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4. EVALUATION OF AN ENVIRONMENTAL IMPACT ASSESSMENT DOCUMENT

Environmental impact assessment documents should present the necessary background information and results of all assessments conducted to assess the relative environmental impacts associated with all reasonable and feasible alternatives to the proposed project. An environmental impact assessment typically proceeds from the purpose and need of the proposed project, project alternatives, and description of the environmental setting to the assessment of potential impacts. The document commonly concludes with a discussion of mitigation measures.

- Typical structure of an environmental impact assessment document:

– Purpose and need
– Project alternatives
– Description of environmental setting
– Assessment of potential impacts
– Mitigation measures

This chapter discusses the contents of a comprehensive environmental impact assessment document and provides the reviewer with guidelines for its assessment. The chapter follows the typical organization of an environmental impact assessment, and the reader should use these descriptions as a guide of what to look for in an environmental impact assessment. As in key sections of Chapter 3, at the end of each section in this chapter, the reader is presented with a road map to help guide review, indicated by the road map icon.

4.1 APPROACHES TO REVIEW: READING AN ENVIRONMENTAL IMPACT ASSESSMENT: WHAT TO LOOK FOR

Many of the specific steps that must be taken during the review of the elements of an environmental impact assessment are described throughout this document. Included in this chapter is guidance on how best to approach the analysis of an environmental impact assessment, and how to maximize the effectiveness of this analysis.

- Reviewer's Focus

In any review of any part of an environmental impact assessment document, the reviewer should keep in mind the six elements of the Reviewer's Focus presented in Chapter 3. Namely, the reviewer should focus on:

1) Completeness/Coverage
2) Significance
3) Adequacy
4) Integrity
5) Accuracy
6) Influence

Throughout this chapter, the road maps for review of each element of an environmental impact assessment document follow these six elements of the Reviewer's Focus where relevant.

There are several different ways to approach the evaluation of an environmental impact assessment, and all are appropriate to some degree or another depending upon the most effective approach within a given country or institution, agency, and/or individual reviewer situation. For example, the approach is different depending on the reviewer's familiarity

with the proposed project, and on his or her level of experience. Each reviewer needs to find the approaches he or she is most comfortable with for different types of projects. This approach will likely change over time as the reviewer gains more experience evaluating environmental impact assessments and develops more expertise in the various disciplines that contribute to environmental impact assessment.

- Each reviewer needs to find the approach to environmental impact assessment review he or she is most comfortable with for different types of projects

The following are some useful approaches to reading an environmental impact assessment:

1) Scan the document, then read it quickly to get a sense of what it is about. Think about:
   - Flagging major issues: Identify them and determine if they were addressed.
   - Spotting where help is needed: Look at the Executive Summary and table of contents, spot key or significant issues and who might be called upon to assist in the review.

2) Read the document several times (depending on time availability) to identify major issues and to determine whether they were addressed. It would be less necessary to read an environmental impact assessment several times if the reviewer had been involved in the scoping process and other stages of the process. When conducting this more in-depth review, keep the following items in mind. Some of these methods are used in the review of the environmental impact assessment document, while others are useful components of managing the environmental impact assessment process. These methods are not mutually exclusive, and individual reviewers should use the methods they are most comfortable with:

   - *Adequate inclusion of stakeholder views and concerns:* Evaluate whether an adequate range of stakeholders was involved in the scoping and other processes. A reviewer should examine the list of people involved to determine if there was a scoping activity. If a key group was absent from scoping, the reviewer should look particularly for the kinds of issues it would have raised.

   - *The train of logic:* Does the environmental impact assessment "make sense" in its internal logic from statement of purpose and need through impacts and consideration of alternatives and mitigation? An environmental impact assessment that attempts to mask or downplay significant concerns often must make leaps in logic that such a review can help to identify. A reviewer should determine if environmental issues are clearly identified and whether there is a clear flow of information. Is there a basis for the conclusions drawn?

   - *Logical application of technical knowledge/methods*: Is the rationale for the choice of models explicit, and consistent with the facts in the situation? What was considered and rejected and why? Were analytical methods and measures used? How were the application of disciplines utilized?

- *Comparative Environmental Impact Assessments or Guidelines*: The reviewer can usefully compare the environmental impact assessment to environmental impact assessments on similar types of projects done elsewhere or EIA guidance for similar projects. Among other things, this can help identify issues that may have been overlooked.

- *Systematic approach: Walk through the environmental impact assessment preparation steps/structure being systematic and using checklists*: Use the structures for preparation of an environmental impact assessment and systematic checklists. Identify different kinds of checklists and their use. Were the impacts addressed completely (e.g., pollution prevention, etc.)? A detailed checklist to guide the review process is included in Appendix A of this document. In addition, there are several useful checklists and other sources of information in the Resource Manual that accompanies the *Principles of Environmental Impact Assessment Review* course. Using these tools will enable a reviewer to determine if the key steps and elements were executed properly by the project proponent.

- *Support of decision-making*: Is information understandably displayed on alternatives and mitigation measures so that decisions can be made?

Road Map for Overall Environmental Impact Assessment Document Review

- Review Table of Contents and Executive Summary
- Scan and read the document several times
- Take notes, write down questions
- Go through key environmental impact assessment elements
  – Purpose and Need, Alternatives, Environmental Setting, Impact, Mitigation
- Use checklists where appropriate
- Review the logic and consistency of the document
- Use a systematic approach to identify areas where the assessment is:
  – Incomplete, inadequate
  – Significance unsupported/unclear/ignored
  – Lacks integration
- Identify and adopt perspectives of all interested and affected parties
- Compare document to other environmental impact assessments
- Determine whether the document supports decision-making

4.2 PURPOSE AND NEED

The environmental impact assessment document should begin with an introduction describing the purpose of, and need for, the proposed project. An accurate description of the purpose and need is critical to a full examination of possible alternatives and the selection of a preferred alternative. The purpose and need must be a clear, objective statement of the rationale for the proposed project. The need for the proposed project can simply be a specific problem that must be addressed, or an available opportunity. For example, a problem may be flooding along a river that affects the local community, and an opportunity may be to attract tourists to an undeveloped coastal area. The purpose of the proposed project describes the goals or objectives for meeting the need.

- The purpose and need must be a clear, objective statement of the rationale for the proposed project

The statement of purpose and need is important because it provides the framework for identifying project alternatives. For example, a project to build a new power plant may be proposed because the existing plant is producing at full capacity and cannot meet projected growth in demand

- The statement of purpose and need provides the framework for identifying project alternatives

for electricity. The need for the proposed project is to provide 500 megawatts of electricity to meet the projected increase in demand. The purpose, or goals to be met in addressing the need, is to minimize the cost to consumers, improve air quality in an area that does not meet current standards, and attract new industries. The project alternatives could include various locations for the proposed new power plant, implementation of conservation measures to avoid building the facility (demand side management), different kinds of power (e.g., wind, solar), different types of fuel (e.g., natural gas, oil, biomass), or a combination of these alternatives and perhaps cogeneration. All of these alternatives address the need for the proposed project. Some of them address the purpose better than others. All reasonable alternatives that fulfill the purpose and need should be evaluated in detail. The more alternatives, the greater the possibility of avoiding significant impacts.

A clear statement of purpose and need can further the goals of the environmental impact assessment process in the following ways:

- Provides basis for determining impacts
- Provides basis for defining alternatives
- Helps all parties to understand the context of the action.

It is helpful to obtain input on the purpose and need of a proposed project from stakeholders, including businesses, citizens, local government, and nongovernmental organizations. This enables the project proponent to understand and consider the priorities and concerns of the local community and government agencies early in the planning process, which could help to avoid future delays.

4.2.1 Review of Purpose and Need

The purpose and need for a proposed project are sometimes accepted as "given," ignored, or under-emphasized in an environmental impact assessment review. However, the reviewer should always review the stated purpose and need of a proposed project. Such a review can find either that the proposed purpose and need statement is a) adequately described, b) adequately described but does not justify the proposed project, c) adequately described but can be met by alternatives not considered in the environmental impact assessment which may be environmentally preferable, or d) is not supported in the document. Proposed projects often take on a "life of their own" simply because money has been made available. It is important to be aware of this. The mere existence of funding for a project does not automatically mean the proposed project is needed or is justifiable.

- The reviewer should always review the stated purpose and need of a proposed project. It is important not to under-emphasize this aspect of environmental impact assessment review

The realities of a reviewer commenting on purpose and need involve, first, the fact that it is often viewed to lie outside the actual or perceived expertise or role of a reviewer, and second, the fact that there are frequently powerful economic and/or political interests in a proposed project. Therefore, comments on purpose and need should be well founded to be taken seriously. The need to review and the time and effort required to review a proposed project's "purpose and need" are usually

- It is most important to evaluate the purpose and need if potential environmental impacts are significant

balanced against the potential for adverse environmental impacts of proposed project. For example, it is most important to be confident in the purpose and need if potential environmental or other impacts are significant. On the other hand, if the purpose and need are weak, but the potential environmental or other impacts are insignificant, it may not make sense to spend large amounts of time and resources scrutinizing this aspect of the environmental impact assessment.

A reviewer should ask for clarification from the project proponent if the purpose and need are vague or confusing. Other reviewers may also be consulted. When a reviewer is confident that the purpose and need merit a challenge, however, the reviewer should certainly offer one. If a reviewer does not challenge the purpose and need of a poorly conceived project, the results of the environmental impact assessment process will be limited to mitigation measures, at best, when the issues may require more profound considerations. When offering a challenge to the purpose and need, it is important to also offer or take steps to help ensure there are viable alternatives to the proposed project. Criticisms without alternatives are not well received, and often do not result in a constructive decision-making process.

4.2.2 Purpose and Need Review Road Map

All of the preceding discussion on purpose and need can be summarized in the following road map for review of purpose and need. As a reviewer, you should focus on answering the following questions:

- Road Map for Overall EIA Document Review

Road Map for Purpose and Need Review

- Describes the purpose and need of the proposed project
- Demonstrates how purpose and need would be met by the proposed project
- Adequately describes the proposed project
  - Maps project site, surrounding land use, and natural features
  - Who and what would benefit; who and what would be affected
  - Phases; site preparation, construction, operation, and closure
  - Time frames, including when proposed project begins and ends

4.3 PROJECT ALTERNATIVES

In most countries, a range of alternatives are evaluated to facilitate identification of the most appropriate means of meeting the purpose and need for a project. Not all countries require the consideration of alternatives. When required, or voluntarily included in an environmental impact assessment, alternatives should include different ways of achieving the purpose and need and alternate designs for the proposed action. The environmental impact assessment should also include the no-action alternative. This alternative provides a baseline of existing and future environmental conditions without the proposed project that can be used for comparison with the potential impacts of the other alternatives. It also provides an opportunity to document the beneficial and adverse effects of not addressing the need. Finally, it supports the decision-maker's choices of project approval or denial.

- The environmental impact assessment should include a no-action alternative

The "alternatives" section of the environmental impact assessment describes all alternatives that were, or are, being considered. All reasonable alternatives, those that meet the purpose and need, are explained in detail. Alternatives that were considered and rejected early in the planning process are described briefly with the rationale for their elimination. The rationale should have sufficient information to support the decision not to proceed with the dismissed alternatives and sufficient backup data to respond to any challenging questions or comments on the draft environmental impact assessment.

The preliminary evaluation of alternatives should narrow the scope of the environmental impact assessment to a reasonable set of alternatives. The environmental impact assessment should focus on the most feasible, cost effective and environmentally sensitive alternatives. For each alternative, the environmental impact assessment should include (1) a balanced description, and (2) a discussion including the size and location of facilities (or the project, if no facility is planned), land requirements, operations and management requirements, auxiliary structures, and construction schedules.

- For each alternative, the environmental impact assessment should include:

1) A balanced description
2) Discussions of:
– Facility size and location (if applicable)
– Land requirements
– Operations and management
– Auxiliary structures

The benefits of evaluating alternatives include the following:

- Selection of the best project design;
- Selection of the best project location;
- Most efficient use of resources;
- Avoidance of adverse impacts;
- Achievement of sustainable development goals only achievable through consideration of new ways of doing business.

When developing alternatives, it is beneficial for the project proponent to solicit input from the public and government agencies. Including these parties is an important technique for identifying potential issues and problems with the proposed project or alternatives. The earlier any problems are identified, the easier and less costly it is for the project proponent and reviewer to address them.

- The earlier any problems are identified, the easier and less costly it is to address them

As part of the description of alternatives, the proponent's own initial evaluation to proceed with the proposed action should be explained to provide insight into the breadth and depth of alternatives considered and rejected or pursued for further study. A well-documented description of the preliminary evaluation processes explaining the process for shortening the list of alternatives can help determine whether a full range of alternatives was evaluated. Exploring and documenting a broad scope of alternatives is to the advantage of the project proponent.

4.3.1 Review of Project Alternatives

It is important that the environmental impact assessment include a sufficient number of alternatives to ensure an effective decision-making process. The reviewer can question whether other alternatives should be included even after the scoping process has ended whether or not the reviewer was actually involved in scoping.

The requirement to develop and analyze alternatives is not a boundless process of generating all possible alternatives. There is an objective process for this aspect of the environmental impact assessment. Alternatives should be developed under the following considerations:

- Alternatives must meet the purpose and need for the proposed project.
- Alternatives should be reasonable, that is they should be practicable; it must be possible to carry them out. They must be feasible from logistical, technical and financial perspectives.

For purposes of decision making, they can be presented as points along a continuous range of alternatives which, when systematically analyzed, provide a solid basis for decision-making.

How Many Types and What Number of Alternatives are Adequate?

How does a reviewer know how many alternatives there should be, and how well they were analyzed? It is important to keep in mind that environmental impact assessment is a tool for a decision-making process. Thus, a reasonable *range* of alternatives should have been identified and evaluated. A single choice does not constitute a range of alternatives, because in such a case there is no decision, no decision-making, and no environmental impact assessment process.

In reality a few or up to hundreds of alternatives may be necessary in a particular environmental impact assessment. To determine whether a reasonable number of alternatives have been identified, the reviewer must take into account time, geography, economics, environment and social impacts. The alternatives should represent a range or points along a spectrum of options that offer real choices for the decision-maker.

- Alternatives:
  - Must meet the purpose and need
  - Should be reasonable and practicable

- Determining the correct number and type of alternatives

- As little as one or two or as many and hundreds of alternatives may be appropriate, depending on the characteristics of the proposed project

The No-Action Alternative

In countries where alternatives are required or commonly evaluated, environmental impact assessments should always include a no-action alternative. Inclusion of the no-action alternative is important for effective decision-making. It provides an assessment of environmental and other conditions absent the proposed project which can be used to compare against the potential environmental impacts of the proposed project, both beneficial and adverse. The no-action alternative presents expected *future* environmental conditions. This can help reviewers determine whether the anticipated deviation from the no-project state will be acceptable.

- Environmental impact assessments should always include a no-action alternative

Baseline environmental conditions are not the same as the no-action alternative. A baseline typically presents *current* environmental conditions, but current conditions may change even in the absence of a proposed project (for example, if a forest were projected to decline over time due to an insect infestation). It is important to identify both the positive and negative potential environmental impacts of a proposed project throughout the life of the project, which requires anticipation of changes in conditions that are not related to the proposed project. Indeed, a proposed project may prove to be beneficial as compared to letting an existing situation deteriorate.

- Baseline environmental conditions are not the same thing as the no-action alternative

Balanced Assessment of Alternatives

Reviewers should determine whether each alternative was evaluated adequately. This implies that some alternatives may receive more attention than others. Often there are some alternatives that are considered but not analyzed because they are clearly not viable. Of the alternatives that are analyzed, each alternative should receive equal analysis so that comparisons are meaningful. Although equivalent analyses are advisable, variation in analysis of alternatives is common. Reviewers should trust their own professional opinions and those of associate reviewers; if an alternative seems to have been neglected without just cause, it is reasonable and advisable to ask the project proponent to revisit it in sufficient depth.

4.3.2 Alternatives Review Road Map

To summarize, when evaluating alternatives, the reviewer needs to ask, at a minimum:

Road Map for Alternatives Review

- Considers the full range of alternatives to meet purpose and need
  - No action
  - Alternative sites, designs, controls
  - Structural vs non-structural
  - Reallocation of social costs and benefits
  - Reasonable, feasible
  - Reflective of the range of choices
  - Meet the purpose and need of the proposed project

- Preferred alternative satisfies purpose and need better than alternatives with less environmental impact

4.4 DESCRIPTION OF THE ENVIRONMENTAL SETTING

The section of the environmental impact assessment document that describes the environmental setting should identify and describe the environmental setting, including the physical-chemical, biological, and socioeconomic environments; aesthetics; and cultural resources. The description of the environmental setting must be complete and accurate because it will serve as the baseline from which the impacts of the proposed action are predicted. The reviewer should refer back to the scoping process of the environmental impact assessment to help ensure that all substantial issues are addressed. The reviewer must identify all substantial issues not covered in the environmental impact assessment.

The description of the environmental setting section should include only the appropriate background information necessary to understand the potential impacts of the project alternatives. The information should be presented objectively. The reviewer should take steps to help ensure that each aspect of the environment that is likely to be affected by the proposed project is adequately addressed. The environmental impact assessment should consider:

- Local ambient air quality conditions

- Location of seismic activity, flood plain, and other special geologic or hydrologic features within the vicinity of the proposed project

- Surface water and ground water quality and quantity

- Description may include:

  – Air resources
  – Water resources
  – Soils and geology
  – Biological resources
  – Waste management and pollution prevention
  – Socioeconomic setting
  – Cultural resources

- Local biological communities and fish and wildlife habitats, including critical habitats of any rare, threatened, or endangered species
- Location of specially protected areas, including wildlife management areas, parks, wetlands, pristine lands or water bodies, or prime agricultural lands
- Renewable and nonrenewable resources
- Current and projected population, population density, and location of population in relation to the proposed project site
- Current and projected land use (within the proposed project area and region) and relevant land use regulations
- Local and regional patterns of energy demand and supply
- Local ambient noise levels
- Location of any properties with cultural heritage values within the vicinity of the proposed project
- Existing regulatory setting for each resource.

The description section should focus on the important issues. Only the components likely to be affected need to be addressed in detail; others should be summarized, consolidated, or referenced. Experience from similar projects can be helpful in identifying the environmental components that should be described.

When feasible, the environmental impact assessment should rely on existing data to describe the environmental setting. If sufficient data are not available to fill a particular need, various techniques can be used to obtain the appropriate data. These techniques include field surveys, checklists, topographic maps, and overlay mapping, including those produced using geographic information systems (GIS). The Resource Manual that accompanies the Principles of Environmental Impact Assessment Review course contains information on these types of information sources.

- Information sources:
  - Existing literature
  - Government agencies
  - Research organizations
  - Field surveys
  - Topographic maps
  - Land use maps
  - Geographic information systems
  - Local specialists

To effectively assess the potential impacts of a proposed project, the reviewer must consider whether the project proponent has established appropriate boundaries for the region of concern and time periods for describing the baseline against which the potential impacts of the proposed project will be compared. The region of concern is the geographic area potentially affected by the proposed project. The most appropriate time period for assessing an impact is the point during construction or operation that creates the greatest change in the present environment. Different time periods and geographic boundaries are chosen for different impacts or parameters. For

- It is critical that the Region of Concern be clearly defined for each media, as well as time periods over which impacts are expected to occur

example, the boundaries of the region of concern are likely to be different for air and water. Projections of local employment may be compared for two different time periods—once during maximum temporary construction work force and later during full operation of the proposed project. The reviewer should make sure that the year(s) and area used for comparing the impacts are clearly indicated for each impact or parameter.

The following sections describe factors that the reviewer should consider when evaluating the adequacy of the description of the environmental setting given in the environmental impact assessment.

4.4.1 Existing Physical-Chemical Environment

The physical-chemical environment comprises the air, water, and geological characteristics of the region of concern. A complete understanding of the physical-chemical environment, and the type of project proposed, helps the reviewer identify specific issues to be investigated in the environmental impact assessment section that describes potential impacts. For example, the identification of frequent temperature inversions may require emphasis on the biological effects of gaseous emissions or a shortage of surface water in the project region may require that the few existing surface water bodies be considered critical habitats.

- Physical-Chemical Environment:
  - Air resources
  - Water resources
  - Soils and geology

4.4.1.1 Air Resources

A wide variety of industrial operations have the potential to affect air resources. These operations include activities at primary metal, pulp and paper, textile, and chemical manufacturing plants; power plants; and mining sites. In addition, increases in air and automobile traffic frequently affect air quality.

- Air Resources:
  - Meteorological data
  - Ambient air quality
  - Sources of air pollution

Air resources are described by the physical dynamic behavior of the lower atmosphere (parameters such as the seasonal distribution of wind velocity and the frequency and height of inversions) and by variations in the concentrations of various gases and suspended matter. Wind velocity and the frequency of occurrence of inversions are influenced by specific local topographic features, particularly surrounding hills or mountains. Air quality is described by the variations in the concentrations of pollutant gases and particulate matter in the lower atmosphere. Both the physical dynamic behavior and air quality of the lower atmosphere are needed to determine the impacts of proposed project construction and operation on air quality.

The physical dynamic behavior of the lower atmosphere is largely determined by the interaction of meteorological conditions and topography. Therefore, the environmental impact assessment should include a general discussion of climate within the region of concern that includes the following factors:

- Meteorological data:
  - Temperature
  - Wind
  - Precipitation
  - Humidity
  - Atmospheric pressure

- Daily and seasonal ground-level temperature
- Wind characteristics at different heights and times (wind roses are particularly helpful and provide wind speed, direction, frequency, and stability characteristics of the atmosphere)
- Total monthly, seasonal, and annual precipitation and frequency of storms and their intensity, including both average and extreme events
- Evaporation
- Height, frequency, and persistence of inversions and atmospheric mixing characteristics
- Description of pattern(s) evident for days of significant pollution episodes.

In addition, information should be included on the frequency of local climatic hazards, including tornadoes, high wind speeds, hurricanes, and floods (see Section 4.4.1.2). Construction techniques and site utilization may be affected by such climatic extremes. Meteorological data are typically available from local weather service stations. Site and area topography are generally determined from topographic maps or field surveys.

Data on ambient air quality (e.g., concentrations of particulates, carbon monoxide [CO], hydrocarbons, ozone [O_3], and sulfur dioxide [SO_2]) are required to predict the potential impacts during the construction and operation of a proposed project. This information is usually available from a local air pollution control agency. Using existing air quality as the background, incremental increases in air pollution concentrations can be predicted for comparison with various national and local standards. Also, the proposed site's location relative to any protected or sensitive areas (e.g., national parks) and any areas that are not meeting applicable air quality standards should be provided.

The typical data sources for air quality are emission monitoring results from individual facilities and ambient air quality monitoring results reported by air pollution control districts. If these data are not available and the project proponent or the reviewer thinks that they are important, then air quality monitoring may be needed. At a minimum, major facilities or stationary sources and their emissions should be characterized, with daily variations in emissions by month, year, and peak season, for pollutants of concern. In addition to information on stationary sources, the environmental impact assessment should also consider the effects of mobile sources on local air quality.

Projections of increases in emissions from both stationary and mobile sources and estimates of long-term pollutant concentrations are

- Ambient air quality:
  - Particulates
  - Carbon Monoxide
  - Hydrocarbons
  - Ozone
  - Sulfur dioxide
  - Other pollutants of concern
- Stationary sources of emissions:
  - Power plants
  - Industrial plants
- Mobile sources of emissions
  - Cars and trucks
  - Airplanes
  - Boats
  - Trains

important for describing future air quality. The comparison of existing air quality and expected trends with national and local air quality standards will assist in assessing potential impacts of emissions expected from the proposed project and in determining the need for air pollution controls.

4.4.1.2 Water Resources

Water resources can be affected by almost any project and should be considered when assessing potential environmental impacts of the construction and operation of manufacturing, industrial, or processing facilities, hazardous waste sites and landfills, tourism development, electricity generation, port and harbor development, and many other projects. Water resources can also be affected by infrastructure projects, including transportation and sewage treatment, and natural resource extraction projects, such as mining and forestry. Potential sources of impacts to water resources from these types of projects include:

- Withdrawal of freshwater from lakes, rivers, streams, or aquifers;
- Discharges of untreated or treated wastewaters;
- Deposition of pollutants from smoke stack and/or vehicle emissions;
- Storm water and agricultural runoff;
- Spills.

- Water resources:
  - Source and location
  - Quality
  - Quantity
  - Uses

The reviewer should check to see whether information in the description section of the environmental impact assessment describes surface water bodies (i.e., streams, lakes, rivers, estuaries, and oceans), ground water aquifers, and special aquatic areas located within the region of concern. The descriptions should include maps of surface water bodies and surface drainage patterns. In addition, they should describe current and future uses of both surface water and ground water. Typical water body uses include wildlife habitat, drinking water supply, industrial/commercial process water, agricultural irrigation water, subsistence uses (e.g., hunting, fishing), recreational uses (e.g., fishing, swimming), and commercial fishing and biota harvesting (e.g., shellfish harvesting, aquaculture). The use of surface waters (diversions, returns, and reclamation) is critically important in locations where water resources are scarce.

- Water quality information:
  - Dissolved oxygen
  - Temperature
  - Salinity
  - Suspended and dissolved solids
  - Nutrients
  - Chemicals of concern
  - Biological contaminants

The environmental impact assessment also should describe current water quality. The description of water quality should include the physical and chemical characteristics of surface water bodies that may be affected by the proposed project. Ambient conditions of conventional parameters (e.g., dissolved oxygen, temperature, salinity, suspended and dissolved solids, and nutrients), as well as concentrations

of any chemicals of concern, should be described for both freshwater and marine water bodies.

In addition, descriptions of surface water bodies should include:

- Seasonal and historical maximum, minimum, and mean flows for rivers and streams;
- Water levels or stages and seasonal patterns of thermal stratification for lakes, ponds, and reservoirs;
- Circulation characteristics (e.g., tides, currents, thermocline, and thermohaline) for tidal rivers, lagoons, estuaries, and ocean waters;
- Biological resources (see Section 4.4.2);
- Fishing grounds;
- Aquaculture sites;
- Habitats.

In addition to the description of the physical and chemical characteristics of surface water bodies, the environmental impact assessment should describe existing pollutant sources, including:

- Industrial plants;
- Wastewater treatment plants;
- Untreated sewage from residential or industrial areas;
- Storm water and agricultural runoff.

Information should include the locations of existing discharges and actual data on pollutant loadings. If actual loading data are not available, they may be estimated based on information about the sources of discharge. An understanding of existing pollutant loads to water bodies and the resultant ambient concentrations is required in order to accurately predict future water quality and the impacts of the proposed project.

A discussion of surface water resources should also include flooding events. The dates, levels, and peak discharges of previous floods should be reported, with the meteorological conditions that created them. Historical data on flood levels support decisions on project siting and design to avoid flood damage.

In addition, the environmental impact assessment should describe ground water resources. Descriptions of alluvial and bedrock aquifers are necessary to determine the potential of project activities to contaminate or

deplete ground water reserves. Projects are more likely to affect ground water when the ground water table is near the land surface, the proposed project is near a ground water recharge zone, or the proposed project will withdraw ground water. The depth to the water table and the nature of overlying soils and geologic features are important. The environmental impact assessment for projects that may affect ground water resources should contain the following information:

- Key factors:
  - Depth to water table
  - Overlying soils
  - Geologic features

- Ground water occurrence, including the locations and boundaries of aquifers;
- The aquifers' ability to transmit water (transmissivity);
- Ground water movement, including the direction and rate of flow;
- Location and rates of ground water recharge and discharge;
- Ground water quality (e.g., pH, total dissolved and suspended solids, salinity, and concentrations of specific contaminants of concern).

- Ground water quality:
  - pH
  - Solids
  - Salinity
  - Chemicals of concern

Site-specific ground water information is often obtained from regional ground water maps or through a hydrogeologic field survey. These surveys often rely on topographic maps to determine surface drainage patterns, geological maps for soils and the sequence and thickness of subsurface materials, and potentiometric surface maps and hydraulic gradients for direction of ground water flow.

4.4.1.3 Soils and Geology

Construction, mining, forestry, agriculture, landfills, and coastal development are some activities that affect soils and geologic formations. Conversely, underlying geologic structures can affect the stability of various structures, including buildings, roads, bridges, dams, and landfills. The environmental impact assessment should include a detailed description of the surface topography and soil composition over the region of concern. Soil maps and geological maps indicating sequencing and thickness of subsurface materials are commonly used. This section of the environmental impact assessment should include information on the following parameters:

- For the region of concern, the environmental impact assessment should include a detailed description of:
  - Surface topography
  - Soils

- Topography;
- Location and condition of joints, faults, fractures, and other potential weaknesses;
- Slope cuts and structural loads;
- Landslide history;
- Soil permeability;

- Soil erodibility;
- Extent of weathering;
- Depths to impervious layers;
- Water table depth;
- Ground water movement.

This information provides most of the baseline information necessary to determine the risks of property damage and safety issues associated with the proposed project.

- Erosion potential

The potential for erosion is an important consideration for certain sites, includin to water resources. The potential for erosion depends on the following factors:

- Local and regional topographic features, such as ridges, hills, mountains, coastlines, valleys, and stream banks;
- Local soils characteristics and proposed slope changes;
- Presence of riparian zone vegetation;
- Precipitation patterns;
- Water circulation patterns.

Meteorological data, topographical maps, and soil maps of the proposed project area are typically sufficient to assess the potential for erosion.

- Subsidence

It is also important to consider the location of any limestone formations or subsurface mining activity in the proposed project area, history of subsidence in area, and planned uses for ground water (e.g., water withdrawal). These factors will help assess the potential for land subsidence. subsoils, and bedrock, as well as knowledge of the proposed grading and con project, will facilitate assessment of the potential for excessive settlement of l related impacts.

Geological features are important when paleontological sites and other areas of scientific or educational value may be disturbed or overlain by facility structures.

In regions that are seismically active, the description of the environmental setting should include information necessary to assess potential risks of damage and loss due to earthquakes and volcanoes. Relevant information includes proximity to faults, the history of earthquakes and volcanoes in the area, locations of epicenters, magnitudes, and frequency of occurrence.

- Seismic activity:
  - Proximity to faults
  - History of earthquakes and volcanic eruptions:
    - Magnitude
    - Frequency

The environmental impact assessment should identify any mineral resources, particularly those with economic value, located in the region of concern. If such resources are present, the document should denote the location of the deposits on a map of the proposed site and describe the type(s) and quantities of the minerals. In addition, the document should identify any mining claims or other present or potential resource development activities at or near the proposed site. This information will be useful in determining whether the presence of mineral resources may affect projected future land use or conflicts over the region of concern.

- Mineral resources:
  - Locations of deposits
  - Type(s) and quantities of
  - minerals
  - Ownership of mining rights

4.4.2 Existing Biological Conditions

The description section of an environmental impact assessment should contain a complete description of key biological elements, including the identification and distribution of dominant, rare, and unique plant and animal species within the region of concern. The description should identify all officially recognized threatened or endangered species in the region of concern. Data are typically reported using maps of the area with overlays of vegetation types, floral and faunal species types, and, when available, abundance lists. This information, in conjunction with a consideration of ecological interrelationships, such as habitat and food sources, provides the basis to determine whether the assessment adequately considers potential impacts on the biological community.

- Biological resources:
  - Aquatic communities
  - Wetland communities
  - Terrestrial communities
  - Ecological interrelationships

Knowledge of both the types of plant communities in the general proposed project area and the specific distribution of vegetation within the proposed site is necessary to assess the potential impact. The presence of wildlife at a proposed site largely depends on the nature and distribution of vegetation. The environmental impact assessment should emphasize species that are likely to be displaced by project construction and operation, as well as any unique or rare species likely to be in the region of concern.

- Information sources:
  - Literature
  - Government agencies
  - Research organizations
  - Field surveys
  - Monitoring

There are a variety of ways that professionals approach review of the description of biological resources in an environmental impact assessment. While there is no single correct way to approach review of a description of biological resources, a three-part categorization is presented in this text: 1) Wildlife and Vegetation; 2) Community and Habitat Characterization; and 3) Ecologically Significant Features.

4.4.2.1 Wildlife and Vegetation

Often the most important information pertaining to existing biological conditions in the description of the environmental setting refers to the existing wildlife and vegetation. Projects with the potential for significant adverse impacts to wildlife and vegetation, particularly threatened or endangered species, can often be highly controversial, invoking public outcry and questions of law. Reviewers of this section of an environmental impact assessment should take extra care when reviewing the description of existing wildlife and vegetation. This will also assist the reviewer in correctly assessing the importance of potential impacts to existing wildlife and vegetation.

Species Composition

Species composition refers to the mix of biological species found in the region of concern (the proposed project site and other potentially affected areas). It is common for environmental impact assessments to include a list of the species found at the proposed project site, broken down into various categories. To assist the reviewer in developing a framework of information to guide review of information on species composition, common and useful categories are presented below, along with a number of examples of species that belong to each.

Aquatic Communities

The following categories should be used as a guide to assist the reviewer in the evaluation of the adequacy of the environmental impact assessment in describing the species composition of aquatic communities:

- Flora
  - Phytoplankton (e.g., diatoms, dinoflagellates, blue-green algae)
  - Submerged vegetation (e.g., sea grasses, rooted aquatic plants, attached algae)
  - Floating vegetation (e.g., water hyacinth, duckweed)
- Fauna
  - Plankton (e.g., copepods, euphausiids)
  - Benthic fauna (e.g., sea star, crab, caddisfly larvae, dobsonflies, polychaete worms, clams)
  - Pelagic invertebrates (e.g., jellyfish, squid)
  - Fishes (e.g., bass, salmon)
  - Reptiles (e.g., turtles, snakes)
  - Birds (e.g., ducks, geese, terns, gulls, cormorants)
  - Mammals (e.g., beavers, sea lions, whales, otters).

Wetland Communities

The following categories can be used to assist the reviewer in evaluating the adequacy of the environmental impact assessment in describing existing flora and fauna in wetland communities:

- Flora
  - Emergent vegetation (e.g., horsetails, sedges, rushes, mangroves)
  - Submerged vegetation (e.g., freshwater grasses)
  - Floating vegetation (e.g., water hyacinth, duckweed)
- Fauna
  - Benthic fauna (e.g., brittle stars, crabs, caddisfly larvae, dobsonfly larvae, polychaete worms, clams, oysters)
  - Insects and other invertebrates (e.g., mosquitos, butterflies, beetles, water striders)
  - Fishes (e.g., bass, darters)
  - Amphibians (e.g., frogs, toads, salamanders)
  - Reptiles (e.g., turtles, water snakes)
  - Birds (e.g., ducks, geese, songbirds, woodpeckers)
  - Mammals (e.g., muskrats).

Terrestrial Communities

The following classifications can be used as a guide in assessing the completeness of the description of the species composition of flora and fauna in terrestrial communities:

- Flora
  - Thalloid plants (e.g., lichens, mosses, algae)
  - Herbaceous plants (e.g., wildflowers, ferns, grasses)
  - Shrubs (e.g., rhododendron, creosote bush)
  - Trees (e.g., palms, figs, pines).
- Fauna
  - Insects and other invertebrates (e.g., beetles, flies)
  - Amphibians (e.g., frogs, toads)
  - Reptiles (e.g., turtles, snakes, lizards)
  - Birds (e.g., songbirds, pheasants, hawks, eagles)
  - Mammals (e.g., raccoons, moles, shrews, mice, lions, antelope, elephants, rats, leopards, monkeys, apes).

Native Species Present

In addition to lists of the dominant, rare, and unique biological species present at the proposed project site or region of concern, the reviewer should check to make sure the project proponent identified native species that are present. A species is considered native if it naturally evolved to occur at the proposed site, or at similar sites in the region. Native species are considered more valuable than non-native species, because they are often integral components in an ecosystem. Over time, particular species may influence site conditions, such as by changing soil acidity or by serving as a "keystone" species — one that a large number of other species depend on either directly or indirectly in the food chain. For this reason, it is important to clearly identify which native species are present.

Exotics

Unlike native species, exotic species have not evolved to occur at the proposed site or similar sites in the region. Exotic species are often introduced by anthropogenic forces. Examples have included the Zebra Mussel introduced to the Great Lakes in North America via the ballast water of foreign ships, the Gypsy Moth caterpillar introduced to the U.S. northeast after escaping from a laboratory, and Africanized "killer bees" which have spread across much of South and Central America. Exotics are often of concern because they may displace native species. Exotic species sometimes have few or no local predators, allowing their populations to rapidly increase. This can adversely affect the food supply, available nesting sites or other factors critical for the survival of native species.

Exotic species should be identified in any description of existing biological conditions. Attention should be paid to particularly invasive and damaging species in the ecosystems of concern. Also addressed should be factors that might lead to an increase in the abundance of exotic species relative to native ones. This distinction will be necessary when reviewing the assessment of potential environmental impacts associated with the proposed project.

Rare and Threatened Species

In the United States and many other countries, rare and threatened species are protected by law. In addition to laws that prevent direct harm to such species, there are often prohibitions against indirect harm through habitat modification or other forms of disturbance (e.g., noise). In the United States, the Endangered Species Act distinguishes between species that are "threatened" and those that are "endangered." Endangered status invokes stricter legal obligations for protection than threatened status. In addition, individual states may create their own classifications and legal protections for rare or threatened species. The reviewer should be aware of all applicable national, state or regional, and local laws and regulations pertaining to rare or threatened species.

The description of existing biological conditions should include a list and discussion of rare and threatened species present at the proposed site or in the region of concern. The reviewer should communicate early-on with the project proponent if this section of the description of existing biological conditions is incomplete, due to the fact that a misunderstanding or misrepresentation of existing rare or threatened species could lead to the proposed project being denied at a later stage of the process.

4.4.2.2 Community and Habitat Characterization

- The environmental impact assessment should clearly identify any critical habitat likely to be affected by the proposed project and describe in detail the life history of those species that depend on critical habitat

Community and habitat characterization involves looking at more than individual species or lists of species. It involves identifying the broader community that supports individual species, and understanding the important features within that community, such as important physical features.

Type of Communities Found in Area

As in the previous section, community types are categorized into three headings: aquatic communities, wetland communities, and terrestrial communities.

Aquatic Communities

- Aquatic communities:
  - Characteristics of flora and fauna
  - Sensitivity
  - Life history
  - Abundance
  - Distribution
  - Diversity
  - Habitat types and locations

Aquatic environments range from freshwater streams to the pelagic regions of the oceans. These diverse environments provide habitats for a wide variety of plant and animal life. When evaluating the completeness of an environmental impact assessment, the reviewer should help ensure that the description section properly identifies and describes the biological components of each aquatic community that might be affected by the proposed project. When reviewing the description of aquatic vegetation, the reviewer should check to determine whether areas in the vicinity and downstream from anticipated discharge locations are emphasized. The first step is to make sure the document correctly identifies all the different aquatic environments within the region (e.g., streams, rivers, lakes, oceans). A map indicating all surface water bodies in the region will help with this step. Once the appropriate environments are verified, the reviewer should check to make sure that all organisms present are identified. Existing literature, biological monitoring, and field surveys are primary sources of data for identifying organisms.

Wetland Communities

- Wetland communities:
  - Tidal
  - Non-tidal

Wetlands form the transition between upland habitats and the waters of rivers, lakes, and oceans. The hydrology of a wetland may be tidal or non-tidal. In general, tidal hydrology supports saltwater wetlands and non-tidal supports freshwater wetlands. Wetlands may be permanently inundated, temporarily inundated, or periodically saturated.

Major wetlands can be classified based on vegetation types into emergent, scrub/shrub, and forested wetlands. Vegetation in emergent wetlands (also referred to as marshes) is dominated by grasses and sedges usually associated with year-round standing water. Typical forested wetland (i.e., swamp) vegetation includes a predominance of tree species, such as mangroves in coastal areas, which are able to survive and/or thrive in standing water for extended periods of time. The scrub/shrub wetland is a mix of the emergent and forested wetlands, consisting of vegetation typical of both. Particular species that dominate each type of wetland vary, depending on geographic location, soil saturation, and other environmental conditions.

- Wetland community classifications:
  - Emergent
  - Scrub/shrub
  - Forested

Wetlands serve as critical habitat for a variety of plants and animals. Tidal wetlands are especially important for estuarine and marine fish and shellfish and certain waterfowl, shorebirds, and wading birds. Non-tidal wetlands provide food sources for freshwater fish. In addition, birds such as ducks and geese, feed, nest, and raise their young in freshwater wetlands. Both tidal and non-tidal wetlands serve as spawning grounds and nurseries for a variety of fish species.

Wetlands also play an important role in maintaining water quality and moderating surges in water quantity. Wetlands slow the velocity of water, reducing the erosional effects of tides, storm surges, and floods. The reduced velocity also allows particulates to settle out of waters, thereby improving water clarity. If toxic pollutants are bound to the particulates, however, they can have a negative effect on wetland communities.

- The environmental impact assessment should include a map delineating wetlands and a list of flora and fauna species and abundances

The environmental impact assessment should include a map delineating wetlands and a list of flora and fauna species and abundances. Species type and abundances are often identified through literature searches and field surveys.

Terrestrial Communities

Terrestrial communities can be classified into general categories, including desert, grassland, coniferous forest, and hardwood forest. Each category provides habitat for unique plant and animal life. Maps of the region with overlays indicating dominant vegetation provide a basis for the evaluation. Existing literature and field surveys conducted by biologists with experience in identifying local flora and fauna may provide specific information, including the various species present and their abundances.

- Examples of terrestrial communities
  - Desert
  - Grassland
  - Coniferous forest
  - Hardwood forest

In different climates, different kinds of communities are climax communities — those communities which have reached dynamic equilibrium after a long period of community succession. It is important that climax communities be identified to evaluate whether adequate genetic resources are available for their preservation. Since it often takes centuries to redevelop climax communities at a location, their loss is potentially significant.

4.4.2.3 Ecologically Significant Features

Support of Broader Ecosystems

- Ecologically significant features include those that support broader ecosystems, important processes or functions, and disturbance regimes

Often it is important to view a proposed project site as a part of an interconnected whole, rather than as an isolated island of land. Any given aquatic, wetland, or terrestrial site may have important influences on the biological resources of other sites. One example is a stop-over location in an avian flyway. Certain locations serve as feeding, nesting, and breeding sites for migratory birds. Although the birds that depend on the proposed site may spend much of their time in other locations during other seasons, maintenance of a particular site along the path of their migration in an undisturbed state may be critical for their health and survival. Such is the case in the United States for the Platt river in Nebraska, and for numerous other rivers, streams, and wetlands located within the various major flyways in Canada, the United States, and Mexico.

Many animals hunt or feed over large areas. Any change in the environment that prevents these animals from accessing any part of their home range has negative impacts on populations. Many threatened and endangered species in the United States have attained that status because of habitat loss or habitat fragmentation. The indigo snake in southern Florida is one such species.

Biotic Interactions

- Habitat
- Limiting factors
- Food sources

The environmental impact assessment should describe the key interrelations and dynamics within the different ecosystems identified in the region of concern. Although it is difficult to determine the extent to which plants and animals are interdependent at a given site, specific attention should be given to identifying predominant species and their trophic levels. A basic understanding of aquatic, wetland, and terrestrial food webs and the relationship among the various trophic levels of each of these ecosystem types forms the basis for predicting impacts to one trophic level based on changes occurring at other levels. For example, when examining the impacts from dredging activities to a wetland marsh, one is most likely to first consider potential losses to resident benthic invertebrates resulting from burial and turbidity increases. Because the affected invertebrates serve as the primary food source for local fish species (which, in turn, are primary prey items for shorebirds and mammals), significant decreases in invertebrates may have far-reaching effects.

Important Process or Functions

A particular aquatic, wetland, or terrestrial area may perform important functions that are not immediately apparent. For example, during periods of high rainfall, wetlands serve as natural retention basins for increased stream flow, absorbing high volumes of flow and

gradually releasing them, thereby helping to prevent flash flooding. Wetlands also serve as natural filters, removing nutrients and toxics from polluted water. Another example is a forest on steep slopes. In addition to all the direct benefits provided by the forest, it also stabilizes slopes and prevents erosion by shielding the mineral soil from wind and rain, and by securing soil in place via root systems.

It is important to recognize such important processes and functions when reviewing the description of existing biological conditions. To ensure inclusion of this type of information, the reviewer should check to see if physical and biological conditions at the proposed project site were studied or monitored over periods of time and during different seasons. Certain important processes or functions are only apparent at specific periods of time (e.g., during rainfall) or over long periods of time (e.g., several seasons).

Disturbance Regimes

Any given site may be subject to natural or anthropogenic disturbances. Natural disturbances (e.g., floods, fires) are those that occur regularly or periodically and are a significant influence on the biological conditions of the site. Anthropogenic disturbances may also play an important part influencing biological conditions, whether by affecting natural disturbances or by causing direct impacts (e.g., habitat destruction).

Natural Disturbances

Two of the most common natural disturbances are fire and flooding. Certain forests and grasslands, for example, naturally experience fires on a periodic basis. In ecosystems influenced by fire, species often adapt to, or even require, the presence of fire. For example, the seeds of certain tree species will not germinate until scarred by fire. Also, certain forests rely upon fire to keep brush and other natural materials from accumulating to dangerous levels. In both of these cases, a project that would result in a cessation of fire events would result in significant changes to the biology of the system, including changes in dominant species types and the potential for massive fires fed by an over abundance of fuel.

Flooding patterns can also have important biological influences. All rivers overflow their banks under natural conditions, some on a regular basis (e.g., each rainy season), and others less predictably. In certain regions, these flooding events transport important waterborne nutrients and sediments to surrounding land areas. Flood waters may also replenish important watering holes and other water sources for wildlife. Understanding the processes at work in such a system is particularly important if a proposed project would alter a river channel or in any way block natural flooding.

Project-induced Disturbances

The effects of constructing and operating a proposed project may include the degradation or loss of habitat. The extent of habitat disturbance depends on existing land use at the proposed site. If the proposed project requires clearing and grading forested land or dredging a pristine water body, for example, the potential for habitat loss is greater than at sites where activities have already occurred.

Adverse effects to critical species habitat, such as fish nursery grounds, breeding sites, or nesting areas, ultimately affects species and population survival. Frequently, one particular life stage of a species requires a specific habitat (e.g., seagrass beds serve as nursery grounds for marine fish, and pristine, coldwater streams are required by some mayfly larva). Loss or degradation of these critical habitats may disrupt or destroy population regeneration. Thus, the environmental impact assessment should clearly identify any critical habitat likely to be affected by the proposed project and describe in detail the life history of those species that depend on critical habitat.

Another consideration relevant to ecological interrelationships is habitat fragmentation. Even if a proposed project may not result in the complete destruction of a particular habitat, it may isolate parts of a previously continuous habitat. Habitat fragmentation can lead to:

- Habitat fragmentation

- Increase in mortality and inbreeding;
- Extinction of wide-ranging species (e.g., wolves, bears, manatees);
- Loss of area-sensitive species;
- Decrease in genetic diversity within rare species.

In addition, fragmentation of critical habitats will probably affect the ability of a particular area to sustain plant and animal populations. Such fragmentation can lead to displacement of individuals and/or degradation or destruction of the remaining habitat.

Hydrologic Processes

Hydrologic processes refer to the amount, location, and duration of water flows to and through a given site. Hydrologic processes involve both ground and surface water. Depending on geology and topography, a particular location may serve as a basin receiving surface or ground water (e.g., a lake or pond), a source of surface or ground water (e.g., a mountain), or a combination of the two.

Hydrologic processes can be critical to biological resources. The amount of water held or released by a particular site, and the duration of capture or release, can have important influences on the biology of the

site and surrounding area. Anadromous fish species may depend on spring river flows to reach spawning sites. Biologically important groundwater aquifers may depend on annual flooding of a certain quantity to fully recharge. Depth to groundwater may determine the survival of both water tolerant and intolerant tree species.

The environmental impact assessment should include descriptions and maps of hydrologic processes important at the proposed site. Such information and maps should indicate depth to groundwater, maximum and minimum annual and seasonal rainfall, the location of any surface water bodies, including lakes, ponds, rivers, and streams, and the flow quantity and seasonality of rivers and streams.

4.4.3 Waste Management and Pollution Prevention

Almost all projects generate waste that must be managed in an environmentally sound manner. Characteristics and volumes of waste, as well as waste management procedures and capacity, influence the potential for significant environment impacts. Pollution prevention policies play an important role in projections of waste management capacity.

The description of the environmental setting should describe existing waste management procedures and facilities. Information on existing wastes generated in the region of concern should describe the quantity and characteristics of materials disposed of. Descriptions of existing waste management procedures should address current policies for reducing the amount of waste generated and current techniques for waste handling, storage, transportation, and disposal.

Typically, waste descriptions will include solid and liquid wastes and discuss the sources of wastes, the quantities generated, and the characteristics of the waste materials. Sources include industrial processes, commercial establishments, and households. The characteristics of waste materials typically describe whether the materials are explosive, corrosive, flammable, ignitable, or toxic. They may also identify pollutants of concern and pollutant concentrations.

- Waste information:
  - Description of management practices
  - Types of waste (liquid or solid)
  - Toxic potential
  - Quantities
  - Location of disposal

The preferred waste management measure is pollution prevention – preventing the generation of waste in the first place through source control and source reduction. Pollution prevention measures not only reduce operational impacts on the environment, but reduce the costs associated with raw materials and waste disposal. Whenever possible, the environmental impact assessment should include a discussion of existing pollution prevention initiatives. This should include identification of opportunities for source reduction, recycling, and waste exchange.

- Pollution prevention:
  - Source control
  - Source reduction

Solid waste management may include disposal at landfills or incineration. In some areas, there are no existing provisions for waste management. The environmental impact assessment should address the

adequacy of landfill construction and operation and whether the landfill has sufficient capacity to handle generated wastes. This information may include an estimate of the waste generated, the average wastes buried in the landfill per year, the unused capacity of the landfill, and a projection of when the landfill will reach its capacity. Descriptions of incinerators should include the amount of wastes the facility can handle in a given timeframe, as well as an estimate of the capacity at which it generally operates.

- Solid waste management:
  - Capacity per unit time
  - Volume capacity
  - Adequacy of design
  - Acceptable wastes

Liquid wastes may be discharged directly to a receiving water body or may be sent to a sewerage system. The environmental impact assessment should describe the characteristics of liquid wastes in order to determine whether treatment is necessary prior to release into the environment or sewerage system.

4.4.4 Socioeconomic Environment

- Socioeconomic issues:
  - Land use
  - Population and housing
  - Economic activity
  - Education
  - Community services and public finance
  - Transportation
  - Health and safety

The attributes of the socioeconomic environment include land use, population and housing, economic activity (including employment and income), community services and public finance, transportation, and health and safety. The anticipated significance of the potential impacts will determine the extent of the socioeconomic analysis. In other words, the level of detail and depth of discussion required in describing each socioeconomic attribute should increase as the significance of potential impacts increases.

Each of the socioeconomic attributes should be defined within the region of concern. Typically, two factors are used in determining the region of concern for socioeconomic resources. The first is the residential distribution of the population to be affected by the proposed project, and the second is the degree of linkage among the economies of communities in the region. This linkage, based on both trade among industry sectors and household purchasing patterns within the region, determines the nature and magnitude of economic multiplier effects in the region. (Section 4.4.4.3 discusses this concept in detail.) Taking into account these two factors, it is common for regions of concern to be drawn along established jurisdictional boundaries, such as counties in the United States, to facilitate data collection and provide comparability of attribute conditions.

- Appropriately delineating the region of concern is critical to ensure the accuracy of the assessment

In some socioeconomic analyses, the region of concern may vary for each attribute. For example, health and safety may be an issue in the local or immediate area and the region of concern might be a 1-kilometer radius from the proposed project site, while impacts on community services should be assessed throughout the entire community. The region of concern for employment and economic activity could be evaluated at several levels, including local, community, and regional. In general, however, the region of concern for population and housing, economic activity, and community services and public finance should be consistent due to the interrelated nature of these attributes. In evaluating the appropriateness of the defined region

of concern, it is necessary to keep in mind that an excessively large region of concern can waste analytical resources and dilute the significance of potential environmental impacts. An excessively small region of concern can inappropriately exclude portions of the environmental setting from consideration.

4.4.4.1 Land Use

The environmental impact assessment should include a description and map of present and future land uses of the region of concern. Various types of land use are possible including undeveloped, agricultural, industrial, commercial, residential, recreational, and conservation areas. The environmental impact assessment should emphasize land uses that pose potential conflicts with the proposed project, such as irreversible conversion of high quality agricultural land or mining in the proximity of residential areas, public facilities, or protected areas.

- Land use types:

– Undeveloped
– Agricultural
– Industrial
– Commercial
– Residential
– Recreational
– Conservation

The land use section also should highlight existing land use or zoning laws and other adjacent or nearby proposed developments. If applicable, official government policy, such as protection of high quality agricultural land, must be included. In addition, the anticipated (and/or required) use of the land once project operations are completed is important.

A proposed project can be evaluated on the basis of its consistency and conformance with an available local or regional planning agencies' "master" or "comprehensive" land use plans. A land use plan commonly details (1) existing land use, (2) future land use, and (3) applicable land use controls. If the existing plan is thorough and the responsible agency has the authority to ensure conformance to the plan, the proposed project can be compared to the plan to help identify potential impacts. If a land use plan does not exist, the plan is inadequate, or the responsible agency has little authority to enforce the plan, the project proponent should have conducted a more thorough assessment. In addition, in the latter situation, the likelihood that adverse effects can be controlled or mitigated is greatly reduced.

- Land use plans contain:

– Existing land use
– Future land use
– Applicable land use controls

4.4.4.2 Population and Housing

A general discussion of the demographic and housing characteristics of the region of concern should include the following data:

- Current and historical total population (e.g., 1995, 1990, 1980, 1970);
- Rate of population growth;
- Population density;
- Average household size;

- Number of available housing units;
- Occupancy and vacancy rates (owner-occupied versus rentals);
- Median home values and median rent.

For a more detailed presentation, the environmental impact assessment can provide information on the age, sex, and ethnic composition of the population, as well as data on educational attainment levels, residential tenure, and population growth factors, such as birth, death, and migration rates. The goal of this section should be to analyze shifts in population and predict changes in community profile, neighborhood composition, and housing demand. Projections of baseline (i.e., without the proposed project) demographic trends for the region of concern are also necessary to determine the relative magnitude of assessed future impacts.

- Additional population information that can be included:
  - Age
  - Sex
  - Ethnicity
  - Education
  - Residential tenure
  - Births and deaths
  - Migration rates

Project-induced employment changes probably will affect the migration rates associated with the region of concern. The permanent and temporary relocation of households in response to employment opportunities will create a demand on the housing market and a demand for additional community services. For this reason, an accurate description of the baseline housing stock and public facilities and services is critical in assessing the extent of potential migration impacts.

It may also be important to identify special segments of the population, such as indigenous and disadvantaged persons, to facilitate a discussion of potential environmental equity issues. If the significance of potential impacts dictates, the demographic and housing data presented in this section should be in a disaggregated form so that they can be used to assess whether the distribution of impacts across segments of the population is equitable.

- Environmental equity

Indigenous population refers to native people with cultural and economic ties to the geographic area in which they reside. These populations are particularly vulnerable to environmental and socioeconomic change. If indigenous populations are identified in the region of concern, the description section of the environmental impact assessment should include a detailed description of their distribution, life style, livelihood and legal status.

4.4.4.3 Economic Activity

A representation of the economic well-being of the region of concern should rely on data regarding the gross output (total sales and receipts) of regional businesses, employment levels by industry, and personal earnings and income. The section should generally begin with an identification of the "base" industries in the region. These would be the industries that bring outside revenues to the region (e.g., by sales to customers or other firms outside the region), which are then re-spent (multiplied) within the region through business purchases and payroll

- Economic activity:
  - Gross output
  - Employment levels by industry
  - Personal earnings and income

spending. The environmental impact assessment should also include unique features of the business community, such as high seasonality of trade, high outflow of profit, declining trade, or downtown revitalization, if pertinent.

A description of current employment categories and unemployment levels is required to provide the basis for determining the suitability and capacity of the available labor pool for meeting potential project demands. This section should present the following employment data:

- Total civilian labor force;
- Total employment and employment by industry;
- Unemployment rates and characteristics.

The characteristics of the unemployed population, if available, are especially important if the proposed project is expected to generate employment. If warranted by the nature of the potential impacts, the employment data should be maintained in a disaggregated form to facilitate assessment of the equity of changes in employment across segments of the local population. In addition, the environmental impact assessment should present projections on anticipated trends in baseline employment and unemployment to facilitate assessment of future project-induced employment changes.

Earnings and income data provide a representation of the relative wealth of the region of concern population. Regional statistics, such as median household income, per capita income, average earnings per job, and percent of households below poverty level, help describe the general financial well-being and solvency of the regional population compared to the broader state or national population. Baseline income and wage data are also helpful in assessing the potential earnings impacts that may be associated with project-induced employment changes.

4.4.4.4 Community Services and Public Finance

- An environmental impact assessment should describe:
  - Community services
  - The agencies or organizations who provide them
  - The nature of services
  - Target populations

Community services include municipal water supply, sewerage, storm drainage and flood control, waste management, power supply, education, health care, police and fire protection, parks and recreation, churches, and libraries. The environmental impact assessment should describe these services, including the agencies or organizations that provide the services, the nature of the services provided, and the target population receiving these services. Existing levels of use and remaining capacity to accommodate growth should be included if potential project-induced impacts are expected to affect the demand for such services. General data on community services could include:

- Utility providers and current levels of service;

- Public school districts, numbers and levels of schools, teacher-student ratios, and total school enrollments;
- Hospitals and clinics, bed capacity, and number of physicians and surgeons;
- Police and fire protection agencies, jurisdictions, and number of officers and firefighters;
- Total park acreage and number and type of recreation facilities.

The environmental impact assessment may include maps showing the location of services within the region of concern and their respective sphere of influence, or service and support areas. Assessing the quality, or adequacy of the services provided, and the ability of the existing public facilities and services to accommodate additional users is critical if there are significant potential impacts, such as substantial population in-migration generated by project-related employment increases.

- Significant population in-migration may tax the ability of existing public facilities and services

The environmental impact assessment can describe public finance in the region of concern based on historic revenues and expenditure levels, changes in fund balances, and reserve bonding capacities. If project-induced impacts are expected to significantly affect public finances, this section should discuss each jurisdiction's governmental funds (e.g., general fund, special revenue funds, and, as applicable, capital projects and debt service funds) and tax and non-tax sources of revenue.

4.4.4.5 ***Transportation***

- Transportation routes:
  - Roads
  - Railways
  - Airways
  - Pipelines
  - Navigable waterways

Transportation systems provide access to a facility for the import of raw materials, export of final products, and the movement of staff and service personnel. The environmental impact assessment should describe all relevant forms of transport that would be affected by the proposed project. Road-based transport usually is crucial for all facilities. In addition, railways, airways, pipelines, and navigable waterways may be important for some facilities. The environmental impact assessment should present current traffic volumes, current traffic capacity, the provision of public transportation, and an assessment of the adequacy of the systems for meeting peak demands. The environmental impact assessment should also highlight any regional transportation plans and indicate whether they were followed.

4.4.4.6 Health and Safety

- The environmental impact assessment should describe any present health and safety issues

If the proposed project is likely to impose risks to the health and safety of the local population, the environmental impact assessment should describe any present health and safety issues. The description should include statistics on industrial accidents in the local area; information on air, water, and radioactive emissions from existing and prior facilities and their effects on human health and the environment; and an analysis

of present levels of noise and its impacts on people and wildlife. The environmental impact assessment should also identify special populations or areas that are more likely to be exposed to adverse impacts (e.g., subsistence fishing populations using water bodies that probably will be affected by the proposed project).

4.4.5 Cultural Resources

Cultural Resources

- Archeological
- Historical
- Religious
- Societal
- Aesthetic

Cultural resources include sites, structures, and remains of archeological, historical, religious, societal, or aesthetic value to local, national, or international interests. The location of any proposed project can result in irretrievable loss of cultural resources, both known and yet to be discovered. Preservation and management of cultural resources is important for maintaining a culture's sense of history and identity. It is also important for the information that can be gained from studying the consequences of past actions and applied to the solution of current problems.

The description section should identify known cultural resources, including the location of the following kinds of sites in relation to the region of concern:

- Archeological sites (where human-made artifacts or other remains dating from prehistoric times are found);
- Paleontological sites (where bones, shells, and fossils of ancient plants or animals are found in soil or imbedded in rock formations);
- Historic sites (where significant events happened or where well-known people lived or worked);
- Sites of particular educational, religious, scientific, or cultural value.

- It may be appropriate to develop a cultural resources sensitivity map

Depending on the nature of the proposed project and the extent of land disturbance involved, it may be appropriate to develop a cultural resources sensitivity map. In addition to mapping known cultural resources, the map should indicate areas of low, medium, and high probability of containing undiscovered cultural resources. These estimates are best made by archaeologists and anthropologists familiar with the local environment and patterns of spatial distribution of cultural resources (e.g., soil conditions, proximity to water sources, and other topographic features associated with previous archeological finds).

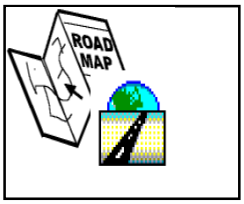
Aesthetics

- Visual
- Aural
- Olfactory

In other words, items that are seen, heard, or smelled

Aesthetics involve the general visual, aural, and olfactory environment (imagine the sensory differences among urban, industrial, agricultural, and forest environments). The description section should describe the aesthetic characteristics of the environmental setting—items that are seen, heard, and smelled in and around the proposed site—and their emotional or psychological effect on people. Descriptions (or pictures)

of views of the proposed site, unique features or features deemed of special value, and public use and appreciation of the proposed site provide information to facilitate the assessment of potential impacts.



4.4.6 Reviewing the Description of the Environmental Setting Road Map

It is clear from the preceding parts of this chapter that the description of the environmental setting in an environmental impact assessment document is both important and complex. It is important because it establishes a baseline against which potential impacts can be compared. It is complex because both the natural and human environment are composed of an almost limitless collection of interacting and interdependent components. The reviewer's focus, that is, reviewing the coverage, significance, adequacy, integrity and accuracy of this chapter of an environmental impact assessment document, and for maintaining the appropriate level of influence over its preparation, is critical to ensuring an effective and informed decision-making process.

To help ensure that the review is systematic and complete, and that the reviewer maintains the reviewer's focus, the following road map was created to guide review of the description of the environmental setting chapter of an environmental impact assessment document. This road map reflects a composite of all of the issues that were described in section 4.4.

Road Map for Environmental Setting Review

- All relevant types of natural and human environmental issues are addressed
- Affected area or community is adequately and accurately defined
- Adequately map impact area and surrounding features
- Baseline is established to measure impact
- Appropriate information and data documented and used appropriately
- Information links back to project description, purpose and need, alternatives?
- Levels of detail are appropriate to significance
- Information and data is of acceptable quality and relevance?
- Section is internally consistent

Addressing all of these issues and questions will help ensure that the review is systematic and complete. If there are many instances where the description of the environmental setting does not meet the reviewer's expectations set forth in the road map, the environmental setting chapter is probably inadequate and will require further work. It is the reviewer's job to point out such deficiencies to the project proponent.

Because descriptions of the environmental setting are often quite complex, no one reviewer is likely to hold expertise in all necessary areas for a fully adequate review. The reviewer should have the confidence to ask questions of colleagues and outside experts when needed.

4.5 POTENTIAL ENVIRONMENTAL IMPACTS

- Each potential impact should be presented clearly and succinctly

The primary objective of the "environmental impacts" section of environmental impact assessment documents is to clearly and succinctly present each potential impact, qualitatively and/or quantitatively. The environmental impacts section forms the scientific and analytical basis for the comparison of alternatives and determination of relative significance of impacts. The reviewer should take steps to help ensure that all impacts (including primary, secondary, and cumulative impacts) that are potentially significant have been considered and discussed in the environmental impact assessment. The environmental impacts section should discuss the potential beneficial and adverse impacts of each alternative and their relative significance, including clear, technical demonstrations of:

- **Primary impacts**—A primary impact is direct and occurs at the same time and place as the action. Primary impacts are associated with the construction, operation, and/or maintenance of a facility or activity. They are generally visibly obvious and quantifiable;

- **Secondary impacts**—Secondary impacts occur later in time, or at a different place from the initial action. These impacts are indirect or induced changes in the environment, population, economic growth, and land use;

- **Cumulative impacts**—Cumulative impacts result from the incremental impact of a proposed action on a common resource when added to other past, present and reasonably foreseeable future actions. These may include the collective effects of individually minor actions over a period of time. (e.g., the combined effect of wastewater discharge, dredging, and agricultural runoff on a small estuary, or several dams constructed throughout a single river basin);

- **Project compliance**—Demonstrated compliance with national, state, and local environmental regulations and standards;

- **Possible conflicts** —Identification of possible conflicts between the alternatives and the objectives of national, regional, state, and local land use plans, policies, and controls for the area concerned;

- **Irreversible and irretrievable commitment of resources** — The irreversible and irretrievable commitments of resources (e.g., land, energy, natural resources associated with the proposed project should be summarized).

It is important for the reviewer to remember that major impacts can occur to a variety of resources (i.e., physical-chemical, biological, socioeconomic, aesthetic, and cultural resources). Therefore, the environmental impact assessment analysis needs to be conducted in a comprehensive, step-by-step fashion, assuring that potential effects have been considered for all resources described in the description of the environmental setting section.

It is also critical that the reviewer remembers that environmental impacts can occur during every stage of a project, from initiation to post-completion operation. Specifically, the reviewer should check to make sure that impacts are assessed for the following project stages:

- Initial site preparation and construction;

- Facility operation;

- Post-facility operations, or site closure.

These categories are, of course, merely three convenient headings for what is actually a spectrum. The reviewer should take steps to help ensure that impacts are assessed for all project phases. Because each phase may have several sub-phases (e.g., there may be several distinct phases during facility operation), there should be a careful assessment as to whether all potential impacts were assessed; long, medium, and short-term.

4.5.1 Methods of Analysis

The potential impacts of each alternative are identified by a systematic disciplinary and interdisciplinary examination of the consequences of implementing each alternative. While information may be gathered from field surveys, related environmental impact assessments, discharge applications, and other sources, the reviewer is responsible for evaluating the scientific and professional integrity of the information used in the environmental impact assessment. Therefore, the environmental impact assessment must clearly identify data sources,

- The environmental impact assessment must clearly identify data sources, references, methodologies, and models used to analyze or predict results

references, methodologies, and models used to analyze or predict results. Detailed methodologies or extensive data can be incorporated by reference if the source is readily obtainable.

Specific methodologies may be available to identify, qualify, and quantify impacts for a variety of media. For example, air quality impacts may be predicted using standard, approved models, if available. A matrix describing models commonly used in environmental impact assessment is presented in Appendix B. These models use site-specific data for existing air quality and expected pollutant emissions from the proposed project, as well as the topographical and meteorological characteristics of the region of concern, to predict the transport and fate of pollutants. This is followed by an assessment of the effect of predicted pollutant levels on receptors, including humans and other biological resources, sensitive habitats, and cultural resources.

The goal of the environmental impacts section is to quantify potential impacts to the physical-chemical, biological and socioeconomic environments including air quality, water quality, soils, biological resources, employment, land use, and community services. The section should identify potential primary and secondary impacts under each alternative, discuss the significance of potential impacts, and assess the potential cumulative impacts. The analysis should identify and assess potential impacts for all stages of the proposed action, including initial site preparation and construction, facility operation, and, in some cases, post-facility or site closure.

- The goal of the environmental impacts section of the environmental impact assessment is to quantify or describe potential impacts on:
  - Air quality
  - Water quality
  - Soils
  - Biological resources
  - Employment
  - Land use, and
  - Community services

4.5.1.1 Determination of Significance

Significance may be defined by law, regulation, policy, or practice of an agency or through the collective wisdom of a recognized group (e.g., industry or trade association standards). Impact significance, however, is often based on the professional judgment of an expert or group of experts. The determination of significance must be based on clearly defined criteria.

Significance can also be examined in terms of the context and intensity of an action. Context relates to geographical scale—local, regional, state, national, or global; intensity is defined by the severity of the impact (e.g., the magnitude of deviation from background conditions, the size of the area affected, the duration of the effect, and the overall likelihood of occurrence). The potential for significant impacts is greater in areas that are protected, unique, sensitive, or recognized by government agencies (e.g., significant historical or cultural resources, parks, prime farm lands, wetlands, wild and scenic rivers, or ecologically critical areas). Other important factors include:

- Degree of controversy among experts of the impact;
- Degree of uncertain or unknown risks;

- Determination of significance must be based on clearly defined criteria

- Likelihood that a precedent will be set;
- Occurrence of cumulative impacts (especially if individual impacts are not viewed as significant);
- Degree to which cultural or historical sites may be affected;
- Degree to which significant scientific, cultural, or historical resources are lost;
- Degree to which commercially or recreationally valuable, threatened, or endangered species or their critical habitat is affected;
- The likelihood of violations of national, state, regional, or local environmental law or requirements or, alternatively, the likelihood that appropriate standards applicable to the operation and various environmental media can be achieved.

Professional standards and design specifications are techniques that can be used to determine impact significance. Use of these techniques consists of comparing project parameters to known professional standards, such as effluent guidelines, to assess potential significance. In addition, public opinion can be used to determine the qualitative significance, or a specific impact.

The threshold of significance is different for each impact, and the parties judging significance need to explain the rationale for the thresholds chosen. Clear descriptions of threshold choices for determining the significance provide the reviewer with a basis for agreeing or disagreeing with the determination of significance based on specific assumptions, criteria, or data. Further guidance on determining significance is presented in Appendix C.2 and in the Resource Manual accompanying the course *Principles of Environmental Impact Assessment Review*.

4.5.1.2 Cumulative Impacts

Cumulative impacts result from the incremental impact of a proposed action on a common resource when added to other past, present and reasonably foreseeable future actions. These may include the collective effects of individually minor actions over a period of time. This "accumulating" impact assessment approach is particularly instructive when no single project is a major cause of a problem but contributes incrementally to a growing problem. It is important to recognize that some projects act as catalysts for future growth and environmental change in the region of concern.

If other projects are planned during the same timeframe as the proposed action and in the same region of concern, they should be listed in the

environmental impact assessment and included in the cumulative impacts analysis. When assessing the potential for cumulative impacts, the project proponent and reviewer should consider the following factors:

- Temporal accumulations of impacts and whether perturbations are spaced adequately to allow the ecosystem to recover from the change;
- Spatial accumulation of impacts and whether there is sufficient distance between perturbations;
- Sources of impact, including primary and secondary effects of individual and multiple sources;
- Pathways of impact accumulation, such as additivity and synergism;
- Thresholds of impact, including linear and non-linear thresholds.

Cumulative impact analysis is hindered by the complexity of the mechanisms of accumulating effects and by limitations in understanding ecosystem processes and responses to perturbations. There is no standard method for assessing cumulative impacts. A combination of analytical techniques and planning processes is frequently used to assess and address potential cumulative impacts. Appendix C.2 and a number of documents in the Resource Manual accompanying the course *Principles of Environmental Impact Assessment Review* describe some of these methods.

4.5.2 Pollutant Generation, Transport, and Receptors

- The environmental impact assessment should thoroughly assess all potential pollutants, their pathways, and predicted receptors based on modeling or other information

Pollutant generation, transport, and fate can affect the air, water, soil, and biological resources in proximity to the proposed site. The pathway of pollutant transport and the ultimate fate of pollutants depend largely on the physical nature of the pollutant itself. Particulates and gases are typically transported by air but may deposit in surface waters or soils. Liquid pollutants (e.g., fuels, solvents) can volatilize into the air or be transported through soils, sediments, or aquatic media, such as ground water or surface streams. Solid pollutants, including sediments and sand, can be transported by winds or surface waters. The environmental impact assessment should thoroughly assess all potential pollutants, their pathways, and predicted receptors based on modeling or other information.

4.5.2.1 Air Resources

Site leveling and grading during construction results in large quantities of airborne dust particulates that may contain toxic constituents. Dust particulates may settle on local vegetation or water bodies or may be

ingested by biological organisms, including humans. Emissions from construction equipment, such as bulldozers and graders, may also adversely affect biological resources.

Impacts from facility operations are primarily associated with pollutant generation and transport and related effects to surrounding habitat. Typically, facilities cannot operate without obtaining environmental permits for air emissions, and most permits are issued only after it is determined that environmental impacts will be acceptably small. Effective implementation and enforcement of environmental requirements serve to minimize adverse impacts from project operations.

Project operations affect air quality through atmospheric emissions of particulates, hydrocarbons, carbon monoxide, carbon dioxide, sulfur oxides, and nitrogen oxides. Particulates result in a "dirty" or "dusty" atmosphere and accumulate on surfaces. Toxic chemicals also attach to particulates, resulting in potential human health impacts if inhaled. Accumulation of toxic chemicals on land surfaces can also cause environmental impacts.

Hydrocarbons and carbon dioxide are primarily responsible for the "greenhouse effect," because they impede the radiation of heat from the earth's surface back to outer space, increasing the temperature of the atmosphere. Carbon monoxide is a known toxicant, which can cause neurological and lung disorders, and even death. Sulfur oxides and nitrogen oxides are "acid rain" constituents, which can lower the pH of natural water bodies and damage natural and human-made materials and structures. Emissions can also produce offensive odors extending throughout large areas in the vicinity of the proposed site.

Facility emission sources include diesel generators, vehicles traveling to and from the proposed site, and pollutants specific to the facility's industrial process. The environmental impact assessment should address all potential emission sources and assess their cumulative impact on the environment.

Air quality impacts can be determined quantitatively by comparing expected emissions with emission standards set by national, state, or local governments and by comparing the expected ambient concentrations of pollutants caused by facility emissions and other sources with ambient concentration standards. Monitoring and modeling are the two most common techniques used for air quality evaluations. Monitoring is often required to establish baseline ambient concentrations for pollutants of concern prior to facility construction and can be used to determine facility compliance after operations begin. In addition, modeling is used to assess potential impacts from the proposed project using mathematical simulations of dispersion. If air quality models are used in the environmental impact assessment,

Primary Effects

- Airborne dust and dust accumulations on surfaces adjacent to the proposed site
- Adverse health effects to biological organisms (including humans) caused by inhalation of toxics

Secondary Effects

- Airborne transfer of pollutants to distant soils and surface waters

Cumulative Effects from Facility Construction

- Greenhouse effect
- Acid rain

Common Air Quality Evaluation Techniques

- Monitoring (to gauge pre-project ambient conditions and to track changes after project initiation)
- Modeling (to predict project-related effects)

the reviewer should take steps to help ensure that the following four major input requirements were used during modeling:

- Emissions data;
- Stack information (e.g., stack height, diameter, temperature of exit gas, flow rate);
- Meteorological data (e.g., local wind speed, direction, and precipitation levels);
- Receptor coordinates and elevations.

Critical Questions:

- Will dust or air pollutants be generated from construction and site preparation activities?
  - Does the environmental impact assessment identify emission sources and project emission rates and compare these rates to applicable national, state, and local standards and limitations (both emissions and air quality)?
  - Does the environmental impact assessment compare predicted atmospheric levels with national, state, or local ambient standards?
- Does the environmental impact assessment identify emission sources and rates, including existing and known potential sources in the vicinity not associated with the proposed site, and assess expected concentrations of pollutants in air?
- Are emission rates and resulting concentrations compared to applicable national, state, and local standards and limitations?
- Will facility operations result in noncompliance with air emission and ambient air quality standards?
- Have measures to control air emissions been addressed in the proposed project design? Will these measures be adequate?
- Does the environmental impact assessment describe stack emissions during operation and maintenance activities and compare these with existing national, state, and local standards?
- Will stack emissions from the facility have deleterious effects on visibility and light scattering (i.e., cause smog); damage

natural or human-made materials and structures (i.e., cause acid rain); or adversely affect human health, domestic animals, wildlife, or vegetation?

4.5.2.2 Water Resources

Construction activities can affect water resources depending on their proximity to the proposed site. Settling of dust into water bodies results in increased water turbidity. Vegetation removal and soil compaction by construction machinery results in increased runoff following rain events and greater volumes and velocity of water that must be carried by local water bodies. This in turn may result in sedimentation in receiving waters and adverse effects to aquatic vegetation and other resident biological organisms, such as fish populations. For example, elevated turbidity may reduce the amount of available light, thereby decreasing photosynthetic rates of aquatic vegetation, or may clog the gills of fish with suspended particulates, reducing respiratory function. In addition, increased sediment loads frequently carry nutrients and toxic pollutants to receiving water bodies.

A minor source of pollutants during the construction phase is oil or other hazardous material that can leak or otherwise emanate from construction equipment. These materials may leach into ground water or be transported with runoff to local water bodies. Depending on their concentration, these materials can cause toxic or bioaccumulative effects to local biological resources.

Impacts to water range from water quality degradation caused by discharges of toxic pollutants and excessive nutrients or oxygen demanding substances to hydromodification impacts associated with increased impervious area, soil exposure, and erosion. Pollutants may enter surface waters from waste disposal to land, effluent discharges to water bodies, and precipitation runoff. Nutrients (nitrogen and phosphorus compounds) in water can lead to eutrophication—excess plant growth resulting in algal blooms, weed-choked water bodies, and fish kills. Excess nitrogen in drinking water causes human health problems, particularly to infants. Toxic contaminants result in acute and chronic toxicity to aquatic biota, as well as possible human health affects associated with ingestion of contaminated water and food. The temperature regimes of receiving waters may be changed through warm water effluents. Increases in ambient temperatures generally reduce biodiversity by limiting the abundance of cold water fish species or can lead to introductions of potential nuisance species.

Potential water quality impacts can be determined by comparing effluent concentrations to relevant water quality standards or by predicting ambient concentrations and comparing these with water quality standards or acute/chronic toxicity levels. If particular contaminants are predicted to be more significant than others (i.e.,

Primary Effects

- Sediment loading of water bodies adjacent to the proposed site and associated habitat alteration
- Accumulation of toxics within adjacent water bodies resulting from site erosion and runoff
- Increased water body turbidity and decreased photosynthetic rates for aquatic vegetation
- Burial of aquatic benthic invertebrates
- Clogging of fish gills with suspended particulates
- Bioaccumulation by aquatic organisms of toxic constituents from eroded sediments and airborne particulates
- Contamination of ground water and/or surface water from leaks or effluent discharge

large quantity or high toxicity), the environmental impact assessment should focus on the transport and ultimate fate of these pollutants. The environmental impact assessment should also consider the potential for contaminant bioaccumulation in the local food chain. Modeling studies can also be used to assess concentrations of contaminants in receiving waters caused by process and storm water discharges or estimate concentrations of chemicals in aquatic biota resulting from the proposed action (e.g., fish uptake and food chain models). If water quality models are a component of the environmental impact assessment, specific inputs should include information on source input(s) (e.g., effluent composition, concentration, and volume) and receiving water characteristics (e.g., currents, wind, flow rate, tidal range, stratification). The assessment should clearly state whether or not model results have been tested or verified using range checks or other evaluation techniques. Modeling exercises should include the impacts of existing and planned sources, in addition to the proposed project and alternatives, and should be calibrated specifically for the system under study.

Critical Questions:

- Does the assessment address the potential for water quality to be degraded by increased surface runoff (sediment and pollutant discharges), discarded or discharged construction materials and other chemicals, herbicides, wastewater, soil additives, disturbance of stream bed, or temperature increases due to increased turbidity or removal of vegetation?
  - Does the assessment predict sediment loading and compare loadings and predicted in-stream concentrations of associated pollutants with existing national, state, and local water quality standards and criteria?
  - Does the document assess the potential effects to ground water quality from use or disposal of chemicals or nutrients? If ground water might be affected, does the assessment consider avoiding placement of contaminant sources over aquifer recharge areas?
- Will facility siting avoid direct contact with ground water during foundation work, tunneling, or construction of underground utilities?
- If the proposed project site is within an aquifer discharge area, will protective measures, such as liners and containment areas, be implemented?
- Is there a potential for increased overland flow, storm water runoff, flooding, stream bed sedimentation, or channel erosion

Secondary Effects

- Modification of watershed drainage
- Eutrophication or contamination of distant surface waters via site runoff

Cumulative Effects from Facility Construction

- Water quality degradation in excess of accepted standards due to multiple source loadings

due to increased runoff following proposed site preparation and construction activities?

– Does the construction plan limit the use of materials that can negatively affect the environment, particularly water resources?

– Is there a spill control/response plan that properly addresses spills of hazardous construction materials?

– Will hazardous materials be stored at the construction site? If so, have provisions been identified to keep them in storage buildings located away from construction activities? (Hazardous materials include petroleum products, fuels, solvents, paints, herbicides, and batteries.)

- Is there a potential for toxic pollutants and/or organic matter from waste disposal, effluent discharges, or precipitation runoff from storage areas to have deleterious effects on ground water or surface water?

- Does the assessment attempt to predict pollutant concentrations in ground waters and surface waters and compare results with existing national, state, and local water quality standards and criteria?

- Does the assessment discuss both short- and long-term impacts to the biological community caused by the discharge?

- Does the document assess receiving water temperature distributions around and below discharge locations and compare results with national, state, or local standards? If standards do not exist, does the environmental impact assessment assess the impact of temperature changes on the aquatic ecosystem?

- Would facility operation cause increased sedimentation and habitat destruction?

- Does the document assess aquatic habitats that might be affected by increased sedimentation or alteration of the existing flow patterns of water courses and assess the magnitude of the effect?

4.5.2.3 Geological Resources

The environmental impact assessment should assess the effects of site constructio Construction activities include leveling of hills, removal of rocks and soil, filling or other alterations to existing terrain. Modification of geological resources can d resources through habitat loss. In addition, these alterations indirectly affect wate local runoff patterns and other watershed features.

Potential Primary Effects

- Soil contamination from leaks or spills
- Loss of soil due to erosion

Potential Secondary Effects

- Slope failure
- Destabilization of shorelines

Potential Cumulative Effects

- Desertification

During site preparation and construction, clear-cutting and removal of ground vegetation typically results in soil erosion. Sediment loadings from uncontrolled construction sites have been reported to be on the order of 35 to 45 times greater than loadings from undisturbed woodlands (typically less than 1 ton per year). The extent of impacts to geological resources depends on site geological/topographic features, including slope, soil composition, and soil permeability, and whether or not mitigative measures (e.g., use of vegetative buffers to filter sediments and sediment-bound pollutants) have been implemented.

The majority of impacts to soils are expected to occur during site preparation and construction. After operations begin, however, the potential for soil contamination is high due to spills in raw material/product loading and unloading areas, materials storage areas, and production areas. The potential for soil contamination is also high in areas used for onsite waste storage or treatment facilities.

Frequently, land treatment units or landfills are used; sometimes waste materials are stored in piles or drums. Contaminant runoff or leachate from these areas can percolate through soils to ground water. Soil contamination can also occur from runoff of contaminant residues onto impervious surfaces, such as roads, parking lots, and runways.

- Soil impacts can occur both during facility construction and after, during facility operation

Soil erosion and sedimentation may continue to occur after construction. The extent of the problem depends on the effectiveness of the erosion control techniques used to stabilize the site after construction.

Critical Questions:

- Does the environmental impact assessment determine the potential for soil loss during construction and facility operation and discuss mitigation activities to reduce erosion?

- Does the environmental impact assessment identify potential sources of soil contamination and describe feasible mitigation measures?

4.5.2.4 Biological Resources

During the project construction phase, biological resources may be affected directly through loss of habitat, food resources, nesting areas, or migration routes present within the region of concern or indirectly through sediment loadings into nearby water bodies or pollutant transfer to adjacent soils or surface waters resulting from site runoff.

As discussed in previous sections, facilities may discharge pollutants to air, water, and soils. Contamination of local resources may result in localized or widespread degradation of vegetative or wildlife habitat.

Sediment loadings potentially affect both terrestrial and aquatic resources. Sediment erosion results in loss of ground cover and foraging ranges for terrestrial species. Sediment transport to local water bodies causes burial of bottom dwelling organisms, reduced dissolved oxygen levels, habitat alteration, and, depending on the presence of toxics, bioaccumulative effects.

Critical Questions:

- Does the environmental impact assessment consider potential losses of biological resources (especially rare and game species and/or critical habitat) known to exist within the region of concern?
- Have mitigative measures, such as vegetative buffers to prevent erosion, and spill response plans been included for the site construction phase?
- Does the environmental impact assessment address sediment transport impacts on aquatic resources during construction and operational phases?
- Does the environmental impact assessment describe effluent and emission concentrations and their potential toxic effects to vegetation and wildlife?
- Does the environmental impact assessment discuss potential bioaccumulative effects to biological resources from facility emissions and discharges?

Secondary Effects

- Water quality degradation
- Modification of aquatic habitat from erosion and runoff

Cumulative Effects

- Bioaccumulation of toxics resulting in ecological and human health risks

4.5.3 Habitat Alteration

Habitat alteration is most evident during initial project construction phases. Site preparation and construction can include some degree of land leveling and soil compaction and the erection of production facilities, raw material loading and unloading areas, raw material storage areas, waste storage and disposal areas, and a transportation system for moving materials from one area to another. In the first stage of construction activity, land is cleared and prepared for storing building materials, transporting materials between the storage areas and building sites, and preparing the building sites themselves. For very large facilities, stone crushing, concrete mixing, and other materials processing facilities may also be built onsite. Facility operations affect habitat primarily through pollutant generalization and transport. The extent of impact depends, in large part, on the effectiveness of restoration measures taken during the construction phase.

4.5.3.1 Biological Resources

The extent to which habitats are affected by proposed site clearing and grading depends on the extent to which natural ecosystems were disturbed previously. Conversion of a wooded area results in greater changes than conversion of a former industrial site. The habitats associated with heavily vegetated areas are usually more densely populated and diverse in species than those associated with previously developed sites.

As described earlier, site construction activities may affect air, water, or geological resources in proximity of the proposed site, all of which may serve as habitat for a variety of organisms. Removal of native vegetation during construction directly affects some species by destroying their protective cover, food sources, or roosting, nesting, or breeding sites. Clear-cutting trees within the proposed site results in reduced shading and may increase water temperatures within local water bodies. Over time, this could lead to reductions in dissolved oxygen concentrations and adverse effects on aquatic resources.

Sediment erosion from the proposed site leads to deposition of sediments on stream bottoms, altering the nature of the substrate and changing stream bottom fauna from hard bottom or riffle communities to soft bottom communities. If the stream bottom community changes, the species of fish inhabiting the stream will also change. Depending on previous site uses, sediment may be associated with toxic chemicals that tend to adsorb to particles. If toxic components exist in dust or sediment, the potential for bioaccumulative effects to biological organisms is greater.

The environmental impact assessment should assess the potential damage or destruction of sensitive ecosystems from siting facilities in close proximity. Improper siting with respect to slope and local hydrology can affect sensitive areas by altering the local hydrological regime, increasing runoff and erosion, and destabilizing slopes, dunes, or shorelines.

- Maintaining a minimum habitat size is crucial to the survival of many species of animals, insects, and plants

Even if natural habitats are not destroyed completely by clearing and grading, they may lose their value for some species because available habitat is diminished. Some species require habitat of a particular minimum size in order to survive. If the habitat is disrupted or otherwise reduced in size, for example, by construction of a road, the size of the available habitat type may prevent continued species survival, and individuals may leave the area or succumb.

Additional potential impacts on habitat

- Noise
- Physical disturbance of nesting, breeding, or roosting sites

In addition, the environmental impact assessment should describe noise and disturbance impacts created by construction activities, such as large trucks, bulldozers, and grading equipment, and their potential effects on feeding, breeding, nesting, and other activities of local species, even those inhabiting areas outside the region of concern. Disturbance also

may result in species leaving the area and subsequent effects to local ecosystem dynamics, in a manner similar to habitat fragmentation.

Critical Questions:

- Does the environmental impact assessment assess the potential effects of site preparation and construction activities on air, water, or geological resources?
  - Is the proposed project designed to avoid or mitigate storm water impacts through the use of an infiltration field, retention basins, or other measures to reduce runoff?
  - Does facility siting avoid steep slopes to prevent erosion or slope failures? If the facility is sited on a slope, will erosion control measures, such as maintenance of vegetative cover, application of temporary soil covers (e.g., straw), and timing of construction activities to avoid heavy seasonal rainfall, be used to prevent erosion?
- Does the environmental impact assessment address the potential for construction and site preparation activities to alter critical habitats for wildlife, which could affect the local presence of such species?
  - Does the environmental impact assessment quantify areas and locations of habitats and associated species that would be lost or adversely affected during site preparation and construction activities?
  - Is the construction designed to cause the least possible disturbance to site vegetation (e.g., have attempts been made to preserve old-growth stands or individual trees)?
  - Does the construction plan provide for erosion and sediment control during and after construction?
  - Will soil excavated from the site be reused, for example, as topsoil in landscaped areas?
  - Will disturbed areas be revegetated following construction?
- Is there a potential for indirect changes in habitats following construction and site preparation activities (e.g., increased erosion potential resulting in habitat disturbance through sedimentation in water bodies, disturbance of habitat and/or species from increased human access, modification of watershed)?

Primary Impacts from Facility Construction

- Loss of protective cover, food sources, or roosting, nesting, or breeding sites
- Reduced species abundance and diversity
- Degradation of sensitive ecosystems
- Alteration of aquatic bottom habitat due to sediment erosion and runoff
- Fragmentation or simplification of habitat

Secondary Impacts from Facility Construction

- Dissolved oxygen reductions in surface waters
- Invasion of exotic species

Cumulative Impacts from Facility Construction

- Bioaccumulation of toxics resulting in potential ecological and human health risks.

  - Does the environmental impact assessment identify activities that would indirectly alter habitats and quantify, to the extent feasible, the areas that would be affected indirectly?

- Will the facility be sited at a maximum distance from sensitive areas, such as wildlife habitats, wetlands, floodplains, streambanks, coastlines, and protected preserves?

  - Does the environmental impact assessment identify any sensitive habitats in the vicinity of the proposed site? If so, have all possible mitigative measures been considered (e.g., alternative site selection; site location away from streambanks/beds, floodplains, shorelines, and flood-prone areas) to avoid impacts to sensitive ecosystems?

  - Will buffers, such as wetlands or forests, be used between the proposed development site and water bodies to minimize impacts to aquatic systems?

- If roads, pipelines, or bridges are planned as part of the construction, does the environmental impact assessment discuss taking advantage of existing corridors (e.g., roadways, transmission lines) to avoid disrupting additional habitat?

After construction is completed, impacts from facility operations are related primarily to pollutant generation and transport. Facility operations can emit or discharge contaminants into air, water, or soils, potentially causing environmental degradation and subsequent effects to local biological resources. The following discussion highlights potential impacts to biological resources caused by facility emissions and discharges during operation phases.

Because construction removes much of the existing vegetative cover, the environmental impact assessment should recognize that impacts to local habitats may continue once facility operations begin. The impacts associated with operational activities vary, depending on the proposed site, but can be particularly acute if environmentally sensitive or ecologically important areas are affected. For most construction projects, removed natural vegetation is not replaced onsite, either because the area is rendered impervious or the land is disturbed to a point that it will no longer support native vegetation. Often, the replanting that does occur is done for aesthetic purposes; land is converted to turf grass or ornamental landscaping plants are used. While aesthetically attractive to humans, these non-native vegetative covers do not offer the same level of environmental protection or ecological value as natural vegetation. Thus, the environmental impact assessment should address the impacts caused by loss of native vegetation. Facility operations may also lead to increased access to remote areas, resulting in additional species disturbance.

The absence or scarcity of vegetation removes or reduces the pollutant buffering capacity of the site, contributing to some of the following impacts:

- Increased potential for water pollution because runoff volume and velocity will be increased and will enter water bodies directly without the filtering effects of vegetation;
- Reductions in wildlife species number and abundance due to the loss of habitat and foraging grounds;
- More severe weather conditions, including wider temperature fluctuations and stronger winds generating dust
- Increased noise levels caused by the loss of trees and other vegetative buffer areas.

Wildlife impacts are primarily associated with changes that occur during site preparation and construction. However, many impacts are carried over into the operation phase and remain throughout the life of the facility. Habitat restoration is often impossible during operations because of irreversible damage done to soils and topography or the construction of buildings, roads, and storage areas.

As described previously in this section, the habitat loss associated with vegetation removal can have both primary and secondary effects. Primary impacts to species are expected if organisms depend on the removed vegetation for survival. Secondary impacts include water quality degradation and stream habitat damage resulting from erosion and runoff.

All of these impacts affect the food supplies and living conditions of biological communities, ranging from the smallest microbes to large animals. Food sources may be destroyed, modified, or contaminated. Foraging, nesting, and breeding locations may be degraded or lost permanently. Living and breeding ranges may become fragmented or simplified, leaving areas too small or unstructured to support species. Exotic species may invade a region and out-compete resident species. Travel/migration routes may be altered by the activities and infrastructure involved in constructing and operating a new project. All of these conditions affect the composition, distribution, abundance, health, and vitality of resident species.

Critical Questions:

- Does the environmental impact assessment assess whether facility operations will permanently cause the loss or displacement of vegetation habitat and, therefore, floral species (rare, threatened, endangered, unique or unusual, or commercially valuable species, communities, or habitats)?
- Does the environmental impact assessment identify critical vegetative habitats and associated species that will not be restored following facility construction?
- Does the environmental impact assessment assess changes in local vegetative species composition, diversity, and abundances resulting from loss of specific types of habitats?
- Does the environmental impact assessment address hazards to vegetation from air and water quality degradation?
- Does the environmental impact assessment describe onsite or offsite compensation to replace vegetation loss?
- Does the environmental impact assessment include a monitoring program to ensure effective implementation of mitigation measures?
- Does the environmental impact assessment assess whether facility operations will cause permanent loss or displacement of wildlife habitat and, therefore, faunal species (rare, threatened, endangered, or game species)?
- Does the environmental impact assessment identify critical habitats for wildlife and associated species that will be lost during construction and not replaced during facility operations? Rare, endangered, and commercially valuable species, as well as ecosystems, communities, and habitats should be included within the assessment.
- Does the environmental impact assessment assess changes in local wildlife species composition, diversity, and abundances caused by human activity in the vicinity of the proposed project, including potential invasion by exotic species?
- Will air, water, and soil quality degradation from toxics produced during operation and maintenance activities pose hazards to area fauna (resulting in death or reduced viability)?
- Does the environmental impact assessment assess hazards to wildlife from air, water, and soil quality degradation?

Primary Effects from Facility Operations

- Degradation of habitat due to facility emissions and discharges
- Species disturbance
- Reductions in species abundance and diversity
- Loss of ground cover, food resources, and breeding, roosting, or nesting habitat

Secondary Effects from Facility Operations

- Pollutant transfer to surface waters and associated aquatic organisms due to erosion and runoff
- Modification of aquatic habitat following sediment loading

Cumulative Effects from Facility Operations

- Bioaccumulation of toxics resulting in potential ecological and human health risks

- Does the environmental impact assessment describe migration routes and movement corridors of sensitive species that may potentially be disturbed by facility operation?

- Will onsite or offsite compensation be used to mitigate loss of wildlife?

4.5.4 Waste Management and Pollution Prevention

Waste generation during project construction and operation can be a significant source of adverse environmental impact in the region of concern. Primary impacts result from contamination of air, soil, and water from improper waste storage, handling, transportation, and disposal. Secondary impacts may include placing a burden on the community's waste management capacity. Cumulative impacts can arise from long-term accumulation of toxic pollutants in the region and from the additive effect of multiple sources of wastes on the community's waste management capacity.

A variety of waste management and pollution prevention measures can be implemented during the siting and construction phase to avoid or minimize adverse impacts. The environmental impact assessment should address these measures. Selection of durable, long-lasting materials containing recycled or refurbished components reduces the overall volume of construction waste. Reuse or recycling of construction materials and natural resources, such as trees removed during construction, further reduces waste volumes.

The environmental impact assessment also should address pollution prevention and waste management during the operational phase of the proposed project. The environmental impact assessment should include a description and estimate of project wastes and should address waste type, quantity, and toxic potential. Pollution prevention opportunities should be investigated by the project proponent. The environmental impact assessment should describe the proposed project waste management plan, including treatment, handling, and disposal. Each of these components should be designed to reduce the risk of accidental releases of toxics to the environment. In addition, onsite and offsite waste management techniques and disposal areas should be identified and their long-term capacity defined.

Critical Questions:

- Will the proposed project include the use of durable, long-lasting materials that will not need to be replaced frequently, reducing the amount of construction waste generated over time?

Primary impacts

- Contamination of air, soil, and water from improper waste storage, handling, and disposal

Secondary impacts

- Additional burden on community waste management capacity

Cumulative impacts

- Accumulation of toxic pollutants
- Rapid consumption of community waste management capacity due to the additive effect of multiple wastes

- Does the construction plan include provisions for proper storage of construction materials to reduce the amount of waste caused by damage or exposure to the elements?

- Will perishable materials, such as paints, be purchased incrementally to ensure reduced spoilage of unused materials?

- Will the proposed construction project use materials containing recycled content when possible and in accordance with accepted standards? Examples of recycled content materials include concrete containing fly ash and thermal insulation composed of cellulose.

- Does the environmental impact assessment describe a facility waste management plan with procedures for treatment, handling, and disposal?

- Does the environmental impact assessment discuss projected facility waste characteristics?

- Does the environmental impact assessment assess long-term waste disposal and disposal site capacities?

4.5.5 Socioeconomic Impacts

In addition to the environmental impacts described above, the construction and operation of new projects, or the modification of existing projects, may affect the local socioeconomic framework in a variety of ways. Elements of the socioeconomic impact analysis can include (1) the compatibility of new land uses with existing land uses, (2) issues associated with human and institutional resources and impacts on community structure, and (3) effects on local economic activity. The elements are often interrelated in their response to a particular action. A project-induced change in employment demand, for example, could lead to population movements into or out of a region and, in turn, lead to changes in demand for housing and community services.

The analysis of socioeconomic impacts should consider both impacts on economic activity and on the community. Economic activity can be measured by changes in regional output, employment, and earnings, and the community by changes in population, demand for housing and community services, and effects on land use, transportation, and public finance. The impact analysis should estimate the potential social and economic impacts expected to occur within the region of concern as a result of implementation of the proposed project.

The socioeconomic impacts estimated in the analysis would be generated by the proposed expenditures and employment associated with the proposed project. The total socioeconomic impact includes both

Socioeconomic impacts

- Compatibility of new land uses with existing land uses
- Issues associated with human and institutional resources and impacts on community structure
- Effects on local economic activity

Changes in economic activity

- Regional output
- Employment
- Earnings

Changes in the community

- Population
- Demand for housing and community services
- Land use
- Transportation
- Public finance

primary and secondary impacts. In general, the primary impacts are the estimated changes in project revenues, employment, and payrolls (employee earnings) that would occur during the construction and operations phases (if applicable) of the proposed project. Primary impacts also include the resultant effects on regional population, housing, and community services associated with the change in employment.

Secondary effects are the impacts on regional economic activity that result from regional project-related purchases of goods and services from local business and suppliers. Related impacts include the additional changes in regional economic activity that result from changes in the household spending of employees whose jobs are affected by either the change in employment at the proposed project or the change in employment at regional businesses that results from the secondary impacts to regional economic activity.

4.5.5.1 Land Use

The impact of the proposed project on land use depends on the adequacy of existing land use planning and control practices. These practices should include both a long-term comprehensive plan and effective implementation mechanisms. To the extent the proposed project is consistent with the plan and addresses implementation of land use controls, then potential impacts may be low. If land use planning and control practices are inadequate or ignored, however, potential land use impacts from both the proposed project and possible encroachment activities caused by the proposed project can be significant.

Project Construction

Site preparation for the construction of new projects can disturb large areas of land and may change land use patterns in the area. Open spaces (agricultural land, forested areas, or other vacant land) are often used for these projects. A new land use may not be compatible with, or easily returned to, its original state. In particular, industrial sites and infrastructure projects are not easily converted back to either forest, agricultural, or residential land. The construction sites for large projects in general are frequently considered temporary industrial land uses, regardless of the ultimate land use being developed. Once construction is initiated, the options for converting the proposed site to other land uses become limited.

- Site preparation for the construction of new projects can disturb large areas of land and may change land use patterns in the area

Of particular importance is the potential for land use in the surrounding area to change as a result of construction activities. Housing usually is needed for the large construction crews required to build large facilities, and construction workers generally prefer to live near the work site. If the proposed site is in a predominantly residential area, then housing will not necessarily be a problem (although housing values may change

- Housing is usually needed for the large construction crews required to build large facilities, and construction workers generally prefer to live near the work site

depending on their proximity to the proposed project). If the proposed site is far from a residential area, however, additional housing, often temporary structures, may develop in the immediate vicinity. In addition, small-scale commercial areas tend to develop around construction sites to provide food and services for workers and to provide construction support services.

Critical Questions:

- Are adequate land use planning and control mechanisms in place and enforced?
- Are the proposed project facilities and associated construction activities in conformance with the plan?
- Will the construction and site preparation activities be compatible with the projected uses of adjacent, existing, or planned land uses?
- Is the proposed site located in an area with existing or planned compatible activities or will the facility result in adverse aesthetic impacts or conflict with current or future residential, agricultural, or other land uses?
- Does the environmental impact assessment identify the amount of existing or planned land use areas lost due to site preparation and construction activities? Does the document describe expected changes in land use on adjacent properties?
- Does existing land availability, as determined by zoning and land use plans, conflict with proposed site preparation and construction activities?
- Does the environmental impact assessment determine the extent to which site preparation and construction activities conflict with zoning requirements and existing or future land uses?

Project Operation

Significant land use impacts can occur during the operational phase. A potential major impact on land use is the conversion of nearby land to new uses stimulated by the proposed project. For example, industrial projects may stimulate conversion of nearby land to related industrial activities or residential use to meet the needs of an expanded labor force. Tourism development projects, including resort hotels, frequently stimulate the development of related facilities, such as restaurants, shops, and other attractions. The conversion of additional land may not cause any adverse impacts if it is controlled through effective planning. The environmental impact assessment should discuss the potential for changes to existing land use patterns that might be stimulated by the

- A potential major impact on land use is the conversion of nearby land to new uses stimulated by the proposed project

proposed project. The potential environmental impacts of additional land use changes should be discussed as cumulative impacts.

Given an appropriate local land use planning process and plan, the assessment of the land use attribute of an environmental impact assessment is driven by two evaluation criteria: (1) conformance with the land use plan and (2) compatibility with adjacent land uses. A third criterion, "capacity," is more conveniently addressed under the transportation and community services resources.

Land use evaluation criteria

1) Conformance with the local land use plan
2) Compatibility with adjacent land uses

To the extent that a proposed project directly causes or indirectly induces a land use that does not conform to the land use plan, there is likely to be a significant adverse impact. A determination of conformance may be made by comparing existing land use maps with the future land use plan and superimposing the land use changes associated with the alternative. In some cases, it will be necessary to evaluate more detailed categories of land use than the generic residential, commercial, industrial, agricultural, public use, and open space categories. For example, residential use is often categorized by 5 to 10 density categories (dwelling units per acre), occupancy types (single-family or multi-family), and structural types (e.g., attached, detached, townhouse, apartment). Similarly, industrial land uses include a range of activities, from warehouses to light and heavy manufacturing facilities. Commercial land uses are sometimes very difficult to evaluate for plan conformance because of the market justification of "pockets" of convenience retail activity.

- A determination of conformance may be made by comparing existing land use maps with the future land use plan and superimposing the land use changes associated with the alternative

To the extent that the conformance criterion does not yield meaningful results, individual assessments of land use compatibility may be appropriate. In these instances, it is important to incorporate as many of the local community's values into the assessment of compatibility as possible, except where there are overriding applicable public health considerations. In many communities, "mixed" land use is an important positive aspect of urban living. It is important to note that compatibility does not imply homogeneity.

Critical Questions:

- Do primary and secondary long-term land use changes conform to the local land use plan?

- Does the environmental impact assessment address long-range, comprehensive land use impacts? Are specific impacts addressed in the same timeframe as the local land use plan(s) (e.g., 10 to 20 years)?

- Do land use requirements for operation and maintenance activities (safe zone or buffer zones included) conflict with adjacent present or future land uses as planned by local, regional, and state agencies?

- Will induced growth around the facility change land use in ways that are counter to currently planned land uses for the area?

- Does the environmental impact assessment describe anticipated changes in nearby land use as a result of the facility? Does it evaluate potential conflicts that could occur during operations?

- Are land use controls adequate to prevent conversion of lands designated for protection by the government, such as prime agricultural land, wildlife management areas, cultural heritage sites?

- Are local land use concerns and values used to develop land use compatibility criteria?

4.5.5.2 Economic Activity

Socioeconomic impacts

- Employment patterns
- Population
- Community resources

The types of projects evaluated in environmental impact assessments vary in terms of the potential socioeconomic impacts associated with their implementation. The development of new facilities could generate extensive changes in community structure stemming from changes in population and employment patterns. The construction of major facilities requires a large, trained workforce that may not be available locally and, therefore, would drive population in-migration. Although this potential influx of workers and their families may not be significant in large and diverse communities, the entire economy of small communities may be affected, including employment patterns, population, and community resources. If the proposed project also requires a large operations workforce, the temporary changes associated with the construction phase may become permanent.

Smaller projects, which may not be associated with large expenditures or significant employment demands, would generate socioeconomic impacts of a relatively smaller magnitude. Therefore, the environmental impact assessment would not analyze the impacts in as much detail as for larger, more complex projects. However, it is still necessary for the analysis to quantify the primary impacts associated with the proposed project and to assess the ability of the region of concern to accommodate such a change. It is important to note that some projects (such as the closing of a large facility) may involve an employment decline and subsequent potential out-migration and reduced demand for housing and public services. This discussion, however, focuses on projects associated with increases, rather than decreases, in economic activity.

The project proponent typically provides a description of the primary economic impacts, including anticipated project expenditures, employment, and payrolls. This project-related data should identify employment and expenditure requirements during the construction and operations phases of the proposed project. Direct earnings (or payrolls) can be estimated based on average wage and salary data.

The numerical relationship between the primary impacts in a region and the total impacts generated in the region is defined as a "multiplier." For example, an employment multiplier of 2.5 in a given industry indicates that for every job in that industry, an additional 1.5 jobs are generated within the region. Because different industries and individuals purchase different mixes of goods and services and not all of these goods and services may be available within a given region, each industry generates a different amount of secondary (i.e., primary plus induced) impacts and, thus, will have a different multiplier.

For example, the construction and operation of a lumber mill may be associated with a higher multiplier than the construction and operation of a retail store. Construction of the mill may require greater expenditures and more labor than the store. In addition, the lumber mill may purchase more of its supplies locally than the retail store. This would result in a higher secondary impact for the forest products activity. In addition, the lower wages in the retail industry compared to the forest products industry could result in a lower induced impacts from the retail activity. In general, higher multipliers are associated with industries with the following attributes: greater revenues generated by sales to buyers outside the region, higher relative wage rates, and larger amounts of purchases made locally.

- Economic multipliers vary depending on project characteristics

The multipliers used in the analysis may be obtained from a variety of sources, including government agencies, financial institutions, universities, and other academic entities. The environmental impact assessment should disclose the source of the multipliers, justify the selection, and list the specific multipliers included.

The selected multipliers are then applied to the primary impacts to provide estimated total employment and earnings impacts associated with the proposed project. The number of potential in-migrant or out-migrant workers is often estimated according to a set of migration rate assumptions. These assumed rates of migration may be based on historical migration trends in the region or migration trends experienced in other regions where similar projects were implemented. In general, the higher the skill level and wage rate of the new positions and the smaller the existing available labor pool, the greater the likelihood of migration.

Critical Questions:

- Does the environmental impact assessment address changes in employment patterns associated with each phase of the proposed project?

- Does the environmental impact assessment address the ability of the available labor pool to meet project-related employment needs?

- Does the environmental impact assessment clearly identify the economic multipliers used in the analysis and their source?

- Does the environmental impact assessment discuss the potential change in overall economic activity in the region?

4.5.5.3 Population and Housing

Changes in population following the construction and operation of a new project are an important determinant of other potential socioeconomic and environmental impacts. These population changes have three key components: (1) primary population impacts (relocation of project workers and their families), (2) secondary population impacts (relocation of workers and their dependents associated with project-related expenditures in the region), and (3) natural increases (births minus deaths) and non-project related migration.

Components of population change

1) Primary population impacts
2) Secondary population impacts
3) Natural increases and non-project-related migration

The potential relocation of direct and indirect employees in response to project construction and operation and the related increase in regional economic activity are usually determined based on a set of assumed migration rates, as discussed in the previous section. The number of dependents expected to relocate with these workers may be estimated using average household size statistics gathered during preparation of the description of the environmental setting section.

Housing demand

- Estimate number of workers migrating to project area
- Estimate available housing
- Identify shortfall in housing (if any)

Population changes associated with the proposed project would result in changes in housing demand. Housing demand impacts may be estimated based on the number of estimated migrating workers, assuming one housing unit for each migrating household. Expected housing availability and the extent of potential impacts should be based on recent housing market conditions, vacancy trends, and residential construction activity.

As was mentioned earlier, indigenous populations are particularly vulnerable to environmental and socioeconomic change. When indigenous populations are identified in the region of concern, the environmental impact assessment should assess impacts to the natural resource base on which the population depends for its livelihood and to the cultural fabric of the community. Special development plans are recommended to avoid or mitigate adverse impacts to indigenous populations.

Critical Questions:

- Does the environmental impact assessment address the relationship between employment increases and population in-migration?

- Does the environmental impact assessment identify deficiencies in available housing for the potential increased workforce and their families?

- Does the environmental impact assessment assess potential impacts to indigenous populations?

4.5.5.4 Community Services and Public Finance

- The environmental impact assessment should assess the potential of the proposed project to impact the capacity of the various utilities, transportation systems, and other infrastructure and community services

The environmental impact assessment should assess the potential impact of the construction and operation phases of the proposed project on the capacity of the various utilities, transportation systems, and other infrastructure and community services. Potential impacts to local community services are determined based on the change in the number and composition of the population associated with the proposed project and should be determined for the jurisdictions expected to have the closest linkages to the proposed project and project-related personnel.

It is important that the impacts of the construction and operation phases are assessed separately because they can be very different. For example, the number of people required to operate the new facility may be much less than the number required for construction. The in-migration of workers during the construction phase may be temporary, with temporary living quarters and support services provided by the builder (which would result in relatively few community impacts) or within the local communities (which could result in significant impacts depending on the size of the temporary workforce and current available capacity in the community). After construction is completed, workers could leave the area and the additional housing and services developed to accommodate them would not be needed.

Population changes associated with the operation phase, on the other hand, are generally expected to be long-term or permanent. The changes in demand for housing and community services associated with these population changes tend to be given greater significance because they may permanently alter the structure of local communities and their resources. An environmental impact assessment typically will address the following impacts to community services:

- Projected changes in public school enrollments and the effect on student-to-teacher ratios and school capacity

- Expected changes in the demand for health care services

- Estimated changes in demand for utilities and effects on current capacity.

The potential effects on other public services can also be determined based on the current levels of service and the expected change in the size of the population served.

Local jurisdiction finances may be evaluated based on changes in historic revenues and expenditure levels, changes in fund balances, and reserve bonding capacities. Project-induced impacts on regional public finances should be analyzed, taking into account the expected increase in regional employment, the expected increase in population in each jurisdiction (including school districts), the expected increase in business revenues and employee earnings, and potential changes in the jurisdiction's property tax base.

Critical Questions:

- Does the environmental impact assessment assess deficiencies in community services and infrastructure during project construction and operations?

- If additional support services are envisioned during the construction phase, what will happen to support services during the operation phase?

- Will there be a change in community structure during any phase of the proposed project? For example, would community life-style or stability be affected?

- Does the environmental impact assessment assess any shortfalls in transportation capacity due to either primary or secondary impacts of the proposed project?

4.5.5.5 Transportation

Transportation impacts are generally characterized by (1) the extent to which required transportation improvements are consistent with applicable local transportation plans and (2) the level of service (LOS) resulting from the assignment of project-induced travel demand to various elements of the existing transportation system.

Consistency with local and regional transportation plans is very important, because transportation systems are very capital intensive and current funding is often applied to projects intended to meet travel demand requirements 10 to 20 years in the future. As a result of long-range transportation planning and capital investment, regional transportation systems exert strong influence on private sector locational and production decisions. Proposed projects that do not conform to such transportation plans or that require short-term “ad hoc” changes to the planned system should generally be described as having significant adverse impacts.

Even where conformance with the local and regional transportation plan(s) exists, it is important to scrutinize the elements of the transportation system that are likely to carry the bulk of the primary and secondary transportation demand resulting from the proposed project. Determinations of the level of service with and without the proposed project and alternatives should be made for all affected public thoroughfares and public transportation systems.

The LOS evaluation criterion provides for ratings ranging from "A" (unrestricted free-flow) through "F" (capacity exceeded, large queues, and long delays). In the United States, the threshold criterion for acceptable performance is usually LOS D or E, and new capital improvements are expected to attain LOS C or better. For the larger air, shipping, and rail facilities, there are often industry and port-specific delay factors that translate into LOS equivalencies.

In addition to capacity issues, some projects may generate heavy vehicle traffic (particularly during construction) that exceeds the weight limits for affected roadways and bridges. Such occurrences should generally be mitigated fully because of public safety implications.

Critical Questions:

- Does the environmental impact assessment assess the extent to which the proposed project and alternatives are consistent with local and/or regional transportation plans?

- Does the assessment assess changes in LOS resulting from the proposed project and alternatives?

- Does the assessment assess the effect of heavy vehicle traffic on affected pavement and bridges? Are significant adverse impacts to structural integrity and public safety fully mitigated?

4.5.5.6 Health and Safety

Impacts to health and safety vary among projects. For example, large and complex operations of new industrial facilities can pose threats to the health and safety of workers, the public, and the ecosystem in general. Health and safety issues tend to be more significant during operations, because they occur over an extended period. The three major health and safety concerns are industrial accidents, exposure to contaminants, and noise.

Major health and safety concerns

1) Industrial accidents
2) Exposure to contaminants
3) Noise

Depending on the nature of the proposed project, hazardous or potentially dangerous materials may be used, produced, and/or stored onsite. Workers and the environment may be exposed to these materials through direct contact, exposure to fugitive dust and other air emissions, or spills. The potential for accidents at many facilities can be fairly

high, if large quantities of raw material are used (and transported) around the facility and large volumes of waste are generated and must be handled during disposal. Noise is another challenging problem at some types of facilities.

A health risk assessment may be appropriate to estimate the potential impacts of increased exposure to pollutants. A health risk assessment combines information on human exposure through air, water, and food with information on the toxicity of expected pollutants. The health risk assessment estimates increases in cancer rates and non-cancer health effects for the overall population in the area. It may be appropriate to calculate different health risks for different segments of the population, if there is reason to believe exposure rates may be different. For example, subsistence fishing communities are at greater risk from consumption of contaminated fish than the general population.

- Health risk assessments should assess human exposure through:

  –Air
  –Food
  –Water

Critical Questions:

- Does the environmental impact assessment assess whether construction, operation, and maintenance activities present health and safety hazards to humans working or living at or near the proposed project site?

- Does the environmental impact assessment assess the potential effects of facility noise levels on workers, local communities, and local fauna (e.g., are high frequency sounds emitted during facility operations that may disturb species sensitive to high frequencies, such as birds)?

- Does the environmental impact assessment assess the potential for long-term contaminant bioaccumulation within the food chain?

4.5.5.7 Environmental Equity

The socioeconomic analysis should address the nature of the distribution of both beneficial and adverse impacts across different segments of the population. The analysis should identify specific disadvantaged groups that may endure greater impacts than others (e.g., indigenous populations, migratory workers, minority groups, or specific population segments based on age, sex, or poverty status).

Commonly disadvantaged groups

- Indigenous populations
- Migratory workers
- Minority groups
- Specific population segments based on age, sex, or poverty status

Critical Questions:

- Does the environmental impact assessment assess the equity of changes in employment patterns attributable to site preparation and construction activities?

- Does the environmental impact assessment assess the equity of community structural changes caused by project construction and operations?

4.5.6 Cultural Resources

Clearing and grading activities associated with project construction may affect cultural resources with archeological, historical, religious, societal, or aesthetic value. Site clearing activities may inadvertently collapse or undermine the structural integrity of archeological sites or uncover artifacts and historical sites. Even if these sites are preserved, their historical or archeological significance can be damaged by proximity to industrial or commercial activity. The magnitude of potential impacts varies according to the type of project, local climate, settlement patterns, and capacity of the local government to enforce protection of resources.

The environmental impact assessment should describe the potential impacts on existing and undiscovered cultural resources. The description should include primary impacts (e.g., loss of subsurface artifacts due to paving) and secondary impacts (e.g., generation of smog due to increased commercial and residential traffic) associated with project construction and operation. It should also predict potential cumulative impacts (e.g., the additive effects of increased business, residence, and tourism on sensitive exposed structures over 10 or more years). If a resource cannot be avoided and remains at or near facility operations, the environmental impact assessment should describe approaches for resource protection and mitigation.

Critical Questions:

- Does the environmental impact assessment assess any historical or cultural resources in close proximity to the proposed site following correspondence with appropriate authorities?
- Is there a potential for historical or cultural resources on the proposed site to be disturbed, destroyed, or covered over by proposed site preparation and construction activities?
- Does the environmental impact assessment discuss any mitigation measures necessary to preserve items of archeological, historical, or cultural interest (e.g., restoration of structural elements, rerouting of traffic, erosion control)?
- Does the environmental impact assessment assess historical and cultural resources that could be reduced in value by the presence of the facility, even if impacts were mitigated?
- Does the environmental impact assessment assess the extent to which construction operation and maintenance activities disrupt the aesthetic or sensory attributes of the proposed site?

Types of cultural resource sites

- Archeological
- Historical
- Religious
- Societal
- Aesthetic

- Does the environmental impact assessment assess whether the facility components are designed with consideration given to human factors (e.g., religious, cultural, aesthetic values)?

- Have all potential mitigative measures been assessed (e.g., restoration of structural elements, rerouting of traffic, erosion control)?

4.5.7 Assessment of Potential Environmental Impacts of Alternatives and their Significance Road Map

The assessment of impacts is conducted several times during the environmental impact assessment process. It is performed during the decision to proceed process to determine if the magnitude and nature of potential impacts require that a full environmental impact assessment be conducted, and again in developing the environmental impact assessment document (both in draft and final) in response to comments. It also is a part of reviewer communications and follow up monitoring activities. How does a reviewer determine whether a project proponent has accurately assessed the completeness, adequacy and significance of an environmental or other impact? One way is to answer the following questions, which form the road map for impact review:

In addition to this generalized list, the reviewer should carefully

- The assessment of impacts is prepared several times during the environmental impact assessment process

Road Map for Environmental Impact Review

- All natural and human (socioeconomic) environmental impacts are identified
- Types of impacts include primary, secondary, and cumulative
- Detail on impacts is balanced among reasonable and feasible alternatives
- Both beneficial and adverse impacts are identified
- Potential impacts are identified for all phases of the proposed project
- Models, experts, and criteria accurately used to project the significance of impacts are valid for appropriate circumstances
- Data, information and key assumptions are representative, accurate, and current
- Appropriate criteria are used to characterize significance

examine all of the questions posed under the "Critical Questions" lists in this section, which contain more detailed questions about each component of environmental impact review.

Review of impacts can be divided into three headings:

1. Completeness and Scope;
2. Adequacy of the Assessment of the Magnitude of the Impacts; and
3. Assessment of the Significance of the Impacts.

Completeness and scope: Review of the completeness of impacts that are addressed and the scope of those that are considered worthy of further analysis include:

- Using checklists and guidance documents for the particular type of proposed project;
- Comparing other environmental impact assessments on related projects;
- Assessing coverage in the environmental impact assessment of each phase of the proposed project including project design, site preparation, construction, installation, operation and closure and shutdown;
- Assessing coverage in the environmental impact assessment of all types of impacts: primary, secondary and cumulative;
- Viewing the proposed project from varied perspectives;
- Reviewing maps and overviews of the area affected to determine if sensitive environments, resources, etc., have been overlooked;
- Using people networks and resource materials.
- Reviewing comments raised during scoping and whether they were addressed.

Adequacy of the assessment of the magnitude of the impacts: A reviewer must also examine the adequacy of the analysis. There are basically three types of approaches used:

- Extrapolation from current or past trends and conditions;
- Expert opinion;
- Predictive models.

<u>Reviewing extrapolations from past trends and conditions</u>:
Environmental impact assessments often base their assessments of potential future impacts on a continuation of past trends and conditions. In reviewing extrapolation, a reviewer should look for:

– Documentation of a rationale which justifies the validity of assumptions that existing or past conditions will continue into the future;

– Internal logic running throughout the environmental impact assessment and whether these assumptions are internally consistent;
– Whether expected changes in key assumptions are known to the reviewer or are obvious from the related impacts of the proposed project.

Reviewing use of expert opinion: Environmental impact assessments often rely upon the opinions and analyses of experts in the field. A reviewer will have his or her own experiences as a professional and a reviewer, and must review critically the use of expert opinion regardless of the reviewer's expertise. The reviewer must carefully evaluate the environmental impact assessment document, as well as understand issues and concerns raised by other reviewers; this is the case even if the document or comments on the document are from an individual with more expertise in a particular area than the reviewer. This is critical, because mistakes can be made and people can be biased toward a particular outcome How is this accomplished in a professional and objective manner?

To help identify whether an expert has applied their expertise appropriately or improperly, a reviewer can:
– Have equivalent technical expertise;
– Bring in an outside expert (e.g., a geologist) or have access to in-house expertise/consultants;
– Understand what expertise is and what it is not in this particular circumstance;
– Examine the use of internal quality control programs in the source agency or organization;
– Understand typical areas of concern, such as boundary conditions, appropriate use of models, etc.;
– Have and use a reference library.

Reviewing the use of predictive models:
– Carefully examine the logic and internal consistency of basic assumptions, including the application of models and techniques that were used in the specific situation, and explore the logic and consistent use of assumptions used in evaluating project alternatives;
– Look for documentation that justifies the choice of one model over another;
– Look for boundary conditions which establish the credibility of the model for specific uses and whether those conditions are present in the current application;
– Look for key assumptions and whether they are internally consistent throughout the analysis or whether they are changed in any significant manner in order to use the model.

Other bases for analysis:
– Did the impact assessment overlook an obvious source of information?

– Did the impact assessment assess impacts inconsistently, using some parameters or impacts for some alternatives and not for others?
– Did the impact assessment include both beneficial and adverse impacts?
– Did the impact assessment include quantification wherever possible?

Assessment of the significance of impacts: Review of the issue of significance of impacts may include:

- Justification of findings of insignificant impact: whether they make sense;
- Comparison to regulatory limits;
- Level of controversy;
- Relative change in existing conditions;
- Cumulative impact analysis. This type of analysis is used to determine whether the cumulative impacts of the proposed project, when combined with existing environmental stressors unrelated to the proposed project, will together create significant impacts. For example, reviewers must consider the issue of biological carrying capacity in the affected geographic area, and whether carrying capacity will be affected by primary or cumulative environmental impacts.

There are several ways a reviewer can address the significance of potential environmental impacts when he or she feels it was not adequately addressed in an environmental impact assessment. The reviewer can:

- Evaluate the methodologies and rationales that were used for predicting impacts. Do they make logical sense? How do they compare to standard methodologies in common use in the scientific community?
- Compare the environmental impact assessment to other environmental impact assessments that were prepared for similar projects. Were potential impacts assessed in the same ways? Why or why not?
- Consult with technical experts either within or outside of the reviewer's agency who have expertise with the particular issue area in question.

See Appendix C.2 for further discussion on determining significance of environmental impacts.

4.6 MITIGATION AND MONITORING MEASURES

Even with the best project siting and design, each of the alternatives to a proposed project will have potential environmental impacts. For all adverse potential impacts, especially the significant impacts, the project proponent must suggest mitigation measures. Mitigation is accomplished by refining the proposed project and alternatives during siting, feasibility, and design processes. The goal is to implement projects with as few significant adverse impacts as possible.

In addition to proposing specific mitigation measures, some mechanism for ensuring that mitigation measures are effective must be put into place. This can be achieved through appropriate monitoring measures for each mitigation type.

4.6.1 Hierarchy of Mitigation Measures

- Avoiding an impact by not taking a certain action or parts of an action should be the first consideration

Avoiding an impact altogether by not taking a certain action or parts of an action should be the highest priority in an environmental impact assessment. There are also other types of mitigation measures. Mitigation measures are prioritized with "avoiding or preventing" impacts as the most desirable mitigation measure and "compensating" for a loss as the least desirable (but preferable to loss without compensation). In descending order of desirability, the primary mitigation types can be classified as follows:

- Avoid or prevent impacts altogether by not taking a certain action or parts of an action
- Minimize impacts by limiting the degree or magnitude of the action and its implementation
- Reduce or eliminate the impact over time by preservation and maintenance operations during the life of the proposed project
- Correct the impact by repairing, rehabilitating, or restoring the existing environment
- Compensate for the impact by replacing or providing substitute resources or environments.

This hierarchy reinforces the objective of trying to avoid or minimize potential impacts during project siting and design. The goal is to identify a project and alternatives that meet the purpose and need, yet do so with as little adverse environmental impact as possible, to carry into the impact assessment process.

4.6.2 Scope of Proposed Mitigation

The environmental impact assessment should describe mitigation measures for all significant environmental and social impacts identified. The following list highlights selected general mitigation measures:

- Air Resources
  - Implement an automobile inspection program to reduce impacts of increased traffic
  - Site the facility so that prevailing winds carry emissions away from sensitive resources or population centers
  - Install (and operate and maintain training) fabric filter collectors or electrostatic precipitators to reduce particulate emissions.
- Water Resources
  - Install and operate treatment systems so that discharges do not exceed the waste assimilation capacity of the receiving stream or sewage treatment plant
  - Modify industrial processes to avoid generation of water pollution
  - Maintain vegetative buffer areas along river banks and shorelines to protect water quality.
- Geologic Resources
  - Revegetate cleared areas to protect soils
  - Avoid clearing steep slopes or highly erosional soil
  - Limit the use of heavy machinery where soil compaction is a concern
- Biological Resources
  - Develop land use plans to avoid incompatible use of sensitive areas such as floodplain, coastlines, wetlands, and conservation areas
  - Maintain normal flow regime of aquatic and wetland systems by restricting channelization, preserving natural meanders, and limiting water diversions

  - Replant areas with a variety of native species to avoid introduction of exotic species and dominance of nuisance species.

- Waste Management
  - Develop a materials management spill response plan
  - Provide training to employees
  - Implement a financial accountability plan to cover costs of remediation in the event of an industrial accident
  - Implement a recycling and waste program.

- Socioeconomic Resources
  - Include local communities in the project planning
  - Provide job training for displaced workers
  - Establish reasonable pricing policies for community services
  - Develop an emergency response plan for industrial accidents.

- Cultural Resources
  - Include local communities in the planning process
  - Develop a plan for responding to chance archaeological finds during land clearing
  - Develop cultural resource sensitivity maps delineating areas of high, medium, and low likelihood of containing cultural resources.

Each mitigation measure should be described in enough detail so that its environmental consequences can be assessed and any residual impacts clearly identified.

In addition to specific mitigation measures, an environmental impact assessment document should propose appropriate monitoring plans to measure the effectiveness of the mitigation measures. For example, if a proposed project could potentially harm water quality in a lake, and a mitigation measure consisting of a waste water treatment plant is proposed, the quality of the water discharging from the plant to the lake should be periodically monitored to ensure the lake is not being adversely impacted.

In some countries, the reviewer may require specific mitigation measures as a condition of project approval. In other countries, opportunities for mitigation of environmental impacts are an important consideration in determining the preferred project alternative. The preferred alternative typically reflects choices among tradeoffs. The tradeoffs can include different processes, pollution control technologies, costs, or other features. The environmental impact assessment should describe the process that led to, and the rationale for, the selection of the preferred alternative. The analysis should be deemed complete if:

- All reasonable alternatives were identified and evaluated;
- All potential impacts are identified and assessed for all alternatives;
- All possible refinements and modifications for environmental protection are incorporated in the alternatives;
- Any residual impacts and consequences of mitigating those impacts have been assessed.

4.6.3 Review of Mitigation and Monitoring Measures Road Map

The role of the reviewer is to assess whether proposed mitigation and monitoring measures are complete and adequate. The World Bank Mitigation Tables that are included in the Resource Manual that is associated with the *Principles of Environmental Impact Assessment Review* text developed by EPA are a tool to support the assessment of mitigation measures. In conducting this assessment, the reviewer should ask the following questions, which serve as the road map for mitigation and monitoring review:

Road Map for Mitigation Review

- Specific mitigation measures are proposed
- All significant adverse impacts are addressed by the mitigation plan
- Measures are proposed for:
  - All types of impacts
  - All phases of the proposed project
  - All environment types
- Preferred mitigation measures at the top of the mitigation type hierarchy are considered
- Mitigation measures are described in sufficient detail relative to the significance of impact
- Mitigation measures are:
  - Technically and financially feasible with adequate financial and non-financial resources to implement the measures
  - Socially and culturally acceptable
- Implementation plans include schedules and interim milestones and timing is consistent with other factors presented in the assessment of impact
- Responsible parties are identified and committed to

A reviewer must address the issues set forth in this road map when conducting mitigation and monitoring review. An environmental impact assessment document lacking any of the above components in its mitigation and monitoring section may be inadequate, and the reviewer should communicate this fact to the project proponent along with suggestions on how to correct the inadequacies.

It is important to remember that, aside from avoiding an action, mitigation is often not an absolute prevention of all environmental impact. There is usually some impact, with mitigation implemented in order to lessen that impact. A law of diminishing returns often applies to mitigation, especially pollution reduction. It is often said that it is costlier to prevent the last 5 percent of pollution than the first 95 percent combined. Emissions from coal fired power plants are an example. It is relatively inexpensive to filter out the larger particulate matter before it escapes out of the stacks. However, ensuring that there are **zero**

emissions of sulfur oxides, nitrogen oxides, carbon monoxide and other pollutants can be astronomically expensive, if not impossible.

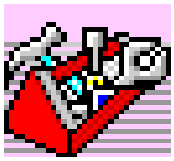
An effective reviewer will develop enough expertise, or know where to find it, to determine how much is enough to ask of a project proponent in terms of mitigation. If the purpose and need for a proposed project are valid, and assessed environmental impacts are acceptable, a reviewer should not expect the project proponent to implement mitigation measures of such cost and difficulty as to prevent the proposed project from moving forward. As in most areas of environmental impact assessment review, a sense of balance is key.

4.7 Tools and Techniques for Environmental Impact Assessment Review

In addition to road maps for review mentioned throughout chapters 3 and 4, there are a variety of "tools and techniques" a reviewer can use to aid his or her review. The following list of tools and techniques is applicable to all elements of a typical environmental impact assessment document and review process. They are also located in Appendix D, along with an indication of where these tools can be found in the course text and resource documents provided.

Tools and Techniques for Environmental Impact Assessment Review

- Information on legal and institutional requirements, policies, and guidance material
- Guidelines
- Road Maps
- Checklists
- Student texts
- Library
- Field reconnaissance
- Analytic and predictive models
- GIS maps and overlays
- Environmental impact assessments for similar projects, geographic area, etc
- Consultation by colleagues/outsiders/experts/academia
- Reviewing other reviewer/public comments



Reviewers are encouraged to use appropriate tools and techniques for each element of the environmental impact assessment document. Further information on these tools and techniques can be found in appendices A through E to this text, as well as in the Resource Manual,

interactive CD-ROM, and case study EIAs that accompany the course *Principles of Environmental Impact Assessment Review.*

Now you are prepared for the important job of reviewer. We appreciate your comments on what is most useful to you and further ideas for best meeting the needs of environmental professionals in the field.