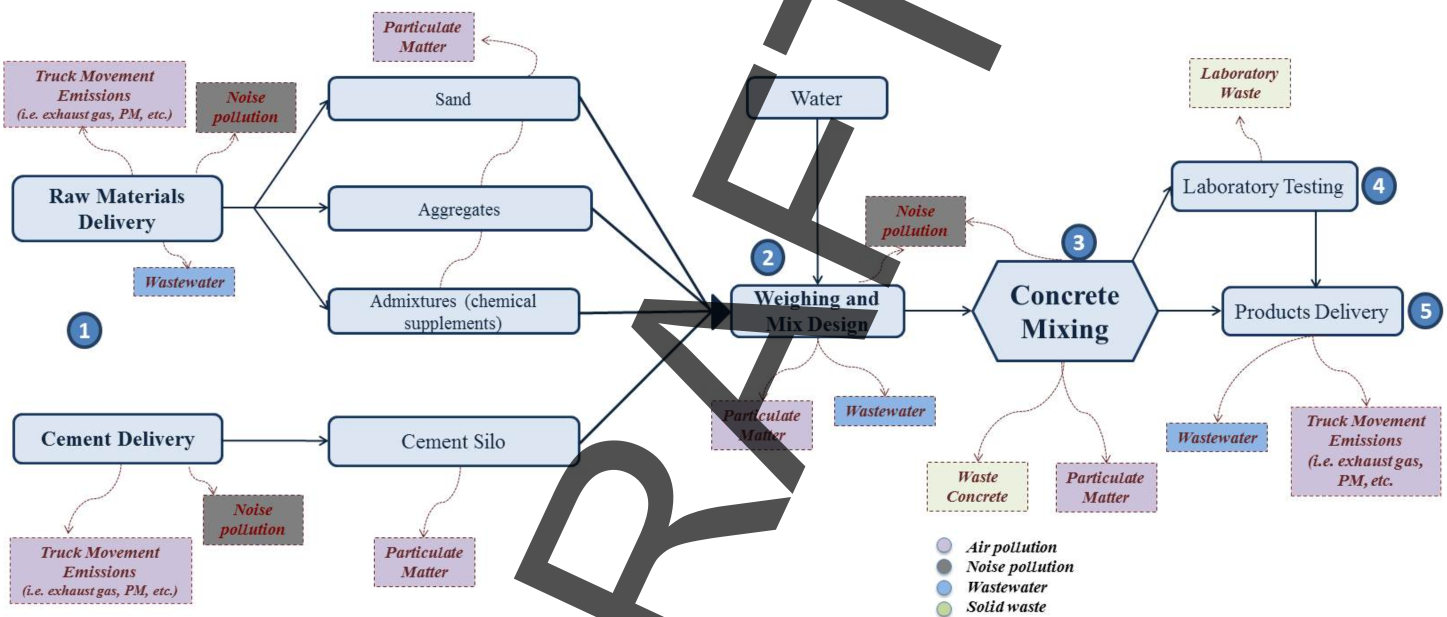


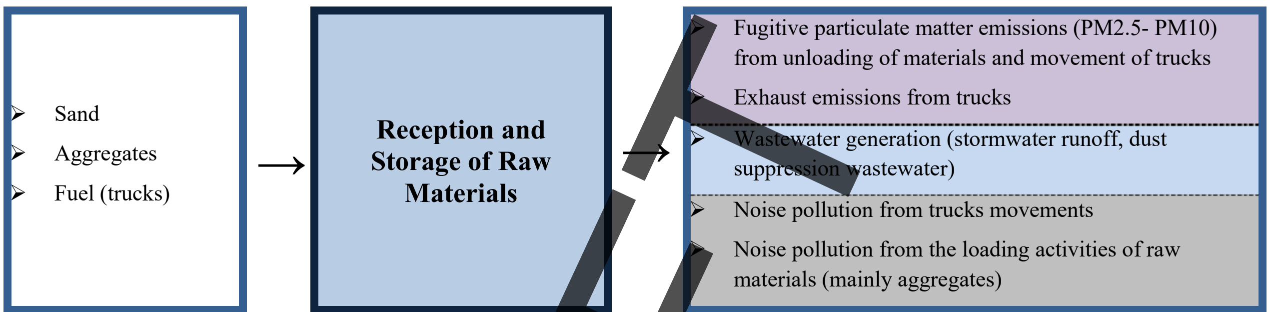
Figure II-1: Detailed Description of the Production Process

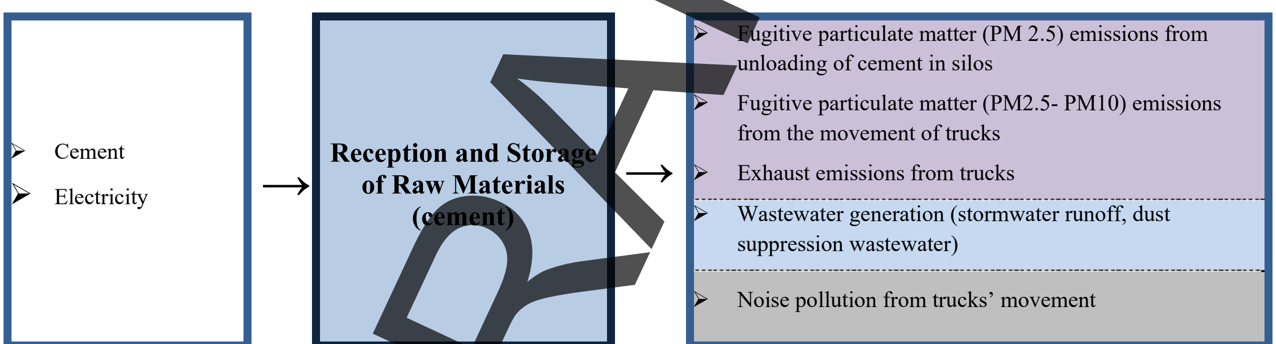
Figure II-2 Typical layout plan for concrete batching plants

The production process can be categorized into five main stages, which include:

1) <u>Reception and Storage of Raw Materials</u>

The first step of the production process includes the acquisition of process raw materials. The reception and storage of cement differs from other raw materials. Cement is usually stored in designated cement silos, whereas other raw materials are stored on-site in open piles or in bunkers. The reception and storage of raw materials inflict potential impacts on the environment, as presented below.





2) <u>Weighing and Mix Design</u>

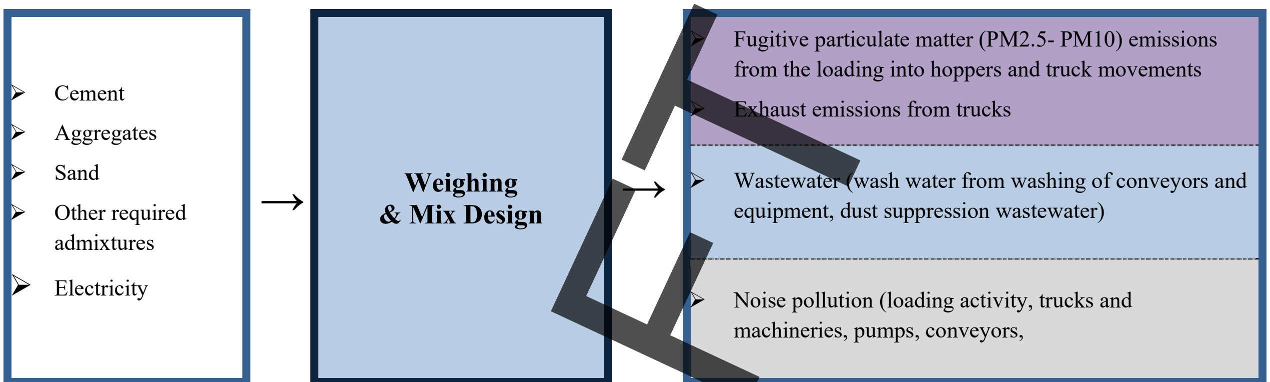
After receiving and storing the raw materials, sand and aggregates are transported via front-end loaders into their respective overhead hoppers, in order to prepare the mix design.

The adequate quantities of each type of raw materials must be identified prior to mixing, in order to achieve the desired composition of concrete. Dry raw materials are measured by weight, whereas admixtures and water are measured by volume or weight prior to blending. The batching of materials is overseen from the central control room, which monitors various parameters in a concrete batching plant, such as:

- The quantities of cement stored in silos
- The quantities of fine aggregates, coarse aggregates and ad mixtures stored in their respective storage bins
- The quantities of water available in tanks
- The silo discharge valve (i.e. controlled adding of cement)

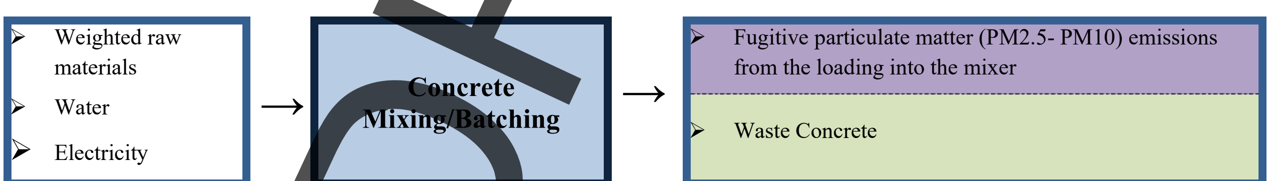
- The storage hoppers discharge valves (i.e. controlled adding of fine aggregates, coarse aggregates and ad mixtures)
- The water tank valve (i.e. controlled adding of water)

Once the desired mix design has been established, the different constituents are added separately to the mixer unit. The desired quantity of aggregates/admixtures is added to the weigh conveyer belt situated directly beneath the overhead storage hoppers. Similarly, cement, stored in separate overhead silos, is added to a weigh conveyer belt in a controlled manner, according to the prepared mix design. Once mix proportions of raw materials have been met, all the constituents are conveyed to the mixer unit to undergo mixing/batching.



3) Concrete Mixing

The main stage of the concrete production process is the mixing/batching stage. Once all raw materials are conveyed to the mixer unit, the amount of water required to chemically combine the constituents is added. The mixer blends all the constituents in order to form a uniform composite, which later on will harden forming the concrete. Once mixing is done, the obtained paste is ready for final slumping, testing and delivery to the client or work site.



4) Laboratory Testing

Testing of batch quality is essential to ensure that a set specifications and standards are met. It can be done onsite, at the batching plant, or at the construction (final usage) site. The standardized procedures for sampling and testing of concrete are dictated by the applied national standards. These procedures include slump test, density and yield, gravimetric air content, temperature, and compression tests that are to be undertaken on batch samples.

➢ Electricity ➢ Mixed cement samples ➢ Water ➢ Laboratory testing materials (such as wax)	→ **Laboratory Testing** →	➢ Waste Concrete ➢ Wastewater from the testing procedure (i.e. slump test)

5) <u>Concrete Delivery</u>

Once the mixing is complete, the batch is ready to be transferred to delivery. The concrete delivery trucks are filled with the designated amount of paste. They are coupled with a rotating drum that keeps the fresh batch from hardening prior to reaching its destination.

➢ Final Products ➢ Electricity ➢ Fuel (trucks)	→ **Concrete Delivery** →	➢ Exhaust emissions from trucks ➢ Fugitive dust emissions (PM2.5-PM10) from truck movements ➢ Waste Concrete ➢ Accidental concrete spills ➢ Truck washing wastewater

III. Potential Impacts of the Production Process:

Concrete Batching Plants can result in significant environmental impacts, if not properly managed or maintained. The environmental impacts are set out in the following sections.

1) Impacts on Air Quality:

The major air pollutant produced by the concrete batching process is particulate matter. The potential sources of particulate matter include:

- Delivery of raw materials: unloading of aggregates or sand from delivery trucks onto storage piles, unloading of cement into silos, and movement of delivery trucks.
- Storage of raw materials: wind erosion of soil and aggregate storage piles, and movement of raw materials to maintain the shape of storage piles.
- Transfer of raw materials into the production process: filling the buckets of the front end loaders, hoppers filling, mixing process, weighing and conveying.
- Leakages or spillages of raw materials: overfilling of silos and hoppers, accidental spills, overloading of mobile mixers during transport, leakage or spillage from silos, inspection covers and duct works, and human errors.

The particulate matter potentially generated in batching plants consists primarily of cement and pozzolan dust, as well as aggregate and sand dust emissions. The PM emissions vary from one plant to another and are dependent on different factors such as, surface moisture content of raw materials, localized wind speeds, control measures adopted…etc (USEPA, 2011). Quantification of particulate matter emissions can be done using specific emission factors and predictive equations, listed in Annex 1.

In addition to Particulate Matter emissions, exhaust gases (CO_2, NO_x, CO, SO_x, VOC_s…) are released as a result of the operation of back-up generator(s), machinery requiring the burning of hydrocarbon based fuels and vehicles to conduct transfer and delivery activities.

2) Impacts on Water and Soil Quality:

The potential pollutants in batching plant wastewater include: cement, sand, aggregates, admixtures, petroleum hydrocarbons and lubricants. Such pollutants can affect the pH levels of water and soil, as well as they can increase the turbidity of water.

The main sources of wastewater at batching plants consist of:

- Contaminated storm water runoff
- Wash water generated from:
    - Trucks or other transport machinery (interior and exterior washing)
    - Central mixers
    - Conveyors
- Dust suppression wastewater
- Slump testing
- Cleaning

The wastewater generated contains cementitious materials and other impurities washed from the facility area. Due to the presence of calcareous materials such as limestone, the wastewater is expected to have an elevated pH (between 11 and 12). Similarly, the wastewater might also have high levels of dissolved limestone solids including sulfates and hydroxides from cement, chlorides from the use of calcium carbonates admixture, and small quantities of chemicals associated with the hydration of Portland cement and derivatives of chemical admixtures (Chini, 196).

If mishandled, the generated wastewater would negatively affect the physical, biological and chemical characteristics of both the local water and soil quality, resulting in implications on both the environment and the public health.

Note: The quantity of wastewater-generated daily in batching plants is unpredictable due to the varying amounts of stormwater runoff, dust suppression wastewater, and testing conducted. However, the quantity of wastewater generated from truck wash alone is estimated to range between 11m^3 to 19 m^3 per day per single ready-mix plant (Chini &Mbwambo, 1996).

According to Chini & Mbwambo (1996), when a 8 m^3 ready-mix truck delivers concrete, 1- 4 percent or approximately 272.155 kg of concrete adhere to the inside of the drum and mixing blades. Removing the residual cementitious material adhering to the drum and blades of a single truck unit can require approximately 568 to 757 L of water.

3) Impacts on Acoustic Environment:

Noise emissions are considered as an environmental impact due to its irritant potential to the local community and the operators of the batching plant. Major noise sources at the concrete batching plants include:

- Trucks, front end loaders, loading devices and other heavy machinery
- Hydraulic pumps
- Raw materials delivery to hoppers/bunkers (especially aggregates)
- Conveyors
- Filters
- Alarms/ warning devices
- Compressors
- Air valves

If noise pollution is not well managed, it is most likely to affect the health of the personnel on-site and the plant's surroundings. In fact, such pollution negatively affects human health and its wellbeing as it induces and promotes health problems such as hearing loss, stress, high blood pressure, sleep loss, distraction and lost productivity and a general reduction in the quality of life and opportunities for tranquility.

4) Impacts on Occupational Health and Safety

The main occupational hazards in concrete batching plants include:

- Dust emissions emitted during the delivery and storage of raw materials, and the production process
- Risk of breathing the crystalline form of Silica which is mainly found in aggregates
- Noise hazards emitted from mechanical equipment, trucks and heavy machinery
- Tripping hazards around mechanical equipment (hoppers, conveyor belts…etc.)
- Traffic accidents
- Tripping hazards during repairs and maintenance works
- Slipping hazard in truck washing area
- Electrical hazards
- Fire hazards in offices and administrative locations

IV. Detailed description of Pollution Prevention and Pollution Abatement Methods

Applying best environmental management practices in concrete batching industries is essential to maximize the efficiency of raw materials and resources, reduce water consumption, minimize wastewater generation, reduce air pollution, decrease solid waste generation rates and protect the amenity of the site. The environmental management practices required to protect the major environmental components are presented in the following sections.

1) Air Quality

The appropriate facility design and management practices can prevent the release of air pollutants. The measures, which should be taken to prevent the degradation of air quality, include:

- The entire plant premises should be paved with hard, impervious materials, including the drive ways from and into the plant.
- The entire plant floor should remain dust-free
- Natural or artificial wind barriers are to be placed to help control the emission of dust into the surroundings of the facility (i.e. trees, fences and landforms in accordance with prevailing wind direction).
- Ensure that the trucks hauling sand, aggregate or other raw materials are covered during transport.
- The loading bay of raw materials should be roofed and enclosed in at least 3 sides
- The stockpiles storage areas should be fitted with dust suppression water sprayers to dampen the stockpiles.
- The facility is required to cover raw materials with rubber sheets, plastic sheets or any water impermeable covers.
- Cement should be stored in sealed and dust-tight silos.
- Cement storage silos and mixers should be equipped with multi-bag fabric filter. Equivalent or better performance dust abatement alternatives are accepted (refer to the specification of the bag filter in the coming section).
- Ensure that no leakages or spillages occurs during unloading of raw materials and dispensing in silos. In cases of spill incidents, spills or leakages should be immediately cleaned and contained.
- Sand and aggregates should be delivered to the site in a dampened state to prevent fugitive dust. These raw materials should be water sprayed, if it has dried out during the transport process.
- Conveyors and storage hoppers should be enclosed and roofed to protect the raw materials from wind.
- The conveyor belts shall be equipped with belt cleaners to ensure that the raw materials remaining on the belt are well-contained and won't emit particulate matter emissions.
- The transport points of conveyors and hopper discharge area should be enclosed. Rubber curtain seals can be used for transfer point outlets.
- Raw materials discharged into hoppers should be damped.
- All trucks leaving the facility's premises should be clean and free of dust.
- Cement should be transported onsite from suppliers who utilize sealed vehicles equipped with the pneumatic transfer of cement into the silos.

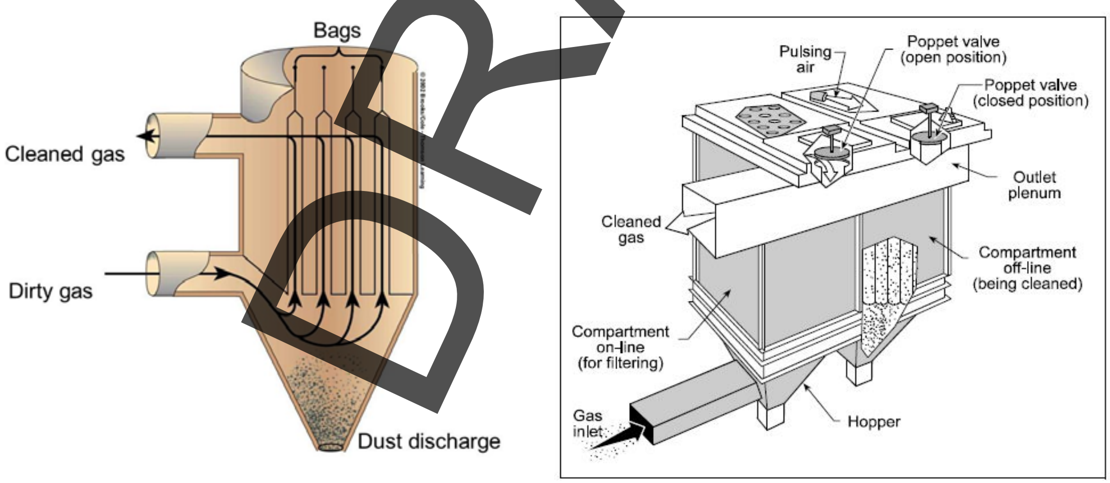
- All duct works should be air tight to prevent any leakages
- Air quality control equipment should be maintained on a weekly basis

Characteristics of Fabric Bag Filter:

The size of the fabric filter system is determined by the gas volume to be filtered, the air-to-cloth ratio, the pressure drop at which the filter can be operated given the fabric type, the dust cake properties and the cleaning method. The area of the fabric surface needed is determined by multiplying the total gas flow by the selected air-to-cloth ratio (EPA, 1986).

The fabric filters should have the following requirements:

- The filters should be equipped, at least, on silos and mixers.
- The bags' materials should be chosen to withstand the continuous exposure to cement (i.e. polyester, polypropylene, etc.).
- The collector bags should be carefully sized according to silo dimensions to prevent clogging (refer to manufacturer's recommendations or requirements).
- A filter should be protected from weather conditions and external factors (i.e. rain, humidity, wind, etc.).
- The bag filters should be cleaned automatically after each filling cycle of the silos.
- The high pressure air used in the bag filters should be oil-free and with low moisture content.
- The bag filter should be capable of withstanding the maximum differential pressure which may be faced. It is recommended to set an alarm to monitor the differential pressure indicators.
- Burst bag detectors should be installed and connected to silo overfill protection circuit to stop the inflow of cement.



(a) Silo Bag Filter *(b) Mixer Bag Filter*

Figure IV-1: Bag filters types

Cleaning of the bag filters (shaking, reverse air or pulse jet) should be done after each filling and operating cycle. The aim of cleaning is to remove some of the captured dust cake. The captured dust can be reintroduced into the production process. Theoretically, a steady-state dust will be formed and will remain on the bag until the bag is damaged. The lifetime of the fabric filter depends on the specific gas flow rate, dust concentration in the inlet gas, design of the filter, and frequency of operating cycles. For example, some bag filters might last for 3 years others for 5 years.

Maintenance of the bag filters:

The installed bag filters and dust control equipment should be maintained to ensure their operation at maximal efficiency. As such, the following factors should be monitored:

- Regularly inspect inlet and outlet gas temperature
- Check pressure drop and gas flow rate
- Visually inspect stack outlet
- Monitor cleaning cycle, pilot lights, or meters on control panel
- Monitor discharge system
- Check compressed air lines including line oilers and filters
- Verify temperature-indicating equipment
- Thoroughly inspect bags
- Calibrate opacity monitor

Characteristics of Silos:

- The internal pressure of the silos should not exceed the design pressure (refer to manufacturer's recommendations or requirements). The silo should be equipped with positive type relief valve(s) calibrated with the proper pressure.

- Sensor alarms should be equipped on silos to prevent cement over filling. It is recommended to have automatic shut-down switches to stop the cement transfer within 60 seconds of alarm activation (EPA, 1998).

- Silos should be controlled by an on/off valve fitted above the weigh conveyor, at the base of the silo cone. This control valve should be fitted ahead of any additional flexible joint(s) in the pipeline (i.e. closest to silo's cone base) to ensure that cement flow can be stopped in case of any system failures (i.e. flexible joints fail, air pressure fails, accidental product discharge…etc.).

2) Water and Soil Quality

The main purpose of the environmental management of water quality is to ensure that the generated wastewater does not directly reach sewerage network(s), surface waters, ground water or land, prior appropriate treatment. The two major approaches to manage wastewater in concrete batching plants are through: wastewater minimization, and wastewater recycling/reuse.

- The entire plant should be paved with hard, impervious materials such as asphalt or concrete.
- All generated wastewater should be collected and retained on-site, including stormwater.
- The generated domestic wastewater should be discharged in a safe manner. Domestic wastewater should be directed to the local sewerage network. In case a sewerage network is absent, a well-controlled septic tank should be used to store the domestic wastewater, prior its evacuation by the responsible personnel.
- Used oils from the generators shall be safely stored and handled to specialized contractors for recycling.

- The areas contaminated with cement dust should be minimized to decrease the amounts of contaminated stormwater runoff.
- Certain areas should be bunded with small bunds or canals to ensure that the wastewater is captured, mainly including: agitators and trucks washout areas, concrete batching areas, generator room(s) and areas around raw materials storage piles or any other area contaminated with residues.
- The water captured from bunds should be diverted into a designated settlement pond or a series of ponds.
- Sediments and sludge from settlement pond(s) must be removed when the storage capacity of the pond is half full. In case any material is causing flow restrictions, this material must be removed immediately.
- Sediments must be stored in a manner that does not promote the generation of fugitive dusts.
- Collected sediments must be properly handled and managed, promoting future reuses whenever possible (i.e. construction sites) or their disposal in designated licensed landfills.
- Settlement of wastewater can be followed by dosing of the alkaline wastewater with the use of appropriate dosing techniques for further treatment (i.e. adding of sulfuric acid or hydrochloric acid, bubbling of gaseous carbon dioxide, adding dry ice/frozen carbon dioxide).
- Recycled wastewater should be used at the earliest opportunity to ensure that the system is ready to receive newly generated wastewater. Potential uses of recycled wastewater mainly include: process batching, dust suppression over stockpiles and washing of vehicles and machinery.

<u>Characteristics of Settlement Pond/Pit:</u>

- Wastewater settlement ponds should be made of impervious watertight material (i.e. concrete).
- Installed settlement ponds should be sized according to the following:
  - Facility operation expectancy (days per week, hours per day)
  - Projected number of unit washing (i.e. mixer(s), chute(s), hopper(s), conveyer(s), etc.)
  - Projected number of vehicles/trucks washing (i.e. delivery trucks)
  - Projected quantities of storm water (it must be able to store contaminated runoff generated by 24 hours rain)
- Installed settlement ponds should have slopped flooring to facilitate settlement and removal of sludge and sediments.
- The use of a series of two or more settlement ponds can facilitate the removal efficiency
- Collection pits should have visual alarms to notify operators in cases of pump failures and when water reaches high levels in the pit.

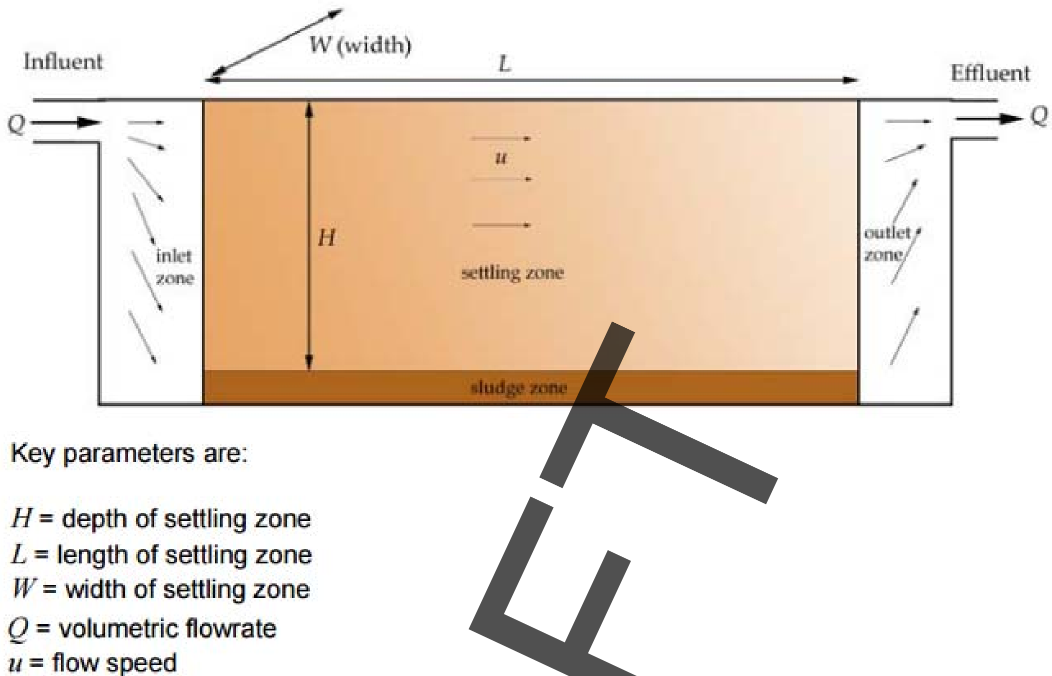


Figure IV-2: Typical settlement pond design (Dartmouth Eng. University)

3) Solid Waste

Solid wastes are inevitably generated during or after the operation of the batching plant. However, a number of management practices and operation modalities can be implemented to minimize generation and ensure the proper handling and disposal. These practices include:

- Adopting a waste minimization approach to all operational activities on-site (i.e. loading, unloading, mixing, washing, etc.), including administrative activities.
- Carefully matching the design mix with the received batching order (i.e. amount, characteristics, number of batches, delivery, etc.).
- Use of all fresh waste concrete in on-site construction activities, whenever feasible.
- Direct fresh, semi-hardened and hardened waste concrete to designated fully enclose pit(s) for drying and future collection.
- Dried concrete waste should be reused wherever possible (i.e. off-site construction, rehabilitation works, etc.) or recycled by licensed facilities (i.e. into gravel, aggregates, etc.) or sent to designated licensed landfills.
- All domestic solid wastes should be sorted at source and handled by designated solid waste management facilities.
- All recyclables generated on-site should be recycled by designated companies (i.e. paper, plastics, cans, aluminum, etc.).

4) Acoustic Environment

Noise pollution can be mitigated to prevent environmental and social implications, as such:

- Ensure that the facility’s noise emissions doesn’t exceed the Environmental Limit Values provided in MoE Decision 52/1 dated 12/9/1996.
- Locate noisy equipment away from sources of conflict or behind noise absorbers/receptors.
- Provide adequate buffer zone of a minimum of 100 meters between the facility and any identified sensitive receptor(s).
- All pressure-operated equipment should be fit with silencers or enclosed (i.e. compressors, pumps, etc.).
- The hoppers should be lined with sound absorbing materials such as rubber or wood
- All roads should be paved with concrete or asphalt.
- Efficient muffling devices should be installed on engines or noisy equipment
- Replace audible alarms with visual alarms, whenever possible.
- Limit, whenever possible, late night working shifts.
- Fine aggregates should be weighed before coarse aggregates.
- Maintenance operations should be conducted in enclosed areas or sheds.

The national maximum allowable noise level as per MoE Decision No. 52/1/1996 are presented in the table below.

Region Type	Limit for Noise Level (dBA)		
	Day time (7 am - 6 pm)	Evening time (6 pm - 10 pm)	Night Time (10 pm - 7am)
Industrial areas	60-70	55-65	50-60

Table IV-1: Permissible Ambient Noise Levels in Different Regions

The maximum national standard of 90 dB for occupational noise exposure limits should not exceed an average duration of 8 hours working days. If the limits are higher than the acceptable limits, then the exposure duration should be reduced as mentioned in the Table below.

Sound Pressure Level dB(A)	Exposure Duration (hrs.)
95	4
100	2
105	1
110	0.5
115	0.25

Table IV-2: Noise exposure limits

5) Occupational Health and Safety

A series of occupational behaviors are required at all times during plant operation to ensure that all foreseeable risks and hazards are prevented, minimized and mitigated. Such actions and behaviors include:

- Wear required Personal Protective Equipment (PPE) when handling raw material or concrete mix (i.e. alkali-resistant gloves, long sleeved and full-length pants coveralls, waterproof boots and eye protection).

- Eat and drink only in dust-free areas to avoid ingestion of dust (i.e. cement dust in particular).
- In case of eye contamination with cement dust, rinse eyes with water and consult a physician.
- In case of eye contamination with wet concrete, rinse with water for at least 15 minutes and immediately contact physician for further treatment.
- Wash contaminated skin areas with cold, running water as soon as possible.
- Meticulously follow advised lockout/tagout procedures when servicing equipment or machinery.
- Avoid working beneath frontload lifters, conveyor belts and stacker/de-stacker machinery.
- Minimize the mechanical lifting of material and bulky material, relying mainly on forklifts or frontload lifters.
- Keep floors clear to avoid slipping and tripping hazards.
- Provide appropriate lightening in closed or dark work places to avoid slipping or tripping hazards.
- Avoid working in awkward postures and in confined areas.
- Make sure back-up alarms on all vehicles are functioning.
- Avoid overloading equipment or machinery.
- Cautiously work with the load out chute on concrete mixers to avoid injuries to hands and fingers.
- Beware of hot surfaces on equipment and truck components.
- Use hearing protection during noisy operations, such as cement and aggregates loading/unloading

V. Contingency Plan

1. Spill Response Plan:

The proper spill risk assessment begins with identifying potential spills, preventing the potential occurrences, containing the areas of potential risks, detecting any leakages or spills and finally properly removing the spill.

The improper storage and management of fluids are the major cause of spills. The spilled materials lead to soil, ground and surface water, wetlands pollution. Furthermore, air quality, as well as occupational health is affected. In order to prevent spills, the following must be undertaken:

- Materials must be stored in closed containers in order to prevent the any spills and evaporation
- The content level of the container must be checked before filling
- The containers must be checked for leakages, the containers that are in good condition can only be used
- Solvents must be filled in containers that are compatible to the specific solvent
- Stored containers must not be in contact with any liquid
- Spilled materials must be kept from entering water drains through the use of drain covers
- Workers must be trained in safe material handling as well as equipment use
- Waste-fluid containers must not be stacked

<u>Response Actions/ Cleanup Methods</u>

- Employees must be trained on the quick and efficient response to different kind of spills as well as the use of spill cleaning equipment
- Once a spill occurs, all workers in the spill area should be alerted
- All ignition sources should be terminated
- Spill cleaning equipment must always be present and maintained
- Dike the spilled liquid as quickly as possible to prevent spreading
- Personnel cleaning the spill should be equipped with proper PPEs such as eye and skin protection, as well as gloves.
- Spill cleaning equipment include as pads, booms and absorbents such as oil dry, absorbent blankets, kitty litter, etc. as well as containers to hold spilled waste.
- Spill cleaning include:
    - Placing the absorbent material (i.e. saw dust) directly on the spill. The absorbent material should be inert and non-combustible.
    - The absorbent materials are then directly placed in a sealed container and disposed of properly
    - Fire extinguishers must be present in close proximity
    - The spill cleanup materials should be cleaned with plastic tools and placed in plastic or glass containers with a sealable lid. It is recommended to double-bag the cleaned materials.
    - Water must not be used to dilute the spills or wash the spill into drainage pipes
    - Any spill of Hazardous materials must be directly reported to the adequate official authority
    - Implement a recording system for all spills

2. Fire Emergency Response Plan:

- Provide all areas with sufficient fire detectors (heat and smoke) and adequate firefighting equipment (sprinklers, hoses, distinguishers, etc.).
- Develop an emergency response plan which includes the floor map and the evacuation directions, exits, stairs and location of extinguishers (this should be written in languages understood by all workers).
- Ensure that contact details of the local firefighting services are available to the relevant staff and operators.
- Every escape route should be distinctively and conspicuously marked by emergency exit signs of adequate size and languages.
- Provide environmental friendly fire-fighting equipment such as dry powder extinguishers within the premises of the project.
- All fire safety equipment and fixtures shall be regularly serviced and maintained. The owner or shall annually certify that each of the fire safety measures specified in this statement has been assessed by a properly qualified person.
- Conduct annual firefighting and leak checks training drills for the operating staff.
- Prohibit smoking as well as flammable materials build-up within the facility's premises.

<u>Response Actions:</u>

- Activate the nearest fire alarm (i.e. pull-stations) in case alarms have not yet been automatically activated
- Confine the facility by closing all windows and doors and access points within reach
- Evacuate the premises immediately using stairways or designated fire escapes only
- Call the local fire department and provide them with prompt and accurate details (i.e. accident, location, extent, etc.)

Type of Impact	Source	Mitigation Measures	Monitoring Plan	Frequency of sampling and testing
Impact on Air Quality	Particulate matter emissions from: • Movement of trucks and heavy machinery • Unloading of raw materials • Storage stockpiles • Transferring of raw materials into the production process • Leakages or spillages of raw materials • Exhaust emissions from trucks, front end loaders or any other fuel-based machinery	• The plant premises should be paved with hard, impervious materials . • The entire plant floor should remain dust-free. • Natural or artificial wind barriers are to be placed landforms in accordance with prevailing wind direction (i.e. trees, and fences). • Trucks hauling sand, aggregate or other raw materials should be covered during transport. • The loading bay of raw materials should be roofed and enclosed in at least 3 sides • Stockpiles storage areas should be fitted with dust suppression water sprayers to dampen the stockpiles. • Raw materials should be covered with rubber sheets, plastic sheets or any water impermeable covers. • Cement should be stored in sealed and dust-tight silos. • Cement storage silos and mixers should be equipped with multi-bag fabric filter. Equivalent or better performance dust abatement alternatives are accepted • Leakages or spillages should be prevented during unloading of raw materials and dispensing in silos • Sand and aggregates should be delivered to the site in a dampened state to prevent fugitive dust. • Conveyors and storage hoppers should be enclosed and roofed to protect the raw materials from wind. • The conveyor belts shall be equipped with belt cleaners to ensure that the raw materials remaining on the belt are well-contained. • The transport points of conveyors and hopper discharge area should be enclosed. Rubber curtain seals can be used for transfer point outlets. • Raw materials discharged into hoppers should be damped. • All trucks leaving the facility's premises should be clean and free of dust. • Cement should be transported onsite from suppliers who utilize sealed vehicles equipped with the pneumatic transfer of cement into the silos. • All duct works should be air tight to prevent any leakages • Air quality control equipment should be regularly maintained	• Ensure that all stockpiles of raw materials are damp and properly covered • All ground and handling surfaces are sprayed with water to ensure fugitive dust suppression	during operation
			• Confirm that all trucks and vehicles exiting the facility are dust-free and all raw materials delivery trucks are covered with impermeable covers	Upon each delivery
			• Check relief valve of the cement silo(s) to ensure absence of blocking/clogging	Upon each delivery
			• All installed alarms and warning devices in silos and the mixer are operating correctly	Weekly
			• Ensure that installed bag filters and dust control equipment are working at maximal efficiency. As such, the following factors should be monitored: - Levels of dust buildup on the mesh bags - Reverse air flow velocity - Potential tears, ruptures or leakages - Potential damaged seals or mechanical abnormalities - Inlet and outlet gas temperature, pressure drop, opacity, and gas velocity	Weekly
			• Ensure that back-up generators are operating with optimal burning efficiency through undergoing exhaust gas emissions testing (PM, CO, SOx, NOx, and other parameters if needed)	Biannually
Impact on Water and Soil Quality	• Contaminated storm water runoff • Wash water generated from washing of: - Trucks or other transport machinery (interior and exterior washing) - Central mixers - Conveyors • Dust suppression wastewater • Slump testing	• The entire plant should be paved with hard, impervious materials such as asphalt or concrete. • All generated wastewater should be collected and retained on-site, including storm water. • The generated domestic wastewater should be discharged in a safe manner. Domestic wastewater should be directed to the local sewerage network. In case a sewerage network is absent, a well-controlled septic tank should be used to store the domestic wastewater, prior its evacuation by the responsible personnel. • Used oils from the generators shall be safely stored and handled to specialized contractors for recycling. • The areas contaminated with cement dust should be minimized to decrease the amounts of contaminated stormwater runoff. • The agitators and trucks washout areas, concrete batching areas, generator room(s) and areas around raw materials storage piles or any other area contaminated with residues, should be bunded with small bunds or canals. • The water captured from bunds should be diverted into a designated settlement pond or a series of ponds. • Settlement of wastewater can be followed by dosing of the alkaline wastewater with the use of appropriate dosing techniques for further treatment (i.e. adding of sulfuric acid or hydrochloric acid, • All maintenance materials should be stored in their respective areas in a closed area with a concrete base to prevent any spillages from reaching the proximal soils. Absorption materials should be available for potential spills.	• Ensure that all water piping systems, drainage systems and bunds/canals are intact (i.e. no leakages, blockages).	Daily
			• Water quality testing should be done on the effluent water of the settlement pond before discharge into network. Testing is to be done by an accredited laboratory or testing center.	Quarterly
			• Water sampling and testing must be taken from proximal surface and groundwater sources. Testing is done by an accredited laboratory or testing center. The parameters that should be tested include: pH, COD, BOD, SS, Mineral oil and grease and other parameters according to the specific case.	Yearly/ Upon accidental spillage
			• Monitor generator rooms or individual generator units are to for spills or leakages of oils, lubricants or any contaminant	Daily
			• To ensure the quantities of generated wastewater are limited, the following should be monitored: - The average quantities of water used for washing per unit (i.e. liters per delivery truck, liters per mixer, etc.) - The settlement pit's pump efficiency - The settlement pit's alarms and warning devices - The capacity of the settlement pit during periods of high rainfall	Weekly
			• Monitor settlement pond(s) to ensure that a minimum of 50% of the capacity is available, and that there are no blockages and ensuring that the pond linings are intact (i.e. no leakages)	Weekly /After heavy rains
			• Ensure that fresh, semi-hardened and hardened waste concrete are directed towards the designated settlement pond, upon occurrence. • Ensure that wastes and collected sediments from treatment units (settlement pond) are stored in a confined enclosed or impervious area prior to reused on site or in other industries.	Daily

Type of Impact	Source	Mitigation Measures	Monitoring Plan	Frequency of sampling and testing
			•Record and monitor the quantities of waste concrete	
Impact on Acoustic Environment	•Trucks, front end loaders, loading devices and other heavy machinery •Hydraulic pumps •Raw materials delivery activities to hoppers/bunkers (especially aggregates) •Conveyors •Filters •Alarms/ warning devices •Compressors •Air valves	•Locate noisy equipment away from sources of conflict or behind noise absorbers/receptors. •All pressure-operated equipment should be fit with silencers or enclosed (i.e. compressors, pumps, etc.). •The hoppers should be lined with sound absorbing materials such as rubber or wood •All roads should be paved with concrete or asphalt. •Efficient muffling devices should be installed on engines or noisy equipment •Replace audible alarms with visual alarms, whenever possible. •Limit, whenever possible, late night working shifts. •Fine aggregates should be weighed before coarse aggregates. •Maintenance operations should be conducted in enclosed areas or sheds •Calibration of the adopted noise meters must be undertaken on an annual basis and verified by the manufacturer every two years in order to ensure the meters' accuracy of measurements	•Calibration of the adopted noise meters	Annually
			•Monitoring of noise levels should be conducted for the overall noise generations of the facility and at sensitive receptors considering the baseline noise levels.	Biannually
Impact on Occupational Health and Safety	•Physical hazards (tripping, electrocution) •Chemical hazards (exposure to dust emissions…etc.) •Ergonomic hazards	•Wear required Personal Protective Equipment (PPE) when handling raw material or concrete mix (i.e. alkali-resistant gloves, long sleeved and full-length pants coveralls, waterproof boots and eye protection). •Eat and drink only in dust-free areas to avoid ingestion of dust (i.e. cement dust in particular). •In case of eye contamination with cement dust, rinse eyes with water and consult a physician. •In case of eye contamination with wet concrete, rinse with water for at least 15 minutes and immediately contact physician for further treatment. •Wash contaminated skin areas with cold, running water as soon as possible. •Meticulously follow advised lockout procedures when servicing equipment or machinery. •Avoid working beneath frontload lifters, conveyor belts and stacker/de-stacker machinery. •Minimize the mechanical lifting of material and bulky material, relying mainly on forklifts or frontload lifters. •Keep floors clear to avoid slipping and tripping hazards. •Provide appropriate lightening in closed or dark work places to avoid slipping or tripping hazards. •Avoid working in awkward postures and in confined areas. •Make sure back-up alarms on all vehicles are functioning. •Avoid overloading equipment or machinery. •Cautiously work with the load out chute on concrete mixers to avoid injuries to hands and fingers. •Beware of hot surfaces on equipment and truck components. •Use hearing protection during noisy operations, such as cement and aggregates loading/unloading activities •Injuries/illnesses and major occupational accidents must be recorded and identified at upon occurrence, including: cuts, respiratory illnesses, dermal diseases, gastro-intestinal infections, eye infections, burns, mortality, accidents leading to handicaps.	•Monitor the use of PPEs by the labor in the facility	Continuously
			•Monitor the presence of safety signs, first aid kits, firefighting devices, etc.	Monthly
			•Ensure that the fire extinguishers are properly installed and in an easily accessible location	Monthly

Table V-1: EMP summary

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Annex 1

PARTICULATE EMISSION FACTORS FOR CONCRETE BATCHING

Emission factors

Particulate emission factors for concrete batching are presented in the table 1 where all emission factors are in Kg of pollutant per Mg of material loaded. Loaded materials include course aggregate, sand, cement and cement supplement.

Material loaded	Uncontrolled emission factors (Kg/Mg)		Controlled emission factors (Kg/Mg)	
	Total PM (sum of PM_{10} and all solids >10micrometers)	Total PM_{10} (sum of $PM_{10-2.5}$ and $PM_{2.5}$)	Total PM (sum of PM_{10} and all solids >10micrometers)	Total PM (sum of PM_{10} and all solids >10micrometers)
Aggregate transfer	0.0035	0.0017	ND	ND
Sand transfer	0.0011	0.00051	ND	ND
Cement unloading to elevated storage silo (pneumatic)	0.36	0.24	0.00051	0.00017
Weigh hopper loading	0.0026	0.0013	ND	ND
Mixer loading (central mix)	0.286	0.078	0.0092	0.0028

Table 1: Particulate Emission Factors for concrete batching (USEPA, AP-42 section 13.2.4, 2011)

Emission Factor Estimation- Predictive Equations

- **General Emission Factor:**

An emission factor is a tool that is used to estimate emissions to the environment. Quantity of substances emitted from a source is related to some common activity associated with those emissions. Emission factors are obtained from US, European, and Australian sources and are usually expressed as the weight of a substance emitted, divided by the unit weight, volume, distance, or duration of the activity emitting the substance (eg. kilograms of sulfur dioxide emitted per tonne of aggregate handled).

Emission factors are used to estimate a facility's emissions by the general equation:

$E_{kpy,\,i}$= [A x OpHrs] EF_i x [1- (CEi/ 100)]

- $E_{kpy,i}$= emission rate of pollutant i, kg/yr
- A= activity rate, t/hr
- OpHrs= operating hours, hr/yr
- EF= uncontrolled emission factor of pollutant i, kg/t
- CE_i = overall control efficiency of pollutant i, %

- **Emission Factor for Central Mix Operation**

Emission factors deriving from the concrete mixing procedure can be developed based on the following equation when site-specific data are available.

$E=k\ x\ [\frac{U^a}{M^b}]+c$

E= Emission factor in lbs./ton of cement and cement supplement

k= Particle size multiplier (dimensionless)

U= Wind speed at the material drop point (mph)

M= Minimum moisture (% by weight) of cement and cement supplement

x= slope constant 0.0032

a, b= Exponents

c= Intercept constant

Equation parameters for central mix operations (for controlled and uncontrolled PM) are presented in the following table:

Condition	**Parameter Category**	**k**	**a**	**b**	**c**
Controlled	Total PM	0.19	0.95	0.9	0.0010
	PM_{10}	0.13	0.45	0.9	0.0010
	$PM_{2.5\text{-}10}$	0.12	0.45	0.9	0.0009
	$PM_{2.5}$	0.03	0.45	0.9	0.0002
Uncontrolled	Total PM	5.90	0.6	1.3	0.120
	PM_{10}	1.92	0.4	1.3	0.040
	$PM_{2.5\text{-}10}$	1.71	0.4	1.3	0.036

Condition	**Parameter Category**	**k**	**a**	**b**	**c**
	$PM_{2.5}$	0.38	0.4	1.3	0

Table 2: Emission factors expressed in lbs/tons of cement and cement supplement (USEPA, AP-42 section 13.2.4 revised 2011)

To convert from units of lbs/ton to units of kilograms per mega gram, the emissions calculated by equation B should be divided by 2.