CONTENTS of Section 2

2 DESCRIPTION OF THE PROJECT 2-1

2.1 CONTEXT OF THE PROJECT 2-1

2.1.1 Need for the Project 2-1

2.1.2 Project Setup 2-2

2.1.3 Level of Planning Detail 2-2

2.2 THE PROJECT SITES 2-3

2.3 GENERAL CEMENT PRODUCTION PROCESS 2-6

2.4 DESCRIPTION OF PRESENT GC PLANT AND PRODUCTION 2-7

2.4.1 Current Plant Operation (Wet Kiln Clinkering Process) 2-7

2.4.2 Site Layout 2-10

2.4.3 Main production installations 2-10

2.4.4 Ancillary Services and Equipment 2-12

2.4.5 Infrastructure 2-12

2.5 DESCRIPTION OF THE PROJECT AND FUTURE OPERATION 2-15

2.5.1 New Dry Kiln 6 Project 2-15

2.5.2 Site Layout 2-20

2.5.2.1 GC Plant 2-20

2.5.3 Ancillary Services and Equipment 2-21

2.5.4 Process Control System 2-21

2.5.5 Infrastructure 2-21

2.5.5.1 On Site GC Plant 2-21

2.5.5.2 Off Site 2-22

2.5.6 Shakhgaya-West Quarry and New Crusher Operations 2-23

2.6 OPERATIONAL CONSUMPTION AND RELEASES TO THE ENVIRONMENT 2-26

2.6.1 Raw Materials 2-26

2.6.2 Fuels 2-28

2.6.3 Energy Demand 2-29

2.6.4 Emissions to the Air 2-29
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.6.4.1</td>
<td>Current Operation</td>
<td>2-29</td>
</tr>
<tr>
<td>2.6.4.2</td>
<td>New Dry Kiln 6 Operation</td>
<td>2-35</td>
</tr>
<tr>
<td>2.6.4.3</td>
<td>Shakhgaya-West Quarry</td>
<td>2-41</td>
</tr>
<tr>
<td>2.6.5</td>
<td>Water Demand and Discharge of Wastewater</td>
<td>2-42</td>
</tr>
<tr>
<td>2.6.5.1</td>
<td>Current Operation</td>
<td>2-42</td>
</tr>
<tr>
<td>2.6.5.2</td>
<td>New Dry Kiln 6 Operation</td>
<td>2-43</td>
</tr>
<tr>
<td>2.6.5.3</td>
<td>Water balance existing vs. future operation</td>
<td>2-45</td>
</tr>
<tr>
<td>2.6.5.4</td>
<td>Shakhgaya West Quarry</td>
<td>2-46</td>
</tr>
<tr>
<td>2.6.6</td>
<td>Hazardous Materials</td>
<td>2-46</td>
</tr>
<tr>
<td>2.6.7</td>
<td>Waste Management</td>
<td>2-47</td>
</tr>
<tr>
<td>2.6.7.1</td>
<td>Current Operation</td>
<td>2-47</td>
</tr>
<tr>
<td>2.6.7.2</td>
<td>New Dry Kiln 6 Operation</td>
<td>2-48</td>
</tr>
<tr>
<td>2.6.7.3</td>
<td>Shakhgaya West Quarry</td>
<td>2-48</td>
</tr>
<tr>
<td>2.6.8</td>
<td>Noise Emissions</td>
<td>2-48</td>
</tr>
<tr>
<td>2.6.8.1</td>
<td>Current Operation</td>
<td>2-48</td>
</tr>
<tr>
<td>2.6.8.2</td>
<td>New Dry Kiln 6 Operation</td>
<td>2-49</td>
</tr>
<tr>
<td>2.6.8.3</td>
<td>Shakhgaya West Quarry</td>
<td>2-49</td>
</tr>
<tr>
<td>2.6.9</td>
<td>Off-site Transportation</td>
<td>2-50</td>
</tr>
<tr>
<td>2.6.10</td>
<td>Summary of Operational Consumption and Releases to the Environment</td>
<td>2-51</td>
</tr>
<tr>
<td>2.6.11</td>
<td>Monitoring of Air Emissions and Effluents</td>
<td>2-55</td>
</tr>
<tr>
<td>2.7</td>
<td>FIRE PROTECTION, SAFETY AND SECURITY FEATURES</td>
<td>2-56</td>
</tr>
<tr>
<td>2.8</td>
<td>OPERATIONAL MANAGEMENT AND STAFFING</td>
<td>2-57</td>
</tr>
<tr>
<td>2.8.2</td>
<td>The Plant Organisation</td>
<td>2-58</td>
</tr>
<tr>
<td>2.8.3.1</td>
<td>Current Operation</td>
<td>2-60</td>
</tr>
<tr>
<td>2.8.3.2</td>
<td>New Dry Kiln 6 Operation</td>
<td>2-60</td>
</tr>
<tr>
<td>2.9</td>
<td>ENVIRONMENTAL AND HEALTH AND SAFETY (EHS) MANAGEMENT</td>
<td>2-61</td>
</tr>
<tr>
<td>2.10</td>
<td>CONSTRUCTION ACTIVITIES AND SCHEDULE</td>
<td>2-63</td>
</tr>
<tr>
<td>2.10.1</td>
<td>Activities on Garadagh Cement Plant Site/ New Dry Kiln 6</td>
<td>2-63</td>
</tr>
<tr>
<td>2.10.1.1</td>
<td>General Construction Setup</td>
<td>2-63</td>
</tr>
<tr>
<td>2.10.2</td>
<td>Construction Activities</td>
<td>2-65</td>
</tr>
<tr>
<td>2.10.2.1</td>
<td>Site Access</td>
<td>2-65</td>
</tr>
<tr>
<td>2.10.2.2</td>
<td>Transportation of Equipment</td>
<td>2-65</td>
</tr>
<tr>
<td>2.10.2.3</td>
<td>Establishment of the Site</td>
<td>2-66</td>
</tr>
<tr>
<td>2.10.3</td>
<td>Construction Programme and Schedule</td>
<td>2-67</td>
</tr>
<tr>
<td>2.10.3.1</td>
<td>Construction Schedule</td>
<td>2-67</td>
</tr>
</tbody>
</table>
2.10.3.2 Construction Machinery Requirements 2-68
2.10.4 Construction Workforce 2-69
2.10.4 Construction Workforce 2-69
2.10.5 Construction Traffic 2-71
2.10.5.1 Transport of Materials 2-71
2.10.5.2 Transported Construction Workforce 2-72
2.10.6 Construction of the New Quarry Crusher 2-72
2.10.7 Road and Railway Rehabilitation 2-72
2.10.8 Site Security during Construction 2-73
2.10.9 Environmental and Health and Safety Management during Construction 2-73

2.11 BENCHMARKING OF THE PROJECT 2-74
2.11.1 Cement Manufacturing 2-74
2.11.2 Performance Indicators 2-77

LIST OF TABLES

Table 2-1 Lifetime of potential limestone resources and reserves for new dry Kiln 6 operation 2-27
Table 2-2 Kiln stack emissions measured in GC plant (2008) vs. examples from kilns operated in Europe 2-31
Table 2-3 Current Emissions to the Atmosphere from Kilns #1 through #4 given as Mass Flow Rates 2-33
Table 2-4 Maximum expected new dry Kiln 6 emission concentrations 2-36
Table 2-5 Emissions to the Atmosphere from the future Main Stack of New Dry Kiln 6 2-38
Table 2-6 Gross and net CO2 estimates 2-41
Table 2-7 Water Balance – comparison between existing Kiln 1–4 and new Kiln 6 2-46
Table 2-8 Main transportation figures for the current and the future situation 2-51
Table 2-9 Consumption and Releases in the Current and the Future Situation 2-52
Table 2-10 Estimated equipment required for Major Civil works and Operation Duration 2-69
Table 2-11 Kiln 6 emission parameters compared to international standards 2-78
Table 2-12 Plant efficiency Benchmarks 2-79
LIST OF FIGURES

Figure 2-1  Site Location Map of the Cement Plant and the Quarries  2-5
Figure 2-2  Exemplary Process Flow Diagram of Cement Production  2-7
Figure 2-3  Flow diagram of Cement Production with the Wet Clinker Production Process  2-9
Figure 2-4  Flow diagram of Cement Production with the Dry Clinker Production Process of New Dry Kiln 6  2-17
Figure 2-5  Shakhgaya-West Quarry layout  2-24
Figure 2-6  Crusher Site Layout  2-25
Figure 2-7  Water Flow Diagram of the Existing Wet Kiln Operation  2-43
Figure 2-8  Water Flow Diagram of the Future Dry Kiln Operation  2-45
Figure 2-9  Key Phases and Activities of Plant Construction – Preliminary Schedule  2-68

LIST OF PHOTOS

Photo 2-1  View of the GC site  2-10
Photo 2-2  Wet kiln and clinker cooler  2-11
Photo 2-3  Rail and truck transportation from the limestone quarries  2-14
Photo 2-4  Planned construction site of Kiln 6 (inside the fenced area)  2-20
Photo 2-5  Existing stacks and emissions control  2-30
Photo 2-6  Wind prone semi-open storage areas  2-30
2 DESCRIPTION OF THE PROJECT

2.1 CONTEXT OF THE PROJECT

2.1.1 Need for the Project

The cement market in Azerbaijan is growing since 2003 and is expected to continue with a strong growth rate in correlation with the forecasted economic growth of Azerbaijan. In 2006, consumption was 2.6 million tonnes; in 2007 the demand for cement was 3.2 million tonnes. It is estimated that by 2015 the domestic cement demand in Azerbaijan would increase further by some 40%.

Garadagh Cement at present is the only cement clinker producer in Azerbaijan and also the largest cement manufacturing plant operating in the country. In 2007, the Garadagh Cement plant manufactured about 1.3 million tonnes of cement, i.e. about 40% of the domestic demand. For manufacturing this quantity of cement, Garadagh Cement had to import additional clinker due to the limited clinker production capacity of the existing 4 wet kilns at the plant (2,600 tonnes/day capacity each).

After Kiln 6 (nominal capacity 4,000 tonnes/day clinker capacity) is working, increased clinker production will allow fully utilizing the existing grinding capacity by own clinker production. The future annual quantity of cement manufactured by Garadagh Cement will be about 1.7 million tonnes based on an on-site clinker production of about 1.2 million tonnes per year.

With this 30% capacity increase in cement production, the Project helps to catch up with the domestic demand development and to avoid a further increase of the Azeri import portion for clinker and cement.

1 GDP growth of the past five years - with an average annual growth rate of 12 percent - was led mainly by oil and gas production. Growth in non-oil output has picked up since 1999 with an average annual growth rate of more than 15 percent (World Bank Azerbaijan Country Brief 2006). For further information on Azeri economy see EBRD Azerbaijan Country Fact Sheet (http://www.ebrd.com/pubs/factsh/country/azer.pdf).

2 For production of cement, some 75% of cement clinker is required (clinker factor), which is mixed with the so-called correctives (e.g. gypsum, iron ore, sand). These additives are used for blending the different cement qualities with specific characteristics.
2.1.2 Project Setup

The project is developed by Garadagh Cement OJSC, supported by its parent company Holcim which includes inter alia Holcim Research and Support Group (HRSG) who provides concept engineering and planning expertise inputs.

Engineering services for the local permit application documents are prepared by the Azeri engineering firm “Azerinshaatlayiha” SMPKTİ.

The New Dry Kiln 6 and related plant modernisation equipment will be constructed pursuant to a turnkey engineering, procurement, and construction (EPC) contract. The EPC contractor will be responsible for the entire construction work. Thereafter, Garadagh Cement will take over the new installations to commence operation. Maintenance will be carried out by Azeri and international contractors.

The Project also includes refurbishment of roads and railway tracks which will be performed by Azeri companies. Railway operations are part of GC’s own operations.

The quarry infrastructure (crusher /conveyor belt / train loading station) will also be established by the EPC turnkey contractor.

The quarry will be operated by an Azeri contractor (present waste limestone collection and clay quarry operations are also carried out by contractors)³.

The plant modernisation with the new Dry Kiln 6 Project is supported by the Azeri Ministry of Economic Development (MED) through the Azeri Investment Corporation (AIC) who is a 10% shareholder in Garadagh Cement.

2.1.3 Level of Planning Detail

In 2007 the Holcim Research and Support Group carried out a Feasibility Study (FS) for the New Dry Kiln 6 Project (Feasibility Study, Holcim, 2007).

Based on this Feasibility Study, technical specifications for the Project were specified by Holcim in accordance with the requirements of the Holcim Group

³ Blasting will need to be undertaken by certified subcontractors (presently only some 2 firms in Azerbaijan have a license for such activities).
and the Request for Proposals (RfP) which included the Tender Document was distributed to interested EPC companies in March 2008).  

Therefore, the detail of planning used for the ESIA is based on the level of the Feasibility Study with additional upgrading information according to the specifications.

The detailed design will be the task of the EPC contractor who will be free to propose engineering solutions within the given layout framework which includes the environmental provisions as specified within this ESIA report and the pertinent Azeri requirements.

Figures given in this ESIA report therefore relate to the presently available planning status and in general are preliminary. However, figures are based on reasonable estimates and/or calculations and are also based on experience with similar installations. Hence, these are considered on the safe side from environmental perspective. In case there are various operational options with different levels of impact potential, the assessment is based on the environmentally worst case assumption; e.g. the assessment of ambient air impact from plant emissions is based on the higher air emission values for solid fuel (hard coal, pet-coke), even though also partly natural gas may be used.

2.2 THE PROJECT SITES

The plant modernisation comprises activities at the following sites:

- Garadagh Cement Plant (production site) located across the highway and railway from Sahil Settlement;
- Shakhgaya-West quarry; and
- The railway track and adjacent road connecting the quarry with the GC plant.

GC Plant site

The new Kiln 6 and other new plant components will basically be erected within the existing site boundaries, which today total of about 52 hectares. The

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4 Negotiations with interested bidders had commenced and were ongoing during preparation of this ESIA.
new Dry Kiln 6 will be located within this boundary, approximately where the former Kiln 5 was situated.5

It is considered by GC to add about 7.5 ha additional off-site area consisting of several patches directly adjacent to the existing premises to realign the plant boundaries. This is public property, which Garadagh would either acquire or lease long term (subject to agreement).

Quarry

Garadagh owns the Shakhgaya West limestone deposit. This is located about 12 km aerial distance and 15 km by road to the north-west of the GC plant. The quarry area of 152 ha was part of the privatisation package. Limestone extraction at this quarry area had started in soviet times, but was abandoned after some initial operation as limestone quality was considered insufficient at that time.

As part of the privatisation, GC also received rights to explore the area of the Caravansaraj limestone deposit (~120 ha 6) which is located about 2 km to south of the Shakhgaya West quarry. The Caravansaraj deposit is a further long term option for limestone supply which may be developed by GC at a later stage.7

Transportation infrastructure

The Shakhgaya-West quarry is connected with the GC plant by a road (partly concrete) and a single track industrial railway line which both belong to Garadagh Cement. As per privatisation requirement, GC has to keep the road from the GC plant to the clay quarry open and accessible for third party/public use. The driving distance from the GC plant to the Shakhgaya-West quarry is about 15 km. The clay quarry and the GC train loading station for the clay and waste limestone is located about halfway between the CG

5 The existing wet process rotary kilns are numbered as kilns 1 through 4. These were put into operation in the years 1951–1958. Kiln 5, which was built in the 1980s, never worked satisfactorily and was dismantled in 2004 after some 20 years of standstill.
6 In total approximately 200 ha of land were allocated to GC at and around Caravansarai.
7 The exploitation of this deposit is not part of the present project and development may take place in some 20 years time from present. Plans for using the Caravansarai deposit are concept/pre-feasibility stage and some test drillings have taken place. The transportation of the material has not been investigated yet by GC. Future transport connection to this long term deposit could possibly be via a belt conveyor to the Shakhgaya West installations which is a state of the art method. (In Soviet times, originally, a 14 km long railway line was foreseen from the southern end of the deposit to the cement plant. However, this previously foreseen alignment is today blocked by the Sangachal Terminal).
plant and the Shakhgaya west quarry. Both transportation infrastructures are in need of refurbishment, in particular the abandoned rail and road sections between the clay quarry and the Shakhgaya-West quarry require complete restoration at some sections. The road is also used by the trucks of the stone cutting companies operating in the area and road surface is partially severely damaged from the heavy load transports.

The location of the GC plant and the associated quarries are shown in their geographical context in Figure 2-1.
2.3 General Cement Production Process

The main stages of the cement manufacturing process are as follows:

Clinker production:

- Limestone, which is the main raw material of clinker production, and other raw materials such as clay are extracted from quarries;
- Raw materials (limestone, clay) are broken down in a crusher to prepare suitably sized material for the next process step;
- The raw-materials are mixed with the so-called correctives (e.g. bauxite, iron ore);
- The homogenized mixture is ground in a raw mill;
- In a wet or dry clinkering process the meal is heated-up for burning the clinker at air temperatures increasing from about 300°C to 2,000°C; the purpose of the increasing air temperature is the stepwise drying, preheating, calcining, and sintering of the material. The clinker temperature reaches about 1,450°C;
- The burned clinker (granules of some 5–30 mm in diameter) is cooled down in a clinker cooler and then stored in the clinker storage.

Cement manufacturing:

- The clinker is blended for various cement qualities by adding further components (e.g. sands, gypsum, limestone);
- The cement blend is ground in cement mills;
- The cement is conveyed to silos for storage prior to packing and shipping;
- Shipping of cement is via road or rail, either in bags (on palettes) after packing or as bulk material by means of silo wagons or silo trucks.

For illustration of the cement manufacturing process in general, a process flow diagram is depicted in Figure 2-2.
2.4 DESCRIPTION OF PRESENT GC PLANT AND PRODUCTION

2.4.1 Current Plant Operation (Wet Kiln Clinkering Process)

The four rotary kilns 1–4 currently operated at the Garadagh plant are wet process kilns with direct slurry feed. Together they provide a total nominal capacity of 2,616 tonnes per day. The raw meal to clinker factor is 1.58, meaning that 1.58 tonnes of raw material is required for the production of 1 tonne of clinker. The daily raw material demand thus amounts to about 4,130 tonnes.

Figure 2-3 shows the process flow exemplary for one wet process kiln. For the wet process, the raw materials and correctives are fed together with water into a slurry mill where the mixture is ground. The slurry is stored in a slurry basin from where it is fed into the wet rotary kilns.
The burners of the kilns are fuelled with natural gas. In the course of the transport of the material in the 150 m long kilns\(^8\) it moves through zones for drying, preheating, calcining and sintering. The clinker leaves the kiln with a temperature of about 600°C and is cooled in planetary clinker coolers prior to further handling.

A portion of the hot air is used as combustion air for the burner and thus saves energy for heating of the combustion air. The other portion is exhausted via an air emissions control system consisting of a particulates filter (electrostatic precipitator – ESP) and a 65 m high stack into the atmosphere.

The clinker is composed of about 80 % limestone and 18.5 % clay with 1.5 % bauxite. The overall clinker to cement factor which describes the quantity of clinker used for cement is about 75 %.

Three qualities of cement for different application purposes are produced by variation of additives: Spesial (43 %), Optimal (32 %) and Ekspert (25 %).

Consumption and releases related with operation of the existing plant are summarised in Section 2.6.

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\(^8\) Kiln outside diameter is 4 m
Flow diagram of Cement Production with the Wet Clinker Production Process
Source: Holcim Group

[Please note: principle scheme, difference to GC plant: (i) graphics shows (i) quarrying instead of waste lime stone collection; (ii) no separate cooler dedusting]
2.4.2 Site Layout

The Garadagh Cement plant site occupies an area of approximately 52 ha (approx. 1,630 m x 430 m). Topographic elevation of the site is about -10 m bsl.

The surrounding area is sloping from north-west to south-east towards the Caspian Sea, which has an average level of -28 m bsl. The area towards the north and north-west is characterised by higher elevations formed primarily by extinct volcanoes with heights between 100 m and 400 m above sea level.

A plan of the current site layout is provided in Annex A.

Photo 2-1 View of the GC site

2.4.3 Main production installations

The main buildings at the site comprise housed production units (e.g. crusher, mills), storage buildings, and administration buildings. Additionally, there are various technical structures, including the four kilns, storage facilities, conveyors etc.

Inter alia, there are the following main installations and storage areas on the current production site:

- Open raw material unloading with storage area for limestone, clay and bauxite (total 25,000 t);
- Process water basin, 3,500 m³
- Slurry mill;
- Slurry basin, 3,500 m³
- Four natural gas fuelled 150 m long wet process rotary kilns;
- Clinker coolers (planetary type);
- Three 65 m high stacks (Kiln 3 and Kiln 4 exhaust via a common stack) with ESP particulate filters at stack inlet;
- Roofed clinker storage hall with open walls for storing clinker, volcanic sand and gypsum (total 40,000 t);
- Outdoor clinker storage of 80,000 t clinker on average (incl. imported clinker);
- Nine clinker mills with a total capacity of 320 t/h;
- Ten out of 18 cement silos with nominal capacity of 2,000 t each are currently used;
- Bag packing department; and
- Dispatch area.

In the first half of 2008, the area for the new dry Kiln 6 was prepared by excavating the cement kiln dust and clearing of construction debris which had been land filled in this area in earlier years (cf. Section 3.4 Soil).

The main road access to the site is from the Northwest through a gate. On-site roads are partly concrete paved and partly gravel. The railway tracks access the plant from the north-west.
2.4.4 Ancillary Services and Equipment

Main ancillary production equipment and activities comprises:

- Operation of trains for transportation of raw-materials from the quarries;
- Truck and train unloading;
- Control of dust emissions from the kilns by means of electrostatic precipitation (ESP);
- Control of dust emissions from mills by bag filters;
- Conveyor systems for on site transportation of raw-materials, clinker, and cement;
- Generation of compressed air in a compressor station;
- Bagging with three packing machines, loading to trailers and trucks (or train) at three loading points (3,100 t/d capacity; 2 % on pallets) and bulk loading directly from silos (2,700 t/d);
- Provision of natural gas via a gas regulation station;
- Operation of a substation with 2 x 40 MW transformers for power which is supplied via two 110 kV overhead transmission lines;
- Diesel fuelled emergency generator for power supply in case of power outage;
- Workshops (electrical, mechanical);
- Laboratory for quality control of raw materials and products;
- Diesel and lubricants storage area in the northern part of the site (3 x 5,000 m³ contained aboveground storage tanks for diesel; oils and lubricants building for approx. 400 m³);
- Site security department.

Exploitation and crushing activities at the quarry sites (Geological Site #1, clay quarry) are outsourced to third party contractors whose activities also include loading of the railway wagons. Transportation of raw materials to the plant by train is carried out by GC.

2.4.5 Infrastructure

Electricity

Electricity is supplied to the GC cement plant via two 110 kV overhead transmission lines and transformed to lower voltage levels at several on-site
substations. The main substation is equipped with 2 x 40 MVA transformers to satisfy the plant's total demand of 15 MW with redundant equipment. Some remaining capacity is used to provide electricity to consumers in the vicinity of the site.

The “Baki Elektrik Shabaka” OJSC operated transmission lines are running adjacent to the site within a corridor following the highway.

In case of emergency (power outage), electricity for the plant is provided from a diesel fuelled emergency generator.

The quarries are supplied via a medium voltage overhead transmission line of 6 kV.

Gas

Natural gas is used as fuel for the kilns. It is provided via a pipeline and the on-site gas regulation station.

The gas pipelines, operated by AZERIGAS, are running adjacent to the site within a corridor following the highway.

Water

Potable water is supplied to the plant via the main Kura River-Baku water supply pipeline which runs in the corridor between the highway and the railway.

Technical water for slurry preparation is provided to the GC plant from the Sahil municipal wastewater treatment plant (WWTP) via a connecting pipeline. In addition, produced water from BP Sangachal oil terminal is used for slurry preparation. This is delivered to the site by tanker trucks.

Waste-Water

The wastewater from the plant is pumped to the Sahil WWTP via a connecting pipeline.

Roads

The main Baku-Astara-Tbilisi highway is running parallel to the south-eastern border of the GC site which gives easy access to the regional and national road network. Access to the site is provided via a junction south of the GC site where the road to the quarries branches off. A connection road links the site's truck entrance gate located in the North-western part of the site.
The roads leading to the quarries are partly owned by GC. They are in poor condition and need refurbishment.

For cement product shipping, the highway provides direct connection with the national road network and in particular with Baku in the north.

**Railway**

The main railway line (Baku – Astara-Tbilisi) runs parallel to the highway. The railway line serves passenger and freight trains. The cement plant is connected to the main railway. Via the railway, raw-materials are delivered and the cement product can be shipped. The Sahil railway station is located about 3 km northeast of the site.

For transportation of raw-materials from the quarries, an industrial railway is operated between the GC site and the quarries. This railway line is owned and operated by GC. There are several official and unofficial level crossings of the railway line (by the road and bypass tracks). Trains are running day and night in 3 shifts (frequency 10 trains/day), each train has a maximum length of 9 wagons (70 tonnes each). The average speed of the trains is 25 km/h due to the conditions of the rail track.

*Photo 2-3*  
**Rail and truck transportation from the limestone quarries**
2.5 DESCRIPTION OF THE PROJECT AND FUTURE OPERATION

2.5.1 New Dry Kiln 6 Project

The new dry Kiln 6 is the key component of the plant modernisation. The dry Kiln 6 Project comprises the following key items:

- Installation of new dry Kiln 6 incl. a new raw mill;
- Installation of coal storage and coal mill;
- Installation of new raw-material and clinker storages;
- New on site roads and also paving of currently unpaved roads;
- Reopening of Shakhgaya West limestone quarry; and
- Refurbishment of roads and railway tracks between GC plant and Shakhgaya West quarry.

The new dry process Kiln 6 is designed for a clinker production capacity of nominally 4,000 tonnes per day. Kiln 6 will replace the capacity of the existing four wet kilns (2,616 t/d) and thus increase production by additional 1,384 t/d.

The raw meal to clinker factor will be 1.58 (i.e. it remains the same as with the present process), thus the daily raw material demand will amount to about 6,320 tonnes.

Figure 2-4 shows the process flow diagram of the new cement manufacturing process with the dry kiln.

In the dry process, the mixture of raw materials and correctives is fed into a raw mill. Appropriate pre-blending of limestone which comes from different sources (waste limestone; Shakhgaya-West quarry) will be accomplished by means of a material analyzer (prompt gamma neutron activation analyzer - PGNA) for direct determination of the raw materials which are fed into the raw mill. This will ensure a constant quality of clinker. Natural moisture of the raw materials is dried in the mill by using hot air from the pre-heatercalciner.

The raw meal is stored in a silo from where it is fed into the pre-heater with pre-calcer to heat the raw meal up to a temperature of 800 - 900°C. The five staged cyclones of the pre-calcer collect the pre-calcined material.
The collected material is fed into the rotary kiln’s cold end and, in the course of the further transport in the 72 m long kiln, it moves from the zone for completion of the calcining process at about 950°C to the sintering zone. The clinker leaves the kiln with a temperature of about 1,300°C and thus has to be cooled in the clinker cooler prior to further handling.

The burner of the kiln is located at the hot end of the kiln and the hot air travels in counter-flow to the clinker material.

The further steps of cement production are similar to the current operation: storage of clinker in silos, blending with gypsum and other additives, grinding in cement mills, packing and shipping.

The burners of the kiln and the pre-calciner are multi-channel burners suitable for coal, petroleum coke (pet-coke)\(^9\), natural gas, and other liquid or solid alternative fuels. The two burners are specified as low NO\(_x\) burners. Since they will be placed at different locations, \(i.e.\) in the kiln and the pre-calciner, a staged combustion for higher energy efficiency is given. Both measures allow for NO\(_x\) reduction. A portion of the air from the hot end of the kiln is piped back to the pre-heater/pre-calciner (tertiary air) to save heating energy.

Waste air from the pre-heater/pre-calciner is exhausted \(via\) an air emissions control system (baghouse with jet-pulse cleaned fabric filters) and an about 140 m high stack into the atmosphere. Dust from the clinker cooler is exhausted via fabric filters for de-dusting and a separate stack.

Solid fuels (\(e.g.\) hard coal, pet-coke) will be stored in the new coal storage hall and ground in a new coal mill. The moisture of the coal will be dried in the coal mill by using hot air from the pre-calciner which saves additional heating energy.

The dry process with a five-stage pre-heater and pre-calciner rotary kiln at the GC plant introduces a modern state-of-the-art technique for clinker production. The change from the wet to the dry process will reduce the specific consumption of heat per tonne clinker by nearly 50 % from 6.37 GJ/t to 3.2 GJ/t.

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\(^9\) Petroleum derived coke: solid derived from oil refinery coker units or other cracking processes
Figure 2-4  Flow diagram of Cement Production with the **Dry** Clinker Production Process of New Dry Kiln 6
Source: Holcim Group
Measures to protect the environment are an integral part of the facility design which includes effluent treatment, waste management facilities, fire fighting and explosion prevention systems. All air and noise emissions, wastewater effluents, wastes, operational and construction activities will be designed, built and operated in such a way that the applicable legal requirements and international standards will be complied with.

In detail, the following modifications will take place at Garadagh Cement with the Project implementation:

**Garadagh production site**

- Construction of the one dry process rotary kiln 72 m long (which replaces the four 160 m long wet kilns);
- Construction of a 5-stage single string cyclone pre-heater with in-line pre-calciner (approximately 132 m high);
- Construction of a new approximately 140 m high stack;
- Construction of a new grate cooler for 4,000 t/d clinker equipped with shock blowers to avoid material clogging;
- Construction of a closed 10,000 t storage hall for solid fuels (coal storage) and a 24 t/h vertical roller mill for the solid fuels (coal mill);
- Construction of a new train unloading station with 2 tracks of 1,500 t/h capacity each;
- Construction of a circular 24,000 t storage hall including pre-blending of different limestone qualities;
- Construction of a longitudinal 2 x 3,500 t pre-blending storage hall for clay and iron corrective (e.g. bauxite);
- Construction of a vertical 355 tonnes per hour (t/h) roller mill for raw meal grinding;
- Construction of a 8,000 tonnes homogenization silo for raw meal;
- Construction of a 75,000 t clinker silo to accommodate the demand seasonality;
- Construction of a 16,000 t cement silo (with 2 bulk truck loaders) which increases the cement storage capacity to a total of 34,000 t;
- Extension of the existing internal infrastructure to include the new kiln (e.g. water network and drainage, power distribution, process control);
- Separation of on site traffic routes for inbound and outbound traffic.
The slurry mill and slurry basin will become obsolete, since no slurry is used in the dry process.

Operation of the four wet kilns will continue until regular production with the new dry Kiln 6 commences\textsuperscript{10}. Thereafter, the wet kilns will be shut-down and decommissioned. It is envisaged that the wet kilns and associated stacks will be dismantled at a later stage.

Other facilities at the production site will remain unchanged since they meet the future capacity requirements.

**Shakhgaya-West quarry**

- Installation of a new crushing plant (750 t/h);
- Operation of machinery and vehicles to exploit the limestone;
- Installation of a belt conveyor (approx. 400 m) for transportation between the crusher and the end of the railway;
- Construction of two limestone buffer silos for train loading.

**Infrastructure**

- Refurbishment of railway track and road between the production site and the quarries;
- Purchase of 2 – 4 locomotives to replace existing locomotives and to move the larger quantity of raw materials from the quarries to the plant site and shunting.

With the new dry Kiln 6, the clinker will be composed of about 86–87 % limestone and 11–12 % clay with 1–2 % bauxite.

GC anticipates that in the future, the clinker to cement factor (quantity of clinker used for cement) will decrease from the 2006 value of 75 % to 72-73 % with an increased use of volcanic sand and/or trass in the cement production.

Consumption and releases related with new plant operation are summarised in Section 2.6.

\textsuperscript{10} The commissioning phase of Kiln 6 will possibly take up to 3 months during which the new kiln is run-in and test production is undertaken. During this time, the existing kilns will continue to run on regular operation.
2.5.2 Site Layout

2.5.2.1 GC Plant

A plan of the future site layout is depicted in Annex A.

Dimensions of the key components of the New Kiln 6 Project are as follows:

- The 132 m high pre-heater/pre-calciner building with the 140 m high stack directly attached. The pre-heater/pre-calciner occupies an area of about 20 m x 20 m;
- The 72 m long rotary new dry Kiln 6 with about 5 m diameter;
- Clinker cooler with de-dusting (24 - 36 m high);
- Raw meal mill (42 m high);
- The new storage for limestone with a diameter of 88 m and 40 m height;
- The new correctives storage hall: 23 m high, 150 m long and 50 m wide;
- The coal storage with 78 m diameter and 28 m height;
- The coal mill (38 m high);
- The new clinker silo with 48 m diameter and 62 m height; and
- The new cement silo for bulk shipping (62 m high).

![Photo 2-4 Planned construction site of Kiln 6 (inside the fenced area)]
2.5.3 Ancillary Services and Equipment

Major changes regarding ancillary services and equipment are the future control of dust emissions from new dry Kiln 6 by means of bag fabric filters, installation of new power substations, and a new compressor station for e.g. the clinker cooler shock blowers. As already listed above, also various unloading/loading and storage facilities and mills will be installed and constructed.

2.5.4 Process Control System

The plant instrumentation and control equipment will be designed for central operation of the new kiln. It will be a state-of-the-art process information management system designed by Holcim and based on Siemens Simatic. The process automation system will be installed in a central control room to have a concentrated overview of the process's technical information in one place. It is considered to include relevant existing equipment, like the mills.

2.5.5 Infrastructure

2.5.5.1 On Site GC Plant

*Electricity*

A new high voltage substation will be installed at the north-western part of the production site and connected to the 110 kV transmission line of “Baki Elektrik Shabaka” OJSC. A new substation will be installed and equipped with two 32 MVA transformers to serve the site’s overall average demand of 32 MW. The peak demand of New Dry Kiln 6 will be 22 MW. By means of forced cooling, the transformers will be able to provide up to 40 MVA.

For the operation of equipment in the Shakhgaya West quarry, the existing 6 kV overhead transmission line will be upgraded and extended. The transmission line is already designed for 35 kV. Hence only additional cables and a step-up and a step-down transformer have to be installed.

*Gas*

Besides a connection with the new dry Kiln 6 to enable fuelling with natural gas, no change of the existing system is planned. Since the preferred fuel will be hard coal, a strong decrease in the annual consumption of natural gas is anticipated.
Water Supply Infrastructure

The existing slurry preparation for the wet process will become obsolete with the new dry Kiln 6. Thus, the feed-wastewater pipeline from the Sahil WWTP will be closed. The storage tanks for slurry water will be removed. The plant will use freshwater from the existing public water supply pipeline. For the new dry Kiln 6, no major installations in addition to the existing water supply system are required. Mainly, a connection pipe connection with the kiln and the equipment which will use cooling water (cooler, mills) is required.

Road Infrastructure

Access to the site will be modified for separate inbound and outbound traffic. For inbound truck traffic (raw material delivery) a new entrance gate is planned in the Southwest of the site. A truck parking area and a new unloading area for trucks and trains complete the raw materials unloading area. Outbound traffic will use the existing gate in the Northwest of the site.

All new roads will be made of concrete and currently unpaved on site roads will be paved in the future.

Railway Infrastructure

A railway unloading station will be built on the north-western boundary of the site to unload the incoming raw limestone, other raw materials and solid fuel (coal/pet-coke). For this, the existing internal tracks will be extended by about 600 m to the western corner of the CG premises.

2.5.5.2 Off Site

Roads

Refurbishment of the roads between the GC plant and the quarries is planned. Access to the crusher location and the Shakhgaya West quarry is provided by the existing road. The road is partially in very bad condition due to the heavy load truck traffic from the stone cutting companies. Rehabilitated road surfaces will be compacted to reduce suspension of dust. The section from the crusher location to the quarry has a concrete hard surface which is in good condition. A concept to avoid interference between public traffic and plant traffic will be developed.

Railway

Parts of the railway tracks between the quarries and the GC site are in poor condition, which requires the trains to drive with slow pace (25 km/h), and
they will be refurbished. The abandoned track section between the clay quarry and the new Shakhgaya-West crusher location will need to be partially rebuilt on the same alignment.

After refurbishment, trains will run between 6 – 22 hrs with a frequency of 11-12 trains/day at a speed of 40 km/h. The train lengths will be extended to 15 wagons (70 tonnes each). The official railway crossings will be equipped with signals as a minimum. The use of the various unofficial crossings will be discouraged by signposting.

2.5.6 Shakhgaya-West Quarry and New Crusher Operations

GC plans to re-open the Shakhgaya-West quarry to ensure long-term limestone availability and to stabilise raw material quality input at the optimal silica ratio of 2.6. It is foreseen that the Shakhgaya-West quarry will continuously provide about 35 % of the demand of Kiln 6 operation. Waste limestone from dimensional stone cutting in the backcountry of the plant will continue to be used as the major raw material source for the GC plant. The deposit holds 45–60 Mio tonnes limestone and could be exploited over about 50 years. The quarry area was fenced by GC in 2007 to prevent encroachment by illegal stonecutting activities.

The quarry was originally opened in Soviet times with drill blast operation, however the quarry, including the railway line and loading station, was abandoned since variations in limestone quality were found to be not adequate for production at that time and could not be controlled due to missing knowledge and analysis technology. Garadagh Cement carried out a comprehensive study, including test drilling and sampling of the limestone quality variations, and setup a detailed exploitation plan which takes into consideration the different raw limestone properties found in the quarry area.

As a result, in order to attain flexibility in materials blending, the quarry will be exploited starting simultaneous from 3 different locations.

It is foreseen to establish a conventional drill-blast and load-haul operation. The quarry will be exploited by taking down shallow benches of 5 metres depth from the surface. This will lead to an irregular staircase/plateau surface. If required non-explosive methods, surface mining or ripping could be applied.

11 Installation of automated gates is also under consideration
12 GC is also investigating an alternative mining method (details cf. Section 4)
Blasting will typically be 2–3 times per week (at the same time each day). Depending on the area of the pit, one blast will yield on average between 3,900–10,000 t of limestone rocks. The blasting pattern and magnitude will depend on bench geometry, drilling, and operating requirements.

The blasted limestone will be loaded by wheel-loader or excavator from the muck piles to dump trucks at the various extraction areas from where the trucks drive to the crusher site.

Inside the quarry area, several haul routes will be established to reach the different extraction points. The northwest part will be serviced by a short, new level haul road leading north and turning towards the southeast onto the existing concrete road. For the mining area in the southwest, a haul road will be established which largely follows an existing north-south track, winding up the hillside. Gradients will be less than 14% slope. The central part of the deposit will be reached via a straight and short new haul road following the same elevation level. The layout for the Shakhgaya-West quarry is shown in Figure 2-5.

![Shakhgaya-West Quarry layout](image)
From the quarry, the limestone will be transported on the road ca. 2 km to the new crusher which will be located on the premises of the former operation buildings.

The crushed material will be transported via an elevated conveyor belt about 400 metres across the road to the train loading station.

The crusher and loading site complex comprises (see Figure 2-6):

- the crusher,
- a cross belt analyser for limestone composition analysis 13,
- the belt conveyor from crusher to rail loading silos,
- Diesel tank and filling station for quarry vehicles,
- a washing station for quarry vehicles,
- a quarry office, and
- Parking for vehicles and mobile equipment.

Figure 2-6  
Crusher Site Layout

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13 PGNA - Prompt gamma neutron activation analyzer.
2.6 **OPERATIONAL CONSUMPTION AND RELEASES TO THE ENVIRONMENT**

2.6.1 **Raw Materials**

The raw meal for clinker production at GC currently comprises about 87% limestone, 12% clay, and 1-2% bauxite. For the various cement products 70-80% of clinker is blended with 15-25% volcanic sand and 5% gypsum.

The installation of the new Kiln 6 and the extension of production capacity imply an increased demand of raw materials. GC has performed a study on availability of resources to cover the demand for the next years (Feasibility Study). For available quantities and reserves see Table 2-1 below.

**Limestone**

Currently, the limestone used by Garadagh Cement comes from the dimensional stonecutting area which is located at about 6-8 km north in the backcountry of the GC plant. The locations of the limestone quarries are shown in Figure 2-1. About 30 stone-cutting companies are active in the backcountry area of the plant. 14

The waste limestone material consists of fine and broken, brick-sized blocks which are generated as by-product from dimensional stone-cutting 15. Stone-block cutting yields large quantities of waste stone material (estimated at 40% of all stone quarried in this manner)16 throughout the area. The stone-cutting area from which GC is presently sourcing waste limestone is named Geological Site #1. There are further large stonecutting areas in the vicinity: Vulkan (Geological Site #2) to the west of the clay quarry, and Gulbaht, to the north of Geological site #1. Vulkan is a potential future source in addition to the Geological Site #1 (subject to agreements underway).

It is intended that the supply of the GC plant with waste limestone from dimensional stone cutting areas will continue as long as possible. The total predicted supply timeline of currently identified limestone resources and reserves is more than 50 years.

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14 Stone cutting requires a license. GC has no ownership of the stone cutting areas and does not performe stone cutting at present.
15 “waste of mining-field or other industry” is privileged as a raw material source under Azeri legislation
16 (Garadagh Cement Head Geologist, pers. comm.)
Table 2-1  Lifetime of potential limestone resources and reserves for new dry Kiln 6 operation

<table>
<thead>
<tr>
<th>Deposit</th>
<th>Lifetime of Resources</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste from dimensional stone cutting operations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geological Site #1</td>
<td>7 years</td>
<td>11.5 mio tonnes</td>
</tr>
<tr>
<td>Vulkan (Geological Site #2)</td>
<td>9 years</td>
<td>15 mio tonnes</td>
</tr>
<tr>
<td>Garadagh owned quarries</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shakhgaya West</td>
<td>29.5 years</td>
<td>51 mio tonnes</td>
</tr>
<tr>
<td>Caravan Sarai</td>
<td>12 years</td>
<td>20 mio tonnes</td>
</tr>
<tr>
<td>Total</td>
<td>57.5 years</td>
<td>97.5 mio tonnes</td>
</tr>
</tbody>
</table>

(source: Feasibility study)

Clay (Shale)

Garadagh owns a clay deposit located about 7 km northwest of the plant situated between Geological Site #1 and Vulkan about halfway to the Shakhgaya-West quarry. The deposit consists of 3 compartments (12.3 ha current, 24 ha deposit) with a total volume of about 7 million tonnes each. CG is presently using the southernmost compartment.

The total predicted lifetime of the clay resources and reserves with new dry Kiln 6 operation is more than 80 years (some 20 million t).

Correctives (Additives)

In the past, iron corrective (mill scale) and filter dust from Baku Steel Plant and foundries in the Baku area were used (about 1,500 tonnes/month). As alternative, so called bauxite waste (red mud) is currently shipped from an alumina plant (about 1,700 tonnes/month) located in the city of Ganja.

Gypsum

Gypsum is the most important mineral component for cement grinding. It is bought by GC from four different companies located in the Goranboy district in the western part of Azerbaijan. With the new dry Kiln 6, the demand will increase from currently approximately of 5,800 tonnes/month to some 7,100 tonnes/month.
Other Mineral Components

Trass from a GC owned quarry and volcanic sand from other companies are shipped from regions some 350 to 450 km west of Baku (trass: Tovuz region, volcanic sand: Aghstafa region). With the new dry Kiln 6, the current demand of approximately 23,000 tonnes/month will increase to some 27,000 tonnes/month.

2.6.2 Fuels

Present plant

At present, natural gas is the primary fuel for clinker production at the GC plant. It is supplied by state owned AZERIGAS. Average monthly gas consumption for all 4 kilns in operation is about 13 million cubic meters. The specific heat required for the process is 6.37 GJ/t clinker.

As secondary fuel and for back-up purposes, oil and oil sludges are used which is stored in a 150 m³ storage tank. Three 5,000 m³ aboveground storage tanks (total capacity 15,000 m³) for oil are in a dilapidated state and not used at the moment.

Kiln 6 Project

Operation of Kiln 6 will be based on imported hard coal\textsuperscript{17}. However, the burners of the new dry kiln will have the flexibility to burn different kind of fuels, including also pet-coke\textsuperscript{18}, and other alternative fuels (see Section 4 – Alternatives). Natural gas will continue to be used to a limited extent to serve as secondary fuel, for start-up of the kiln and in the context of short production interruptions or non-availability of coal imports.

For handling of the solid fuels, additional unloading and storage facilities are required. Therefore, a housed raw coal storage, a coal mill and fine coal silos are part of the new components for the Kiln 6 project. For storage of the coal, a closed storage hall will be constructed which will avoid re-suspension of coal dust from piles under windy conditions. For grinding of the coal, a new vertical roller mill will be installed.

\textsuperscript{17} Since there are no hard coal resources available in Azerbaijan, the coal will most likely be imported from Russia.

\textsuperscript{18} Pet-Coke = Petroleum derived coke: solid derived from oil refinery cooker units or other cracking processes.
The monthly demand of coal will be approximately 15,000 tonnes. The specific heat required for the process will be 3.2 GJ/t clinker.

The exhaust of the coal mill will be equipped with bag filters for control of coal dust emissions. Burning of the solid fuel will generate no waste or ashes since these are incorporated in the clinker and thus substitute raw-material.

2.6.3 Energy Demand

Despite the fact that production capacity is increased with the new Dry Kiln 6 by more than 50%, only the electrical energy demand will increase. With the dry process technology, the specific thermal energy consumption for clinker production will significantly drop by about 50% (from 6,369 kJ/kg clinker to 3,200 kJ/kg clinker). The specific electrical energy consumption will slightly increase by 16% (from 81 kWh/t cement to 94 kWh/t cement) because slurry preparation is replaced by raw materials grinding which requires more electricity, and due to fuel switch from gas to coal and the resulting additional electrical energy demand for grinding the coal.

2.6.4 Emissions to the Air

2.6.4.1 Current Operation

The waste gas of the currently operated four kilns is exhausted via an electrostatic precipitator (ESP) for each kiln. Thereafter the dedusted waste gas is emitted into the atmosphere via 65 m high stacks. There are three separate stacks: older individual stacks for kiln #1, kiln #2, and a newer common stack for kilns #3 and #4.

The ESPs at the present kilns were repaired and upgraded after privatization to reduce dust emissions to locally permissible limits. Still, present plant operations constitute a major source of dust in the area with the plants emission plume being visible from far distance.
Other relevant point sources are associated with ventilation and dedusting systems of silos, conveyors, and the grinding areas (clinker mills, cement mills).

Open, uncovered or partly open unloading and storage areas for raw materials and clinker are sources of fugitive dust emissions in particular generated from loading activities and re-suspension by strong winds. A maximum of 80,000 tonnes of clinker is stored outdoors for the current operation and some 65,000 tonnes of various raw materials and clinker are stored in halls with open façade fronts.

Since 2001, GC has performed comprehensive measurements of plant emission sources. Emissions of the kilns are monitored annually. As a reaction on the results, GC took measures to improve the efficiency of the emissions control equipment and thus to reduce atmospheric emissions.
Concentrations noted in the last monitoring report dated January 2008 are shown in Table 2-2.

For comparison, Table 2-2 also shows emission concentration values reported for cement plants in Europe. These figures are taken from the European BREF19 document for cement industries and summarize the variations resulting from the different production and emission control techniques employed and also from the age of the installations. Higher values often refer to older plants with less efficient emissions control.

<table>
<thead>
<tr>
<th>Substance</th>
<th>Emission concentration at kilns #1 to #4; (range in mg/Nm³ *)</th>
<th>Emission concentrations of cement kilns in Europe; (range in mg/Nm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particulate Matter (Dust)</td>
<td>170 – 230</td>
<td>5 – 200</td>
</tr>
<tr>
<td>Carbon monoxide (CO)</td>
<td>70 – 120</td>
<td>500 – 2,000</td>
</tr>
<tr>
<td>Nitrogen oxides (NOx)</td>
<td>390 – 900</td>
<td>200 – 3,000</td>
</tr>
<tr>
<td>Sulphur dioxide (SO₂)</td>
<td>30 - 180</td>
<td>&lt; 10 – 3,500</td>
</tr>
<tr>
<td>Heavy metals (sum)</td>
<td>0.10 - 0.13</td>
<td>0.005 – 0.3</td>
</tr>
</tbody>
</table>

*) Normalized for dry gas flow at normalized conditions (indicated by Nm³) for 0°C temperature and 1013 hekto Pascal (1013 mbar) pressure and reduced by the water content


The measurements revealed high filter efficiencies of more than 99 % for the ESPs with regard to particulate reduction meaning that less than 1 % of particulates can pass through the ESPs. Nevertheless, concentrations measured in 2008 at Garadagh show higher dust emissions than reported for the plants described for Europe in the BREF. Since the installed ESPs no longer represent state of the art technologies; modern baghouse filters are proposed for the Project, providing a high efficiency.20

20 It can be well assumed that particulate emissions were considerably higher in former times.
It can be seen from Table 2-2 that, compared to the European plants, the measured emission concentrations are low for sulphur dioxide (SO$_2$), low for carbon monoxide (CO), and average for nitrogen oxides (NO and NO$_2$) and the sum of heavy metals.

Average concentration values measured for other gases were: 36 mg/Nm$^3$ for hydro chloride (HCl), 0.2 mg/Nm$^3$ for hydro fluoride (HF), 20 mg/Nm$^3$ for ammonia (NH$_3$).

Concentration values for heavy metals on average were 59 µg/Nm$^3$ for manganese (Mn), 25 µg/Nm$^3$ for lead (Pb), 11 µg/Nm$^3$ for copper (Cu), between 10 and 5 µg/Nm$^3$ for cadmium (Cd) and chromium (Cr), between 5 and 1 µg/Nm$^3$ for arsenic (As) and nickel (Ni), and below 1 µg/Nm$^3$ for mercury (Hg), cobalt (Co), tin (Sn), thallium (Tl), and vanadium (V).

Measurements of organic compounds showed average values of 17 mg/Nm$^3$ for volatile organic compounds (VOC), 0.012 mg/Nm$^3$ for benzene, and 0.007 ng TEQ/Nm$^3$ for dioxins and furans.

Table 2-3 summarizes the hourly mass flow rates of the emissions from the four kilns based on the measured concentration values.

---

21 Due to low sulfur content in the fuel gas, the presently used raw materials, and wet process related incorporation of sulfur within the clinker.

22 TEQ –toxic equivalent, calculated according to international standards which takes into consideration the relative toxicity of the different dioxins and furans.
### Table 2-3  
**Current Emissions to the Atmosphere from Kilns #1 through #4 given as Mass Flow Rates**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Kiln #1</th>
<th>Kiln #2</th>
<th>Kiln #3</th>
<th>Kiln #4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gas flow</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gas flow, not normalized</td>
<td>m³/h</td>
<td>234,300</td>
<td>239,300</td>
<td>255,600</td>
<td>230,500</td>
</tr>
<tr>
<td>Gas flow; wet</td>
<td>Nm³/h</td>
<td>155,500</td>
<td>160,400</td>
<td>166,800</td>
<td>138,700</td>
</tr>
<tr>
<td>Gas flow; dry</td>
<td>Nm³/h</td>
<td>126,600</td>
<td>132,700</td>
<td>134,700</td>
<td>111,200</td>
</tr>
<tr>
<td><strong>Gases</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon monoxide (CO)</td>
<td>kg/h</td>
<td>10</td>
<td>12</td>
<td>10</td>
<td>16</td>
</tr>
<tr>
<td>Nitrogen oxides (NOₓ)</td>
<td>kg/h</td>
<td>56</td>
<td>54</td>
<td>135</td>
<td>71</td>
</tr>
<tr>
<td>Sulphur dioxide (SO₂)</td>
<td>kg/h</td>
<td>6</td>
<td>4</td>
<td>4</td>
<td>21</td>
</tr>
<tr>
<td>Hydrogen chloride (HCl)</td>
<td>kg/h</td>
<td>8</td>
<td>4</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Hydrogen fluoride (HF)</td>
<td>kg/h</td>
<td>0.03</td>
<td>0.04</td>
<td>0.03</td>
<td>0.04</td>
</tr>
<tr>
<td>Ammonia (NH₃)</td>
<td>kg/h</td>
<td>3.5</td>
<td>2.0</td>
<td>3.6</td>
<td>2.3</td>
</tr>
<tr>
<td><strong>Particulate matter</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dust</td>
<td>kg/h</td>
<td>33</td>
<td>24</td>
<td>39</td>
<td>29</td>
</tr>
<tr>
<td><strong>Heavy metals</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sum</td>
<td>g/h</td>
<td>15</td>
<td>18</td>
<td>16</td>
<td>14</td>
</tr>
<tr>
<td>Arsenic (As)</td>
<td>g/h</td>
<td>0.2</td>
<td>0.2</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Cadmium (Cd)</td>
<td>g/h</td>
<td>1.3</td>
<td>1.2</td>
<td>1.0</td>
<td>0.7</td>
</tr>
<tr>
<td>Cobalt (Co)</td>
<td>g/h</td>
<td>0.03</td>
<td>0.06</td>
<td>0.04</td>
<td>0.03</td>
</tr>
<tr>
<td>Chromium (Cr)</td>
<td>g/h</td>
<td>1.4</td>
<td>0.4</td>
<td>0.9</td>
<td>1.2</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>g/h</td>
<td>2.3</td>
<td>1.5</td>
<td>1.2</td>
<td>1.0</td>
</tr>
<tr>
<td>Mercury (Hg)</td>
<td>g/h</td>
<td>0.02</td>
<td>0.02</td>
<td>0.03</td>
<td>0.04</td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td>g/h</td>
<td>8</td>
<td>11</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Nickel (Ni)</td>
<td>g/h</td>
<td>0.5</td>
<td>0.3</td>
<td>0.3</td>
<td>0.2</td>
</tr>
<tr>
<td>Lead (Pb)</td>
<td>g/h</td>
<td>1.4</td>
<td>4</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Tin (Sn)</td>
<td>g/h</td>
<td>0.05</td>
<td>0.04</td>
<td>0.02</td>
<td>0.03</td>
</tr>
<tr>
<td>Thallium (Tl)</td>
<td>g/h</td>
<td>0.02</td>
<td>0.03</td>
<td>0.06</td>
<td>0.03</td>
</tr>
<tr>
<td>Vanadium (V)</td>
<td>g/h</td>
<td>0.04</td>
<td>0.02</td>
<td>0.03</td>
<td>0.02</td>
</tr>
<tr>
<td><strong>Organic Compounds</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volatile Organic Compounds (VOC)</td>
<td>kg/h</td>
<td>2.2</td>
<td>1.6</td>
<td>2.7</td>
<td>3</td>
</tr>
<tr>
<td>Benzene</td>
<td>g/h</td>
<td>0.3</td>
<td>0.7</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Dioxins/Furans</td>
<td>µg TEQ/h</td>
<td>0.8</td>
<td>1.0</td>
<td>1.1</td>
<td>1.1</td>
</tr>
</tbody>
</table>

Measurements were also carried out at other point sources of dust, like silo exhausts and at the clinker grinding shop. For dust emission control these sources are provided with bag fabric filters. In 2003, the dust emissions at 14 of these sources were measured and found to range widely between 0 and 530 mg/Nm³ with a total mass flow of about 11 kg per hour which was about 9% compared to the 124 kg/h mass flow from the four kilns (Environmental Baseline Study, Report No 79103024, DNV, 2003; and Garadagh Cement Emission Monitoring 2005, Azecolab Project C002P26FR, Azecolab, 2006).

The currently operated open storage areas with loading and unloading are sources of fugitive dust emissions, in particular under windy conditions. The fugitive emissions are estimated to about 25 kg/h (for details refer to Section 3.8).

The point sources add to dust emissions of 135 kg/h for the current operation, including the fugitive emissions this becomes a total of 160 kg/h.

**Greenhouse Gases**

Carbon dioxide (CO₂) emissions from cement production are generated by three processes:

- Conversion of limestone to calcium oxide: CaCO₃ -> CaO + CO₂
- Combustion of fuels, and
- Indirectly through generation of electricity in a power plant.

The CO₂ emissions from burning limestone are independent of the process employed and only depend on the amount of limestone used per unit time.

The fuel used in the present wet process serves two aspects:

- to dry the raw material slurry, and
- to provide hot gas for the clinkering process.
For the wet kiln operation, CO₂ emission figures for 2010 (prior to new kiln operation) are provided in the Feasibility Study (2007) as follows:

- Annual total CO₂ gross²⁴ emissions of the site (2010): 739 million tonnes CO₂
- Corresponding specific CO₂ emissions: 629 kg CO₂/t cement²⁵

Other greenhouse gases like nitrous oxide (N₂O) or methane (CH₄) are in general not emitted from cement plants.

**Odours**

Emission of odorous substances is not common with cement production. However, for the current operation the slurry can pose a source of odours in case the slurry water contains organic substances which are evaporated and/or decomposed. It was reported that the water used for slurry preparation sometimes is provided in a not completely treated quality by the suppliers, who are the Sahil municipal WWTP and BP Sangachal terminal. Hence, generation of odours may happen during slurry preparation, in particular as fugitive emissions from the open slurry basins. After the slurry is fed into the kiln, organic compounds including the odorous substances may be evaporated and not be destroyed.

### 2.6.4.2 New Dry Kiln 6 Operation

With the installation of the new kiln and decommissioning of the old kilns, the main sources of air emissions will shift from the old stacks to the stacks of the new kiln. The main stack of the pre-heater will be about 140 m high to overtop the pre-heater/pre-calciner tower and to enable free dispersion of the emissions. The kiln and pre-heater dust emissions are controlled by highly efficient fabric bag filters. Since the exhaust gas is too hot for the fabric filters, it has to be cooled by water injection in a downcomer (alternatively a conditioning tower) installed prior to the fabric filters baghouse. Extracted

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²³ The above figures are based on a production of 0.838 million tonnes of clinker and 1.245 million tonnes of cement.

²⁴ Gross values include the CO₂ emissions from the clinker process and also those associated with the generation of energy by the power supplier.

²⁵ Specific emissions, meaning the CO₂ emissions per tonne of produced cement, are commonly calculated in order to compare different plants (for benchmarking, see Section 2.11).
dust is conveyed to the cement grinding or re-introduced into the kiln feed via an interim storage silo.

Nitrogen oxide emissions from the kiln are reduced by installation of low NOx burners in the pre-calciner and the kiln (staged combustion), and SNCR (Selective Non Catalytic Reduction) equipment.

Table 2-4 provides the emission data predicted for the new dry Kiln 6. It can be seen that dust concentration will significantly reduce from presently 200 mg/Nm³ levels to below 30 mg/Nm³.

Due to the fuel switch to coal, the sulphur content in the fuel will increase. This, however, will have no significant impact on the SO₂ stack emissions since sulphur is retained in the clinker.

Table 2-4 Maximum expected new dry Kiln 6 emission concentrations

<table>
<thead>
<tr>
<th>Pollutant Substance</th>
<th>New Dry Kiln 6 emissions in mg/Nm³ (design parameters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dust</td>
<td>&lt;30</td>
</tr>
<tr>
<td>Carbon monoxide (CO)</td>
<td>&lt; 500</td>
</tr>
<tr>
<td>Nitrogen oxides (NOx)</td>
<td>&lt;500</td>
</tr>
<tr>
<td>Sulphur dioxide (SO₂)</td>
<td>&lt;200 (compound operation)26</td>
</tr>
<tr>
<td></td>
<td>&lt;500 (direct operation)</td>
</tr>
<tr>
<td>Heavy metals (sum)</td>
<td>&lt; 0.1</td>
</tr>
<tr>
<td>Total organic carbon</td>
<td>&lt;100</td>
</tr>
<tr>
<td>Ammonia (NH₃)</td>
<td>&lt;40</td>
</tr>
</tbody>
</table>

Hot air from the clinker cooler is exhausted from a 30 m high stack after control of dust with fabric filters. The filtered dust is transferred into a clinker silo via the clinker transport system.

Other sources of air emissions comprise the storages, mills, and transport systems:

26 There are two differing operation modes: Compound and direct operation. Compound operation is used in 80-90% of the production time, meaning that the hot gas of the kiln is fed back into the kiln via the raw mill. Direct operation is used in 10-20% of the production time when the raw mill is not operated. SO₂ emissions during direct operation are higher due to lacking sulphur absorbing processes which occur during milling.
Open storage

The present plant has many open storage areas which favours dust generation. With the plant modernization, housed storages will reduce the potential for re-suspension of dust through wind. All new storages are enclosed and exhaust air will be controlled by fabric filters.

Mills

The raw mill receives a portion of the hot waste gas from the kiln for drying of the raw meal. The dust containing waste gas is re-circled to the kiln's waste gas stream and dust emissions thus controlled in the baghouse.

The coal mill also uses a portion of the kiln's hot waste gas for drying the coal. The waste gas is treated by fabric filters to control coal dust emissions.

Transportation

Conveyors will be enclosed and exhausted as controlled waste air streams to avoid fugitive dust emissions.

Overall, the emission situation will significantly improve with the new dry Kiln 6.

Table 2-5 summarizes the expected concentration values based on the hourly mass flow rates for the future new dry Kiln 6 operation.
### Table 2-5  
*Emissions to the Atmosphere from the future Main Stack of New Dry Kiln 6*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>New Dry Kiln 6 air emissions (maximum estimate)</th>
<th>Mass flow</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gas flow</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gas flow; dry</td>
<td>313,000 Nm³/h</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Gases</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon monoxide (CO)</td>
<td>157 kg/h</td>
<td>500 mg/Nm³</td>
<td></td>
</tr>
<tr>
<td>Nitrogen oxides (NOx)</td>
<td>157 kg/h</td>
<td>500 mg/Nm³</td>
<td></td>
</tr>
<tr>
<td>Sulphur dioxide (SO2)</td>
<td>157 kg/h</td>
<td>&lt;200 (500)²⁷ mg/Nm³</td>
<td></td>
</tr>
<tr>
<td>Hydrogen chloride (HCl)</td>
<td>3 kg/h</td>
<td>10 mg/Nm³</td>
<td></td>
</tr>
<tr>
<td>Hydrogen fluoride (HF)</td>
<td>0.3 kg/h</td>
<td>1 mg/Nm³</td>
<td></td>
</tr>
<tr>
<td>Ammonia (NH3)</td>
<td>12 kg/h</td>
<td>40 mg/Nm³</td>
<td></td>
</tr>
<tr>
<td><strong>Particulate matter</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dust</td>
<td>9.4 kg/h</td>
<td>30 mg/Nm³</td>
<td></td>
</tr>
<tr>
<td><strong>Heavy metals</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sum</td>
<td>31 g/h</td>
<td>0.1 mg/Nm³</td>
<td></td>
</tr>
<tr>
<td>Arsenic (As)</td>
<td>0.3 g/h</td>
<td>1 µg/Nm³</td>
<td></td>
</tr>
<tr>
<td>Cadmium (Cd)</td>
<td>2.1 g/h</td>
<td>6.7 µg/Nm³</td>
<td></td>
</tr>
<tr>
<td>Cobalt (Co)</td>
<td>0.08 g/h</td>
<td>0.25 µg/Nm³</td>
<td></td>
</tr>
<tr>
<td>Chromium (Cr)</td>
<td>1.9 g/h</td>
<td>6 µg/Nm³</td>
<td></td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>3 g/h</td>
<td>10 µg/Nm³</td>
<td></td>
</tr>
<tr>
<td>Mercury (Hg)</td>
<td>3 g/h</td>
<td>10 µg/Nm³</td>
<td></td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td>16 g/h</td>
<td>52 µg/Nm³</td>
<td></td>
</tr>
<tr>
<td>Nickel (Ni)</td>
<td>0.6 g/h</td>
<td>2 µg/Nm³</td>
<td></td>
</tr>
<tr>
<td>Lead (Pb)</td>
<td>7 g/h</td>
<td>21 µg/Nm³</td>
<td></td>
</tr>
<tr>
<td>Tin (Sn)</td>
<td>0.07 g/h</td>
<td>0.2 µg/Nm³</td>
<td></td>
</tr>
<tr>
<td>Thallium (Tl)</td>
<td>0.07 g/h</td>
<td>0.2 µg/Nm³</td>
<td></td>
</tr>
<tr>
<td>Vanadium (V)</td>
<td>0.05 g/h</td>
<td>0.17 µg/Nm³</td>
<td></td>
</tr>
<tr>
<td><strong>Organic Compounds</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volatile Organic Compounds (VOC)</td>
<td>14 kg/h</td>
<td>45 mg/Nm³</td>
<td></td>
</tr>
<tr>
<td>Benzene</td>
<td>900 g/h</td>
<td>3 mg/Nm³</td>
<td></td>
</tr>
<tr>
<td>Dioxins/Furans</td>
<td>31 µg TEQ/h</td>
<td>0.1 ng TEQ/Nm³</td>
<td></td>
</tr>
</tbody>
</table>

**Source:** Calculated from maximum average emission concentrations provided with the Feasibility Study / or calculated from dust emissions monitoring data by Garadagh Cement).

²⁷ For SO2 the annual average emission concentration will be below 200 mg/Nm³; 500 mg/Nm³ is the maximum for direct operation during 10-20% of annual operation time (cf. footnote 26)
The emission values summarized in Table 2-5 are based on the following:

- **Gases**: Maximum concentrations as per the Feasibility Study and regulatory requirements.
  - For SO₂, the Feasibility Study states that an average emission concentration of 200 mg/Nm³ or lower can be reasonably expected due to the general low sulphur content of the raw limestone materials\(^{28}\).
  - For the ammonia (NH₃) emissions, values of a factor of 3 lower can be assumed based on the raw material data. However, operation of a SNCR for nitrogen oxide reduction\(^{29}\) may cause some additional ammonia emissions due to ammonia slip.

- **Dust**: Maximum concentration as per the Feasibility Study and regulatory requirements.

- **Heavy metals**: Content in the dust was assumed to be unchanged compared with the current dust. Variations of some 20-50% can result from varying heavy metal content in the raw materials and through usage of the solid fuels.

- **Organic Compounds**: Concentrations are conservative figures since these substances will be destroyed in the kiln as demonstrated by the measurements for the wet kilns. Operational concentrations might be lower by factors of 3 for VOCs (<15 mg/Nm³), a factor of 10 for dioxins/furans (<0.01 ng TEQ/Nm³), and a factor of more than 30 for benzene (0.1 mg/Nm³).

- Overall the given values are considered conservative average figures which will not be exceeded during normal operation.

Beside the kiln, there will be other major point sources of dust emissions, like the clinker cooler, the coal mill, the clinker grinding shop, and exhausts of silos. For dust emission control all sources will be provided with fabric filters to meet a maximum dust emission concentration of 30 mg/Nm³. Considering these measures, the maximum total mass flow of dust from all future point sources will be about 35 kg per hour, which is significantly lower than the 125 kg/h of the current operation. Current fugitive dust emissions (estimate 27 kg/h) will be significantly reduced below 3 kg/h by enclosing the open storages (for details refer to Section 5.2 – ambient air impact).

---

\(^{28}\) The fuel switch from gas to coal is not relevant in this regard, since sulphur from the fuel is bound in the clinker as pyrite.

\(^{29}\) Reduction of NO in the SNCR is done by injection of ammonia or urea solution which can have some surplus ammonia emissions if the dosage is higher than necessary for NO reduction.
Greenhouse Gases

For the dry kiln operation, CO₂ emission figures for 2013 are reported in the Feasibility Study as follows:

- Annual total CO₂ gross emissions of the site (2013):
  1,030 million tonnes CO₂

- Corresponding specific CO₂ emissions:
  606 kg CO₂/t cement

The above figures are based on a production of 1.241 million tonnes of clinker and 1.7 million tonnes of cement.

For the three sources of CO₂ emissions, the following can be stated:

- The CO₂ emissions from burning limestone (conversion into CaO) are independent of the process employed and only depend on the amount of limestone used per unit time, therefore there is not much difference between the wet and dry process for this share in the specific emissions, which is roughly 60%.

- The primary fuel will be changed in the future from natural gas to hard coal. Since hard coal has a CO₂ emissions coefficient nearly twice the value of natural gas, the increased energetic efficiency of the dry kiln (also a factor of about two) has only a limited reducing effect on the overall CO₂ balance.

- Indirect CO₂ emissions from electricity generation will increase slightly due to higher electricity demand for operation of additional equipment, in particular for the raw mill and the coal mill. These figures are not included in the figures given above.

Therefore, the gross specific CO₂ emission overall will decrease only slightly a little from 629 to 606 kg/t cement.

Table 2-6 summarizes the CO₂ emission figures for the current and future operation. Beside the gross CO₂ emissions the table also includes the net CO₂ emissions. The net CO₂ emissions do not include the emissions from alternative fuels. For the table a thermal substitution rate of 5% with alternative fuels is assumed.
Table 2-6  

<table>
<thead>
<tr>
<th></th>
<th>Existing Plant estimation for 2010 (0.838 million t clinker/a, 1.245 million t cement/a)</th>
<th>New Dry Kiln 6 estimation for 2013 (1.241 million t clinker/a, 1.700 million t cement/a)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>t CO₂/a</td>
<td>kg CO₂/t cement</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>------------------------------</td>
<td>------------------------------------</td>
</tr>
<tr>
<td>Gross CO₂ emissions</td>
<td>739,000</td>
<td>629</td>
</tr>
<tr>
<td>Net CO₂ emissions</td>
<td>698,000</td>
<td>594</td>
</tr>
</tbody>
</table>

For gross and net explanation c.f. Footnote 24.

Overall, the CO₂ gross emissions of the cement production will increase by 40 % from presently 739,000 t/a to 1.03 Mio t/a, which corresponds with a clinker production increase of 48%. The specific gross CO₂ emissions per tonne of cement will be reduced by 4 % and the specific net CO₂ emissions only by about 1 %.

As already mentioned above, other greenhouse gases like dinitrogen oxide (N₂O) or methane (CH₄) are not emitted from cement plants in general.

Odours

The current plant operation has a potential source for odour emissions from the water used for slurry preparation. Emission of odorous substances is not expected for the new dry Kiln 6 operation, since no slurry has to be prepared.

2.6.4.3  

Shakhgaya-West Quarry

Beside emissions from vehicles moving on the quarry area and to the loading area, the following sources of air emissions will be present:

- The crusher as source of dust emissions will be provided with bag filters to achieve emission concentration below 30 mg/Nm³.
- The blasting and hauling activities generate dust emissions. Blasting will occur only once per day.

The quantities of air emissions related to these activities are only minor.
2.6.5 Water Demand and Discharge of Wastewater

2.6.5.1 Current Operation

Water demand and supply

The wet kiln process requires substantial amounts of water. The water demand for slurry preparation is about 600,000 m³ per year. For this purpose, mainly treated or partially treated wastewater from the public Sahil WWTP is used. In addition, the CG plant receives so-called produced water from the Sangachal oil terminal.

Potable water is supplied to the GC plant by AZERSU JC from the fresh water pipeline which passes the site. The water in this pipeline originates from the Kura River.

Wastewater Discharge

Slurry water is evaporated in the kiln and is a visible component of the plume. About 93 t H₂O per hour are released to the atmosphere via the stacks.

Other wastewater on the Garadagh site originates from sanitary and cooling purposes, and rainwater. This wastewater is discharged via the sewer system to the Sahil WWTP that is located about 1 km from the site. There is no pre-treatment of wastewater on site.

Figure 2-7 provides both the water supply and wastewater streams with flow rates.

---

30 approximately 0.7 m³ water / t clinker
31 Since the Sahil WWTP is not effectively treating wastewaters, the GC plant presently provides relief to the Caspian Sea, since insufficiently treated wastewater effluent is used for slurry preparation and evaporated in the kiln.
32 water separated from crude oil
2.6.5.2 New Dry Kiln 6 Operation

The future water supply and discharge situation is shown in Figure 2-8.

Water demand and supply

In the future, the slurry water demand becomes obsolete, since Kiln 6 with the dry process requires no water for the preparation of the raw-material to be fed into the kiln. Technical water will still be required mainly for water injections in the process, cooling of equipment and of waste gas. Since treated wastewater does not fulfil the technical requirements of the modern plant, this water will come from the public water pipeline. In addition, water will be needed for washing and for sanitary purposes. In order to use the fresh water in an environmentally responsible manner, the application of a circulating...
water system by the Project will reduce the annual use of cooling water to about 30,000 m³/a. The total annual water demand of the modernized plant will be about 211,500 m³/a, with peak demand of approximately 85 m³/h.

The technical water system will have a dosing system for corrosion inhibitor injection and biocide injection. However, since the water source for process water is potable water, it is not anticipated that anti-scaling / antifouling agents for water would actually be required. If required, GC will use least hazardous alternatives (with regards to toxicity, biodegradability, bioavailability, and bioaccumulation potential). Doses will conform with local regulatory requirements and manufacturer recommendations.

**Wastewater Discharge**

As in at present situation, the plant after modernization will produce wastewater from sanitary and cleaning purposes and in addition spent water from the cooling system. This wastewater will be discharged via the sewer to the Sahil WWTP.

However, the Sahil WWTP is in poor physical condition and the biological processes are frequently inactive. International standards require, in such case, that GC will pre-treat the wastewater as part of the own operations on site. The Project therefore includes a compact wastewater treatment unit to pre-treat its effluent to the quality required by Azeri and international standards for discharge to a receiving water body.

Should any chemical dosing be applied in the cooling system, the treated effluent will need to fulfil the Azeri requirements and the IFC Standards for process wastewater discharge. Testing for residual biocides and other pollutants of concern will be conducted to determine the need for dose adjustments or separate treatment of residual cooling water prior to discharge.

---

33 See IFC General EHS Guideline: p27 on effluent discharge to public sewage system

Figure 2-8  Water Flow Diagram of the Future Dry Kiln Operation

2.6.5.3  Water balance existing vs. future operation

With the Project implementation the fresh water consumption at GC will be reduced by about 15 %, while the overall water consumption will be reduced by about 24 %. A key factor in future reduction of water use is the recirculation of cooling water. The future waste water discharge besides being about 57 % lower volume than present, will more significantly be of a much better quality (after on-site treatment) than the present untreated discharge to Sahil WWTP.
Table 2-7  Water Balance – comparison between existing Kiln 1–4 and new Kiln 6

<table>
<thead>
<tr>
<th></th>
<th>Kiln 1-4</th>
<th>Kiln 6</th>
<th>Difference new – old</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average cubic meter per year based on monthly average</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potable water (city water supply pipeline)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- for Domestic Consumption in the plant</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- for cooling water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- for process purposes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- for washing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process Water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- from sewage water (WWTP)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- from produced water BP (Sangachal oil terminal)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total water consumption</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wastewater discharge</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.6.5.4  Shakhgaya West Quarry

The quarry and crusher area will not require the supply of water, except the use of tank trucks for moistening of dusting areas, and shipment of sanitary water.

2.6.6  Hazardous Materials

Present plant operations involve a very limited number of hazardous substances including:

- Diesel for trains and trucks fuelling, and
- Chemicals (minor amounts of paints, solvents and lubricants) for maintenance and repair work.
- Lubricants
After the plant modernisation the situation will change as follows:

- The operation of SNCR requires either (i) an ammonia storage tank (as 10% solution) or (ii) solid urea (pellets, powder) storage and a respective solution preparation tank; and
- Hydraulic oils for mills/kiln will be used and stored. The overall amount of hydraulic oils and lubricants will not increase.

2.6.7 Waste Management

In general, only few wastes are generated at the cement plant.

2.6.7.1 Current Operation

Present operations create following types of waste:

- clinker kiln dust from electrostatic precipitators (ESP),
- waste oil,
- empty grinding aid (IBCs – international bulk container; 1 m³) and media,
- metal scrap (repair works),
- fireclay bricks (from kiln liner repairs),
- construction debris,
- fluorescent tubes,
- Asbestos from e.g. roofing,
- General/domestic type garbage.

Before privatization cement kiln dust and construction waste was landfilled in the southern part of the site; areas cover 5.5 ha and 3.1 ha with landfilled layers of 1-4.5 m.

GC holds a contract with a licensed government organization ("Sanitary-Communal Remediation") for disposal of recyclable and non-recyclable solid waste. Scrap metal is reused or sold to scrap dealers.

Liquid waste is mainly waste oil generated in the plant from maintenance. The waste oil is collected in 200 l drums or other suitable containers and disposed via an authorized disposal company.

For the Kiln 6 project, 148,103 m³ of previously dumped cement kiln dust (from an estimated total 275,000 m³ was excavated and disposed of at the
Garadagh District hazardous waste disposal facility near Lokhbatan by a licensed contractor in the first half of 2008.

2.6.7.2 **New Dry Kiln 6 Operation**

For the future operation, there will no longer be dust from ESPs. Also the generation of waste oil will be reduced with employment of modern equipment. Besides this, no significant changes of waste types and quantities are anticipated. In the plant, dust will generally be collected in the fabric filters and reintroduced into the process. Only minor amounts of dust can be generated in the course of maintenance cleaning. 35

The technical water treatment and wastewater pre-treatment will produce only minor quantities of sludge.

Waste disposal will be managed the same way as today. As with present operations, wastes from the modernized plant will be disposed of by contracted licensed disposal companies.

2.6.7.3 **Shakhgaya West Quarry**

Only minor amounts of waste will be generated at the quarry site. They will be collected in appropriate drums or containers and shipped to the production site for disposal via the licensed disposal companies. There will be no need for the removal of overburden.

2.6.8 **Noise Emissions**

2.6.8.1 **Current Operation**

Present plant operations do not cause significant noise impact at the nearest residential areas at Sahil Settlement.

The relevant sources of noise from current operations are the kilns, the mills, compressors, fans, conveyors, on site truck traffic with loading/unloading activities, front loader activities at open storage piles, moving and unloading

35 In case that alternative fuel material (AFR) with high chlorine content would be used in the future, in order to avoid chlorine enrichment in the clinker, dust filtered out by the bag filters has to be removed and disposed of.
of trains. More details are provided in Section 3.9 (noise baseline), where the results of ambient noise monitoring and modelling for the present situation are documented.

2.6.8.2 New Dry Kiln 6 Operation

For the future operation the noise sources will change as follows:

- New sources are the new kiln, the raw mill and the coal mill and belt conveyors.
- On site traffic will increase due to the higher transportation volumes for raw material and cement shipping.
- On the other hand, the old kilns will be decommissioned, and
- Since open storages will be enclosed, moving of loaders and trucks will be drastically reduced.

As per specification for the guarantee value for the equipment supplier, the noise impact generated by the Kiln 6 operations at the nearest residential area of Sahil shall not exceed levels of 45 dB(A) at daytime or 40 dB(A) during night time. The EPC contractor will have to optimise the plant design accordingly. In particular, significant noisy components such as the mills will be enclosed in buildings. Noise generating equipment will be provided with noise reducing dampers or shielding as necessary to achieve compliance with these limit values.

At the Shakhgaya West quarry area and the crusher and loading site, noise will be generated by blasting activities, usage of exploitation equipment, operation of the crusher and loading and transportation activities. Since no sensitive receivers are in the vicinity, the operational health and safety limits for noise exposure of workers is relevant.

2.6.8.3 Shakhgaya West Quarry

Noise sources related to Shakhgaya West operations are blasting and hauling. Blasting will occur only once per day. Blasting noise is extremely loud and may be noticeable even in a large distance. Therefore, an alarm signal will be given prior to the blasting to warn people in the vicinity.
2.6.9 Off-site Transportation

Off site transportation of raw materials and cement is carried out by trucks (mainly 30 t capacity) or railway wagons (70 t). Table 2-8 provides transportation figures for the current and the future situations.

Raw materials

Trains operated by GC for hauling limestone and clay are presently composed of 6 wagons with 70 t capacity each, i.e. about 420 tonnes capacity per train. Train transport operates in 3 shifts on 7 days a week. In the future train lengths will be extended to 15 wagons, i.e. about 1,000 tonnes capacity per train. Trains will run from 6-22 hrs 5 days per week. In case of special conditions e.g. bad weather this may be increased to 6 days per week.

GC currently operates six locomotives with diesel traction, four for transportation, one for shunting of wagons on site, and one locomotive as back-up for wagons pooling.

For the current production approximately 3,600t limestone and 500 t clay are delivered per day which corresponds with 10 trains per day.

For the future production, another two locomotives will be purchased, one for transportation and a second shunting locomotive.

The future production requires that approximately 5,600t limestone and 800 t clay are delivered per day which corresponds with 8 - 9 trains per day.

Cement shipping

In 2006, transportation of cement product was 94 % by road and 6 % by train. Due to changed structures of customers (smaller companies, sites without rail access) transportation by railway decreased in the last years. About 56 % of the cement was shipped in bags, the remaining was shipped as bulk material in silo trucks or silo wagons. Due to the high truck traffic load some limitations were experienced in the past at the main gate which resulted in jams and delays. This is a major reason for construction of the new gate and separating inbound and outbound traffic at the site.

For the next years, GC has the objective to again increase transportation by train and to reach a share of up to 50 % by 2016.
Table 2-8  Main transportation figures for the current and the future situation

<table>
<thead>
<tr>
<th>Material</th>
<th>Transport by</th>
<th>Sourced from</th>
<th>Annual quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2006</td>
<td>2011</td>
</tr>
<tr>
<td></td>
<td></td>
<td>From</td>
<td></td>
</tr>
<tr>
<td>Limestone</td>
<td>Rail</td>
<td>Limestone waste deposit</td>
<td>1.2 mio t</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Shakhgaya-West</td>
<td>-</td>
</tr>
<tr>
<td>Clay</td>
<td>Rail</td>
<td>Clay deposit</td>
<td>0.22 mio t</td>
</tr>
<tr>
<td>Iron corrective</td>
<td>Truck</td>
<td>Clay deposit</td>
<td>11,400 t</td>
</tr>
<tr>
<td>Volcanic sand/trass</td>
<td>Truck/rail</td>
<td>3rd party quarry in Agstafa Region</td>
<td>0.272 mio t</td>
</tr>
<tr>
<td>Gypsum</td>
<td>Truck/rail</td>
<td>3rd party quarry in Goranboy Region</td>
<td>69,500 t</td>
</tr>
<tr>
<td>Natural gas</td>
<td>Pipe</td>
<td>Azerigas OJSC</td>
<td>157.5 mio Nm³</td>
</tr>
<tr>
<td>Hard coal</td>
<td>Rail</td>
<td>Likely Russia</td>
<td>-</td>
</tr>
<tr>
<td>Clinker</td>
<td>Truck/rail</td>
<td></td>
<td>112,000 t</td>
</tr>
<tr>
<td>Cement total</td>
<td>Truck/rail</td>
<td></td>
<td>1.28 mio t</td>
</tr>
<tr>
<td></td>
<td>- by rail</td>
<td></td>
<td>76,000 t</td>
</tr>
<tr>
<td></td>
<td>- by truck</td>
<td></td>
<td>1.203 mio t</td>
</tr>
</tbody>
</table>

2.6.10  Summary of Operational Consumption and Releases to the Environment

In Table 2-9, a summary of environmentally relevant input and output data is given for the current wet process operation and the future Kiln 6 dry process operation. Key consumptions and releases from operation comprise the following:

- Raw materials consumption;
- Fuel consumption;
- Energy demand and carbon dioxide (CO₂) emissions;
- Emissions to the atmosphere;

³⁶ In the future, hard coal may be partially substituted by limited portion of pet coke. This is presently available only from one refinery near Baku and would be transported to the plant by rail.
- Noise emissions from the installations and vehicle movements;
- Water demand for e.g. cooling, slurry preparation, washing, sanitary purpose;
- Water discharge from wastewater streams (e.g. cooling, washing, sanitary purpose);
- Transportation requirements.

Table 2-9  Consumption and Releases in the Current and the Future Situation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Current Operation (Kilns 1–4)</th>
<th>Future Operation (New Dry Kiln 6)</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process</td>
<td></td>
<td>Wet</td>
<td>Dry</td>
<td></td>
</tr>
<tr>
<td><strong>Production Figures</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinker production capacity</td>
<td>t/d</td>
<td>2,616</td>
<td>4,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>t/a</td>
<td>0.855 million (plus 0.11 million for import)</td>
<td>1.24 million</td>
<td></td>
</tr>
<tr>
<td>Cement production</td>
<td>t/a</td>
<td>1.27 million</td>
<td>1.7 million</td>
<td></td>
</tr>
<tr>
<td>Raw meal to clinker factor</td>
<td>--</td>
<td>1.58</td>
<td>1.58</td>
<td>quantity of raw material per tonne of clinker</td>
</tr>
<tr>
<td>Clinker to cement factor</td>
<td>--</td>
<td>75%</td>
<td>72 - 73%</td>
<td>quantity of clinker used for cement</td>
</tr>
<tr>
<td><strong>Raw materials consumption</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raw material demand</td>
<td>t/d</td>
<td>4,130</td>
<td>6,320</td>
<td></td>
</tr>
<tr>
<td><strong>Fuel Consumption</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel net calorific value</td>
<td></td>
<td>Natural gas: 34.5 MJ/Nm³</td>
<td>Hard coal: 25-26 MJ/kg (pet coke: 30.7 MJ/kg)</td>
<td></td>
</tr>
<tr>
<td>Fuel consumption</td>
<td></td>
<td>157 mill m³/a</td>
<td>150,000 t/a</td>
<td></td>
</tr>
<tr>
<td>Parameter</td>
<td>Unit</td>
<td>Current Operation (Kilns 1–4)</td>
<td>Future Operation (New Dry Kiln 6)</td>
<td>Comment</td>
</tr>
<tr>
<td>-----------------------------------------</td>
<td>----------</td>
<td>------------------------------</td>
<td>----------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wet</td>
<td>Dry</td>
<td></td>
</tr>
<tr>
<td><strong>Energy demand</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat consumption</td>
<td>GJ/a</td>
<td>5,420</td>
<td>4,680</td>
<td></td>
</tr>
<tr>
<td>Specific heat consumption per</td>
<td>MJ/t clinker</td>
<td>6.37</td>
<td>3.2</td>
<td></td>
</tr>
<tr>
<td>tonne of clinker</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specific heat consumption per</td>
<td>MJ/t cement</td>
<td>4.3</td>
<td>2.3</td>
<td></td>
</tr>
<tr>
<td>tonne of cement</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specific electrical energy demand</td>
<td>kWh/t clinker</td>
<td>59</td>
<td>70</td>
<td>Energy demands are specific for the respective process</td>
</tr>
<tr>
<td></td>
<td>kWh/t cement</td>
<td>81</td>
<td>94</td>
<td></td>
</tr>
<tr>
<td><strong>Air Emissions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume flow, dry</td>
<td>Nm³/h</td>
<td>505,000</td>
<td>313,000</td>
<td>Values for the New Dry Kiln 6 are conservative figures and some may be much lower in real operation.</td>
</tr>
<tr>
<td>Dust / Particulate Matter</td>
<td>kg/h</td>
<td>124</td>
<td>9.4</td>
<td></td>
</tr>
<tr>
<td>NOx</td>
<td>kg/h</td>
<td>315</td>
<td>157</td>
<td></td>
</tr>
<tr>
<td>SO₂</td>
<td>kg/h</td>
<td>35</td>
<td>6337 *</td>
<td></td>
</tr>
<tr>
<td>CO</td>
<td>kg/h</td>
<td>48</td>
<td>157</td>
<td></td>
</tr>
<tr>
<td>HCl</td>
<td>kg/h</td>
<td>20</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>HF</td>
<td>kg/h</td>
<td>0.14</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>NH₃</td>
<td>kg/h</td>
<td>11</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Heavy metals</td>
<td>kg/h</td>
<td>0.063</td>
<td>0.031</td>
<td></td>
</tr>
<tr>
<td>VOC</td>
<td>kg/h</td>
<td>9.4</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Dioxins/furans</td>
<td>µg/h</td>
<td>4</td>
<td>31</td>
<td></td>
</tr>
</tbody>
</table>

* For the New Dry Kiln 6 operation, the utilisation of limestone from Shakhgaya West is already taken into account. Since this limestone contains higher amounts of pyritic sulphur compared to the waste limestone used in 2006 in the old kilns, higher SO₂ emissions were estimated.

**CO₂**
- **t/a**
  - 739,000 (for 2010)
  - 1,030,000 (for 2013)

**Specific gross CO₂ emissions**
- **kg CO₂/t cement**
  - 629
  - 606

---

37 Based on the SO₂ content in the raw material, the SO₂ concentration was estimated to be 200 mg/Nm³ on average, corresponding to 63 kg/h (Feasibility Study). The value of 157 kg/h mentioned in other tables of the ESIA results from a standard design SO₂ concentration of 500 mg/Nm³.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Current Operation (Kilns 1–4)</th>
<th>Future Operation (New Dry Kiln 6)</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process</td>
<td></td>
<td>Wet</td>
<td>Dry</td>
<td></td>
</tr>
<tr>
<td>Noise</td>
<td></td>
<td>For details see Chapter 3.9</td>
<td>For details see Chapter 5.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(noise baseline)</td>
<td>(noise impact)</td>
<td></td>
</tr>
<tr>
<td>Water demand/Wastewater discharge</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potable Water</td>
<td>m³/a</td>
<td>250,000</td>
<td>211,500</td>
<td></td>
</tr>
<tr>
<td>Water – slurry</td>
<td>m³/a</td>
<td>605,000</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Wastewater</td>
<td>m³/a</td>
<td>168,000</td>
<td>72,360</td>
<td></td>
</tr>
<tr>
<td>Wastewater quality</td>
<td></td>
<td>Discharge to Sahil WWTP</td>
<td>Pre-treatment on site prior to discharge to Sahil WWTP</td>
<td></td>
</tr>
<tr>
<td>Waste types</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>waste oil,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>empty grinding aid (BCs – international bulk container; 1 m³) and media,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>metal scrap (repair works),</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>refractory bricks and refractory concrete (from kiln liner repairs),</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>construction debris</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>fluorescent tubes</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>clinker kiln dust from electrostatic precipitators (ESP)</td>
<td>Kiln dust from maintenance cleaning (e.g. in case of accumulation in the filter hopper): 1,000 to 2,000 tonnes per year</td>
<td></td>
</tr>
</tbody>
</table>
Parameter | Unit | Current Operation (Kilns 1–4) | Future Operation (New Dry Kiln 6) | Comment
---|---|---|---|---
Process | | Wet | Dry | 
\textit{Transportation}

Train | Trains/d | 9 - 10 | 8 -9 | Raw material/quarries
(ref 1-2 for other materials and clinker import) | Via national railway grid
Trains/d | 0,3 | 2,4\(^{38}\) | Cement; national grid
Total trains/d | 9 - 10, 1 - 3 | 8 - 9, 4 - 6 | Quarries, national grid
Trucks | Trucks/d | 16 – 18 \(^{39}\) | 13 | Raw materials
Trucks/d | 160 [170] | 150 [230] | Cement [no transportation by rail presumed as worst case]
Total trucks/d | 180 [200] | 170 [250] | 

\subsection*{2.6.11 Monitoring of Air Emissions and Effluents}

\textit{Flue Gas Emission Monitoring System}

Present plant emissions are regularly monitored once a year for substances: NO\(_x\), SO\(_2\), CO, HCl, HF, particulate matter (PM), heavy metals, VOC (as total organic carbon), benzene, dioxins/furans.

Since 2007, a permanent emission monitor is mounted at the common stack of kiln 3 and 4 for NO\(_x\), SO\(_2\), CO, HCl, and PM.

The new dry Kiln 6 will be equipped with continuous monitors for particulate matter, NO\(_x\), CO, SO\(_2\), CO\(_2\), HCl, HF, and VOC. The other components, i.e. heavy metals, ammonia, benzene, dioxins/furans, will be monitored discontinuously once a year. The exhausts of other emission sources, e.g. coal

\(^{38}\) As a general objective, GC intends to increase shipment by train in the next years independent of the realization of the New Dry Kiln 6 project.

\(^{39}\) Based on truck transportation of 10% volcanic sand, 50% gypsum and import clinker
mill, raw mill, grinding, clinker cooler) will be monitored for PM at least once a year.

**Monitoring of Wastewater Discharge**

The efficiency of the wastewater pre-treatment unit which will be installed on site will probably need continuous monitoring of pH, temperature, TSS, BOD and COD (e.g. monthly) as it is common practice for operating the plant.

### 2.7 FIRE PROTECTION, SAFETY AND SECURITY FEATURES

As a general rule, the measures on fire protection, safety and security taken in the course of the new Kiln 6 Project will be in compliance with international and national requirements and standards (e.g. European Norms). A respective requirement will be included as obligation in the EPC contract.

**Fire Protection**

The buildings and facilities at the GC site are provided with a fire detection and depending on the location automatic and/or manual alarm system. Fire fighting water is supplied via an independent water circuit which serves fire hydrants. The water is pumped from a water reservoir of 600 m³ capacity. The site has dedicated fire fighting people.

For the new dry Kiln 6, the existing system will be extended by a separate circuit for Kiln 6 including fire hydrants, fire fighting equipment, separate fire fighting water storage tank, and booster pumps to provide the required water flow rate (minimum 45 l/s) and pressure. The system will serve all buildings and facilities. Fire fighting sections can separated to fight a local fire. Function of the system will be safeguarded via connection to the GC site's emergency power system. Diesel fuelled emergency pumps are planned for back-up. Fire extinguishers will be placed at relevant locations, particularly in electrical rooms and potential fire hazard areas.

**Explosion Prevention**

The operation of the new kiln adds new fire-risk relevant components related to the fuelling with coal, i.e. the coal storage and the coal mill. Fire protection is covered by inclusion in the fire fighting circuit.

The handling of pulverized coal poses a particular risk of explosion, since coal dust can create a potential explosive atmosphere. Therefore, all vessels for pulverized coal will be provided with explosion vents. Temperature and carbon monoxide (CO) will be monitored to automatically alarm the operator.
in case of an irregular situation. The atmosphere in the vessels can be inertized by flooding with carbon dioxide (CO₂) which displaces the oxygen and thus eliminates the potential explosive atmosphere.

At the Shakhgaya West quarry, blasting will involve the usage of explosives. As per Azeri requirements the storage and handling of explosives, including the blasting, has to be performed only by licensed companies. GC will commission a respective company for these works.

*Emergency Power*

The GC site operates an emergency power generation system to ensure reliability of the cooling water circuit, and the fire alarm and fire fighting system in case of power failure or black-out.

There will not be any changes for the future operation.

*Traffic Safety*

Site access at present is via a single entrance gate where the truck traffic often causes a jam. Routing of the on-site traffic routes is not optimized and poses a risk for accidents.

Within the Kiln 6 Project, the on-site traffic will be improved by construction of a second gate for trucks and separate routing for in- and outbound traffic. Thus the risk for accidents will be reduced.

### 2.8 OPERATIONAL MANAGEMENT AND STAFFING

#### 2.8.1 Plant Management

The GC plant is headed by a management group of 40 persons with the General Director as head.

The plant is organised in four operational departments, each headed by a director. Additionally there are four administrative support functions which, in 2008, were expanded by three further functions:
### Operational Departments:
1. Cement Manufacturing / Technical Department
2. Marketing, Sales and Outbound Logistics
3. Financial/Controlling
4. Human Resources

### Support Functions:
1. Legal Services
2. CSR
3. Administration
4. Business Development
5. Communication
6. Internal Audit
7. Aggregates

* effective since 2008

#### 2.8.2 The Plant Organisation

The Garadagh Cement Plant is organised in the units described below. No change of the present organisation structure is necessary for the plant modernisation with the new dry Kiln 6.

**Quarry Activities**

Currently, all quarry activities up to loading to the railway wagons are outsourced to a third party company. The future operations in the Shakhgaya West Quarry will be outsourced as well (i.e. blasting, crushing, loading on lorry, lorry transportation to the crusher, loading to wagons). Rail transportation from the quarry to the GC site will be carried out by GC herself.

**Production**

The production (from raw material delivery to cement grinding) is organised as shift work including all auxiliary activities like raw materials preparation, fuel preparation, cement grinding, dispatch. The production is performed by GC employees.

**Project & Maintenance**

The Project & Maintenance unit is responsible for projects related to installation or construction, and for the planning of preventive maintenance measures (e.g. for fixed and mobile equipment and machinery, water supply and wastewater treatment, spare parts provision). The unit is staffed with GC employees.
Alternative Fuels and Raw Materials (AFR)

Currently the AFR unit is mainly responsible for activities related to receiving and storage of the produced water received from BP. Since the use of other AFR is an option, the unit is also responsible for sourcing of local AFR, communication with potential AFR suppliers and the competent authorities, and for preparation and dosing of AFR.

When the new dry Kiln 6 is operational, the use of the BP water will stop. Also in the future the use of AFR is an option to substitute raw materials or fuel.

Quality Assurance

The Quality Assurance Unit is responsible for the control of the quality of all materials and products by means of analyses.

OH&S, Environmental Security

The OH&S, Environmental Security unit was implemented in March 2007 within the technical department. The team consists of the OH&S, Environmental and Security Manager, a Safety Officer and an OH&S and Security Officer. The unit manages all issues related to environment, occupational health and safety, as well as security. It also coordinates security issues with third party companies.

Administration

The administration activities comprise General Management, Finance/Controlling (contracts, procurement, IT), Marketing/Sales/Logistics, and Human Resources.

Specific management aspects relevant for the adequate completion of a new project are:

- Decentralisation of tasks
- Delegation of tasks and responsibilities
- Establishment of objectives for every level and function (“management by objectives”)
- Control of objectives and performance (“management by results”).
- Participative Management which involves employees as partners of their supervisors by establishing common objectives.
2.8.3 Staffing

2.8.3.1 Current Operation

The GC plant presently employs 462 people are employed in cement production. Production is running on a four shifts 24 hours basis a day and 7 days a week.

Mining activities at the limestone and clay quarries are outsourced to contractors since 2002. Presently 76 contractor employees are working in the quarry operations.

The overall number of employees of Garadagh Cement company is 585, including staff which do not work in the plant at Sahil Settlement itself (e.g. including local sales offices throughout the country).

Further there are several maintenance and subcontractor companies with an average staffing around 50 persons and in peak times approximately 300.

2.8.3.2 New Dry Kiln 6 Operation

Introduction of state-of-the-art technology will lead to increased productivity and as a result will lead to redundancy of obsolete working places and eventually to staff reduction.

The total planned reduction of employment due to the Project will be 72 staff full-time-employments (FTE) once Kiln 6 is in full operation in 2013. Related with the installation of a palletizer system independently from the project another reduction of 10 FTEs is foreseen. Mainly positions for low level skills will become redundant. Garadagh Cement will provide comprehensive assistance programs to the employees subject to redundancy (c.f. Section 5.13.3.5 for details).

In the frame of the Project, significant investment will be made to enhance current skills of the company personnel, technical staff in particular. Internal, on-the-job training sessions for technical staff and visits to other Holcim companies using the dry kiln technology will be organized to bring staff to the required level of proficiency.

In the same time period (2008-2013) the Garadagh Cement will likely employ 54 FTE for the extension of business not related to the project (e.g. aggregates business development).
The numbers of staff for subcontracted work are anticipated to stay about the same as present.

2.9 ENVIRONMENTAL AND HEALTH AND SAFETY (EHS) MANAGEMENT

In 2003, GC implemented an Environmental Management System (EMS) according to ISO 14001 in parallel to the ISO 9001 Quality Management System. The company has a unit for operational health and safety, and environmental and security issues.

The Project will be included in the site's existing management system. Employees' training will include the issues related to the new installations and materials.

The GC plant runs an established Occupational Health and Safety (OHS) management system in line with Holcim corporate requirements. As part of Holcim's corporate EHS policy for providing a safe workplace, there is a system for incident reporting and root cause analysis.

The Holcim corporate OHS management system further guides the implementation of the OHS policy at plant level. Clear organizational accountabilities are supported by a program of training, communication, strict procedural discipline and locally developed policies and action plans. In general employees are required to follow *Five Cardinal Rules*, throughout all Holcim operations, including Garadagh Cement:

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41 Holcim investigates the causes of all accidents throughout the operations and develops corrective measures to avoid them in the future. Based on this, Holcim has identified 14 major causes of fatalities (the most frequent of which were traffic accidents and falling from height). Holcim directives on fatality prevention are being developed and rolled out to address these 14 major causes. The directives encompass hazard identification, risk assessment and controls, training, and maintenance and emergency procedures. Accountabilities are set at each line management level.
### Box 2-1 Holcim Cardinal rules

#### Five Cardinal Rules

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong></td>
<td>Do not override or interfere with any safety provision and do not let others override or interfere with safety provisions.</td>
</tr>
<tr>
<td><strong>2</strong></td>
<td>Personal protective equipment rules applicable to a given task must be adhered to at all times.</td>
</tr>
<tr>
<td><strong>3</strong></td>
<td>Isolation and lock-out procedures must always be followed.</td>
</tr>
<tr>
<td><strong>4</strong></td>
<td>No person may work if under the influence of alcohol or drugs.</td>
</tr>
<tr>
<td><strong>5</strong></td>
<td>All injuries and incidents must be reported.</td>
</tr>
</tbody>
</table>


There is zero tolerance for breaches and a stringent consequence management. All contractors are required to comply with Holcim safety standards, including the *Five Cardinal Rules* and a new directive on contractor safety management will be released by Holcim in 2008.

OHS measures and programs by Garadagh Cement include *inter alia*:

- Training and drill of staff,
- Medical service,
- Regular health examination of staff,
- Designated personal protection equipment (PPE) zones where wearing of safety shoes, hard hat, mask, hearing protection is obligatory, and
- Incidents and accidents and illnesses reporting.

The site has an own medical centre with a doctor present at all times.

Garadagh Cement has undertaken workplace exposure measurements to evaluate potential workplace hazards. This included noise, particulate matter, and volatile organic substances (e.g. benzene from produced water), vibrations and radiation.

The existing OHS system will be transferred to the operation with Kiln 6. Special awareness training will be provided for employees working with new or modified equipment related to the new dry Kiln 6 including transportation logistics. For quarry activities, the contractors will be trained and supervised accordingly.
For the construction of the Project, specific OHS plans will need to be set up and implemented by the contractors (cf. chapter 2.10.9). These shall be according to IFC Occupational Health and Safety Standards and Azeri standards for health and safety.42

2.10 CONSTRUCTION ACTIVITIES AND SCHEDULE

2.10.1 Activities on Garadagh Cement Plant Site/ New Dry Kiln 6

2.10.1.1 General Construction Setup

The New Dry Kiln 6 Project will be constructed pursuant to a turnkey engineering, procurement, and construction (EPC) contract. The provisions of the EPC contract will include a guaranteed completion date for the Project.

Local workforce and subcontractors will be used under the direct supervision of the EPC contractor’s superintendents in order to combine technical experience with the local experience and knowledge of construction in Azerbaijan. In particular the Civil Works and prefabrication works will be carried out by Azeri local workforce and local subcontractor(s) for the works provided that they have the required qualifications and valuable technical references; otherwise the EPC contractor’s own personnel and foreign qualified subcontractors, being fully registered in Azerbaijan, will be invited for the execution of all other civil works.

All site works required for the execution of the project will be done by contractors and subcontractors. Such works will include, but not be limited to:

- Demolishing and disposal of existing buildings and structures;
- Site levelling works, incl. mass excavation and filling;
- Construction of new railway ramp and new railways inside the plant area and rehabilitation of the railway to the new Shakhgaya West limestone quarry;
- Construction of new roads and places inside the plant area and rehabilitation of the road to the new Shakhgaya West limestone quarry;

• Civil construction works, including delivery of materials, excavation, piling works, reinforced concrete foundations, substructures and superstructures, masonry works, silos construction, etc.;
• Structural steel delivery, preassemble and erection works Mechanical equipment delivery, preassemble and erection works;
• Electrical equipment delivery, preassemble and installation works, and
• Dry-run tests and commissioning of the new plant.

Garadagh Cement will emphasise to the EPC contractor that their approach to work should be governed by careful pre-planning and safe work execution.

The Project Plan (cf. Figure 2-9) will allow initial design and procurement activities to be accomplished to a schedule that provides for supply of design information, equipment and materials, and the traffic and logistical conditions imposed on the site in advance of construction, so that work can be accomplished without interruption following initial mobilisation.

Critical path activities and weather cycles (e.g. occurrence of strong winds) will be identified, and the construction schedule will be developed accordingly.

The EPC contractor will be responsible for system cleaning, flushing, and checkout and will start-up the new plant. Start-up will be performed with the assistance of the plant operational and management personnel for equipment operations under the EPC contractor’s supervisory direction.

The EPC contractor will provide an operation supervisor and shift engineer for:
• Supervising and directing the Project’s operations staff from initial plant start-up through performance testing and substantial completion;
• Assisting in developing items like staff organisational charts, job descriptions, and maintenance procedures; and
• Providing on-the-job training for the Plant’s personnel.

The EPC contractor will be responsible provide for training of the operations personnel and will co-ordinate and advise the Project of vendor representative schedules for on-site training. The entire Project’s operational and management personnel will receive on-the-job training. In addition, classroom equipment for orientation training will be provided by the EPC contractor or major equipment suppliers.
2.10.2 Construction Activities

Together with the new kiln, additional buildings, structures, new roads and other infrastructure will be constructed.

Off site works relate to refurbishment of the access road to the quarry and the railway and the establishment of the crusher and loading station near the quarry.

Construction works may involve short term nuisance from noise and air pollutants incl. dust (e.g. from piling, vehicle movements).

2.10.2.1 Site Access

The Garadagh Cement Plant can be accessed via the Salyan Highway Intersection located to the west of the plant, travelling from Baku by turning right off the Highway, as sign-posted and from the opposite direction by crossing the highway bridge. Access is possible for multiaxle- and semitrailer trucks.

For construction site access, an access road (length about 100 metres) will be constructed from the main GC plant access road through the existing boundary wall to provide direct access to the location where the new Kiln 6 will be constructed; thus avoiding congesting the existing Plant’s entry and exit points. All other roads and points of access are already existent.

2.10.2.2 Transportation of Equipment

Transportation of equipment will be under the responsibility of the EPC Contractor who has to explore suitable ways to deliver materials to the construction site. The EPC Contractor will be required to develop a logistics concept and to confirm the feasibility with the relevant Azeri authorities. Following likely logistics scenario and options can be assumed at this stage:

- As most of the Cement Plant equipment, e.g. process-, mechanical- and electrical parts and units will be manufactured outside of Azerbaijan; these parts will reach the country via sea ports or by railway or by truck.
- For onward transportation to the GC Project Site some options may be feasible; this may include road and rail transport and/or a combination of transportation modes.
- The EPC contractor will be required to study at an early stage of the Project implementation, i.e. within the first three months, the transport logistics conditions in detail and propose a feasible solution.

**Road Transport**

At present no constraints are envisaged by Garadagh Cement concerning transportation by road of the goods delivered to Azerbaijan and the Azeri regulations with respect to road traffic since the site has short distance access to the main highway.

**Railway Transport**

The existing main-line railway passes in immediate vicinity to the GC plant. The plant has a direct connection rail to the main line to facilitate the movement of materials and equipment into and out of the existing Cement Plant. It can generally be said that the rail network appears to be in a position to carry heavy cargo items.

### 2.10.2.3 Establishment of the Site

**Site Formation / Levelling**

The new Kiln 6 will be constructed adjacent to the existing Plant, within the existing Cement Plants territory. Prior to construction, the site for the new installation needs to be cleared from cement kiln dust which was dumped in Soviet times at the south-western part of the site, construction debris and refuse and unused structures and foundations (incl. from old Kiln 5 and a former oil basin) have to be dismantled, and some levelling of the ground will be necessary. Most of these preparatory clearing activities were already accomplished by GC by mid-2008.

**Foundations**

It can be assumed that the foundations for all required large and heavy installations will be based on piles. A detailed soil investigation campaign for the new structures has been carried out to specify the type of foundations and the length of the piles. Raft foundations may be considered for minor components (small cubicles, containers, panels, etc, storage halls and ancillary buildings), if proof can be given by the EPC Contractor that differential settlements will not pose a problem.

**Erection of Structures**

Subsequent to the piling and foundation works the construction of buildings and erection of structures can be carried out by the local construction
company. Buildings and supports may be constructed in situ as reinforced concrete (RC)-buildings with block/brick walls, as well as pre-engineered buildings and steel structures.

Road Works

The on-site road network is established but it will be upgraded. A total of approximately 1,000 metres of asphalt or concrete roads are planned to develop the external access and the internal network on site and about 100 metres of external access road to establish with all necessary connections and modifications to the existing road network.

For the layout of connection of the new Plant access road to the main road, a solution will be developed which considers the traffic situation on the main road and traffic safety aspects arising thereof, although this is thought to be minimum because it is little used by others.

The existing access road to the new Shakhgaya West limestone quarry will be upgraded (cf. Section 2.4.5).

2.10.3 Construction Programme and Schedule

2.10.3.1 Construction Schedule

It is planned that establishment of the complete new dry Kiln 6 Project will be accomplished within an estimated 3 years period.

The main civil and structural works will require about 22 months in total. Civil and structural works that are not affecting the mechanical and electromechanical works may extend beyond 22 months into other periods of the construction phase.

A general schedule indicating key phases and activities of the construction programme are given in Figure 2-9. This is to be understood as a preliminary overview for the purpose of the present ESIA and evaluating potential construction impacts.
Figure 2-9  
Key Phases and Activities of Plant Construction – Preliminary Schedule  
(Source: Gardagh Cement/Holcim)

The detailed and final construction schedule will be subject to the contractual provision among the Project Proponent and the EPC contractor.

2.10.3.2  
Construction Machinery Requirements

Construction technologies for civil and structural works in Azerbaijan utilize the optimum amount of Construction Machinery and Plant Equipment. Table 2-10 provides a preliminary overview on the main civil works and the estimated construction machinery necessary to carry out the works. In addition, an indication on the preliminary duration of the single tasks is given.
**Table 2-10 Estimated equipment required for Major Civil works and Operation Duration**

<table>
<thead>
<tr>
<th>No.</th>
<th>Task</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>General Excavation Works</td>
<td>10 to 15 Trucks, 3 to 5 Bulldozers, 3 to 4 Vibro Rollers</td>
</tr>
<tr>
<td>2</td>
<td>Road Works</td>
<td>4 Trucks, 2 Graders (or equivalent), 2 Rollers, 2 to 4 concrete mixers</td>
</tr>
<tr>
<td>3</td>
<td>Piling Works</td>
<td>2 to 3 Piling rigs; each rig to be fed by at least 2 to 3 concrete mixers</td>
</tr>
<tr>
<td>4</td>
<td>Foundation Works</td>
<td></td>
</tr>
<tr>
<td>4.1</td>
<td>Equipment foundations</td>
<td>2 to 4 Concrete mixers, 1 truck</td>
</tr>
<tr>
<td>4.2</td>
<td>Steel Building foundations</td>
<td>2 to 4 Concrete mixers, 1 truck</td>
</tr>
<tr>
<td>4.3</td>
<td>Auxiliary foundations</td>
<td>2 to 4 Concrete mixers, 1 truck</td>
</tr>
<tr>
<td>5</td>
<td>Civil and Structural Works</td>
<td></td>
</tr>
<tr>
<td>5.1</td>
<td>Main Process Buildings</td>
<td>1 Crane, 3 concrete mixers, welding machines, tools</td>
</tr>
<tr>
<td>5.2</td>
<td>Storage Halls</td>
<td>1 to 2 Cranes, 2 concrete mixers, welding machines, tools</td>
</tr>
<tr>
<td>5.3</td>
<td>Pre-Heater Tower</td>
<td>1 to 2 Cranes, 2 concrete mixers, welding machines, tools</td>
</tr>
<tr>
<td>5.4</td>
<td>Silos</td>
<td>1 to 2 Cranes, 2 to 3 concrete mixers, welding machines, tools</td>
</tr>
<tr>
<td>5.5</td>
<td>Workshop</td>
<td>1 Crane, 4 concrete mixers, welding machines, tools</td>
</tr>
<tr>
<td>5.6</td>
<td>Administration Building</td>
<td>1 Crane, 2 concrete mixers, welding machines, tools</td>
</tr>
</tbody>
</table>

**2.10.4 Construction Workforce**

Construction works for the Project are labour intensive and will generate significant employment opportunities. The estimated required labour force on site during project execution works is:

- For transporting, excavation, infrastructure works, approximately 150 to 200 workers;
- For piling and foundation works, approximately 50 to 100 workers;
• For structural, building and finishing works, approximately 250 to 350 workers.

• For mechanical and electrical erection on site 250 to 350 workers

About 60 – 80% of the labourers for civil and structural works will be unskilled or semi skilled. For mechanical and electrical work, some workers (30 – 40%) with higher skills will be needed. Especially the assembly of the Kiln, the Pre-Heater Tower, Clinker Cooler and the Vertical Roller Mills, which will involve extensive welding works, will provide skilled work opportunities.

At present, GC anticipates that overall a maximum workforce of 700 to 900 will be involved in constructing the Project. Most of the workers required (estimated > 60%) can be locally employed.

The EPC contractor will be a company from outside Azerbaijan. It is estimated that there maybe about 250 Third Country Nationals (TCN’s) employed mostly during mechanical and electrical erection. However, depending on the EPC contractor’s procurement, for a short period the total number of TCNs could reach up to an order of 500 staff at construction peak. GC will require that local Azeri labour should be recruited by the EPC Contractor wherever possible, and that maximum use shall be made of Azeri subcontractors and suppliers wherever possible. New infrastructures, plant services and ancillary buildings will be constructed by Garadagh Cement with local contractors.

The potential for local procurement of works, goods and services, either directly via Garadagh Cement or the EPC contractor, is presently estimated to be in the range of 50–80 million Euro. Garadagh Cement plans to hold an information event for interested local companies about business opportunities in relation to the Project. This will be undertaken in coordination with the Azeri Ministry of Economic Development (MED) and the Baku Chamber of Commerce and local entrepreneur organisations. Information about work opportunities in relation to the project will be made available to the local population.

The EPC contractor will be required to issue a Work Site Regulation and a Workers Code of Conduct, both to be approved by GC, in order to reduce the potential for cultural related conflicts among the foreign and local workforce and the local population.

The vast majority of on-site construction personnel will be male. Regarding the Project Office staff, probably 60% male and 40% female are anticipated.
Details of workers logistics will need to be developed by the EPC Contractor. It is probably not required to establish a construction worker’s camp, since the majority of workers will be locally based and therefore live at home. Workers will be transported by dedicated buses from their home or base to the site daily and returned in the evening. No camp is foreseen at the GC plant site; workers accommodation will be provided using existing local lodging capacities. TCN’s may be put up accommodation facility in the neighbouring area which has a good track record of housing and feeding similar workers from the same countries from other previous local projects.

Fully operating medical and social facilities (canteen; sanitation, amenities) and services will be provided within the confines of the Site and inside the Garadagh Cement boundary walls for the construction workers.

Further information on social aspects of construction workforce (such as measures to minimise potential culturally related among foreign and local construction workforce and local population, and measures to provide local employment opportunities) is provided in Section 5.13 (Social Impacts) and Section 6 (ESMP).

**2.10.5 Construction Traffic**

**2.10.5.1 Transport of Materials**

In the first stage of construction, the main traffic generated will be from civil and structural works activities (excavation and fill materials, concrete materials, reinforcement, earth moving equipment, construction materials, paint, steel structure, concrete pipes etc.). In the second stage, heavy equipment will be transported on site. Oversized transport may also be used for the transport of special equipment such as Kiln Shells, Rollers, Cyclones and Mill Sheets Parts, etc.

A detailed transportation logistics concept will be elaborated by the EPC contractor; consequently no details on the traffic volumes and frequencies can be given at present.

As described above (*cf.* Section 2.10.2.2), a combination of rail and road transport will be most likely. If assumed that the bulk of construction materials and plant parts would be brought to the site by road (truck), it is estimated that on average 3 to 5 trucks per day would have to deliver construction material for civil and structural works. In addition, it is estimated that roughly 2 trucks per day will transport small parts to the site over the entire period of construction work.
2.10.5.2 *Transported Construction Workforce*

During the peak construction period, it is anticipated that approximately 700 to 900 employees will be accessing the site. Typically, the employees will work regularly in one or two shifts (06:00-20:00 hours). For special activities (like piling, slipforming, refractories, etc) also three shifts will be required.

It is assumed that most of the local workforce will originate from the Sahil, Baku area. It is anticipated that most of the employees will be brought to the site by bus/minibus and only a few will arrive by private car.

Contractors will be requested organise transport of the employees to the site by bus/minibus and to encourage their staff to use this option. It is anticipated that with this offer only a few will arrive by private car.

2.10.6 *Construction of the New Quarry Crusher*

The new crusher will be built at the site of the former operations buildings near the former rail loading station.

2.10.7 *Road and Railway Rehabilitation*

*Road*

Detailed plans for the road rehabilitation are not yet available. It is not foreseen to alter the alignment or the width of the existing road. In general, on damaged sections the road embankment will be rehabilitated by use of standard road building machinery such as graders, bulldozers and loaders. The road will receive a roller compacted surface. Some sections, such as approaches to railway crossings will likely receive hard surface, *e.g.* concreted.

*Railway*

The railway line to be rehabilitated can be accessed by the existing road which is running in parallel. The detailed extent of works and method (*e.g.* by track building work train on track and/or by truck and crane from outside) necessary to rehabilitate the railway tracks is not yet determined. The gravel bed will be re-compacted and missing track substructure will be replaced. Where rails and sleepers are in acceptable condition they remain on the track, or else they will be replaced by new installations. On the last 2 kilometres to the train loading station, the rails are missing and the track will be re-built in the old alignment.
2.10.8 Site Security during Construction

All work at the main plant will be executed within the closed, fenced-in boundary walls of GC.

Before entry into GC premises there will be a vigilant security system with Identity Cards complete with photograph – swipe cards issued and only those with legitimate ID cards will be allowed to enter the site and enter the buses to and from work.

The workforce should not venture outside the confines of the Site and the GD boundary during the working day.

2.10.9 Environmental and Health and Safety Management during Construction

GC will obligate the EPC contractor to issue a health & safety plan which has to be complied with, by both workers of the contractor and all subcontractors. This plan shall be guided by the IFC General EHS Guidelines (Section 4 on Construction activities)\(^4\) and must meet, as a minimum standard, the specific requirements of Holcim.

The EPC contractor will be responsible for regular inspections and controls of compliance.

Besides general construction site EHS hazards, particular attention will need to be paid to working at great heights when the preheater tower and stacks is erected (140 m), but also silos and transport belt reach considerable heights (60 m).

Of particular note in this context are specific OHS provisions, which will need to be in place under consideration that the production with the existing wet kilns will continue to be running during construction of the new dry Kiln 6. In particular, since the new pre-heater tower and stack will be considerably higher than the existing stack (140 m vs. 65 m) and in close proximity, construction workers may be at risk when working under the emissions from the exhaust of the continued operation of the 4 wet kilns, which includes noxious gases (carbon monoxide) and dust. Also, strong winds are a safety issue to be considered for civil construction activities in particular for the erection of high structures such as the pre-calculator tower/stack.

General supervision of construction activities will be exercised by Garadagh Cement as part of the developer responsibility. GC will dedicate an appropriate staff team for this.

Beside the EPC contractor, each subcontractor working on the site will be responsible for the tidiness of its own working areas as well as for the transport and correct disposal of all his waste, scrap and spills, in accordance with all local laws and regulations.

2.11 BENCHMARKING OF THE PROJECT

2.11.1 Cement Manufacturing

In this section the new Kiln 6 Project is compared against national and international standards applicable to cement manufacturing. Reference is made to documents published on the international level which outline the Best Available Techniques (BAT) for the process in order to achieve a good environmental performance. Furthermore, Holcim has set forth corporate target levels.

The following guidelines are used as references for evaluation on the Project:

- Reference Document on Best Available Techniques in the Cement and Lime Manufacturing Industries (BREF), European Commission, 2001; and
- Holcim environmental guidelines and objectives.


The IFC guideline and the EU BREF document provide performance levels and measures which generally should be considered for new facilities. Their applicability, however, has to take into account the site specific situation such as country context, sensitivity and assimilative capacity of the environment, and the results of the ESIA. Hence, IFC performance levels have to be understood as references rather than limit values. The guidelines provide various technological and/or management measures “to achieve the performance levels” (IFC) and “good environmental performance” (EU BREF).
The EU BREF documents reflect the current performance of some installations within the cement manufacturing sector. Best Available Techniques (BAT) related parameters should not be understood as limits for emissions. They are no legally binding standards.

*Inter alia*, the following major measures are stated in the IFC Guideline and BREF document as best practice:

- The use of a dry process kiln with multistage pre-heating and pre-calcination,
- Pre-heater/pre-calciner kilns are generally preferred in terms of environmental performance,
- Dust should be controlled by means of fabric filters or electrostatic precipitators,
- Conveyor systems shall be enclosed and transfer points emission controlled,
- Storage areas shall be housed as much possible and exhausted via fabric filters,
- NOx emissions reduction shall be achieved by using low-NOx burners and staged combustion; SNCR may be a further option,
- SO₂ emissions mainly depend on the sulphur content in the raw materials and may be reduced by managing the raw materials,
- Operation of a pre-heater/pre-calciner promotes reduction of greenhouse gas CO₂ (energy efficiency),
- CO₂ reduction by manufacturing blended cements with low specific CO₂ emissions (e.g. cement with low clinker content),
- Selection of fuel with a lower ratio of carbon content to calorific value; like natural gas, waste materials as fuel,
- Limiting emissions of non-volatile heavy metals by an efficient dust control system,
- In case of high content of mercury (Hg) or other volatile metals in the raw materials, absorption on activated carbon may become necessary,
- Selection of materials based on monitoring and control of their heavy metal content can further reduce heavy metal emissions,
Waste fuels with high calorific value can be used in cement kilns to substitute fossil fuel which reduces CO₂ emissions; this however, is likely to impose the need for extended measures to control potential hazardous emissions.

Waste raw materials can be used to reduce consumption of natural resources; this also most likely requires additional measures.

Energy efficiency should be improved by heat recovery from the cooler’s waste gas, e.g. in the pre-calciner.

Further improvement of energy efficiency include implementation of a power management system and use of equipment with high energy efficiency.

The cooler shall be designed to cool down the clinker temperature as quickly as possible (for Kiln 6, shock blowers are foreseen).

Industrial wastewater can be generated in some operations which have high pH and suspended solids content; this wastewater should be treated adequately in the case of direct discharge into surface water.

Flow of stormwater through stockpiles of solid fuel or waste material shall be prevented to prevent discharge of contaminated stormwater (for the Kiln 6 Project only roofed storages are planned).

The installations should be operating close to process parameter set points (e.g. by employing an automatic control system).

Management of occupational health and safety shall cover the following impacts: dust, heat, noise, vibrations, physical and chemical hazards, radiation.

Dust impact can be controlled by e.g. implementation of good housekeeping and maintenance, closed cabins, dust extraction systems/air ventilation.

Control of noise may include installation of enclosures (mills), silencers (fans) and construction of noise barriers, and

Use of PPE as appropriate (safety glasses, masks, (insulated) gloves and shoes, hearing protection, etc.).
Almost all of the above aspects are taken into account for the Kiln 6 Project. The following exemptions apply:

- Since hard coal will be the primary fuel, the CO₂ emitting ratio per calorific value is higher than for natural gas. However, due to the increase in energy efficiency (which means a reduction of fuel demand), the specific CO₂ emissions per ton of product will be reduced overall. In addition, the BREF guideline states that pulverized coal is the most commonly used fuel in the cement industry.

- Additional measures to control volatile heavy metals were not considered necessary in the Feasibility Study based on the analyses of the future raw materials.

- The use of alternative fuels and raw materials (AFR) beyond what is used today (bauxite waste from the Ganja Aluminum plant) is not included in the current scope of the Project but may become relevant in the future depending on availability and quality of such materials. For the use of waste fuels and waste raw materials, it needs to be studied if additional emission controls are necessary.

2.11.2 Performance Indicators

Air Emissions

Performance indicators set out in the BREF and IFC guidance documents are compiled in Table 2-11 and Table 2-12 for benchmarking of the Project.

In general, the maximum emission values of Kiln 6 are well within the range of the reference values. Modern kilns like Kiln 6 employ high efficiency air emissions abatement control systems, for which it can reasonably be assumed that actual emission values for many substances will be significantly lower than the maximum values provided as design parameters and respective guarantee values by manufacturers. In particular, this holds true for particulate matter which actual concentration can be expected to be significantly below the maximum of 30 mg/Nm³ used in the dispersion modelling for this ESIA. Values of 20 mg/Nm³ or less are anticipated by Holcim. Since most of the heavy metals are present in particulate matter, their levels can be assumed to be reduced accordingly.

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44 Some 80% of kilns in Europe use coal (BREF)
## Kiln 6 emission parameters compared to international standards

<table>
<thead>
<tr>
<th>Parameter/Unit</th>
<th>Kiln 6 maximum emission values</th>
<th>Regulations in Germany for new kilns</th>
<th>EU BREF; range for new kilns</th>
<th>IFC Guideline</th>
<th>BAT BREF</th>
<th>Holcim</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particulate Matter, kiln mg/Nm³</td>
<td>&lt;30</td>
<td>20</td>
<td>20 – 100 (20 – 50)</td>
<td>30</td>
<td>20 – 30</td>
<td>30</td>
</tr>
<tr>
<td>Particulate Matter, other point sources mg/Nm³</td>
<td>&lt;30 (new sources) &lt;100 (existing)</td>
<td>20</td>
<td>20 – 100</td>
<td>100</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>SO₂ mg/Nm³</td>
<td>&lt;200</td>
<td>350</td>
<td>200 – 600</td>
<td>400</td>
<td>200 – 400</td>
<td>400</td>
</tr>
<tr>
<td>NOₓ mg/Nm³</td>
<td>&lt;500</td>
<td>500</td>
<td>200 – 1,800</td>
<td>600</td>
<td>200 – 500</td>
<td>500</td>
</tr>
<tr>
<td>HCl mg/Nm³</td>
<td>&lt;10</td>
<td>30</td>
<td>10 – 250</td>
<td>(10)*</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>HF mg/Nm³</td>
<td>&lt;1</td>
<td>3</td>
<td>1 – 50</td>
<td>(1)*</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Total organic carbon mg/Nm³</td>
<td>&lt;45</td>
<td>50</td>
<td>30 – 75</td>
<td>(10)*</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Dioxins/furans ng/Nm³</td>
<td>&lt;0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>(0.1)*</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Cd + Tl mg/Nm³</td>
<td>&lt;0.01</td>
<td>0.05 (Tl)</td>
<td>0.1 – 0.2</td>
<td>(0.05)*</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Hg mg/Nm³</td>
<td>&lt;0.01</td>
<td>0.05</td>
<td>(0.05)*</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Total metals ** mg/Nm³</td>
<td>&lt;0.1</td>
<td>1 – 5</td>
<td>1 – 5</td>
<td>0.5</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Benzene mg/Nm³</td>
<td>&lt;3</td>
<td>1 – 5</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>NH₃ mg/Nm³</td>
<td>&lt;40</td>
<td>--</td>
<td>250 °</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>CO mg/Nm³</td>
<td>&lt;500</td>
<td>--</td>
<td>1,000 °</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>


° specified only in one EU state

* only applicable if >40% fuel energy originates from hazardous waste

** e.g. As, Pb, Co, Cr, Cu, Mn, Ni, V, Sb

---

Note: these are design values to be guaranteed by the equipment manufacturer. Emission actually expected for regular operation will usually be significantly lower than the maximum emission values in this table.
### Table 2-12  Plant efficiency Benchmarks

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Kiln 6</th>
<th>IFC</th>
<th>BREF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource and energy consumption</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raw material substitution in clinker production</td>
<td>not planned at this stage of the project</td>
<td>2% - 10%</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Raw material substitution in cement production</td>
<td>not planned at this stage of the project</td>
<td>up to 70%/80% (blast furnace slag) up to 30% (fly ash)</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Fuel energy (pre-heater/pre-calciner kiln)</td>
<td>GJ/t clinker</td>
<td>3.2</td>
<td>3.0 - 4.2</td>
<td>3.0</td>
</tr>
<tr>
<td>Electric energy</td>
<td>kWh/t cement</td>
<td>94</td>
<td>90 - 180</td>
<td>--</td>
</tr>
<tr>
<td>Electric energy - clinker grinding</td>
<td>kWh/ t clinker</td>
<td>&lt;40</td>
<td>40 -45</td>
<td>--</td>
</tr>
<tr>
<td>Waste</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quantity</td>
<td>kg waste/t clinker</td>
<td>No figure; recycling of collected dust</td>
<td>0.25 - 0.6</td>
<td>recycling of collected dust</td>
</tr>
<tr>
<td>Emissions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dust</td>
<td>g/t cement</td>
<td>56 (30 mg/Nm³) 38 (20 mg/Nm³)</td>
<td>20 - 50</td>
<td>--</td>
</tr>
<tr>
<td>NOx</td>
<td>g/t cement</td>
<td>700</td>
<td>600 - 800</td>
<td>--</td>
</tr>
<tr>
<td>SO2</td>
<td>kg/t</td>
<td>0.37</td>
<td>0.1- 2</td>
<td>--</td>
</tr>
<tr>
<td>CO₂ from decarbonation</td>
<td>kg/t clinker</td>
<td>&lt;430</td>
<td>400 - 525</td>
<td>--</td>
</tr>
<tr>
<td>CO₂ from fuel</td>
<td>kg/t cement</td>
<td>&lt;200</td>
<td>150 - 350</td>
<td>--</td>
</tr>
</tbody>
</table>

*Carbon Dioxide Emissions*

Table 2-12 above shows that the predicted specific CO₂ emissions for production with the new kiln will be at the lower end of the benchmarks.*
Holcim corporate objective\textsuperscript{46} is to avoid CO\textsubscript{2} emissions in order to achieve a 20\% reduction of the specific CO\textsubscript{2} emissions by 2010 compared to 1990. For 2013 the predicted value for Garadagh Cement is 606 kg CO\textsubscript{2}/t cement which will be 21\% less than the 770 kg CO\textsubscript{2}/t cement reported for the plant for the year 2003. The Holcim objective therefore will be met even though the fuel is shifted from natural gas to coal.

\textit{Wastewater}

In the EU BREF document, no particular requirements for wastewater treatment are set due to the fact that wastewater from cement manufacturing usually includes no hazardous chemicals.

Effluent levels for wastewater are specified in the IFC \textit{General EHS guidelines} only for discharge of treated effluents directly into a surface water body. For wastewater discharged into public wastewater treatment systems, the IFC guidance contains following principle statements:

- The pre-treatment and monitoring requirements of the sewer treatment system shall be met;
- Operation and maintenance of the collection and treatment systems shall not be interfered with;
- There shall be no risk to workers health and safety;
- Characteristics of residuals from the (municipal) wastewater treatment operations shall not be adversely impacted by the effluent;
- Wastewater shall be discharged into a municipal wastewater treatment system with adequate capacity to meet local regulatory requirements for treatment of wastewater generated from the project; or if this wastewater treatment system does not have adequate capacity to maintain regulatory compliance, pre-treatment of wastewater to meet regulatory requirements before discharge from the project site is required.

The wastewater from the GC plant site presently is discharged into the Sahil WWTP. At the same time the plant is taking large amounts of treated wastewater for slurry preparation (\textit{c.f.} Section 2.6.5.1). However, the performance of the Sahil WWTP is poor, as it can be seen by the incompletely treated water currently supplied to the GC plant for the slurry preparation. After plant modernisation with the Kiln 6 Project, the plant will continue to discharge the wastewater to the Sahil WWTP. However, considering the

\textsuperscript{46} http://www.holcim.com/corp/en/id/1610652462/mod/gnm50/page/editorial.html
requirement of the last bullet above, GC will install a pre-treatment on site before discharge.

Considering the above benchmarking, it can be stated that the Kiln 6 meets the requirements for an environmentally diligent project.