TECHNICAL EIA GUIDANCE MANUAL
FOR
SODA ASH INDUSTRY

Prepared for

The Ministry of Environment and Forests
Government of India






by

IL&FS Ecosmart Limited
Hyderabad

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PROJECT TEAM

Project Coordination **Ministry of Environment & Forests**	**Dr. Nalini Bhat** Advisor, Ministry of Environment and Forests **Dr. T. Chandni** Director, Ministry of Environment and Forests
Core Project Coordination Team **IL&FS Environment**	**Mr. Mahesh Babu** CEO **Mr. N. Sateesh Babu** Vice President & Project Director **Mr. B.S.V. Pavan Gopal** Manager –Technical **Mr. Vijaya Krishna. D** Senior Environmental Engineer **Ms. Chaitanya Vangeti** Assistant Manager **Ms. Suman Benedicta Thomas** Technical Writer
Resource Person	**Mr. V. N. Desai** Vice President, M/s.Nirma Limited
Expert Core & Peer Committee **Chairman**	**Dr. V. Rajagopalan, IAS** Additional Secretary Ministry of Chemicals & Fertilizers
Core Members	**Dr. R. K. Garg** Former Chairman, EIA Committee, Ministry of Environment and Forests **Mr. Paritosh C. Tyagi** Former Chairman, Central Pollution Control Board **Prof. S.P. Gautam** Chairman, Central Pollution Control Board **Dr. Tapan Chakraborti** Director, National Environmental Engineering Research Institute **Mr. K. P. Nyati** Former Head, Environmental Policy, Confederation of Indian Industry **Dr. G.K. Pandey** Former Advisor, Ministry of Environment and Forests **Dr. Nalini Bhat** Advisor, Ministry of Environment and Forests **Dr. G.V. Subramaniam** Advisor, Ministry of Environment and Forests **Dr. B. Sengupta** Former Member Secretary, Central Pollution Control Board **Dr. R. C. Trivedi** Former Scientist, Central Pollution Control Board
Peer Member	**Mr. N. K. Verma** Former AD, Central Pollution Control Board
Member Convener	**Mr. N. Sateesh Babu** Project Director

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ACRONYMS

AAQ	Ambient Air Quality
B/C	Benefits Cost Ratio
BAT	Best Available Technology
BOD	Biological Oxygen Demand
BOQ	Bill of Quantities
BOT	Build Operate Transfer
$CaSO_4$	Calcium Sulfate
$Ca(OH)_2$	Calcium Hydroxide
CCA	Conventional Cost Accounting
CER	Corporate Environmental Reports
CEAA	Canadian Environmental Assessment Agency
CO_2	Carbon Dioxide
CFE	Consent for Establishment
CPCB	Central Pollution Control Board
CREP	Corporate Responsibility for Environmental Protection
CRZ	Coastal Regulatory Zone
DBO	Distiller Blowoff
DCW	Dharangadhra Chemical Works Ltd.
DfE	Design for Environment
DMP	Disaster Management Plan
EAC	Expert Appraisal Committee
ECI	Environmental Condition Indicators
EcE	Economic-cum-Environmental
EIA	Environmental Impact Assessment
EIS	Environmental Information System
EMA	Environmental Management Accounting
EMP	Environmental Management Plan
EMS	Environmental Management System
EPI	Environmental Performance indicators
ES	Environmental Statements
FCA	Full Cost Assessment
GHCL	Gujarat Heavy Chemicals Ltd.
HAZOP	Hazard and Operability Studies
HCl	Hydrochloric Acid
HTL	High Tide Level

IL&FS	Infrastructure Leasing & Financial Services Limited
IVI	Importance Value Index
ISO	International Standard Organization
LCA	Life Cycle Assessment
LDAR	Leak Detection and Repair
LTL	Low Tide Level
MCA	Maximum Credible Accident
MEE	Multiple Effect Evaporators
MoEF	Ministry of Environment & Forests
Na_2CO_3	Sodium Carbonate
NaCl	Sodium Chloride
NAQM	National Air Quality Monitoring
NGO	Non-Government Organizations
Nox	Nitrogen Oxides
O&M	Operation and Maintenance
OECD	Organization for Economic Co-operation and Development
PM	Particulate Matter
PPA	Participatory Poverty Assessment
PRA	Participatory Rural Appraisal
QA/QC	Quality Assurance/Quality Control
QRA	Quantitative Risk Assessment
SEA	Strategic Environmental Assessment
SEAC	State Level Expert Appraisal Committee
SEIAA	State Level Environment Impact Assessment Authority
SEZ	Special Economic Zone
SIA	Social Impact Assessment
SPCB	State Pollution Control Board
SPM	Suspended Particulate Matter
TA	Technology Assessment
TACFL	Tuticorin Alkali Chemicals and Fertilizer Ltd.
TCA	Total Cost Assessment
TEQM	Total Environmental Quality Movement
TGM	Technical EIA Guidance Manual
ToR	Terms of Reference
UT	Union Territory
UTEIAA	Union Territory Level Environment Impact Assessment Authority
UTPCC	Union Territory Pollution Control Committee

IL&FS | Environment

IL&FS Ecosmart Limited

3rd Level
Ambience Corp. Tower
Ambience Mall
Ambience Island
National Highway # 8
Gurgaon-122001
Haryana, India

T +91 124 4716601
F +91 124 4716638
W www.ilfsecosmart.com
www.ilfsindia.com

Mahesh Babu
Chief Executive Officer

Acknowledgement

The Notification issued on the prior environmental clearance process by the Ministry of Environment and Forests (MoEF) on September 14, 2006 delegated substantial powers to the State Level Environment Impact Assessment Authorities (SEIAA) to grant environmental clearance for certain categories of developmental activities/projects. It was felt that proper guidance to the stakeholders would enhance appreciation of environmental impacts of proposed projects and possible mitigation measures. Further, such a guidance would also help ensure that decision making authorities across different States and Union Territories could adopt similar considerations and norms with due weightage for site-specific considerations.

We feel privileged to be part of the interventions being spearheaded by Sh. Jairam Ramesh, Hon'ble Minister, MoEF, Government of India, to mainstream environmental considerations in the decision making process. IL&FS Ecosmart as part of this important initiative, prepared Technical EIA Guidance Manuals for 27 identified development activities. In view of the diversity of 27 developmental activities entrusted to IL&FS Ecosmart Ltd., in consultation with the MoEF, an expert Peer and Core Committee was constituted to review and finalize each of the draft Manuals. The Manuals prepared by IL&FS were technically reviewed and up-dated by the respective sector-specific expert resource persons.

The Manuals designed by the Expert Committee have benefitted from the advise and feedback received from MoEF. The Manuals are designed to provide readers with an in-depth understanding of the environmental clearance mechanism, developmental activity specific environmental impacts with possible mitigation measures, environmentally compliant manufacturing/ production processes and pollution control technologies, etc.

IL&FS Ecosmart hopes that these Manuals are a step forward to realize the MoEF's desired objective of enhancing functional efficiency and effectiveness in the environmental clearance process. We hope the stakeholders will find the Manuals useful.

We take this opportunity to convey our appreciation to the MoEF team under the leadership of Mr. J.M. Mauskar, Additional Secretary, for the technical inputs, guidance and support extended throughout the project period for successful completion of the project. The technical guidance and support extended by the Expert Peer and Core Committee under the Chairmanship of Dr. V. Rajagopalan, former Chairman, Central Pollution Control Board and inputs of the sector-specific resource persons are gratefully acknowledged.

(Mahesh Babu)

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जयराम रमेश
JAIRAM RAMESH

सत्यमेव जयते

राज्य मंत्री (स्वतंत्र प्रभार)
पर्यावरण एवं वन
भारत सरकार
नई दिल्ली-110003

MINISTER OF STATE (INDEPENDENT CHARGE)
ENVIRONMENT & FORESTS
GOVERNMENT OF INDIA
NEW DELHI - 110 003

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FOREWORD

The Ministry of Environment & Forests (MOEF) introduced the Environmental Impact Assessment (EIA) Notification 2006 on 14th September 2006, which not only reengineered the entire environment clearance (EC) process specified under the EIA Notification 1994, but also introduced a number of new developmental sectors which would require prior environmental clearance. The EIA Notification 2006 has notified a list of 39 developmental sectors which have been further categorised as A or B based on their capacity and likely environmental impacts. Category B projects have been further categorised as B1 and B2. The EIA Notification 2006 has further introduced a system of screening, scoping and appraisal and for the setting up of Environment Impact Assessment Authority (EIAA) at the Central level and State Level Environment Impact Assessment Authorities (SEIAAs) to grant environmental clearances at the Central and State level respectively. The Ministry of Environment & Forests is the Environment Impact Assessment Authority at the Central level and 25 State Level Environment Impact Assessment Authorities (SEIAAS) have been set up in the various States/UTs. The EIA Notification 2006 also stipulates the constitution of a multi-disciplinary Expert Appraisal Committee (EAC) at the Centre and State level Expert Appraisal Committees (SEACs) at State/UT Level for appraisal of Category A or B projects respectively and to recommend grant/rejection of environmental clearance to each project/activities falling under the various sectors to the EIAA/SEIAAs respectively.

Although the process of obtaining environmental clearance consisting of Screening, Scoping and Appraisal and for undertaking public consultation including the process of conduct of Public Hearing has been elaborated under the EIA Notification 2006, the Notification itself provides for bringing out guidelines from time to time on the EIA Notification 2006 and the EC process with a view to bringing clarity on the EC process for expediting environmental clearance. This need was further reinforced after the constitution of SEIAAs and SEACs in various States, who were assigned the task for the first time and for addressing the concerns of standardization of the quality of appraisal and in reducing inconsistencies between SEACs/SEIAAs in granting ECs for similar projects in different States.

The Technical Guidance Manual of **"Soda Ash Industry"** sector describes types of EIA, process and pollution control technologies, operational aspects of EIA with model TOR of that Sector, technological options with cleaner production and waste minimization techniques,

monitoring of environmental quality, post clearance monitoring protocol, related regulations, and procedure of obtaining EC if linked to other clearances for e.g., CRZ, etc.

A Soda Ash plant is also characterised by very large volume of liquid and high gas flows, interdependency between unit operations and very high degree of recycle between units . Emphasis should be given to control Ammonia, Hydrogen Sulphide besides PM, SO_2, NO_x, Ammonia and $CaCl_2$ should be recovered. Standards notified by the Ministry for Soda Ash industry should be adhered to. The improvements are long term investments and in many case one particular technology is inter-dependent on another. The real environment benefits have also to be carefully assessed and taken into consideration. There is therefore no individual solution to produce a single list of best available technology.

India's industrial competitiveness and environmental future depends on Industries such as Soda Ash Industry adopting energy and resource efficient technologies. Recycling and reuse of materials is critical. To keep pace with changing technologies and needs of sustainable development, the manual would require regular updating in the future. The manual will be available on the MoEF website and we would appreciate receiving responses from stakeholders for further improvements.

I congratulate the entire team of IL&FS Ecosmart Ltd., experts from the sector who were involved in the preparation of the Manuals, Chairman and members of the Core and Peer Committees of various sectors and various Resource Persons whose inputs were indeed valuable in the preparation and finalization of the Manuals.

(Jairam Ramesh)

1. INTRODUCTION TO THE TECHNICAL EIA GUIDANCE MANUALS PROJECT

Environmental Impact Assessment (EIA) is a process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made. These studies integrate the environmental concerns of developmental activities into the process of decision-making.

EIA has emerged as one of the successful policy innovations of the 20th Century in the process of ensuring sustained development. Today, EIA is formalized as a regulatory tool in more than 100 countries for effective integration of environmental concerns in the economic development process. The EIA process in India was made mandatory and was also given a legislative status through a Notification issued by the Ministry of Environment and Forests (MoEF) in January 1994. The Notification, however, covered only a few selected industrial developmental activities. While there are subsequent amendments, the Notification issued on September 14, 2006 supersedes all the earlier Notifications, and has brought out structural changes in the clearance mechanism.

The basic tenets of this EIA Notification could be summarized into the following:

- Pollution potential as the basis for prior environmental clearance instead of investment criteria; and
- Decentralization of clearing powers to the State/Union Territory (UT) level Authorities for certain developmental activities to make the prior environmental clearance process quicker, transparent and effective.

Devolution of the power to grant clearances at the state level for certain category of the developmental activities / projects is a step forward to fulfill the basic tenets of the re-engineering *i.e.*, quicker, transparent and effective process but many issues impede/hinder its functional efficiency. These issues could be in technical and operational as listed below:

Technical issues

- Ensuring level playing ground to avoid arbitrariness in the decision-making process
- Classification of projects which do not require public hearing and detailed EIA (Category B2)
- Variations in drawing Terms of Reference (ToR) of EIA studies for a given developmental activity across the States/UTs
- Varying developmental-activity-specific expertise requirement for conducting EIA studies and their appraisal
- Availability of adequate sectoral experts and variations in competency levels
- Inadequate data verification, cross checking tools and supporting institutional framework

- Meeting time targets without compromising with the quality of assessments/ reviews
- Varying knowledge and skill levels of regulators, consultants and experts
- Newly added developmental activities for prior environmental clearance, *etc.*

Operational issues

- State level /UT level EIA Authorities (SEIAA/UTEIAA) are formulated for the first time and many are functioning
- Varying roles and responsibilities of involved organizations
- Varying supporting institutional strengths across the States/UTs
- Varying manpower availability, *etc.*

1.1 Purpose

The purpose of developing the sector-specific technical EIA guidance manuals (TGM) is to provide clear and concise information on EIA to all the stakeholders *i.e.*, the project proponent, the consultant, the reviewer, and the public. The TGMs are organized to cover following:

Chapter 1 (Introduction): This chapter provides a brief introduction on the EIA, basic tenets of EIA Notification, technical & operational issues in the process of clearance, purpose of the TGMs, project implementation process and additional information.

Chapter 2 (Conceptual facets of an EIA): Provides an overall understanding to the conceptual aspects of control of pollution and EIA for the developmental projects. This basic understanding would set the readers at same level of understanding for proper interpretations and boundaries for identifying the environmental interactions of the developmental projects and their significance for taking mitigative measures. This chapter covers the discussion on environment in EIA context *i.e* sustainable development, pollution control strategies, preventive environmental management tools, Objectives of EIA, types and basic principles of EIA, project cycle for soda ash industry, understanding on type of environmental impacts and the criteria for the significance analysis.

Chapter 3 (Soda ash industry): The purpose of this chapter is to provide the reader precise information on all the relevant aspects of the industry, which is essential to realize the likely interaction of such developmental activities on the receiving environment. Besides, this Chapter gives a holistic understanding on the sources of pollution and the opportunities of the source control.

The specific coverage which provides precise information on the industry include (i) introduction to industry in India, (ii) Scientific Aspects: Raw materials, Industrial Processes, Co-products (iii) Quantitative Analysis of Inputs and Outputs (iv) Sources of Environmental Pollution: Gaseous emissions, Liquid effluents, Solid waste (v) Control of pollution from the industry: Emission management technologies and (vi) Summary of Applicable National Regulations for Soda Ash industry.

Chapter 4 (Operational aspects): The purpose of this chapter is to facilitate the stakeholders to extend clear guidance on coverage of legislative requirements, sequence of procedures for obtaining the EIA clearance and each step-wise provisions and considerations.

The coverage of the Chapter include provisions in the EIA Notification regarding soda ash industry, siting guidelines, scoping (pre-feasibility report, guidance for filling form 1, identification of valued environmental components, identification of impacts, *etc.*), arriving at terms of reference for EIA studies, impact assessment studies (EIA team, assessment of baseline quality of environment, impact prediction tools, significance of impacts), social impact assessment, risk assessment considerations, typical mitigation measures, designing considerations for environmental management plan, structure of EIA report for incorporation of study findings, process of public consultation, project appraisal, decision making process and post-clearance monitoring protocol.

Chapter 5 (Roles and responsibilities of various organizations involved in the process of prior environmental clearance): The purpose of this Chapter is to brief the stakeholders on the institutional mechanism and roles & responsibilities of the stakeholders involved in the process of prior environmental clearance. The Coverage of the Chapter include (i) roles and responsibilities of the stakeholders, (ii) organization specific functions, (iii) constitution, composition and decision making process of EAC and (iv) other conditions which may be considered.

For any given industry, each topic listed above could alone be the subject of a lengthy volume. However, in order to produce a manageable document, this project focuses on providing summary information for each topic. This format provides the reader with a synopsis of each issue. Text within each section was researched from many sources, and was condensed from more detailed sources pertaining to specific topics.

The contents of the document are designed with a view to facilitate addressing of the relevant technical and operational issues as mentioned in the earlier section. Besides, facilitates various stakeholders involved in the EIA clearance process *i.e,*

- Project proponents will be fully aware of the procedures, common ToR for EIA studies, timelines, monitoring needs, *etc.*, in order to plan the projects/studies appropriately.
- Consultants across India will gain similar understanding about a given sector, and also the procedure for EIA studies, so that the quality of the EIA reports gets improved and streamlined
- Reviewers across the States/UTs will have the same understanding about an industrial sector and would able to draw a benchmark in establishing the significant impacts for the purpose of prescribing the ToR for EIA studies and also in the process of review and appraisal.
- Public who are concerned about new or expansion projects, use this manual to get a basic idea about the manufacturing/production details, rejects/wastes from the operations, choice of cleaner/control technologies, regulatory requirements, likely environmental and social concerns, mitigation measures, *etc.*, in order to seek clarifications appropriately in the process of public consultation. The procedural clarity in the document will further strengthen them to understand the stages involved in clearance and roles and responsibilities of various organizations.
- In addition, these manuals would substantially ease the pressure on reviewers at the scoping stage and would bring in functional efficiency at the central and state levels.

1.2 Project Implementation

The Ministry of Environment & Forests (MoEF), Government of India took up the task of developing sector-specific TGMs for all the developmental activities listed in the re-engineered EIA Notification. The Infrastructure Leasing and Financial Services Ecosmart Limited (IL&FS Ecosmart), has been entrusted with the task of developing these manuals for 27 industrial and related sectors. Soda ash industry is one of these sectors, for which this manual is prepared.

The ability to design comprehensive EIA studies for specific industries depends on the knowledge of several interrelated topics. Therefore, it requires expert inputs from multiple dimensions *i.e.*, administrative, project management, technical, scientific, social, economic, risk *etc.*, in order to comprehensively analyze the issues of concern and to draw logical interpretations. Thus, Ecosmart has designed a well-composed implementation framework to factor inputs of the experts and stakeholders in the process of finalization of these manuals.

The process of manual preparation involved collection & collation of the secondary available information, technical review by sectoral resource persons and critical review & finalization by a competent Expert Committee composed of core and sectoral peer members.

The MoEF appreciates the efforts of Ecosmart, Expert Core and Peer Committee, resource persons and all those who have directly and indirectly contributed to this Manual.

1.3 Additional Information

This TGM is brought out by the MoEF to provide clarity to all the stakeholders involved in the 'Prior Environmental Clearance' process. As such, the contents and clarifications given in this document do not withstand in case of a conflict with the statutory provisions of the Notifications and Executive Orders issued by the MoEF from time-to-time.

TGMs are not regulatory documents. Instead, these are the tools designed to assist in successful completion of an EIA.

For the purpose of this project, the key elements considered under TGMs are: conceptual aspects of EIA; developmental activity-specific information; operational aspects; and roles and responsibilities of involved stakeholders.

This manual is prepared considering the Notification issued on 14th September, 2006 and latest amendment as on 1st December 2009. For recent updates, if any, may please refer the website of the MoEF, Government of India *i.e.,* http://moef.nic.in/index.php.

2. CONCEPTUAL FACETS OF EIA

It is an imperative requirement to understand the basic concepts concerned to the pollution control and the environmental impact assessment in an overall objective of the sustainable development. This Chapter highlights the pollution control strategies and their tools besides the objectives, types & principles of EIA, type of impacts their significance analysis, in order to provide consistent understanding to the reader before assessing the development of activity-specific environmental concerns in Chapter 3 and identification & prediction of significant impacts in order to design mitigation measures as detailed in Chapter 4.

2.1 Environment in EIA Context

"Environment" in EIA context mainly focuses, but is not limited to physical, chemical, biological, geological, social, economical, and aesthetic dimensions along with their complex interactions, which affect individuals, communities and ultimately determines their forms, character, relationship, and survival. In EIA context, 'effect' and 'impact' can often be used interchangeably. However, 'impact' is considered as a value judgment of the significance of an effect.

Sustainable development is built on three basic premises *i.e.*, economic growth, ecological balance and social progress. Economic growth achieved in a way that does not consider the environmental concerns, will not be sustainable in the long run. Therefore, sustainable development needs careful integration of environmental, economic, and social needs in order to achieve both an increased standard of living in short term, and a net gain or equilibrium among human, natural, and economic resources to support future generations in the long term.

It is necessary to understand the links between environment and development in order to make choices for development that will be economically efficient, socially equitable and responsible, as well as environmentally sound.

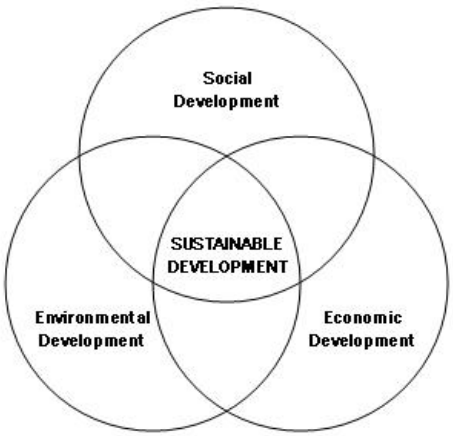

Figure 2-1: Inclusive Components of Sustainable Development

2.2 Pollution Control Strategies

Pollution control strategies can be broadly categorized in to preventive and reactive. The reactive strategy refers to the steps that may be applied once the wastes are generated or contamination of the receiving environment takes place. The control technology or a combination of technologies to minimize the impact due to the process rejects/wastes varies with quantity and characteristics, desired control efficiency and economics.

Many combinations of techniques could be adopted for treatment of a specific waste or the contaminated receiving environment, but are often judged based on techno-economic feasibility. Therefore, the best alternative is to take all possible steps to avoid pollution it self. This preventive approach refers to a hierarchy that involves i) prevention & reduction; ii) recycling and re-use; iii) treatment; and iv) disposal, respectively.

Therefore, there is a need to shift the emphasis from the reactive to preventive strategy *i.e.,* to promote preventive environmental management. Preventive environmental management tools may be grouped into management based tools, process based tools and product based tools, which are given below:

Management Based Tools	Process Based Tools	Product Based Tools
Environmental Management System (EMS)	Environmental Technology Assessment	Industrial Ecology
Environmental Performance Evaluation	Toxic Use Reduction	Extended Producers Responsibility
Environmental Audits	Best Operating Practices	Eco-labeling
Environmental Reporting and Communication	Environmentally Best Practice	Design for Environment
Total Cost Accounting	Best Available Technology (BAT)	Life Cycle Assessment (LCA)
Law and Policy	Waste Minimization	
Trade and Environment	Pollution Prevention	
Environmental Economics	Cleaner Production	
	4-R Concept	
	Cleaner Technology	
	Eco-efficiency	

2.3 Tools for Preventive Environmental Management

The tools for preventive environmental management can be broadly classified into following three groups.

- Tools for assessment and analysis - risk assessment, life cycle assessment, total cost assessment, environmental audit / statement, environmental benchmarking, environmental indicators
- Tools for action - environmental policy, market based economic instruments, innovative funding mechanism, EMS and ISO certification, total environmental quality movement, eco-labeling, cleaner production, eco-efficiency, industrial ecosystem or metabolism, voluntary agreements
- Tools for communication - state of environment, corporate environmental reporting

Specific tools under each group are discussed precisely in next sections.

2.3.1 Tools for assessment and analysis

2.3.1.1 Risk assessment

Risk is associated with the frequency of failure and consequence effect. Predicting such situations and evaluation of risk is essential to take appropriate preventive measures. The major concern of the assessment is to identify the activities falling in a matrix of high & low frequencies at which the failures occur and the degree of its impact. The high frequency, low impact activities can be managed by regular maintenance *i.e*, LDAR (Leak detection and repair) programmes. Whereas, the low frequency, high impact activities are of major concern (accidents) in terms of risk assessment. As the frequency is low, often the required precautions are not realized or maintained. However, the risk assessment identify the areas of major concerns, which require additional preventive measures; likely consequence distances considering domino effects, which will give the possible casualties and ecological loss in case of accidents. These magnitudes demand the attention for preventive and disaster management plans (DMP). Thus is an essential tool to ensure safety of operations.

2.3.1.2 Life cycle assessment

A broader approach followed to deal with environmental impacts during manufacturing is called LCA. This approach recognizes that environmental concerns are associated with every step of the processing w.r.t. manufacturing of products and also examines environmental impacts of the product at all stages of project life cycle. LCA includes product design, development, manufacturing, packaging, distribution, usage and disposal. LCA is concerned with reducing environmental impacts at all the stages and considering the total picture rather than just one stage of the production process.

By availing this concept, firms can minimize costs incurred on the environmental conservation throughout the project life cycle.

2.3.1.3 Total cost assessment

Total Cost Assessment (TCA) is an enhanced financial analysis tool that is used to assess the profitability of alternative courses of action ex. raw material substitution to reduce the costs of managing the wastes generated by process; an energy retrofit to reduce the costs of energy consumption. This is particularly relevant for pollution prevention options, because of their nature, often produce financial savings that are overlooked in conventional financial analysis, either because they are misallocated, uncertain, hard to quantify, or occur more than three to five years after the initial investment. TCA involves all of the relevant costs and savings associated with an option so that it can compete for scarce capital resources fairly, on a level playing field. The assessments are often beneficial in respect of the following:

- Identification of costly resource inefficiencies
- Financial analysis of environmental activities/projects such as investment in cleaner technologies
- Prioritization of environmental activities/projects
- Evaluation of product mix and product pricing
- Bench marking against the performance of other processes or against the competitors

A comparison of cost assessments is given below:

- Conventional cost accounting (CCA): Direct and indirect financial costs+ Recognized contingent costs
- Total Cost Assessment (TCA): A broader range of direct, indirect, contingent and less quantifiable costs
- Full Cost assessment (FCA): TCA + External social costs borne by society

2.3.1.4 Environmental audit/statement

The key objectives of an environmental audit includes compliance verification, problem identification, environmental impact measurement, environmental performance measurement, conforming effectiveness of EMS, providing a database for corrective actions and future actions, developing companies environmental strategy, communication and formulating environmental policy.

The MoEF, Government of India issued Notification on '*Environmental Statements*' (ES) in April, 1992 and further amended in April 1993 – As per the Notification, the industries are required to submit environmental statements to the respective State Pollution Control Board (SPCB). ES is a pro-active tool for self-examination of the industry itself to reduce/minimize pollution by adopting process modifications, recycling and reusing of the resources. The regular submission of ES will indicate the systematic improvement in environmental pollution control being achieved by the industry. In other way, the specific points in ES may be used as environmental performance indicators for relative comparison, implementation and to promote better practices.

2.3.1.5 Environmental benchmarking

Environmental performance and operational indicators could be used to navigate, manage and communicate the significant aspects and give enough evidence of good environmental house keeping. Besides prescribing standards, an insight to identify the performance indicators and prescribing schedule for systematic improvement in performance of these indicators will yield better results.

Relative indicators may be identified for different industrial sectors and be integrated in the companies and organizations to monitor and manage the different environmental aspects of the company, to benchmark and compare two or more companies from the same sector. These could cover the water consumption, wastewater generation, energy consumption, solid/hazardous waste generation, chemical consumption *etc.*, per tonne of final product. Once these bench marks are developed, the industries which are below them may be guided and enforced to reach the level and those which are better than the bench mark may be encouraged further by giving incentives *etc.*

2.3.1.6 Environmental indicators

Indicators can be classified in to environmental performance indicators (EPI) and environmental condition indicators (ECI). The EPIs can be further divided into two categories *i.e.,* operational performance indicators and management performance indicators.

The operational performance indicators are related to the process and other operational activities of the organization, these would typically address the issue of raw material consumption, energy consumption, water consumption in the organization, the quantities of wastewater generated, other solid wastes generated, emission from the organization *etc.*

Management performance indicators are related to the management efforts to influence the environmental performance of the organizations operations.

The environmental condition indicators provide information about the environment. These indicators provide information about the local, regional, national or global condition of the environment. This information helps the organization to understand the environmental impacts of its activities and thus helps in taking decisions to improve the environmental performance.

Indicators basically used to evaluate environmental performance against the set standards and thus indicate the direction in which to proceed. Selection of type of indicators for a firm or project depends upon its relevance, clarity and realistic cost of collection and its development.

2.3.2 Tools for action

2.3.2.1 Environmental policy

An environmental policy is a statement of the organization's overall aim and principles of action w.r.t the environment, including compliance with all relevant regulatory requirements. It is a key tool in communicating the environmental priorities of the organizations to all its employees. To ensure organization's commitment towards a formulated environmental policy, it is essential for the top management to be involved in the process of formulating the policy and setting priorities. Therefore, the first step is to get the commitment from the higher levels of management. The organization should then conduct an initial environmental review and draft an environmental policy. This draft should be discussed and approved by the board of directors and finally the approved environmental policy statement must be communicated internally among all its employees and must also be made available to the public.

2.3.2.2 Market-based economic instruments

Market based instruments are regulations that encourage behavior through market signals rather than through explicit directives regarding pollution control levels. These policy instruments such as tradable permits, pollution charge are often described as harnessing market forces. Market based instruments can be categorized into the following four major categories which are discussed below.

- **Pollution charge:** Charge system will assess a fee or tax on the amount of pollution a firm or source generates. It is worthwhile for the firm to reduce emissions to the point, where its marginal abatement costs is equal to the tax rate. Thus firms control pollution to different degrees *i.e.,* High cost controllers – less; low-cost controllers-more. The charge system encourages the industries to further reduce the pollutants. The collected charges can form a fund for restoration of the environment. Another form of pollution charge is a deposit refund system, where, consumers pay a surcharge when purchasing a potentially polluting product, and receive a refund on return of the product after useful life span at appropriate centers. The concept of extended producers' responsibility brought in to avoid accumulation of dangerous products in the environment.
- **Tradable permits:** Under this system, firms that achieve the emission levels below their allotted level may sell the surplus permits. Similarly, the firms, which are

required to spend more to attain the required degree of treatment/allotted levels, can purchase permits from others at lower costs and may be benefited.

- **Market barrier reductions:** Three known market barrier reduction types are as follows:
  - Market creation: Measures that facilitate the voluntary exchange of water rights and thus promote more efficient allocation of scarce water supplies.
  - Liability concerns: Encourage firms to consider potential environmental damages of their decisions
  - Information programmes: Eco-labeling and energy efficiency product labeling requirements
- **Government subsidy reduction:** Subsidies are the mirror images of taxes and, in theory, can provide incentive to address environmental problems. However, it has been reported that the subsidies encourage economically inefficient and environmentally unsound practices, and often leads to market distortions due to differences in the area. However, these are important to sustain the expansion of production, in the national interests. In such cases, the subsidy may be comparable to the net social benefit.

2.3.2.3 Innovative funding mechanism

There are many forums under which the fund is made available for the issues which are of global/regional concern *i.e.,* climate change, Basal convention and further fund sources are being explored for the Persistent Organic Pollutants Convention. Besides the global funding mechanism, there needs to be localized alternative mechanisms for boosting the investment in environmental pollution control. For example, in India the Government has established mechanism to fund the common effluent treatment plants, which are specifically serving the small and medium scale enterprises *i.e.,* 25% share by the State Government, matching grants from the Central Government and surety for 25% soft loan. It means that the industries need to invest only 25% initially, thus encouraging voluntary compliance.

There are some more options *i.e.,* if the pollution tax/charge is imposed on the residual pollution being caused by the industries, municipalities *etc.*, fund will automatically be generated, which in turn, can be utilized for funding the environmental improvement programmes. The emerging concept of build-operate-transfer (BOT) is an encouraging development, where there is a possibility to generate revenue by application of advanced technologies. There are many opportunities which can be explored. However, what is required is the paradigm shift and focused efforts.

2.3.2.4 EMS and ISO certification

EMS is that part of the overall management system, which includes the organizational structure, responsibilities, practices, procedures, process and resources for determining and implementing the forms of overall aims, principles of action w.r.t the environment. It encompasses the totality of organizational, administrative and policy provisions to be taken by a firm to control its environmental influences. Common elements of an EMS are the identification of the environmental impacts and legal obligations, the development of a plan for management & improvement, the assignment of the responsibilities and monitoring of the performance.

2.3.2.5 Total environmental quality movement

Quality is regarded as

- A product attribute that had to be set at an acceptable level and balanced against the cost
- Something delivered by technical systems engineered by experts rather than the organization as a whole
- Assured primarily through the findings and correction of mistakes at the end of the production process

One expression of the total environment quality movement (TEQM) is a system of control called Kaizen. The principles of Kaizen are:

- Goal must be continuous improvement of quality instead of acceptable quality
- Responsibility of the quality shall be shared by all members of an organization
- Efforts should be focused on improving the whole process and design of the products

With some modifications, TEQM approach can be applied in the improvement of corporate environmental performance in both process and product areas.

2.3.2.6 Eco-labeling

It is known as the practice of supplying information on the environmental characteristics of a product or service to the general public. These labeling schemes can be grouped in to three types:

- Type I: Multiple criteria base; third party (Govt. or non-commercial private organizations) programme claims overall environmental preferability.
- Type II: Specific attribute of a product; often issued by a company/industrial association
- Type III: Agreed set of indices; provides quantified information; self declaration

Among the above, Type I are more reliable because they are established by a third party and considers the environmental impacts of a product from cradle to grave. However, the labeling program will only be effective if linked with complementary program of consumer education and up on restriction of umbrella claims by the producers.

2.3.2.7 Cleaner production

Cleaner production is one of the tools, which has lot of bearing on environmental pollution control. It is also seen that the approach is changing with time *i.e.,* dumping-to-control-to-recycle-to-prevention. Promotion of cleaner production principles involves an insight into the production processes not only to get desired yield but also to optimize on raw material consumption *i.e.,* resource conservation and implications of the waste treatment and disposal.

2.3.2.8 4-R concept

The concept endorses utilization of the wastes as a by-product to the extent possible *i.e.,* Re-cycle, Recover, Reuse, Recharge. Recycling refers to using the wastes/by-products in

the process again as a raw material to maximize the production. Recovery refers to engineering means such as solvent extraction, distillation, precipitation *etc.,* to separate the useful constituents of the wastes, so that these recovered materials can be used. Reuse refers to the utilization of waste from one process as a raw material to other. Recharging is an option in which the natural systems are used for renovation of waste for further use.

2.3.2.9 Eco-efficiency

The World Business Council on sustainable development (WBCSD) defines eco-efficiency as "the delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life cycle, to a level at least in line with earth's carrying capacity". The business implements the eco-efficiency on four levels *i.e.* optimized processes, recycling of wastes, eco-innovation and new services. Fussler (1995) defined six dimensions of eco efficiency, which are given below to understand/examine the system.

- **Mass:** There is an opportunity to significantly reduce mass burdens (raw materials, fuels, utilities consumed during the life cycle)
- **Reduce energy use:** The opportunity is to redesign the product or its use to provide significant energy savings
- **Reduce environmental toxins:** This is concern to the environmental quality and human health. The opportunity here is to significantly control the dispersion of toxic elements.
- **Recycle when practical:** Designing for recyclibility is important
- **Working with mother nature:** Materials are borrowed and returned to the nature without negatively affecting the balance of the ecosystem.
- **Make it Last Longer:** It relates to useful life and functions of products. Increasing the functionality of products also increase their eco efficiency.

The competitiveness among the companies and long-term survival will continue and the successful implementation of eco efficiency will contribute to their success. There is a need to shift towards responsible consumerism equal to the efficiency gains made by corporations – doing more with less.

2.3.2.10 Industrial ecosystem or metabolism

Eco-industrial development is a new paradigm for achieving excellence in business and environmental performance. It opens up innovative new avenues for managing business and conducting economic development by creating linkages among local 'resources', including businesses, non-profit groups, governments, unions, educational institutions, and communities can creatively foster the dynamic and responsible growth. Antiquated business strategies based on isolated enterprises are no longer responsive enough to market, environmental and community requirements.

Sustainable eco-industrial development looks systematically at development, business and environment, attempting to stretch the boundaries of current practice - on one level, it is as directly practical as making the right connections between the wastes and resources needed for production and at the other level, it is a whole new way of thinking about doing business and interacting with communities. At a most basic level, it is each

organization seeking higher performance within it self. However, most eco-industrial activity is moving to a new level by increasing the inter connections between the companies.

Strategic partnership, networked manufacturing and performed supplier arrangements are all the examples of ways used by the businesses to ensure growth, contain costs and to reach out for new opportunities.

For most businesses, the two essentials for success are the responsive markets and access to cost-effective, quality resources for producing products or delivering services. In absence of these two factors, virtually, every other incentive becomes a minor consideration.

Transportation issues are important at two levels, the ability to get goods to market in an expeditious way is essential to success in this day of just in time inventories. The use of least impact transportation with due consideration of speed and cost supports business success and addresses concerned in the community.

Eco-industrial development works because it consciously mixes a range of targeted strategies shaped to the contours of the local community, most importantly, it works because the communities wants nothing less than the best possible in or near their neighborhoods. For companies, it provides a path towards significantly higher operating results and positive market presence. For our environment, it provides great hope that the waste will be transformed in to valued product and that the stewardship will be a joint pledge of both businesses and communities.

2.3.2.11 Voluntary agreements

Voluntary environmental agreements among the industries, government, public representatives, NGOs and other concerned towards attaining certain future demands of the environment are reported to be successful. Such agreements may be used as a tool where Government would like to make the standards stringent in future (phase-wise-stringent). These may be used when conditions are temporary and requires replacing timely. Also these may be used as supplementary/complimentary in implementation of the regulation. The agreements may include:

- Target objectives (emission limit values/standards)
- Performance objectives (operating procedures)
- R&D activities – Government and industry may have agreement to establish better control technologies.
- Monitoring & reporting of the agreement conditions by other agents (NGOs, public participants, civil authority *etc.*)

In India, the MoEF has organized such programme, popularly known as the corporate responsibility for environment protection (CREP) considering identified 17 categories of high pollution potential industrial sectors. Publication in this regard, is available with Central Pollution Control Board (CPCB).

2.3.3 Tools for communication

2.3.3.1 State of environment

The Government of India brought out the state of environment report for entire country and similar reports available for many of the states. These reports are published at regular intervals to record trends and to identify the required interventions at various levels. These reports consider the internationally accepted DPSIR framework for the presentation of the information. DPSIR refers to

- D – Driving forces – causes of concern *i.e.,* industries, transportation *etc.*
- P – Pressures – pollutants emanating from driving forces *i.e.,* emission
- S – State – quality of environment *i.e.,* air, water & soil quality
- I – Impact – Impact on health, eco-system, materials, biodiversity, economic damage *etc.*
- R – Responses – action for cleaner production, policies (including standards/ guidelines), targets *etc.*

Environment reports including the above elements gives a comprehensive picture of specific target area in order to take appropriate measures for improvement. Such reports capture the concerns, which could be considered in EIAs.

2.3.3.2 Corporate environmental reporting

Corporate environmental reports (CERs) are only one form of environmental reporting defined as publicly available, stand alone reports, issued voluntarily by the industries on their environmental activities. CER is a means to environmental improvement and greater accountability, not an end in itself.

Three categories of environmental disclosure are:

- Involuntary disclosure: Without its permission and against its will (env. Campaign, press *etc.*)
- Mandatory disclosure: As required by law
- Voluntary disclosure: The disclosure of information on a voluntary basis

2.4 Objectives of EIA

Objectives of EIA include the following:

- To ensure environmental considerations are explicitly addressed and incorporated into the development decision-making process;
- To anticipate and avoid, minimize or offset the adverse significant biophysical, social and other relevant effects of development proposals;
- To protect the productivity and capacity of natural systems and the ecological processes which maintain their functions; and
- To promote development that is sustainable and optimizes resource use and management opportunities.

2.5 Types of EIA

Environmental assessments could be classified into four types *i.e.,* strategic environmental assessment (SEA), regional EIA, sectoral EIA and project level EIA. These are precisely discussed below:

Strategic environmental assessment

SEA refers to systematic analysis of the environmental effects of development policies, plans, programmes and other proposed strategic actions. SEA represents a proactive approach to integrate environmental considerations into the higher levels of decision-making – beyond the project level, when major alternatives are still open.

Regional EIA

EIA in the context of regional planning integrates environmental concerns into development planning for a geographic region, normally at the sub-country level. Such an approach is referred to as the economic-cum-environmental (EcE) development planning. This approach facilitates adequate integration of economic development with management of renewable natural resources within the carrying capacity limitation to achieve sustainable development. It fulfils the need for macro-level environmental integration, which the project-oriented EIA is unable to address effectively. Regional EIA addresses the environmental impacts of regional development plans and thus, the context for project-level EIA of the subsequent projects, within the region. In addition, if environmental effects are considered at regional level, then cumulative environmental effects of all the projects within the region can be accounted.

Sectoral EIA

Instead of project-level-EIA, an EIA should take place in the context of regional and sectoral level planning. Once sectoral level development plans have the integrated sectoral environmental concerns addressed, the scope of project-level EIA will be quite minimal. Sectoral EIA will help in addressing specific environmental problems that may be encountered in planning and implementing sectoral development projects.

Project level EIA

Project level EIA refers to the developmental activity in isolation and the impacts that it exerts on the receiving environment. Thus, it may not effectively integrate the cumulative effects of the development in a region.

From the above discussion, it is clear that EIA shall be integrated at all the levels *i.e.,* strategic, regional, sectoral and the project level. Whereas, the strategic EIA is a structural change in the way the things are evaluated for decision-making, the regional EIA refers to substantial information processing and drawing complex inferences. The project-level EIA is relatively simple and reaches to meaningful conclusions. Therefore in India, largely, the project-level EIA studies are taking place and are being considered. However, in the re-engineered Notification, provisions have been incorporated for giving a single clearance for the entire industrial estate for *e.g.*, Leather parks, pharma cities *etc.*, which is a step towards the regional approach.

As we progress and the resource planning concepts emerge in our decision-making process, the integration of overall regional issues will become part of the impact assessment studies.

2.6 Basic EIA Principles

By integrating the environmental impacts of the development activities and their mitigation early in the project planning cycle, the benefits of EIA could be realized in all stages of a project, from exploration and planning, through construction, operations, decommissioning, and beyond site closure.

A properly-conducted-EIA also lessens conflicts by promoting community participation, informing decision makers, and also helps in laying the base for environmentally sound projects. An EIA should meet at least three core values:

- Integrity: The EIA process should be fair, objective, unbiased and balanced
- Utility: The EIA process should provide balanced, credible information for decision-making
- Sustainability: The EIA process should result in environmental safeguards

Ideally an EIA process should be:

- Purposive - should inform decision makers and result in appropriate levels of environmental protection and community well-being.
- Rigorous - should apply 'best practicable' science, employing methodologies and techniques appropriate to address the problems being investigated.
- Practical - should result in providing information and acceptable and implementable solutions for problems faced by proponents.
- Relevant - should provide sufficient, reliable and usable information for development planning and decision making.
- Cost-effective - should impose the minimum cost burdens in terms of time and finance on proponents and participants consistent with meeting accepted requirements and objectives of EIA.
- Efficient - should achieve the objectives of EIA within the limits of available information, time, resources and methodology.
- Focused - should concentrate on significant environmental effects and key issues; *i.e.,* the matters that need to be taken into account in making decisions.
- Adaptive - should be adjusted to the realities, issues and circumstances of the proposals under review without compromising the integrity of the process, and be iterative, incorporating lessons learned throughout the project life cycle.
- Participative - should provide appropriate opportunities to inform and involve the interested and affected publics, and their inputs and concerns should be addressed explicitly in the documentation and decision making.
- Inter-disciplinary - should ensure that the appropriate techniques and experts in the relevant bio-physical and socio-economic disciplines are employed, including use of traditional knowledge as relevant.
- Credible - should be carried out with professionalism, rigor, fairness, objectivity, impartiality and balance, and be subject to independent checks and verification.
- Integrated - should address the interrelationships of social, economic and biophysical aspects.

- Transparent - should have clear, easily understood requirements for EIA content; ensure public access to information; identify the factors that are to be taken into account in decision making; and acknowledge limitations and difficulties.
- Systematic - should result in full consideration of all relevant information on the affected environment, of proposed alternatives and their impacts, and of the measures necessary to monitor and investigate residual effects.

2.7 Project Cycle

The generic project cycle including that of soda ash industry has six main stages:

1. Project concept
2. Pre-feasibility
3. Feasibility
4. Design and engineering
5. Implementation
6. Monitoring and evaluation

It is important to consider the environmental factors on an equal basis with technical and economic factors throughout the project planning, assessment and implementation phases. Environmental considerations should be introduced at the earliest in the project cycle and must be an integral part of the project pre-feasibility and feasibility stage. If the environmental considerations are given due respect in the site selection process by the project proponent, the subsequent stages of the environmental clearance process would get simplified and would also facilitate easy compliance to the mitigation measures throughout the project life cycle.

A project's feasibility study should include a detailed assessment of significant impacts and the EIA include a detailed prediction and quantification of impacts and delineation of Environmental Management Plan (EMP). Findings of the EIA study should preferably be incorporated in the project design stage so that the project as well as the site alternatives is studied and necessary changes, if required, are incorporated in the project design stage. This practice will also help the management in assessing the negative impacts and in designing cost-effective remedial measures. In general, EIA enhances the project quality and improves the project planning process.

2.8 Environmental Impacts

Environmental impacts resulting from proposed actions can be grouped into following categories:

- Beneficial or detrimental
- Naturally reversible or irreversible
- Repairable via management practices or irreparable
- Short term or long term
- Temporary or continuous
- Occurring during construction phase or operational phase
- Local, regional, national or global
- Accidental or planned (recognized before hand)
- Direct (primary) or Indirect (secondary)

- Cumulative or single

The category of impact as stated above, and the significance will facilitate the Expert Appraisal Committee (EAC) to take a look at the ToR for EIA studies, as well as, in decision making process about the developmental activity.

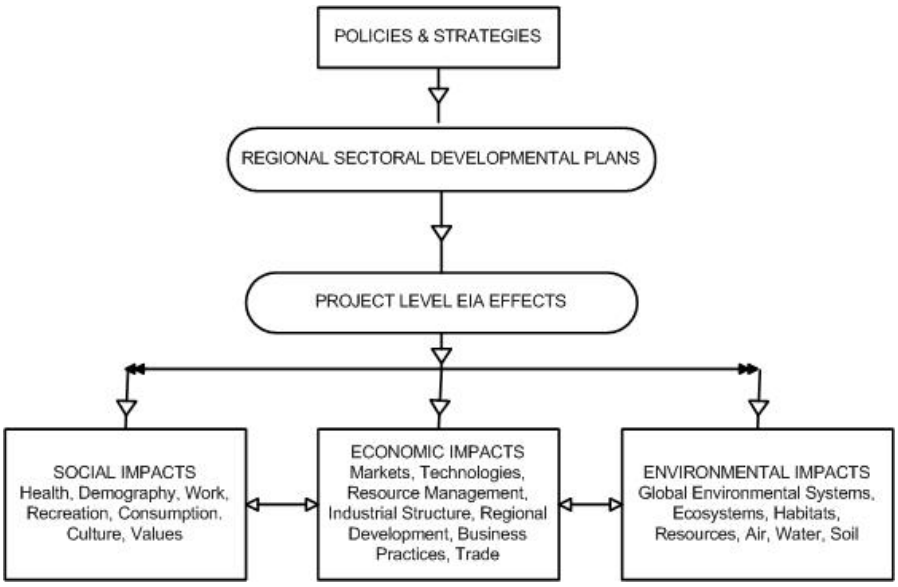

Figure 2-2: Types of Impacts

The nature of impacts could fall within three broad classifications *i.e.*, direct, indirect and cumulative, based on the characteristics of impacts. The assessment of direct, indirect and cumulative impacts should not be considered in isolation or considered as separate stages in the EIA. Ideally, the assessment of such impacts should form an integral part of all stages of the EIA. The TGM does not recommend a single method to assess the types of impacts, but suggests a practical framework/approach that can be adapted and combined to suit a particular project and the nature of impacts.

2.8.1 Direct impacts

Direct impacts occur through direct interaction of an activity with an environmental, social, or economic component. For example, a discharge of soda ash industry or effluent from the Effluent Treatment Plant (ETP) into a river may lead to a decline in water quality in terms of high biochemical oxygen demand (BOD) or dissolved oxygen (DO) or rise of water toxins.

2.8.2 Indirect impacts

Indirect impacts on the environment are those which are not a direct result of the project, often produced away from or as a result of a complex impact pathway. The indirect impacts are also known as secondary or even tertiary level impacts. For example, ambient air SO_2 rise due to stack emissions may deposit on land as SO_4 and cause acidic soils. Another example of indirect impact, is the decline in water quality due to rise in temperature of water bodies receiving cooling water discharge from the nearby industry. This, in turn, may lead to a secondary indirect impact on aquatic flora in that water body and may further cause reduction in fish population. Reduction in fishing harvests, affecting the incomes of fishermen is a third level impact. Such impacts are characterized

as socio-economic (third level) impacts. The indirect impacts may also include growth-inducing impacts and other effects related to induced changes to the pattern of land use or additional road network, population density or growth rate. In the process, air, water and other natural systems including the ecosystem may also be affected.

2.8.3 Cumulative impacts

Cumulative impact consists of an impact that is created as a result of the combination of the project evaluated in the EIA together with other projects in the same vicinity, causing related impacts. These impacts occur when the incremental impact of the project is combined with the cumulative effects of other past, present and reasonably foreseeable future projects. Figure 2-3 depicts the same. Respective EAC may exercise their discretion on a case-by-case basis for considering the cumulative impacts.

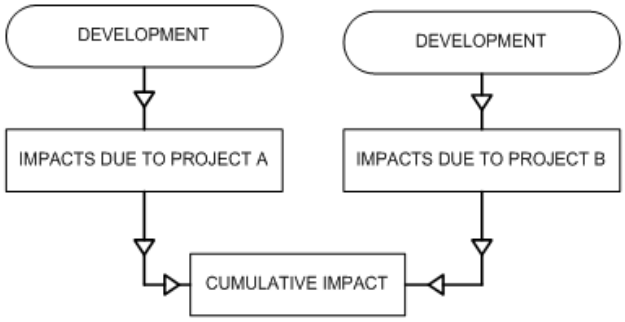

Figure 2-3: Cumulative Impact

2.8.4 Induced impact

The cumulative impacts can be due to induced actions of projects and activities that may occur if the action under assessment is implemented such as growth-inducing impacts and other effects related to induced changes to the pattern of future land use or additional road network, population density or growth rate (*e.g.*, excess growth may be induced in the zone of influence around a project area, and in the process causing additional effects on air, water and other natural ecosystems). Induced actions may not be officially announced or be part of any official plan. Increase in workforce and nearby communities contributes to this effect.

They usually have no direct relationship with the action under assessment, and represent the growth-inducing potential of an action. New roads leading from those constructed for a project, increased recreational activities (*e.g.*, hunting, fishing), and construction of new service facilities are examples of induced actions.

However, the cumulative impacts due to induced development or third level or even secondary indirect impacts are difficult to be quantified. Because of higher levels of uncertainties, these impacts cannot normally be assessed over a long time horizon. An EIA practitioner usually can only guess as to what such induced impacts may be and the possible extent of their implications on the environmental factors. Respective EAC may exercise their discretion on a case-by-case basis for considering the induced impacts.

2.9 Significance of Impacts

This TGM establishes the significance of impacts first and proceeds to delineate the associated mitigation measures. So the significance here reflects the "worst-case scenario" before mitigation is applied, and therefore provides an understanding of what may happen if mitigation fails or is not as effective as predicted. For establishing significance of different impacts, understanding the responses and interaction of the environmental system is essential. Hence, the impact interactions and pathways are to be understood and established first. Such an understanding will help in the assessment process to quantify the impact as accurately as possible. Complex interactions, particularly in the case of certain indirect or cumulative impacts, may give rise to non-linear responses, which are often difficult to understand and therefore their significance is difficult to assess. It is hence understood that indirect or cumulative impacts are more complex than the direct impacts. Currently the impact assessments are limited to direct impacts. In case mitigation measures are delineated before determining significance of the effect, the significance represents the residual effects.

However, the ultimate objective of an EIA is to achieve sustainable development. The development process shall invariably cause some residual impacts even after implementing an EMP effectively. Environmentalists today are faced with a vital, not-easy-to-answer question—"What is the tolerable level of environmental impact within the sustainable development framework?" As such, it has been recognized that every ecosystem has a threshold for absorbing deterioration and a certain capacity for self-regeneration. These thresholds based on concept of carrying capacity are as follows:

- Waste emissions from a project should be within the assimilative capacity of the local environment to absorb without unacceptable degradation of its future waste absorptive capacity or other important services.
- Harvest rates of renewable resource inputs should be within the regenerative capacity of the natural system that generates them; depletion rates of non-renewable inputs should be equal to the rate at which renewable substitutes are developed by human invention and investment.

The aim of this model is to curb over-consumption and unacceptable environmental degradation. But because of limitation in available scientific basis, this definition provides only general guidelines for determining the sustainable use of inputs and outputs. To establish the level of significance for each identified impact, a three-stage analysis may be referred:

- First, an impact is qualified as being either negative or positive.
- Second, the nature of impacts such as direct, indirect, or cumulative is determined using the impact network
- Third, a scale is used to determine the severity of the effect; for example, an impact is of low, medium, or high significance.

It is not sufficient to simply state the significance of the effect. This determination must be justified, coherent and documented, notably by a determination methodology, which must be described in the methodology section of the report. There are many recognized methodologies to determine the significance of effects.

2.9.1 Criteria/methodology to determine the significance of the identified impacts

The criteria can be determined by answering some questions regarding the factors affecting the significance. This will help the EIA stake-holders, the practitioner in particular, to determine the significance of the identified impacts eventually. Typical examples of such factors include the following:

- Exceeding threshold Limit: Significance may increase if a threshold is exceeded. *e.g.*, particulate matter emissions exceed the permissible threshold.
- Effectiveness of mitigation: Significance may increase as the effectiveness of mitigation measures decreases. *e.g.*, control technologies, which may not assure consistent compliance to the requirements.
- Size of study area: Significance may increase as the zone of effects increases.
- Incremental contribution of effects from action under review: Significance may increase as the relative contribution of an action increases.
- Relative contribution of effects of other actions: Significance may decrease as the significance of nearby larger actions increase.
- Relative rarity of species: Significance may increase as species becomes increasingly rare or threatened.
- Significance of local effects: Significance may increase as the significance of local effects is high.
- Magnitude of change relative to natural background variability: Significance may decrease if effects are within natural assimilative capacity or variability.
- Creation of induced actions: Significance may increase as induced activities also highly significant.
- Degree of existing disturbance: Significance may increase if the surrounding environment is pristine.

For determining significance of impacts, it is important to remember that secondary and higher order effects can also occur as a result of a primary interaction between a project activity and the local environment. Wherever a primary effect is identified, the practitioner should always think if secondary or tertiary effects on other aspects of the environment could also arise.

The EIA should also consider the effects that could arise from the project due to induced developments, which take place as a consequence of the project. Ex. Population density and associated infrastructure and jobs for people attracted to the area by the project. It also requires consideration of cumulative effects that could arise from a combination of the effects due to other projects with those of other existing or planned developments in the surrounding area. So the necessity to formulate a qualitative checklist is suggested to test significance, in general.

3. ABOUT SODA ASH INDUSTRY INCLUDING PROCESS AND POLLUTION CONTROL TECHNOLOGIES

3.1 Introduction

Soda Ash (commercial name Sodium Carbonate) forms an important part of Indian inorganic chemical industry. It accounts for 50-60% of Chlor-alkali industry by turnover. It is a high volume, low-value product and finds application mainly in the production of detergents (42% light soda ash), glass (23% dense soda ash), chemicals (17% mainly light soda ash), sodium silicate, pulp & paper and water treatment.

3.1.1 Structure and status of Indian industry

The manufacture of soda ash in India started in 1932 at Dharangadhra in Gujarat with an installed capacity of 50 tonne per day under the name of Shri Shakti Alkali Works, which later became Dharangadhra Chemical Works Ltd. (DCW). This was followed by the entry of Tata Chemicals at Mithapur in Gujarat in 1994, with an installed capacity of 100 tonnes per day (TPD). In a span of 50 years it has grown to be the biggest soda ash unit in the country with daily capacity of 2000 tonne. In the same Saurashtra region, two more soda ash plants came up afterwards. Saurashtra Chemicals at Porbandar was commissioned in 1959 with a capacity of 200 tonne per day, which has been expanded to 800 tonne per day. Gujarat Heavy Chemicals Ltd. (GHCL) at Sutrapada, near Veraval was commissioned in 1988 with a capacity of 1200 tonne per day. All these four units in Saurashtra are based on Solvay process.

These three units were using modified Solvay process (Dual Process) in which ammonium chloride is the co-product. The first plant based on this technology was set up in 1959 at Varanasi, Uttar Pradesh in the name of Sahu Chemicals & Fertiliser with an installed capacity of 120 tonne per day, but since August 1988 this unit is lying idle. The other two units operating on dual process at a capacity of 200 tonne per day are Tuticorin Alkali Chemicals and Fertiliser Ltd (TACFL) at Tuticorin, Tamil Nadu (established in 1982), and Punjab National Fertiliser & Chemical at Nayanangal, Punjab (established in 1984). The present installed capacity of six soda ash manufacturing units is 17.09 lakh tonne. With expansion of existing soda ash manufacturing units and after commencement of new units, the total production of soda ash is estimated to be 27.4 lakh tonnes. Substantial quantity of soda ash was being imported up to 1987-88 (till the commissioning of Gujarat Heavy Chemicals Ltd in 1988) to meet the domestic demand.

Soda ash export potential does exist specially to the Middle-East and South-East Asia. Tata Chemicals, Gujarat Heavy Chemicals Ltd and Saurashtra Chemicals were exporting to Middle-East Asia in early 90s. Soda ash demand in India during the decade of 1999-2000 was about 26.80 lakh tonnes, which was met through expansion of existing units and with commencement of new companies. Nirma commissioned its Soda ash and Pure Water Plant (Editable salt) in 2000 and thereafter expanded capacity of Soda Ash in 2002 and Pure Water Plant (Editable salt) in 2007.

Raw materials for Solvay process are salt, lime-stone and coke. Ammonia is also used in the process as an intermediate carrier catalyst. In soda ash industry, solar salt is used which contains 93-94% sodium chloride (NaCl) as against 98% available in the international market. Similarly, the quality of lime stone does not meet the International standard. As regards coke, the industry has no option, but to import it from countries like China, Japan, *etc.*

Coal is not a raw material for soda ash manufacture, but all soda ash units mostly have coal-based captive power plants for cogeneration of steam and power required for the process. In India out of six soda ash manufacturing units, four are based on Solvay process and 91.2% soda ash is produced by this process. Though some soda ash units have imported technology, a few of the Indian soda ash units are capable of designing and engineering soda ash plants. All the manufacturing units in India are producing soda ash of BIS grade.

3.1.2 Present industry dynamics

The industrial structure and characteristics would help us to understand the real impact. There are five main producers of soda ash in India viz. TCL, GHCL, DCW Limited, Nirma & Tuticorin Alkalies (TAFCL) and competition is mainly on the basis of price. India has the advantage of abundance of raw materials *viz*. limestone and salt, energy-efficient technological plants and growing domestic demand. However, Indian players are facing problems of comparatively higher electricity costs, lack of port infrastructure and higher local taxes.

3.1.3 Uses in industrial sectors

Soda ash is a type of chemical commodity used in several branches of industry. The main ones are quoted in the following paragraphs.

- **Glass industry:** Soda ash is used in manufacturing of flat and container glass. Acting as a network modifier or fluxing agent, it lowers the melting temperature of sand and therefore reduces energy consumption.
- **Detergent industry:** Soda ash is used in a large number of prepared domestic products: soaps, scouring powders, soaking and washing powders containing varying proportions of sodium carbonate, where the soda ash acts primarily as a builder or water softener.
- **Steel industry:** Soda ash is used as a flux, a desulfuriser, dephosphoriser and denitrider.
- **Non-ferrous metallurgy industry**
  - treatment of uranium ores
  - oxidizing calcination of chrome ore
  - lead recycling from discarded batteries
  - recycling of zinc, aluminum
- **Chemical industry:** Soda ash is used in a large number of chemical reactions to produce organic or inorganic compounds, which are used in different applications.
- Sodium bicarbonate

- animal feed to balance their diets for compensating seasonal variations and for meeting specific biological and rearing needs
- paper industry for paper sizing
- plastic foaming
- water treatment
- leather treatment
- flue gas treatment, especially in incinerators
- detergent and cleaning products such as washing powders and liquids, dishwashing products, *etc*
- drilling mud to improve fluidity
- fire extinguisher powder
- human food products and domestic uses: baking soda, effervescent drinks, toothpaste, fruit cleaning, and personal hygiene, *etc*,
- pharmaceutical applications: effervescent tablets, haemodialysis

- **Sodium sesquicarbonate [$Na_3H(CO_3)_2$]:** used as bath salts, water softener
- **Chemically pure sodium carbonate:** used in pharmaceuticals industry, cosmetics, food industry and fine chemicals
- **Sodium bichromate:** used as cooling systems, corrosion inhibitors, mineral leather tanning agents in industries like machinery manufacturing and repair, corrosion inhibitors, leather, and pesticides *etc.*
- **Sodium per carbonate:** used as bleaching agent for various fabrics and a constituent for domestic detergent powders and cosmetology
- Sodium phosphates:
  - Sodium phosphates are used as food additives. Sodium phosphates are added to many foods as an emulsifier to prevent oil separation. Some examples are processed cheese, processed meat, ready-made meal and tinned (canned) soups. Sodium phosphates are also commonly added to powdered soups, and gravy mixtures.
  - Sodium phosphates can also be used as a leavening agent. Some examples of these foods include batter coating on breaded fish or chicken, and commercially baked cakes. Adding sodium phosphates to food increases the shelf life of the food; and also helps in maintaining the texture and appearance of the food. Sodium Phosphate (trisodium phosphate) is also an ingredient of cleaning products; *e.g.*, Sugar soap
- Sodium silicates: Sodium silicate powder is a water-soluble silicate, generally assumed as a combination of alkali metal oxide, silica and water. It is widely used in basic chemical material form. Some of its uses are as under:
  - used in soap industry
  - used in detergent industry
  - used as anti-oil agent, filling agent and corrosion buffer
  - used as binder and high temperature filling agent
  - as utilised refractory
  - used as the filing-hole material and to strengthen material
  - used to strengthen the force character and durability for cement as fast-drying material
  - natural gas exploitation
  - utilised in oil-exploitation

  - used in chemical industry as flame retardant agent, emulsifier, and anti-rust agent.
  - used in light industry as ceramic adhesive, ingredient in electric welding rod.
  - used as the application scope of liquid sodium silicate
- Sodium sulfites: Sodium sulfite is primarily used in the pulp and paper industry. It is used in water treatment as an oxygen scavenger agent, in photographic industry to protect developer solutions from oxidation and (as hypo clear solution) to wash fixer (sodium thiosulfate) from film and photo-paper emulsions, in the textile industry as a bleaching agent, desulfurising and dechlorinating agent, and in leather trade for sulfitisation of tanning extracts. It is used in the purification of TNT for military use. It is used in chemical manufacturing as a sulfonation and sulfomethylation agent. It is used in the production of sodium thiosulfate. It is used in other applications, including froth flotation of ores, oil recovery, food preservatives, and in making dyes.
- Other applications:
  - production of various chemical fertilisers
  - production of artificial sodium bentonites or activated bentonites
  - manufacture of synthetic detergents
  - organic and inorganic coloring industry
  - enameling industry
  - petroleum industry
  - fats, glue and gelatine industry, *etc.*

3.2 Scientific Aspects

Soda ash is the common name given for the technical grade anhydrous sodium carbonate (Na_2CO_3). In the eighteenth century soda ash was produced by LeBlanc process based on roasting salt cake with carbon and limestone. The synthetic process for manufacture of soda ash by ammonia soda process was developed by Ernest Solvay in 1861. Natural deposits of soda containing sodium carbonate (known as Trona1) are mostly found in America, East Africa, Mexico and China. About 30% of world soda ash production (90% of this is in U.S. alone) is from natural deposits and the rest 70% is developed from synthetic process.

Soda ash is a white, finely crystalline hygroscopic powder. When freshly packed, contains at least 98.5% Na_2CO_3. It absorbs moisture and carbon dioxide (CO_2) from the atmosphere during storage and transit. Soda ash is available in four standard forms as light, medium, dense and granular according to the bulk density to suit various industrial requirements.

Soda ash is moderately soluble in water and the solution is strongly alkaline. Although it is low in toxicity, its ingestion could be harmful. Product dust may cause irritation of eyes, nose, throat and lungs. Packing of soda ash is generally done in 75 kilogram (kg) and 50 kg gunny bags and storing is done inside a godown on concrete or wooden floor. It should not be stacked more than 15 ft high. The main consuming industries of soda ash are glass, detergent, laundry soap, sodium silicate, cotton yarn, dyes and dye stuff, paper board and other chemical industries.

For countries which do not posses natural resources of soda ash, the following synthetic processes are available:

- Le Blanc Process
- Solvay Process

- Akzo Dry Lime Process (modification of Solvay process)
- Dual Process (modification of Solvay process)

3.2.1 Raw materials

The raw materials and utility consumption by different process routes are as follows:

- Brine
- Limestone
- Carbon for the lime kiln
- Ammonia
- Additives

3.2.1.1 Brine

Sodium chloride (NaCl or common salt) is extracted by solution mining from underground deposits, which are formed during the geological periods (mesozoïc and cenozoïc ages) by evaporation of sea water.

In the Solvay process, NaCl reacts in liquid phase. This is known as brine, which contains as much NaCl as possible and is virtually saturated. Brine also contains unwelcome impurities, mainly magnesium, calcium, sulfates, etc.

In several cases mother liquor from salt production process can be used as raw material to partially replace brine when the mother liquor has a suitable composition for the soda ash process.

3.2.1.2 Limestone

Limestone deposits originate from calcareous shell and skeletons of biota as well as chemical and bio-chemical precipitation in the sea during geological ages (mesozoïc).

Basically, a high content of CaCO3 in the limestone is an important parameter to avoid difficulties related to the limestone calcination and improves production efficiency. The cost to transport the inert part of the limestone from the quarry to the plant is also minimised. A limestone rich in CaCO3 will not only reduce solid matters in the effluent of the distillation unit, but will also, for those soda ash plants that have settling, reduce the volume of solids to be treated.

Particle size distribution of the limestone from quarries is generally between 40 and 200 mm. The more homogeneous it is, the better the lime kiln will work, but greater the amount of limestone fine by-product produced at the quarry.

3.2.1.3 Carbon for the lime kiln

Coke, and rarely coal are used in lime kilns for soda ash production due to the necessity to obtain the highest CO_2 concentration. Other type of fuels, natural gas or fuel oil, would result in a too low CO_2 concentration in the kiln gas. This is important because the kiln gas is used further in the process for its CO_2 contents. Higher CO_2 concentration enables reduction of the equipment size and ammonia losses.

The particle size distribution of the solid fuel has to be appropriate in order to get a homogeneous distribution within the kiln.

3.2.1.4 Ammonia

The Solvay process for soda ash requires an input of ammonia to compensate for the inherent losses from the process. The input is generally carried out as aqueous ammonia solution (10 to 35%), or direct injection of anhydrous gaseous ammonia or by the use of aqueous solution of ammonium bisulfide. Ammonia addition may also be achieved by the use of ammonical liquor from coal gas plants.

3.2.1.5 Miscellaneous additives

In addition to the major raw materials there are a number of miscellaneous raw materials, which may be added to the process for their various physical attributes: compounds to aid gas absorption, compounds to avoid scaling, corrosion inhibitors, and settling aids. These all may have minor potential environmental impact.

3.2.2 Industrial Processes

3.2.2.1 LeBlanc process

This process was invented by Nicolas LeBlanc, in 1775. Along with several others, LeBlanc had submitted an outline of a process for making soda ash from common salt, in response to an offer of reward by the French Academy in Paris. LeBlanc's proposal was accepted as it was workable on a commercial scale.

Process description

Reactions

$2NaCl + H_2SO_4 \rightarrow Na_2SO_4 + 2HCl$

$4C + NaSO_4 \rightarrow NaS + 4CO$

$Na_2S + CaCO_3 \rightarrow Na_2CO_3 + CaS$

A mixture of equivalent quantities of salt and concentrated sulphuric acid is heated in cast iron salt cake furnace. Hydrochloric acid (HCL) gas is given off and sodium hydrogen sulphate is formed. The gas is dissolved in water and the mixture is raked and transferred to the muffle bed reverbratory furnace where it is subjected to stronger heat. Here sodium sulphate called salt cake is formed.

The cake is broken, mixed with coke and limestone and charged into black ash furnace. The mass is heated and a porous grey mass of black ash is withdrawn. The black ash is leached with water in the absence of air in a series of tanks. The extract containing sodium carbonate, sodium hydroxide and many other impurities, is sprayed from the top of a tower, counter-current to the flow of hot gases from the black ash furnace. This converts sodium hydroxide, aluminate, silicate, cyanate to sodium carbonate. The liquor is concentrated in open pans until the solution is concentrated enough to precipitate sodium carbonate on cooling. The product is calcined to get crude soda ash, which is purified by recrystallisation. The liquor remaining after removal of first crop of soda crystals is purified to remove iron and causticised with lime to produce caustic soda. The mud remaining in the leaching tanks containing calcium sulphide is suspended in water and lime kiln gas is passed through it. The following reaction occurs.

$CaS + H_2O + CO_2 \rightarrow CaCO_3 + H_2S$

The lean gas containing hydrogen sulphide is passed through another tank obtaining suspension of calcium sulphide.

$CaS + H_2S \rightarrow Ca(SH)_2$

This solution is again treated with lime kiln gas liberating a gas rich in hydrogen sulphide.

$Ca(SH)_2 + CO_2 + H_2O \rightarrow CaCO_3 + 2H_2S$

The hydrogen sulphide is burnt in limited supply of air in a special furnace in presence of hydrated iron oxide as a catalyst to obtain sulphur.

$H_2S + ½\ O_2 \rightarrow H_2O + S$

The sulphur is sublimed and collected.

3.2.2.2 Solvay process

Solvay process is also known as ammonia soda process, uses salt (NaCl) and limestone ($CaCO_3$) as raw materials. Ammonia used in the process is almost totally regenerated and recycled. The main advantage of this process is the availability of the raw materials, which can be found almost everywhere in the world and therefore allows operation of production units in proximity to the market.

The Solvay process produces "light soda ash", with a specific weight or pouring density of about 500 kg/m^3. It is used in that form mainly for the detergent market and certain chemical intermediates.

Light soda ash is transformed by recrystallization firstly to sodium carbonate monohydrate, and finally to dense soda ash after drying (dehydration). Dense soda ash has a pouring density of about 1000 kg/m3. It is used mainly in the glass industry. Dense soda ash can also be produced by compaction.

Some producers have made several modifications to the original process. The main ones are:

- Dual process, which allows production units to co-produce nearly equal quantities of ammonium chloride, which may be used as a fertilizer in rice cultivation. There are several plants in the world which are working with that process. Most are situated in China
- Akzo or dry lime process, which uses dry lime instead of lime milk for ammonia recovery

(i) Main chemical reactions

Solvay process for production of soda ash could be summarised by the theoretical global equation involving the two main components: sodium chloride and calcium carbonate.

$2\ NaCl + CaCO_3 \rightarrow Na_2CO_3 + CaCl_2$

In practice, this direct way is not possible and it needs the participation of other substances and many different process steps to get the final product as soda ash.

First reactions occur in brine. First of all, ammonia is absorbed (1) and then, the ammoniated brine is reacted with carbon dioxide to form successive intermediate compounds: ammonium carbonate (2) then ammonium bicarbonate (3) By continuing carbon dioxide injection and cooling the solution, precipitation of sodium bicarbonate is achieved and ammonium chloride is formed (4) Chemical reactions relative to different steps of the process are written below:

$NaCl + H_2O + NH_3 \leftrightarrow NaCl + NH_4OH$ ---------- (1)

$2\ NH_4OH + CO_2 \leftrightarrow (NH_4)_2\ CO_3 + H_2O$ ---------- (2)

$(NH_4)_2CO_3 + CO_2 + H_2O \leftrightarrow 2\ NH_4HCO_3$ ---------- (3)

$2\ NH_4HCO_3 + 2\ NaCl \leftrightarrow 2\ NaHCO_3 \downarrow + 2\ NH_4Cl$ ---- (4)

Sodium bicarbonate crystals are separated from the mother liquor by filtration, then sodium bicarbonate is decomposed thermally into sodium carbonate, water and carbon dioxide (5).

$2\ NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$ ---------- (5)

CO_2 is recovered in the carbonation step (see equations 2 and 3 above). CO_2 recovery cycle is shown in Figure 3-1. Mother liquor is treated to recover ammonia. The ammonium chloride filtrate (4) is reacted with alkali, generally milk of lime (6), followed by steam stripping to recover free gaseous ammonia:

$2\ NH_4Cl + Ca(OH)_2 \rightarrow CaCl_2 + 2\ NH_3 + 2\ H_2O$ ----- (6)

NH_3 is recycled to the absorption step (see equation 1 above). Ammonia recovery cycle is shown in Figure 3-1.

Carbon dioxide and calcium hydroxide originate from limestone calcination (7) followed by calcium oxide hydration (8).

$CaCO_3 \rightarrow CaO + CO_2$ ---------- (7)

$CaO + H_2O \rightarrow Ca(OH)_2$ ---------- (8)

Brine has to be treated before the input in the process to remove impurities: calcium and magnesium. If not removed they would react with alkali and carbon dioxide to produce insoluble salts contributing to scale formation inside equipment. Brine purification reactions are described in the following equations:

$Ca^{2+} + CO_3^{\ 2-} \rightarrow CaCO_3 \downarrow$ ---------- (9)

$Mg^{2+} + 2\ OH^- \rightarrow Mg(OH)_2 \downarrow$ ---------- (10)

Sodium carbonate formed (equation 5) is called light soda ash because its bulk density is approximately 0.5 t/m^3. A subsequent operation called densification enables this value to be doubled by crystallization into sodium monohydrate, by adding water (equation 11) then followed by drying (equation 12). Final product is dense soda.

$Na_2CO_3 + H_2O$ -------- > $Na_2CO_3.H_2O$ ---------- (11)

$Na_2CO_3.H_2O$ --------- > $Na_2CO_3 + H_2O$ ---------- (12)

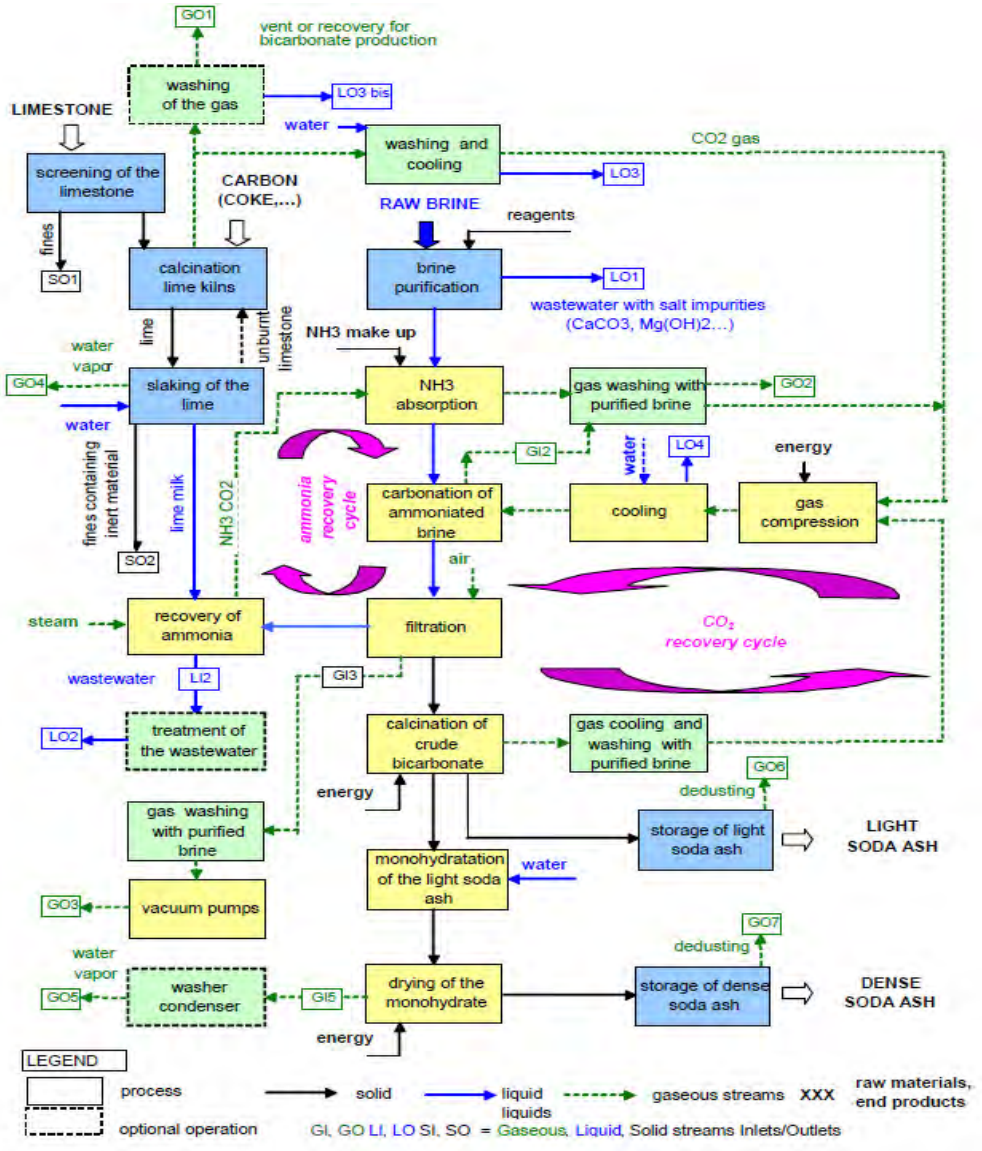

Figure 3-1: Process Block Diagram for the Manufacture of Soda Ash by the Solvay Process

(ii) Unit operations

The usual names of the plant area where the main process operations are taking place are given in Table 3-1.

Table 3-1: Plant Area/Operations

Area	Operation	Process reaction
Brine purification	Brine preparation	9,10
Lime kilns and slaker (dissolver)	Limestone calcination and milk of lime reduction	7,8

Area	Operation	Process reaction
Absorption	Absorption of ammonia	1
Columns (Carbonation Towers)	Precipitation of $NaHCO_3$	2,3,4
Filtration	Separation of $NaHCO_3$ crystals from mother liquor	
Calcination	Decomposition of $NaHCO_3$ to Na_2CO_3	5
Distillation	Recovery of ammonia	6
Densification	Production of dense soda ash	11,12

(a) Brine purification

Impurities such as calcium and magnesium have to be removed from brine. This operation is achieved in the brine purification area.

Magnesium ions, Mg2+, are precipitated as insoluble magnesium hydroxide, $Mg(OH)_2$, by the addition of an alkaline reagent. The most commonly used reagent is milk of lime as this is already produced in large quantity from ammonia recovery. Another possibility is the use of sodium hydroxide (NaOH).

Calcium ions, Ca_2+ are precipitated as insoluble calcium carbonate, $CaCO_3$, by reaction with sodium carbonate. Depending upon the purification process used to remove sulfate and magnesium contents, a certain amount of calcium can be precipitated as gypsum ($CaSO_4.2H_2O$). Addition of these two reagents is regulated in such a way as to reach the necessary reagent excesses for adequate purification. A sufficient reaction time of the suspension that contains suspended $CaCO_3$ and $Mg(OH)_2$ ensures a correct crystallization of the two components. Thereafter the separation of $Mg(OH)_2$ and $CaCO_3$ from the purified brine is usually achieved in a decanter or brine settler. The decanter has to be purged frequently.

(b) Lime kilns and milk of lime production

Theoretically, in the soda ash process, the CO_2 balance is stoichiometrically neutral. However, a CO_2 excess is needed to compensate the incomplete absorption of CO_2 in the carbonation stage in the different washers (streams GO_2 and GO_3) and losses in the treatment of the mother liquid in the distillation. This excess is generated by combustion of normally coke, which provides an energy source used for limestone decomposition, as well as the additional CO_2.

Burning of the limestone (natural form of $CaCO_3$) is carried out in a temperature range of 950°C to 1100°C. The operating conditions for a lime kiln fitted to soda ash production are critically different from those used for lime production, because of the need to produce a gas with the maximum concentration of carbon dioxide for its subsequent use in the process. This is done to the detriment of produced lime purity, which will be less than that necessary in the lime industry. To improve particle sizing of limestone loaded in lime kiln, screening is sometimes carried out prior to kiln charging

In case of soda ash plants, considering the quantities of limestone to be burned and the necessary CO_2 concentration, the energy contribution is generally provided by means of solid high carbon fuels such as coke, coal or lignite. Use of gaseous fuel leads to too low

CO_2 concentration in the gas produced making its subsequent use impossible without an expensive reconcentration unit.

Raw burnt lime produced by lime kilns associated with a soda ash plant contains approximately 75 to 90% of CaO. Its direct use in the solid form is uncommon because of the difficulty in controlling an adequate feed rate of a material in which the active constituent, CaO, is not constant. By hydrating the CaO to milk of lime a better control of the alkali addition is achieved during the ammonia recovery step.

Hydration of the raw lime is carried out in slakers (dissolvers) where raw lime and water flows are regulated to ensure that the alkali content of milk of lime produced is as constant as possible. This reaction is highly exothermic. A part of the heat generated vaporises some water, which is released from the slaker vent (GO_4). During hydration, fine inert materials contained in limestone (sulfates, silica, clay, silico-alumina compounds, unburned limestone and others) can mainly be found in milk of lime. Larger particles are separated by screening, then washed and recycled or released out of the process. The unburnt pieces of limestone are recycled.

(c) Absorption of ammonia

Ammonia is recovered by recycling the outlet gas from the distillation plant to the absorption stage where it is absorbed in purified brine. This flow mainly contains recovered NH_3 and a quantity of CO_2. This chemical operation is achieved in equipment that allows close gas/liquid contact.

Because this is an exothermic reaction, cooling of the liquid is necessary during the operation to maintain efficiency. The outlet solution, with a controlled ammonia concentration, is called ammoniacal brine. Any gas that is not absorbed is sent to washer where it is contacted with purified brine to remove traces of ammonia before it is recycled or released to the atmosphere.

(d) Precipitation of sodium bicarbonate

Ammoniacal brine is progressively CO_2 enriched (carbonated) with recycled carbon dioxide from sodium bicarbonate calcination and carbon dioxide originating from lime kilns. To ensure adequate CO_2 absorption and sodium bicarbonate precipitation, the ammoniacal brine is cooled with water. Suspension of crystals exiting from columns or carbonators is sent to the filters.

Outlet gas from the carbonation towers is sent to a final washer, contacted with purified brine to absorb NH_3 traces still present in the gas before released to the atmosphere. These may be separate or combined washers with waste gas from the absorber vacuum system

(e) Separation of sodium bicarbonate from mother liquor

Separation of sodium bicarbonate crystals from mother liquor is achieved by means of centrifuges or vacuum filters. After washing of cake to eliminate mother liquor chloride, it is sent to calcination. In liquid phase, mother liquor is sent to the distillation sector for ammonia recovery.

Where filters are used, air is pulled through the cake by means of vacuum pumps. Thereafter, this gas carrying ammonia and some CO_2 is cleaned by a washer fed with purified brine before exhausting to atmosphere.

Crude sodium bicarbonate manufactured by the carbonation process is the primary output of the Solvay ammonia soda process. The bicarbonate produced in this way is the feed to the calcination stage, for conversion to the finished product—solid soda ash. In some cases, a small part of this crude bicarbonate (predominantly sodium bicarbonate) also contains a mixture of different salts like ammonium bicarbonate and sodium chloride. This resultant crude product (after drying) from Solvay process using crude sodium bicarbonate, may find applications in some commercial outlets. However, since any drying gases produced by this simple process are handled in combination with gases from the Solvay ammonia soda ash process and common abatement technology is applied, this process is not described in any more detail. Crude bicarbonate is not to be confused with refined sodium bicarbonate, which is a purified product manufactured according to the process

(f) Sodium bicarbonate calcination

Sodium bicarbonate cake is heated (160 to 230°C) to achieve calcination into a solid phase (light soda ash) and a gaseous phase containing CO_2, NH_3 and H_2O.

This gas is cooled to condense water and the condensates formed are sent to distillation for NH_3 recovery, either directly or via filter wash water. After cleaning, the gas (high CO_2 concentration) is compressed and sent back to the carbonation columns (CO_2 recovery cycle).

Normally, energy needed for sodium bicarbonate calcination is provided by steam that condenses in a tubular heat exchanger, which rotates through the sodium bicarbonate. The method consisting of heating externally by gas or fuel oil combustion in a rotating drum containing sodium bicarbonate is occasionally encountered.

(g) Ammonia recovery

One of the major achievements of the Solvay process is the high efficiency of the ammonia recycle loop. This loop circulates roughly 500 to 550 kg NH_3 per tonne of soda ash from which the ammonia loss is less than 0.5 % of this flow rate. The purpose of this important distillation process is to recover ammonia from the ammonium chloride containing mother liquors recovered from the bicarbonate filters/centrifuges.

After pre-heating with outlet gas from the distiller, supported by the injection of steam at the bottom of the NH_3 stripping column, the mother liquor releases almost all its CO_2 content. Addition of alkali normally in the form of milk of lime decomposes ammonium chloride (NH_4Cl) into NH_3 which is stripped from the solution by injected low pressure steam at the bottom of the distillation column. The outlet solution contains calcium chloride together with all the residual solid materials. Ammonia recovery yield is controlled according to the permitted ammonia concentration in the released liquid. Lower the permitted value, the higher would be the quantity of stripping steam and therefore, lower global energy consumption, and higher cost of the ammonia recovery. This control can only be applied to a theoretical minimum ammonia level.

After cooling and condensation of steam, the gaseous phase containing recovered CO_2 and NH_3 is returned to the absorption area for reuse.

The liquid phase coming out from distillation unit contains – unreacted sodium chloride is not complete due to thermodynamic and kinetic limitations), calcium chloride resulting from reaction with NH_4Cl, solid matter that is derived primarily from the original limestone and finally, small quantity in excess of lime that can ensure a total

decomposition of NH_4Cl. This liquid called DS-liquid or Distiller Blowoff (DBO) will be treated in different ways depending on the particular site and processes used. Clear liquid from DS-liquid can be further used for calcium chloride production, prepared as a concentrated solution or an anhydrous or partially hydrated solid.

(h) Product storage and handling

Soda ash has to be stored in a dry place to avoid hydration, formation of crusts or hardening. Precautions to be taken to prevent contamination by other nearby stored products, and to prevent the release of soda ash dust during handling.

Most of the time, sodium carbonate is stored in large capacity metallic or concrete silos. Because of high daily production in large production units (1000 t/day or more), the available total storage volume is normally less than a week production.

Bulk handling of dense soda ash is easily achieved, for example, by belt conveyor. Necessary precautions have to be taken to avoid and control dust release. Handling methods are selected to minimise any particle size reduction of the product.

(iii) Advantages of Solvay process

- Can use low-grade brine
- Less electric power
- Less corrosion problems
- No co-products to dispose off
- Does not require ammonia plant investment

(iv) Disadvantages of Solvay process

- Higher salt consumption
- Higher investment in ammonia recovery unit versus crystallisation units for ammonium chloride
- Waste disposal of calcium chloride brine stream
- More steam consumption
- Higher capacity plant for economic break-even operation
- With current fertiliser shortage, all of the ammonium chloride will be used as a mixed chemical fertilizer ingredient, so co-product disposal no problem

3.2.2.3 Akzo dry lime process

Akzo dry lime process is a modification of the conventional Solvay process to the extent that milk of lime slurry is not prepared and the heat of hydration of lime and of chemical reaction are sufficient to raise mother liquor to the boiling temperature, thereby reducing the steam and lime consumption in distillation process as compared to Solvay process.

3.2.2.4 Dual process

In dual process, ammonia recovery unit and milk of lime section are replaced with an ammonium chloride section, where ammonium chloride is crystallized and recovered. In this process ammonium chloride is produced as a co-product in equivalent quantities and differs from the conventional Solvay process as it does not recycle ammonia.

Process description

The mother liquor from the carbonating system, containing ammonium chloride, unreacted salt and traces of carbonate is ammoniated in ammonia absorber. The ammoniated mother liquor is passed through a bed of salt in a salt dissolver. Exit liquor from the dissolver, saturated with salt, is gradually cooled from 40oC to 10oC by evapouration under vacuum to separate ammonium chloride. The slurry containing ammonium chloride is centrifuged and dried. The product is 98% pure and is marked as ammonium chloride fertilizer with nitrogen content of 25%.

The mother liquor obtained after the separation of ammonium chloride crystals is recycled to the carbonation vessels placed in series. Carbon dioxide obtained from ammonia plant and the calciner section of soda ash plant is injected in the carbonation vessels. There is a provision of cooling coils in the lower carbonation vessels. Sodium bicarbonate is formed. The growth of crystals, of sodium bicarbonate is controlled by the supply of cooling water to cool coils in carbonation vessels.

Sodium bicarbonate is concentrated in a thickener and centrifuged. The sodium bicarbonate is calcined to soda ash.

The plant has several advantages over the conventional Solvay process. It uses less raw material, has no effluent disposal problem, and both sodium and chloride radical of salt are fully utilized giving valuable ammonium as a by-product.

3.2.3 Co-products

The manufacturing of soda ash by Solvay process enables production of two main co-products — calcium chloride, ammonium chloride — along with the main product, refined sodium bicarbonate.

Raw material consumption per ton of co-product is given in Table 3-2.

Table 3-2: Raw material consumption per ton of co-product

Raw material	Consumption per ton
Salt	1.3 tons
Ammonia	335 kg
Power	250 kwh
Fuel oil:	18 litres
Steam (including refrigeration)	5.2 tons

3.2.3.1 Calcium chloride

Relatively a few synthetic soda ash plants recover calcium chloride, and most of those that do utilize only a small part of the total amount available in the distiller waste. To produce calcium chloride, the distiller waste liquor is settled and then evapourated in multiple effect evaporators (MEE). During concentration, most of the NaCl is separated. The remaining solution is further concentrated to the equivalent of $CaCl_2.2H_2O$. This solution is cooled, forming flakes which are dried in a rotary dryer giving a product, sold as 77-80% calcium chloride. A small amount is processed to the anhydrous state.

Calcium chloride is used on unpaved roads as a dust abater and as a deicer (defroster) on highways in winter. It is used for freeze-proofing and dust-proofing coal and coke, and in refrigeration brines as a drying agent, and in cement products.

3.2.3.2 Ammonium chloride

Ammonium chloride is the principal salt present in the mother liquor from the crude sodium bicarbonate filtration in the ammonia–soda process. Small amounts have been produced in soda ash plants by carbonation of the filter liquor, concentration, and crystallization of the ammonium chloride. Most of the demands in the United States are of low tonnage. The end uses are primarily in dry cells and fluxing agents.

However, ammonium chloride is also a good fertilizer for important crops in rainy climates, particularly for rice. In Japan, the production of ammonium chloride as a by-product is quite large. In one of the process for manufacturing large quantities of by-product of ammonium chloride, more ammonia is first added to the filter liquor, which is chilled to approximately $10^{o}C$. Solid NaCl is added, dissolved, and an ammonium chloride precipitates, which is separated for sale, the mother liquor being recycled to the carbonation operation. There are significant differences in equipment of the conventional ammonia soda process and the ammonium chloride producing soda ash process. For example, there is no ammonia recovery and therefore no distillation tower, likewise, no milk of lime and consequently no lime kilns which are also the source of CO_2 for bicarbonation. However, the ammonium chloride producing process requires, unlike the regular ammonia – soda plant, equipment to process solid salt, and of the ammonium chloride production, crystallizers, filters, dryers, and cooling equipment of corrosion resistant materials. In addition, an ammonia source is required which preferably supplies carbon dioxide also for the bicarbonation.

3.2.3.3 Refined sodium bicarbonate

Refined sodium bicarbonate is mostly produced from a solution of sodium carbonate that may also contain small amounts of dissolved sodium bicarbonate. This solution can be prepared following two ways.

- The first consists of dissolving soda ash in water.
- In the second, the solution is the result of the thermal decomposition of crude sodium bicarbonate from the filtration step of the soda ash process after being suspended in a soda ash solution.

In the latter case, the thermal decomposition reaction is as follows:

$$2\ NaHCO_3 \rightarrow Na_2CO_3 + CO_2 + H_2O$$

The CO_2 produced by this reaction is totally recovered in the soda ash process by mixing with the outlet gas from calcination of crude sodium bicarbonate.

The prepared sodium carbonate solution is sent to a bicarbonation tower where CO_2 is blown until precipitation of sodium bicarbonate occurs. This crystallisation (precipitation) after dissolution ensures the purity of the product.

$$Na_2CO_3 + CO_2 + H_2O \rightarrow 2\ NaHCO_3$$

If refined sodium bicarbonate unit is linked to a soda ash plant, the CO_2 gas is sourced from the lime kiln gas excess. The quantity of CO_2 fixed in the carbonation reaction represents a net additional consumption of CO_2, removed from the quantity otherwise vented.

The bicarbonate is separated from the mother liquor by filtration/centrifugation. The mother liquor is recycled upstream by the preparation of sodium carbonate solution. The purge from the recycle loop may be used as a carbonate source. In case of a soda ash plant, it could be sent to the brine purification area. The bicarbonate cake from separation is dried (*e.g.* by hot gas), sieved, graded, stored and sold as bagged or bulk product.

Different grades of refined sodium bicarbonate, differentiated by their properties (particle size distribution, purity, *etc*) are sold to the market according to the final uses of the product *e.g.* animal feed, food, pharmaceutical or technical applications.

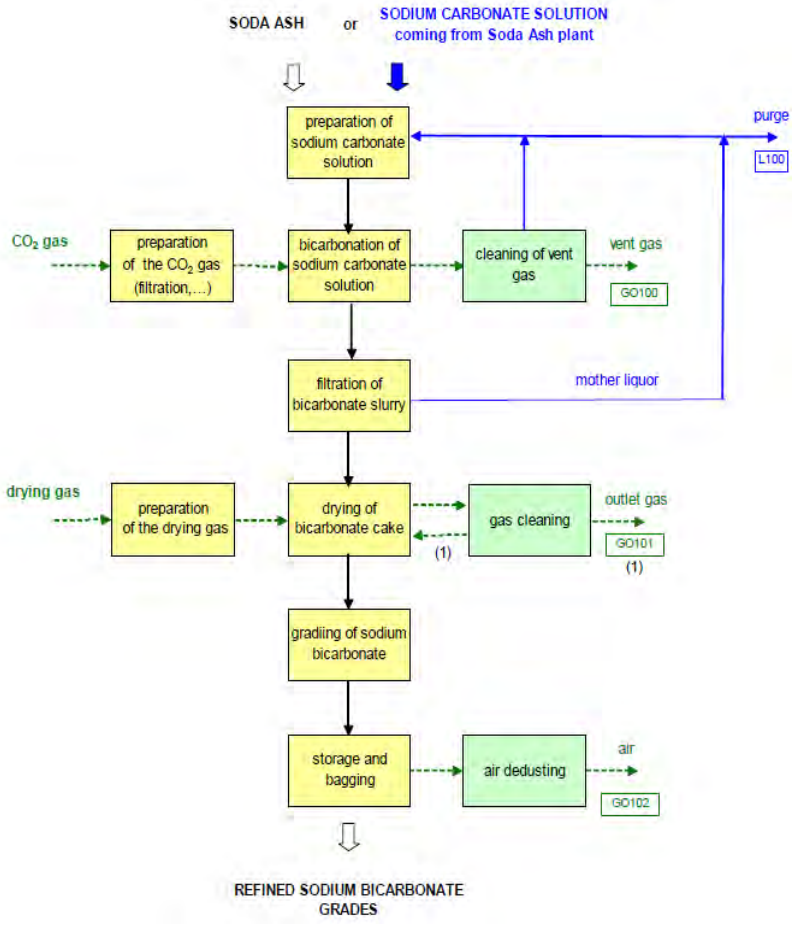

Figure 3-2: Typical Process for the Manufacture of Refined Sodium Bicarbonate

3.3 Quantitative analysis of input and output

3.3.1 Specific raw material consumption and emission factors

Soda Ash industries in India adopt solvay process/modified solvay process to manufacture soda ash for which chemical grade lime stone is one of the major raw materials. Quality of limestone (Chemical grade lime stone) available in India is

restricted and rapidly depleting/deteriorating. Quality of limestone varies from mine to mine in case of indigenous lime stone (CaCO3 content ranges between 83-93%) or supplier-to-supplier basis in case of imported lime stone. Hence the inert content i.e. TSS varies case to case basis. Further, content of TSS in the effluent also varies with respect to the process of soda ash production i.e. dry process or wet process. The indicative ranges for the major emissions levels of the Solvay soda ash process are given in Table 3-3.

Table 3-3: Major Emissions Levels from Solvay Soda Ash Process

INPUT	
Main raw material	**kg/t sodium**
Limestone	1050-1600 (inlet lime kiln) 1090-1820 (inlet plant)
Raw brine	NaCl (1530-1800) + water (4500-5200)
NH_3 make up	0.8-2.1
Water	**m^3/t soda ash (dense)**
Process	2.5-3.6
Cooling	50-100
Energy	**GJ/t soda ash (dense)**
Fuels (lime kiln)	2.2-2.8
Fuels (soda ash), including electricity	7.5-10.8, 0.18-0.47 (50-130kWh/t soda ash)
OUTPUT	
CO_2	200-400
CO	4-20
NH_3	<1.5
Dust	<0.2
Liquid emissions (outlet distillation)	**Kg/t soda ash**
Cl^-	850-1100
Ca^{2+}	340-400
Na^+	160-220
SO_4^{2-}	1-11
NH^{4+}	0.3-2
Suspended solids	90-700
Solids emissions	**Kg/t soda ash**
Fines of limestone	30-300
Non recycled grits at slaker	10-120

3.4 Sources of Environmental Pollution

3.4.1 Gaseous emissions

(i) Carbon dioxide and carbon monoxide

During the burning of $CaCO_3$ to CaO inside the limekilns, CO and CO_2 are produced from the combustion of coke and from the decomposition of limestone. A normal Solvay process needs excess of CO_2. Some of the excess is required to compensate for non-ideal absorption of CO_2 in the carbonation towers.

Carbonating towers also have an outlet for the discharge of gases that have not reacted in the process. This gas is cleaned with brine in a washer to recover NH_3 and possibly H_2S, if present, and to reintroduce these components back into the process, while CO_2, CO and other inert gases pass out to atmosphere.

Further, excess CO_2 may be beneficially used in sodium bicarbonate production. Any surplus CO_2 is vented as kiln gas to atmosphere [GO_1]. The amount of CO_2 vented to atmosphere from a stand-alone soda ash process is in the order of 200 to 300 kg CO_2 per tonne of soda ash. The split of losses to atmosphere depends upon the detailed plant configuration.

CO gas is virtually inert through the process. All CO produced must therefore be vented to the atmosphere either at the kilns or through the carbonation tower after gas scrubbers. CO generation is in the order of 4 to 20 kg CO per tonne of soda ash, depending on the conversion of CO into CO_2 (Boudart reaction) during the limestone calcination step.

When released into the atmosphere, the CO is converted by natural processes into CO_2, which is a gas naturally present in the atmosphere. Furthermore, provided the dispersion of CO and CO_2 is adequate and the stack responds to the normal dispersion rules, no local impact on the environment or health are expected or experienced.

(ii) Nitrogen oxides (NOx)

NOx are produced inside the kiln by oxidation of nitrogen during the combustion. Since the temperature inside the kiln is moderate (up to 1100 °C), the formation of NOx is rather limited. Measurements in some plants indicate concentration after washing less than 500 milligram (mg) of NOx per Nm^3.

(iii) Sulfur oxides

SOx are produced by the oxidation of sulphur containing compounds in the limestone and coke. The formation of SOx is limited due to low sulphur content of fuels used and some auto-purification reactions in the lime kilns. Furthermore, SOx in the kiln gas sent to the process is absorbed.

(iv) Ammonia

Primary atmospheric emissions containing ammonia originate from the bicarbonate precipitation and filtration stages of the process.

- from precipitation of bicarbonate in carbonation tower after cleaning in tower washers

- from filtration of bicarbonate, after cleaning in filter washers
- in addition, there are a number of diffuse ammonia from the filters, bicarbonate conveyors and from the handling, and processing of the distillation effluent.

Fluctuation in the emissions can be explained by the:

- performance of stripping columns and operating parameters control (height, steam injection, temperature control, monitoring of outlet concentrations)
- disturbances in the mother liquor feed (flow rate, composition)

The emitted gaseous load is on an average of 0.55 kg NH_3/t soda ash, but the spread can be very large, from 0.09 up to a typical range of 0.6 to 1.5 kg NH_3/t soda ash from the production unit, representing a release into the environment of 30 to 750 t/year for a 500 kilotonne (kt)/year soda ash unit.

Typical concentration lies around 30-40 mg/Nm^3 but much higher values can be encountered (> 100 mg/Nm^3). This wide range has resulted from a number of international variations in regulatory requirements and equipment availability.

Considering the high turnover into the process (550 kg NH_3 / t soda ash), the loss rate of ammonia therefore is very low in the process (generally less than 0.5 %).

Considering the type of release (continuous emission from elevated stack ensuring appropriate dispersion), the very low persistence of ammonia into the atmosphere (in the range of a few days), due to its high solubility in rainwater and its rapid turnover into the ecosystems by biological nitrification/denitrification mechanisms, the local or regional environmental impact burden is to be considered as very low.

(v) Hydrogen sulfide

In some plants H_2S may be added as a corrosion inhibitor, in the form of sodium hydrogen sulfide. Emission sources are from the tower gas washers and H_2S is typically controlled at maximal emission levels of 5 to 15 mg/Nm^3.

(vi) Particulate dust

Dust is emitted from soda ash production in limited quantities, arising from the following steps:

- handling of mineral raw materials (coke, limestone) as diffuse sources
- limestone conversion in kilns, but in limited quantities or during abnormal operation since all the gas is collected to a washing cooling step and thereafter is used in the carbonation stage in a liquid solution
- handling of soda ash and densification of light soda ash (hydration and dehydration) to produce dense soda ash
- handling of these products

It is common to use bag filters or wet scrubbers which will significantly reduce the levels of dust emitted to atmosphere. The dust emitted is around 0.10-0.15 kg of dust/t soda ash, and represents a typical quantity of 50-75 t/year.

The composition of the dust reflects the composition of material handled, namely:

- C from coke
- $CaCO_3$, Al_2O_3 and SiO_2 from limestone, sand and clays
- CaO from burnt lime
- Na_2CO_3 and $NaHCO_3$ from soda ash and sodium bicarbonate production and transport

Most stringent environmental regulations in the Western countries require threshold values of 40 or 50 mg/Nm^3 for atmospheric emission of dust. For instance, in Germany, limits are 50 mg/Nm^3 if the discharge is more than 0.5 kg/h and 150 mg/Nm^3 if the discharge is less than 0.5 kg/h, No maximal load is defined.

Measurements which are made in some plants indicate that more than 75 % of the dust emissions are relatively large particles >10 microns (μ) and that the contribution to PM_{10} is relatively low.

3.4.2 Liquid effluents

The sources of liquid effluent from the soda ash process are typically:

- wastewater from distillation (after treatment)
- wastewater from brine purification
- cooling waters from lime kiln gas washers, cooling in the CO_2 compression loop, cooling of the absorption and distillation towers, calcination (once through or closed circuits)

3.4.2.1 Wastewater from distillation

Flow rates and concentrations for major components present outlet distillation are given in Table 3-4. These indicative ranges represent the effluent from the distiller prior to any form of treatment and should not necessarily be considered as levels or concentrations emitted to the environment.

The size distribution of the suspended solid (SS) particle is typically characterized by an average particle size between 5 and 10 μm, 85% of particles smaller than 50 μm and 100% smaller than 1.25 mm.

It is worth noting that large variations in SS quantity and composition can occur according to the composition of the type of the available limestone.

Table 3-4: Wastewater from distillation

Component	Quantity (kg/t soda ash)	Concentration (kg/m^3 clear liquid)
Clear liquid	9300 - 11800 8.5 – 10.7 (m^3/t soda ash)	
Cl-	850 – 1100	99 – 115
OH-	9 – 30	1 – 2.7
SO_4^{2-}	1 – 11	0.1 – 1.2
Ca2+	340 – 400	39 – 45
Na+	160 – 220	18 – 25

Component	Quantity (kg/t soda ash)	Concentration (kg/m^3 clear liquid)
NH_4+	0.3 – 2.0	0.03 – 0.24
Suspended solids	90 – 700	11 – 70
Alkalinity expressed as CaO	7 – 20 – 80	0.7 – 9.0
$CaCO_3$	30 – 70 – 110	3.8 – 11
SO_4 as $CaSO_4$	15 – 35 – 90	1.7 – 7.1
Rest (clays, sands, *etc.*)	by difference	by difference

Note:

(1) Underlined values are typical averages, (2) Determined as total Ca minus Ca in $CaSO_4$, $CaCO_3$ and $CaCl_2$, (3)kg/m^3 raw liquid, (4) Figures in this table are indicative ranges of annual averages based on various measurement or estimation techniques.

Some additional low quantities of calcium sulfate ($CaSO_4$), calcium hydroxide ($Ca(OH)_2$) and trace elements are also present. Traces of heavy metals originating naturally from raw materials are related to limestone, coke and salt composition; the process in itself does not add heavy metals. Given the alkaline nature of wastewater emissions, metals are — in major part — insoluble and are included as part of SS.

According to its composition, the SS are classified as non-hazardous.

3.4.2.2 Wastewater from brine purification

Wastewater from brine purification is basically brine with suspended precipitated $CaCO_3$ and $Mg(OH)_2$ in variable proportions according to the nature of salt deposits (calcium and magnesium ions coming naturally from the original sea water).

These solids (10-70 kg/t soda ash) can be treated separately or can be disposed together with liquid effluent from the distillation unit for solid removal and treatment. Typical concentration is as follows in Table 3-5.

Table 3-5: Effluent from Brine Purification (Typical Composition)

Component	Concentration (% w/w)
$CaSO_4$ $2H_2O$	0 – 8
$Mg(OH)_2$	1 – 6
$CaCO_3$	5 – 15
Brine	By difference

Note: Figures in this table are indicative ranges of annual averages based on various measurement or estimation techniques

3.4.3 Solid waste

The typical solid wastes produced by the soda ash process are given in Table 3-6.

Table 3-6: Solid effluents from soda ash process

Effluent	Quantity (kg/t soda ash)
Fines of raw limestone from screening	30 – 300
Grits from slaker containing inert material	10 – 120

Note: Figures in this table are indicative ranges of annual averages based on various measurement or estimation techniques.

3.4.3.1 Fines of limestone

After crushing, the limestone is passed through a sieve in order to remove the fine gravel fraction (0-40 mm), which could be a cause of plugging and bad distribution of combustion air in the lime kiln. This may be done at the quarry or, in some cases, at the soda ash plant, if the limestone is too crumbly.

The fines' composition is 85% to 97% $CaCO_3$ with impurities of sand, clays (as SiO_2, Al_2O_3) depending on the limestone composition in the deposit.

3.4.3.2 Non-recycled stone grits at slaker

Due to imperfect conversion reaction there will be some under-burnt stones inside the kiln, which are drawn with the lime to the slaker. The coarser unburnt stone can be separated at the slaker and is sent back to the kiln. Unburnt stones of smaller sizes are rejected and a very fine material is suspended in the milk of lime. This is simply passed through the distiller and out in the distiller waste liquid.

The unburnt stone contains most of the impurities and pieces of silica present in the limestone feeding the kiln.

3.5 Control of Pollution from the Industry

3.5.1 Gaseous emissions management

Gaseous emissions are generated in the following main steps of the process:

- calcination of limestone
- precipitation of crude bicarbonate
- filtration of bicarbonate
- storage of light soda and dense soda

(i) Calcination of limestone

The calcination of limestone produces CaO and CO_2 and is designed to maximise the CO_2 content by minimising the presence of oxygen in the outlet gas. A conventional ammonia soda process produces about 30% more CO_2 than theoretically needed and it is necessary to purge some of the CO_2 produced to the atmosphere. If there is an associated sodium bicarbonate plant then this excess gas can be diverted for usage there.

Atmospheric emissions of SO_2 from the lime kilns are low (less than 350 mg/Nm^3) because the concentration of sulphur in the fuel (coke) and the limestone employed is

very low. Small amounts of SO_2 produced tends to be fixed by CaO and $CaCO_3$ as $CaSO_4$, producing auto-purification similar to the technique used for boiler flue gas treatment.

Before discharge to the atmosphere, kiln gas may be cleaned and generally cooled at the same time by washing towers.

Alternatively, gas cleaning systems (normally bag filters) can also be used to collect the dust as dry material. If dry cleaning is used, residual material is made of fine particulates containing limestone, lime, organic carbon (coke). This can be collected separately and may be disposed without further treatment. However, this type of gas cleaning is difficult to operate because the lime kiln gas may be too hot for the filtering media (risk of fire).

Typical quantities of CO_2, CO and dust in the gas effluent from lime kilns after cleaning are given in Table 3-7. This excludes the major component which is inert, mainly N_2.

Table 3-7: Vent gas from lime kilns after cleaning

Component	Quantity (kg/t soda ash)
CO_2	200-300
CO	0-8
Dust	0.1-0.2

Note: (1) Values are significantly lower when a refined sodium bicarbonate plant is operating. (2) Figures in this table are indicative ranges of annual averages based on various measurement or estimation techniques.

(ii) Precipitation of crude sodium bicarbonate

Outlet gas from the carbonation columns is subjected to a cleaning process with brine in a packed or plate washer to recover NH_3 and possibly H_2S and recycle them into the process via the feed brine. Washers may have an optional final water washing section to minimise emissions. This type of equipment has been designed to meet the specific needs of the process and to allow efficient recycle of valuable raw materials.

Typical quantities of CO_2, CO, and NH_3 in the gas from column section after cleaning are given in Table 3-8.

Table 3-8: Vent gas from column section after washing

Component	Quantity (kg/t soda ash)
CO_2	40-100
CO	4-12
NH_3	0.01-0.6

Note: Figures in this table are indicative ranges of annual averages based on various measurement or estimation techniques.

(iii) Filtration of bicarbonate

Air containing ammonia from the filtration (vacuum) step of crude sodium bicarbonate undergoes a cleaning process with brine in a washing tower to recover NH_3 and

reintroduce it to the process. The design is normally very similar to that used for scrubbing the gases from carbonation towers. Typical quantities of CO_2 and NH_3 in the filter air after cleaning are given in Table 3-9.

Table 3-9: Typical quantities of CO_2 and NH_3 in the filter air after cleaning

Component	Quantity (kg/t soda ash)
CO_2	2-4
NH_3	0.005-0.3

Note: Figures in this table are indicative ranges of annual averages based on various measurement or estimation techniques.

(iv) Production of dense soda ash

Outlet watervapour of dense soda dryers is cleaned with water by means of a packed or spray washer to eliminate soda ash particles in the vapour and recover this soda water for use in the production process. The cleaned vapour stream (GO_5) is a mixture of air and watervapour.

Additional gas cleaning may be required where calcination is carried out in fluid beds rather than steam-heated rotary calciners.

(v) Convey and storage of light and dense soda ash

Storage of light and dense soda ash is achieved in large silos equipped with dedusting systems, which keep the products dry and isolated to prevent dust emission into the atmosphere.

Because of the nature of conveyers, elevators, airlock valves, *etc.*, the soda ash process typically uses a range of high-efficiency bag filters to separate dust from vent gas streams.

3.5.2 Liquid effluent management

Wastewater discharge treatment is environmental aspect in which significant differences arise from one production plant to another.

Apart from cooling water, aqueous emissions of soda ash production plants are characterized by a high concentration of SS and dissolved salts. These solids and salts are unreacted limestone and salts of natural origin.

SS and dissolved salts originate from three different steps of the process

- brine purification
- ammonia recovery
- as a minor contribution, cleaning of CO_2 originating from calcination of limestone

In most production plants, brine purification effluent is discharged jointly with effluent originating from the distillation unit.

The typical composition varies according to raw material quality. However, different treatment schemes are developed according to geographical location of the production plants and the requirements of the local regulatory authorities.

Options available for treatment of these effluents are:

- direct discharge of raw effluent, with or without partial removal of some fraction of the solids, and with or without preliminary pH adjustment
- indirect discharge of wastewater after removal of suspended solids and with or without preliminary pH adjustment
- further treatment to produce by-product such as $CaCl_2$

(i) Liquid effluent treatment and discharge

According to the location of production plant and raw material deposits, two basic lines are established for the SS treatment – total dispersion and/or separation of the SS and liquid dispersion.

Total dispersion is employed when production plant is close to the sea or high flow rivers. This technique ensures that the solid material is assimilated with the natural sediments of similar composition. Chlorides and other soluble salts present in the liquid fraction are dispersed in a medium which, in the sea case, already has them in large quantities or, as in case of high flow rivers, is able to ensure that water quality is suitable for subsequent uses. With a careful study of environmental aspects and a good selection of the discharge point, it can be ensured that the disposal system has an acceptable impact completely assimilated by the environment.

Deposition/dispersion is generally used where there is no suitable environmental medium to allow for total dispersion. This method involves the physical separation of liquid and solid phases. The liquid phase is then discharged to a local watercourse with or without pH adjustment as appropriate and solids are used to build up the settling basin itself. The underground deposition of the solids is carried out when salt deposits are found near production plants and when deposit characteristics and the salt extraction system enables it.

(ii) Marine outfalls

Soda ash production wastewater containing suspended solids can be discharged directly to the sea or in estuary under tidal influence by means of an open channel or underwater outfalls, designed with necessary environmental, technical and marine ecological studies. The environmental impact is minimal due to the similarity between the chemicals present in the receptor medium and in the discharged material (chloride, sodium, calcium as ions).

In addition to the hydraulic calculations, the marine outfall diffuser design requires a detailed study of the receptor medium to set the coordinates of the discharge point to ensure an adequate dispersion and a minimum impact.

In an environmental impact study, coastal and marine dynamics (bathymetry, currents, physiochemical analysis of water and sediments, *etc.*) and biology (planktons, *etc*) may be considered and assessed.

With data obtained and the use of transport, dispersion models, the length and the optimum depth of outfall can be determined assuring an impact acceptable to the receiving environment.

(iii) Lake and river discharge

The direct discharge or discharge after preliminary treatment is to be decided after a careful examination of the local conditions of the receiving water and available land and environmental impact assessment.

Direct discharge is practiced when the flow rate of the receiving medium is high when compared to the industrial effluent.

Mixing effluents with either cooling water or with natural waters (river or lake) leads to a natural homogeneous pH adjustment.

(iv) Settling ponds

The clarification by decanting (liquid/solid separation) large quantities of SS in aqueous effluents is usually achieved in settling ponds (also called 'lagoons' or 'dykes').

Fines of limestones or solid particles settled in the basin can be used to build up the walls as the deposit in the basin accumulates. The height of the deposit can reach 25-40 m above ground.

Each basin has a typical with at least 15-25 ha of area for operations, but can be much larger in order to limit the number of alternate settling/drying phases (2-4 times/year).

The aqueous outfall is collected at several points through separators and drainage pipes to a peripheral channel collecting all outfalls of drainage.

The location of settling ponds depends on several factors including – area available for permanent long-term land occupation, distance between factory and final discharge point, underground geological and hydrogeological characteristics and landscape impact.

In case of available alluvial deposits with economical value (gravels or sands), the area can be previously excavated, thereby increasing the volume available for deposition, the excavated material being used for civil engineering.

Zero discharge may be achieved where project involves saltworks facilities in the close vicinity. If one mixes the clear liquor of Soda Ash in the salt brine then the hardness gets affected. The hardness/impurities needs to be controlled

(v) Liquid effluent discharge management

The impact of direct discharge of the liquid waste containing soluble salts in rivers is linked to the flow rate of the receiving rivers, the fluctuations of it and the inherent qualities of the water including its natural salinity.

(vi) Adjustment of pH

The typical pH value of raw effluent is higher than 11.5 due to the alkalinity of OH^- ions from $Ca(OH)_2$.

Theoretically, the pH adjustment of such an effluent can be achieved either by mixing in open channels or basins, with natural or raw waters containing dissolved bicarbonate, by reacting with gas containing CO_2 (for example flue gas from power units) in pH

adjustment columns or by other pH adjustment mechanisms if acid solutions or acid wastewaters are available.

In practice, the pH adjustment of soda ash wastewater is usually achieved by mixing with natural water according to the following mechanism:

$Ca(OH)_2 + Ca(HCO_3)_2 \rightarrow 2\ CaCO_3 \downarrow + 2\ H_2O$

Wastewater is mixed with available natural water (either cooling waters after use or surface waters—river, channel, lake, sea or underground water, *etc.*) in a typical ratio natural water/wastewater at 5 to 10:1. The $CaCO_3$ particles thus formed are discharged or settled in ponds, in natural or artificial lakes or in a dedicated channel of the waterway or estuary. Appropriate hydraulic retention time for settling in quiescent waters is usually 6-8 hours. Periodic removal of settled particles is achieved by dredging where the speed of the existing stream is not sufficient to keep the particles in suspension up to settling zones (*e.g.* in the sea). This method offers numerous advantages:

- pH adjustment mechanism is efficient and reliable.
- No consumption of supplementary reactants is needed.
- The settled particles are inert.
- Complex mixing and decanting neither equipment nor instrumentation and monitoring are needed.

(vii) Recovery and reuse of by-products

The by products can recovered from the units are:

- Dissolved $CaCl_2$ in distillation wastewater
- SS in distillation wastewater
- SS in distillation wastewater

3.5.3 Solid waste management

(i) Limestone fines

Since the composition of the limestone fines it is same as or is closer to raw limestone, this material can be used without any restriction for civil engineering works and filler material for roads, highway, dams, banks and for cement manufacturing. In some existing soda ash factories, it is mainly used for internal purposes (walls of the dikes, roads in quarry operation). Higher specification would require a further separation of gravel and clay material by water washing.

(ii) Grits from slaker

The composition of grits from slaking operation enables recycling of this product to the lime kiln, reuse of it as soil conditioner for pH correction or as filler for concrete.

A milling step is required to adjust the particle size distribution, as fine as possible for soil conditioning or as regular as possible for concrete incorporation.

3.6 Summary of Applicable National Regulations

3.6.1 General description of major statutes

A compilation of legal instruments applicable to the soda ash industry is provided as **Annexure I**.

3.6.2 General standards for discharge of environmental pollutants

General standards are applicable wherever industry-specific standards are not mentioned or notified. General standards for discharge of environmental pollutants as per CPCB are given in Annexure II.

3.6.3 Industry-specific requirements

Table 3-10: Effluent standards

Parameter	Concentration not to exceed		
	Marine	Brackish	Inland surface water
pH	6.5 - 9	6.5 – 9	6.5 – 9
Temperature	450C or less	450C or less	450C or less
Oil & grease	20 mg/l	20 mg/l	10 mg/l
Suspended solids (SS)	500 mg/l	200 mg/l	100 mg/l
Ammonical nitrogen	50 mg/l	50 mg/l	30 mg/l
Bioassay (96 hours)	90% survival	90% survival	90% survival

Note: MINAS for disposal in brackish and inland surface water are without any dilutions.

Table 3-11: Dual Process Soda Ash Plants

Parameter	MINAS (Inland Surface Water)
pH	6.5 - 8.0
Ammonical nitrogen, as N (mg/l)	50
Nitrate nitrogen, as N (mg/l)	10
Cyanide, as CN (mg/l)	0.2
Hexavalent chromium (mg/l)	0.1
Total chromium (mg/l)	2.0
Suspended solids, (mg/l)	100
Oil and grease (mg/l)	10

Note: These standards are to be implemented by the industry in a time targetted schedule by December, 1999. The progress on the time targetted implementation schedule shall be periodically submitted by the industry to the SPCB and the CPCB.

4. OPERATIONAL ASPECTS OF EIA

Prior environmental clearance process has been revised in the Notification issued on 14th September, 2006, into following four major stages *i.e.*, screening, scoping, public consultation and appraisal. Each stage has certain procedures to be followed. This section deals with all the procedural and technical guidance, for conducting objective-oriented EIA studies, their review and decision-making. Besides, the Notification also classifies projects into Category A, which require prior environmental clearance from MoEF and Category B from SEIAA/UTEIAA.

Consistency with other requirements

- Clearance from other regulatory bodies is not a pre-requisite for obtaining the prior environmental clearance and all such clearances will be treated as parallel statutory requirements.
- Consent for Establishment (CFE) and Prior Environmental Clearance are two different legal requirements, a project proponent should acquire. Therefore, these two activities can be initiated and proceeded with simultaneously.
- If a project falls within the purview of CRZ and EIA Notifications, then the project proponent is required to take separate clearances from the concerned Authorities.
- Rehabilitation and Resettlement (R&R) issues need not be dealt under the EIA Notification as other statutory bodies deal with these issues. However, socio-economic studies may be considered while taking environmental decisions.

4.1 Coverage of the Industry under the Purview of Notification

All new soda ash industrial projects including expansion and modernization require prior environmental clearance. Based on pollution potential, all these projects are classified into Category A

The sequence of steps in the process of prior environmental clearance for Category A projects is shown in Figure 4.1. The timelines indicated against each stage are the maximum permissible time lines set in the Notification for said task. In case the said task is not cleared/objected by the concerned Authority, within the specified time, said task is deemed to be cleared, in accordance to the proposal submitted by the proponent. Each stage in the process of prior environmental clearance for the soda ash industry is discussed in subsequent sections.

In case of Expansion or Modernization of the developmental Activity:

- Any developmental activity, which has an EIA clearance (existing plant), when undergoes expansion or modernization (change in process or technology) with or without increase in production capacity or any change in product mix beyond the list of products cleared in the issued clearance is required to submit new application for EIA clearance.

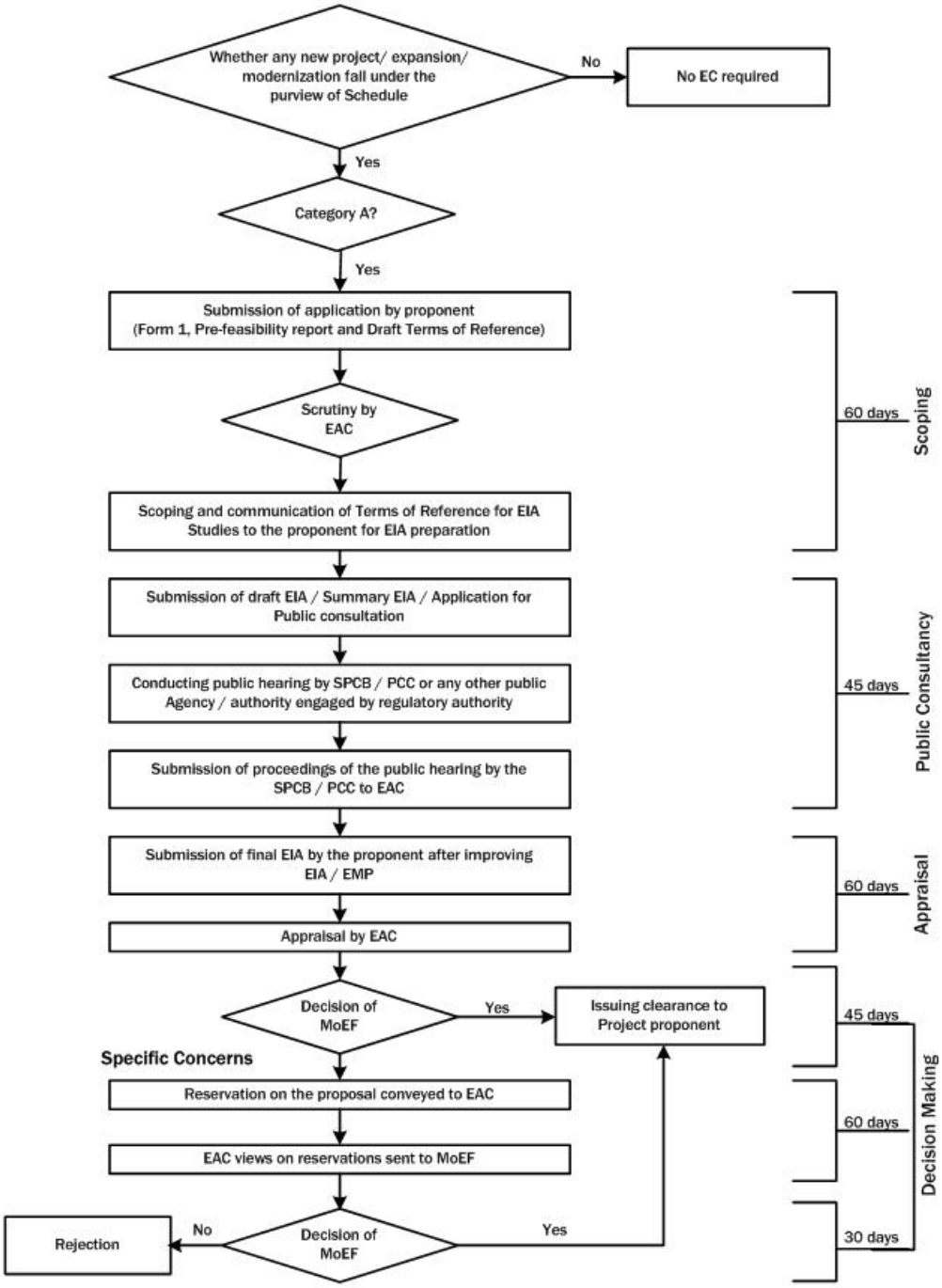

Figure 4-1: Prior Environmental Clearance Process

4.1.1 Application for prior environmental clearance

- The project proponent, after identifying the site and carrying out a pre-feasibility study, is required to apply for the prior environmental clearance using Form 1 given in **Annexure III**. The proponent has to submit the filled in Form 1 along with the pre-feasibility report and draft ToR for EIA studies to the concerned Authority *i.e.* MoEF, Government of India for Category A projects. Please refer subsequent sections for

the information on how to fill the Form 1, contents of pre-feasibility report and draft for sector-specific ToRs.

- Prior environmental clearance is required before starting any construction work, or preparation of land is started on the identified site/project or activity by the project management, except for securing the land.
- If the application is made for a specific developmental activity, which has an inherent area development component as a part of its project proposal and the same project also attracts the construction and area development provisions under 8a and 8b of the Schedule, then the project will be seen as a developmental activity other than 8a and 8b of the Schedule.

4.1.2 Siting guidelines

These are the guidelines, stakeholders may consider while siting the developmental projects, to minimize the associated possible environmental impacts. In some situations, adhering to these guidelines is difficult and unwarranted. Therefore these guidelines may be kept in the background, as far as possible, while taking the decisions.

Areas preferably be avoided

While siting industries, care should be taken to minimize the adverse impact of the industries on immediate neighborhood as well as distant places. Some of the natural life sustaining systems and some specific landuses are sensitive to industrial impacts because of the nature and extent of fragility. With a view to protect such sites, the industries may maintain the following distances, as far as possible, from the specific areas listed:

- Ecologically and/or otherwise sensitive areas: Preferably 5 km; depending on the geo-climatic conditions the requisite distance may be decided appropriately by the agency.
- Coastal areas: Preferably ½ km away from high tide line (HTL).
- Flood plain of the riverine system: Preferably ½ km away from flood plain or modified flood plain affected by dam in the upstream or flood control systems.
- Transport/Communication System: Preferably ½ km. away from highway and railway line.
- Major settlements (3,00,000 population): Distance from major settlements is difficult to maintain because of urban sprawl. At the time of siting of the industry, if the notified limit of any major settlement is found to be within 50 km from the project boundary, the spatial direction of growth of the settlement for at least a decade must be assessed. Subsequently, the industry may be sited at least 25 km from the projected growth boundary of the settlement.
- For all new projects, preferred location may be the sea coast with adequate plan for safeguarding the marine ecology.
- Critically polluted areas are identified by MoEF, from time-to-time. Current list of critically polluted areas is given in **Annexure IV.**

Note:

Ecological and/or otherwise sensitive areas include (i) Religious and Historic Places; (ii) Archaeological Monuments (e.g. identified zone around Taj Mahal); (iii) Scenic Areas; (iv) Hill Resorts; (v) Beach Resorts; (vi) Health Resorts; (vii) Coastal Areas rich in Corals, Mangroves, Breeding Grounds of Specific Species; (viii) Estuaries rich in Mangroves, Breeding grounds of

Specific Species; (ix) Gulf Areas; (x) Biosphere Reserves; (xi) National Parks and Sanctuaries; (xii) Natural lakes, Swamps; (xiii) Seismic Zones; (xiv) Tribal Settlements; (xv) Areas of Scientific and Geological Interest; (xvi) Defence Installations, specially those of security importance and sensitive to pollution; (xvii) Border Areas (International) and (xviii) Air Ports.

Pre-requisite: State and Central Governments are required to identify such areas on a priority basis.

General siting factors

In any particular selected site, the following factors must also be recognized.

- No forest land shall be converted into non-forest activity for the sustenance of the industry (Ref: Forest Conversation Act, 1980).
- No prime agricultural land shall be converted into industrial site.
- Land acquired shall be sufficiently large to provide space for appropriate green cover including green belt, around the battery limit of the industry.
- Layout of the industry that may come up in the area must conform to the landscape of the area without affecting the scenic features of that place.
- Associated township of the industry may be created at a space having physiographic barrier between the industry and the township.

4.2 Scoping for EIA Studies

Scoping exercise is taken up soon after the project contours are defined. The primary purpose of scoping is to identify the concerns and issues which may affect the project decisions. Besides, scoping defines the requirements and boundaries of an EIA study.

Scoping refers to the process by which the EAC, including applications for expansion and/or modernization of existing projects, determine ToR for EIA studies addressing all relevant environmental concerns for preparation of an EIA Report for a particular project.

- Project proponent shall submit the application to the MoEF. The application (Form 1 as given in Annexure III) shall be attached with pre-feasibility report and proposed ToR for EIA Studies. The proposed sequence to arrive at the draft ToR is discussed below:
  - Pre-feasibility report provides a precise summary of project details and also the likely environmental concerns based on secondary information, which will be availed for filling Form 1.
  - From pre-feasibility report and Form 1, valued environmental components (VECs) may be identified for a given project (receiving environment/social components, which are likely to get effected due to the project operations/ activities).
  - Once the project details from the pre-feasibility report & Form 1; and VECs are identified, a matrix establishing the interactions which can lead to the effects/ impacts could be developed (Qualitative analysis).
  - For each identified possible effect in the matrix, significance analysis could be conducted to identify the impacts, which need to be studied further (quantitative analysis) in the subsequent EIA studies. All such points find a mention in the draft ToR to be proposed by the project proponent. The draft ToR shall include

applicable baseline parameters (refer Annexure VII) and impact prediction tools (refer Annexure IX) proposed to be applied.

- The information to be provided in pre-feasibility report, guidelines for filling Form 1 and guidelines for developing draft ToR is summarized in subsequent sections.
- Authority consults the EAC to reply to the proponent. The EAC reviews the application form, pre-feasibility report and proposed draft ToR by the proponent and make necessary additions/deletions to make it a comprehensive ToR that suits the statutory requirements for conducting the EIA studies.

- A site (pipeline route) visit by sub-committees of EAC will be planned, only if considered necessary by the EAC with the written approval of the Chairperson. Project proponent will facilitate such site visits of the sub-committees.
- EAC shall provide an opportunity to the project proponent for presentation and discussions on the proposed project and related issues as well as the proposed ToR for EIA studies. If the State Government desires to present their views on any specific project in the scoping stage, it can depute an officer for the same at the scoping stage to EAC, as an invitee but not as a member of EAC. However, non-appearance of the project proponent before EAC at any stage will not be a ground for rejection of the application for the prior environmental clearance.
- If a new or expansion project is proposed in a problem area as identified by the CPCB, then the MoEF may present their views, if any at the stage of scoping, to the EAC.
- The final set of ToR for EIA studies shall be conveyed to the proponent by the EAC within sixty days of the receipt of Form 1 and pre-feasibility report. If the finalised ToR for EIA studies is not conveyed to the proponent within sixty days of the receipt of Form 1, the ToR suggested by the proponent shall be deemed as final and will be approved for EIA studies.
- Final ToR for EIA studies shall be displayed on websites of the MoEF.
- Applications for prior environmental clearance may be rejected by the concerned Authority based on the recommendations by the EAC at this stage itself. In case of such rejection, the decision together with reasons for the same, shall be communicated to the proponent in writing within sixty days of the receipt of the application.
- The final EIA report and other relevant documents submitted by the applicant shall be scrutinized by the MoEF strictly with reference to the approved ToR for EIA studies.

4.2.1 Pre-feasibility report

The pre-feasibility report should include, but not limited to highlight the proposed project information, keeping in view the environmental sensitivities of the selected site, raw material (limestone, brine, coke, ammonia, *etc.*), technology options (LeBlanc process, Solvay process, *etc.*), and its availability. Information required in pre-feasibility report varies from case to case even in the same sector depending upon the local environmental setting within which the plant is located/proposed. However, the information which may be furnished in the pre-feasibility report may include as under:

I. Executive summary

II. Project details: Description of the project including in particular;

- a description of the main characteristics of the production processes, for instance, nature and quantity of materials used
- an estimate, by type and quantity, of expected residues and emissions (water, air and soil pollution, noise, vibration, light, heat, radiation, *etc.*) resulting from the operation of the proposed project.
- a description of the physical characteristics of the whole project and the land-use requirements during the construction and operational phases

III. Selection of site based on least possible impacts

- An outline of the main alternatives studied by the developer and an indication of the main reasons for this choice, taking into account the environmental effects.

IV. Anticipated impacts based on project operations on receiving environment

- A description of the aspects of the environment likely to be significantly affected by the proposed project, including, in particular, population, fauna, flora, soil, water, air, climatic factors, material assets, including the architectural and archaeological heritage, landscape and the inter-relationship between the above factors.
- A description of the likely significant effects of the proposed project on the environment resulting from:
  - existence of project,
  - use of natural resources
  - emission of pollutants, the creation of nuisances and the elimination of waste
  - project proponent's description of the forecast methods used to assess the effects on environment.

V. Proposed broad mitigation measures which could effectively be internalized as project components to have environmental and social acceptance of the proposed site

- A description of key measures envisaged to prevent, reduce and where possible offset any significant adverse effects on the environment

VI. An indication of any difficulties (technical deficiencies or lack of know-how) encountered by the developer in compiling the required information

Details of the above listed points which may be covered in pre-feasibility report are listed in **Annexure IV**.

4.2.2 Guidance for providing information in Form 1

The information given in specifically designed pre-feasibility report for this developmental activity may also be availed for filling Form 1.

Form 1 is designed to help users identify the likely significant environmental effects of proposed projects right at the scoping stage. There are two stages for providing information under two columns:

- First - identifying the relevant project activities from the list given in Column 2 of Form 1. Start with the checklist of questions set out below and complete Column 3 by answering:

  - Yes - if the activity is likely to occur during implementation of the project;
  - No - if it is not expected to occur;
  - May be - if it is uncertain at this stage whether it will occur or not.
- Second - For each activity for which the answer in Column 3 is "Yes" the next step is to refer to the fourth column which quantifies the volume of activity which could be judged as significant impact on the local environmental characteristics, and identify the areas that could be affected by that activity during construction /operation / decommissioning of the project. Form 1 requires information within 15 km around the project, whereas actual study area for EIA will be as prescribed by respective EAC. Project proponent will need information about the surrounding VECs in order to complete this Form 1.

4.2.3 Identification of appropriate valued environmental components

VECs are components of natural resources and human world that are considered valuable and are likely to be affected by the project activities. Value may be attributed for economic, social, environmental, aesthetic or ethical reasons. VECs represent the investigative focal point for further EIA process. The indirect and/or cumulative effects can be concerned with indirect, additive or even synergistic effects due to other projects or activities or even induced developments on the same environmental components as would be considered direct effects. But such impacts tend to involve larger scale VECs such as within entire region, river basins or watersheds; and, broad social and economic VECs such as quality of life and the provincial economy. Once VECs are identified then appropriate indicators are selected for impact assessments on the respective VECs.

4.2.4 Methods for identification of impacts

There are various factors which influence the approach adopted for the assessment of direct, indirect, cumulative impacts, *etc.,* for a particular project. The method should be practical and suitable for the project given the data, time and financial resources available. However, the method adopted should be able to provide a meaningful conclusion from which it would be possible to develop, where necessary, mitigation measures and monitoring. Key points to consider when choosing the method(s) include:

- Nature of the impact(s)
- Availability and quality of data
- Availability of resources (time, finance and staff)

The method chosen should not be complex, but should aim at presenting the results in a way that can be easily understood by the developer, decision maker and the public. A comparative analysis of major impact identification methods is given in the following Table: 4-1

Table 4-1: Advantages and Disadvantages of Impact Identification Methods

	Description	Advantages	Disadvantages
Checklists	▪ Annotate the environmental features that need to be addressed when identifying the impacts of activities in the project	▪ Simple to understand and use ▪ Good for site selection and priority setting	▪ Do not distinguish between direct and indirect impacts ▪ Do not link action and impact ▪ The process of

	Description	Advantages	Disadvantages
		▪ Simple ranking and weighting	incorporating values can be controversial
Matrices	▪ Identify the interaction between project activities (along one axis) and environmental characteristics (along other axis) using a grid like table ▪ Entries are made in the cells which highlights impact severity in the form of symbols or numbers or descriptive comments	▪ Link action to impact ▪ Good method for displaying EIA results	▪ Difficult to distinguish direct and indirect impacts ▪ Significant potential for double-counting of impacts
Networks	▪ Illustrate cause effect relationship of project activities and environmental characteristics ▪ Useful in identifying secondary impacts ▪ Useful for establishing impact hypothesis and other structured science based approaches to EIA	▪ Link action to impact ▪ Useful in simplified form for checking for second order impacts ▪ Handles direct and indirect impacts	▪ Can become very complex if used beyond simplified version
Overlays	▪ Map the impacts spatially and display them pictorially ▪ Useful for comparing site and planning alternatives for routing linear developments ▪ Can address cumulative effects ▪ Information incentive	▪ Easy to understand ▪ Good to display method ▪ Good siting tool	▪ Address only direct impacts ▪ Do not address impact duration or probability
GIS	▪ Maps the impacts spatially and display them pictorially ▪ Useful for comparing site and planning alternatives for routing linear developments ▪ Can address cumulative effects ▪ Information incentive	▪ Easy to understand ▪ Good to display method ▪ Good siting tool ▪ Excellent for impact identification and analysis	▪ Do not address impact duration or probability ▪ Heavy reliance on knowledge and data ▪ Often complex and expensive
Expert System	▪ Assist diagnosis, problem solving and decision making ▪ Needs inputs from user by answering systematically developed questions to identify impacts and determine their mitigability and significance ▪ Information intensive, high	▪ Excellent for impact identification and analysis ▪ Good for experimenting	▪ Heavy reliance on knowledge and data ▪ Often complex and expensive

	Description	Advantages	Disadvantages
	investment methods of analysis		

The project team made an attempt to construct an impact matrix considering major project activities (generic operations) and stage-specific likely impacts which is given in Table 4-2.

While the impact matrix is each project-specific, Table 4-2 may facilitate the stakeholders in identifying a set of components and phase-specific project activities for determination of likely impacts. However, the location-specific concerns may vary from case to case, therefore, the components even without likely impacts are also retained in the matrix for the location-specific reference.

Table 4-2: Matrix of Impacts

			PHASE I					PHASE II							PHASE III					
			Pre Construction					Construction/ Establishment							Operation and Maintenance					
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
ENVIRONMENT	Component	Project Activities / Parameter/ factor	Detailed Topographic Survey	Land Acquirement	Site Clearing	Burning of wastes, refuse and cleared vegetation	Site Preparation / Change in Topography	Civil works such as earth moving and building of structures including temporary structures	Heavy Equipment operations	Disposal of construction wastes	Generation of sewerage	Influx of construction workers	Deforestation	Transportation of material	Transportation of raw materials, chemicals and finished products	Unloading, crushing and storage of crushed coal/unloading and storage of oil	Burning of fuel	Water treatment , effluent treatment and disposal	Maintenance – cleaning, oven-haul, oil change, lubrication, *etc.*	Transportation and disposal of ash
Physical	**Soil**	Erosion Risks											*							
		Contamination						*		*						*		*	*	*
		Soil Quality						*								*		*	*	*
	Resources	Fuels/ Electricity												*	*	*	*			
		Raw materials						*							*	*				
		Land especially undeveloped or agricultural land								*										
	Water	Interpretation or Alteration of River Beds					*													
		Alteration of Hydraulic Regime											*							
		Alteration of surface run-off and interflow					*	*												
		Alteration of aquifers					*	*										*		
		Water quality						*			*					*			*	*
		Temperature																	*	
	Air	Air quality				*		*	*					*		*	*	*	*	*
		Noise						*	*					*		*	*		*	

			PHASE I					PHASE II							PHASE III					
			Pre Construction					Construction/ Establishment							Operation and Maintenance					
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
		Climate				*							*							
Biological	**Terrestrial Flora**	Effect on grass & flowers			*		*			*			*							
		Effect on trees & shrubs			*		*						*							
		Effect on farmland			*		*			*										
		Endangered species			*		*						*							
	Aquatic Biota	Habitat removal			*		*													
		Contamination of habitats			*		*									*		*		
		Reduction of aquatic biota			*		*											*		*
	Terrestrial Fauna	Fragmentation of terrestrial habitats			*		*						*							
		Disturbance of habitats by noise or vibration			*		*									*	*			
		Reduction of Biodiversity			*		*						*			*	*	*		*
Social	**Economy**	Creation of new economic activities	*									*				*			*	
		Commercial value of properties										*				*	*	*		*
		Conflict due to negotiation and/ compensation payments																		
		Generation of temporary and permanent jobs										*				*	*	*	*	*
		Effect on crops			*			*			*									*
		Reduction of farmland productivity		*																*
		Income for the state and private sector																		
		Savings for consumers & private consumers																		
		Savings in foreign currency for the state																		
	Education	Training in new technologies	*													*				*

			PHASE I					PHASE II							PHASE III					
			Pre Construction					Construction/ Establishment							Operation and Maintenance					
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
		Training in new skills to workers	*													*		*		*
	Public Order	Political Conflicts		*														*		
		Unrest, Demonstrations & Social conflicts		*														*		
	Infrastructure and Services	Conflicts with projects of urban, commercial or Industrial development	*					*												
	Security and Safety	Increase in Crime								*										
		Accidents caused by							*							*	*		*	
	Health					*										*				
	Cultural	Land use			*		*									*		*		*
		Recreation														*				*
		Aesthetics and human interest								*			*			*	*	*		*
		Cultural status														*				*

Note:

1. The above table represents a model for likely impacts, which will have to be arrived case-to-case basis considering VECs and significance analysis (Ref Section 2.9).

2. Project activities are shown as indicative. However, in Form 1 (application for EIA Clearance), for any question for which answer is 'Yes', then the corresponding activity shall reflect in project activities. Similarly 'parameters'/'factors' will also be changed within a component in order to reflect the target species of prime concern in the receiving local environment.

4.2.5 Testing the Significance of Impacts

The following set of conditions may be used as the checklist for testing the significance of the impacts and also to provide information in Column IV of Form 1.

- Will there be a large change in environmental conditions?
- Will new features be out-of-scale with the existing environment?
- Will the effect be unusual in the area or particularly complex?
- Will the effect extend over a large area?
- Will there be any potential for trans-frontier impact?
- Will many people be affected?
- Will many receptors of other types (fauna and flora, businesses, facilities) be affected?
- Will valuable or scarce features or resources be affected?
- Is there a risk that environmental standards will be breached?
- Is there a risk that protected sites, areas, features will be affected?
- Is there a high probability of the effect occurring?
- Will the effect continue for a long time?
- Will the effect be permanent rather than temporary?
- Will the impact be continuous rather than intermittent?
- If it is intermittent will it be frequent rather than rare?
- Will the impact be irreversible?
- Will it be difficult to avoid, or reduce or repair or compensate for the effect?

For each "Yes" answer in column 3, the nature of effects and reasons for it should be recorded in the column 4. The questions are designed so that an "Yes" answer in column 3, will generally point towards the need for analyzing for the significance and requirement for conducting impact assessment for the effect.

4.2.6 Terms of reference for EIA studies

ToR for EIA studies in respect of soda ash industry may include, but not limited to the following:

1. Executive summary of the project – giving a *prima facie* idea of the objectives of the proposal, use of resources, justification, *etc.* In addition, it should provide a compilation of EIA report including EMP and the post-project monitoring plan in brief.

Project description

2. Justification for selecting the proposed unit size.
3. Land requirement for the project including its break up for various purposes, its availability and optimization.
4. Details of proposed layout clearly demarcating various facilities of the plant.
5. Complete process flow diagram describing each unit, its processes and operations, along with material and energy inputs and outputs (material and energy balance).
6. Details on the processes used – type (Le Blanc process, Solvay process, Akzo dry lime process, dual process, *etc.*), raw materials required, products, co-products, recovery options, *etc.*

7. Details on requirement of raw materials (salt, lime-stone, coke, ammonia, brine, additives, *etc.*), its source and storage at the plant.
8. Details of handling ammonia and risk assessment.
9. Details on requirement of energy (fuels, electricity) and water along with its source and authorization from the concerned department.
10. Details of power consumption and standby arrangements like DG sets *etc.*
11. Details of the proposed methods of water conservation and recharging.
12. Details of liquid emissions such as wastewater from distillation, brine purifications, cooling waters, *etc.* – its quantity, quality and control schemes.
13. Details on water balance including water use, quantity of effluent generated, recycled and reused and discharged to receiving water body.
14. Details of effluent treatment plant, inlet and treated water quality with specific efficiency of each treatment unit in reduction in respect of all concerned/regulated environmental parameters.
15. Details on gaseous emissions from calcinations, precipitation, filtration, *etc.,* such as CO_2, CO, NOx, ammonia, SOx, H_2S, particulate dust, *etc.,* – its quantity, quality and control technologies.
16. Details of air borne dust management.
17. Details of CO_2 emissions including its quantum per tonne of soda ash.
18. Details of fugitive emissions and their control measures
19. Management plan for solid waste generation (fines of lime stone, grits, brine sludge *etc.*), storage, utilization and disposal modes.
20. In case of coastal plants details on extraction of sea water and effluent disposal, development of solar salt works based on sea water evaporation, etc,.
21. Details of proposed source-specific pollution control schemes and equipments to meet the national standards.
22. Details regarding infrastructure facilities such as sanitation, fuel storage, sanitation, rest room, *etc.,* to the workers during construction and operation phase.
23. Details on locating the residential colony on upwind direction.
24. In case of expansion of existing industries, remediation measures adopted to restore the environmental quality if the groundwater, soil, crop, air, *etc.*, and a detailed compliance to the prior environmental clearance/consent conditions.
25. Any litigation pending against the project and /or any direction /order passed by any Court of Law related to the environmental pollution and impacts in the last two years, if so, details thereof.

Description of the environment

26. The study area shall be up to a distance of 10 km from the boundary of the proposed project site.
27. Location of the project site and nearest habitats with distances from the site to be demarcated on a toposheet (1: 50000 scale).
28. Landuse based on satellite imagery including location specific sensitivities such as national parks / wildlife sanctuary, villages, industries, *etc.,* for the study area.

29. Demography details of all the villages falling within the study area.
30. Topography details of the project area.
31. The baseline data to be collected from the study area w.r.t. different components of environment viz. air, noise, water, land, and biology and socio-economic (please refer Section 4.4.2 for guidance for assessment of baseline components and identify attributes of concern). Actual monitoring of baseline environmental components shall be strictly according to the parameters prescribed in the ToR and shall commence after finalization of ToR by the competent Authority.
32. Geological features and geo-hydrological status of the study area.
33. Details on groundwater quality and surface water quality of nearby water sources and other surface drains. The parameters of water quality may include Cl^-*, Ca^{2+}*, Na^+*, SO_4^{2-}*, NH_4^+, Suspended solids* *etc*. (* - As applicable)
34. Details on existing ambient air quality and expected, emissions for PM10, PM 2.5, SO_2*, NOx*, CO_2*, CO*, NH_3*, *etc*., and evaluation of the adequacy of the proposed pollution control devices to meet standards for point sources and to meet AAQ standards. (* - As applicable)
35. The air quality contours may be plotted on a location map showing the location of project site, habitation nearby, sensitive receptors, if any and wind roses.
36. Details on noise levels at sensitive/commercial receptors.
37. Site-specific micro-meteorological data including mixing height.
38. One season site-specific data excluding monsoon season.
39. Proposed baseline monitoring network for the consideration and approval of the Competent Authority.
40. Ecological status (terrestrial and aquatic) of the study area such as habitat type and quality, species, diversity, rarity, fragmentation, ecological linkage, age, abundance, *etc.*
41. If any incompatible landuse attributes fall within the study area, proponent shall describe the sensitivity (distance, area and significance) and propose the additional points based on significance for review and acceptance by the EAC. Incompatible landuse attributes include:
    - Public water supply areas from rivers/surface water bodies, from ground water
    - Scenic areas/tourism areas/hill resorts
    - Religious places, pilgrim centers that attract over 10 lakh pilgrims a year
    - Protected tribal settlements (notified tribal areas where industrial activity is not permitted)
    - Monuments of national significance, World Heritage Sites
    - Cyclone, Tsunami prone areas (based on last 25 years);
    - Airport areas
    - Any other feature as specified by the State or local government and other features as locally applicable, including prime agricultural lands, pastures, migratory corridors, *etc.*
42. If ecologically sensitive attributes fall within the study area, proponent shall describe the sensitivity (distance, area and significance) and propose the additional points based on significance for review and acceptance by the EAC. Ecological sensitive attributes include:

- National parks
- Wild life sanctuaries
- Tiger reserve/elephant reserve/turtle nesting ground
- Mangrove area
- Wetlands
- Reserved and protected forests
- Any other closed/protected area under the Wild Life (Protection) Act, 1972.
- Any other eco – sensitive areas *etc,*.

43. If the location falls in Valley, specific issues connected to the natural resources management shall be studied and presented.

44. If the location of the project and its associate facilities are near seashore: A CRZ map duly authenticated by one of the authorized agencies demarcating LTL, HTL, CRZ area, location of the project and associate facilities w.r.t. CRZ along with landuse map. Marine impact assessment studies for seawater intake and effluent disposal if applicable.

45. In case of coastal plants discharging effluent in to the sea provide details on bathymetry, sediment quality, fisheries studies, marine ecological/biological studies *etc*.

Anticipated environmental impacts and mitigation measures

46. Anticipated generic environmental impacts due to this project are indicated in Table 4-2, which may be evaluated for significance and based on corresponding likely impacts VECs may be identified. Baseline studies may be conducted for all the concerned VECs and likely impacts will have to be assessed for their magnitude in order to identify mitigation measures (please refer Chapter 4 of the manual for guidance).

47. Tools as given in Section 4.4.3 may be referred for the appropriate assessment of environmental impacts and same may be submitted in draft ToR for consideration and approval by EAC.

48. While identifying the likely impacts, also include the following for analysis of significance and required mitigation measures:

    - impacts due to transportation of raw materials and end products on the surrounding environment
    - impacts due to wastewater generated from brine purification, distillation and other processes on surface water, soil and groundwater
    - impacts due to gaseous emissions - CO_2, CO, NOx, ammonia, SOx, H_2S, particulate dust, *etc.*
    - impacts due to fugitive emissions
    - impacts due to noise
    - impacts due to solid waste generated from slaker operations, fine lime stone from screening operations, *etc.*
    - impact on health of workers due to proposed project activities, *etc.*

49. Proposed odour control measures

50. In case of likely impact from the proposed project on the surrounding reserve forests, if any. Plan for the conservation of wild fauna in consultation with the State Forest Department.

51. Modeling studies for predicting the impacts, requirement of dredging, beach protection, cyclone/ tsunami bunds *etc*,.

52. Action plan for the greenbelt development – species, width of plantations, planning schedule *etc*. in accordance to CPCB published guidelines.

53. For identifying the mitigation measures, please refer Chapter III for source control and treatment. Besides typical mitigation measures which may also be considered are discussed in Table 4-5.

Analysis of alternative resources and technologies

54. Comparison of alternate sites considered and the reasons for selecting the proposed site. Conformity of the site with prescribed guidelines in terms of CRZ, river, highways, railways, *etc.*

55. Details on improved technologies and new expansion plans to reduce solid waste generation.

56. Details on proposed recycling and recovery options for ammonia and CO_2.

Environmental monitoring program

57. Monitoring programme for pollution control at source.

58. Monitoring pollutants at receiving environment for the appropriate notified parameters – air quality, groundwater, surface water, gas quality, *etc.,* during construction and operational phase of the project.

59. Specific programme to monitor safety and health protection of workers.

60. Stack and fugitive emissions may be monitored for Dust, SPM, PM10, PM 2.5, SO_2, NOx, CO_2, CO, NH_3 and evaluation of the adequacy of the proposed pollution control devices to meet gaseous emission standards.

61. Monitoring of carbon foot print.

62. Appropriate monitoring network has to be designed and proposed, to assess the possible residual impacts on VECs.

63. Details of in-house monitoring capabilities and the recognized agencies if proposed for conducting monitoring.

Additional studies

64. Details on risk assessment and damage control during different phases of the project and proposed safeguard measures.

65. Details on socio-economic development activities such as commercial property values, generation of jobs, education, social conflicts, cultural status, accidents, *etc.*

66. Proposed plan to handle the socio-economic influence on the local community. The plan should include quantitative dimension as far as possible.

67. Details on compensation package for the people affected by the project, considering the socio-economic status of the area, homestead oustees, land oustees, and landless labourers.

68. Points identified in the public hearing and commitment of the project proponent to the same. Detailed action plan addressing the issues raised, and the details of necessary allocation of funds.

69. Details on plan for corporate social responsibility including the villages, population spread, SC/ST/backward communities, upgradation of existing schools, establishing

new schools with facilities (such as laboratories, toilets, *etc.*), link roads, community halls, primary health facilities, health camps, *etc.*

Environmental management plan

70. Administrative and technical organizational structure to ensure proposed post-project monitoring programme for approved mitigation measures.
71. EMP devised to mitigate the adverse impacts of the project should be provided along with item-wise cost of its implementation (Capital and recurring costs).
72. Allocation of resources and responsibilities for plan implementation.
73. Details of the emergency preparedness plan and on-site and off-site disaster management plan.

Note:

Above points shall be adequately addressed in the EIA report at corresponding chapters, in addition to the contents given in the reporting structure (Table: 4-6).

4.3 Environmental Impact Assessment

The generic approach for accomplishing EIA studies is shown in Figure 4.3. Each stage is discussed, in detail in subsequent sections.

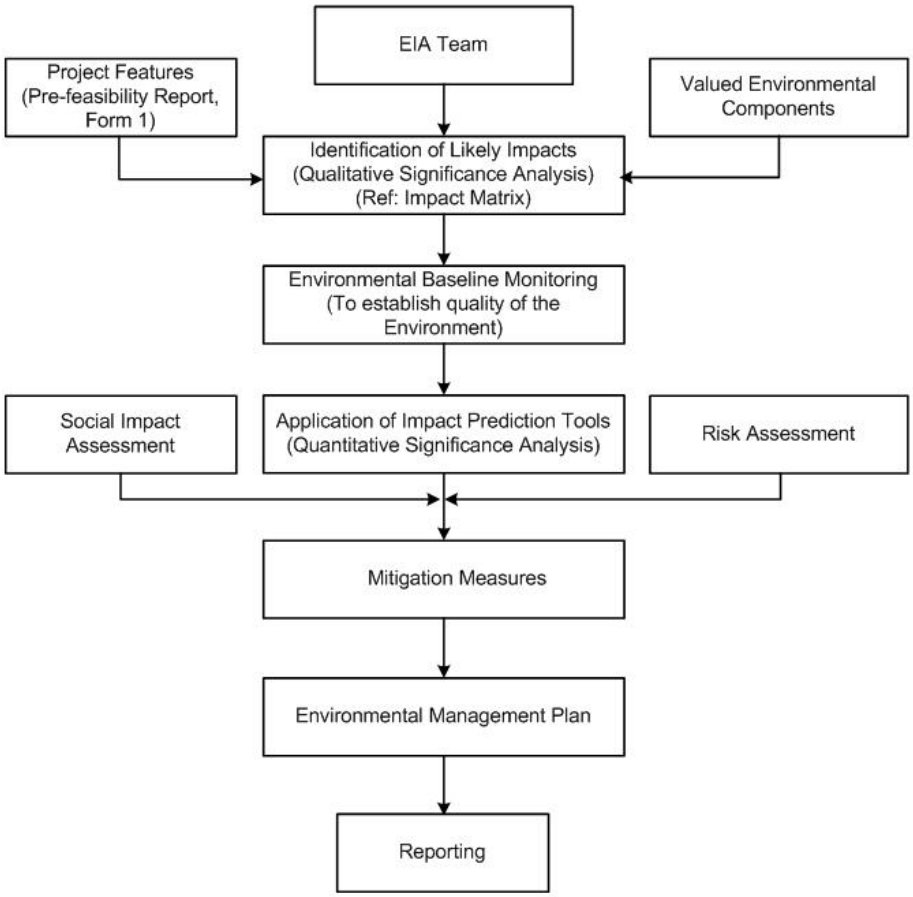

Figure 4-2: Approach for EIA Study

4.3.1 EIA team

The success of a multi-functional activity like an EIA primarily depends on constitution of a right team at the right time (preferable at the initial stages of an EIA) in order to assess the significant impacts (direct, indirect as well as cumulative impacts).

The professional Team identified for a specific EIA study should consist of qualified and experienced professionals from various disciplines in order to address the critical aspects identified for the specific project. Based on the nature and the environmental setting, following professionals may be identified for EIA studies:

- Environmental management specialist/regulatory expert
- Occupational safety and health expert
- Air and noise quality expert
- Water quality expert
- Chemical engineer
- Geology/geo-hydrology expert
- Ecologist
- Marine biologist
- Social scientist, *etc*

4.3.2 Baseline quality of the environment

EIA Notification 2006 typically specifies that an EIA Report should contain a description of the existing environment that would be or might be affected directly or indirectly by the proposed project. Environmental Baseline Monitoring (EBM) is a very important stage of EIA. On one hand EBM plays a very vital role in EIA and on the other hand it provides feedback about the actual environmental impacts of a project. EBM, during the operational phase, helps in judging the success of mitigation measures in protecting the environment. Mitigation measures, in turn are used to ensure compliance with environmental standards, and to facilitate the needed project design or operational changes.

The description of the existing environment should include the natural, cultural, socio-economic systems and their interrelationships. The intention is not to describe all baseline conditions, but to focus the collection and description of baseline data on those VECs that are important and are likely to be affected by the proposed industrial activity.

4.3.2.1 Objective of EBM in the EIA context

The term 'baseline' refers to conditions existing before development. EBM studies are carried out to:

- identify environmental conditions which might influence project design decisions (*e.g.*, site layout, structural or operational characteristics);
- identify sensitive issues or areas requiring mitigation or compensation;
- provide input data to analytical models used for predicting effects;
- provide baseline data against which the results of future monitoring programs can be compared.

At this stage of EIA process, the EBM is primarily discussed in the context of first purpose wherein feedback from EBM programs may be used to:

- determine available assimilative capacity of different environmental components within the designated impact zone and whether more or less stringent mitigation measures are needed; and
- improve predictive capability of EIAs.

There are many institutional, scientific, quality control, and fiscal issues that must be addressed in implementation of an environmental monitoring program. Careful consideration of these issues in the design and planning stages will help avoid many of the pitfalls associated with environmental monitoring programs. Such major issues are as under:

4.3.2.2 Environmental monitoring network design

Monitoring refers to the collection of data through a series of repetitive measurements of environmental parameters (or, more generally, to a process of systematic observation). Design of environmental quality monitoring programme depends on the monitoring objectives specified for the selected area of interest. Types of monitoring and network design considerations are discussed in **Annexure VI**.

4.3.2.3 Baseline data generation

List of important physical environmental components and indicators of EBM are given in Table 4-3.

Table 4-3: List of Important Physical Environment Components and Indicators of EBM

Environmental Component	Environmental Indicators
Climatic variables	▪ Rainfall patterns – mean, mode, seasonality ▪ Temperature patterns ▪ Extreme events ▪ Climate change projections ▪ Prevailing wind - direction, speed, anomalies ▪ Relative humidity ▪ Stability conditions and mixing height, *etc.*
Topography	▪ Slope form ▪ Landform and terrain analysis ▪ Specific landform types, *etc.*
Drainage	▪ Surface hydrology ▪ Natural drainage pattern and network ▪ Rainfall runoff relationships ▪ Hydrogeology ▪ Groundwater characteristics – springs, *etc.*
Soil	▪ Type and characteristics ▪ Porosity and permeability ▪ Sub-soil permeability ▪ Run-off rate ▪ Infiltration capacity ▪ Effective depth (inches/centimeters) ▪ Inherent fertility ▪ Suitability for method of sewage disposal, *etc.*
Geology	▪ Underlying rock type, texture

Environmental Component	Environmental Indicators
	▪ Surgical material ▪ Geologic structures (faults, shear zones, *etc.*) ▪ Geologic resources (minerals, *etc.*)
Water	▪ Raw water availability ▪ Water quality ▪ Surface water (rivers, lakes, ponds, gullies) – quality, water depths, flooding areas, *etc.* ▪ Ground water – water table, local aquifer storage capacity, specific yield, specific retention, water level depths and fluctuations, *etc.* ▪ Coastal ▪ Floodplains ▪ Wastewater discharges ▪ Thermal discharges ▪ Waste discharges, *etc.*
Air	▪ Ambient ▪ Respirable ▪ Airshed importance ▪ Odour levels, *etc.*
Noise	▪ Identifying sources of noise ▪ Noise due to traffic/transportation of vehicles ▪ Noise due to heavy equipment operations ▪ Duration and variations in noise over time, *etc.*
Coastal dynamics and morphology	▪ Wave patterns ▪ Currents ▪ Shoreline morphology – near shore, foreshore ▪ Sediment – characteristics and transport, *etc.*
Biological	▪ Species composition of flora and fauna ▪ Flora – type, density, exploitation, *etc.* ▪ Fauna – distribution, abundance, rarity, migratory, species diversity, habitat requirements, habitat resilience, economic significance, commercial value, *etc.* ▪ Fisheries – migratory species, species with commercial/ recreational value, *etc.*
Landuse	▪ Landuse pattern, *etc.*

Guidance for assessment of baseline components and attributes describing sampling network, sampling frequency, method of measurement is given in **Annexure VII**.

Infrastructure requirements for EBM

In addition to devising a monitoring network design and monitoring plans/program, it is also necessary to ensure adequate resources in terms of staffing and skills, equipment, training, budget, *etc.*, for its implementation. Besides assigning institutional responsibility, reporting requirements, QA/QC plans and its enforcement capability are essential. A monitoring program that does not have an infrastructural support and QA/QC component will have little chance of success.

Defining data statistics/analyses requirements

The data analyses to be conducted are dictated by the objectives of environmental monitoring program. Statistical methods used to analyze data should be described in detail prior to data collection. This is important because repetitive observations are recorded in time and space. Besides, the statistical methods could also be chosen so that uncertainty or error estimates in the data can be quantified. For *e.g.*, statistical methods useful in an environmental monitoring program include: 1) frequency distribution analysis; 2) analysis of variance; 3) analysis of covariance; 4) cluster analysis; 5) multiple regression analysis; 6) time series analysis; 7) the application of statistical models.

Use of secondary data

The EBM program for EIA can at best address temporal and/or spatial variations limited to a certain extent because of cost implications and time limitations. Therefore analysis of all available information or data is essential to establish the regional profiles. So all the relevant secondary data available for different environmental components should be collated and analyzed.

To facilitate stakeholders, IL&FS Ecosmart Ltd., has made an attempt to compile the list of information required for EIA studies and sources of secondary data are provided in **Annexure VIIIA** and **Annexure VIIIB**.

4.3.3 Impact prediction tools

The scientific and technical credibility of an EIA relies on the ability of EIA practitioners to estimate the nature, extent, and magnitude of change in environmental components that may result from project activities. Information about predicted changes is needed for assigning impact significance, prescribing mitigation measures, designing & developing EMPs and monitoring programs. The more accurate the predictions, the more confident the EIA practitioner will be in prescribing specific measures to eliminate or minimize the adverse impacts of development project.

Choice of models/methods for impact predictions in respect of air, noise, water, land, biological and socio-economic environment are precisely tabulated in **Annexure IX**.

4.3.4 Significance of the impacts

Evaluating the significance of environmental effects is perhaps the most critical component of impact analysis. The interpretation of significance is also a contentious process. The interpretation of significance bears directly on the subsequent EIA process and also during prior environmental clearance on project approvals and condition setting. At an early stage, it also enters into screening and scoping decisions on what level of assessment is required and which impacts and issues will be addressed.

Impact significance is also a key to choosing among alternatives. In total, the attribution of significance continues throughout the EIA process, from scoping to EIS review, in a gradually narrowing “cone of resolution” in which, one stage sets up the next. But at this stage it is the most important as better understanding and quantification of impact significance is required.

One common approach is based on determination of the significance of predicted changes in the baseline environmental characteristics and compares these w.r.t. regulatory

standards, objective criteria and similar 'thresholds' as eco-sensitivity, cultural /religious values. Often, these are outlined in guidance. A better test proposed by the CEAA (1995) is to determine if 'residual' environmental effects are adverse, significant, and likely (given under). But at this stage, the practice of formally evaluating significance of residual impacts, *i.e.*, after predicting the nature and magnitude of impacts based on before-versus-after-project comparisons, and identifying measures to mitigate these effects is not being followed in a systematic way.

i. Step 1: Are the environmental effects adverse?

Criteria for determining if effects are "adverse" include:

- effects on biota health
- effects on rare or endangered species
- reductions in species diversity
- habitat loss
- transformation of natural landscapes
- effects on human health
- effects on current use of lands and resources for traditional purposes by aboriginal persons
- foreclosure of future resource use or production

ii. Step 2: Are the adverse environmental effects significant?

Criteria for determining 'significance' are to judge that the impacts:

- are extensive over space or time
- are intensive in concentration or proportion to assimilative capacity
- exceed environmental standards or thresholds
- do not comply with environmental policies, landuse plans, sustainability strategy
- adversely and seriously affect ecologically sensitive areas
- adversely and seriously affect heritage resources, other landuses, community lifestyle and/or indigenous peoples traditions and values

iii. Step 3: Are the significant adverse environmental effects likely?

Criteria for determining 'likelihood' include:

- probability of occurrence, and
- scientific uncertainty

4.4 Social Impact Assessment

Social Impact Assessment (SIA) is an instrument used to analyze social issues and solicit stakeholder views for the design of projects. SIA helps in making the project responsive to social development concerns, including options that enhance benefits for poor and vulnerable people while mitigating risk and adverse impacts. It analyzes distributional impacts of intended project benefits on different stakeholder groups, and identifies differences in assets and capabilities to access the project benefits.

The scope and depth of SIA should be determined by the complexity and importance of issues studied, taking into account the skills and resources available. SIA should include studies related to involuntary resettlement, compulsory land acquisition, impact of imported workforces, job losses among local people, damage to sites of cultural, historic

or scientific interest, impact on minority or vulnerable groups, child or bonded labour, use of armed security guards. However, SIA may primarily include the following:

Description of the socio-economic, cultural and institutional profile

Conduct a rapid review of available sources of information to describe the socio-economic, cultural and institutional interface in which the project operates.

Socio-economic and cultural profile: Describe the most significant social, economic and cultural features that differentiate social groups in the project area. Describe different interests in the project, and their levels of influence. Explain any specific effects that the project may have on the poor and underprivileged. Identify any known conflicts among groups that may affect project implementation.

Institutional profile: Describe the institutional environment; consider both the presence and function of public, private and civil society institutions relevant to the operation. Are there important constraints within existing institutions *e.g.,* disconnect between institutional responsibilities and the interests and behaviors of personnel within those institutions? Or are there opportunities to utilize the potential of existing institutions, *e.g.,* private or civil society institutions, to strengthen implementation capacity.

Legislative and regulatory considerations

To review laws and regulations governing the project's implementation and access of poor and excluded groups to goods, services and opportunities provided by the project. In addition, review the enabling environment for public participation and development planning. SIA should build on strong aspects of legal and regulatory systems to facilitate program implementation and identify weak aspects while recommending alternative arrangements.

Key social issues

SIA provides baseline information for designing social development strategy. The analysis should determine the key social and Institutional issues which affect the project objectives; identify the key stakeholder groups in this context and determine how relationships between stakeholder groups will affect or be affected by the project; and identify expected social development outcomes and actions proposed to achieve those outcomes.

Data collection and methodology

Describe the design and methodology for social analysis. In this regard:

- Build on existing data;
- Clarify the units of analysis for social assessment: intra-household, household level, as well as communities/settlements and other relevant social aggregations on which data is available or will be collected for analysis;
- Choose appropriate data collection and analytical tools and methods, employing mixed methods wherever possible; mixed methods include a mix of quantitative and qualitative methods.

Strategy to achieve social development outcomes

Identify the likely social development outcomes of the project and propose a social development strategy, including recommendations for institutional arrangements to

achieve them, based on the findings of the social assessment. The social development strategy could include measures that:

- strengthen social inclusion by ensuring inclusion of both poor and excluded groups and intended beneficiaries are included in the benefit stream; offer access to opportunities created by the project
- empower stakeholders through their participation in design and implementation of the project, their access to information, and their increased voice and accountability (*i.e.,* a participation framework); and
- enhance security by minimizing and managing likely social risks and increasing the resilience of intended beneficiaries and affected persons to socio-economic shocks

Implications for analysis of alternatives

Review proposed approaches for the project, and compare them in terms of their relative impacts and social development outcomes. Consider what implications the findings of social assessment might have on those approaches. Should some new components be added to the approach, or other components be reconsidered or modified?

If SIA and consultation processes indicate that alternative approaches may to have better development outcomes, such alternatives should be described and considered, along with the likely budgetary and administrative effects these changes might have.

Recommendations for project design and implementation arrangements

Provide guidance to project management and other stakeholders on how to integrate social development issues into project design and implementation arrangements. As much as possible, suggest specific action plans or implementation mechanisms to address relevant social issues and potential impacts. These can be developed as integrated or separate action plans, for example, as Resettlement Action Plans, Indigenous Peoples Development Plans, Community Development Plans, *etc.*

Developing a monitoring plan

Through SIA process, a framework for monitoring and evaluation should be developed. To the extent possible, this should be done in consultation with key stakeholders, especially beneficiaries and affected people.

The framework shall identify expected social development indicators, establish benchmarks, and design systems and mechanisms for measuring progress and results related to social development objectives. The framework shall identify organizational responsibilities in terms of monitoring, supervision, and evaluation procedures. Wherever possible, participatory monitoring mechanisms shall be incorporated. The framework should establish:

- a set of monitoring indicators to track the progress achieved. The benchmarks and indicators should be limited in number, and should combine both quantitative and qualitative types of data. The indicators for outputs to be achieved by the social development strategy should include indicators to monitor the process of stakeholder participation, implementation and institutional reform;
- indicators to monitor social risk and social development outcomes; and indicators to monitor impacts of the project's social development strategy. It is important to suggest mechanisms through which lessons learnt from monitoring and stakeholder

feedback can result in changes to improve operation of the project. Indicators should be of such a nature that results and impacts can be disaggregated by gender and other relevant social groups

- Define transparent evaluation procedures. Depending on context, these may include a combination of methods, such as participant observation, key informant interviews, focus group discussions, census and socio-economic surveys, gender analysis, Participatory Rural Appraisal (PRA), Participatory Poverty Assessment (PPA) methodologies, and other tools. Such procedures should be tailored to the special conditions of the project and to the different groups living in the project area; Estimate resource and budget requirements for monitoring and evaluation activities, and a description of other inputs (such as institutional strengthening and capacity building) needs to be carried out.

4.5 Risk Assessment

Industrial accidents results in great personal and financial loss. Managing these accidental risks in today's environment is the concern of every industry including soda ash industry, because either real or perceived incidents can quickly jeopardize the financial viability of a business. Many facilities involve various manufacturing processes that have the potential for accidents which may be catastrophic to the plant, work force, environment, or public.

The main objective of risk assessment study is to propose a comprehensive but simple approach to carry out risk analysis and conducting feasibility studies for industries and planning and management of industrial prototype hazard analysis study in Indian context.

Risk analysis and risk assessment should provide details on Quantitative Risk Assessment (QRA) techniques used world-over to determine risk posed to people who work inside or live near hazardous facilities, and to aid in preparing effective emergency response plans by delineating a Disaster Management Plan (DMP) to handle onsite and offsite emergencies. Hence, QRA is an invaluable method for making informed risk-based process safety and environmental impact planning decisions, as well as being fundamental to any decisions while siting a facility. QRA whether, site-specific or risk-specific for any plant is complex and needs extensive study that involves process understanding, hazard identification, consequence modeling, probability data, vulnerability models/data, local weather and terrain conditions and local population data. QRA may be carried out to serve the following objectives.

- Identification of safety areas
- Identification of hazard sources
- Generation of accidental release scenarios for escape of hazardous materials from the facility
- Identification of vulnerable units with recourse to hazard indices
- Estimation of damage distances for the accidental release scenarios with recourse to Maximum Credible Accident (MCA) analysis
- Hazard and Operability studies (HAZOP) in order to identify potential failure cases of significant consequences
- Estimation of probability of occurrences of hazardous event through fault tree analysis and computation of reliability of various control paths
- Assessment of risk on basis of above evaluation against the risk acceptability criteria relevant to the situation
- Suggest risk mitigation measures based on engineering judgement, reliability and risk analysis approaches

- Delineation / upgradation of DMP.
- Safety Reports: with external safety report/ occupational safety report.

The risk assessment report may cover the following in terms of the extent of damage with resource to MCA analysis and delineation of risk mitigations measures with an approach to DMP.

- Hazard identification – identification of hazardous activities, hazardous materials, past accident records, *etc.*
- Hazard quantification – consequence analysis to assess the impacts
- Risk Presentation
- Risk Mitigation Measures
- Disaster Management Plans

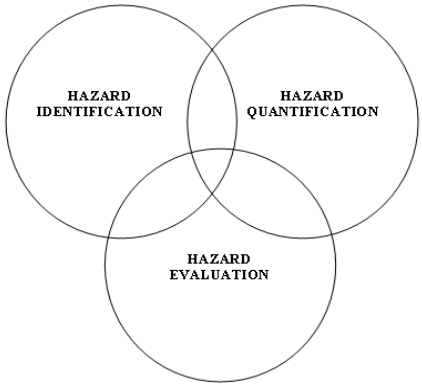

Figure 4-3: Risk Assessment – Conceptual Framework

Methods of risk prediction should cover all the design intentions and operating parameters to quantify risk in terms of probability of occurrence of hazardous events and magnitude of its consequence. Table 4-4 shows the predictive models for risk assessment.

Table 4-4: Choice of Models for Impact Predictions: Risk Assessment

Name	Application	Remarks
EFFECT	Consequence Analysis for Visualization of accidental chemical release scenarios & its consequence	Heat load, press wave & toxic release exposure neutral gas dispersion
WHAZAN	Consequence Analysis for Visualization of accidental chemical release scenarios & its consequence	
EGADIS	Consequence Analysis for Visualization of accidental chemical release scenarios & its consequence	Dense gas dispersion
HAZOP and Fault Tree Assessment	For estimating top event probability	Failure frequency data is required
Pathways reliability and protective system hazard analysis	For estimating reliability of equipments and protective systems	Markov models
Vulnerability Exposure models	Estimation of population exposure	Uses probit equation for population exposure
F-X and F-N curves	Individual / Societal risks	Graphical Representation

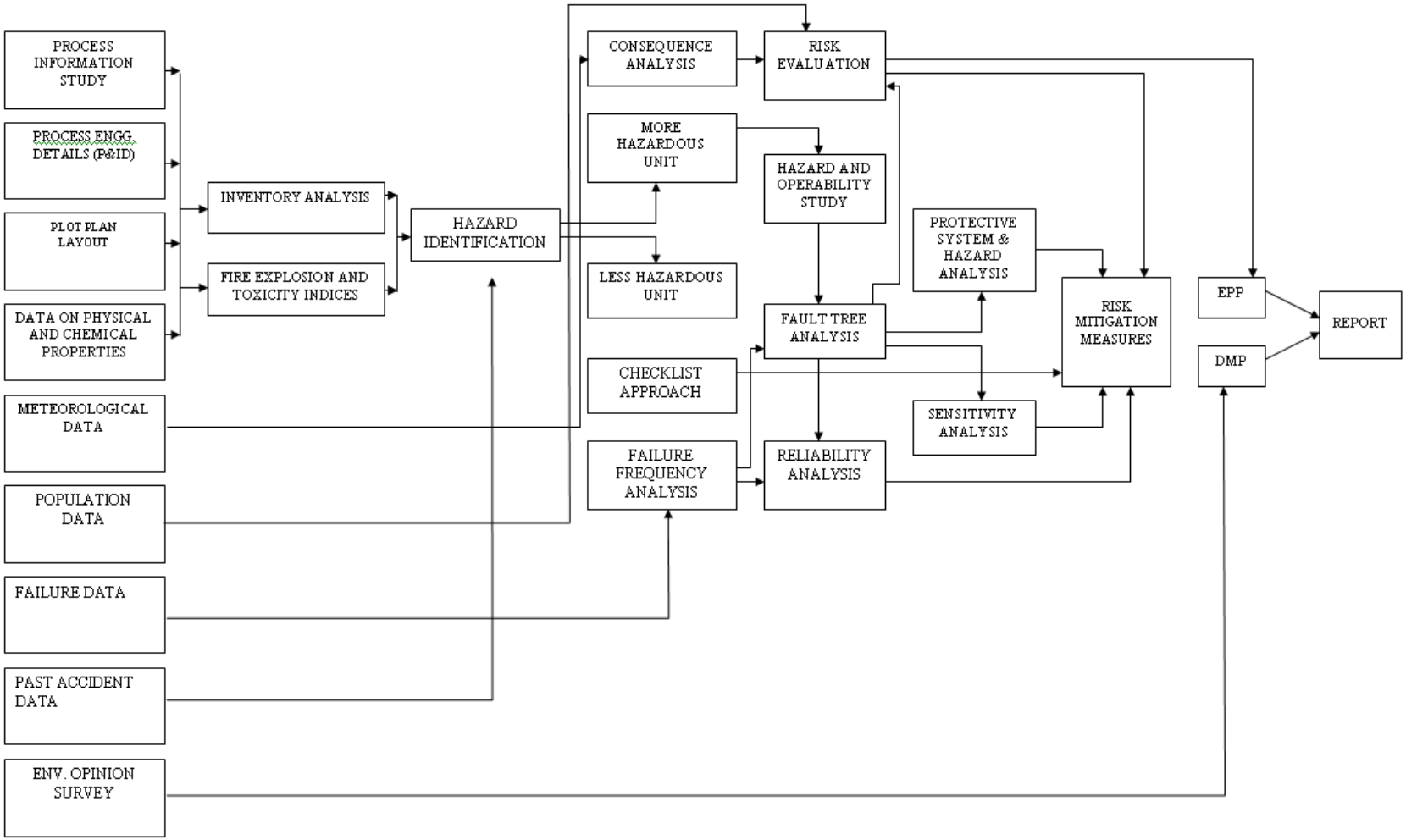

Figure 4-4: Comprehensive Risk Assessment - At a Glance

4.5.1 Disaster management plan (DMP)

A disaster is a catastrophic situation in which suddenly, people are plunged into helplessness and suffering and, as a result, need protection, clothing, shelter, medical, social care and other necessities of life.

DMP is aimed to ensure safety of life, protection of environment, protection of installation, restoration of production and salvage operations in this same order of priorities. For effective implementation of the DMP, it should be widely circulated and a personnel training is to be provided through rehearsals/drills.

To tackle the consequences of a major emergency inside the plant or immediate vicinity of the plant, a plan has to be formulated and this planned emergency document is called "Disaster Management Plan".

The objective of the Industrial DMP is to make use of the combined resources of the plant and of outside services to achieve the following:

- Effective rescue and medical treatment of casualties
- Safeguard other people
- Minimize damage to property and the environment
- Initially contain and ultimately bring the incident under control
- Identify any dead
- Provide for the needs of relatives
- Provide authoritative information to the news media
- Secure the safe rehabilitation of affected area
- Preserve relevant records and equipment for the subsequent inquiry into the cause and circumstances of the Emergency

In effect, it is to optimize operational efficiency to rescue rehabilitation and render medical help and to restore normalcy.

DMP should include Emergency Preparedness Plan, Emergency Response Team, Emergency Communication, Emergency Responsibilities, Emergency Facilities, and Emergency Actions

Emergency preparedness plan

Incidents, accidents and contingency preparedness should be accounted during Construction and operation process. This shall be a part of EMS. Emergency Preparedness Plan (EPP) should be prepared following the National Environmental Emergency Plan and OSHA guidelines. According to these guidelines, an environmental emergency plan would essentially provide the following information:

- Assignment of duties and responsibilities among the authorities, participating agencies, the response team and coordinators and/or those responsible for the pollution incident
- Relationship with other emergency plans
- A reporting system that ensures rapid notification in event of a pollution incident
- Establishment of a focal point for coordination and directions connected to the implementation of the plan

- Response operations; should always cover these four phases
  - Discovery and alarm
  - Evaluation, notification and plan invocation
  - Containment and countermeasures
  - Cleanup and disposal
- Identification of expertise and response resources available for assistance for the implementation of the plan
- Directions on necessary emergency provisions applicable to the handling, treatment or disposal of certain pollutants
- Link to the local community for assistance, if necessary
- Support measures, such as procedures for providing public information, carrying out surveillance, issuing post incident reports, review and updating of the plan, and periodic exercising of the plan

Emergency response

Various industrial activities within the soda ash industry are always subjected to accidents and incidents of many a kind. Therefore, a survey of potential incidents and accidents is to be carried out. Based on this, a plan for response to incidents, injuries and emergencies should be prepared. Response to emergencies should ensure that:

- The exposure of workers should be limited as much as possible during the operation
- Contaminated areas should be cleaned and if necessary disinfected
- Limited impact on the environment at the extent possible

Written procedures for different types of emergencies should be prepared and the entire workforce should be trained in emergency response. All relevant emergency response equipment should also be readily available.

With regard to dangerous spills, associated clean-up and fire-fighting operations should be carried out by specially allocated and trained personnel.

Response team

It is important to setup an Emergency Organization. A senior executive who has control over the affairs of the plant would be heading the Emergency Organization. He would be designated at Site Controller. Manager (Safety) would be designated as the Incident Controller. In case of stores, utilities, open areas, which are not under control of the Production Heads, Senior Executive responsible for maintenance of utilities would be designated as Incident Controller. All the Incident Controllers would be reporting to the Site Controller.

Each Incident Controller organizes a team responsible for controlling the incidents with the personnel under his control. Shift In-charge would be the reporting officer, who would bring the incidence to the notice of the Incidence Controller and Site Controller.

Emergency Coordinators would be appointed who would undertake the responsibilities like firefighting, rescue, rehabilitation, transport and provide essential and support services. For this purposes, Security In-charge, Personnel Department, Essential services personnel would be engaged. All these personnel would be designated as Key personnel.

In each shift, electrical supervisor, electrical fitters, pump house in-charge, and other maintenance staff would be drafted for emergency operations. In the event of power or communication system failure, some of staff members in the office/facility would be drafted and their services would be utilized as messengers for quick passing of communications. All these personnel would be declared as essential personnel.

Response to injuries

Based on a survey of possible injuries, a procedure for response to injuries or exposure to hazardous substances should be established. All staff should have minimum training to such response and the procedure ought to include the following:

- Immediate first aid, such as eye splashing, cleansing of wounds and skin, and bandaging
- Immediate reporting to a responsible designated person
- If possible, retention of item and details of its source for identification of possible hazards
- Rapid additional medical care from medical personnel
- Medical surveillance
- Recording of the incident
- Investigation, determination and implementation of remedial action

It is vital that incident reporting should be straightforward so that reporting is actually carried out.

Emergency communication

Whoever notices an emergency situation such as fire, growth of fire, leakage, *etc*., would inform his immediate superior and Emergency Control Center. The person on duty in the Emergency Control Center, would appraise the Site Controller. Site Controller verifies the situation from the Incident Controller of that area or the Shift In charge and takes a decision about an impending On-site Emergency. This would be communicated to all the Incident Controllers, Emergency Coordinators. Simultaneously, the emergency warning system would be activated on the instructions of the Site Controller.

Emergency responsibilities

Responsibilities of the following key personnel should be defined:

- Site controller
- Incident controller
- Emergency coordinator - rescue, fire fighting
- Emergency coordinator-medical, mutual aid, rehabilitation, transport and communication
- Emergency coordinator - essential services
- Employers responsibility

Emergency facilities

- Emergency Control Center – with access to important personnel, telephone, fax, telex facility, safe contained breathing apparatus, hand tools, emergency shut down procedures, duties and contact details of key personnel and government agencies, emergency equipments, *etc*.
- Assembly Point – with minimum facilities for safety and rescue

- Emergency Power Supply – connected with diesel generator, flame proof emergency lamps, *etc*.
- Fire Fighting Facilities – first aid fire fighting equipments, fire alarms, *etc*.
- Location of wind Stock – located at appropriate location to indicate the direction of wind for emergency escape
- Emergency Medical Facilities – Stretchers, gas masks, general first aid, emergency control room, breathing apparatus, other emergency medical equipment, ambulance

Emergency actions

- Emergency Warning
- Evacuation of Personnel
- All Clear Signal
- Public information and warning
- Coordination with local authorities
- Mutual aid
- Mock drills

4.6 Mitigation Measures

The purpose of mitigation is to identify measures that safeguard the environment and the community affected by the proposal. Mitigation is both a creative and practical phase of the EIA process. It seeks to find the best ways and means of avoiding, minimizing and remedying impacts. Mitigation measures must be translated into action in right way and at the right time, if they are to be successful. This process is referred to as impact management and takes place during project implementation. A written plan should be prepared for this purpose, and should include a schedule of agreed actions. Opportunities for impact mitigation will occur throughout the project cycle.

4.6.1 Important considerations for mitigation methods

The responsibility of project proponents to 'internalize' the full environmental costs of development proposals is now widely accepted under "Polluter Pay" principle. In addition, many proponents have found that good design and impact management can result in significant savings applying the principles of cleaner production to improve their environmental performance.

- The predicted adverse environmental as well as social impacts for which mitigation measures are required should be identified and briefly summarized along with cross referencing them to the significance, prediction components of the EIA report or other documentation.
- Each mitigation measure should be briefly described w.r.t the impact of significances to which it relates and the conditions under which it is required (for example, continuously or in the event of contingencies). These should also be cross-referenced to the project design and operating procedures which elaborate on the technical aspects of implementing the various measures.
- Cost and responsibilities for mitigation and monitoring should be clearly defined, including arrangements for coordination between various authorities responsible for mitigation.

- The proponent can use the EMP to develop environmental performance standards and requirements for the project site as well as supply chain. An EMP can be implemented through EMS for the operational phase of the project.

Prior to selecting mitigation plans it is appropriate to study the mitigation alternatives for cost-effectiveness, technical and socio-political feasibility. Such mitigation measures could include:

- avoiding sensitive areas such as eco-sensitive area *e.g.,* fish spawning areas, dense mangrove areas or areas known to contain rare or endangered species
- adjusting work schedules to minimize disturbance
- engineered structures such as berms and noise attenuation barriers
- pollution control devices such as scrubbers and electrostatic precipitators
- changes in fuel feed, manufacturing, process, technology use, or waste management practices, *etc.*

4.6.2 Hierarchy of elements of mitigation plan

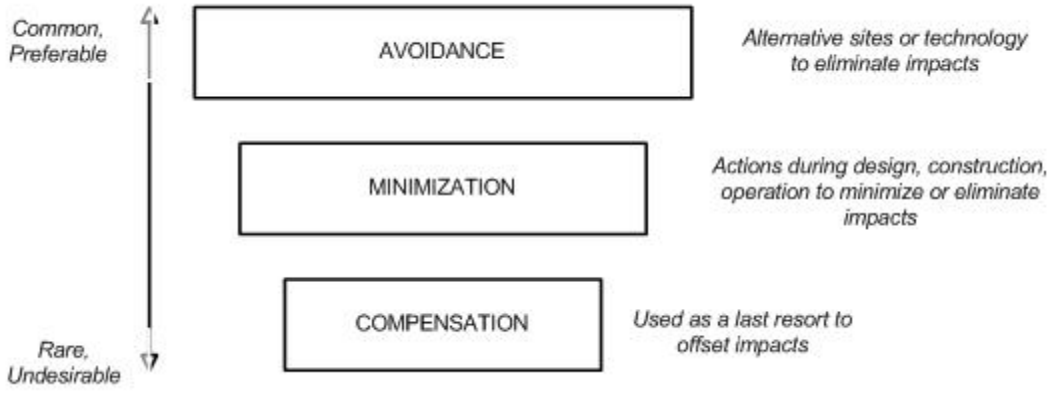

Figure 4-5: Elements of Mitigation

Good EIA practice requires a relevant technical understanding of the issues and the measures that work in the circumstances: The priority of selection of mitigation measures should be in the order:

Step One: Impact avoidance

This step is most effective when applied at an early stage of project planning. It can be achieved by:

- not undertaking certain projects or elements that could result in adverse impacts
- avoiding areas that are environmentally sensitive
- Proper preventative measures to stop adverse impacts from occurring, for *e.g.*, release of water from a reservoir to maintain a fisheries regime

Step Two: Impact minimization

This step is usually taken during impact identification and prediction to limit or reduce the degree, extent, magnitude, or duration of adverse impacts. It can be achieved by:

- scaling down or relocating the proposal
- redesigning elements of the project
- taking supplementary measures to manage the impacts.

Step Three: Impact compensation

This step is usually applied to remedy unavoidable residual adverse impacts. It can be achieved by:

- rehabilitation of the affected site or environment, for example, by habitat enhancement and restocking fish;
- restoration of the affected site or environment to its previous state or better, as typically required for mine sites, forestry roads and seismic lines; and
- replacement of the same resource values at another location. For example, by wetland engineering to provide an equivalent area to that lost to drainage or infill.

Important compensation elements

Resettlement Plans: Special considerations apply to mitigation of proposals that displace or disrupt people. Certain types of projects, such as reservoirs and irrigation schemes and public works, are known to cause involuntary resettlement. This is a contentious issue because it involves far more than re-housing people; in addition, income sources and access to common property resources are likely to be lost. Almost certainly, a resettlement plan will be required to ensure that no one is worse off than before, which may not be possible for indigenous people whose culture and lifestyle is tied to a locality. This plan must include the means for those displaced to reconstruct their economies and communities and should include an EIA of the receiving areas. Particular attention should be given to indigenous, minority and vulnerable groups who are at higher risk from resettlement.

In-kind compensation

When significant or net residual loss or damage to the environment is likely, in kind compensation is appropriate. As noted earlier, environmental rehabilitation, restoration or replacement have become standard practices for many proponents. Now, increasing emphasis is given to a broader range of compensation measures to offset impacts and assure the sustainability of development proposals. These include impact compensation 'trading', such as offsetting CO_2 emissions by planting forests to sequester carbon.

4.6.3 Typical mitigation measures

Choice of location for the developmental activity plays an important role in preventing the adverse impacts on the surrounding environment. Detailed guidelines on siting of industries are provided in Section 4.1. However, if the developmental activity still produces any adverse impacts, mitigation measures should be taken.

Previous subsections of the Section 4.6 could be precisely summarized into following:

- Impacts from a developmental project could have many dimensions. As most of the direct impacts are caused by the releases from developmental projects, often control at source is the best opportunity to either eliminate or mitigate the impacts, in case these are cost-effective. In other words, the best way to mitigate the impacts is to prevent them from occurring. Choice of raw materials/technologies/processes which produce least impact would be one of the options to achieve it.

- After exploring cost-effective feasible alternatives to control impacts at source, various interventions to minimize the adverse impacts may be considered. These interventions, primarily aim at reducing the residual impacts on VECs of the receiving environment to the acceptable concentrations.
- Degree of control at source and external interventions differs from situation-to - situation and is largely governed by techno-economic feasibility. While the regulatory bodies stress for further source control (due to high reliability), the project proponents bargain for other interventions which may be relatively cost-effective than further control at source (in any case project authority is required to meet the industry-specific standards by adopting the best practicable technologies. However, if the location demands further control at source, then the proponents are required to adopt further advanced control technologies *i.e.,* towards best available control technologies). After having discussions with the project proponent, EAC reaches to an agreed level of source control + other interventions (together called as mitigation measures in the given context) that achieve the targeted protection levels for the VECs in the receiving environment. These levels will become the principle clearance conditions.
- Chapter 3 of this TGM offers elaborate information on cleaner technologies, waste minimization opportunities, and control technologies for various kinds of polluting parameters that emanate from this developmental activity. This information may be used to draw control measures applicable at source.

The choice of interventions for mitigation of impacts may also be numerous and depend on various factors. Mitigation measures based on location-specific suitability and some other factors are discussed in sub-sections 4.6.1 and 4.6.2. A few typical measures which may also be explored for mitigation of impacts are listed in Table 4-5.

Table 4-5: Typical Mitigation Measures

Impacts	Typical Mitigation Measures
Soil	▪ Windscreens, maintenance, and installation of ground cover ▪ Installation of drainage ditches ▪ Runoff and retention ponds ▪ Minimize disturbances and scarification of the surface ▪ Usage of appropriate monitoring and control facilities for construction equipments deployed ▪ Methods to reuse earth material generated during excavation ▪ Use of liners for sludge handling areas and other potential sources of contamination, *etc.*
Resources – fuel/construction material, *etc.*	▪ Availing the resources which could be replenished by natural systems, *etc.*
Deforestation	▪ Plant or create similar areas ▪ Initiate a tree planning program in other areas ▪ Donate land to conservationalist groups, *etc.*
Water pollution (surface and ground water)	▪ Plan to have well-connected operational areas with a wastewater collection network. ▪ Plan to have a sewage treatment plant (STP) for treating wastewater generated onsite. ▪ Runoff and wastewater (effluent& sewage) may be collected by gravity into ETP/STP ▪ Prohibit discharge of contaminated water onto the land or

Impacts	Typical Mitigation Measures
	waterbody. ▪ Conjunctive use of ground/surface water, to prevent flooding/water logging/depletion of water resources. Included are land use pattern, land filling, lagoon/reservoir/garland canal construction, and rainwater harvesting and pumping rate. ▪ Minimise flow variation from the mean flow ▪ All effluents containing acid/alkali/organic/toxic wastes should be properly treated. ▪ Monitoring of ground waters ▪ Neutralization and sedimentation of wastewaters, where applicable ▪ Dewatering of sludges and appropriate disposal of solids ▪ By controlling discharge of sanitary sewage and industrial waste into the environment ▪ By avoiding the activities that increases erosion or that contributes nutrients to water (thus stimulating alga growth) ▪ For wastes containing high TDS, treatment methods include removal of liquid and disposal of residue by controlled landfilling to avoid any possible leaching of the fills ▪ All surface runoffs around mines or quarries should be collected treated and disposed. ▪ Treated wastewater (such as sewage, industrial wastes, or stored surface runoffs) can be used as cooling water makeup. ▪ Wastewater carrying radioactive elements should be treated separately by means of de-watering procedures, and solids or brine should be disposed of with special care. ▪ Develop spill prevention plans in case of chemical discharges and spills ▪ Develop traps and containment system and chemically treat discharges on site, *etc.*
Air Pollution	▪ Periodic checking of vehicles and construction machinery to ensure compliance to emission standards ▪ Attenuation of pollution/protection of receptor through green belts/green cover ▪ Dilution of odourant (dilution can change the nature as well as strength of an odour), odour counteraction or neutralise (certain pairs of odours in appropriate concentrations may neutralise each other), odour masking or blanketing (certain weaker malodours may be suppressed by a considerably stronger good odour). ▪ Regular monitoring of air polluting concentrations, *etc.*
Dust pollution	▪ Adopt sprinkling of water ▪ Wetting of roadways to reduce traffic dust and reentrained particles ▪ Control vehicle speed on sight ▪ Ensure priodical wahsing of cosntruction equipment and transport vehicles to prevent accumulated dust ▪ Ensure that vehicles should be covered during transportation ▪ Installation of windscreens to breakup the wind flow ▪ Burning of refuse on days when meteorological conditions provide for good mixing and dispersion ▪ Providing dust collection equipment at all possible points ▪ Maintaining dust levels within permissible limits ▪ Provision for masks when dust level exceeds, *etc.*

Impacts	Typical Mitigation Measures
Noise pollution	▪ Use of suitable muffler systems/enclosures/sound-proof glass panelling on heavy equipment/pumps/blowers ▪ Pumps and blowers may be mounted on rubber pads or any other noise absorbing materials ▪ Limiting certain activities ▪ Proper scheduling of high noise generating activities to minimise noise impacts ▪ Usage of well maintained construction equipment meeting the regulatory standards ▪ Placement of equipments emitting high noise in an orientation that directs the noise away from sensitive receptors ▪ Periodic maintenance of equipments/repalcing whenever necessary/lubrication of rotating parts, *etc.* ▪ By using damping, absorption, dissipation, and deflection methods ▪ By using common techniques such as constructing sound enclosures, applying mufflers, mounting noise sources on isolators, and/or using materials with damping properties ▪ Performance specifications for noise represent a way to insure the procured item is controlled ▪ Use of ear protective devices. ▪ In case of steady noise levels above 85-dB (A), initiation of hearing conservation measures ▪ Implementation of greenbelt for noise attentuation may be taken up, *etc.*
Biological	▪ Installation of systems to discourage nesting or perching of birds in dangerous environments ▪ Increased employee awareness to sensitive areas, *etc.*
Social	▪ Health and safety measures for workers ▪ Development of traffic plan that minimizes road use by workers ▪ Upgrade of roads and intersections ▪ Provide suffiecient counselling and time to the affected population for relocation ▪ Discuss and finalize alternate arrangements and associated infrastructure in places of religious importance ▪ Exploration of alternative approach routes in consultation with local community and other stakeholders ▪ Provision of alternate jobs in unskilled and skilled categories, *etc.*
Marine	▪ Water quality monitoring program ▪ Limit construction activities to day time to provide recuperation time at night and reduce turbidity ▪ Prevention of spillage of diesel, oil, lubes, *etc.* ▪ Avoid discharge of construction/dredging waste (lose silt) into sea. It may be disposed at the identified disposal point. ▪ Ensure usage of suitable/proper equipment for dredging in order to minimize the turbidity and suspensions at the dredging site. ▪ Checking with the complainace conditions before discharging wastes into the sea water ▪ Take up periodic maintenance dredging including inspectionof sub-sea conditions, *etc.* ▪ Disposal of treated wastewater and saline water through marine diffusers having sufficient length into the sea. ▪ Modelling studies to ensure that the resultant salinity profiles

Impacts	Typical Mitigation Measures
	does not affect marine environment. ▪ Using appropriate mesh to protect the juvinial fish at the water intake point, *etc.*
Occupational health and safety	▪ Provision of worker camps with proper santiation and medical facilities, as well as making the worker camps self- sufficient with resources like water supply, power supply, etc ▪ Arrangement of periodic health check-ups for early detection and control of communicatble diseases. ▪ Arrangement to dispose off the wastes at approved disposal sites. ▪ Provide preventive measures for potentital fire hazards with requisite fire detection, fire-fighting facilities and adequate water storage, *etc.*
Construction	▪ Have a transport management plan in place in order to prevent/minimize the disturbance on surrounding habitats ▪ Initiate traffic density studies, *etc.*
Solid / Hazardous waste	▪ Proper plan to collect and dispose off the solid/hazardous waste generated onsite. ▪ Identify an authorized waste handler for segregation of construction and hazardous waste and its removal on a regular basis to minimise odour, pest and litter impacts ▪ Prohibit buring of refuse onsite. ▪ Providing concrete platform with liners before storing solid/hazardous waste within the premises, *etc.*

4.7 Environmental Management Plan

A typical EMP shall be composed of the following:

1. summary of the potential impacts of the proposal
2. description of the recommended mitigation measures
3. description of monitoring programme to ensure compliance with relevant standards and the residual impacts
4. allocation of resources and responsibilities for plan implementation
5. implementation schedule and reporting procedures
6. contingency plan when impacts are greater than expected

Summary of impacts: The predicted adverse environmental and social impacts for which mitigation measures are identified in the earlier sections to be briefly summarized with cross referencing to the corresponding sections in the EIA report.

Description of mitigation measures: Each mitigation measure should be briefly described with reference to the impact to which it relates and the conditions under which it is required. These should be accompanied by, or referenced to, project design and operating procedures which elaborate on the technical aspects of implementing the various measures.

Description of monitoring programme to ensure compliance with relevant standards and residual impacts: Environmental monitoring refers to compliance monitoring and residual impact monitoring. Compliance monitoring refers to meeting the industry-

specific statutory compliance requirements (Ref. Applicable National regulations as detailed in Chapter 3).

Residual impact monitoring refers to monitoring of identified sensitive locations with adequate number of samples and frequency. The monitoring programme should clearly indicate the linkages between impacts identified in the EIA report, measurement indicators, detection limits (where appropriate), and definition of thresholds that will signal the need for corrective actions.

Allocation of resources and responsibilities for plan implementation: These should be specified for both the initial investment and recurring expenses for implementing all measures contained in the EMP, integrated into the total project costs, and factored into loan negotiation.

The EMP should contain commitments that are binding on the proponent in different phases of project implementation *i.e.,* pre-construction or site clearance, construction, operation, decommissioning.

Responsibilities for mitigation and monitoring should be clearly defined, including arrangements for coordination between the various actors responsible for mitigation. Details should be provided w.r.t deployment of staff (detailed organogram), monitoring network design, parameters to be monitored, analysis methods, associated equipments, *etc.*

Implementation schedule and reporting procedures: The timing, frequency and duration of mitigation measure should be specified in an implementation schedule, showing links with overall project implementation. Procedures to provide information on the progress and results of mitigation and monitoring measures should also be clearly specified.

Contingency Plan when the impacts are greater than expected: There shall be a contingency plan for attending to the situations where residual impacts are higher than expected. It is an imperative requirement for all the project authorities to plan additional programmes to deal with the situation, after duly intimating the concerned local regulatory bodies.

4.8 Reporting

Structure of the EIA report (Appendix III of the EIA Notification), applicable for soda ash industry is given in the Table 4.6. Each task prescribed in ToR shall be incorporated appropriately in the contents in addition to the contents described in the following table.

Table 4-6: Structure of EIA Report

S.No	EIA Structure	Contents
1.	Introduction	▪ Purpose of the report ▪ Identification of project & project proponent ▪ Brief description of nature, size, location of the project and its importance to the country, region ▪ Scope of the study – details of regulatory scoping carried out (As per Terms of Reference)
2.	Project Description	Condensed description of those aspects of the project (based on project feasibility study), likely to cause environmental effects.

S.No	EIA Structure	Contents
		Details should be provided to give clear picture of the following: ▪ Type of project ▪ Need for the project ▪ Location (maps showing general location, specific location, project boundary & project site layout) ▪ Size or magnitude of operation (incl. Associated activities required by or for the project) ▪ Proposed schedule for approval and implementation ▪ Technology and process description ▪ Project description including drawings showing project layout, components of project *etc.* Schematic representations of the feasibility drawings which give information important for EIA purpose ▪ Description of mitigation measures incorporated into the project to meet environmental standards, environmental operating conditions, or other EIA requirements (as required by the scope) ▪ Assessment of new & untested technology for the risk of technological failure
3.	Description of the Environment	▪ Study area, period, components & methodology ▪ Establishment of baseline for VECs, as identified in the scope ▪ Base maps of all environmental components
4.	Anticipated Environmental Impacts & Mitigation Measures	▪ Details of Investigated Environmental impacts due to project location, possible accidents, project design, project construction, regular operations, final decommissioning or rehabilitation of a completed project ▪ Measures for minimizing and / or offsetting adverse impacts identified ▪ Irreversible and Irretrievable commitments of environmental components ▪ Assessment of significance of impacts (Criteria for determining significance, Assigning significance) ▪ Mitigation measures
5.	Analysis of Alternatives (Technology & Site)	▪ Incase, the scoping exercise results in need for alternatives: ▪ Description of each alternative ▪ Summary of adverse impacts of each alternative ▪ Mitigation measures proposed for each alternative and selection of alternative
6.	Environmental Monitoring Program	▪ Technical aspects of monitoring the effectiveness of mitigation measures (incl. measurement methodologies, frequency, location, data analysis, reporting schedules, emergency procedures, detailed budget & procurement schedules)
7.	Additional Studies	▪ Public consultation ▪ Risk assessment ▪ Social impact assessment, R&R action plans
8.	Project Benefits	▪ Improvements in the physical infrastructure ▪ Improvements in the social infrastructure ▪ Employment potential –skilled; semi-skilled and unskilled ▪ Other tangible benefits
9.	Environmental Cost Benefit Analysis	▪ If recommended at the scoping stage

S.No	EIA Structure	Contents
10.	EMP	▪ Description of the administrative aspects of ensuring that mitigative measures are implemented and their effectiveness monitored, after approval of the EIA
11.	Summary & Conclusion (This will constitute the summary of the EIA Report)	▪ Overall justification for implementation of the project ▪ Explanation of how, adverse effects have been mitigated
12.	Disclosure of Consultants engaged	▪ The names of the Consultants engaged with their brief resume and nature of Consultancy rendered

4.9 Public Consultation

Public consultation refers to the process by which the concerns of local affected people and others who have plausible stake in the environmental impacts of the project or activity are ascertained.

- Public consultation is not a decision taking process, but is a process to collect views of the people having plausible stake. If the SPCB/Public agency conducting public hearing is not convinced with the plausible stake, then such expressed views need not be considered.
- Public consultation involves two components, one is public hearing, and other one is inviting written responses/objections through Internet/by post, *etc.*, by placing the summary of EIA report on the website.
- All Category A projects require public hearing except the following:
  - Once prior environmental clearance is granted to an industrial estates/SEZs/EPZs *etc.*, for a given composition (type and capacity) of industries, then individual units will not require public hearing
  - Expansion of roads and highways, which do not involve any further acquisition of land.
  - All building/construction projects/area development projects/townships
  - All projects concerning national defense and security or involving other strategic considerations as determined by the Central Government
- Public hearing shall be carried out at the site or in its close proximity, district-wise, for ascertaining concerns of local affected people.
- Project proponent shall make a request through a simple letter to the Member–Secretary of the SPCB/UTPCC to arrange public hearing.
- Project proponent shall enclose with the letter of request, at least 10 hard copies and 10 soft copies of the draft EIA report including the summary EIA report in English and in the official language of the State/local language prepared as per the approved scope of work, to the concerned Authority.
- Simultaneously, project proponent shall arrange to send, one hard copy and one soft copy, of the above draft EIA report along with the summary EIA report to the following Authorities within whose jurisdiction the project will be located:
  - District magistrate/District Collector/Deputy Commissioner (s)
  - Zilla parishad and municipal corporation or panchayats union
  - District industries office

  - Urban local bodies (ULBs)/PRIs concerned/development authorities
  - Concerned regional office of the MoEF/SPCB

- Above mentioned Authorities except regional office of MoEF shall arrange to widely publicize the draft EIA report within their respective jurisdictions requesting the interested persons to send their comments to the concerned regulatory authorities. They shall also make draft EIA report for inspection electronically or otherwise to the public during normal office hours till the public hearing is over.
- Concerned regulatory Authority (MoEF) shall display the summary of EIA report on its website and also make full draft EIA report available for reference at a notified place during normal office hours at their head office.
- SPCB or UTPCC concerned shall also make similar arrangements for giving publicity about the project within the State/UT and make available the summary of draft EIA report for inspection in select offices, public libraries or any other suitable location, *etc.* They shall also additionally make available a copy of the draft EIA report to the above five authorities/offices as mentioned above.
- The Member-Secretary of the concerned SPCB or UTPCC shall finalize the date, time and exact venue for the conduct of public hearing within seven days of the date of the receipt of the draft EIA report from the project proponent and advertise the same in one major National Daily and one Regional vernacular Daily/official State language.
- A minimum notice period of 30 (thirty) days shall be provided to the public for furnishing their responses.
- No postponement of the date, time, venue of the public hearing shall be undertaken, unless some untoward emergency situation occurs and then only on the recommendation of the concerned District Magistrate/District Collector/Deputy Commissioner, the postponement shall be notified to the public through the same National and Regional vernacular dailies and also prominently displayed at all the identified offices by the concerned SPCB/ UTPCC.
- In the above exceptional circumstances fresh date, time and venue for the public consultation shall be decided by the Member–Secretary of the concerned SPCB/ UTPCC only in consultation with the District Magistrate/District Collector/Deputy Commissioner and notified afresh as per the procedure.
- The District Magistrate/District Collector/Deputy Commissioner or his or her representative not below the rank of an Additional District Magistrate assisted by a representative of SPCB or UTPCC, shall supervise and preside over the entire public hearing process.
- The SPCB/UTPCC shall arrange to video film the entire proceedings. A copy of the videotape or a CD shall be enclosed with the public hearing proceedings while forwarding it to the Regulatory Authority concerned.
- The attendance of all those who are present at the venue shall be noted and annexed with the final proceedings
- There shall be *no quorum* required for attendance for starting the proceedings
- Persons present at the venue shall be granted the opportunity to seek information or clarifications on the project from the proponent. The summary of the public hearing proceedings accurately reflecting all the views and concerns expressed shall be recorded by the representative of the SPCB/UTPCC and read over to the audience at the end of the proceedings explaining the contents in the local/vernacular language

and the agreed minutes shall be signed by the District Magistrate/District Collector/Deputy Commissioner or his or her representative on the same day and forwarded to the SPCB/UTPCC concerned.

- A statement of the issues raised by the public and the comments of the proponent shall also be prepared in the local language or the official State language, as the case may be and in English and annexed to the proceedings.
- The proceedings of the public hearing shall be conspicuously displayed at the office of the Panchayats within whose jurisdiction the project is located, office of the concerned Zilla Parishad, District Magistrate/District Collector/Deputy Commissioner, and the SPCB or UTPCC. The SPCB/ UTPCC shall also display the proceedings on its website for general information. Comments, if any, on the proceedings, may be sent directly to the concerned regulatory authorities and the Applicant concerned.
- The public hearing shall be completed within a period of 45 (forty five) days from date of receipt of the request letter from the Applicant. Therefore the SPCB or UTPCC concerned shall send the public hearing proceedings to the concerned regulatory authority within 8(eight) days of the completion of the public hearing. Simultaneously, a copy will also be provided to the project proponent. The proponent may also directly forward a copy of the approved public hearing proceedings to the regulatory authority concerned along with the final EIA report or supplementary report to the draft EIA report prepared after the public hearing and public consultations incorporating the concerns expressed in the public hearing along with action plan and financial allocation, item-wise, to address those concerns.
- Upon receipt of the same, the Authority will place executive summary of the report on the website to invite responses from other concerned persons having a plausible stake in the environmental aspects of the project or activity.
- If SPCB/UTPCC is unable to conduct the public hearing in the prescribed time, the Central Government incase of Category A projects can engage any other agency or Authority for conducting the public hearing process within a further period of 45 days. The respective governments shall pay the appropriate fee to the public agency for conducting public hearing.
- A public agency means a non-profit making institution/ body such as technical/academic institutions, government bodies not subordinate to the concerned Authority.
- If SPCB/Public Agency authorized for conducting public hearing informs the Authority, stating that it is not possible to conduct the public hearing in a manner, which will enable the views of the concerned local persons to be freely expressed, then Authority may consider such report to take a decision that in such particular case, public consultation may not have the component of public hearing.
- Often restricting the public hearing to the specific district may not serve the entire purpose, therefore, NGOs who are local and registered under the Societies Act in the adjacent districts may also be allowed to participate in public hearing, if they so desire.
- Confidential information including non-disclosable or legally privileged information involving intellectual property right, source specified in the application shall not be placed on the website.

- The Authority shall make available on a written request from any concerned person the draft EIA report for inspection at a notified place during normal office hours till the date of the public hearing.
- While mandatory requirements will have to be adhered to, utmost attention shall be given to the issues raised in the public hearing for determining the modifications needed in the project proposal and the EMP to address such issues.
- Final EIA report after making needed amendments, as aforesaid, shall be submitted by the applicant to the concerned Authority for prior environmental clearance. Alternatively, a supplementary report to draft EIA and EMP addressing all concerns expressed during the public consultation may be submitted.

4.10 Appraisal

Appraisal means the detailed scrutiny by the EAC of the application and the other documents like the final EIA report, outcome of the public consultation including public hearing proceedings submitted by the applicant for grant of prior environmental clearance.

- The appraisal shall be made by EAC to the Central Government.
- Project proponent either personally or through consultant can make a presentation to EAC for the purpose of appraising the features of the project proposal and also to clarify the issues raised by the members of the EAC.
- On completion of these proceedings, EAC shall make categorical recommendations to the respective Authority, either for grant of prior environmental clearance on stipulated terms & conditions, if any, or rejection of the application with reasons.
- In case EAC needs to visit the site or obtain further information before being able to make categorical recommendations, EAC may inform the project proponent accordingly. In such an event, it should be ensured that the process of prior environmental clearance is not unduly delayed to go beyond the prescribed timeframe.
- Upon the scrutiny of the final report, if EAC opines that ToR for EIA studies finalized at the scoping stage are covered by the proponent, then the project proponent may be asked to provide such information. If such information is declined by the project proponent or is unlikely to be provided early enough so as to complete the environmental appraisal within prescribed time of 60 days, the EAC may recommend for rejection of the proposal with the same reason.
- Appraisal shall be strictly in terms of the finalized ToR for EIA studies at the scoping stage and the concerns expressed during public consultation.
- This process of appraisal shall be completed within 60 days from the receipt of the updated EIA report and EMP report, after completing public consultation.
- The EIA report will be typically examined for following:
  - Project site description supported by topographic maps & photographs – detailed description of topography, land use and activities at the proposed project site and its surroundings (buffer zone) supported by photographic evidence.
  - Clarity in description of drainage pattern, location of eco-sensitive areas, vegetation characteristics, wildlife status - highlighting significant environmental attributes such as feeding, breeding and nesting grounds of wildlife species, migratory corridor, wetland, erosion and neighboring issues.

- Description of the project site – how well the interfaces between the project related activities and the environment have been identified for the entire project cycle *i.e.,* construction, operation and decommissioning at the end of the project life.
- How complete and authentic are the baseline data pertaining to flora and fauna and socio economic aspects?
- Citing of proper references, with regard to the source(s) of baseline data as well as the name of the investigators/ investigating agency responsible for collecting the primary data.
- How consistent are the various values of environmental parameters with respect to each other?
- Is a reasonable assessment of the environmental and social impact made for the identified environmental issues including project affected people?
- To what extent the proposed environmental plan will mitigate the environmental impact and at what estimated cost, shown separately for construction, operation and closure stages and also separately in terms of capital and recurring expenses along with details of agencies that will be responsible for the implementation of environmental plan/ conservation plan.
- How well the concerns expressed/highlighted during the Public hearing have been addressed and incorporated in the EMP giving item wise financial provisions and commitments (in quantified terms)?
- How far the proposed environmental monitoring plan will effectively evaluate the performance of the EMP? Are details for environmental monitoring plan provided in the same manner as the EMP?
- Identification of hazard and quantification of risk assessment and whether appropriate mitigation plan has been included in the EMP?
- Does the proposal include a well formulated time bound green belt development plan for mitigating environmental problems such as fugitive emission of dust, gaseous pollutants, noise, odour, *etc.*
- Does EIA makes a serious attempt to guide the project proponent for minimizing the requirement of natural resources including land, water energy and other non renewable resources?
- How well the EIA statement has been organized and presented so that the issues, their impact and environmental management strategies emerge clearly from it and how well organized was the power point presentation made before the expert committee?
- Is the information presented in the EIA adequately and appropriately supported by maps, imageries and photographs highlighting site features and environmental attributes?

4.11 Decision Making

The Chairperson reads the sense of the Committee and finalizes the draft minutes of the meeting, which are circulated by the Secretary to all the expert members invited to the meeting. Based on the response from the members, the minutes are finalized and signed by the Chairperson. This process for finalization of the minutes should be so organized that the time prescribed for various stages is not exceeded.

Approval / Rejection / Reconsideration

- The Authority shall consider the recommendations of concerned appraisal Committee and convey its decision within 45 days of the receipt of recommendations.
- If the Authority disagrees with the recommendations of the Appraisal Committee, then reasons shall be communicated to concerned Appraisal Committee and applicant with in 45 days from the receipt of the recommendations. The Appraisal Committee concerned shall consider the observations of the Authority and furnish its views on the observations within further period of 60 days. The Authority shall take a decision with in the next 30 days based on the views of appraisal Committee.
- If the decision of the Authority is not conveyed within the time, then the proponent may proceed as if the prior environmental clearance sought has been granted or denied by the regulatory authority in terms of the final recommendation of the concerned appraisal Committee. For this purpose, the decision of the Appraisal Committee will be public document, once the period specified above for taking the decision by the Authority is over.
- Deliberate concealment and/or submission of false or misleading information or data which is material to screening or scoping or appraisal or decision on the application shall make the application liable for rejection, and cancellation of prior environmental clearance granted on that basis. Rejection of an application or cancellation of a prior environmental clearance already granted, on such ground, shall be decided by the regulatory authority, after giving a personal hearing to the applicant, and following the principles of natural justice.

If approved

- The MoEF will issue an prior environmental clearance for the project.
- The project proponent should make sure that the award of prior environmental clearance is properly publicized in at least two local newspapers of the district or state where the proposed project is located. For instance, the executive summary of the prior environmental clearance may be published in the newspaper along with the information about the location (website/office where it is displayed for public) where the detailed prior environmental clearance is made available. The MoEF shall also place the prior environmental clearance in the public domain on Government Portal. Further copies of the prior environmental clearance shall be endorsed to the Heads of local bodies, Panchayats and Municipal bodies in addition to the relevant offices of the Government.
- The prior environmental clearance will be valid from the start date to actual commencement of the production of the developmental activity.
- Usual validity period will be 5 years from the date of issuing environmental clearance, unless specified by EAC.
- A prior environmental clearance issued to a project proponent can be transferred to another legal person entitled to undertake the project, upon application by the transferor to the concerned Authority or submission of no-objection of the transferor by the transferee to the concerned Authority for the concurrence. In this case, EAC concurrence is not required, but approval from the concerned authority is required to avail the same project configurations, validity period transferred to the new legally entitled person to undertake the project.

4.12 Post-clearance Monitoring Protocol

The MoEF, Government of India will monitor and take appropriate action under the EP Act, 1986.

- In respect of Category A projects, it shall be mandatory for the project proponent to make public the environmental clearance granted for their project along with the environmental conditions and safeguards at their cost by advertising it at least in two local newspapers of the district or State where the project is located and in addition, this shall also be displayed in the project proponents website permanently.
- The MoEF shall also place the environmental clearance in the public domain on Government Portal.
- The copies of the environmental clearance shall be submitted by the project proponents to the Heads of the local bodies, Panchayats and Municipal bodies in addition to the relevant offices of the Government who in turn has to display the same for 30 days from the date of receipt.

The project proponent must submit half-yearly compliance reports in respect of the stipulated prior environmental clearance terms and conditions in hard and soft copies to the regulatory authority concerned, on 1st June and 1st December of each calendar year.

All such compliance reports submitted by the project management shall be public documents. Copies of the same shall be given to any person on application to the concerned regulatory authority. The latest such compliance report shall also be displayed on the web site of the concerned regulatory authority.

The SPCB shall incorporate EIA clearance conditions into consent conditions in respect of Category A projects and in parallel monitor and enforce the same.

5. STAKEHOLDERS' ROLES AND RESPONSIBILITIES

Prior environmental clearance process involves many stakeholders *i.e.*, Central Government, State Government, EAC at the National Level, Public Agency, SPCB, the project proponent, and the public.

- The roles and responsibilities of the organizations involved in different stages of prior environmental clearance are given in Table 5-1.
- Organization-specific functions are listed in Table 5-2.

In this Chapter, constitution, composition, functions, *etc.*, of the Authorities and the Committees are discussed in detail.

Table 5-1: Roles and Responsibilities of Stakeholders Involved in Prior Environmental Clearance

Stage	MoEF	EAC	Project Proponent	EIA Consultant	SPCB/ Public Agency	Public and Interest Group
Screening	Receives application and takes advise of EAC	Advises the MoEF	Submits application (Form 1) and provide necessary information	Advises and assists the proponent by providing technical information		
Scoping	Approves the ToR and communicates the same to the project proponent and places the same in the web-site	Reviews ToR and visits the proposed site, if required and recommends the ToR to the MoEF	Submits the draft ToR to EAC and facilitates the visit of the sub-committee members to the project site	Prepares ToR		
EIA Report & Public Hearing	Reviews and forwards copies of the EIA report to SPCB /public agency for conducting public hearing Places the summary of EIA report in the web-site		Submits detailed EIA report as per the finalized ToR Facilitates the public hearing by arranging presentation on the project, EIA and EMP – takes note of objections and updates the	Prepares the EIA report Presents and appraises the likely impacts and pollution control measures proposed in the public hearing	Reviews EIA report and conducts public hearing in the manner prescribed Submits proceedings and views of SPCB, as well, to the Authority	Participates in public hearings and offers comments and observations. Comments can be sent directly to MoEF through Internet in

Stage	MoEF	EAC	Project Proponent	EIA Consultant	SPCB/ Public Agency	Public and Interest Group
	Conveys objections to the project proponent for update, if any		EMP accordingly		and the project proponent as well	response to the summary placed in the website
Appraisal and Clearance	Receives updated EIA Takes advise of EAC, and takes decision (Clearance with required conditions or re-examination/rejection	Critically examines the reports, presentation of the proponent and appraises MoEF (recommendations are forwarded to MoEF)	Submits up-dated EIA, EMP reports to MoEF. Presents the overall EIA and EMP including public concerns to EAC	Provides technical advise to the project proponent and if necessary presents the proposed measures for mitigation of likely impacts (terms and conditions of clearance)		
Post Clearance Monitoring			Implements environmental protection measures prescribed and submits periodic monitoring results	Conducts periodic monitoring	Incorporates the clearance conditions into appropriate consent conditions and ensures implementation	

Table 5-2: Organization-specific Functions

Organization	Functions
Central Government	▪ Constitutes the EAC ▪ Receives application from the project proponent ▪ Communicates the ToR finalized by the EAC to the project proponent ▪ Receives EIA report from the project proponent and soft copy of summary of the report for placing in the website ▪ Summary of EIA report will be placed in website. Forwards the received responses to the project proponent ▪ Engages other public agency for conducting public hearing in case where the SPCB does not respond within time ▪ Receives updated EIA report from project proponent incorporating the considerations from the proceedings of public hearing and responses received through other media ▪ Forwards updated EIA report to the EAC for appraisal ▪ Either accepts the recommendations of EAC or asks for reconsideration of specific issues for review by the EAC. ▪ Takes the final decision – acceptance/rejection of the project proposal and communicates the same to the project proponent

Organization	Functions
EAC	▪ Reviews Form 1 and its attachments ▪ Visits site(s), if necessary ▪ Finalizes ToR and recommend to the Central Government, which in turn communicates the finalized ToR to the project proponent if not exempted by the Notification ▪ Reviews EIA report, proceedings and appraises their views to the Central government ▪ If the Central Government has any specific views, then the EAC reviews again for appraisal
SPCB	▪ Receives request from project proponent and conducts public hearing in the manner prescribed. ▪ Conveys proceedings to MoEF and project proponent
Public Agency	▪ Receives request from the respective Governments to conduct public hearing ▪ Conducts public hearing in the manner prescribed. ▪ Conveys proceedings to the MoEF and the Project proponent

5.1 EAC

EAC is an independent Committee to review each developmental activity and offer its recommendations for consideration of the Central Government.

A. Constitution

- EAC shall be constituted by the Central Government comprising a maximum of 15 members including a Chairperson and Secretary.
- The Central Government will notify the committee.
- The Chairperson and the non-official member shall have a fixed term of three years, from the date of Notification by the Central Government.
- The Chairperson shall be an eminent environmental expert with understanding on environmental aspects and environmental impacts.

B. Composition

- Composition of EAC as per the Notification is given in **Annexure X.**
- Secretary to EAC may invite a maximum of two professionals/experts with the prior approval of the Chairperson, if desired, for taking the advisory inputs for appraisal. In such case, the invited experts will not take part in the decision making process.
- The Secretary of EAC preferably be an officer of the level equivalent to or above the level of Director, MoEF, GoI.

C. Decision making

The EAC shall function on the principle of collective responsibility. The Chairperson shall endeavour to reach a consensus in each case, and if consensus cannot be reached, the view of the majority shall prevail.

D. Operational issues

- Secretary may deal with all correspondence, formulate agenda and prepare agenda notes. Chairperson and other members may act only for the meetings.
- Chairperson of EAC shall be one among the expert members having considerable professional experience with proven credentials.

- EAC shall meet at least once every month or more frequently, if so needed, to review project proposals and to offer recommendations for the consideration of the Authority.
- EAC members may inspect the site at various stages *i.e.,* during screening, scoping and appraisal, as per the need felt and decided by the Chairperson of the Committee.
- The respective Governments through the Secretary of the Committee may pay/ reimburse the participation expenses, honorarium *etc.*, to the Chairperson and members.

i. Tenure of EAC

The tenure of Authority/Committee(s) shall be for a fixed period of three years. At the end of the three years period, the Authority and the committees need to be re-constituted. However, staggered appointment dates may be adopted to maintain continuity of members at a given point of time.

ii. Qualifying criteria for nomination of a member to EAC

While recommending nominations and while notifying the members of the Authority and Expert Committees, it shall be ensured that all the members meet the following three criteria:

- Professional qualification
- Relevant experience/Experience interfacing with environmental management
- Absence of conflict of interest

These are elaborated subsequently.

a) Professional qualification

The person should have at least (i) 5 years of formal University training in the concerned discipline leading to a MA/MSc Degree, or (ii) in case of Engineering/Technology/ Architecture disciplines, 4 years formal training in a professional training course together with prescribed practical training in the field leading to a B.Tech/B.E./B.Arch. Degree, or (iii) Other professional degree (*e.g.* Law) involving a total of 5 years of formal University training and prescribed practical training, or (iv) Prescribed apprenticeship/articleship and pass examinations conducted by the concerned professional association (*e.g.* MBA/IAS/IFS). In selecting the individual professionals, experience gained by them in their respective fields will be taken note of.

b) Relevant experience

- Experience shall be related to professional qualification acquired by the person and be related to one or more of the expertise mentioned for the expert members. Such experience should be a minimum of 15 years.
- When the experience mentioned in the foregoing sub-paragraph interfaces with environmental issues, problems and their management, the requirement for the length of the experience can be reduced to a minimum of 10 years.

c) Absence of conflict of interest

For the deliberations of the EAC to be independent and unbiased, all possibilities of potential conflict of interests have to be eliminated. Therefore, serving government officers; persons engaged in industry and their associations; persons associated with the

formulation of development projects requiring prior environmental clearance, and persons associated with environmental activism shall not be considered for membership of EAC.

iii. Age

Below 70 years for the members and below 72 years for the Chairperson of the EAC. The applicability of the age is at the time of the Notification of the EAC by the Central Government.

Summary regarding the eligibility criteria for Chairperson and Members of the EAC is given in Table 5-3.

Table 5-3: EAC: Eligibility Criteria for Chairperson / Members / Secretary

S. No.	Attribute		Requirement		
			Expert members	Secretary	Chairperson
1	Professional qualification as per the Notification		Compulsory	Compulsory	Compulsory
2	Experience (Fulfilling any one of a, b, c)	a	Professional Qualification + 15 years of experience in one of the expertise area mentioned in the Appendix VI	Professional Qualification + 15 years of experience in one of the expertise area mentioned in the Appendix VI	Professional Qualification + 15 years of experience in one of the expertise area mentioned in the Appendix VI
		b	Professional Qualification +PhD+10 years of experience in one of the expertise area mentioned in the Appendix VI	Professional Qualification +PhD+10 years of experience in one of the expertise area mentioned in the Appendix VI	Professional Qualification +PhD+10 years of experience in one of the expertise area mentioned in Appendix VI
		c	Professional Qualification +10 years of experience in one of the expertise area mentioned in the Appendix VI + 5 years interface with environmental issues, problems and their management	Professional Qualification +10 years of experience in one of the expertise area mentioned in the Appendix VI + 5 years interface with environmental issues, problems and their management	----------
3	Test of independence (conflict of interest) and minimum grade of the Secretary of the Committees		Shall not be a serving government officer Shall not be a person engaged in industry and their associations Shall not be a person associated with environmental activism	In case of EAC, not less than a Director from the MoEF, Government of India Incase of SEAC, not below the level of Director/Chief Engineer from the State Government (DoE)	Shall not be a serving government officer Shall not be a person engaged in industry and their associations Shall not be a person associated with environmental activism

S. No.	Attribute	Requirement		
		Expert members	Secretary	Chairperson
4	Age	Below 67 years at the time of Notification of the Committee	As per state Government Service Rules	Below 72 Years at the time of the Notification of the Committee
5	Membership in Central/State Expert Appraisal committee	Only one other than this nomination is permitted	Shall not be a member in other SEIAA/EAC/SEAC	Shall not be a member in any other SEIAA/EAC/SEAC
6	Tenure of earlier appointment (continuous)	Only one term before this in continuity is permitted	Not applicable	Only one term before this in continuity is permitted
7	Eminent environmental expertise with understanding on environmental aspects and impacts	Desirable	Not applicable	Compulsory

Notes:

1. A member after continuous membership in two terms (six years) shall not be considered for further continuation. His/her nomination may be reconsidered after a gap of one term (three years), if other criteria meet.

2. Chairperson/Member once notified may not be removed prior to the tenure of 3 years with out cause and proper enquiry. A member after continuous membership in two terms (6 years) shall not be considered for further continuation. The same profile may be considered for nomination after a gap of three years, i.e., one term, if other criteria are meeting.

E. Other conditions that may be considered

- An expert member of one State/UT, can have at the most another State/UT Committee membership, but in no case more than two Committees at a given point of time.
- An expert member of a Committee shall not have membership continuously in the same committee for more than two terms, *i.e.,* six years. They can be nominated after a gap of three years, *i.e.*, one term. When a member of Committee has been associated with any development project, which comes for prior environmental clearance, he/she may not participate in the deliberations and the decisions in respect to that particular project.
- At least four members shall be present in each meeting to fulfill the quorum
- If a member does not consecutively attend six meetings, without prior intimation to the Committee his/her membership may be terminated by the Notifying Authority. Prior information for absence due to academic pursuits, career development and national/state-endorsed programmes may be considered as genuine grounds for retention of membership.

ANNEXURE I
A Compilation of Legal Instruments

Sl. No.	Legal Instrument (Type, Reference, Year)	Responsible Ministries or Bodies	Chemical Use Categories/ Pollutants	Objective of Legislation	Relevant Articles/Provisions
1	Air (Prevention and Control of Pollution) Act, 1981 amended 1987	Central Pollution Control Board and State Pollution Control Boards	Air pollutants from chemical industries	The prevention, control and abatement of air pollution	Section 2: Definitions Section 21: Consent from State Boards Section 22: Not to allow emissions exceeding prescribed limits Section 24: Power of Entry and Inspection Section 25: Power to Obtain Information Section 26: Power to Take Samples Section 37-43: Penalties and Procedures
2	Air (Prevention and Control of Pollution) (Union Territories) Rules, 1983	Central Pollution Control Board and State Pollution Control Boards	Air pollutants from chemical industries	The prevention, control and abatement of air pollution	Rule 2: Definitions Rule 9: Consent Applications
3	Water (Prevention and Control of Pollution) Act, 1974 amended 1988	Central Pollution Control Board and State Pollution Control Boards	Water Pollutants from water polluting industries	The prevention and control of water pollution and also maintaining or restoring the wholesomeness of water	Section 2: Definitions Section 20: Power to Obtain Information Section 21: Power to Take Samples Section 23: Power of Entry and Inspection Section 24: Prohibition on Disposal Section 25: Restriction on New Outlet and New Discharge Section 26: Provision regarding existing discharge of sewage or trade effluent Section 27: Refusal or withdrawal of consent by state boards Section 41-49: Penalties and Procedures
4	Water (Prevention and Control of Pollution) Rules, 1975	Central Pollution Control Board and State Pollution Control Boards	Water Pollutants from water polluting industries	The prevention and control of water pollution and also maintaining or restoring the wholesomeness of water	Rule 2: Definitions Rule 30: Power to take samples Rule 32: Consent Applications
5	The Environment (Protection) Act, 1986,	Ministry of Environment and	All types of environmental pollutants	Protection and Improvement of the Environment	Section 2: Definitions Section 7: Not to allow emission or discharge of

Sl. No.	Legal Instrument (Type, Reference, Year)	Responsible Ministries or Bodies	Chemical Use Categories/ Pollutants	Objective of Legislation	Relevant Articles/Provisions
	amended 1991	Forests, Central Pollution Control Board and State Pollution Control Boards			environmental pollutants in excess of prescribed standards Section 8: Handing of Hazardous Substances Section 10: Power of Entry and Inspection Section 11: Power to take samples Section 15-19: Penalties and Procedures
6	Environmental (Protection) Rules, 1986 (Amendments in 1999, 2001, 2002, 2002, 2002, 2003, 2004)	Ministry of Environment and Forests, Central Pollution Control Board and State Pollution Control Boards	All types of Environmental Pollutants	Protection and Improvement of the Environment	Rule 2: Definitions Rule 3: Standards for emission or discharge of environmental pollutants Rule 5: Prohibition and restriction on the location of industries and the carrying on process and operations in different areas Rule 13: Prohibition and restriction on the handling of hazardous substances in different areas Rule 14: Submission of environmental statement
7	Hazardous Waste (Management and Handling) Rules, 1989 amended 2000 and 2003	MoEF, CPCB, SPCB, DGFT, Port Authority and Customs Authority	Hazardous Wastes generated from industries using hazardous chemicals	Management & Handling of hazardous wastes in line with the Basel convention	Rule 2: Application Rule 3: Definitions Rule 4: Responsibility of the occupier and operator of a facility for handling of wastes Rule 4A: Duties of the occupier and operator of a facility Rule 4B: Duties of the authority Rule 5: Grant of authorization for handling hazardous wastes Rule 6: Power to suspend or cancel authorization Rule 7: Packaging, labeling and transport of hazardous wastes Rule 8: Disposal sites Rule 9: Record and returns Rule 10: Accident reporting and follow up

Sl. No.	Legal Instrument (Type, Reference, Year)	Responsible Ministries or Bodies	Chemical Use Categories/ Pollutants	Objective of Legislation	Relevant Articles/Provisions
					Rule 11: Import and export of hazardous waste for dumping and disposal Rule 12: Import and export of hazardous waste for recycling and reuse Rule 13: Import of hazardous wastes Rule 14: Export of hazardous waste Rule 15: Illegal traffic Rule 16: Liability of the occupier, transporter and operator of a facility Rule 19: Procedure for registration and renewal of registration of recyclers and re-refiners Rule 20: Responsibility of waste generator
8	Manufacture Storage and Import of Hazardous Chemicals Rules, 1989 amended 2000	Ministry of Environment & Forests, Chief Controller of Imports and Exports, CPCB, SPCB, Chief Inspector of Factories, Chief Inspector of Dock Safety, Chief Inspector of Mines, AERB, Chief Controller of Explosives, District Collector or District Emergency Authority, CEES under DRDO	Hazardous Chemicals - Toxic, Explosive, Flammable, Reactive	Regulate the manufacture, storage and import of Hazardous Chemicals	Rule 2: Definitions Rule 4: responsibility of the Occupier Rule 5: Notification of Major Accidents Rule 7-8: Approval and notification of site and updating Rule 10-11: Safety Reports and Safety Audit reports and updating Rule 13: Preparation of Onsite Emergency Plan Rule 14: Preparation of Offsite Emergency Plan Rule 15: Information to persons likely to get affected Rule 16: Proprietary Information Rule 17: Material Safety Data Sheets Rule 18: Import of Hazardous Chemicals
9	Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996	CCG, SCG, DCG, LCG and MAH Units	Hazardous Chemicals - Toxic, Explosive, Flammable, Reactive	Emergency Planning Preparedness and Response to chemical accidents	Rule 2: Definitions Rule 5: Functions of CCG Rule 7: Functions of SCG Rule 9: Functions of DCG

Sl. No.	Legal Instrument (Type, Reference, Year)	Responsible Ministries or Bodies	Chemical Use Categories/ Pollutants	Objective of Legislation	Relevant Articles/Provisions
					Rule 10: Functions of LCG
10	EIA Notification, 2006	MoEF, SPCB	For all the identified developmental activities in the notification	Requirement of environmental clearance before establishment of or modernization / expansion of identified developmental projects.	Requirements and procedure for seeking environmental clearance of projects
11	Factories Act, 1948	Ministry of Labour, DGFASLI and Directorate of Industrial Safety and Health/Factories Inspectorate	Chemicals as specified in the Table	Control of workplace environment, and providing for good health and safety of workers	Section 2: Interpretation Section 6: Approval, licensing and registration of factories Section 7A: General duties of the occupier Section 7B: General duties of manufacturers etc., as regards articles and substances for use in factories Section 12: Disposal of wastes and effluents Section 14: Dust and fume Section 36: Precautions against dangerous fumes, gases, etc. Section 37: Explosion or inflammable dust, gas, etc. Chapter IVA: Provisions relating to Hazardous processes Section 87: Dangerous operations Section 87A: Power to prohibit employment on account of serious hazard Section 88: Notice of certain accident Section 88A: Notice of certain dangerous occurrences Chapter X: Penalties and procedures

ANNEXURE II
General Standards for Discharge of Environmental Pollutants as per CPCB

Table: Water Quality Standards

S. No.	Parameter	Standards			
		Inland Surface Water	Public Sewer	Land for Irrigation	Marine Coastal Areas
1.	2.	3.			
		(a)	(b)	(c)	(d)
1.	Colour and odour	See Note-1	—	See Note-1	See Note-1
2.	Suspended Solids, mg/l, Max	100	600	200	(a) For process waste water-100 (b) For cooling water effluent-10 per cent above total suspended matter of influent cooling water.
3.	Particle size of suspended solids	Shall pass 850 micron IS Sieve	—	—	(a) Floatable solids, Max 3 mm (b) Settleable solids Max 850 microns.
4.	Dissolved solids (inorganic), mg/a, mac	2100	2100	2100	—
5.	pH value	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0
6.	Temperature ^{o}C, Max	Shall not exceed 40 in any section of the stream within 15 meters down stream from the effluent outlet	45 at the point of discharge	—	45 at the point of discharge
7.	Oil and grease, mg/l, max	10	20	10	20
8.	Total residual chlorine, mg/l, Max.	1.0	—	—	1.0
9.	Ammonical nitrogen (as N), mg/l, Max.	50	50	—	50
10.	Total Kjeldahl nitrogen (as N), mg/l, Max.	100	—	—	100
11.	Free Ammonia (as NH3), mg/l, Max.	5.0	—	—	5.0
12.	Biochemical Oxygen Demand (5 days at 20^{o}C) Max.	30	350	100	100
13.	Chemical Oxygen Demand, mg/l, Max.	250	—	—	250
14.	Arsenic (as As), mg/l, Max.	0.2	0.2	0.2	0.2
15.	Mercury (as Hg), mg/l, Max.	0.01	0.01	—	0.01
16.	Lead (as Pb), mg/l, Max.	0.1	1.0	—	1.0
17.	Cadmium (as Cd), mg/l, Max.	2.0	1.0	—	2.0

S. No.	Parameter	Standards			
		Inland Surface Water	Public Sewer	Land for Irrigation	Marine Coastal Areas
1.	2.	3.			
		(a)	(b)	(c)	(d)
18.	Hexavalent chromium (as Cr+6) mg/l, Max.	0.1	2.0	—	1.0
19.	Total chromium as (Cr), mg/l, Max.	2.0	2.0	—	2.0
20.	Copper (as Cu), mg/l, Max.	3.0	3.0	—	3.0
21.	Zinc (as Zn), mg/l, Max.	5.0	15	—	15
22.	Selenium (as Se), mg/l, Max.	0.05	0.05	—	0.05
23.	Nickel (as Ni), mg/l, Max.	3.0	3.0	—	5.0
24.	Boron (as B), mg/l, Max.	2.0	2.0	2.0	—
25.	Percent Sodium, Max.	—	60	60	—
26.	Residual sodium carbonate, mg/l, Max.	—	—	5.0	—
27.	Cyanide (as CN), mg/l, Max.	0.2	2.0	0.2	0.2
28.	Chloride (as Cl), mg/l, Max.	1000	1000	600	(a)
29.	Fluoride (as F), mg/l, Max.	2.0	15	—	15
30.	Dissolved Phosphates (as P), mg/l, Max.	5.0	—	—	—
31.	Sulphate (as SO4), mg/l, Max.	1000	1000	1000	—
32.	Sulphide (as S), mg/l, Max.	2.0	—	—	5.0
33.	Pesticides	Absent	Absent	Absent	Absent
34.	Phenolic compounds (as C_6H_5OH), mg/l, Max.	1.0	5.0	—	5.0
35.	Radioactive materials (a) Alpha emitters MC/ml, Max. (b) Beta emitters uc/ml, Max.	10^{-7} 10^{-6}	10^{-7} 10^{-6}	10^{-8} 10^{-7}	10^{-7} 10^{-6}

Note :-

1. All efforts should be made to remove colour and unpleasant odour as far as practicable.
2. The standards mentioned in this notification shall apply to all the effluents discharged such as industrial mining and mineral processing activities municipal sewage etc.

Table: Noise Standards

Ambient air quality standards in respect of noise

Area Code	Category of Area	Limits in dB (A) Leq	
		Day Time	Night Time
(A)	Industrial area	75	70
(B)	Commercial area	65	55
(C)	Residential area	55	45
(D)	Silence zone	50	40

Note :

1. Day time is reckoned in between 6.00 AM and 9.00 PM
2. Night time is reckoned in between 9.00 PM and 6.00 AM
3. Silence zone is defined as areas upto 100 meters around such premises as hospitals, educational institutions and courts. The Silence zones are to be declared by the Competent Authority.
4. Use of vehicular horns, loudspeakers and bursting of crackers shall be banned in these zones.
5. Mixed categories of areas should be declared as one of the four above mentioned categories by the Competent Authority and the corresponding standards shall apply.

Standards/Guidelines for Control of Noise Pollution from Stationary Diesel Generator (DG) Sets

(A) Noise Standards for DG Sets (15-500 KVA)

The total sound power level, Lw, of a DG set should be less than, 94+10 log10 (KVA), dB (A), at the manufacturing stage, where, KVA is the nominal power rating of a DG set.

This level should fall by 5 dB (A) every five years, till 2007, i.e. in 2002 and then in 2007.

(B) Mandatory acoustic enclosure/acoustic treatment of room for stationary DG sets (5 KVA and above)

Noise from the DG set should be controlled by providing an acoustic enclosure or by treating the room acoustically.

The acoustic enclosure/acoustic treatment of the room should be designed for minimum 25 dB(A) Insertion Loss or for meeting the ambient noise standards, whichever is on the higher side (if the actual ambient noise is on the higher side, it may not be possible to check the performance of the acoustic enclosure/acoustic treatment. Under such circumstances the performance may be checked for noise reduction upto actual ambient noise level, preferably, in the night time). The measurement for Insertion Loss may be done at different points at 0.5m from the acoustic enclosure/room, and then averaged.

The DG set should also be provide with proper exhaust muffler with Insertion Loss of minimum 25 dB(A).

(C) Guidelines for the manufacturers/users of DG sets (5 KVA and above)

1. The manufacturer should offer to the user a standard acoustic enclosure of 25 dB(A) Insertion Loss and also a suitable exhaust muffler with Insertion Loss of 25 dB(A).

2. The user should make efforts to bring down the noise levels due to the DG set, outside his premises, within the ambient noise requirements by proper siting and control measures.
3. The manufacturer should furnish noise power levels of the unlicensed DG sets as per standards prescribed under (A)
4. The total sound power level of a DG set, at the user's end, shall be within 2 dB(A) of the total sound power level of the DG set, at the manufacturing stage, as prescribed under (A).
5. Installation of a DG set must be strictly in compliance with the recommendation of the DG set manufacturer.
6. A proper routine and preventive maintenance procedure for the DG set should be set and followed in consultation with the DG set manufacturer which would help prevent noise levels of the DG set from deteriorating with use.

Order of the Lt. Governor of Delhi in respect of D.G. Sets (5th December, 2001)

In exercise of the powers conferred by section 5 of the Environment (Protection) Act, 1986, (29 of 1986), read with the Government of India, Ministry of Home Affairs notification S.O. 667 (E) bearing No. F.No. U-11030/J/91-VTL dated 10th September, 1992, the Lt. Governor of Government of National Capital of Delhi hereby directs to all owners/users of generators sets in the National Capital Territory of Delhi as follows :-

1. that generator sets above the capacity of 5 KVA shall not be operated in residential areas between the hours of 10.00 PM to 6.00 AM;
2. that the generator sets above the capacity of 5 KVA in all areas residential/commercial/industrial shall operate only with the mandatory acoustic enclosures and other standards prescribed in the Environment (Protection) Rules, 1986;
3. that mobile generator sets used in social gatherings and public functions shall be permitted only if they have installed mandatory acoustic enclosures and adhere to the prescribed standards for noise and emission as laid down in the Environment (Protection) Rules, 1986.

The contravention of the above directions shall make the offender liable for prosecution under section 15 of the said Act which stipulates punishment of imprisonment for a term which may extend to five years with fine which may extend to one lakh rupees, or with both, and in case the failure of contravention continues, with additional fine which may extend to five thousand rupees for every day during which such failure or contravention continues after the conviction for the first such failure or contravention and if still the failure or contravention continues beyond a period of one year after the date of contravention, the offender continues beyond a period of one year after the date of contravention, the offender shall be punishable with imprisonment for a term which may extend to seven years.

Order Dated: 21st June, 2002

In exercise of the powers conferred by section 5 of the Environment (Protection) Act, 1986 (29 of 1986) read with the Govt. of India, Ministry of Home Affairs notification S.O. 667(E) bearing No. U-11030/J/91-VTL dated the 10th September, 1992, the Lt. Governor Govt. of the National Capital Territory of Delhi hereby makes the following amendment/modification in his order dated the 5th December, 2001 regarding the operation of generator sets, namely:-

Amendments/modifications

In the above said order, for clause(1), the following shall be substituted, namely:-

"(1) that the generator sets above 5KVA shall not be operated in residential areas between the hours from 10.00 p.m. to 6.00 a.m. except generator sets of Group Housing Societies and Multi-storey residential apartments".

DIESEL GENERATOR SETS: STACK HEIGHT

The minimum height of stack to be provided with each generator set can be worked out using the following formula:

$H = h + 0.2 \times \sqrt{KVA}$

H = Total height of stack in metre

h = Height of the building in metres where the generator set is installed

KVA = Total generator capacity of the set in KVA

Based on the above formula the minimum stack height to be provided with different range of generator sets may be categorized as follows:

For Generator Sets	Total Height of stack in metre
50 KVA	Ht. of the building + 1.5 metre
50-100 KVA	Ht. of the building + 2.0 metre
100- 150 KVA	Ht. of the building + 2.5 metre
150-200 KVA	Ht. of the building + 3.0 metre
200-250 KVA	Ht. of the building + 3.5 metre
250-300 KVA	Ht. of the building + 3.5 metre

Similarly for higher KVA ratings a stack height can be worked out using the above formula

Source: Evolved By CPCB

[Emission Regulations Part IV: COINDS/26/1986-87]

ANNEXURE III
Form 1 (Application Form for Obtaining EIA Clearance)

FORM 1

(I) BASIC INFORMATION

S. No.	Item	Details
1.	Name of the project/s	
2.	S.No. in the schedule	
3.	Proposed capacity/area/length/tonnage to be handled/command area/lease area/number of wells to be drilled	
4.	New/Expansion/Modernization	
5.	Existing Capacity/Area etc.	
6.	Category of Project i.e., 'A' or 'B'	
7.	Does it attract the general condition? If yes, please specify.	
8.	Does it attract the specific condition? If yes, Please specify.	
9.	Location	
	Plot/Survey/Khasra No.	
	Village	
	Tehsil	
	District	
	State	
10.	Name of the applicant	
11.	Registered Address	
12.	Address for correspondence:	
	Name	
	Designation (Owner/Partner/CEO)	
	Address	
	Pin Code	
	E-mail	
	Telephone No.	
	Fax No.	
13.	Details of alternative Sites examined, if any location of these sites should be shown on a toposheet.	Village-District-State 1. 2. 3.

S. No.	Item	Details
14.	Interlined Projects	
15.	Whether separate application of interlined project has been submitted	
16.	If yes, date of submission	
17.	If no, reason	
18.	Whether the proposal involves approval/clearance under: The Forest (Conservation) Act, 1980 The Wildlife (Protection) Act, 1972 The C.R.Z. Notification, 1991	
19.	Forest land involved (hectares)	
20.	Whether there is any litigation pending against the project and/or land in which the project is propose to be set up Name of the Court Case No. Orders/directions of the Court, if any and its relevance with the proposed project.	

(II) ACTIVITY

1. Construction, operation or decommissioning of the Project involving actions, which will cause physical changes in the locality (topography, land use, changes in water bodies, etc.)

S.No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities /rates, wherever possible) with source of information data
1.1	Permanent or temporary change in land use, land cover or topography including increase in intensity of land use (with respect to local land use plan)		
1.2	Clearance of existing land, vegetation and buildings?		
1.3	Creation of new land uses?		
1.4	Pre-construction investigations e.g. bore houses, soil testing?		
1.5	Construction works?		

S.No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities /rates, wherever possible) with source of information data
1.6	Demolition works?		
1.7	Temporary sites used for construction works or housing of construction workers?		
1.8	Above ground buildings, structures or earthworks including linear structures, cut and fill or excavations		
1.9	Underground works including mining or tunneling?		
1.10	Reclamation works?		
1.11	Dredging?		
1.12	Offshore structures?		
1.13	Production and manufacturing processes?		
1.14	Facilities for storage of goods or materials?		
1.15	Facilities for treatment or disposal of solid waste or liquid effluents?		
1.16	Facilities for long term housing of operational workers?		
1.17	New road, rail or sea traffic during construction or operation?		
1.18	New road, rail, air waterborne or other transport infrastructure including new or altered routes and stations, ports, airports etc?		
1.19	Closure or diversion of existing transport routes or infrastructure leading to changes in traffic movements?		
1.20	New or diverted transmission lines or pipelines?		
1.21	Impoundment, damming, culverting, realignment or other changes to the hydrology of watercourses or aquifers?		
1.22	Stream crossings?		
1.23	Abstraction or transfers of water form ground or surface waters?		
1.24	Changes in water bodies or the land surface affecting drainage or run-off?		
1.25	Transport of personnel or materials for construction, operation or decommissioning?		

S.No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities /rates, wherever possible) with source of information data
1.26	Long-term dismantling or decommissioning or restoration works?		
1.27	Ongoing activity during decommissioning which could have an impact on the environment?		
1.28	Influx of people to an area in either temporarily or permanently?		
1.29	Introduction of alien species?		
1.30	Loss of native species or genetic diversity?		
1.31	Any other actions?		

2. Use of Natural resources for construction or operation of the Project (such as land, water, materials or energy, especially any resources which are non-renewable or in short supply):

S.No.	Information/checklist confirmation	Yes/No	Details thereof (with approximate quantities /rates, wherever possible) with source of information data
2.1	Land especially undeveloped or agricultural land (ha)		
2.2	Water (expected source & competing users) unit: KLD		
2.3	Minerals (MT)		
2.4	Construction material – stone, aggregates, sand / soil (expected source – MT)		
2.5	Forests and timber (source – MT)		
2.6	Energy including electricity and fuels (source, competing users) Unit: fuel (MT), energy (MW)		
2.7	Any other natural resources (use appropriate standard units)		

3. Use, storage, transport, handling or production of substances or materials, which could be harmful to human health or the environment or raise concerns about actual or perceived risks to human health.

S.No	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data
3.1	Use of substances or materials, which are hazardous (as per MSIHC rules) to human health or the environment (flora, fauna, and water supplies)		
3.2	Changes in occurrence of disease or affect disease vectors (e.g. insect or water borne diseases)		
3.3	Affect the welfare of people e.g. by changing living conditions?		
3.4	Vulnerable groups of people who could be affected by the project e.g. hospital patients, children, the elderly etc.,		
3.5	Any other causes		

4. Production of solid wastes during construction or operation or decommissioning (MT/month)

S.No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data
4.1	Spoil, overburden or mine wastes		
4.2	Municipal waste (domestic and or commercial wastes)		
4.3	Hazardous wastes (as per Hazardous Waste Management Rules)		
4.4	Other industrial process wastes		
4.5	Surplus product		
4.6	Sewage sludge or other sludge from effluent treatment		
4.7	Construction or demolition wastes		
4.8	Redundant machinery or equipment		

S.No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data
4.9	Contaminated soils or other materials		
4.10	Agricultural wastes		
4.11	Other solid wastes		

5. Release of pollutants or any hazardous, toxic or noxious substances to air (kg/hr)

S.No	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data
5.1	Emissions from combustion of fossil fuels from stationary or mobile sources		
5.2	Emissions from production processes		
5.3	Emissions from materials handling including storage or transport		
5.4	Emissions from construction activities including plant and equipment		
5.5	Dust or odours from handling of materials including construction materials, sewage and waste		
5.6	Emissions from incineration of waste		
5.7	Emissions from burning of waste in open air (e.g. slash materials, construction debris)		
5.8	Emissions from any other sources		

6. Generation of Noise and Vibration, and Emissions of Light and Heat:

S.No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data with source of information data
6.1	From operation of equipment e.g. engines, ventilation plant, crushers		
6.2	From industrial or similar processes		
6.3	From construction or demolition		
6.4	From blasting or piling		
6.5	From construction or operational traffic		
6.6	From lighting or cooling systems		
6.7	From any other sources		

7. Risks of contamination of land or water from releases of pollutants into the ground or into sewers, surface waters, groundwater, coastal waters or the sea:

S.No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data
7.1	From handling, storage, use or spillage of hazardous materials		
7.2	From discharge of sewage or other effluents to water or the land (expected mode and place of discharge)		
7.3	By deposition of pollutants emitted to air into the land or into water		
7.4	From any other sources		
7.5	Is there a risk of long term build up of pollutants in the environment from these sources?		

8. Risk of accidents during construction or operation of the Project, which could affect human health or the environment

S.No	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data
8.1	From explosions, spillages, fires etc from storage, handling, use or production of hazardous substances		
8.2	From any other causes		
8.3	Could the project be affected by natural disasters causing environmental damage (e.g. floods, earthquakes, landslides, cloudburst etc)?		

9. Factors which should be considered (such as consequential development) which could lead to environmental effects or the potential for cumulative impacts with other existing or planned activities in the locality

S. No.	Information/Checklist confirmation	Yes/No	Details thereof (with approximate quantities/rates, wherever possible) with source of information data
9.1	Lead to development of supporting facilities, ancillary development or development stimulated by the project which could have impact on the environment e.g.: ▪ Supporting infrastructure (roads, power supply, waste or waste water treatment, etc.) ▪ housing development ▪ extractive industries ▪ supply industries ▪ other		
9.2	Lead to after-use of the site, which could have an impact on the environment		
9.3	Set a precedent for later developments		
9.4	Have cumulative effects due to proximity to other existing or planned projects with similar effects		

(III) ENVIRONMENTAL SENSITIVITY

S.No.	Areas	Name/ Identity	Aerial distance (within 15 km.) Proposed project location boundary
1	Areas protected under international conventions, national or local legislation for their ecological, landscape, cultural or other related value		
2	Areas which are important or sensitive for ecological reasons - Wetlands, watercourses or other water bodies, coastal zone, biospheres, mountains, forests		
3	Areas used by protected, important or sensitive species of flora or fauna for breeding, nesting, foraging, resting, over wintering, migration		
4	Inland, coastal, marine or underground waters		
5	State, National boundaries		
6	Routes or facilities used by the public for access to recreation or other tourist, pilgrim areas		
7	Defence installations		
8	Densely populated or built-up area		
9	Areas occupied by sensitive man-made land uses *(hospitals, schools, places of worship, community facilities)*		
10	Areas containing important, high quality or scarce resources *(ground water resources, surface resources, forestry, agriculture, fisheries, tourism, minerals)*		
11	Areas already subjected to pollution or environmental damage. *(those where existing legal environmental standards are exceeded)*		
12	Areas susceptible to natural hazard which could cause the project to present environmental problems (*earthquakes, subsidence, landslides, erosion, flooding or extreme or adverse climatic conditions*)		

(IV) PROPOSED TERMS OF REFERENCE FOR EIA STUDIES

"I hereby given undertaking that the data and information given in the application and enclosure are true to the best of my knowledge and belief and I am aware that if any part of the data and information submitted is found to be false or misleading at any stage, the project will be rejected and clearance give, if any to the project will be revoked at our risk and cost.

Date:_____
Place:_____

Signature of the applicant
With Name and Full Address
(Project Proponent / Authorized Signatory)

NOTE:

1. The projects involving clearance under Coastal Regulation Zone Notification, 1991 shall submit with the application a C.R.Z. map duly demarcated by one of the authorized, agencies, showing the project activities, w.r.t. C.R.Z. and the recommendations of the State Coastal Zone Management Authority. Simultaneous action shall also be taken to obtain the requisite clearance under the provisions of the C.R.Z. Notification, 1991 for the activities to be located in the CRZ.
2. The projects to be located within 10km of the National Parks, Sanctuaries, Biosphere Reserves, Migratory Corridors of Wild Animals, the project proponent shall submit the map duly authenticated by Chief Wildlife Warden showing these features vis-à-vis the project location and the recommendations or comments of the Chief Wildlife Warden thereon."

ANNEXURE IV
Critically Polluted Industrial Areas and Clusters/Potential Impact Zones

Table 1: Details of Critically Polluted Industrial Areas and Clusters / Potential Impact Zone (Ref: Office Memorandum No. J-11013/5/2010-IA.II(I) Dated 13.1.2010)

S. No.	Critically Polluted Industrial Area and CEPI	Industrial Clusters/ Potential Impact Zones
1.	Ankeshwar (Gujarat) CEPI-88.50(Ac_Wc_Lc)	▪ GIDC Ankeshwar and GIDC, Panoli
2	Vapi (Gujarat) CEPI-88.09(Ac_Wc_Lc)	▪ GIDC Vapi
3	Ghaziabad (Uttar Pradesh) CEPI-87.37(Ac_Wc_Lc)	Sub-cluster A ▪ Mohan nagar industrial area ▪ Rajinder nagar industrial area ▪ Sahibabad industrial area Sub-cluster B ▪ Pandav nagar industrial area ▪ Kavi nagar industrial area ▪ Bulandshahar road industrial area ▪ Amrit nagar ▪ Aryanagar industrial area Sub-cluster C ▪ Merrut road industrial are Sub-cluster D ▪ Loni industrial area ▪ Loni Road industrial area ▪ Roop nagar industrial area Sub-cluster E ▪ Hapur Road industrial area ▪ Dasna ▪ Philkura Sub-cluster F (Other scattered industrial areas) ▪ South side of GT road ▪ Kavi Nagar ▪ Tronica city ▪ Anand Nagar ▪ Jindal Nagar ▪ Prakash Nagar ▪ Rural industrial estate
4	Chandrapur (Maharashtra) CEPI-83.88 (Ac_Wc_Lc)	▪ Chandrapur (MIDC Chandrapur, Tadali, Ghuggus, Ballapur)
5	Kobra (Chhatisgarh) CEPI-83.00 (Ac_Ws_Lc)	▪ Industrial areas and their townships of NTPC, BALCO, CSEB (East) & CSEB (West) ▪ Korba town
6	Bhiwadi (Rajasthan) CEPI-82.91 (Ac_Wc_Ls)	▪ RIICO industrial areas Phase I to IV ▪ Bhiwadi town ▪ Other surrounding industrial areas: Chopanki, Rampura Mundana, Khuskhera Phase I to III
7	Angul Talcer(Orissa) CEPI-82.09 (Ac_Wc_Lc)	▪ MCL Coal mining area, Augul – Talcer region ▪ Industrial area (60 km x 45 km) Following blocks of Augul district: ▪ Kohina block ▪ Talcher block

S. No.	Critically Polluted Industrial Area and CEPI	Industrial Clusters/ Potential Impact Zones
		▪ Angul block ▪ Chhendipada block ▪ Banarpal block ▪ Odapada block of Dhenkamal district
8	Vellore (North Arcot) (Tamil Nadu) CEPI-81.79 (Ac_Wc_Lc)	▪ Ranipet, SIPCOT industrial complex
9	Singrauli (Uttar Pradesh) CEPI-81.73 (Ac_Wc_Ls)	Sonebhadra (UP) ▪ Dala-Tola ▪ Obra ▪ Renukoot ▪ Anpara ▪ Renusagar ▪ Kakri ▪ Dudhichuwa ▪ Bina ▪ Khadia ▪ Shakti nagar ▪ Rihand nagar ▪ Bijpur Sigrauli (Madhya Pradesh) Vindhyachal nagar and Jaynat, Nigahi, Dudhichua, Amlohri & Jhingurdah townships
10	Ludhiana (Punjab) CEPI-81.66 (Ac_Wc_Ls)	Ludhiana municipal limits covering industrial clusters: ▪ Focal point along with NH-I- Total eight phase ▪ Industrial area-B- from sherpur chowk to Gill road & Gill road to Miller Kotla road (left side of road) ▪ Mixed industrial area – right side of Gill road ▪ Industrial area –C (near Juglana village) ▪ Industrial area A & extension: area between old GT road and Ludhiana bypass road ▪ Industrial estate: near Dholwal chowk ▪ Mixes industrial area (MIA) Miller gunj ▪ MIA – bypass road ▪ Bahdur industrial area ▪ Tejpur industrial complex
11	Nazafgarh drain basin, Delhi CEPI-79.54 (As_Wc_Lc)	▪ Industrial areas: Anand Parvat, Naraina, Okhla and Wazirpur
12	Noida (Uttar Pradesh) CEPI-78.90 (Ac_Wc_Lc)	Territorial Jurisdiction of: ▪ Noida Phase-1 ▪ Noida Phase-2 ▪ Noida Phase-3 ▪ Surajpur industrial area ▪ Greater Noida industrial area ▪ Village- Chhaparaula
13	Dhanbad (Jharkhand) CEPI-78.63 (Ac_Ws_Lc)	Four blocks of Dhanbad district: ▪ Sadar (Dhanbad Municipality) ▪ Jharia (Jharia Municipality, Sindri industrial area) ▪ Govindpur (Govindpur industrial estate) ▪ Nirsa

S. No.	Critically Polluted Industrial Area and CEPI	Industrial Clusters/ Potential Impact Zones
14	Dombivalli (Maharashtra) CEPI-78.41 (Ac_Wc_Ls)	▪ MIDC Phase- I, Phase- II
15	Kanpur (Uttar Pradesh) CEPI-78.09 (Ac_Wc_Ls)	Industrial areas: ▪ Dada nagar ▪ Panki ▪ Fazalganj ▪ Vijay nagar ▪ Jajmau
16	Cuddalore (Tamil Nadu) CEPI-77.45 (As_Wc_Lc)	▪ SIPCOT industrial complex, Phase I & II
17	Aurangabad (Maharashtra) CEPI-77.44 (Ac_Wc_Ls)	▪ MIDC Chikhalthana, MIDC Waluj, MIDC Shendra, and Paithan road industrial area
18	Faridabad (Haryana) CEPI-77.07 (Ac_Ws_Lc)	▪ Sector 27-A, B, C, D ▪ DLF phase- 1, sector 31,32 ▪ DLF phase- 2, sector 35 ▪ Sector 4, 6, 24, 27, 31, 59 ▪ Industrial area Hatin ▪ Industrial model township
19	Agra (Uttar Pradesh) CEPI-76.48 (As_Wc_Ls)	▪ Nunihai industrial estate, Rambag nagar, UPSIDC industrial area, and Runukata industrial area
20	Manali (Tamil Nadu) CEPI-76.32 (Ac_Ws_Ls)	▪ Manali industrial area
21	Haldia (West Bengal) CEPI-75.43 (As_Wc_Ls)	▪ 5 km wide strip (17.4 x 5.0 km) of industrial area on the southern side of the confluence point of Rivers Hugli and Rupnarayan, covering ▪ Haldia municipal area & Sutahata block – I and II
22	Ahmedabad (Gujarat) CEPI-75.28 (Ac_Ws_Ls)	▪ GIDC Odhav ▪ GIDC Naroda
23	Jodhpur (Rajasthan) CEPI-75.19 (As_Wc_Ls)	▪ Industrial areas including Basni areas (phase-I & II), industrial estate, light & heavy industrial areas, industrial areas behind new power house, Mandore, Bornada, Sangariya and village Tanwada & Salawas. ▪ Jodhpur city
24	Greater Cochin (Kerala) CEPI-75.08 (As_Wc_Ls)	▪ Eloor-Edayar industrial belt, ▪ Ambala Mogal industrial areas
25	Mandi Gobind Garh (Punjab) CEPI-75.08 (Ac_Ws_Lc)	▪ Mandi Govindgarh municipal limit and khanna area
26	Howrah (West Bengal) CEPI-74.84 (As_Ws_Lc)	▪ Liluah-Bamangachhi region, Howrah ▪ Jalan industrial complex-1, Howrah
27	Vatva (Gujarat) CEPI-74.77 (Ac_Wc_Ls)	▪ GIDC Vatva, Narol industrial area (Villages Piplaj, Shahwadi, Narol)
28	Ib Valley (Orissa) CEPI-74.00 (Ac_Ws_Ls)	▪ Ib Valley of Jharsuguda (Industrial and mining area)
29	Varansi-Mirzapur (Uttar Pradesh) CEPI-73.79 (As_Wc_Ls)	▪ Industrial estate, Mirzapur ▪ Chunar ▪ Industrial estate, Chandpur, Varansi

S. No.	Critically Polluted Industrial Area and CEPI	Industrial Clusters/ Potential Impact Zones
		▪ UPSIC, industrial estate, Phoolpur ▪ Industrial area, Ramnagar, Chandauli
30	Navi Mumbai (Maharashtra) CEPI-73.77 (Ac_Ws_Ls)	▪ TTC industrial area, MIDC, Navi Mumbai (including Bocks-D, C, EL, A, R, General, Kalva)
31	Pali (Rajasthan) CEPI-73.73 (As_Wc_Ls)	▪ Existing industrial areas: Mandia road, Puniyata road, Sumerpur ▪ Pali town
32	Mangalore (Karnataka) CEPI-73.68 (Ac_Ws_Ls)	▪ Baikampady industrial area
33	Jharsuguda (Orissa) CEPI-73.34 (Ac_Ws_Ls)	▪ Ib valley of Jharsuguda (Industrial and mining area)
34	Coimbatore (Tamil Nadu) CEPI-72.38 (Ac_Ws_Ln)	▪ SIDCO, Kurichi industrial Clusters
35	Bhadravati (Karnataka) CEPI-72.33 (Ac_Ws_Ln)	▪ KSSIDC Industrial area, Mysore paper mill & VISL township complex
36	Tarapur (Maharashtra) CEPI-72.01 (Ac_Ws_Ls)	▪ MIDC Tarapur
37	Panipat (Haryana) CEPI-71.91 (As_Ws_Ls)	▪ Panipat municipal limit and its industrial clusters
38	Indore (Madhya Pradesh) CEPI-71.26 (As_Ws_Ls)	Following 09 industrial area: ▪ Sanwer road ▪ Shivaji nagar ▪ Pologround ▪ Laxmibai nagar ▪ Scheme no.71 ▪ Navlakha ▪ Pipliya ▪ Palda ▪ Rau Indore city Other surrounding industrial areas: Manglia, Rajoda, Asrawad, Tejpur Gadwadi
39	Bhavnagar (Gujarat) CEPI-70.99 (As_Ws_Ls)	▪ GIDI Chitra, Bhavnagar
40	Vishakhapatnam (Andhra Pradesh) CEPI-70.82 (As_Ws_Ls)	▪ Bowl area (the area between Yarada hill range in the south to Simhachalam hill range in the north and sea on the east and the present NH-5 in the west direction)
41	Junagarh (Gujarat) CEPI-70.82 (As_Ws_Ls)	Industrial areas: ▪ Sabalpur ▪ Jay Bhavani ▪ Jay Bhuvneshwari ▪ GIDC Junagarh (I&II)
42	Asansole (West Bengal) CEPI-70.20 (As_Ws_Ls)	▪ Bumpur area surrounding IISCO
43	Patancheru - Bollaram (Andhra Pradesh)	Industrial area: ▪ Patancheru ▪ Bollaram

S. No.	Critically Polluted Industrial Area and CEPI	Industrial Clusters/ Potential Impact Zones
	CEPI-70.07 (As_Ws_Ls)	

Note:

Names of identified industrial clusters/potential impact zones are approximate location based on rapid survey and assessment and may alter partially subject to the detailed field study and monitoring. Detailed mapping will be made available showing spatial boundaries of the identified industrial clusters including zone of influence/ buffer zone, after in depth field study.

ANNEXURE V
Pre-Feasibility Report: Points for Possible Coverage

Table 1: Points for Possible Coverage in Pre-feasibility Report

S. No.	Contents	Points of Coverage in Pre-feasibility Report
I.	**Executive summary**	▪ Details on prima facie idea of the project.
II.	**Project Details**	
	Need/Justification of the Project	▪ Current demand scenario of the product (soda ash and its co-products, *etc*.) ▪ Alternatives to meet the demand of the product ▪ Post project scenario on residual demand, *etc*.
	Capacity of Soda Ash Industry	▪ Production capacity of the industry ▪ Sustainability of raw material supply and quality ▪ Optimization of plant capacity, *etc*.
	Features of the project	▪ Analysis of all available/advanced technologies (LeBlanc process, solvay process, Akzo dry lime process, dual process, *etc*.) ▪ Analysis of various possible configurations for each technology or a combination of these technologies ▪ Process flow diagrams for each alternative technology ▪ Equipments used in the project and balance of the plant equipment ▪ General plant layout ▪ Construction details - Estimated duration - Number of construction workers including migrating workers - Construction equipment - Vehicular traffic - Source, mode of transportation and storage of construction material ▪ Traffic that would arise during different phases of the project and transportation mechanism to handle such traffic ▪ New facilities needed ▪ Product storage and associated transportation system ▪ Product demand & supply position data on regional basis, *etc*.
	Resources/raw materials	▪ Details on raw material, by products/byproducts – brine, limestone, ammonia, coke, additives, fuels, *etc*. ▪ Water requirement for process, utilities, domestic purposes, *etc*. ▪ Manpower ▪ Infrastructure ▪ Electrical power ▪ Construction materials like sand, brick, stone chips, borrow earth, metals, *etc*.
	Rejects (Pollution potential)	▪ Air emissions – CO_2, NOx, SOx, CO, H_2S, ammonia, particulate dust, *etc*. ▪ Water pollution – wastewater, cooling water, *etc*. ▪ Solid / hazardous waste – fines of limestone, grits, sludge, *etc*. ▪ Noise ▪ Odour, *etc*.
	Project schedule	▪ Outline project implementation and procurement arrangement including contract packaging ▪ Project implementation schedule showing various

		activities, *etc*.
	Future prospects	▪ Ascertain the costs and benefits of the proposed project for project life ▪ Technical and logistic constraints/requirements of project sustainability, *etc*.
III.	**Selection of site based on least possible impacts**	
i.	**Choice of site selection**	
	Major techno-economic feasibility considerations	▪ Land availability & its development ▪ Product demand around the selected site ▪ Access to site for transportation of equipments/ construction machinery, materials, *etc*. ▪ Raw material availability and its transportation ▪ Water availability and consumptive use ▪ Product transportation ▪ Infrastructure availability at selected site ▪ Inter-state issue, if any, *etc*.
	Incompatible landuse and ecologically sensitive attributes with respect to identified suitable sites	▪ If any incompatible land-use attributes fall within the study area, the following details has to be provided: - Public water supply areas from rivers/surface water bodies, from groundwater - Scenic areas/tourism areas/hill resorts - Religious places, pilgrim centers that attract over 10 lakh pilgrims a year - Protected tribal settlements (notified tribal areas where industrial activity is not permitted); CRZ - Monuments of national significance, World Heritage Sites - Cyclone, Tsunami prone areas (based on last 25 years); - Airport areas - Any other feature as specified by the State or local government and other features as locally applicable, including prime agricultural lands, pastures, migratory corridors, etc. ▪ If ecologically sensitive attributes fall within the study area, please give details. Ecologically sensitive attributes include - National parks - Wild life sanctuaries Game reserve - Tiger reserve/elephant reserve/turtle nesting ground - Breeding grounds - Core zone of biosphere reserve - Habitat for migratory birds - Mangrove area - Tropical forests - Important lakes - Endangered species of flora and fauna, *etc*.
	Social aspects	▪ Corporate responsibilities ▪ Employments and infrastructure added in the vicinity of the plant ▪ Status of land availability, current and post project land use variation ▪ Social sensitivity and likely project affected people, *etc*.
ii.	**Details of selected site**	
	Land details	▪ Land requirement and availability

		▪ Land ownership details such as Government, private, tribal, non-tribal, etc. ▪ Total area of the project/site ▪ Prevailing land cost details, *etc*.
	Location	▪ Geographical details - Longitude & latitude, village, taluka, district, state ▪ Approach to site – roads, railways and airports ▪ Distance from nearest residential and industrial areas ▪ Distance from nearest water bodies such as river, canal, dam, etc ▪ Distance from ecologically sensitive areas ▪ In case of flood prone areas, HFL of the site ▪ In case of seismic areas, seismic zone, active faults, occurrence on earthquakes, etc. ▪ Proximity from infrastructural facilities, *etc*.
	Physical characteristics	▪ Demography ▪ Meteorological data ▪ Landuse pattern such as agricultural, barren, forest, *etc.* and details thereof ▪ Topography of the area ▪ Drainage patterns ▪ Soil condition and soil investigation results ▪ Ground profile and levels, *etc*.
IV.	**Anticipated impacts based on project operations on receiving environment**	▪ Population ▪ Flora and fauna ▪ Water ▪ Soil ▪ Air ▪ Climate ▪ Landscape, *etc.*
V.	**Proposed broad mitigation measures which could effectively be internalized as project components to have environmental and social acceptance of the proposed site**	▪ Preventive measures ▪ Source control measures ▪ Mitigation measures at the receiving environment, *etc*.
VI.	**An indication of any difficulties (technical deficiencies or lack of know-how) encountered by the developer in compiling the required information.**	

The above listing is not exhaustive. Thus the proponent may provide additional necessary information, felt appropriate, to include in the pre-feasibility study report in support of selecting the site for the proposed developmental activities. The EAC during scrutiny, may specifically ask for any additional information/data required to substantiate the requirement to prescribe the ToR for EIA studies. However, it is to make clear that all the required further information by EAC may be mentioned in one single letter, within the prescribed time.

ANNEXURE VI
Types of Monitoring and Network Design Considerations

TYPES OF MONITORING AND NETWORK DESIGN CONSIDERATIONS

A. Types of Monitoring

Monitoring refers to the collection of data using a series of repetitive measurements of environmental parameters (or, more generally, to a process of systematic observation). The environmental quality monitoring programme design will be dependent upon the monitoring objectives specified for the selected area of interest. The main types of EIA monitoring activities are:

- Baseline monitoring is the measurement of environmental parameters during the pre-project period for the purpose of determining the range of variation of the system and establishing reference points against which changes can be measured. This leads to the assessment of the possible (additional available) assimilative capacity of the environmental components in pre-project period w.r.t. the standard or target level.
- Effects monitoring is the measurement of environmental parameters during project construction and implementation to detect changes which are attributable to the project to provide the necessary information to:
  - verify the accuracy of EIA predictions; and
  - determine the effectiveness of measures to mitigate adverse effects of projects on the environment.
  - Feedback from environmental effect monitoring programs may be used to improve the predictive capability of EIAs and also determine whether more or less stringent mitigation measures are needed
- Compliance monitoring is the periodic sampling or continuous measurement of environmental parameters to ensure that regulatory requirements and standards are being met.

Compliance and effects monitoring occurs during the project construction, operation, and abandonment stages. The resources and institutional set-up should be available for the monitoring at these stages. All large-scale construction projects will require some construction stage monitoring. To control the environmental hazards of construction as specified in the EIA, a monitoring program should be established to ensure that each mitigation measure is effectively implemented. There are numerous potential areas for monitoring during operations.

The scope of monitoring topics discussed in this chapter is limited to Baseline and Effects monitoring. In addition, this chapter will also discuss the Compliance monitoring during the construction phase. Post-project monitoring requirements are discussed in the EMP.

Before any field monitoring tasks are undertaken there are many institutional, scientific, and fiscal issues that must be addressed in the implementation of an environmental monitoring program. Careful consideration of these issues in the design and planning stages will help avoid many of the pitfalls associated with environmental monitoring programs. Although these issues are important but the discussions here are confined to the monitoring network design component.

B. Network Design

Analysis of Significant Environmental Issues

At the outset of planning for an environmental monitoring network, the EIA manager may not know exactly what should be monitored, when monitoring should begin, where it should monitor, which techniques should be employed, and who should take responsibility for its conduct. Because there are usually a number of objective decisions associated with network design to be made, it is important to start with an analysis of environmental issues. The scoping phase of an EIA is designed to identify and focus on the major issues. Scoping should provide a valuable source of information on the concerns that need to be addressed by the monitoring network design. These are project specific as well as specific to the environmental setting of the location where the project is proposed to be located

Hence, the network designs are associated with questions like:

- What are the expected outputs of the monitoring activity?
- Which problems do we need to address to? *etc*.

Defining the output will influence the design of the network and optimize the resources used for monitoring. It will also ensure that the network is specially designed to optimize the information on the problems at hand

What to Monitor?

The question of what to monitor is associated with the identification of VECs.

VECs are generally defined as environmental attributes or components of the environment that are valued by society as identified during the scoping stage of the project. They are determined on the basis of perceived public concerns. For example, changes to water quality and quantity could have implications on fish by affecting habitat, food supply, oxygen, and contaminant uptake. Similarly, employment and business, and economies are both VECs that serve as pathways.

The choice of VECs is also related to the perceived significant impact of the project implementation on important environmental components. In general, the significance or importance of environmental components is judged based on:

- legal protection provided (for example, rare and endangered species)
- political or public concerns (for example, resource use conflicts and sustainable development)
- scientific judgment (for example, ecological importance); or
- commercial or economic importance

However, in addition to their economic, social, political or ecological significance, the chosen VEC should also have unambiguous operational ease, be accessible to prediction and measurement; and be susceptible to hazard. Once the VECs are defined, the VECs may be directly measured (for example, extent of habitat for an endangered species). In cases where it is impossible or impractical to directly measure the VECs, the chosen measurement endpoints or environmental indicators must correspond to, or be predictive of assessment endpoints.

The chosen environmental indicators must be: 1) measurable; 2) appropriate to the scale of disturbance/ contamination; 3) appropriate to the impact mechanism; 4) appropriate

and proportional to temporal dynamics; 5) diagnostic; and 6) standardized; as well as have: 1) a low natural variability; 2) a broad applicability; and 3) an existing data series.

Where, How and How Many Times to Monitor?

These are the other components of Monitoring Network Design. These questions are best answered based on local field conditions, capacity and resources available, prevailing legal and regulatory priorities, *etc*. For this screening or reconnaissance Surveys of the study area also necessary. This may also include some simple inexpensive measurements and assimilative/dispersion modeling. The data will give some information on the prevailing special and temporal variations, and the general background air pollution in the area. The number of monitoring stations and the indicators to be measured at each station in the final permanent network may then be decided upon based on the results of the screening study as well as on the knowledge of the sources of the proposed development and prevailing local environmental/meteorological conditions. The best possible definition of the air pollution problem, together with the analysis of the resources: personnel, budget and equipment available, represent the basis for the decision on the following questions:

- What spatial density (number) of sampling stations is required? How many samples are needed and during what period (sampling (averaging) time and frequency)?
- Where should the stations be located?
- What kind of equipment should be used?
- What additional background information is needed?
  - meteorology
  - topography
  - population density
  - emission sources and emission rates
  - effects and impacts
- How will the data be made available/communicated?

C. Site Selection

This normally means that for designing a monitoring programme in an (study) area which might have an impact, several monitoring stations are needed for characterizing the baseline conditions of the impacted area. When considering the location of individual samplers, it is essential that the data collected are representative for the location and type of area without the undue influence from the immediate surroundings. In any measurement point in the study area the total ambient concentration is the representative of:

- natural background concentration
- regional background
- impact of existing large regional sources such as Industrial emissions and other power plants

To obtain the information about the importance of these different contributions it is therefore necessary to locate monitoring stations so that they are representative for different impacts. In addition to the ambient pollution data, one would often need other data governing the variations such as meteorological data for air pollution, to identify and quantify the sources contributing to the measurements.. When considering the location of individual samplers, it is essential that the data collected are representative for the location and type of area without undue influence from the immediate surroundings.

ANNEXURE VII
Guidance for Assessment of Baseline Components and Attributes

GUIDANCE FOR ASSESSMENT OF BASELINE COMPONENTS AND ATTRIBUTES*

Attributes	Sampling		Measurement Method	Remarks
	Network	**Frequency**		
A. Air				
Meteorological ▪ Wind speed ▪ Wind direction ▪ Dry bulb temperature ▪ Wet bulb temperature ▪ Relative humidity ▪ Rainfall ▪ Solar radiation ▪ Cloud cover	▪ Minimum 1 site in the project impact area requirements ▪ Other additional site(s) are require depending upon the model applied or site sensitivities	▪ Min: 1 hrly observations from continuous records	▪ Mechanical / automatic weather station ▪ Rain gauge ▪ As per IMD ▪ As per IMD	▪ IS 5182 Part 1-20 Sit-specific primary data is essential ▪ Secondary data from IMD, New Delhi for the nearest IMD station
Pollutants ▪ SPM ▪ PM10, PM2.5 ▪ SO_2 ▪ NO_2 ▪ CO ▪ H_2S* ▪ $NH*_3$ ▪ HC* ▪ Fluoride* ▪ Pb* ▪ VOC-PAH* ▪ Ozone ▪ Benzene ▪ Benzo(a)pyrene (Particulate phase only) ▪ Arsenic ▪ Nickel (parameters to be proposed by the proponent, in draft ToR, which will be reviewed and approved by EAC)	▪ 10 to 15 locations in the project impact area	▪ 24 hrly twice a week ▪ 8 hrly twice a week ▪ 24 hrly twice a week	▪ Gravimetric (High – Volume) ▪ Gravimetric (High – Volume with Cyclone) ▪ EPA Modified West & Gaeke method ▪ Arsenite Modified Jacob & Hochheiser ▪ NDIR technique ▪ Methylene-blue ▪ Nessler's Method ▪ Infra Red analyzer ▪ Specific lon meter ▪ TOEM ▪ Beta attenuation ▪ UV photometric ▪ Chemilminescence ▪ Chemical method ▪ Gas chromatography based continuos analyzer ▪ Adsorption and desorption followed by GC analysis	▪ Monitoring Network ▪ Minimum 2 locations in upwind side, more sites in downwind side / impact zone ▪ All the sensitive receptors need to be covered ▪ Measurement Methods ▪ As per CPCB standards for NAQM, 1994

Attributes	Sampling		Measurement Method	Remarks
	Network	Frequency		
			▪ Solvent extraction folllowed by HPLC/GC analysis ▪ AAS/ICP method after sampling on EPM 2000 or equivalent filter paper	
B. Noise				
Hourly equivalent noise levels	▪ Same as for Air Pollution along with others Identified in study area	▪ At lest one day continuous in each season on a working and non-working day	▪ Instrument : Sensitive Noise level meter (preferably recording type)	▪ Min: IS: 4954- 1968 as adopted by CPCB
Hourly equivalent noise levels	▪ Inplant (1.5 m from machinery or high emission processes)	▪ Same as above for day and night	▪ Instrument : Noise level metre	▪ CPCB / OSHA
Hourly equivalent noise levels	▪ Highways (within 500 metres from the road edge)	▪ Same as above for day and night	▪ Instrument : Noise level meter	▪ CPCB / IS : 4954-1968
Peak particle velocity	▪ 150- 200m from blast site	▪ Based on hourly observations	▪ PPV meter	▪
C. Water				
Parameters for water quality ▪ Ph, temp, turbidity, magnesium hardness, total alkalinity, chloride, sulphate, nitrate, fluoride, sodium, potassium salinity ▪ Total nitrogen, total phosphorus, DO, BOD, COD, Phenol ▪ Heavy metals ▪ Total coliforms, faecal coliforms ▪ Phyto plankton ▪ Zooplankton	▪ Set of grab samples during pre and post-monsoon for ground and surface water for the whole study zone. For lab analysis the samples should be preserved for transport safe	▪ Diurnal and season-wise	▪ Samples for water quality should be collected and analyzed as per: ▪ IS: 2488 (Part 1-5) methods for sampling and testing of industrial effluents ▪ Standard methods for examination of water and waste water analysis published by American Public Health Association. ▪ International standard practices for benthos and	

Attributes	Sampling		Measurement Method	Remarks
	Network	Frequency		
▪ Fish & other aquatic flora & fauna (parameters are given in ToR for EIA studies based on nature of project, raw material & process technology, location-nature/activities within of air basin)			aquatic flora & fauna	
For Surface Water Bodies				
▪ Total Carbon ▪ PH ▪ Dissolved Oxygen ▪ Biological Oxygen ▪ Demand ▪ Free NH_4 ▪ Boron ▪ Sodium Absorption ratio ▪ Electrical Conductivity	▪ Monitoring locations should include up-stream, on site, down stream of proposed discharge point. Besides sampling should cover width of the river in case water quality modeling is proposed. ▪ Standard methodology for collection of surface water (BIS standards) ▪ At least one grab sample per location per season	▪ Yield & impact on water sources to be measured during critical season ▪ River Stretch within project area be divided in grids (say 1 km length and 1/3 width) and samples should be from each grid at a time when the wastewater discharged by other sources of pollution is expected to be maximum	▪ Samples for water quality should be collected and analyzed as per: ▪ IS: 2488 (Part 1-5) methods for sampling and testing of industrial effluents ▪ Standard methods for examination of water and wastewater analysis published by American Public Health Association. ▪ ▪	▪ Historical data should be collected from relevant offices such as central water commission, state and central ground water board, Irrigation dept. ▪
Parameters for wastewater characterization				
▪ Temp, colour, odour, turbidity, TSS, TDS ▪ PH , alkalinity as CaCO3, p value, M value, tatal hardness as CaCO3, chloride as cl, sulphate as S04, Nitrate as NO3, Floride as F, Phosphate as P04, Chromium as Cr (Hexavalent, total) Ammonical Nitrogen as N, TKN, % sodium, BOD at 20 C, COD,	▪ Implant Source depending upon the different waste streams the parameters can be optimized ▪ Grab and composite sampling representing avg of different process operations as well as worst emission scenario should be represented	▪ Different operational cycles as well as raw material variations should be reflected in the analysis	▪ Samples for water quality should be collected and analyzed as per: ▪ IS: 2488 (Part 1-5) methods for sampling and testing of industrial effluents ▪ Standard methods for examination of water and wastewater analysis published by American	All plant sources categorized as: ▪ Different Process waste streams as well as run-off conditions ▪ ETP wastewater ▪ Domestic/ sanitary wastewater

Attributes	Sampling		Measurement Method	Remarks
	Network	Frequency		
DO, total residual chlorine as Cl_2, oil and grease, sulphide, phenolic compound			Public Health Association.	
D. Land Environment				
▪ Soil ▪ Particle size distribution ▪ Texture ▪ pH ▪ Electrical conductivity ▪ Caution exchange capacity ▪ Alkali metals ▪ Sodium Absorption Ratio (SAR) ▪ Permeability ▪ Porosity	▪ One surface sample from each landfill and/or hazardous waste site (if applicable) and prime villages, (soil samples be collected as per BIS specifications) in the study area	▪ Season-wise	▪ Collected and analyzed as per soil analysis reference book, M.I.Jackson and soil analysis reference book by C.A. Black ▪	▪ The purpose of impact assessment on soil (land environment) is to assess the significant impacts due to leaching of wastes or accidental releases and contaminating ▪
Landuse / Landscape				
▪ Location code ▪ Total project area ▪ Topography ▪ Drainage (natural) ▪ Cultivated, forest plantations, water bodies, roads and settlements	▪ At least 20 points along with plant boundary and general major land use categories in the study area.	▪ Drainage once in the study period and land use categories from secondary data (local maps) and satellite imageries	▪ Global positioning system ▪ Topo-sheets ▪ Satellite Imageries (1:25,000)	▪ Drainage within the plant area and surrounding is very important for storm water impacts. ▪ From land use maps sensitive receptors (forests, parks, mangroves etc.) can be identified

Attributes	Sampling		Measurement Method	Remarks
	Network	Frequency		
E. Solid Waste				
Quantity: ▪ Based on waste generated from per unit production ▪ Per capita contribution ▪ Collection, transport and disposal system ▪ Process Waste ▪ Quality (oily, chemical, biological)	▪ For green field unites it is based on secondary data base of earlier plants.	▪ Process wise or activity wise for respective raw material used. Domestic waste depends upon the season also	Guidelines ▪ IS 9569 : 1980 ▪ IS 10447 : 1983 ▪ IS 12625 : 1989 ▪ IS 12647 : 1989 ▪ IS 12662 (PTI) 1989	
Quality: ▪ General segregation into biological/organic/inert/hazardous ▪ Loss on heating ▪ pH ▪ Electrical Conductivity ▪ Calorific value, metals etc.	▪ Grab and Composite samples	▪ Process wise or activity wise for respective raw material used. Domestic waste depends upon the season also	Analysis ▪ IS 9334 : 1979 ▪ IS 9235 : 1979 ▪ IS 10158 : 1982	
Hazardous Waste				
▪ Permeability And porosity ▪ Moisture pH ▪ Electrical conductivity ▪ Loss on ignition ▪ Phosphorous ▪ Total nitrogen ▪ Caution exchange capacity ▪ Particle size distribution ▪ Heavy metal ▪ Ansonia ▪ Fluoride	▪ Grab and Composite samples. Recyclable components have to analyzed for the recycling requirements	▪ Process wise or activity wise for respective raw material used.	Analysis ▪ IS 9334 : 1979 ▪ IS 9235 : 1979 ▪ IS 10158 : 1982	▪ Impacts of hazardous waste should be performed critically depending on the waste characteristics and place of discharge. For land disposal the guidelines should be followed and impacts of accidental releases should be assessed
F. Biological Environment Aquatic				
▪ Primary productivity ▪ Aquatic weeds	▪ Considering probable impact, sampling points	▪ Season changes are very important	▪ Standards techniques (APHA et. Al. 1995, Rau	▪ Seasonal sampling for aquatic biota

Attributes	Sampling		Measurement Method	Remarks
	Network	Frequency		
▪ Enumeration of ▪ phytoplankton, zooplankton and benthos ▪ Fisheries ▪ Diversity indices ▪ Trophic levels ▪ Rare and endangered species ▪ Sanctuaries / closed areas / Coastal regulation zone (CRZ) ▪ Terrestrial ▪ Vegetation – species, list, economic importance, forest produce, medicinal value ▪ Importance value index (IVI) of trees ▪ Wild animals	and number of samples to be decided on established guidelines on ecological studies based on site eco-environment setting within 10/25 km radius from the proposed site ▪ Samples to collect from upstream and downstream of discharge point, nearby tributaries at down stream, and also from dug wells close to activity site		and Wooten 1980) to be followed for sampling and measurement	▪ One season for terrestrial biota, in addition to vegetation studies during monsoon season ▪ Preliminary assessment ▪ Microscopic analysis of plankton and meiobenthos, studies of macrofauna, aquatic vegetation and application of indices, viz. Shannon, similarity, dominance IVI etc ▪ Point quarter plot-less method (random sampling) for terrestrial vegetation survey.
Avifauna ▪ Rare and endangered species ▪ Sanctuaries / National park / Biosphere reserve	▪ For forest studies, chronic as well as short-term impacts should be analyzed warranting data on micro climate conditions			▪ Secondary data to collect from Government offices, NGOs, published literature ▪ Plankton net ▪ Sediment dredge ▪ Depth sampler ▪ Microscope ▪ Field binocular
G. Socio Economic				
▪ Demographic structure ▪ Infrastructure resource base ▪ Economic resource base ▪ Health status: Morbidity pattern ▪ Cultural and aesthetic attributes	▪ Socio-economic survey is based on proportionate, stratified and random sampling method	▪ Different impacts occurs during construction and operational phases of the project	▪ Primary data collection through R&R surveys (if require) or community survey are based on personal interviews and questionnaire	▪ Secondary data from census records, statistical hard books, toposheets, health records and relevant official records available with Govt. agencies

* Project Specific concerned parameters needs to be identified by the project proponent and shall be incorporated in the draft ToR, to be submitted to the Authority for the consideration and approval by the EAC.

ANNEXURE VIII
Sources of Secondary Data

Annexure VIIIA: Potential Sources of Data For EIA

	Information	Source
	Air Environment	
1.	Meteorology- Temperature, Rainfall, Humidity, Inversion, Seasonal Wind rose pattern (16 point compass scale), cloud cover, wind speed, wind direction, stability, mixing depth	⑨ Indian Meteorology Department, Pune
2.	Ambient Air Quality- 24 hourly concentration of SPM, RPM, SO_2, NO_x, CO	⑨ Central Pollution Control Board (CPCB), ⑨ State Pollution Control Board (SPCB), ⑨ Municipal Corporations ⑨ Ministry of Environment and Forests (MoEF) ⑨ State Department of Environment (DoEN)
	Water Environment	
3.	Surface water- water sources, water flow (lean season), water quality, water usage, Downstream water users Command area development plan Catchment treatment plan	⑨ Central Water Commission (CWC), ⑨ Central Pollution Control Board (CPCB), ⑨ State Pollution Control Board (SPCB), Central Water and Power Research Institute (CWPRS), Pune ⑨ State Irrigation Department ⑨ Hydel Power generation organizations such as NHPC, State SEBs
4.	Ground Water- groundwater recharge rate/withdrawal rate, ground water potential groundwater levels (pre monsoon, post monsoon), ground water quality, changes observed in quality and quantity of ground water in last 15 years	⑨ Central Ground Water Board (CGWB) ⑨ Central Ground Water Authority (CGWA) ⑨ State Ground Water Board (SGWB) ⑨ National Water Development Authority (NWDA)
5.	Coastal waters- water quality, tide and current data, bathymetry	⑨ Department of Ocean Development, New Delhi ⑨ State Maritime Boards ⑨ Naval Hydrographer's Office, Dehradun ⑨ Port Authorities ⑨ National Institute of Oceanography (NIO), Goa
	Biological Environment	
6.	Description of Biological Environment- inventory of flora and fauna in 7 km radius, endemic species, endangered species, Aquatic Fauna, Forest land, forest type and density of vegetation, biosphere, national parks, wild life sanctuaries, tiger reserve, elephant reserve, turtle nesting ground, core zone of biosphere reserve, habitat of migratory birds, routes of migratory birds	⑨ District Gazetteers ⑨ National Remote Sensing Agency (NRSA), Hyderabad ⑨ Forest Survey of India, Dehradun ⑨ Wildlife Institute of India ⑨ World Wildlife Fund ⑨ Zoological Survey of India ⑨ Botanical Survey of India ⑨ Bombay Natural History Society, (BNHS), Mumbai ⑨ State Forest Departments ⑨ State Fisheries Department ⑨ Ministry of Environment and Forests ⑨ State Agriculture Departments ⑨ State Agriculture Universities
	Land Environment	
7.	Geographical Information-Latitude, Longitude, Elevation (above MSL)	⑨ Toposheets of Survey of India, Pune ⑨ National Remote Sensing Agency (NRSA), Hyderabad ⑨ Space Application Centre (SAC), Ahmedabad

	Information	Source
8.	Nature of Terrain, topography map indicating contours (1:2500 scale)	⑨ Survey of India Toposheets ⑨ National Remote Sensing Agency (NRSA), Hyderabad ⑨ State Remote Sensing Centre, ⑨ Space Application Centre (SAC), Ahmedabad
9.	Hydrogeology- Hydrogeological report (in case of ground water is used/area is drought prone/wastewater is likely to discharged on land) Geomorphological analysis (topography and drainage pattern) Geological analysis (Geological Formations/Disturbances- geological and structural maps, geomorphological contour maps, structural features, including lineaments, fractures, faults and joints) Hydrogeological analysis (disposition of permeable formations, surface-ground water links, hydraulic parameter determination etc) Analysis of the natural soil and water to assess pollutant absorption capacity	⑨ NRSA, Hyderbad ⑨ Survey of India Toposheets ⑨ Geological Survey of India ⑨ State Geology Departments ⑨ State Irrigation Department ⑨ Department of Wasteland Development, Ministry of Rural Areas ⑨ National Water Development Authority (NWDA)
10.	Nature of Soil, permeability, erodibility classification of the land	⑨ Agriculture Universities ⑨ State Agriculture Department ⑨ Indian Council for Agriculture Research ⑨ State Soil Conservation Departments ⑨ National Bureau of Soil Survey and Landuse Planning ⑨ Central Arid Zone Research Institute (CAZRI), Jodhpur
11.	Landuse in the project area and 10 km radius of the periphery of the project	⑨ Survey of India- Toposheets ⑨ All India Soil and Landuse Survey; Delhi ⑨ National Remote Sensing Agency (NRSA), Hyderabad ⑨ Town and County Planning Organisation ⑨ State Urban Planning Department ⑨ Regional Planning Authorities (existing and proposed plans) ⑨ Village Revenue Map- District Collectorate ⑨ Directorate of Economics and Statistics-State Government ⑨ Space Application Centre, Ahmedabad
12.	Coastal Regulation Zones- CRZMP, CRZ classification, Demarcation of HTL and LTL*	⑨ Urban Development Department ⑨ State Department of Environment ⑨ State Pollution Control Board ⑨ Space Application Centre* ⑨ Centre for Earth Sciences Studies, Thiruvanthapuram* ⑨ Institute of Remote Sensing, Anna University Chennai* ⑨ Naval Hydrographer's Office, Dehradun* ⑨ National Institute of Oceanography, Goa* ⑨ National Institute of Ocean Technology, Chennai ⑨ Centre for Earth Science Studies

* *Agencies authorized for approval of demarcation of HTL and LTL*

	Information	Source
	Social	
13.	Socioeconomic - population, number of houses and present occupation pattern within 7 km from the periphery of the project	⑨ Census Department ⑨ District Gazetteers- State Government ⑨ District Statistics- District Collectorate ⑨ International Institute of Population Sciences, Mumbai (limited data) ⑨ Central Statistical Organisation
14.	Monuments and heritage sites	District Gazetteer Archeological Survey of India, INTACH District Collectorate Central and State Tourism Department State Tribal and Social Welfare Department
	Natural Disasters	
15.	Seismic data (Mining Projects)- zone no, no of earthquakes and scale, impacts on life, property existing mines	⑨ Indian Meteorology Department, Pune ⑨ Geological Survey of India
16.	Landslide prone zone, geomorphological conditions, degree of susceptibility to mass movement, major landslide history (frequency of occurrence/decade), area affected, population affected	⑨ Space Application Centre
17.	Flood/cyclone/droughts- frequency of occurrence per decade, area affected, population affected	⑨ Natural Disaster Management Division in Department of Agriculture and Cooperation ⑨ Indian Meteorological Department
	Industrial	
18.	Industrial Estates/Clusters, Growth Centres	⑨ State Industrial Corporation ⑨ Industrial Associations ⑨ State Pollution Control Boards ⑨ Confederation Indian Industries (CII) ⑨ FICCI
19.	Physical and Chemical properties of raw material and chemicals (Industrial projects); fuel quality	⑨ Material and Safety Data Sheets ⑨ ENVIS database of Industrial Toxicological Research Centre, Lucknow ⑨ Indian Institute Petroleum
20.	Occupational Health and Industrial Hygiene- major occupational health and safety hazards, health and safety requirements, accident histories	⑨ Central Labour Institute, Mumbai ⑨ Directorate of Industrial Safety ⑨ ENVIS Database of Industrial Toxicological Research Centre, Lucknow ⑨ National Institute of Occupational Health, Ahmedabad
21.	Pollutant release inventories (Existing pollution sources in area within 10 km radius)	⑨ Project proponents which have received EC and have commenced operations
22.	Water requirement (process, cooling water, DM water, Dust suppression, drinking, green belt, fire service)	⑨ EIA Reports ⑨ National and International Benchmarks

Annexure VIIIB: Summary of Available Data with Potential Data Sources for EIA

	Agency	Information Available
1.	Archaeological Survey of India Department of Culture Government of India Janpath, New Delhi - 110011 Asi@del3.vsnl.net.in	⑨ Inventory of monuments and sites of national importance- Listing and documentation of monuments according to world heritage, pre historic, proto historic and secular, religious places and forts
2.	Botanical Survey Of India P-8, Brabourne Road Calcutta 700001 Tel#033 2424922 Fax#033 2429330 Email: envis@cal2.vsnl.net.in. . RO - Coimbatore, Pune, Jodhpur, Dehradun, Allahabad, Gantok, Itanagar, Port Blair	⑨ Photodiversity documentation of flora at National, State and District level and flora of protected areas, hotspots, fragile ecosystems, sacred groves etc ⑨ Identification of threatened species including endemics, their mapping, population studies ⑨ Database related to medicinal plants, rare and threatened plant species ⑨ Red data book of Indian plants (Vol 1,2, and 3) ⑨ Manual for roadside and avenue plantation in India
3.	Bureau of Indian Standards Manak Bhawan, 9 Bahadur Shah Zafar Marg, New Delhi 110 002 Tel#3230131, 3233375, 3239402 (10 lines) Fax : 91 11 3234062, 3239399, 3239382 Email- bis@vsnal.com	⑨ Bureau of Indian Standards Committees on Earthquake Engineering and Wind Engineering have a Seismic Zoning Map and the Wind Velocity Map including cyclonic winds for the country
4.	Central Water Commission (CWC) Sewa Bhawan, R.K.Puram New Delhi - 110066 cmanoff@niccwc.delhi.nic.in RO- Bangalore, Bhopal, Bhubaneshwar, Chandigarh, Coimbatore/Chennai, Delhi, Hyderabad, Lucknow, Nagpur, Patna, Shillong, Siliguri and Vadodara	⑨ Central Data Bank -Collection, collation and Publishing of Hydrological, Hydrometeorological, Sediment and Water Quality data-. ⑨ Basin wise Master Plans ⑨ Flood atlas for India ⑨ Flood Management and Development and Operation of Flood Forecasting System- CWC operate a network of forecasting stations Over 6000 forecasts are issued every year with about 95% of the forecasts within the permissible limit. ⑨ Water Year Books, Sediment Year Books and Water Quality Year Books. ⑨ Also actively involved in monitoring of 84 identified projects through National, State and Project level Environmental Committees for ensuring implementation of environmental safeguards
5.	Central Ground Water Board (HO) N.H.IV, New CGO Complex, Faridabad - 121001 RO - Guwahati, Chandigarh, Ahemadabad, Trivandrum, Calcutta, Bhopal, Lucknow, Banglore, Nagpur, Jammu, Bhubneshwar, Raipur, Jaipur, Chennai, Hyderabad, Patna	⑨ surveys, exploration, monitoring of ground water development

[16] *Based on web search and literature review*

6.	Central Pollution Control Board Parivesh Bhawan, CBD-cum-Office Complex East Arjun Nagar, DELHI - 110 032 INDIA E-mail : cpcb@alpha.nic.in	⑨ National Air Quality Monitoring Programme ⑨ National River Water Quality Monitoring Programme- Global Environment Monitoring , MINARS ⑨ Zoning Atlas Programme ⑨ Information on 17 polluting category industries (inventory, category wise distribution, compliance, implementation of pollution control programmes
7.	Central Arid Zone Research Institute, Jodhpur Email : cazri@x400.nicgw.nic.in Regional Centre at Bhuj in Gujarat	⑨ AGRIS database on all aspects of agriculture from 1975 to date ⑨ Also have cell on Agriculture Research Information System; ⑨ Working on ENVIS project on desertification ⑨ Repository of information on the state of natural resources and desertification processes and their control ⑨ The spectrum of activities involves researches on basic resource inventories; monitoring of desertification, rehabilitation and management of degraded lands and other areas
8.	Central Inland Capture Fisheries Research Institute, Barrackpore-743101, Tel#033-5600177 Fax#033-5600388 Email : cicfri@x400.nicgw.nic.in	⑨ Data Base on Ecology and fisheries of major river systems of India. Biological features of commercially important riverine and estuarine fish species. Production functions and their interactions in floodplain wetlands. ⑨ Activities - Environmental Impact Assessment for Resource Management ; Fisheries Resource surveys
9.	Central Institute of Brackish Water Aquaculture 141, Marshalls Road, Egmore , Chennai - 600 008, Tel# 044-8554866, 8554891, Director (Per) 8554851 Fax#8554851,	⑨ Repository of information on brackish water fishery resources with systematic database of coastal fishery resources for ARIS ⑨ Agricultural Research Information System (ARIS) database covers State wise data on soil and water quality parameters, land use pattern, production and productivity trends, ⑨ Social, economic and environmental impacts of aquaculture farming, ⑨ Guidelines and effluent standards for aquaculture farming
10.	Central Marine Fisheries Research Institute (CMFRI), Cochin	⑨ Assessing and monitoring of exploited and un-exploited fish stocks in Indian EEZ ⑨ Monitoring the health of the coastal ecosystems, particularly the endangered ecosystems in relation to artisanal fishing, mechanised fishing and marine pollution ⑨ The institute has been collecting data on the catch and effort and biological characteristics for nearly half a century based on scientifically developed sampling scheme, covering all the maritime States of the country ⑨ The voluminous data available with the institute is managed by the National Marine Living Resources Data Centre (NMLRDC)
11.	Central Water and Power Research Station, Pune Tel#020-4391801-14; 4392511; 4392825 Fax #020-4392004,4390189	⑨ Numerical and Physical models for hydro-dynamic simulations
12.	Central Institute of Road Transport, Bhosari, Pune 411 026, India. Tel : +91 (20) 7125177, 7125292, 7125493, 7125494	⑨ Repository of data on all aspects of performance of STUs and a host of other related road transport parameters

13.	Department of Ocean Development	⑨ Assessment of environment parameters and marine living resources (primary and secondary) in Indian EEZ (Nodal Agency NIO Kochi) ⑨ Stock assessment, biology and resource mapping of deep sea shrimps, lobsters and fishes in Indian EEZ (Nodal agency-Fisheries Survey of India) ⑨ Investigations of toxical algal blooms and benthic productivity in Indian EEZ (Nodal agency- Cochin University of Science and technology) ⑨ Coastal Ocean Monitoring and Prediction System (COMAP) - monitoring and modelling of marine pollution along entire Indian coast and islands. Parameters monitored are temp, salinity, DO, pH, SS, BOD, inorganic phosphate, nitrate, nitrite, ammonia, total phosphorus, total nitrite, total organic carbon, petroleum hydrocarbons, pathogenic vibros, pathogenic E.coli, shigella, salmonella, heavy metals (Cd, Hg, Pb) and pesticide residues (DDT, BHC, Endosulfan). Monitoring is carried out along the ecologically sensitive zones and urban areas (NIO Mumbai- Apex coordinating agency). ⑨ Sea Level Measurement Programe (SELMAM)- sea level measurement at selected stations (Porbandar, Bombay, Goa, Cochin, Tuticorin, Madras, Machilipatnam, Visakhapatnam, Paradeep, Calcutta and Kavaratti (Lakshadweep Island)) along Indian coast and islands using modern tide gauges ⑨ Detailed coastal maps through Survey of India showing contour at 1/2 a metre interval in the scale of 1:25000. (Nellore- Machhalipatnam work already over) ⑨ Marine Data Centre (MDC) IMD for Ocean surface meteorology, GSI for marine geology, SOI for tide levels, Naval Hydrographic Office for bathymetry, NIO Goa for physical chemical and biological oceanography, NIO Mumbai for marine pollution, CMFRI for coastal fisheries, Institute of Ocean Management Madras for coastal geomorphology ⑨ DOD has setup Indian National Centre for Ocean Information Services (INCOIS) at Hyderabad for generation and dissemination of ocean data products (near real time data products such as sea surface temperature, potential fishing zones, upwelling zones, maps, eddies, chlorophyll, suspended sediment load etc). MDC will be integrated with INCOIS ⑨ Integrated Coastal and Marine Area Management (ICMAM) programme - GIS based information system for management of 11 critical habitats namely Pichavaram, Karwar, Gulf of Mannar, Gulf of Khambat, Gulf of Kutch, Malvan, Cochin, Coringa mangroves, Gahirmata, Sunderbans and Kadamat (Lakshadeep) ⑨ Wetland maps for Tamil Nadu and Kerala showing the locations of lagoons, backwaters, estuaries, mudflats etc (1:50000 scale) ⑨ Coral Reef Maps for Gulf of Kachch, Gulf of Mannar, Andaman and Nicobar and Lakshadeep Islands (1:50,000 scale) indicating the condition of corals, density etc
14.	Environment Protection Training and Research Institute Gachibowli, Hyderabad - 500 019, India Phone: +91-40-3001241, 3001242, 3000489 Fax: +91-40- 3000361 E-mail: info@eptri.com	⑨ Environment Information Centre- has appointed EPTRI as the Distributed Information Centre for the Eastern Ghats region of India. EIC Collaborates with the Stockholm Environment Institute Sweden Database on Economics of Industrial Pollution Prevention in India Database of Large and Medium Scale Industries of Andhra Pradesh Environmental Status of the Hyderabad Urban Agglomeration Study on 'water pollution-health linkages' for a few Districts of A.P

		⑨ Environment Quality Mapping Macro level studies for six districts in the State of Andhra Pradesh Micro level studies for two study zones presenting the permissible pollutant load and scoping for new industrial categories Zonation of the IDA, Parwada which helped APIIC to promote the land for industrial development Disaster management plan for Visakhapatnam Industrial Bowl Area
15.	Forest Survey of India (FSI) Kaulagarh Road, P.O., IPE Dehradun - 248 195 Tel# 0135-756139, 755037, 754507 Fax # 91-135-759104 E-Mail : fsidir@nde.vsnl.net.in fsihq@nde.vsnl.net.in RO- Banglore, Calcutta, Nagpur and Shimla	⑨ State of Forest Report (Biannual) ⑨ National Forest Vegetation Map (Biannual exercise) (on 1: 1 million scale) ⑨ Thematic mapping on 1:50,000 scale depicting the forest type, species composition, crown density of forest cover and other landuse National ⑨ Basic Forest Inventory System ⑨ Inventory survey of non forest area ⑨ Forest inventory report providing details of area estimates, topographic description, health of forest, ownership pattern, estimation of volume and other growth parameters such as height and diameter in different types of forest, estimation of growth, regeneration and mortality of important species, volume equation and wood consumption of the area studied
16.	Geological Survey of India 27 Jawaharlal Nehru Road, Calcutta 700 016, India Telephone +91-33-2496941 FAX 91-33-2496956 gsi_chq@vsnl.com	⑨ Environmental hazards zonation mapping in mineral sector ⑨ Codification of base line information of geo-environmental appreciation of any terrain and related EIA and EMP studies ⑨ Lineament and geomorphological map of India on 1:20,000 scale. ⑨ Photo-interpreted geological and structural maps of terrains with limited field checks.
17.	Indian Council of Agriculture Research, Krishi Bhawan, New Delhi, Tel#011-338206 – ICAR complex, Goa- Agro metrology – Central Arid Zone Research Institute- Agro forestry – Central Soil salinity Research Institute, – Indian Institute of Soil Science – Central Soil and Water Conservation Research and Training Institute – National Bureau of Soil Survey and Landuse Planning	⑨ A total of 80,000 profiles at 10 kms grid across the country were analyzed to characterize the soils of India. ⑨ Detailed soil maps of the Country (1:7 million), State (1:250,000) and districts map (1:50,000) depicting extent of degradation (1:4.4 millions) have been prepared. ⑨ Thematic maps depicting soil depth, texture drainage, calcareousness, salinity, pH, slope and erosion have been published ⑨ Agro-climate characterization of the country based on moisture, thermal and sunshine regimes ⑨ Agro-ecological zones (20) and sub-zones (60) for the country were delineated based on physiography, soils, climate, Length of Growing Period and Available Water Content, and mapped on 1:4.4 million scale. ⑨ Digitization of physiography and soil resource base on 1:50,000 scale for 14 States have been completed. ⑨ .Soil fertility maps of N,P,K,S and Zn have also been developed ⑨ Water quality guidelines for irrigation and naturally occurring saline/sodic water ⑨ Calibration and verification of ground water models for predicting water logging and salinity hazards in irrigation commands
18.	Indian Bureau of Mines Indira Bhawan, Civil Lines Nagpur Ph no - 0712-533 631, Fax- 0712-533 041	⑨ National mineral inventory for 61 minerals and mineral maps ⑨ Studies on environmental protection and pollution control in regard to the mining and mineral beneficiation operations ⑨ Collection, processing and storage of data on mines, minerals and mineral-based industries, collection and maintenance of world mineral intelligence, foreign mineral legislation and other related matters

19.	Indian Meteorology Department Shivaji nagar, Pune 41100 RO- Mumbai, Chennai, Calcutta, New Delhi, Nagpur, Guwahati	⑨ Meteorological data ⑨ Background air quality monitoring network under Global Atmospheric Watch Programme (operates 10 stations) ⑨ Seismicity map, seismic zoning map; seismic occurrences and cyclone hazard monitoring; list of major earthquakes ⑨ Climatological Atlas of India , Rainfall Atlas of India and Agroclimatic Atlas of India ⑨ Monthly bulletin of Climate Diagnostic Bulletin of India ⑨ Environmental Meteorological Unit of IMD at Delhi to provide specific services to MoEF
20.	INTACH Natural Heritage, 71 Lodi Estate, New Delhi-110 003 Tel. 91-11-4645482, 4632267/9, 4631818, 4692774, 4641304 Fax : 91-11-4611290 E-mail : nh@intach.net	⑨ Listing and documentation of heritage sites identified by municipalities and local bodies (Listing excludes sites and buildings under the purview of the Archaeological Survey of India and the State Departments of Archaeology)
21.	Industrial Toxicology Research Centre Post Box No. 80, Mahatma Gandhi Marg, Lucknow-226001, Phone: +91-522-221856,213618,228227; Fax : +91-522 228227 Email: itrc@itrcindia.org	⑨ Activities include health survey on occupational diseases in industrial workers, air and water quality monitoring studies, ecotoxicological impact assessment, toxicity of chemicals, human health risk assessment ⑨ Five databases on CD-ROM in the area of environmental toxicology viz: TOXLINE, CHEMBANK, POISINDEX, POLTOX and PESTBANK. The Toxicology Information Centre provides information on toxic chemicals including household chemicals ⑨ ENVIS centre and created a full-fledged computerized database (DABTOC) on toxicity profiles of about 450 chemicals
22.	Indian Institute of Forest Management Post Box No. 357, Nehru Nagar Bhopal - 462 003 Phone # 0755-575716, 573799, 765125, 767851 Fax # 0755-572878	⑨ Consultancy and research on joint forest management (Ford Foundation, SIDA, GTZ, FAO etc)
23.	Indian Institute of Petroleum Mohkampur , Dehradun, India, 248005 0135- 660113 to 116 0135- 671986	⑨ Fuel quality characterisation ⑨ Emission factors
24.	Ministry of Environment and Forest	⑨ Survey of natural resources ⑨ National river conservation directorate ⑨ Environmental research programme for eastern and western ghats ⑨ National natural resource management system ⑨ Wetlands conservation programme- survey, demarcation, mapping landscape planning, hydrology for 20 identified wetlands National ⑨ wasteland identification programme
25.	Mumbai Metropolitan Regional Development Authority	⑨ Mumbai Urban Transport Project ⑨ Mumbai Urban Development Project ⑨ Mumbai Urban Rehabilitation Project ⑨ Information on MMR; statistics on councils and corporations Regional ⑨ Information Centre- Basic data on population, employment, industries and other sectors are regularly collected and processed

26.	Municipal Corporation of Greater Mumbai	⑨ Air Quality Data for Mumbai Municipal Area ⑨ Water quality of lakes used for water supply to Mumbai
27.	Ministry of Urban Development Disaster Mitigation and Vulnerability Atlas of India Building Materials & Technology Promotion Council G-Wing,Nirman Bhavan, New Delhi-110011 Tel: 91-11-3019367 Fax: 91-11-3010145 E-Mail: bmtpc@del2.vsnl.net.in	⑨ Identification of hazard prone area ⑨ Vulnerability Atlas showing areas vulnerable to natural disasters ⑨ Land-use zoning and design guidelines for improving hazard resistant construction of buildings and housing ⑨ State wise hazard maps (on cyclone, floods and earthquakes)
28.	Natural Disaster Management Division in Department of Agriculture and Cooperation	⑨ Weekly situation reports on recent disasters, reports on droughts, floods, cyclones and earthquakes
29.	National Bureau Of Soil Survey & Land Use Planning P.O. Box No. 426, Shankar Nagar P.O., Nagpur-440010 Tel#91-712-534664,532438,534545 Fax#:91-712-522534 RO- Nagpur, New Delhi, Banglore, Calcutta, Jorhat, Udaipur	⑨ NBSS&LUP Library has been identified as sub centre of ARIC (ICAR) for input to AGRIS covering soil science literature generated in India ⑨ Research in weathering and soil formation, soil morphology, soil mineralogy, physicochemical characterisation, pedogenesis, and landscape-climate-soil relationship. ⑨ Soil Series of India- The soils are classified as per Soil Taxonomy. The described soil series now belong to 17 States of the country. ⑨ Landuse planning- watershed management, land evaluation criteria, crop efficiency zoning ⑨ Soil Information system is developed state-wise at 1:250,000 scale. Presently the soil maps of all the States are digitized, processed and designed for final output both digital and hardcopy. The thematic layers and interpreted layers of land evaluation (land capability, land irrigability and crop suitability), Agro-Ecological Zones and soil degradation themes are prepared. ⑨ Districts level information system is developed for about 15 districts at 1: 50, 000 scale. The soil information will be at soil series level in this system. Soil resource inventory of States, districts water-sheds (1:250,000; 1:50,000; 1:10,000/8000)
30.	National Institute of Ocean Technology, Velacherry-Tambaram main road Narayanapuram Chennai, Tamil Nadu Tel#91-44-2460063 / 2460064/ 2460066/ 2460067 Fax#91-44-2460645	⑨ Waste load allocation in selected estuaries (Tapi estuary and Ennore creek) is one the components under the Integrated Coastal and Marine Area Management (ICMAM) programme of the Department of Ocean Development ICMAM is conducted with an IDA based credit to the Government of India under the Environmental Capacity Building project of MoEF (waste assimilation capacity of Ennore creek is over) ⑨ Physical oceanographic component of Coastal & Ocean monitoring Predictive System (COMAPS) a long term monitoring program under the Department of Ocean Development ⑨ Identification of suitable locations for disposal of dredge spoil using mathematical models & environmental criteria ⑨ EIA Manual and EIA guidelines for port and harbour projects
31.	National Institute of Oceanography, Goa RO- Mumbai, Kochi	⑨ Coastal Ocean Monitoring and Predictions(COMAP)-Monitoring of coastal waters for physicochemical and biological parameters including petroleum hydrocarbons, trace metals, heavy metals, and biomass of primary (phytoplankton) and secondary (zooplankton, microbial and benthic organisms) ⑨ Marine Biodiversity of selected ecosystem along the West Coast of India

32.	National Botanical Research Institute, Post Box No 436 Rana Pratap Marg Lucknow- 226001, Tel: (+91) 522 271031-35 Fax: (+91) 522 282849, 282881 Lucknow	⑨ Dust filtering potential of common avenue trees and roadside shrubs has been determined, besides studies have also been conducted on heavy-metals accumulation potential of aquatic plants supposedly useful as indicators of heavy metal pollution in water bodies and capable of reducing the toxic metals from water bodies. ⑨ Assessment of bio-diversity of various regions of India
33.	National Geophysical Research Institute, Uppal Road, Hyderabad Telephone:0091-40-7171124, FAX:0091-40-7171564	⑨ Exploration, assessment and management of ground water resources including ground water modelling and pollution studies
34.	National Environmental Engineering Research Institute, Nagpur RO- Mumbai, Delhi, Chennai, Calcutta, Ahmedabad, Cochin, Hyderabad, Kanpur	⑨ National Air Quality Monitoring (NAQM) for CPCB ⑨ Database on cleaner technologies of industrial productions
35.	National Hydrology Institute, Roorkee RO- Belgaum (Hard Rock Regional Centre), Jammu (Western Himalayan Regional Centre), Guwahati (North Eastern Regional Centre), Kakinada (Deltaic Regional Centre), Patna (Ganga Plains North Regional Centre), and Sagar (Ganga Plains South)	⑨ Basin studies, hydrometeorological network improvement, hydrological year book, hydrological modelling, regional flood formulae, reservoir sedimentation studies, environmental hydrology, watershed development studies, tank studies, and drought studies.
36.	National Institute Of Urban Affairs, India Habitat Centre, New Delhi	⑨ Urban Statistics Handbook
37.	National Institute of Occupational Health Meghaninagar, Ahmedabad RO- Banglore, Calcutta	⑨ epidemiological studies and surveillance of hazardous occupations including air pollution, noise pollution, agricultural hazards, industrial hazards in organised sectors as well as small scale industries, carcinogenesis, pesticide toxicology, etc ⑨ WHO collaborative centre for occupational health for South East Asia region and the lead institute for the international programme on chemical safety under IPCS (WHO)
38.	NRSA Data Centre Department of Space, Balanagar, Hyderabad 500 037 Ph- 040-3078560 3078664 sales@nrsa.gov.in	⑨ Satellite data products (raw data, partially processed (radiometrically corrected but geometrically uncorrected), standard data (radiometrically and geometrically corrected), geocoded data(1:50,000 and 1:25000 scale), special data products like mosaiced, merged and extracted) available on photographic (B?W and FCC in form of film of 240 mm X 240mm or enlargements/paper prints in scale varying between 1:1M and 1:12500 and size varying between 240mm and 1000mm) and digital media (CD-ROMs, 8 mm tapes)
39.	Rajiv Gandhi National Drinking Water Mission	⑨ Database for groundwater using remote sensing technology (Regional Remote Sensing Service Centre involved in generation of ground water prospect maps at 1:50,000 scale for the State of Kerala, Karnataka, AP, MP and Rajasthan for RGNDWM)
40.	Space Application Centre Value Added Services Cell (VASC) Remote Sensing Application Area Ahmedabad 380 053 079-676 1188	⑨ National Natural Resource Information System ⑨ Landuse mapping for coastal regulation zone (construction setback line) upto 1:12500 scale ⑨ Inventory of coastal wetlands, coral reefs, mangroves, seaweeds ⑨ Monitoring and condition assessment of protected coastal areas

	Fax- 079-6762735	⑨ Wetland mapping and inventory ⑨ Mapping of potential hotspots and zoning of environmental hazards ⑨ General geological and geomorphological mapping in diverse terrain ⑨ Landslide risk zonation for Tehre area
41.	State Pollution Control Board	⑨ State Air Quality Monitoring Programme ⑨ Inventory of polluting industries ⑨ Identification and authorization of hazardous waste generating industries ⑨ Inventory of biomedical waste generating industries ⑨ Water quality monitoring of water bodies receiving wastewater discharges ⑨ Inventory of air polluting industries ⑨ Industrial air pollution monitoring ⑨ Air consent, water consent, authorization, environment monitoring reports
42.	State Ground Water Board	
43.	Survey of India	⑨ Topographical surveys on 1:250,000 scales, 1:50,000 and 1:25,000 scales ⑨ Digital Cartographical Data Base of topographical maps on scales 1:250,000 and 1:50,000 ⑨ Data generation and its processing for redefinition of Indian Geodetic Datum ⑨ Maintenance of National Tidal Data Centre and receiving/ processing of tidal data of various ports. ⑨ Coastal mapping along the Eastern coast line has been in progress to study the effect of submergence due to rise in sea-level and other natural phenomenon. Ground surveys have been completed for the proposed coastal region and maps are under printing. ⑨ District planning maps containing thematic information (135 maps) have been printed out of 249 maps covering half the districts of India. Districts planning maps for remaining half of the area are being processed by National Atlas and Thematic Mapping Organisation (NATMO)
44.	Town and Country Planning Organisation	⑨ Urban mapping - Thematic maps and graphic database on towns (under progress in association with NRSA and State town planning department)
45.	Wildlife Institute of India Post Bag No. 18, Chandrabani Dehradun - 248 001, Uttaranchal Tel#0135 640111 -15, Fax#0135 640117 email : wii@wii .	⑨ Provide information and advice on specific wildlife management problems. ⑨ National Wildlife Database
46.	Zoological Survey of India Prani Vigyan Bhawan 'M' Block, New Alipore Calcutta - 700 053 Phone # 91-33-4786893, 4783383 Fax # 91-33-786893 RO - Shillong, Pune, Dehradun, Jabalpur, Jodhpur, Chennai, Patna, Hyderabad, Canning, Behrampur, Kozikode, Itanagar, Digha, Port Bliar, Solan	⑨ Red Book for listing of endemic species ⑨ Survey of faunal resources

ANNEXURE IX
Impact Prediction Tools

Table 1: Choice of Models for Impact Prediction: Air Environment*

Model	Application	Remarks
ISCST 3	▪ Appropriate for point, area and line sources ▪ Application for flat or rolling terrain ▪ Transport distance up to 50 km valid ▪ Computes for 1 hr to annual averaging periods	▪ Can take up to 99 sources ▪ Computes concentration on 600 receptors in Cartesian on polar coordinate system ▪ Can take receptor elevation ▪ Requires source data, meteorological and receptor data as input.
AERMOD with AERMET	▪ Settling and dry deposition of particles; ▪ Building wake effects (excluding cavity region impacts); ▪ Point, area, line, and volume sources; ▪ Plume rise as a function of downwind distance; ▪ Multiple point, area, line, or volume sources; ▪ Limited terrain adjustment; ▪ Long-term and short-term averaging modes; ▪ Rural or urban modes; ▪ Variable receptor grid density; ▪ Actual hourly meteorology data	▪ Can take up to 99 sources ▪ Computes concentration on 600 receptors in Cartesian on polar coordinate system ▪ Can take receptor elevation ▪ Requires source data, meteorological and receptor data as input.
PTMAX	▪ Screening model applicable for a single point source ▪ Computes maximum concentration and distance of maximum concentration occurrence as a function of wind speed and stability class	▪ Require source characteristics ▪ No met data required ▪ Used mainly for ambient air monitoring network design
PTDIS	▪ Screening model applicable for a single point source ▪ Computes maximum pollutant concentration and its occurrences for the prevailing meteorological conditions	▪ Require source characteristics ▪ Average met data (wind speed, temperature, stability class *etc*.) required ▪ Used mainly to see likely impact of a single source
MPTER	▪ Appropriate for point, area and line sources applicable for flat or rolling terrain ▪ Transport distance up to 50 km valid ▪ Computes for 1 hr to annual averaging periods ▪ Terrain adjustment is possible	▪ Can take 250 sources ▪ Computes concentration at 180 receptors up to 10 km ▪ Requires source data, meteorological data and receptor coordinates
CTDM PLUS (Complex Terrain Dispersion Model)	▪ Point source steady state model, can estimate hrly average concentration in isolated hills/ array of hills	▪ Can take maximum 40 Stacks and computes concentration at maximum 400 receptors ▪ Does not simulate calm met conditions ▪ Hill slopes are assumed not to exceed 15 degrees ▪ Requires sources, met and terrain characteristics and receptor details
UAM (Urban Airshed Model)	▪ 3-D grid type numerical simulation model ▪ Computes O_3 concentration short term episodic conditions lasting for 1 or 2 days resulting from NOx and VOCs ▪ Appropriate for single urban area having significant O_3 problems	▪

Model	Application	Remarks
RAM (Rural Airshed Model)	▪ Steady state Gaussian plume model for computing concentration of relatively stable pollutants for 1 hr to 1 day averaging time ▪ Application for point and area sources in rural and urban setting	▪ Suitable for flat terrains ▪ Transport distance less than 50 km.
CRESTER	▪ Applicable for single point source either in rural or urban setting ▪ Computes highest and second highest concentration for 1hr, 3hr, 24hr and annual averaging times ▪ Tabulates 50 highest concentration for entire year for each averaging times	▪ Can take up to 19 Stacks simultaneously at a common site. ▪ Unsuitable for cool and high velocity emissions ▪ Do not account for tall buildings or topographic features ▪ Computes concentration at 180 receptor, circular wing at five downwind ring distance 36 radials ▪ Require sources, and met data
OCD (Offshore and coastal Dispersion Model)	▪ It determines the impact of offshore emissions from point sources on the air quality of coastal regions ▪ It incorporates overwater plume transport and dispersion as well as changes that occur as the plume crosses the shore line ▪ Most suitable for overwater sources shore onshore receptors are below the lowest shore height	▪ Requires source emission data ▪ Require hrly met data at offshore and onshore locations like water surface temperature; overwater air temperature; relative humidity *etc*.
FDM (Fugitive Dust Model)	▪ Suitable for emissions from fugitive dust sources ▪ Source may be point, area or line (up to 121 source) ▪ Require particle size classification max. up to 20 sizes ▪ Computes concentrations for 1 hr, 3hr, 8hr, 24hr or annual average periods	▪ Require dust source particle sizes ▪ Source coordinates for area sources, source height and geographic details ▪ Can compute concentration at max. 1200 receptors ▪ Require met data (wind direction, speed, Temperature, mixing height and stability class) ▪ Model do not include buoyant point sources, hence no plume rise algorithm
RTDM (Rough Terrain Diffusion Model)	▪ Estimates GLC is complex/rough (or flat) terrain in the vicinity of one or more co-located point sources ▪ Transport distance max. up to 15 km to up to 50 km ▪ Computes for 1 to 24 hr. or annual ave5rage concentrations	▪ Can take up to 35 co-located point sources ▪ Require source data and hourly met data ▪ Computes concentration at maximum 400 receptors ▪ Suitable only for non reactive gases ▪ Do not include gravitational effects or depletion mechanism such as rain/ wash out, dry deposition
CDM(Climatol ogically Dispersion Model)	▪ It is a climatologically steady state GPM for determining long term (seasonal or annual) ▪ Arithmetic average pollutant concentration at any ground level receptor in an urban area	▪ Suitable for point and area sources in urban region, flat terrain ▪ Valid for transport distance less than 50 km ▪ Long term averages: One month to one year or longer
PLUVUE-II (Plume Visibility Model)	▪ Applicable to assess visibility impairment due to pollutants emitted from well defined point sources ▪ It is used to calculate visual range reduction	▪ Require source characteristics, met data and receptor coordinates & elevation ▪ Require atmospheric aerosols

Model	Application	Remarks
	and atmospheric discoloration caused by plumes ▪ It predicts transport, atmospheric diffusion, chemical, conversion, optical effects, and surface deposition of point source emissions.	(back ground & emitted) characteristics, like density, particle size ▪ Require background pollutant concentration of SO_4, NO_3, NOx, NO_2, O_3, SO_2 and deposition velocities of SO_2, NO_2 and aerosols
MESO-PUFF II (Meso scale Puff Model)	▪ It is a Gaussian, Variable trajectory, puff superposition model designed to account fro spatial and temporal variations in transport, diffusion, chemical transformation and removal mechanism encountered on regional scale. ▪ Plume is modeled as a series of discrete puffs and each puff is transported independently ▪ Appropriate for point and area sources in urban areas ▪ Regional scale model.	▪ Can model five pollutants simultaneously (SO2, SO4, NOx, HNO3 and NO3) ▪ Require source characteristics ▪ Can take 20 point sources or 5 area source ▪ For area source – location, effective height, initial puff size, emission is required ▪ Computes pollutant concentration at max. 180 discrete receptors and 1600 (40 x 40) grided receptors ▪ Require hourly surface data including cloud cover and twice a day upper air data (pressure, temp, height, wind speed, direction) ▪ Do not include gravitational effects or depletion mechanism such as rain/ wash out, dry deposition

Table 2: Choice of Models for Impact Modeling: Noise Environment*

Model	Application
FHWA (Federal Highway Administration)	Noise Impact due to vehicular movement on highways
Dhwani	For predictions of impact due to group of noise sources in the industrial complex (multiple sound sources)
Hemispherical sound wave propagation Air Port	Fore predictive impact due to single noise source For predictive impact of traffic on airport and rail road

Table 3: Choice of Models for Impact Modeling: Land Environment*

Model	Application	Remarks
Digital Analysis Techniques	Provides land use / land cover distribution	
Ranking analysis for soil suitability criteria	Provides suitability criteria for developmental conversation activities	Various parameters viz. depth, texture, slope, erosion status, geomorphology, flooding hazards, GW potential, land use *etc*., are used.

Table 4: Choice of Models for Impact Modeling: Water Environment*

Model	Application	Remarks
QUAL-II E	Wind effect is insignificant, vertical dispersive effects insignificant applicable to streams Data required Deoxygenation coefficients, re-aeration coefficients for carbonaceous, nitrogenous and benthic substances, dissolved oxygen deficit	Steady state or dynamic model
	The model is found excellent to generate water quality parameters Photosynthetic and respiration rate of suspended and attached algae	
	Parameters measured up to 15 component can be simulated in any combination, e.g. ammonia, nitrite, nitrate, phosphorous, carbonaceous BOD, benthic oxygen demand, DO, coliforms, conservative substances and temperature	
DOSAG-3, USEPA: (1-D) RECEIV – II, USEPA	Water quality simulation model for streams & canal A general Water quality model	Steady-state
Explore –I, USEPA	A river basin water quality model	Dynamic, Simple hydrodynamics
HSPE, USEPA	Hydrologic simulation model	Dynamic, Simple hydrodynamics
RECEIVE-II, USEPA	A general dynamic planning model for water quality management	
Stanford watershed model	This model simulates stream flows once historic precipitation data are supplied The major components of the hydrologic cycle are modeled including interception, surface detention, overland inflow, groundwater, evapo-transpiration and routing of channel flows, temperature, TDS, DO, carbonaceous BOD coliforms, algae, zooplanktons, nitrite, nitrate, ammonia, phosphate and conservative substances can be simulated	
Hydrocomp model	Long-term meteorological and wastewater characterization data is used to simulate stream flows and stream water quality	Time dependant (Dynamic)
Stormwater Management model (SWMM)	Runoff is modeled from overland flow, through surface channels, and through sewer network Both combined and separate sewers can be modeled. This model also enables to simulate water quality effects to stormwater or combined sewer discharges. This model simulates runoff resulting from individual rainfall events.	Time Dependent
Battelle Reservoir model	Water body is divided into segments along the direction of the flow and each segment is divided into number of horizontal layers. The model is found to generate excellent simulation of temperature and good prediction of water quality parameters. The model simulates temperature, DO, total and	Two Dimensional multi-segment model

Model	Application	Remarks
	benthic BOD, phytoplankton, zooplankton, organic and inorganic nitrogen, phosphorous, coliform bacteria, toxic substances and hydrodynamic conditions.	
TIDEP (Turbulent diffusion temperature model reservoirs)	Horizontal temperature homogeneity Coefficient of vertical turbulent diffusion constant for charge of area with depth negligible coefficient of thermal exchange constant Data required wind speed, air temperature, air humidity, net incoming radiation, surface water temperature, heat exchange coefficients and vertical turbulent diffusion coefficients.	Steady state model
BIOLAKE	Model estimates potential fish harvest from a take	Steady state model
Estuary models/ estuarial Dynamic model	It is simulates tides, currents, and discharge in shallow, vertically mixed estuaries excited by ocean tides, hydrologic influx, and wind action Tides, currents in estuary are simulated	Dynamic model
Dynamic Water Quality Model	It simulates the mass transport of either conservative or non-conservative quality constituents utilizing information derived from the hydrodynamic model Bay-Delta model is the programme generally used. Up to 10 independent quality parameters of either conservative or non-conservative type plus the BOD-DO coupled relationship can be handled	Dynamic model
HEC -2	To compute water surface profiles for stead7y, gradually: varying flow in both prismatic & non-prismatic channels	
SMS	Lake circulation, salt water intrusion, surface water profile simulation model	Surface water Modeling system Hydrodynamic model
RMA2	To compute flow velocities and water surface elevations	Hydrodynamic analysis model
RMA4	Solves advective-diffusion equations to model up to six non-interacting constituents	Constituent transport model
SED2D-WES	Model simulates transport of sediment	Sediment transport model
HIVEL2D	Model supports subcritical and supercritical flow analysis	A 2-dimensional hydrodynamic model
MIKE-II, DHI	Model supports, simulations of flows, water quality, and sediment transport in estuaries, rives, irrigation systems, channels & other water bodies	Professional Engineering software package

Table 5: Choice of Models for Impact Modeling: Biological Environment*

Name	Relevance	Applications	Remarks
Flora			
Sample plot methods	Density and relative density Density and relative	Average number of individuals species per unit area Relative degree to which a	The quadrant sampling technique is applicable in all types of plant communities and for the study of submerged, sessile (attached at the base) or

Name	Relevance	Applications	Remarks
	dominance	species predominates a community by its sheer numbers, size bulk or biomass	sedentary plants
	Frequency and relative frequency importance value	Plant dispersion over an area or within a community	Commonly accepted plot size: 0.1 m^2- mosses, lichens & other mat-like plants
		Average of relative density, relative dominance and relative frequency	0.1 m^2- herbaceous vegetation including grasses
			10.20 m^2 – for shrubs and saplings up to 3m tall, and
			100 m^2 – for tree communities
Transects & line intercepts methods	Cover	Ratio of total amount of line intercepted by each species and total length of the line intercept given its cover	This methods allows for rapid assessment of vegetation transition zones, and requires minimum time or equipment of establish
	Relative dominance	It is the ratio of total individuals of a species and total individuals of all species	Two or more vegetation strata can be sampled simultaneously
Plot-less sampling methods	Mean point plant Mean area per plant	Mean point – plant distance Mean area per plant	Vegetation measurements are determined from points rather than being determined in an area with boundaries
	Density and relative density		Method is used in grass-land and open shrub and tree communities
	Dominance and relative dominance		It allows more rapid and extensive sampling than the plot method
	Importance value		Point- quarter method is commonly used in woods and forests.
Fauna			
Species list methods	Animal species list	List of animal communities observed directly	Animal species lists present common and scientific names of the species involved so that the faunal resources of the area are catalogued
Direct Contact Methods	Animal species list	List of animals communities observed directly	This method involves collection, study and release of animals
Count indices methods (Roadside and aerial count methods)	Drive counts Temporal counts	Observation of animals by driving them past trained observers	Count indices provide estimates of animal populations and are obtained from signs, calls or trailside counts or roadside counts
	Call counts	Count of all animals passing a fixed point during some stated	These estimates, through they do not provide absolute population

Name	Relevance	Applications	Remarks
		interval of time	numbers, Provide an index of the various species in an area
			Such indices allow comparisons through the seasons or between sites or habitats
Removal methods	Population size	Number of species captured	Removal methods are used to obtain population estimates of small mammals, such as, rodents through baited snap traps
Market capture methods	Population size estimate (M)	Number of species originally marked (T) Number of marked animals recaptured (t) and total number of animals captured during census (n) N = nT/t	It involves capturing a portion of the population and at some later date sampling the ratio of marked to total animals caught in the population

Table 6: Choice of Models for Impact Predictions: Socio-economic Environment*

Relevance		
Name	**Application**	**Remarks**
Extrapolative Methods	A prediction is made that is consistent with past and present socio-economic data, e.g. a prediction based on the linear extrapolation of current trends	
Intuitive Forecasting (Delphi techniques)	Delphi technique is used to determine environmental priorities and also to make intuitive predictions through the process of achieving group consensus	Conjecture Brainstorming Heuristic programming Delphi consensus
Trend extrapolation and correlation	Predictions may be obtained by extrapolating present trends Not an accurate method of making socio-economic forecasts, because a time series cannot be interpreted or extrapolated very far into the future with out some knowledge of the underlying physical, biological, and social factors	Trend breakthrough precursor events correlation and regression
Metaphors and analogies	The experience gained else where is used to predict the socio-economic impacts	Growth historical simulation commonsense forecasts
Scenarios	Scenarios are common-sense forecasts of data. Each scenario is logically constructed on model of a potential future for which the degrees of "confidence" as to progression and outcome remain undefined	Common-sense
Dynamic modeling (Input- Out model)	Model predicts net economic gain to the society after considering all inputs required for conversion of raw materials along with cost of finished product	
Normative Methods	Desired socio-economic goals are specified and an attempt is made to project the social environment backward in time to the present to examine whether existing or planned resources and	Morphological analysis technology scanning contextual mapping - functional array

Relevance		
Name	**Application**	**Remarks**
	environmental programmes are adequate to meet the goals	- graphic method Mission networks and functional arrays decision trees & relevance trees matrix methods scenarios

*** NOTE:** (i) If a project proponent prefer to use any model other than listed, can do so, with prior concurrence of concerned appraisal committee. (ii) Project-specific proposed prediction tools need to be identified by the project proponent and shall be incorporated in the draft ToR to be submitted to the Authority for the consideration and approval by the concerned EAC/SEAC.

ANNEXURE X
Composition of EAC

Composition of the EAC

The Members of the EAC shall be Experts with the requisite expertise and experience in the following fields /disciplines. In the event that persons fulfilling the criteria of "Experts" are not available, Professionals in the same field with sufficient experience may be considered:

- Environment Quality Experts: Experts in measurement/monitoring, analysis and interpretation of data in relation to environmental quality
- Sectoral Experts in Project Management: Experts in Project Management or Management of Process/Operations/Facilities in the relevant sectors.
- Environmental Impact Assessment Process Experts: Experts in conducting and carrying out Environmental Impact Assessments (EIAs) and preparation of Environmental Management Plans (EMPs) and other Management plans and who have wide expertise and knowledge of predictive techniques and tools used in the EIA process
- Risk Assessment Experts
- Life Science Experts in floral and faunal management
- Forestry and Wildlife Experts
- Environmental Economics Expert with experience in project appraisal

ANNEXURE XI

Best Practices & Latest Technologies available and reference

Best Practices & Latest Technologies available and reference

Soda ash is not only a product of essential importance for the industrial framework but also a "commodity" product in a world-wide highly competitive market

Because of the large tonnage involved, the production units require large quantities of limestone and sodium chloride brine (the basic raw materials) together with very significant amounts of energy, cooling water and a range of minor raw materials including ammonia. A soda ash plant is also characterised by very large volumes of liquid and high gas flows, interdependency between unit operations and a very high degree of recycle between units.

The main environmental impacts of the ammonia soda process are the atmospheric and aqueous emissions associated with the calcination of limestone, the carbonation of ammoniated brine and the waste waters (and their subsequent treatment) from the “distillation” (ammonia recovery) stage of the process.

Geographical location of the production plants and the availability and quality of raw materials have a large influence on composition, volume and treatment of effluents (liquids, solids and gasses).

Development of the process and the individual techniques used have been significantly influenced by the geographical location of the plants; the location, availability and quality of basic raw materials; the geological conditions (including ground porosity, subsurface rock structure, local groundwater conditions etc.); and the availability of water for brine making, process cooling and its availability as a disposal route for the liquid effluents.

Additional factors in the development of the process and its associated environmental abatement techniques have been national or local environmental sensitivities and priorities which have been controlled by regulation. This is discussed in more detail below.

This complex inter-relationship between the process, the environment in which it is operated and the position taken by the local regulator(s) has lead to the development of a range of “local” technologies, most appropriate to meet the particular needs of a production unit within the community in which it operates.

One common feature of the abatement technologies, due primarily to the large volumes involved is the high capital cost associated with development and installation. As a result such improvements are long term investments and in many cases one particular technology is inter-dependant on another. The real environmental benefits have also to be carefully assessed and taken into consideration. There is therefore no individual solution to produce a single list of best available technology.

In particular it must be noted that this interdependence means that abatement techniques may be mutually exclusive. It is not a simple case of selecting all best performances and the techniques used to achieve them and integrate them into a single process.

The other significant aspect of soda ash manufacture is its energy need in different forms: electrical, thermal and mechanical. Much attention has been paid, during the historical development of the process, to reduce the energy consumption and to improve the transformation efficiency of the involved primary fuels. Those improvements have had a positive impact on the environment through the reduction of primary fuels consumption and the reduction of the emissions related to their combustion.

Soda ash production by the Solvay process has been developed over a 140 year period with the focus of attention on raw materials and energy efficiencies and minimisation of the environmental impact.

Emission to Water

I) Ammonia

The primary abatement technique for ammonia is the ammonia recovery stage of the process i.e. distillation.

This recovery of the ammonia and re-circulation within the Solvay process is been described below. It is achieved in the Distillation sector in two steps: initially a chemical reaction between mother liquor (ammonium chloride solution) leaving filtration and a strong alkali (milk-of-lime) followed by steam stripping of the released ammonia.

The strong alkali used is a suspension of $Ca(OH)_2$ which also contains all the inerts of the calcined limestone as well as fine fractions of the non decomposed limestone and traces of ash from the carbon source (usually coke) used in the CO_2 production process in the kilns.

During chemical reaction phase of the above mentioned “distillation”, crystallisation of calcium sulphate is observed in a number of different complex forms, due to the presence of sulphate ions in the mother liquor. This can appear as suspended crystals or deposited scale depending upon reaction conditions, retention times etc. This reaction needs a sufficient residence time to ensure good crystallisation in situ and not as scale in the downstreamequipment. Only after this holding time, can the released ammonia be effectively stripped by steam and recycled to the process.

This set of successive chemical engineering unit operations involves hot chloride, high alkalinity and scaling liquids loaded with suspended solids. The technique used have, over the years, been fine tuned to enable a good contact between the reactive components and to achieve an optimal stripping of the ammonia, despite the solids loading, while treating very high flow rates (e.g. about 570m^3/h for a 500 kt/year soda ash plant).

Distillation uses low pressure steam to strip ammonia from the solution. The amount of ammonia remaining in the distiller effluent is related to the amount of steam consumed. In simple terms, the higher the quantity steam used (and therefore energy consumption), the lower the ammonia concentration in the liquid leaving the distiller. However, the relationship between steam consumption and ammonia concentration is asymptotic, because of the theoretical limitations related to the physico-chemical equilibria, heat and mass constrains and hydrodynamic conditions. Increasing the amount of steam has therefore to be balanced with energy conservation and minimisation. Also increasing the amount energy used increases the amount of greenhouse gasses emitted during its generation.

In spite of the difficult conditions described here, it can be concluded that, with modern and adequate equipment and with the objective to remain economically sustainable, it is possible to keep the annual average ammonia losses as low as 0.9 kg N-NH3/t soda ash. However older equipment may no be able to achieve these conditions and yet may not be economically replaced.

From the energy point of view, the stripping with low-pressure steam (1 to 3 bar abs) contributes positively to the rational and optimal use of primary energy. This is the basic concept of high efficiency embedded combined heat and power. The configuration enables the distillation to operate as a final stage condenser for pass out steam from any upstream electricity turbo-generator or similar use of high pressure steam such as driving force for compression or vacuumation.

It is obvious that such high recovery rates necessitate advanced automatic control of the apparatus as well as consistent quality of the reactive materials, although this quality is always dependent on the quality of the available natural raw materials (limestone, brine).

II) Suspended solids

The liquid leaving the distiller, following the stripping of ammonia, contains solids which are a combination of those derived from the burnt lime stone (usually via milk of lime), a quantity of $CaCO_3$ formed by reaction between the milk of lime and residual CO_2 not desorbed from the NH_4Cl containing liquid (in spite of a recovery rate higher than 95%) and precipitated calcium sulphate from sulphate ions in the incoming brine.

The total quantity and composition of this solid matters depend directly of the composition of the raw materials i.e. limestone and brine. These are mainly $CaCO_3$, $CaSO_4$, $Mg(OH)_2$, silica and alumina components and a small quantity of lime corresponding to the reactive excess needed to achieve effective decomposition of NH_4Cl. The treatment of this effluent for the suspended solids depends on the local

conditions for the plant. There are no abatement techniques as such to eliminate the solid arising and again the environmental impact is one of cross media effects.

Two basic techniques are used: (a) total dispersion or (b) separation and storage of the solids and dispersion of the liquid. Which technique is used depends upon plant location, quality of raw materials and local regulation.

(a) If the receptor is suitable for dispersion and assimilation of sedimentary material (sea, high flow rate river, lake) then it is possible for this route to be used for total disposal. The processes involved will include reaction of residual alkalinity with the natural bicarbonates contained in the receiving water and the formation of $CaCO_3$, some dissolution of sparingly soluble materials such as sulphates and dispersion of insoluble solids within the natural sediments of the receptor. With a study of environmental aspects and a good selection of the discharge point, it can be ensured that the disposal system has an acceptable impact and is completely assimilated by the environment.

(b) Solid deposition/liquid dispersion involves the separation of the liquid and solid phases in basins (settling ponds) or separators. This technique may be applied where there is sufficient land area and suitable environmental conditions. The outgoing clear liquid is directed to the receptor (river). The separated solids deposited in the settling ponds may, in some cases, be used for the construction and the build up of the basins. Under some geologic conditions, solids can be retrieved and stored by wet deposition in the solution mined cavities in the salt deposit.

On many occasions throughout the history of the Solvay process, these solid materials have been the subject of research and tests to find alternative uses. Various sectors have been investigated including the use in construction (for block and cement manufacture), as fillers and potential road building materials and in agricultural applications as soil conditioners and acidity regulators. Attempts have failed to provide a long term viable alternative, the major restrictions being the chloride content of the material and its physical properties. Moreover, the variability of their composition due to the composition of the natural raw materials does not guarantee a material of constant quality; this limits any potential use to low value applications for which other more readily processed materials already exist in abundance.

The best environmental option is highly dependent upon local conditions and there is no particular technique that can be described as BAT.

Emission to Air

The main gaseous effluents discharged from point sources to the atmosphere have three origins: the excess gas from lime kilns, the production of sodium carbonate itself and the handling and storage of the sodium carbonate.

Lime kilns gas

The CO_2 necessary for the formation of the sodium carbonate molecule originates from the $CaCO_3$ contained in the limestone.

The decomposition of limestone for sodium carbonate manufacturing places a number of constraints on the type and design of lime burning kiln that can be used. These constraints include:

- CO_2 concentration in the resulting gas as high as possible (>40%)
- sufficient supply of CO2 providing an excess over the basic stoechiometric quantity for the bicarbonate production reaction, this excess being derived from the energy source
- maximum thermal efficiency of the calcination process
- an ability to accept a wide particle size distribution of limestone to minimise the take at the quarrying step
- high unit capacity considering tonnages to be treated

Analysing the standard available types of kiln such as vertical shaft, rotary, annular and Maerz kilns, fuelled with coke, fuel oil or natural gas, one can conclude that the vertical shaft kiln, fed with coke, represents the best compromise satisfying the constraints mentioned above. Indeed:

- concentration of gas: between 36 and 42% CO_2. The other kilns can only deliver a gas ranging between 25% and 32% CO_2
- CO_2 contribution by combustion sufficient to feed a soda ash unit and, possibly, an associated refined sodium bicarbonate plant
- achieves the maximum thermal efficiency compatible with the requirements above. The other solutions have an energy demand up to 52% greater
- the other types of kilns require limestone with a narrower particle size distribution. Other types of kiln therefore need a more highly graded product producing larger quantities of rejected fines and less efficient use of natural resources
- the design and operation of the vertical shaft kiln also gives the additional advantage of providing a reserve gas capacity of several hours without loss of kiln control

In the operation of the kilns, two factors are to be considered in relation to the gas produced: the quantity of gas produced and its composition.

Quantity of lime kiln gas produced

Theoretically, in the Solvay process, the CO_2 balance is stoechiometrically neutral. A certain excess is however necessary and is provided by CO_2 in the combustion gases of the fuel delivering the energy necessary to decompose the $CaCO_3$. Under normal circumstances the quantitative operation of the kiln is driven by the amount of lime needed to recover ammonia in the distillation stage. The CO_2 generated is in excess of that required for production.

Any excess of lime kilns gas, before its discharge to the air, may be de-dusted but its composition remains unchanged and will be identical to that used in the soda ash unit.

Composition of lime kiln gas

Various fuels can be used but, in the case of a soda ash plant using the gas as a reactive in the process, the CO_2 concentration must be as high as possible. This condition is maximised by the use of solid rather than gaseous fuels.

The above quoted operating parameters not only require a reduction in the amount of excess air that would normally be associated with combustion processes, in order to increase the CO_2 content, but also adjustment of the fuel flow rate so as to minimise the production of CO. This helps to maximise thermal efficiency and avoid excessive operating costs. The CO content of the kiln gas is not directly manageable but depends of the load, the quality (variable) of fuel, the composition of limestone.

The retention time for lime in this type of kiln is of 24 to 48 hours.

NO_x and SO_x are not directly controllable by the process but are components of kiln gas. NO_x is limited by the normal kiln operating temperatures and SO_x is regualted by the auto purification reaction with lime. These components are essentially inert through the process and will leave with the Nitrogen content of the gas.

Gas effluent of the manufacturing sector

The gas effluents of this sector are mainly composed, in addition to the nitrogen (inerts), of CO_2, CO and of NH_3 traces resulting from the bicarbonation columns.

The major quantities of CO_2 and CO are derived from the lime kiln gas not absorbed in the carbonation columns. The ammonia is derived mainly from the stripping effect of the inerts and un-reacted CO_2 passing up through the carbonation columns.

The final washing of gases before discharge to the atmosphere has the principal objective of ammonia recovery but also acts as a critical abatement step. CO_2 and CO are virtually inert not being absorbable in the brine.

The kind of apparatus used consists of a tower sprayed with the fresh brine (entering the process) which is fed counter-current to the gas leaving the carbonation columns. The efficiency of this absorption depends on the type of internals uses, in general packing rings or plates. High efficiency modern units achieve concentration in the vent equal to or lower than 50 mg NH3/Nm3 (annual average). This represents an efficiency of almost 100%.

However it is necessary to minimize the pressure drop across these units in order not to increase the pressure at the outlet of the CO_2 blowers (gas compressors) and at the inlet to the carbonation columns, thus minimising the total energy consumption.

Within the plant itself, reductions of energy losses are obtained by favouring energy transfer between flows at different thermal levels by the installation of heat exchangers and flash vessels for hot fluids.

CO emissions are effectively uncontrollable as this is virtually inert through the process. Regarding the potential of CO_2 emission reduction, one has to consider the balance of the process because the kilns are run to provide sufficient amount of lime for decomposition of ammonium chloride in the distillation phase with an associated excess of CO_2. Therefore, any reduction of CO_2 from the carbonation towers would have to be off-set by increased wasting of CO_2 at the kilns.

Dust

The emissions of dust are generated mainly during the handling (conveying) and the storage of the soda ash, when fine material is entrained in forced air flow through the various pieces of equipment. The high volumes of gas flows that require treatment often require very large pieces of equipment. A number of abatement techniques are used which may be expected to achieve figures below 50mg/Nm^3 although this figure is seen as an overall achievable standard.

ENERGY

Several possibilities to reduce the energy consumptions are possible as far as the technology and the economics allow. Due to the diversity of the existing plants and forms of energy supply, it is difficult to give too precise indications where and how the energy savings are possible but some guidelines may be considered.

At the level of the use of primary energy, the initial design stages have to verify the interest of combined heat and power generation to improve the generation efficiency of electricity since the soda ash plant acts as the final stage condenser. Primary energy efficiency is outside the scope of this document.

Heat recovery

Low grade heat may be used to preheat different streams such as:

- raw brine entering the brine purification step to improve purification efficiency
- raw water used for milk of lime production
- boiler feed water
- mother liquor from the filtration to the recovery of ammonia by the distillation off gas

Vacuum flashing of distillation liquor may be used for producing low pressure steam available for distillation and any evaporation units like salt production.

Energy minimization

The following techniques may be considered:

- careful control of the burning of limestone and a good choice of the raw materials allow a reduction of the primary energy necessary for the operation. However availability of suitable materials and economic considerations may remove this element of choice.
- improvement of process control by the installation of distributed control systems (DCS)
- reduction of water content of the crude bicarbonate before calcination to minimize energy need for drying and decomposition
- back-pressure evaporation (e.g. calcium chloride liquors)
- energy management of stand-by machinery
- equipment lagging, steam trap control and elimination of energy losses

In addition to the techniques listed above, operator training and awareness are key factors in energy minimization. The applicability of each technique will depend on the economics of its application.

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IL&FS Ecosmart Limited
Flat # 408, Saptagiri Towers
Begumpet
Hyderabad – 500 016
Ph: + 91 40 40163016
Fax: + 91 40 40032220
For any queries or technical inputs kindly mail:
sateesh.babu@ilfsecosmart.com
suman.thomas@ilfsecosmart.com