



Environmental Impact Assessments for Cement Plants

Hilary Hoagland - Grey

**Inter-American
Development Bank**

VPS/ESG

TECHNICAL NOTE

No. IDB - TN - 301

May 2011

Environmental Impact Assessments for Cement Plants

Hilary Hoagland - Grey



Inter-American Development Bank

2011

Cataloging-in-Publication data provided by the
Inter-American Development Bank
Felipe Herrera Library

Hoagland – Grey, Hilary.
Environmental impact assessments for cement plants / Hilary Hoagland – Grey.
p. cm. (IDB Technical Note; 301)

Includes bibliographical references.

1. Environmental impact analysis—Latin America. 2. Inter-American Development Bank—Evaluation. 3. Cement industries. I. Inter-American Development Bank. Environmental and Social Safeguards Unit. II. Title. III. Series.

JEL CODES Q56 L99

<http://www.iadb.org>

The opinions expressed in this publication are those of the authors and do not necessarily reflect the views of the Inter-American Development Bank, its Board of Directors, or the countries they represent.

The unauthorized commercial use of Bank documents is prohibited and may be punishable under the Bank's policies and/or applicable laws.

Copyright © 2011 Inter-American Development Bank. All rights reserved; may be freely reproduced for any non-commercial purpose.

Contents

Introduction.....	1
1. Environmental and Social Impact Assessment.....	1
2. Public Disclosure of an Environmental Impact Assessment	5
3. Related Environmental, Health and Safety Documents.....	6
4. Outline of an ESIA for Cement Plants.....	7
5. Table 1: Public Disclosure of Project Environmental Impact Assessments	25
Annex A: Reference Materials.....	27
Annex B: Cumulative Effects Assessment and Management.....	30
Annex C: Climate Change Considerations for Cement Plants	32

Acronyms

AM: Adaptive management

EEAA: Egyptian Environmental Affairs Agency

EIA: Environmental Impact Assessment

ESIA: Environmental Impact Assessment is the Environmental and Social Impact Assessment

CEAA: Canadian Environmental Assessment Agency

CEAM: Cumulative effects assessment and management

CEQ's: Council on Environmental Quality's

CSI: Cement Sustainability Initiative

GHG: Green House Gas

IDB: Inter-American Development Bank

IFC: International Finance Corporation

IPCC: Intergovernmental Panel on Climate Change

NGOs: non-governmental organization

PRI: Private Sector Department

VECs: Valued Ecosystem Components

Introduction

The Inter-American Development Bank (IDB) policy requires that an Environmental Impact Assessment (EIA) be carried out by the project sponsor/borrower for all projects to be financed by the Bank with potentially significant impacts on the natural and human environment. Bank policy also requires that the project EIA be made available in the borrowing country at some public place accessible to affected groups and local NGOs and available to various Bank offices. Associated with a project EIA there are other environmental, health and safety documents that may need to be developed to ensure adequate protection and controls related to the natural and human environment. An alternative to the Environmental Impact Assessment is the Environmental and Social Impact Assessment (ESIA), where the environmental and social impacts assessments are merged into one assessment process. To ensure coverage of both environmental and social issues, this Technical Note refers to the ESIA.

The objective of this Technical Note is to describe the necessary Bank requirements for the content and disclosure of Environmental and Social Impact Assessments (ESIAs), with a focus on the particular issues related to cement plants. This Technical Note is a basic document and is designed to assist borrowers (project sponsors) in understanding what IDB requires on an ESIA for a proposed cement plant. This document is not intended to provide a complete or detailed guidance on the preparation of an ESIA, but rather the basic ESIA requirements. For additional information or details please refer to an annotated reference list in Annex A. Any questions or comments on this Technical Note should be referred to the IDB Environmental and Safeguards Unit.

1. Environmental and Social Impact Assessment

The Bank policy requires that the project sponsor/borrower prepare an ESIA, in form and content acceptable to the Bank, for all projects to be financed by the Bank with potentially significant impacts on the natural and human environment.¹ The development of the ESIA entails the systematic study, analysis and evaluation of an operation's potential environmental and social impacts (both positive and negative) taking into account overall cumulative primary (direct) and secondary (indirect) consequences likely to alter significantly the quality of the

¹ For projects without significant impacts on the natural or human environment, the Bank may require some alternative form of general study or analysis (e.g., environmental analysis) or area specific study or analysis.

natural and human environment. ESIA's will vary in scope and type of analysis depending on the operation's characteristics. In general, they include a complete analysis of the potential or expected environmental and social impacts of the construction and operational phases, as well as decommissioning, necessary monitoring, and an evaluation of its environmental and social costs and benefits, including a discussion of the economic implications of the operation as proposed, and of alternatives including that of no action.

The specific objectives of an ESIA of any Bank financed project are:

- To identify the positive and/or negative alterations of the natural and human environment which may affect the quality of life as well as present and future options for sustainable social and economic development in the operations area of influence;
- To identify preventive or mitigation measures to minimize the negative impacts and enhance the positive impacts of project design alternatives;
- To determine whether the proposed operation is the optimal or at least a viable solution to the development needs it addresses after the costs and benefits of impacts, mitigated or not, are internalized; and
- To recommend a course of action including preventive or mitigation measures after comparing the alternatives, including that of no action.

The ESIA must include, as a minimum, the items listed below. The subsequent sections present a recommended format and content for ESIA's for Bank financed cement plant projects.

- A non-technical executive summary with an overview of the project, the alternatives considered, the time schedule for construction, the potential environmental impacts and their effects, and proposed mitigation measures. It should conclude by setting out the residual effects of the development after mitigation and an overall conclusion on the environmental viability of the project;
- A description of the proposed operation and its objectives;
- An analysis of the project involving a description and evaluation of the impacts and cost benefit analysis of the considered alternatives, including a no-project option, the rationale for selecting the proposed alternative, and a description of its impacts;
- A description of the institutional and legal environmental framework associated with the project, including any project specific legal (e.g., concession contracts, etc.) or other requirements as contained in IDB policies and guidelines. This should include local

regulatory requirements, international standards (IFC Performance Standards, relevant EHS Guidelines and applicable IDB environmental and social policy or guidelines such as OP-703 Environmental Safeguards Compliance Policy, and World Bank Group Performance Standards), and sector-specific guidance;

- A description of the existing environmental and social baseline conditions of the project facility sites and their direct and indirect areas of influence;
- An analysis of the direct and indirect environmental and social/cultural impacts and risks, including cumulative impacts which represent combined effects from multiple projects or activities in the direct and indirect areas of influence. Annex B includes definitional information on cumulative effects and a six-step protocol for incorporating cumulative effects in cement plant ESIA's. Further, Annex C addresses climate change considerations for cement plants. This topic is receiving increasing attention due to large emissions of CO₂ from such plants;
- A record of the ESIA process and a summary of the results of consultation with affected groups;
- Options and recommendations for mitigation measures such as preventing, avoiding, reducing, eliminating or compensating for the impacts of the selected alternative;
- A description of the proposed environmental and social management and monitoring framework, including the schedule, assignment of responsibility and budget;
- The monitoring, reporting and evaluation requirements during the execution of the operation and thereafter; and
- A description and quantification (when possible) of the environmental and social benefits, and of the costs of any unmitigated environmental and social impacts.

The ESIA should also include the following scientific and technical features:

- Ambient monitoring and surveys (e.g., ambient air quality, meteorological, water quantity and quality, noise levels, soil and ground water conditions, flora and fauna, social, etc.);
- Mathematical modeling (e.g., impacts of air emissions on ambient air quality, impacts of waste water discharges on water quality, contaminant transport within terrestrial or aquatic ecosystems, water withdrawals, spill releases, noise, etc.);
- Use of geographical information systems (e.g., for project siting and related linear

projects such as roads, pipelines, etc.);

- Human and/or environmental risk assessments. Risk assessments can be focused on consequences to the health of plant workers and nearby residents resulting from operational accidents or emergencies. This may entail evaluation of low probability events and the human health consequences over both short-term and longer-term time periods. Similar concepts could be used in the conduction of ecological risk assessments from plant accidents or emergencies. Such assessments encompass evaluation of the probability and resulting adverse effects on non-human terrestrial or aquatic populations or related ecological systems. Information related to assessing industrial hazards at can be found in World Bank Technical Paper 55, “Techniques for Assessing Industrial Hazards” (1988); World Bank Technical Paper Number 154, “Industrial Hazard Management” section of Chapter 10 – Energy and Industry, Vol. III of the Environmental Assessment Sourcebook (1991); and Environmental Assessment Sourcebook Update Number 21, “Environmental Hazard and Risk Assessment” (1997). Human and ecological risk assessments could also be used to examine the consequences of airborne and waterborne releases of pollutants, and from unsanitary conditions and vector borne diseases. Such considerations could be incorporated in planning ambient monitoring programs for cement plants. Calculation methodologies for determining human health consequences based on dose-response relationships are also available. Information related to these topics, as well as the use of relative ecological risk determinations for consequences on non-human populations and ecological systems are available. Examples of information sources include Environmental Assessment Sourcebook Update Number 18, “Health Aspects of Environmental Assessment” (1997); Canter, L.W., “Pragmatic Suggestions for Incorporating Risk Assessment Principles in EIA Studies”, The Environmental Professional, Vol. 15, No. 1, 1993, pp. 125-138; and U.S. Environmental Protection Agency, “Proposed Guidelines for Ecological Risk Assessment” (1998); and
- Quantitative economic evaluation of project benefits and costs (impacts, mitigations, etc.).

2. Public Disclosure of an Environmental Impact Assessment

IDB policy requires that an ESIA or Environmental Analysis prepared by borrowers (project sponsors) is made available in the borrowing country at some public place accessible to affected groups and local NGOs, before the IDB conducts its due-diligence mission. Once an ESIA or Environmental Analysis is released locally and officially submitted to the IDB, it will be directly available to the public on the IDB website, and for Category A projects, in print at Headquarters, and in the Country Offices.

The project sponsor/borrower must perform the two actions listed below in order to comply with the IDB's requirements on public disclosure of the ESIA or associated document (Environmental Analysis):

- The Project Sponsor must make the ESIA or associated document available locally near the proposed project site at some public place accessible to affected groups and local NGOs. The ESIA should be made available to the public as early as possible (e.g., at least four months prior to the presentation of the project Loan Proposal to the Bank's Board of Directors), and must be made available prior to the Bank's due-diligence mission as required by the Bank policy; and
- The Project Sponsor must provide the ESIA or associated document to the IDB Project Team Leader. The ESIA or associated documents should be provided to the IDB as soon as they have been completed.

The IDB expects project Borrowers to consult affected communities and other local stakeholders having a legitimate direct interest in an operation. Guidance related to public consultation is in IDB's Private Sector Department (PRI) Guideline for Environmental Impact Assessments (1999). The IDB requires that borrowers: (1) employ reasonable consultation procedures to elicit the informed opinion of concerned groups, and take their views into account during project preparation and implementation, especially during the scoping and draft phases of an ESIA; and (2) provide evidence of compliance with national legislation, regulations and administrative procedures regarding public consultation. The methodology and results of consultations, and the manner in which those results are taken into account, as well as provisions for community participation during project implementation, when applicable, must be documented (e.g., in the project ESIA or the IDB's Environmental and Social Management

Report).

3. Related Environmental, Health and Safety Documents

Based upon the specific project characteristics there may be a need to prepare an ESIA and/or other documents during the environmental assessment process. These documents may include:

- Resettlement Plan,
- Risk Assessment (e.g., engineering, human health, environmental),
- Emergency Response and Contingency Plan,
- Industrial Hygiene and Worker Safety Plan,
- Public Consultation Plan,
- Environmental Site Assessment consisting of an evaluation of existing soil, groundwater, and surface water contamination at the proposed plant site,
- Environmental, Health and Safety Compliance Audit (for projects with existing facilities and/or operations).

These documents can be procured from IDB websites.

4. Outline of an ESIA for Cement Plants

1.0 EXECUTIVE SUMMARY

The section should present a concise discussion of the key and significant aspects, including the following: project description; applicable environmental, health and safety legal requirements; environmental and social conditions; principal project impacts; proposed mitigation and monitoring measures; project alternatives, and public consultation. It should conclude by setting out the residual effects of the development after mitigation. The Executive Summary should be written in clear non-technical language in order to make the information accessible to as wide an audience as possible.

2.0 PROJECT DESCRIPTION

This section must include a detailed quantitative description of the proposed project (including any associated project facilities and operations). The following recommended subjects should be included:

Objectives and Scope of the Project

This subsection should address:

- Project basis and objectives;
- A general description of the proposed built development or the land uses expected such as port facilities, chalk pits, limestone, clay, pyrite, gypsum and sand sources and their reclamation, storage facilities (raw materials, product, waste), buildings, installations (kilns, mills/grinders, separators, heat exchangers, stacks), tanks (above ground and underground), products, hazardous materials, special materials (e.g., radioactive substances, asbestos, PCB, ozone-depleting compounds, radon), wastes, emissions/discharges, associated infrastructure, etc.;
- Location of all facilities (direct, indirect and associated) – examples include transport of raw materials and finished products, power source, and, as appropriate, quarry operations;
- The reason and/or need for the development;
- Project proponents (sponsors);

- The proposed program of construction works for development;
- Operation activities;
- Project costs;
- The expected project life and closure activities (including quarries);
- Land ownership/tenure; and
- Designations or restriction such as zoning (including any marine / port or quarry zoning), which could affect the site. This includes an evaluation to determine if there are any protected zones in the surrounding area such as nature reserves, drinking water interests (groundwater/surface water), or recreational areas which could be affected by the proposed development.

The Location

A site description and maps, plans and aerial or other photographs should be provided; they should clearly identify the location of the proposed development relative to:

- Land uses in the surrounding area, both urban and rural, e.g., housing, industrial activities, agriculture, fishing, and recreation (the rationale for the surrounding area designation should be provided);
- Distance from surrounding towns/communities, their population size and characterization of the socioeconomic composition; e.g., occupation/sources of livelihoods, ethnicity, gender, and education;
- Social services such as availability of surrounding clinics/hospitals, schools, sanitation facilities/water treatment, and landfills;
- Water bodies and surface water; e.g., rivers, lakes and canals and the use made of these, e.g., fishing, water supply, navigation, and irrigation;
- Habitats, both natural and manmade, for flora and fauna;
- Infrastructure including transport of workers, raw materials, and finished products, and utilities;
- Any local or regional strategy such as management plans for nature conservation areas; and
- Any historical/cultural significance sites or environmental protection areas, e.g. sacred caves or quarries, archaeological buildings, monuments or relics.

Detailed Description and Layout of the Proposed Industrial Development and Associated Facilities

The following information should be provided:

- Site plans which must show the maximum land area affected by the proposal, including port facilities, quarries, pits (sand, chalk, limestone, clay, pyrite, gypsum etc.), sand extraction areas, storage areas (e.g. raw material and fuel), cement plant location, etc.;
- Layout plan(s) of the development showing buildings, stacks, storage areas for raw material and waste, roads, parking, and infrastructure including all utilities, such as fuel filling station, power supply, and water supply;
- Elevations, cross sections and plans of all built development supported by photomontages or similar methods to show the visual appearance proposed;
- A description of the extent and type of industrial development proposed, including a description of the uses proposed and the processes to be incorporated. This includes the following information:
 - Flow chart of the proposed activity, and information on input rates (raw materials, water, chemicals, etc.) and output rates (wastewater, solid or hazardous wastes, air emissions, etc.). Include sand, limestone, clay, pyrite, gypsum and chalk extraction activities, water catchments, port facilities, transportation, storage of raw materials, the cement process (mills/grinders, preheaters, precalciner, kilns), storage silos, packing facilities etc.. Several flow charts are included in the references in Annex A; examples include Egyptian Environmental Affairs Agency (2005) and U.S. Environmental Protection Agency (1995)
 - List of machinery and process equipment – technical information (such as capacity and expected hours of operation) and operational control measures (emissions limitations and rate data related to NO_x, SO_x, dust, noise etc.). The 2005 U.S. Environmental Protection Agency report includes numerous emission factors
 - An estimate of the essential types and expected consumption of raw materials and fuel types. This should include a description of the intention of reusing

byproducts or waste products from other industries. This might comprise granulated blast furnace slag from iron industries, aluminum silicate from refining of oil, “oxiton” from regeneration of aluminum scrap, calcines which is an intermediate product from cellulose industry, and fly ash from the electrostatic filters at power plants

- Power supply requirements and proposed energy conservation measures such as energy consumption during port activities, pumping activities (e.g., sand extraction, delivery of raw materials, and transport of product), milling, mixing, pre-heating, precalcination, and kiln processes. Furthermore, describe the energy conservation measures considered; e.g., kiln technology and heat exchangers;
- Proposed usage of water in the different industrial stages and sources of water supply (ground water, surface water and discharges from any nearby desalination plants) and options for water recycling and reuse;
- Quantities of solid and liquid waste generated and programs for collection, recycling, storage, treatment and disposal (solid waste and hazardous waste);
- Transportation description including internal and external transport activities (transport of raw materials and product by train, truck, and ship);
- Details of access, parking, and loading/unloading arrangements;
- Description of unloading of raw materials and loading of product;
- Plans for preventing unnecessary dust nuisance;
- Details of storage facilities for raw materials (type of storage, size, number, surface coating, roofing, drainage, measures to prevent dust problems, etc.);
- Details of storage of any hazardous, toxic or inflammable substances;
- Technical information on the packing system, including expected dust and noise emissions and what preventive measures have been considered;
- Identification of measures for surface water drainage;
- The anticipated employment in the operation for technical and non-technical jobs; and the employment disaggregated by age, occupation, and gender;
- Identification of the proposed housing and service facilities for on-site workers and personnel (health clinic/center);
- The anticipated operating hours (week days, week end and holidays);

- The anticipated hours for transportation (internal transportation at site, delivery of raw materials and transport of product); and
- Monitoring program – Describe the monitoring program planned to control the pre-heater, pre-calciner and the kiln processes during steady operation, e.g. temperature, O₂-content, and water content.
 - Risk management
 - Evaluate the risk management considerations made during the programming/planning of the project., e.g. monitoring of the pre-heaters, pre-calciners and kilns noise during milling/grinding, packing (high pressure packing), emergency and contingency planning.

Site Preparation and Construction

Describe the construction works required prior to commencement of industrial operations, including:

- Timing, staging and hours of construction work;
- Proposed construction methods including temporary works, the equipment to be used and methods of transport of the equipment to the site;
- Proposals for environmental management during construction, e.g. erosion and sediment control systems, wastewater holding tanks, and noise mitigation strategies;
- Any land clearing and/or disposal of cleared material;
- Any stabilization structures or earthworks including the dredging, reclamation, excavation or landfilling associated with these;
- Quantities of material to be moved to or from the site, the method of disposal of excess material, and the sources of material to be brought to the site;
- Details of the construction workforce, including source, expected numbers, work camps, and fluctuations throughout the construction period; and
- Details of any emergency/evacuation and security plans.

Furthermore, investigate types of previous activities on the land intended to be included in the proposed project:

- Previous activities that may have caused serious soil contamination and resulted in the use of remediation measures

- Remediation of the site that may be necessary prior to any building/construction activities
- What kind of remediation technology is possible (technical and economical)?
- What possibilities for soil treatment or disposal facilities exist?

Existing Development in the Locality

The description of the proposed cement industry development project shall outline:

- The nature of past, existing or planned urban or other developments on or near the proposed site;
- Past environmental performance, including the impacts of existing developments on the environment and the effectiveness of any impact mitigation measures applied on the site; and
- The relationship of the proposed development to any existing developments in nearby neighborhoods or areas.

3.0 ANALYSIS OF ALTERNATIVES

This section should present a systematic comparison of feasible project alternatives in terms of the project (technology, design, size, operation, etc.) and site selection. Systematic comparisons can be facilitated by the development of decision tables, with the rows reflecting decision factors related to impacts, costs, and mitigation, and the columns reflecting the alternatives. The cells in the table could be completed via the inclusion of summary information on each alternative relative to each decision factor. A description should be provided as to how the proposed project relates to the overall strategy/policy for the applicable technical area (e.g., the identified need and rationale for the project). The project alternatives assessment and site selection must include environmental and social impact criteria and a no action (without the project) scenario. The assessment should be quantitative and expressed in economical terms, as feasible. The assessment must clearly state the rationale leading to the selected (proposed) alternative.

4.0 INSTITUTIONAL AND LEGAL FRAMEWORK

A. Applicable host country environmental, cultural, labor, and occupational safety and health institutions and legal requirements

This subsection should include the following: national, state or province, customary and local (e.g., municipal or city) institutions and legal requirements (including all necessary permits/authorizations and applicable standards or limits for emissions, discharges, and ambient conditions); relevant requirements of applicable international treaties/agreements; and other applicable legal requirements (e.g., concession contract). These requirements must cover all environmental, social, cultural, health and safety related areas, including, but not limited to ESIA's, air quality, water supply, wastewater, protection of known archaeological and historic sites/ monuments, procedures for addressing new chance finds (especially in quarries), sensitive areas and endangered species, land use controls, waste management (non-hazardous and hazardous), hazardous materials, expropriation, resettlement, labor, and worker health and safety. Internet searching can be used to identify applicable institutions and legal requirements.

- B. Applicable IDB policies and standards
- C. This subsection should include the relevant IDB policies, standards and directives applicable to the project, covering similar topics to those mentioned above for the national requirements. Searching of the IDB website can facilitate the identification and procurement of these documents.
- D. Other requirements or standards

This subsection should include any other requirements that will be applicable to the project (e.g., international treaties, standards or guidelines, best/good management practices, requirements of other potential investors, lenders and insurers, other international financial institution such as the World Bank Group, and specifically the Environmental, Health and Safety Guidelines).²

5.0 ENVIRONMENTAL AND SOCIAL CONDITIONS

This section should present a detailed description, including quantitative data and information, on the existing environmental and social conditions at the proposed project site(s)/location(s) and within the project area of influence as related to direct, indirect, and cumulative impacts. The following is a representative list (not necessarily totally inclusive) of the environmental and social conditions that should be summarized and assessed.

² <http://www.ifc.org/ifcext/sustainability.nsf/Content/EHSGuidelines>

A. Environmental Conditions

An overview of the existing environmental conditions should be provided in order to place the proposal in its local and regional context. Detailed baseline information considered important for ESIA's for cement plant development proposals should be presented. This information includes:

- Land characteristics and use (i.e., topography, soil characteristics, terrain stability and susceptibility to erosion or landslip, existing land uses occurring at the site, and existing surface characteristics of the surrounding area). Further, existing land uses occupying the surrounding area should be addressed; particularly those land uses which would be sensitive to industrial development or other types of uses;
- Landscape character and existing views (i.e., existing character of the landscape both on the site and in the surrounding area; and views of the site from adjoining properties and public areas, particularly where these are sensitive, e.g., residential, recreational or tourist areas, etc.);
- Air quality including (1) meteorological data particularly prevailing wind direction and speed, rainfall, and temperature; (2) occurrence of extreme weather such as storms and droughts, and their location and duration; (3) existing ambient air quality data, including source(s) and levels of contaminants in the local and extended area (a specialist company with air emissions monitoring and modeling capabilities may need to be solicited to conduct the analyses); and (4) risk related to inversion conditions. Existing air quality cannot be determined with precision without sampling over an extended period. This may not be practicable, and a descriptive approach based on prevailing weather conditions and identification of the main local emission sources affecting air quality; e.g., traffic and heavy industries with multiple stacks, is often a better approach. A frequently used approach for minimizing atmospheric impacts is to minimize or prevent emissions at their source. Most likely these data may be obtained from either the local airport or a local meteorological institute or department;
- Noise. Noise levels are relatively easy to measure, and this may be undertaken at the nearest sensitive receptor locations; e.g., residential areas or schools which are nearby the proposed cement manufacturing plant. Existing sources of elevated noise levels,

which might result in nuisance even if they are located a considerable distance from the source, should be taken into account. Existing noise levels should be monitored over a number of 15 minute periods during a typical working day. Ideally, 4 or 5 periods should be monitored at each sensitive receptor location. A specialist company with noise monitoring equipment may need to be solicited to conduct such monitoring studies. This will establish the background noise levels and the extent to which these are exceeded during the period monitored. Where noise monitoring equipment is not a key concern or equipment not available, a descriptive approach identifying the main sources of existing noise and the extent to which these cause nuisance may be adequate;

- Geology and soils;
- Natural hazards (seismic, faults, sink holes, flooding, hurricanes, tornadoes, etc.);
- Water, including hydrology, groundwater and water quality. Topics which should be addressed include (1) existing drainage, including the location and capacity of sensitive receptors such as canals, drains and rivers; identification of areas prone to flash floods; and depth to groundwater; (2) surface water and groundwater movement patterns, including groundwater hydrology, the range of water levels and daily flushing regime in canals, drains and rivers, tidal ranges and wave climate in coastal areas and sediment transport processes; (3) the quality of waters, both surface water and groundwater; and (4) abstraction of waters including abstraction of groundwater, reservoirs and intakes of surface waters, the usage of the waters for irrigation, public water supply or watering of animals, and the quantities abstracted., etc.);
- Habitats – terrestrial and aquatic. As appropriate, two types of habitats may be relevant; namely, natural habitats and critical natural habitats. Information on these types is in Section B.9 of IDB’s Environment and Safeguards Compliance Policy (2006), and in the International Finance Corporation’s (IFC’s) Performance Standards on Social and Environmental Responsibility (2006). Detailed information on categories of habitats or species is in IFC’s 2006 standards;
- Flora (especially tropical rain forests, wetlands, or unique or sensitive habitats);
- Fauna;

- Endangered and threatened species (including sensitive species and economically important species);
- National parks or protected areas; and
- Traffic flows and transport infrastructure. Traffic is almost always an issue for industrial developments. The baseline includes: existing transport infrastructure such as roads, railways, port and canals; existing traffic flows on that infrastructure and anticipated changes which would take place even if the development did not proceed.

Environmental data must be relevant to the proposed development. The level of detail should match the level of importance of the issue in decision-making.

B. Social and Cultural Conditions

An overview of the existing social and cultural conditions should be provided in order to place the proposal in its local and regional context. The detailed baseline information considered important to ESIA for cement plant proposals should be presented. This information includes:

- Towns/communities surrounding the area, and their population and socioeconomic characterization by age, gender, ethnicity, language, literacy/education, income and occupation;
- Sources of livelihood (level/availability of employment by gender/occupation and income patterns);
- Land tenure/titling;
- Migration and settlement patterns;
- Health and education levels (including disease patterns and endemic diseases);
- Archeological/cultural sites and monuments, including sacred sites such as caves, lakes, quarries, etc.;
- Services and infrastructure (i.e., existing utility infrastructure including water supply, sewage, wastewater treatment works, power lines and transformer sub-stations; and existing capacity of and load on utilities infrastructure);
- Access to basic healthcare, education (i.e., existing clinics/hospitals, capacity of healthcare system; existing schools/training centers, and daycare facilities);
- Social organizations and dynamics;
- Indigenous populations/territories;

- Access to infrastructure/roads or network of existing transportation modes to/from the proposed plant; and
- Vulnerable populations (elderly, poor, disabled, and young).

6.0 ENVIRONMENTAL AND SOCIAL IMPACTS

This section should present a detailed description (quantitative to the extent possible) of the anticipated project-specific environmental, social, and health and safety impacts. This should include the following: impacts on the environmental and social conditions presented in Section 4.0; impacts related to all project phases (e.g., construction, operation, and closure) and all directly associated project facilities and operations; negative and positive impacts; direct and indirect impacts; and unmitigated, irreversible, and unavoidable impacts. Also included must be an evaluation of cumulative impacts. As feasible, the economic value of impact (positive and negative) should be provided.

Criteria for evaluating the significance of impacts and their effects should be established in advance. They should be based on both local and international standards (e.g., World Bank, World Health Organization, U.S. Environmental Protection Agency, etc.). In all cases, the choice of appropriate standards or criteria must be robust, defensible and relevant to the local situation. If no suitable existing standard or criterion is available, then any other identified criteria must be clearly explained in the ESIA.

To provide a detailed example, the World Bank Group, including the IFC, has general guidelines on environmental, health, and safety. These 2007 guidelines can be used for evaluating potential environmental impacts of proposed manufacturing projects. Specific sections are included on issues related to environmental, occupational health and safety, community health and safety, and construction and decommissioning. Examples of specific guidelines or policies are included on:

- World Health Organization ambient air quality guidelines for five common air pollutants (Table 1.1.1)
- Small combustion facilities (3 MWth to 50 MWth) air pollutant emissions guidelines (Table 1.1.2)

- Point source air emissions prevention and control technologies (Annex 1.1.2)
- Examples of VOC emissions controls (Annex 1.1.4)
- Fugitive particulate matter emissions controls (Annex 1.1.5)
- Energy conservation measures (Section 1.2)
- Wastewater and ambient water quality guidelines (Section 1.3)
- Indicative values for treated sanitary sewage discharges (Table 1.3.1)
- Examples of industrial wastewater treatment approaches (Annex 1.3.1)
- Water conservation (Section 1.4)
- Hazardous materials management (Section 1.5)
- Waste management -- general waste management and hazardous waste management (Section 1.6)
- Noise level guidelines (Table 1.7.1)
- Contaminated land, including risk screening, risk reduction, detailed risk assessment, and permanent risk reduction measures (Section 1.8)
- Occupational health and safety -- several topics (Sections 2.1 through 2.9)
- Community health and safety, including topics on water quality and availability, structural safety of project infrastructure, life and fire safety, traffic safety, transport of hazardous materials, disease prevention, and emergency preparedness, and response (Sections 3.1 through 3.7)
- Construction and decommissioning as related to the environment (noise and vibration, soil erosion, air quality, solid waste, hazardous materials, wastewater discharges, and contaminated land – Section 4.1)
- Construction and decommissioning as related to occupational safety and health (Section 4.2)
- Construction and decommissioning as related to community health and safety (general site hazards, disease prevention, and traffic safety – Section 4.3)

Examples of potential direct and indirect impacts of industrial developments, including cement plants, and their significant effects include, but are not limited to:

- Land take leading to the loss of ecological habitats and negative effects on flora and fauna populations;

- Construction works which directly damage the existing landform and add to the impacts by land take;
- Economic impacts during construction which may create job opportunities and increase local business;
- Economic impacts during operation which may create longer term benefits, such as new jobs and business opportunities; such benefits have positive effects on the economic welfare of the local population;
- Economic impacts during construction and operation (more jobs) may also lead to a large population influx into the project/site area, thus creating worker-community conflict/violence, an increase in the availability of drugs/alcohol, and pressure on existing health infrastructure and services;
- The presence of large workforces (predominantly male) in economically depressed areas have also been associated with an increase in prostitution and the introduction and spread of communicable and sexually-transmitted diseases such as TB, HIV/AIDS, syphilis, and influenza;
- The provision of proper services and infrastructure with wider benefits to those living and working in the local area;
- Dust generated during construction or operation which may affect human, plant and animal growth - could use emission factors and calculate annual inventories of dust emissions;
- Gaseous emissions to the atmosphere resulting in negative effects on the health of the local population - could use emission factors and calculate annual inventories of types of gaseous emissions;
- Discharge of untreated or inadequately treated wastewater effluent to canals and drains with resulting effects on water quality and potential adverse effects on crops and human health - using monitoring data, calculate annual discharges to study area water resources;
- Disposal of solid waste, particularly that containing toxic or otherwise harmful compounds with resulting detrimental effects on amenity, water quality and land quality, and potential adverse effects on crops and human health;

- Noise which may disturb people in their homes, schools and other sensitive land use areas;
- Traffic which may increase delays and result in traffic-related effects such as road or highway accidents and traffic noise;
- Impacts on existing utility infrastructure and possible benefits as a result of improved infrastructure;
- Health risks to local people as a result of the storage and use of inflammable or toxic substances; and
- Additional solid waste production which may stress local existing landfills and sanitation services and infrastructure, and can lead to water contamination, thus increasing the likelihood of food poisoning and water-borne diseases.

7.0 ENVIRONMENTAL AND SOCIAL MANAGEMENT

This section should describe the proposed environmental and social management plan for the cement plant project. This plan must include, as a minimum, the following components:

- Detailed description of the proposed environmental and social control and mitigation measures for project construction (e.g., air quality management plan, and landscape management plans) and operation (e.g., hazardous materials and fuel management, transport and packing management, maintenance and site security plans, air quality management plan, and emergency evacuation and contingency plans);
- Detailed description of the planned environmental and social monitoring program for both construction and operation and how the information will support management practices;
- Description of the planned worker health and safety plan, procedures and controls;
- Description of planned environmental contingency plan and procedures;
- Description of a proposed environmental, health and safety management system (including personnel, training, documentation, auditing, etc.);
- Description of a plan to manage population influx into the project site (e.g., contracting requirements to manage potential worker expectations);
- Description of a plan/mechanism to receive and facilitate resolution of affected community concerns and grievances about the project and its negative impacts;
- Description of a plan to protect, reduce, and manage the negative impacts on sacred/archaeological and historic sites/monuments;
- Description of project specific supervision and evaluation actions to be implemented;
- Public awareness, communication and training programs for operational staff; and
- Indicators of compliance with licensing and approval requirements.

For each component listed above, the proposed time schedule (i.e., when initiated, when completed, and frequency), responsibility (i.e., who will implement), and the estimated

cost must be provided; this information should also be provided for the individual actions within a component.

More specifically, evaluation parameters which may be relevant include:

- Performance indicators in relation to critical operational issues (i.e., water quality -- marine and fresh, shoreline morphology and sediment budget, soils and sediments, noise and air quality, public health indicators, land surface and hydrology, flora and fauna, etc.);
- Waste management performance indicators in relation to recycling and reuse;
- Monitoring of complaints received;
- Also, monitoring procedures should cover: (1) the key conditions that will be monitored such as noise (low frequency, high frequency, and vibrations), dust (particulate matter), air emissions (NO_x, SO_x, CO, CO₂, H₂O %, metals, etc.), wastewater (volume, suspended solids, pH, toxic substances, etc.), waste (solid waste and hazardous waste) and odor, and their criteria and the reason for monitoring; (2) the monitoring locations (air emission outlet: particulate matter, NO_x, and SO_x; the property boundary: noise, odor, particulate matter, NO_x, SO_x and other relevant substances; outdoor storage areas for raw materials (dustfall), intervals and duration; (3) actions to be undertaken if the monitoring indicates a noncompliance condition or abnormality; and (4) internal reporting and links to management practices and action plans;
- Reporting to relevant authorities and, if appropriate, to the consent authority or the community on matters such as reports on interruptions of operations, operational journals, list of used raw materials, protocol on stored raw materials, dustfall reports from the storage areas for raw materials, and noise documentation; and
- Reports on odor and air pollutant emissions and ambient concentrations, CO₂ % documentation reports, energy consumption reports, wastewater reports, etc.

8.0 PUBLIC PARTICIPATION

The section must describe the specific actions conducted to disclose project-related environmental and social information. This should specifically include the method and language (including the exact date, location and form) of public disclosure of the project ESIA or any other related documents that may also have been made available. Planned future activities (modernization, project size and throughput increases, etc.) associated with the manufacturing plant should also be disclosed. At the conclusion of the public participation effort, a description should be provided of stakeholder input and the completed (i.e., already performed) project-related public participation / consultation activities and programs related to populations affected by the project (e.g., who was consulted, when, where and how, etc.). The section must also include a description of information dissemination activities that will be performed during project construction and operation to inform and consult with the affected population. A complete record of public participation activities should be presented as an appendix in the ESIA. Finally, Table 1 summarizes IDB requirements related to public disclosure of project-focused ESIA's.

APPENDICES TO ESIA

The ESIA should include several appendices. Examples include, but are not limited to, the following:

- Authors of the ESIA (names, affiliations, qualifications, and relationship to project sponsor)
- Terms of reference for preparation of the ESIA
- Complete record of public consultation activities (e.g., meetings, public hearings, etc.)
- Environmental, health and safety permits/authorizations
- Complete results of pre-project ambient monitoring or sampling performed for the ESIA
- Complete results of mathematical modeling (or related quantification) of project impacts
- Bibliography and references

5. Table 1: Public Disclosure of Project Environmental Impact Assessments

Listed below are the recommended steps and methods to be performed in order to comply with IDB requirements on public disclosure of a project ESIA or associated document (e.g., Environmental Analysis).

- The ESIA document released must be an adequate ESIA, which implies providing sufficient information to the public (e.g., local affected population, groups, NGOs -- non-governmental organizations, etc.) to allow adequate evaluation of the project. Thus, the ESIA released does not necessarily (albeit it could) have to be the final ESIA which would be submitted to the applicable governmental authorities to meet regulatory requirements; rather, it could be a preliminary ESIA that provides sufficient information on the project characteristics, anticipated impacts and proposed mitigation measures.
- The ESIA must be made available to the affected population and general public. This means that, for example, simply having the ESIA completed or submitted to a governmental agency is NOT sufficient. Thus, the Project Borrower should develop and implement various measures, which account for the specific characteristics, culture and language of the project location and local population, to accurately and sufficiently inform the public of the proposed project and the availability of the ESIA (e.g., notices in newspapers, radio announcements, etc.), to obtain/receive comments from the public regarding the project (e.g., meetings and location to send written comments), to review the comments from the public, and incorporate, as appropriate, the comments into the project design. The measures developed and implemented should be part of an overall Project Public Participation/Consultation Plan.
- The release of the ESIA must be done as early as possible, especially in relation to the IDB's evaluation process for the project. The intent is to allow the affected population adequate time to sufficiently understand the project such that the public may provide comments and that these comments can be considered both by the Borrower and the Bank. Thus, the ESIA should be made available prior to the initiation of IDB's environmental and social due-diligence visit for the project. For projects having potentially significant environment affects, the ESIA's, at a minimum, should be made available at least four months prior to the consideration of the project by the Bank's Board of Directors.

- The Borrower should document the exact date and location of ESIA availability to the Bank and to the public, the method(s) and language used to make available the ESIA to the public, the method(s) used by the Borrowers to receive comments from the public, and how the comments received were addressed and incorporated into the project design.

Annex A: Reference Materials

The following seven reports and one paper contain useful information related to the preparation of ESIA or ESIA for cement plants. Brief annotations are included for each document. Further, the documents can be readily procured by Internet searching.

Battye, R., Walsh, S., and Lee-Greco, J. 2000. NO_x Control Technologies for the Cement Industry. EPA-457/R-00-002. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina.

Summary information is included on control technologies which can be used to reduce atmospheric emissions of NO_x from cement plants. Such information could be useful in planning for mitigation of the effects of NO_x emissions.

Canter, L., and Ross, B. 2010. State of Practice of Cumulative Effects Assessment and Management. *Impact Assessment and Project Appraisal*, 28 (4): 261-268.

Among other things, this paper summarizes a six-step framework that can be used to address cumulative effects assessment and management (CEAM). As appropriate, regarding plant size and location, these steps could be used to address cumulative effects associated with proposed cement plants.

Chennoufi, L., Hoagland-Grey, H., Breisinger, M., Boulet, E., and URS France, 2010. Cement Manufacturing Plant Guidelines – An Approach to Reconciling the Financing of Cement Manufacturing Plants with Climate Change Objectives. Inter-American Development Bank, Washington, D.C.

These guidelines are focused on assessing greenhouse gas (GHG) emissions from cement plants (primarily CO₂), and on reducing such emissions via the use of alternative fuels, carbon capture and storage, and other approaches. Such emissions reductions will contribute to mitigating climate changes and related effects on natural resources, and they will also enhance sustainable development.

Egyptian Environmental Affairs Agency (EEAA). 2005. Environmental Impact Assessment Guidelines for Cement Manufacturing Plants. Arab Republic of Egypt, Cairo, Egypt.

The structure of this document is similar to the IDB Technical Note. However, additional technical details are in the EEAA document. Accordingly, for professionals interested in more details, the EEAA document could be used to develop a more in-depth knowledge of cement plants, their operations, and their potential environmental consequences.

The Federal-Provincial-Territorial Committee on Climate Change and Environmental Assessment. 2003. Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners. Canadian Environmental Assessment Agency, Ottawa, Ontario, Canada.

This report provides useful summary information related to causes of climate change and various consequences associated therewith. This information would be beneficial to those professionals needing to understand fundamental concepts. Also, five-step protocols for assessing GHG considerations and for assessing impact considerations are particularly useful for planning how to address climate change in EIAs for development projects, including cement plants.

- U.S. Environmental Protection Agency. 1995. Compilation of Air Pollutant Emission Factors – Volume I: Stationary Point and Area Sources – Section 11.6 – Portland Cement Manufacturing. AP-42. Fifth Edition. Research Triangle Park, North Carolina: 11.6-1 to 11.6-26.

This document is focused on emission factors for multiple air pollutants released from cement plants. Supporting information is included on the manufacturing process, raw material inputs, generated products, water usage and quality, and emitted types of air pollutants. Control technologies for air pollutant emissions are also described. The emission factors could be used in addressing air quality impacts of proposed cement plants.

- World Bank. Environmental Assessment Sourcebook . 1999. Guidelines for Environmental Assessment of Energy and Industry Projects. Vol 3. Chapter 10, Energy and Industry, Section on Cement. Washington, D.C. (Note: the Section on Cement is the same as that in the 1991 edition – World Bank Technical Paper Number 154).

This 1991 document contains succinct information on EIAs for cement plants. It includes one table (Table 10.10) that displays a variety of 17 direct and indirect negative impacts

from cement plants, along with several mitigation measures for each which could be evaluated in EIAs. As a result, this document could serve as a background reference for the IDB Technical Note. Further, many of the mitigation measures are already mentioned in the Technical Note.

- World Business Council for Sustainable Development. 2005. Cement Sustainability Initiative (CSI) – Environmental and Social Impact Assessment (ESIA) Guidelines. Geneva, Switzerland.

This 2005 document is both comprehensive and international in scope. Unique features include separate sections on the construction phase, operations phase, the lifetime and closure of the plant site, including future site use. Further, information is included on post-closure monitoring, mitigation planning, and stakeholder involvement in the ESIA process. An extensive reference list is included in Appendix 1 to the document.

Accordingly, this document could be useful as a resource for planning and implementing ESIA's for cement plants in numerous countries.

Annex B: Cumulative Effects Assessment and Management

Cumulative impacts (effects) typically refer to those effects on Valued Ecosystem Components (VECs) which result from incremental direct and indirect effects from the proposed project, as well as added contributed effects to the same VECs from other past, present, and future projects or actions in the same study area. Several protocols have been developed to address such cumulative effects and their significance, as well as to assess appropriate mitigation measures for the project's incremental effects, and even VEC-based management measures for local and regional areas. Such management measures would typically involve collaboration with other contributors to cumulative effects concerns. Regarding cement plants, cumulative effects may be of greater importance for proposed locations which are near other existing or developing industrial areas.

One example of a protocol is a six-step process described by Canter and Ross (2010). The process combines protocols used in the United States, Canada, the European Union, Australia, and elsewhere. In brief, the six steps are (Canter and Ross, 2010):

- Step 1 – Initiate the process by identifying the incremental direct and indirect effects of the proposed project on selected VECs within the environs of the project location. The VECs can be selected based on information related to current or anticipated future degraded or stressed conditions, the occurrence of protected species or habitats, and the presence or anticipated presence of other human activities that would (adversely) affect the same VEC;
- Step 2 – Identify other past, present, and future actions within the space and time boundaries that have been, are, or could contribute to cumulative effects (stresses) on the VECs or their indicators. Based on this knowledge, identify appropriate spatial and temporal study boundaries for each VEC;
- Step 3 – For the selected VECs, assemble appropriate information on their indicators, and describe and assess their historical to current and even projected conditions. The historical information should coincide with the selected past temporal boundary (i.e., an historical reference point). Further, and depending upon the availability of information, any

identified trends in the conditions of the VECs and their indicators should be determined and analyzed;

- Step 4 – “Connect” the proposed project and other actions in the CEAM study area to the selected VECs and their indicators. Numerous tools could be used to establish either descriptive or quantitative connections. Examples include cumulative effects matrices, conceptual models, indices and indicators, and VEC-specific quantitative models;
- Step 5 – Assess the significance of the cumulative effects on each VEC over the time horizon for the study. Such significance determinations should begin with the incremental effects (the direct and indirect effects) of the proposed project or action on specific VECs. The focus should be on the VEC, not on the project or action. Criteria for such determinations of significance already exist within the ESIA systems in numerous countries; as well as development banks and aid agencies; and
- Step 6 – For VECs or their indicators that are expected to be subject to negative incremental impacts from the proposed project and for which the cumulative effects are significant, develop appropriate action or activity-specific “mitigation measures” for such impacts. Further, if significant cumulative effects are anticipated on any VEC or its indicators, consideration should be given to multi-stakeholder collaboration to develop joint cumulative effects management measures, either locally or regionally, or both. Further, an emerging topic of growing relevance to cumulative effects management, either locally or regionally, is adaptive management (AM). A foundational element for AM is a carefully planned monitoring program, with the results used to inform subsequent operational practices and decision making.

Annex C: Climate Change Considerations for Cement Plants

Climate change is being increasingly recognized as a relevant topical issue for inclusion in EIAs for numerous types of development topics, including proposed new or expanded manufacturing plants. At this time, most developing protocols focus on: (1) calculating and assessing emission inventories of greenhouse gases (GHGs), including CO₂; and (2) consideration of the potential future effects of climate change within study boundaries and regional areas associated with proposed projects or actions. In addition to CO₂, GHGs also include methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. Climate change effects can occur on atmospheric temperatures, precipitation levels and patterns, water resources, terrestrial and aquatic habitats, threatened and endangered species, agricultural productivity, and many other natural and man-made resources. Such anticipated effects could prompt consideration of adaptations in project design and operational features.

To provide a context for GHG emissions, it is important to note IDB policy B.11 which is focused on pollution prevention and abatement (Inter-American Development Bank, 2006). The policy is that Bank-financed operations will include as appropriate, measures to prevent, reduce or eliminate pollution emanating from their activities. Specific features of the policy include:

- The Bank will require clients to follow source-specific emission and discharge standards recognized by multilateral development banks. Taking into account local conditions and national legislation and regulations, the EIA will justify the standards selected for the particular operation, consistent with this policy;
- As part of agreed mitigation measures, the Bank may require that the borrower, where feasible and cost effective, adopt cleaner production processes, energy-efficiency or renewable energy; and
- The Bank encourages the reduction and control of GHG emissions in a manner appropriate to the nature and scale of operations. Operations that produce significant quantities of greenhouse gases will annually quantify direct GHG emissions, in accordance with the emission estimation methodologies of the Intergovernmental Panel on Climate Change (IPCC) or other internationally accepted methodologies.

An additional context factor related to both GHG emissions and the effects of climate change on projects is the United States Council on Environmental Quality's (CEQ's) issuance of draft

guidance for addressing these two topics in EIAs (Council on Environmental Quality, 2010). Other countries have also initiated policies on these topics.

Several climate change protocols for EIAs have also been developed. One example will be summarized herein. In 2003, a Canadian Environmental Assessment Agency (CEAA) report described a five-step procedure for GHG considerations, and a separate five-step procedure for assessing climate change effects on environmental features and VECs (The Federal-Provincial-Territorial Committee on Climate Change and Environmental Assessment, 2003). These two procedures are both pragmatic and useful. Also, they provide an effective framework for planning and implementing a CEAM-related study of climate change considerations in EIAs, including those for manufacturing plants. However, it should be noted that such detail may not be necessary for each proposed manufacturing plant, although GHG emissions are a common concern.

GHG Considerations

The pragmatic five-step procedure for GHG considerations includes (after The Federal-Provincial-Territorial Committee on Climate Change and Environmental Assessment, 2003):

- Preliminary scoping based upon general GHG information and the types of GHG emissions typically associated with the manufacturing plant. Based upon the findings, it would be possible to limit subsequent analyses to only those GHGs actually emitted from plant operations;
- Identifying the context for the GHG considerations by determining jurisdictional considerations, such as GHG-related policies, plans or programs in the host country; conducting a detailed review of industry and project-specific information related to GHG emissions and possible cleaner production; determining the industry profile in relation to emission factors for GHGs; and clarifying the magnitude, intensity and timing of the proposed manufacturing plant GHG emissions;
- Assessing direct GHG emissions by comparing the proposed manufacturing plant annual emissions with the industry sector profile, regional and national GHG inventories; and describing routine indirect GHG emissions, as well as potential emissions and consequences of plant accidents or malfunctions. It should be noted that GHG annual emissions are expressed in carbon dioxide equivalents (CO₂e). The term CO₂e means the

number of metric tons of CO₂ emissions with the same global warming potential of one metric tone of another GHG. The calculation involves multiplying the annual mass emissions of each GHG by its global warming potential, and then summing the results;

- If the anticipated plant GHG emissions are high in relation to the industry profile or jurisdictional requirements, consider the incorporation of emissions control technologies and/or operational practices to reduce such emissions. Further, consider the development of a monitoring and adaptive management plan which could be used to further reduce GHG emissions from the manufacturing plant; and
- If deemed necessary, plan and implement a focused monitoring and adaptive management plan for GHG emissions. Such monitoring could be used to verify GHG emissions forecasts, determine the effectiveness of GHG reduction or offset measures, and incorporate “lessons learned” into normal procedures. Information related to planning an adaptive management program is available elsewhere (Canter and Atkinson, 2010).

Finally, it should be noted that information is available on emission factors and global warming potentials for GHGs which are released from numerous manufacturing plants (U.S. Environmental Protection Agency, 2009). Examples of such plants include manufacturers of lumber and wood products, pulp and paper mills, chemical manufacturers, petroleum refineries, manufacturers of rubber and miscellaneous plastic products, ammonia manufacturing cement production, glass production, iron and steel production, lime production, petrochemical production, pulp and paper manufacturing, zinc production, soda ash manufacturing, and others. This information could be used to develop GHG inventories for proposed manufacturing plants. Further, many sectors of manufacturing plants have already developed GHG emission factors and size-based inventories for usage in plant renovation projects or new facilities. Such information can be located via Internet searching by industry sector or via usage of IPCC emission estimation methodologies.

Climate Change Effects Consideration

The five-step Canadian procedure for assessing current or anticipated climate change effects in the local and regional area of the proposed new or renovated manufacturing plant includes (after The Federal-Provincial-Territorial Committee on Climate Change and Environmental Assessment, 2003):

- Preliminary scoping to identify actual or potential effects from climate change which could occur in the study area and region associated with the manufacturing plant. Information related to such effects could be contained in regional or in-country reports focused on experienced or anticipated climate changes. For example, several IPCC reports contain climate change information on regional, in-country, and continental scales; examples include Bates, et al. (2008), Bernstein, et al. (2007), Metz, et al. (2007), Parry, et al., (2007), and Solomon, et al. (2007);
- Evaluation of the relative vulnerability the proposed manufacturing plant to existing or anticipated climate changes; also consider the magnitude, geographical distribution, and rates of climate change effects; and continue to periodically review climate change effects and their influence on plant location, design, and operation;
- Assess likely climate change effects on the proposed manufacturing plant via determining the range and extent of such effects, and considering potential risks to the public or selected VECs over time. Based on these findings determine whether a plant management plan is needed;
- If deemed appropriate, develop a management plan. The plan itself could include plant design or management measures to mitigate climate change effects. These measures are often referred to as adaptations to enable the manufacturing plant to be successfully protected and utilized over its life cycle. In this regard, it may be desirable to distinguish between public and private sector risks and responsibilities, and to develop collaborative approaches for minimizing climate change effects on the proposed manufacturing plant. One example could be a long-term monitoring and adaptive management program; and
- If necessary, and in conjunction with a program for minimizing GHG emissions, implement a focused effects-related monitoring and adaptive management program. Incorporate risk-based lessons learned into the normal program, and implement remedial actions as necessary.

Numerous types of mathematical models have been developed for forecasting regional to continent-level to global conditions for atmospheric temperatures, precipitation, river flows, sea-level rise, etc. Modifications and revisions of such models are on-going, and debates continue over their accuracy, precision, and applicability. However, at this time it does not appear that the use of sophisticated quantitative modeling will be required in EIAs addressing effects on, and from, climate change. Conversely, longer-term forecasting of future conditions is relevant, thus some attention to quantitative models may be necessary.

One particular method for addressing alternative futures (or future conditions) involves the use of one or more analytical approaches to uncertainty analysis. Byer and Yoemens (2007) suggested three possible approaches – scenario analysis, sensitivity analysis, and probabilistic analysis. Scenario analysis for climate change has also been proposed by Duinker and Greig (2007).

Adaptation and Mitigation

As noted above, the terms adaptation and mitigation represent important concepts associated with both GHG emissions and climate change effects. The term “adaptation” has become a central focus related to natural and ecological resources subjected to climate change conditions and effects. One definition is that adaptation refers to responses to climate changes which have already occurred (Larsen and Kornov, 2009). The same term can be applied to responses to future conditions associated with climate change. Further, adaptation can be considered for local-scale manufacturing plants as well as regional and even national strategic planning needs (Panel on Adapting to the Impacts of Climate Change, 2010).

“Mitigation” is another term which is routinely applied; however, its usage is primarily associated with measures for reducing GHG emissions into the atmosphere (Larsen and Kornov, 2009). Examples of such measures include, but are not limited to, the following (after Christopher, 2008), pp. 598-600):

- “methane capture” whereby methane gas is captured from sources such as solid waste disposal sites, industrial plants, and agricultural facilities; the captured methane could be diverted for secondary purposes such as energy generation;

- use of pertinent control technologies hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride;
- “project redesign” relative to location, thus reducing distances to commercial areas and residential communities, and reducing GHG emissions from transportation sources;
- “project redesign” focused on energy conservation measures to reduce energy needs; concomitant GHG decreases at energy facilities would be anticipated; and
- use of renewable or non-coal energy sources to meet the energy needs of a proposed project.

To provide an example of adaptive project design, the U.S. Army Corps of Engineers’ 2009 Engineering Circular (EC) 1165-2-211 contains “...guidance for incorporating the direct and indirect physical effects of projected future sea-level change in managing, planning, engineering, designing, constructing, operating, and maintaining USACE projects and systems of projects” (U.S. Army Corps of Engineers, 2009, p. 1). Further, the EC noted that sea-level related effects to coastal and estuarine zones and related nearby land must be considered in all phases of Corps of Engineers Civil Works programs. Such nearby land uses could include manufacturing plants on coastal lands. This infers that EIAs for such plants should address sea-level changes and their effects. Three key foundational statements within this EC are (U.S. Army Corps of Engineers, 2009, pp. 2-3): (1) planning, engineering, and designing for sea-level change must consider how sensitive and adaptable natural and managed ecosystems and human systems are to climate change; (2) planning studies and engineering designs should consider alternatives that are developed and assessed for the entire range of possible future rates of sea-level change (this infers the use of scenarios for future conditions); and (3) determining how sensitive alternative plans and designs are to these rates of local mean sea-level change, how this sensitivity affects calculated risk, and what designs or operations and maintenance measures should be implemented to minimize adverse consequences while maximizing beneficial effects.

Early attention should also be given to multiple adaptation measures in areas characterized by excessive vulnerability. In a National Research Council study in the United States, it was noted that “... in the long term, adaptation to climate change calls for a new paradigm that takes into account a range of possible future climate conditions and associated changes in human and natural systems instead of managing our resources based on previous experience and the historical

range and variability of climate. This does not mean waiting until uncertainties have been reduced to consider adaptation actions. Actions taken now can reduce the risk of major disruptions to human and natural systems; inaction could serve to increase these risks, especially if the rate or magnitude of climate change is particularly large” (Panel ...2010, p. 4).

The Panel also described a multiple-activity planning process for developing and implementing an adaptation strategy. The process, which could be used for manufacturing plants, consists of the following activities (Panel ...2010, p. 10):

- Activity 1 – Identify current and future climate changes and their potential effects which are relevant to the system being studied (e.g., river reach, lakes, public water system, coastal area, etc.). This is particularly relevant for determining the “future without project condition” and, ultimately, the “future with project condition” under various scenarios or alternative plans;
- Activity 2 – Assess the vulnerabilities and risks to the VECs associated with the system being studied;
- Activity 3 – Develop an adaptation strategy using risk-based prioritization schemes applied to an array of options (note that the array could range from one option to various combinations of multiple options);
- Activity 4 – Identify opportunities for VEC-related co-benefits and synergies resulting from combinations of multiple options;
- Activity 5 – Implement adaptation options within the system; and
- Activity 6 – Monitor, re-evaluate, and adjust (if necessary) implemented adaptation options.

Selected References

- Bates, B., Kundzewicz, Z.W., Wu, S., and Palutikof, J., Editors. 2008. *Climate Change and Water*, IPCC Technical Paper VI, Intergovernmental Panel on Climate Change, IPCC Secretariat, Geneva, Switzerland.
- Bernstein, L., et al. (over 40 co-authors). 2007. *Climate Change 2007: Synthesis Report*, IPCC Fourth Assessment Report Climate Change (AR4), Intergovernmental Panel on Climate Change, Cambridge University Press, New York, New York.
- Byer, P.H., and Yoemans, J.S., 2007. Methods for Addressing Climate Change Uncertainties in Project Environmental Impact Assessments, *Impact Assessment and Project Appraisal* 25 (2): 85-99.
- Canter, L., and Atkinson, S.F. 2010. Adaptive Management with Integrated Decision Making: An Emerging Tool for Cumulative Effects Management, *Impact Assessment and Project Appraisal* 28 (4): 287-297.
- Christopher, C.W. 2008. Success by a Thousand Cuts: The Use of Environmental Impact Assessment in Addressing Climate Change, *Vermont Journal of Environmental Law* 9: 549-613.
- Council on Environmental Quality. 2010. Draft NEPA Guidance on Consideration of the Effects of Climate Change and Greenhouse Gas Emissions. Executive Office of the President, Washington, D.C.
- Duinker, P.N., and Greig, L.A..2007.Scenario Analysis in Environmental Impact Assessment: Improving Explorations of the Future, *Environmental Impact Assessment Review* 27: 206-219.
- Inter-American Development Bank. 2006. Environment and Safeguards Compliance Policy, Washington, D.C.
- Larsen, S.V., and Kornov, L. 2009. SEA of River Basin Management Plans: Incorporating Climate Change, *Impact Assessment and Project Appraisal* 27 (4): 291-299.
- Metz, B., Davidson, O., Bosch, P., Dave, R., and Meyer, L., Editors. 2007. *Climate Change 2007: Mitigation, Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Intergovernmental Panel on Climate Change, Cambridge University Press, New York, New York.

- Panel on Adapting to the Impacts of Climate Change. 2012. *Adapting to the Impacts of Climate Change*. Board on Atmospheric Sciences and Climate, National Research Council, National Academies Press, Washington, D.C.
- Parry, M., Canziani, O., Palutikof, J., van der Linden, P., and Hanson, C., Editors. 2007. *Climate Change 2007: Impacts, Adaptation, and Vulnerability, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Intergovernmental Panel on Climate Change, Cambridge University Press, New York, New York.
- Solomon, S., Qin, D., Manning, M., Marquis, M., Averyt, K., Tignor, M., Miller, Jr., H., and Chen, Z., Editors. 2007. *Climate Change 2007, The Physical Science Basis, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Intergovernmental Panel on Climate Change, Cambridge University Press, New York, New York.
- The Federal-Provincial-Territorial Committee on Climate Change and Environmental Assessment. 2003. *Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners*, Canadian Environmental Assessment Agency, Ottawa, Ontario, Canada.
- U.S. Army Corps of Engineers. 2009. *Incorporating Sea-Level Change Considerations in Civil Works Programs*, EC 1165-2-211, Washington, D.C.
- U.S. Environmental Protection Agency. 2009. *Mandatory Reporting of Greenhouse Gases*, 40 CFR Parts 86, 87, 89, 90, 94, 98, 1033, 1039, 1042, 1045, 1048, 1051, 1054, and 1065, Federal Register, Vol. 74, No. 209, pp. 56260-56519.