CONTENTS: Water quality impact: Water quality criteria, standards and indices, Impacts on water quality of development projects. Air quality impact: Air quality criteria, standards and indices, air quality impact of industry transport systems

WATER QUALITY PARAMETERS

1.ACIDITY :Arises from the presence of weak or strong acids and/or inorganic salts. The presence of dissolved carbon dioxide is usually the main acidity factor in unpolluted surface waters (it forms the weak acid H_2CO_3 - carbonic acid).

2. ACRYLAMIDE: Highly toxic, acrylamide is a carcinogenic substance. It can also be absorbed readily through unbroken skin and it affects the central nervous system.

3.ALKALINITY: The alkalinity of a natural water is generally due to the presence of bicarbonates formed in reactions in the soils through which the water percolates. It is a measure of the capacity of the water to neutralise acids and it reflects its so-called *buffer capacity* (its inherent resistance to pH change). A poorly-buffered water will have a low or very low alkalinity and will be susceptible to pH reduction by, for example, "acid rain." At times, however, river alkalinity values of up to 400 mg/l $CaCO_3$ may be found; they are without significance in the context of the quality of the water.

4.ALUMINIUM: The compound aluminium sulphate ("alum") is very widely used in water treatment to remove colour and non-filtrable matter in raw waters. The alum is hydrolyzed and is converted to a flocculent hydroxide which, being dense and insoluble, precipitates bringing with it the offending colour and turbidity particles.

5.AMMONIA Ammonia is generally present in natural waters, though in very small amounts, as a result of microbiological activity which causes the reduction of nitrogen-containing compounds. When present in levels above 0.1 mg/l N, sewage or industrial contamination may be indicated.

6.ANTIMONY Naturally occurring trace element used in metal industry and in flame retardant materials. Antimony can occur naturally in water from weathering of rocks but is more likely to arise from effluents.

7.ARSENIC "it is introduced into water through the dissolution of minerals and ores, from industrial effluents, and from atmospheric deposition: concentrations in ground water in some areas are sometimes elevated as a result of erosion from natural sources. The average daily intake of inorganic arsenic in water is estimated to be similar to that from food; intake from air is negligible." Arsenic is used in the glass and semiconductor industries and as a fungicide in timber processing.

8.BARIUM Chemical food is the main source of barium intake by humans, where barium occurs in drinking water supplies the latter can contribute a significant proportion of total intake. Excessive amounts of barium can cause muscular, cardiovascular and renal damage. Although not markedly toxic, barium in excess quantities is clearly undesirable.

9.BENZENE Chemical Constituent of some petroleum products; industrial raw material; solvent. Health/Sanitary Significance: Carcinogenic substance which also affects the central nervous system adversely.

10.BENZO(a)PYRENE Synthetic complex aromatic organic compound formed by pyrolysis or combustion of organic materials Benzo(a)pyrene is a carcinogenic and mutagenic substance which is considered to be highly undesirable in drinking water

11.BERYLLIUM Chemical The major source is combustion of fossil fuels, the metal reaching

waterthrough atmospheric fall- or wash-out. Weathering of rocks and soils, as well as discharges, also contributes. The metal and its compounds, if inhaled for example, are very toxic and can lead to a variety of respiratory and other diseases. The picture regarding the toxicity of beryllium and compounds in water and food is, however, very unclear and there is no compelling evidence in favour of restriction, hence the lack of standards

12.BORON Naturally occurring trace element. Used in cleaning compounds and in alloys. Although excessive amounts of boron can cause nervous problems, the element is not considered a problem in drinking water. It has been identified as a danger to crops when present in irrigation water at the 1 - 2 mg/l concentration range.

13.BROMATE Occurs when bromide ions [Br^-] present in water are oxidized by ozone and some other oxidizing agents

14 CADMIUM Chemical In ores, including those of zinc. Cadmium in water is due nearly exclusively to industrial discharges (e.g. from electroplating, paint-making, manufacture of plastics etc) and landfill leachates.

15.CALCIUM Occurs in rocks, bones, shells etc. Very abundant

16.CARBON DIOXIDE From air, algal respiration, organic breakdown

17.CHLORIDE Chloride exists in all natural waters, the concentrations varying very widely and reaching a maximum in sea water (up to 35,000 mg/l Cl). In fresh waters the sources include soil and rock formations, sea spray and waste discharges. Sewage contains large amounts of chloride, as do some industrial effluents.

18.CHLORINE, RESIDUAL Water treatment processes, industrial effluents, chlorinated sewage and other effluents.

19.CHLOROPHYLL Naturally-occurring green pigment in algae, cyanobacteria, plants, vegetation.

20. CHROMIUM

Chemical Natural occurrence is in ore, but chromium arises in surface waters from discharges from electroplating, tanning, textile, paint and dyeing plants

21.CLOSTRIDIUM PERFRINGENS (Including Spores) Human and animal wastes and/or soil

22.COBALT

Chemical Occurs in ores. Presence in water due to discharges.

23.COLIFORMS, FAECAL & TOTAL Faecal coliforms originate in human and animal waste. Total coliforms
include faecal and also other bacteria with similar properties which originate in soil and are non faecal.

24.COLONY COUNT Incubation on appropriate media plates

25.COLOUR

26.CONDUCTIVITY Reflects mineral salt content of water.

27.COPPER

28.CRYPTOSPORIDIUM *Cryptosporidium* is a small (microscopic) parasite present in

faecal material. It has pathogenic effects in both children and adults, when it enters the gastrointestinal tract and causes an infection termed *cryptosporidiosis*. The effects of the latter include fever, stomach upsets, weight loss and diarrhoea. While healthy adults will normally
recover within three days, the effects on both old and young, and those with weakened immune systems, are much more serious and can lead to death.

29.CYANIDE Industrial effluents (principally electroplating). Health/Sanitary Significance: Cyanide is a reactive, highly toxic entity which in excessive amount will cause mortality rapidly to humans and to fish.

301,2-DICHLOROETHANE Synthetic organic solvent used in various industries. Health/Sanitary Significance: Toxic substance which causes a variety of ill-effects in humans, including eye damage, dermatitis, narcotic effects etc.

31ENTEROCOCCI Sewage and similar wastes.Health/Sanitary Significance: Some members of the group "enterococci" have pathogenic properties.

32ENTEROPATHOGENIC VIRUSES Viruses are pathogens with highly specific reactions, causing several well-known major diseases in man,

33EPICHLOROHYDRIN Toxic substance which is a strong skin irritant and which can cause kidney and other damage. Background Information: Solvent for resins, gums, enamels, cellulose, lacquers etc.

34FLUORIDE Occurs naturally in quite rare instances; arises almost exclusively from fluoridation of public water supplies and from industrial discharges. Health/Sanitary Significance: Health studies have shown that the addition of fluoride to water supplies in levels above 0.6 mg/l F leads to a reduction in tooth decay in growing children and that the optimum beneficial effect occurs around 1.0 mg/l.

35GIARDIA Present in human and animal wastes.Health/Sanitary Significance: *Giardia* is a small (microscopic) parasite present in human and animal wastes which has pathogenic effects m both children and adults. If ingested in water, *Giardia* can cause fever, stomach upsets (often very severe) and diarrhoea; however, it is rarely fatal. The organism is protected by an outer shell (termed a cyst) which affords it protection and permits it to survive for long periods outside the body.

36HARDNESS Hardness is a natural characteristic of water which can enhance its palatability and consumer acceptability for drinking purposes. Health studies in several countries in recent years indicate that mortality rates from heart diseases are lower in areas with hard water

37HEAVY METALS Principally from effluent discharges, or from distribution piping, or from geological formations. Health/Sanitary Significance: Toxic to humans (to a degree varying greatly from metal to metal) and to fish (the hazard levels for which are generally very much lower). Easily accumulable in fish and other tissue and hence liable to enter food chain.

38HYDROCARBONS, DISSOLVED & EMULSIFIED The main implications are organoleptic in the context of this parameter as covered by the Directives and Regulations (see below), but many complex hydrocarbon materials are carcinogenic (e.g. polycyclic aromatic hydrocarbons, q.v.).
Background Information: This heading includes petroleum, oil, grease and related materials. Problems caused by these substances include interference with such vital processes as the mass transfer of oxygen from air to water (essential in river reaeration, for example), blockage of pipes, fouling of plant and animal life, odour and taste problems, and the like.

39.IRON Geological formations (especially under reducing conditions); acid drainage; effluent discharges.Health/Sanitary Significance: The objections to iron are primarily organoleptic, but there has been recent medical concern about high levels in drinking water.

40LEAD Toxic cumulative poison. Background Information: Lead is one of the most commonly determined heavy metals. Because it accumulates in body tissue it follows that strict limits on its presence in raw and
finished drinking waters must be imposed. Particular attention is paid to this element as in many
older houses extensive use is made of lead piping and there is a danger of lead being brought into solution ("plumbosolvency"). Levels may be quite marked in samples taken first thing in the morning when the initial yield will be of water which has been standing in such pipes for perhaps twelve hours. Hence the recommendation that drinking water pipes be flushed briefly in the morning before the water is consumed.

41MAGNESIUM Major constituent of geological formations.

42MANGANESE Widely distributed constituent of ores and rocks. Health/Sanitary Significance: No particular toxicological connotations; the objections to manganese - like iron - are aesthetic

43MERCURY Normally from industrial waste discharges. Health/Sanitary Significance: Very toxic, especially in organo-mercury compounds (e.g. methyl-mercury). This is a very toxic element, the hazards of which are magnified by the accumulation of organo-mercury compounds in fish. It is generally industrial in origin (dental amalgams, anti-fouling paints, plastics manufacture, paper-making and so on) though some comes from the natural environment.

44METHYLENE BLUE-ACTIVE SUBSTANCES Synthetic materials in domestic and industrial wastes. Health/Sanitary Significance: No immediate implications as other problems (see below) will prevent consumption of waters with these materials present.

45MOLYBDENUM Industrial effluents, but low occurrence rate.

46NICKEL Principal sources are minerals and industrial wastes. Health/Sanitary Significance: Very limited.

47NITRATE Oxidation of ammonia: agricultural fertiliser run-off. Health/Sanitary Significance: Hazard to infants above 11 mg/l N [50 mg/l NO_3].

National Sanitation Foundation Water Quality Index (NSFWQI)

Water quality index developed by Brown et al. using Delphi method was done by selecting parameters rigorously, developing a common scale and assigning weights to the parameters. National Sanitation Foundation (NSF) supported this index so also called as NSFWQI. It has been mentioned in many papers because it's the most comprehensive work.Based on experts opinion rating curves are developed to attribute values for variation in the level of water quality caused by different levels of each of the selected parameters.

II. Oregon Water Quality Index (OWQI) The Oregon Water Quality Index, developed by the Oregon Department of Environmental Quality (ODEQ) in the late 1970s and updated several times since then is another frequently used WQI in public domain . However, the original OWQI was discontinued in 1983 on account of the enormous resources required for calculating and reporting the results. With the advancements in the computer technology, enhanced tools of data display and

visualization and a better understanding of water quality, the OWQI was updated in 1995 by refining the original sub-indice, adding temperature and total phosphorus sub-indice, and improving the aggregation calculation. OWQI is calculated by integrating values of eight water quality variables. It was applied for the ambient water quality of Oregon's stream but in its application in other geographic regions or water body caution should be taken. OWQI developed in the 1970's has improved markedly the science of water quality . The original OWQI was modelled after the NSFWQI where the Delphi method was used for variable selection. Delphi method was employed to develop recreational water quality index.

III. Bhargava method Bhargava identified 4 groups of parameters. Each group contained sets of one type of parameters. Coliform organisms were included in the first group which represent the bacterial quality of drinking water. Heavy metals and toxicants were included in the second group. The third group included parameters that cause physical effects, such as odour, colour, and turbidity. Organic and inorganic substances such as sulphate and chloride, etc were included in the fourth group. The simplified model for WQI is given by: WQI = ∏ ( ) Where, n = number of of relevant variables fi(Pi) = function of sensitivity of the ith variable including the effect of weighting of the i th variable This WQI was applied to the raw data in the stretch of river Yamuna at Delhi, India .

IV. Smith's index Index developed by Smith is hybrid of the two common index and based on expert opinion as well as water quality standards used for four water uses i.e., contact as well as non-contact. Delphi method was used for the selection of parameters for each water class, developing sub indices, and assigning weightages.

V. British Columbia Water quality Index (BCWQI) In 1995, BCWQI was developed by the Canadian Ministry of Environment as increasing index for water quality evaluation. This index is similar to Canadian Council of Ministers of the Environment Water Quality Index (CCMEWQI) where water quality parameters are measured and their violation is determined by comparison with a predefined limit.

VI. Canadian Council of Ministers of the Environment (CCME) Water Quality Index (WQI)

For simplifying complex and technical water quality data, a water quality index has developed by the Canadian Council of Ministers of the Environment (CCME) . The CCME WQI is a science-based communication tool that tests multi-variable water quality data against specified water quality benchmarks determined by the user. The WQI mathematically combines three measures of variance (scope, frequency and magnitude) to produce a single unit less number that represents overall water quality at a site relative to the benchmark chosen (e.g., protection of aquatic life). End result is represented as single unit-less number ranging from 0-100 where 100 indicates that the variables were similar to the selected benchmarks or below the benchmark. To simplify, the CCME developed a calculator that is a pre-programmed spreadsheet with mathematical equations

that helps users evaluate the condition (or health) or a water body. In the assessment of spatial and temporal changes in water quality CCME WQI is used which is based on Canadian Water Quality Guidelines .

VII. Overall Index of Pollution (OIP) It was developed by Sargaonker et al. at National Environmental Engineering Research Institute (NEERI), Nagpur, India in order to assess the status of surface waters, specifically under Indian conditions. Based on classification schemes developed by CPCB and one proposed by Prati et al. a general classification scheme has been formulated . OIP developed by Sargaonkar and Deshpande for Indian rivers is based on measurements and subsequent classification of hardness, total dissolved solids, pH, dissolved oxygen, BOD, turbidity, arsenic, fluoride and total coliforms . According to BIS, WHO and European Community standards water quality observations are classified in six categories. The categories are: heavily polluted, polluted, slightly polluted, acceptable and excellent. OIP was calculated as the average of each pollution index assigned to each observation. OIP = ∑ Where Pi = pollution index for ith parameter, n = number of parameters.

VIII. The River Ganga Index As the name indicates it was developed for the water quality assessment of river Ganga. It is based on NSFWQI with weighted multiplication form as set by Central Water Pollution Board, India with slight modifications in the weightages. Four important water quality parameters dissolved oxygen (DO), biochemical oxygen demand (BOD), pH and fecal coliform were selected through Delphi. A weighted sum aggregation function was used to evaluate the overall water quality index. = where Ii = subindex for the ith water quality parameter; wi = weight associated with the ith water quality parameter; P = water quality parameters. This index was used for water quality assessment of river Ganga and to find out the highly polluted areas in the stretch of the river requiring immediate pollution control measures .

IX. Recreational water quality index (RWQI) Ideally, recreational water quality indicators are microorganisms or chemical substances whose concentrations can be quantitatively related to swimming and associated to health hazards. Additional variables causes rigidity problem when included so parameters should be carefully selected for RWQI calculation, but water quality index does not give true water quality due to the faulty aggregation function. Magnitude of aggregated index decreases with increasing water quality variables resulting in ambiguity. Numerical scales related to the degree of quality were established for each variable to assess variation in quality of water and to convey findings in a comprehensive manner to others. These rating curves are, in fact, the essence of the development of this index. Rating curves have the ability to reproduce the relationship between swimming-associated illness and water quality indicator. Waters with slight colour, scum, apparent non-natural turbidity, 0.50 for Water with polluted appearance and strong odour, 0.25 for black waters that present fermentations and odours. For each sample assessed, the sum of the weighted parameters being considered is calculated and multiplied by a constant related to the sample's sensitivity features, such as appearance and water odour. The parameters frequently

used are: major ions, biochemical oxygen demand (BOD), dissolved solids or those in suspension, nitrogen compounds, phosphorous sulphur, pH, hardness, turbidity, electrical conductivity and toxic and pathogenic elements. The major ions were used for assessing WQIs in the Mexico Basin. The ICA indices range from 0 to 100, and quality scales are 90-100 (Excellent), 80-90 (Acceptable), 70-80 (Slightly polluted), 50-70 (Polluted), 40-50 (Strongly polluted), and 0-40 (Excessively polluted). XI. Contamination index (CI) The CI represents the sum of the individual factors of those components that exceed permissible values, as established by the EPA. This method makes possible to assess and map the degree of groundwater contamination. It takes into account ion elements and species that exceed permissible limits for human health, according to Environmental Protection Agency guidelines. Assessment of the CI was carried out as follows: Cd = ∑ Where, = − 1 Cfi is the contamination factor for the Nth component, N =total number of parameters CAi is the analytical value of the Nth component CNi is the permissible superior concentration of the Nth component This method uses the ion elements and species contained in the groundwater, as previously determined by chemical sample analysis done in the laboratory, and that exceed maximum limits

XII. Aquatic Toxicity Index (ATI) It was developed by Wepener et al. to assess the health of aquatic ecosystems. Since extensive toxicity database are available for fishes, the toxic effects of different water quality to fishes have been employed as health indicators of the aquatic ecosystem . The physical water quality parameters employed were pH, dissolved oxygen and turbidity while the chemical determinant included ammonium, total dissolved salts, fluoride, potassium and orthophosphates and the potentially hazardous metals chosen were total zinc, manganese, chromium, copper, lead and nickel concentrations. An ATI scale, similar to the WQI scale proposed by Smith for salmonid spawning was used. The Solway modified un-weighted additive aggregation function was initially employed to aggregate the values obtained from the rating curves [33]. = · ∑ 2 Where I is the final index score, qi is the quality of the ith parameter (a value between 0–100) and n is the number of determinants in the indexing system. Wepener et al. didn't employ the weighted sum system, as too little information is available about the importance of one determinant compared to another under different local conditions and the inherent chemistry of the system as a whole.

XIII. Dinius Water Quality Index (DWQI) It is a multiplicative water quality index developed by Dinius for six categories of water uses: public water supply, recreation, fish, shellfish, agriculture and industry. He employed the liberal use of Delphi for decision making. The index included 12 parameters: dissolved oxygen, 5-day BOD, coliform count, E-coli count, pH, alkalinity, hardness, chloride, specific conductivity, temperature, colour and nitrate. The weightage of each parameter was assigned based on the evaluation of importance by the Delphi panel members. The individual sub-index functions were combined with the help of a multiplicative aggregation function as follows = Where, IWQ is the Dinius water quality index whose value ranges from 0–100, Ii is the

subindex function of the pollutant parameter, Wi is the unit weight of the pollutant parameter whose value ranges from, 0–1 and n is the number of pollutant parameters.

Air Quality Index-It is Index for reporting air quality and Provides indicator of the quality of the air and its health effects

AIR QUALITY STANDARDS

The Clean Air Act requires EPA to set two types of outdoor air quality standards: primary standards, to protect public health, and secondary standards, to protect the public against adverse environmental effects. The law requires that primary standards be "requisite to protect public health with an adequate margin of safety," including the health of people most at risk from PM exposure. These include people with heart or lung disease, children, older adults and people of lower socioeconomic status. Secondary standards must be "requisite to protect the public welfare" from both known and anticipated adverse effects. Standards to Protect Public Health EPA reviewed thousands of studies as part of this review of the standards, including hundreds of new studies published since EPA completed the last review in 2006.

The new evidence includes more than 300 new epidemiological studies, many of which report adverse health effects even in areas that meet the current PM2.5 standards. EPA also considered analyses by agency experts, input from the independent Clean Air Scientific Advisory Committee (CASAC) and extensive public comments. In addition, the agency conducted a provisional review of significant new studies, including studies submitted during the public comment period on the proposed standards. New studies continue to report a wide range of health effects associated with both long- and short-term exposures to PM2.5. 2 Primary (Health) Standards for Fine Particles: EPA has set both an annual and a 24-hour standard for PM2.5. These standards work together to protect public health from harmful health effects from both long- and short term fine particle exposures.

Revised annual standard: The primary annual fine particle standard is designed to protect against health effects associated with both long- and short- term exposure to PM2.5. The existing annual standard has been in place since 1997.EPA has determined that the current annual fine particle standard (set in 1997) is not adequate to protect public health as required by law. Primary (Health) Standard for Coarse Particles Studies suggest that short-term exposure to coarse particles (PM10) may be linked to premature death and increased hospital admissions and emergency department visits for heart and lung disease. EPA is retaining the existing primary 24-hour standard for coarse particles at 150 µg/m3 . An area meets the 24-hour PM10 standard if it does not exceed the 150 µg/m3 level more than once per year on average over a three-year period. 3 The existing coarse particle standard has been in place since 1987. Secondary Standards for Particle Pollution: Particle pollution causes haze in cities and some of the country's most treasured national parks. In addition, particles such as nitrates and sulfates contribute to acid rain formation which makes lakes, rivers and streams unsuitable for many fish. Acid rain also erodes buildings, historical monuments and paint on cars. Particle pollution also can affect the climate by absorbing or reflecting sunlight, contributing to cloud formation and influencing rainfall patterns. EPA is retaining the levels of the existing secondary standards for PM2.5 and PM10 to address PM-related effects such ecological effects, damage to materials and climate impacts.

REVISIONS TO THE AIR QUALITY INDEX

EPA is updating the Air Quality Index (AQI) for fine particle pollution (PM2.5). The AQI is EPA's color-coded tool for telling the public how clean or polluted the air is, and steps they can take to reduce their daily exposure to pollution. The AQI converts concentrations for fine particles to a number on a scale from 0 to 500. EPA is changing the upper end of the range for the "Good" AQI category (an index value of 50) by setting it at the level of the revised annual PM2.5 standard (12.0µg/m3). 4 EPA also is setting the 100 value of the index at the level of the current 24-hour PM2.5 standard, which is 35 µg/m3 . An AQI of 100 is the upper end of the "Moderate" range, and the level above which EPA begins cautioning at-risk groups. In addition, EPA is setting the upper end of the "Unhealthy for Sensitive Groups" range (AQI of 150) at 55 µg/m3. EPA is retaining the existing level of 500 µg/m3 for the upper end ofthe "Hazardous" category (AQI of 500). The agency also is retaining the existing levels of 150 µg/m3 and 250 µg/m3 for the upper ends of the "Unhealthy" (AQI of 200) and "Very Unhealthy" (AQI of 300) categories. .

Impact of industry transport systems

The **environmental impact of transport** is significant because transport is a major user of energy, and burns most of the world's petroleum. This creates air pollution, including nitrous oxides and particulates, and is a significant contributor to global warming through emission

of carbon dioxide. Within the transport sector, road transport is the largest contributor to global warming.

Environmental regulations in developed countries have reduced the individual vehicle's emission. However, this has been offset by an increase in the number of vehicles, and increased use of each vehicle (an effect known as the Jevons paradox). Some pathways to reduce the carbon emissions of road vehicles have been considerably studied. Energy use and emissions vary largely between modes, causing environmentalists to call for a transition from air and road to rail and human-powered transport, and increase transport electrification and energy efficiency.

The transportation sector is a major source of greenhouse gas emissions (GHGs) in the United States. An estimated 30 percent of national GHGs are directly attributable to transportation—and in some regions, the proportion is even higher. Transportation methods are the greatest contributing source of GHGs in the U.S., accounting for 47 percent of the net increase in total U.S. emissions since 1990.

Other environmental impacts of transport systems include traffic congestion and automobile-oriented urban sprawl, which can consume natural habitat and agricultural lands. By reducing transportation emissions globally, it is predicted that there will be significant positive effects on Earth's air quality, acid rain, smog and climate change.

The health impact of transport emissions is also of concern. A recent survey of the studies on the effect of traffic emissions on pregnancy outcomes has linked exposure to emissions to adverse effects on gestational duration and possibly also intrauterine growth.

Direct impacts such as noise pollution and carbon monoxide emissions create direct and harmful effects on the environment, along with indirect impacts. The indirect impacts are often of higher consequence which leads to the misconception that it's the opposite since it is frequently understood that initial effects cause the most damage. For example, particulates which are the outcome of incomplete combustion done by an internal combustion engine**,** are not linked with respiratory and cardiovascular problems since they contribute to other factors not only to that specific condition. Even though the environmental impacts are usually listed individually there are also cumulative impacts. The synergetic consequences of transport activities. They take into account of the varied effects of direct and indirect impacts on an ecosystem. Climate change is the sum total impact of several natural and human-made factors. 15% of global CO_2 emissions are attributed to the transport sector.

Contents: Noise, Effects of noise on people, noise scales and rating methods, Noise barriers, estimating transportation noise impacts. Land Pollution due to construction activities. Biota: Impact on fauna and flora, mitigation measures, alternatives

Noise sources and their measurement

Basic Aspects of Acoustical Measurements Most environmental noises can be approximately described by one of several simple measures. They are all derived from overall sound pressure levels, the variation of these levels with time and the frequency of the sounds. Ford (1987) gives a more extensive review of various environmental noise measures.

Sound pressure level The sound pressure level is a measure of the air vibrations that make up sound. All measured sound pressures are referenced to a standard pressure that corresponds roughly to the threshold of hearing at 1 000 Hz. Thus, the sound pressure level indicates how much greater the measured sound is than this threshold of hearing. Because the human ear can detect a wide range of sound pressure levels (10–102 Pascal (Pa)), they are measured on a logarithmic scale with units of decibels (dB). A more technical definition of sound pressure level is found in the glossary. The sound pressure levels of most noises vary with time. Consequently, in calculating some measures of noise, the instantaneous pressure fluctuations must be integrated over some time interval. To approximate the integration time of our hearing system, sound pressure meters have a standard Fast response time, which corresponds to a time constant of 0.125 s. Thus, all measurements of sound pressure levels and their variation over time should be made using the Fast response time, to provide sound pressure measurements more representative of human hearing. Sound pressure meters may also include a Slow response time with a time constant of 1 s, but its sole purpose is that one can more easily estimate the average value of rapidly fluctuating levels. Many modern meters can integrate sound pressures over specified periods and provide average values. It is not recommended that the Slow response time be used when integrating sound pressure meters are available. Because sound pressure levels are measured on a logarithmic scale they cannot be added or averaged arithmetically. For example, adding two sounds of equal pressure levels results in a total pressure level that is only 3 dB greater than each individual sound pressure

level. Consequently, when two sounds are combined the resulting sound pressure level will be significantly greater than the individual sound levels only if the two sounds have similar pressure levels.

Individual noise events It is often desired to measure the maximum level (LAmax) of individual noise events. For cases such as the noise from a single passing vehicle, LAmax values should be measured using the Fast response time because it will give a good correlation with the integration of loudness by our hearing system. However, for very short-duration impulsive sounds it is often desirable to measure the instantaneous peak amplitude to assess potential hearing-damage risk. If actual instantaneous pressure cannot be determined, then a time-integrated 'peak' level with a time constant of no more than 0.05 ms should be used (ISO 1987b). Such peak readings are often made using the C- (or linear) frequency weightings. Alternatively, discrete sound events can be evaluated in terms of their A-weighted sound exposure level . The total amount of sound energy in a 23 particular event is assessed by the SEL. One can add up the SEL values of individual events to calculate a LAeq,T over some time period, T, of interest. In some cases the SEL may provide more consistent evaluations of individual noise events because they are derived from the complete history of the event and not just one maximum value. However, A-weighted SEL measurements have been shown to be inadequate for assessing the (perceived) loudness of complex impulsive sounds, such as those from large and small weapons (Berglund et al. 1986). In contrast, C-weighted SEL values have been found useful for rating impulsive sounds such as gun shots (Vos 1996; Buchta 1996; ISO 1987b).

Choice of noise measure LAeq,T should be used to measure continuing sounds such as road traffic noise, many types of industrial noises and noise from ventilation systems in buildings. When there are distinct events to the noise such as with aircraft or railway noise, measures of the individual events should be obtained (using, for example, LAmax or SEL), in addition to LAeq,T measurements. In the past, time-varying environmental sound levels have also been described in terms of percentile levels. These are derived from a statistical distribution of measured sound levels over some period. For example, L10 is the A-weighted level exceeded 10% of the time. L10 values have been widely used to measure road-traffic noise, but they are usually found to be highly correlated measures of the individual events, as are LAmax and SEL. L90 or L95 can be used as a measure of the general background sound pressure level that excludes the potentially confounding influence of particular local noise events.

Sound and noise Physically, there is no distinction between sound and noise: sound is a sensory perception evoked by physiological processes in the auditory brain. The complex pattern of sound waves is perceptually classified as "Gestalts" and are labeled as noise, music, speech, etc. Consequently, it is not possible to define noise exclusively on the basis of the physical parameters of sound. Instead, it is common practice to define noise simply as unwanted sound. However, in some situations noise may adversely affect health in the form of acoustical energy.

Sources of Noise This section describes various sources of noise that can affect a community. Namely, noise from industry, transportation, and from residential and leisure areas. It should be noted that equal values of LAeq,T for different sources do not always imply the same expected effect.

Industrial noise Mechanized industry creates serious noise problems. It is responsible for intense noise indoors as well as outdoors. This noise is due to machinery of all kinds and often increases with the power of the machines. Sound generation mechanisms of machinery are reasonably well understood. The noise may contain predominantly low or high frequencies, tonal components, 24 be impulsive or have unpleasant and disruptive temporal sound patterns. Rotating and reciprocating machines generate sound that includes tonal components; and air-moving equipment tends also to generate noise with a wide frequency range. The high sound pressure levels are caused by components or gas flows that move at high speed (for example, fans, steam pressure relief valves), or by operations involving mechanical impacts (for example, stamping, riveting, road breaking). Machinery should preferably be silenced at the source. Noise from fixed installations, such as factories or construction sites, heat pumps and ventilation systems on roofs, typically affect nearby communities. Reductions may be achieved by encouraging quieter equipment or by zoning of land into industrial and residential areas. Requirements for passive (sound insulating enclosures) and active noise control, or restriction of operation time, may also be effective.

Transportation noise Transportation noise is the main source of environmental noise pollution, including road traffic, rail traffic and air traffic. As a general rule, larger and heavier vehicles emit more noise than smaller and lighter vehicles. Exceptions would include: helicopters and 2- and 3-wheeled road vehicles. The noise of road vehicles is mainly generated from the engine and from frictional contact between the vehicle and the ground and air. In general, road-contact noise exceeds engine noise at speeds higher than 60 km/h. The physical principle responsible for generating noise from tire road contact is less well understood. The sound pressure level from traffic can be predicted from the traffic flow rate, the speed of the vehicles, the proportion of heavy vehicles, and the nature of the road surface. Special problems can arise in areas where the traffic movements involve a change in engine speed and power, such as at traffic lights, hills, and intersecting roads; or where topography, meteorological conditions and low background levels are unfavourable (for example, mountain areas). Railway noise depends primarily on the speed of the train, but variations are present depending upon the type of engine, wagons, and rails and their foundations, as well as the roughness of wheels and rails. Small radius curves in the track, such as may occur for urban trains, can lead to very high levels of high-frequency sound referred to as wheel squeal. Noise can be generated in stations because of running engines, whistles and loudspeakers, and in marshaling yards because of shunting operations. The introduction of high-speed trains has created special noise problems with sudden, but not impulsive, rises in noise. At speeds greater than 250 km/h, the proportion of high-frequency sound energy increases and the sound can be perceived as similar to that of overflying jet aircraft. Special problems can arise in

areas close to tunnels, in valleys or in areas where the ground conditions help generate vibrations. The long-distance propagation of noise from high-speed trains will constitute a problem in the future if otherwise environment-friendly railway systems are expanded. Aircraft operations generate substantial noise in the vicinity of both commercial and military airports. Aircraft takeoffs are known to produce intense noise, including vibration and rattle. The landings produce substantial noise in long low-altitude flight corridors. The noise is 25 produced by the landing gear and automatic power regulation, and also when reverse thrust is applied, all for safety reasons. In general, larger and heavier aircraft produce more noise than lighter aircraft. The main mechanism of noise generation in the early turbojet-powered aircraft was the turbulence created by the jet exhaust mixing with the surrounding air. This noise source has been significantly reduced in modern high by-pass ratio turbo-fan engines that surround the high-velocity jet exhaust with lower velocity airflow generated by the fan. The fan itself can be a significant noise source, particularly during landing and taxiing operations. Multi-bladed turbo-prop engines can produce relatively high levels of tonal noise. The sound pressure level from aircraft is, typically, predicted from the number of aircraft, the types of airplanes, their flight paths, the proportions of takeoffs and landings and the atmospheric conditions. Severe noise problems may arise at airports hosting many helicopters or smaller aircraft used for private business, flying training and leisure purposes. Special noise problems may also arise inside airplanes because of vibration. The noise emission from future super jets is unknown. A sonic boom consists of a shock wave in the air, generated by an aircraft when it flies at a speed slightly greater than the local speed of sound. An aircraft in supersonic flight trails a sonic boom that can be heard up to 50 km on either side of its ground track, depending upon the flight altitude and the size of the aircraft (Warren 1972). A sonic boom can be heard as a loud double boom sound. At high intensity it can damage property. Noise from military airfields may present particular problems compared to civil airports For example, when used for night-time flying, for training interrupted landings and takeoffs (so-called touch-and-go), or for low-altitude flying. In certain instances, including wars, specific military activities introduce other intense noise pollution from heavy vehicles (tanks), helicopters, and small and large fire-arms.

Construction noise and building services noise Building construction and excavation work can cause considerable noise emissions. A variety of sounds come from cranes, cement mixers, welding, hammering, boring and other work processes. Construction equipment is often poorly silenced and maintained, and building operations are sometimes carried out without considering the environmental noise consequences. Street services such as garbage disposal and street cleaning can also cause considerable disturbance if carried out at sensitive times of day. Ventilation and air conditioning plants and ducts, heat pumps, plumbing systems, and lifts (elevators), for example, can compromise the internal acoustical environment and upset nearby residents.

Domestic noise and noise from leisure activities In residential areas, noise may stem from mechanical devices (e.g. heat pumps, ventilation systems and traffic), as well as voices, music and

other kinds of sounds generated by neighbour (e.g. lawn movers, vacuum cleaners and other household equipment, music reproduction and noisy parties). Aberrant social behavior is a well-recognized noise problem in multifamily dwellings, as well as at sites for entertainment (e.g. sports and music events). Due to predominantly low-frequency components, noise from ventilation systems in residential buildings may also cause considerable concern even at low and moderate sound pressure levels. 26 The use of powered machines in leisure activities is increasing. For example, motor racing, off road vehicles, motorboats, water skiing, snowmobiles etc., and these contribute significantly to loud noises in previously quiet areas. Shooting activities not only have considerable potential for disturbing nearby residents, but can also damage the hearing of those taking part. Even tennis playing, church bell ringing and other religious activities can lead to noise complaints. Some types of indoor concerts and discotheques can produce extremely high sound pressure levels. Associated noise problems outdoors result from customers arriving and leaving. Outdoor concerts, fireworks and various types of festivals can also produce intense noise. The general problem of access to festivals and leisure activity sites often adds to road traffic noise problems. Severe hearing impairment may also arise from intense sound produced as music in headphones or from children's toys.

Land pollution, in other words, means degradation or destruction of the Earth's surface and soil, directly or indirectly, as a result of human activities. Anthropogenic activities are conducted citing development, and the same affects the land drastically as we witness land pollution.

By drastic, we are referring to any activity that lessens the quality and/or productivity of the land as an ideal place for agriculture, forestation, construction etc. The degradation of land that could be used constructively, in other words, is land pollution.

Land Pollution has led to a series of issues that we have come to realize in recent times, after decades of negligence. The increasing numbers of barren land plots and the decreasing numbers of forest cover are increasing at an alarming ratio.

Disastrous Effects of Land Pollution

1. Soil Pollution

Soil pollution is another form of land pollution, where the upper layer of the soil or the topsoil's composition is damaged or becomes altered. This is caused by the overuse of chemical fertilizers, soil erosion triggered by running water and other pest control measures, leading to loss of fertile land for agriculture, forest cover, fodder patches for grazing, etc.The regeneration process takes at least 500 years for 2.5 centimeters of topsoil. The United States loses soil at the rate 17 times higher than it usually takes to generate new topsoil

2. Groundwater Poisoning

When harmful substances from industrial processes, chemicals are improperly disposed of on the land or in illegal landfills or storages, the chemicals and other substances could end up in the groundwater system.The process is called leaching. It can happen on farms, industrial sites, and landfills and affect the health of animals, plants and also humans.

3. Drinking-Water Problem

Drinking water is highly affected by land pollution. Nearly 50% of the world's population does not have access to safe drinking water, and each year water-based diseases cause up to 10 million deaths.

4. Change in Climate Patterns

The effects of land pollution are very hazardous and can lead to the loss of ecosystems. When land is polluted, it directly or indirectly affects the climate patterns.

5. Environmental Impact

When deforestation is committed, the tree cover is compromised. This leads to a steep imbalance in the rain cycle. A disturbed rain cycle affects a lot of factors.Most importantly, the green cover is reduced. Trees and plants help balance the atmosphere; without them, we are subjected to various concerns like Global warming, the greenhouse effect, irregular rainfall and flash floods, among other imbalances.

6. Effect on Human Health

The land, when contaminated with toxic chemicals and pesticides, lead to potentially fatal problems like skin cancer and the human respiratory ailments in particular. Globally, 9,500 people are diagnosed with skin cancer every day. The toxic chemicals can reach our body through foods and vegetables that we eat as they are grown in polluted soil.Land pollution also caused developmental deficiency in children. Chemicals, such as lead that are commonly found in contaminated soil and water, can impact a child's cognitive development even when the exposure is very low.

7. Causes Air Pollution

Landfills across the city keep on growing due to an increase in waste and are later burned, which leads to air pollution. They become home for rodents, mice, etc., which in turn transmit diseases.

8. Distraction for Tourists

The city loses its attraction as a tourist destination as landfills do not look good when you move around the city. It leads to a loss of revenue for the state government.

9. Effect on Wildlife

The animal kingdom has suffered most in the past decades. They face a serious threat with regard to the loss of habitat and natural environment.

The constant human activity on land is leaving it polluted, forcing these species to move further away and adapt to new regions or die trying to adjust. Several species are also pushed to the verge of extinction, due to no homeland.

10. Water Nutrient Enrichment

Chemicals that are frequently used on agricultural farms, such as nitrogen, end up benefitting the crops only in a small proportion. The rest ends up in water populated by fish, algae, and other lifeforms.

As the nutrient-heavy water saps up most of the oxygen in the water, it leaves little oxygen for fish and other marine life. The water in that situation becomes unable to support most life forms.

11. Wildfires

When land areas are polluted, they usually become quite dry. The dry conditions created by pollutants in the soil create the perfect environment for wildfires and increases the probability of wildfires dramatically. The fires can grow quickly because of the dry conditions and widening area of polluted land, thereby harming the whole environment and killing plants, animals and even humans.

12. Habitat Shifting

When deforestation and soil erosion are in progress, animals are forced to move from their natural habitat to find shelter and food. The change is too traumatic for some animals, and this even leads to loss of life. As a consequence, some species are posed with a greater risk of extinction.

13. Other Issues

Other issues that we face include increased temperature, unseasonal weather activity, acid rains, etc. The discharge of chemicals on land makes it dangerous for the ecosystem too.

These chemicals are consumed by the animals and plants and thereby making their way in the ecosystem. This process is called bio magnification and is a serious threat to the ecology.

Amazing Solutions To Land Pollution

1. Make people aware of the concept of Reduce, Recycle and Reuse.

2. Reusing materials help to reduce the requirement of harvesting resources. The products that cannot be reused can likely be recycled.

3. Reduce the use of pesticides and fertilizers in agricultural activities.

4. Reduce the use of non-biodegradable materials. By simply switching to a reusable cloth bag for groceries instead of plastic shopping bags will help cut down on the need for non-biodegradable materials.

Landfills and reclamations are being planned and executed to meet the increased demand for lands. This leads to further deterioration of land, and pollution caused by the landfill contents. Also, due to the lack of green cover, the land gets affected in several ways, like soil erosion, which washes away the fertile portions of the land. A landslide can also be viewed as an example.

Various Causes of Land Pollution

Deforestation and Soil Erosion

Deforestation carried out to create drylands is one of the major concerns. Land that is once converted into dry or barren land can never be made fertile again, whatever the magnitude of measures to redeem it is.

Land conversion, meaning the alteration or modification of the original properties of the land to make it use-worthy for a specific purpose, is another major cause. It hampers the land immensely.

Also, there is a constant waste of land. Unused available land over the years turns barren; this land then cannot be used. So in search of more land, potent land is hunted, and its indigenous state is compromised.

2. Agricultural Activities

With the growing human population, the demand for food has increased considerably. Farmers often use highly toxic fertilizers and pesticides to get rid of insects, fungi and bacteria from their crops. However, with the overuse of these chemicals, they result in contamination and poisoning of soil.

3. Mining Activities During extraction and mining activities, several land spaces are created beneath the surface. We constantly hear about land caving in, which is nothing but nature’s way of filling the spaces left out after mining or extraction activity.

4. Overcrowded Landfills

Each household produces tonnes of garbage each year. Garbage like aluminum, plastic, paper, cloth, wood is collected and sent to the local recycling unit. Items that can not be recycled become a part of the landfills that hamper the beauty of the city and cause land pollution.

5. Industrialization

Due to an increase in demand for food, shelter, and house, more goods are produced. This resulted in the creation of more waste that needs to be disposed of.

To meet the demand of the growing population, more industries were developed, which led to deforestation. Research and development paved the way for modern fertilizers and chemicals that were highly toxic and led to soil contamination.

6. Urbanization

We humans have been making permanent settlements for at least the past 10,000 years. Most of the cities and towns, and the infrastructure created, will remain with us for thousands of more years into the future.

Many of us may not classify human settlements as “land pollution;” however, urbanization marks a significant change to the landscape that can cause land pollution in a variety of subtle and not-so-subtle ways.

7. Construction Activities

Due to urbanization, a large number of construction activities are taking place, which has resulted in huge waste articles like wood, metal, bricks, plastic that can be seen by naked eyes outside any building or office which is under construction.

8. Nuclear Waste

Nuclear plants can produce a huge amount of energy through nuclear fission and fusion. The leftover radioactive material contains harmful and toxic chemicals that can affect human health. They are dumped beneath the earth to avoid any casualty.

9. Sewage Treatment

A large amount of solid waste is leftover once the sewage has been treated. The leftover material is then sent to the landfill site, which ends up polluting the environment.

10. Littering

Littering is a common problem, no matter it is a city or a rural region. People just throw their garbage on the ground without caring about the adverse effects on the environment.

A common instance is that people just throw their cigarette butt on the ground every time. Since cigarettes contain elements harmful to the environment, it leads to land contamination.

Impacts on flora, fauna and vulnerable ecosystems

Since waste always contains organic matter, a landfill will attract insects, birds and animals, e.g. scavengers such as vultures, hyenas and jackals feeding on the waste. Insects and some animals, e.g. rats, breed in the rubbish and can represent a health problem. The food in the landfill can also contribute to the growth of unnaturally large populations of some species, which will in turn contribute to the displacement of other species, and so imbalance the local ecosystem. Moreover, species being displaced may be species constituting a part of the nutritional base for the local population.

Large landfills with associated roads can create barriers that disturb feeding and breeding patterns of fauna, and in other ways occupy vital habitats of flora and fauna. Landfills should in no way be localized near mangrove swamps or other especially vulnerable or conservation-worthy ecosystems. Noisy activities can have negative impacts on fauna, and gases from landfills and incinerators may damage surrounding vegetation. Pollution of watercourses and canals can cause damage to vegetation, fish and fauna.

During the construction phase of preparing a landfill area, or building a major waste processing plant, an increased temporary demand for water and energy may arise. If fuel from nearby woods is used, vulnerable vegetation can be damaged. A considerably increased use of water may affect the local water balance, and great care should be shown in dry areas.

Dumping of hazardous waste in sea and lakes can have serious consequences for flora and fauna . Toxicants may also enter into food chains and ultimately affect the health of humans.

The primary pathways of impacts on the biological environment are contamination of soil, water and air and alteration of flow in surface water. However, biological resources can also be affected by land use conversions, increased human activity in the vicinity of the project, and increased pressure on natural resources in the area of influence due to human population increases associated with the project.

Flora, Fauna and Ecosystems

Terrestrial Species and Associated Ecosystems Terrestrial species are those which may occur on land, including mammals, birds, reptiles, amphibians, invertebrates, trees, shrubs, forbs, grasses, fungi, mosses and microbes.

Possible impacts on terrestrial species and the ecosystems associated with them (including wetlands and riparian areas) include:

- Destruction, modification or fragmentation of habitat

• Disruption of behavior, including feeding, migration, breeding, nesting, and calving

• Direct impacts ○ Poisoning from direct contact with hazardous substances or contamination of watering holes ○ Electrocution or incineration ○ Impacts with wind turbine blades ○ Increased collection and hunting

Destruction or fragmentation of terrestrial ecosystems is largely associated with land clearing, earthmoving and terrain shaping at the facility site and along access roads and right-of-ways. However, the creation of water impoundments can also flood ecosystems. This may be a relatively small area in the case of cooling ponds, or several hundreds of hectares in the case of a large hydroelectric dam. Excessive collection of fuel wood by workers during construction or operation can also lead to deforestation. Destruction of ecosystems can also be caused indirectly if emissions from a thermal/combustion plant kill or reduce productivity of vegetation downwind from the facility. For biomass projects that propose burning wood, the associated increase in the amount of forest wood harvested could have both positive and negative effects. On one hand, it could provide an incentive for the forest-products industry to manage its resources more efficiently, and thus improve forest health. But it could also provide an excuse, under the "green" mantle, to exploit forests in an unsustainable fashion, resulting in the destruction of species habitat. Unfortunately, commercial forests have not always been soundly managed, and many people view with alarm the prospect of increased wood cutting. Wildfire is another source of ecosystem destruction. Facility construction and operation increases the number of humans in its vicinity, which increases the possibility of human caused wildfires. This is also true along access routes and right-of-ways. If vegetative management of right-of-ways allow for the build-up of fire fuels, such as slash, this can increase the intensity of fires in the right-of-ways. Hydroelectric dams can cause seepage below the dam, which can impact terrestrial ecosystems where the seepage occurs. Riverbed scouring caused by hydroelectric dams can cause stream bed erosion, which can lower water availability in riparian zones in the area of the scouring, causing die-off of vegetation The construction of access roads and right-of-ways can fragment existing ecosystems and interrupt migratory corridors. Access roads and right-of-ways can also open to human activities areas that had previously been relatively wild, disturbing the species in those areas and creating opportunities for increased collection or harvest of plant life and collection or hunting of animals. Some ecosystems are more critical to species survival than others. These include migratory routes or corridors, watering holes, salt licks, and breeding, nesting and calving areas. These areas should have been identified in the preparation of the Environmental Setting. Any impacts in these areas should receive special attention. Modification of habitat can be associated with right-of-way management as well as with releases of noxious or invasive species. Excessive vegetation maintenance in right-of-ways may remove unnecessary amounts of vegetation resulting in disrupting succession and increasing the likelihood of the establishment of non-native invasive species. Alteration of terrestrial habitat for construction of transmission and distribution projects may also yield benefits for wildlife such as the creation of protective nesting, rearing, and foraging habitat for certain species; the establishment of travel and foraging corridors for ungulates and other large mammals; and nesting and perching opportunities for large bird species atop transmission towers and associated infrastructures Energy generation and transmission projects

can disrupt animal behavior in several ways. If the project involves a construction camp or onsite housing during operation, animals can be attracted to garbage and food waste thus changing there feeding habits and their interactions with humans. Regular maintenance of right-of-ways to control vegetation may involve the use of mechanical methods, such as mowing or pruning machinery, in addition to manual hand clearing and herbicide use, all of which can disrupt wildlife and their habitats. Noise, vibration, illumination, and vehicular movement can disrupt animal activities. These are particularly of concern if animals are disrupted in sensitive habitats, such as migratory routes or corridors, watering holes, salt licks, and breeding, nesting and calving areas. Light pollution can pose a serious threat to wildlife, having negative impacts on plant and animal physiology. Light pollution can confuse animal navigation, alter competitive interactions, change predator-prey relations, and cause physiological harm. The rhythm of life is orchestrated by the natural diurnal patterns of light and dark, so disruption to these patterns impacts the ecological dynamics. Direct impacts to wildlife can be caused by increase hunting, improper solid or liquid waste disposal and direct contact by animals with project components. Increased collection and hunting can be stimulated by increased human activity in the area by workers and the population that grows to meet those workers needs. Improper waste disposal can bring animals into direct contact with hazardous substances or poison watering holes. The most common form of animal contact is electrocution via contact with equipment in substations, but other types of negative contacts can also occur including avian collisions with solar heliostat towers and potential for bird incineration and blinding from solar technology. The combination of the height of transmission towers and the electricity carried by transmission lines can pose potentially fatal hazard to birds and bats through collisions and electrocutions. Avian collisions with power lines can occur in large numbers if located within daily flyways or migration corridors, or if groups are traveling at night or during low light conditions (e.g., dense fog). In addition, bird and bat collisions with power lines may result in power outages and fires. Birds and bats also may be directly impacted by wind turbines. Many factors affect the potential risk of harm to birds and bats from wind turbines, including turbine variables (size, rotational speed, operational time, rotor swept area, spacing, tower type), variables at the turbine site (habitat, presence of features such as caves or cliffs) and bird/bat behavior (seasonal migration, hunting or feeding behaviors, other species-specific behaviors). Loss of bat populations can have significant secondary impacts on both agriculture and public health because of the role bats play in controlling insect populations. Morbidity and mortality of birds as a result of wind turbine operation is caused by blade impact – typically at or near the tip of the blade where radial velocities are high. Morbidity and mortality among bats is largely caused by barotraumas – a sudden reduction in barometric pressure near the blade.

Aquatic species are those species that may live in water. They include species that live in marine water as well as freshwater.

Impacts that can affect aquatic species and the ecosystems associated with them include:

Water contamination

- Changes in water flows or water levels in surface water
- Direct aquatic habitat alteration
- Injury or mortality from: ○ Direct contact with in-water technologies (e.g., hydroelectric and hydrokinetic turbines) ○ Increased collection or fishing
- Habitat avoidance due to noise or visual disturbances Impacts on aquatic ecosystems caused by water contamination and water flows are derived directly from the water quantity and quality impacts. If the project can impact water quality or quantity in surface water, then it has the potential to impact the aquatic species in those waters. For example, discharges with elevated temperature and chemical contaminants can affect phytoplankton, zooplankton, fish, crustaceans, shellfish, and many other forms of aquatic life. Discharges from hydroelectric dams can often lower the temperature downstream of the dam, which can cause changes in the ecosystem and the species composition. Similar ecosystem and species composition impacts can occur if the amount of flow is reduced or if the project introduces large variances in flow rates. These types of ecosystem changes can often lead to invasion by non-native species. These impacts and others caused by changes in water quality and quantity should be investigated and characterized. Direct aquatic habitat alteration can occur during construction or upgrading of access roads and right-of-ways. If such activities require construction across wetlands or streams; on the borders of ponds or lakes estuaries; or on coastlines, they can disrupt watercourses and wetland flow regimes, impact water quality and cause bank erosion all of which impact aquatic habitats. The installation of power transmission cables on marine floors can disrupt marine habitat including intertidal vegetation (e.g., eelgrass), coral reefs, and marine life. Hydroelectric dams can cause changes in river ecosystems. Dams block movement of species from downstream of the dam to upstream of the dam. This can be a major issue if migratory fish are in the river or if spawning grounds for downstream populations are located upstream of the dam. As discussed in the Water Resources subsection, dams also hold back sediments, which lead to downstream riverbed scouring. This cuts off sediment that would naturally replenish downstream ecosystems and reduces habitat for fish that spawn in river bottoms, and for invertebrates that live there. In addition, proliferation of aquatic weeds in hydroelectric reservoirs and downstream of the dam (introduced at the reservoir) can impair fisheries by depleting dissolved oxygen. In worst cases, this can lead to eutrophication and aquatic species mortality. Projects using instream energy generation technologies without dams or diversions may have adverse impacts on aquatic species depending upon the specific species, settings and technologies used. Recent field studies at a limited number of specific instream energy generation locations have found low impacts on fish attributed to the dynamics of these types of devices, which involved: 1) relatively slow turbine rotations and water velocities, allowing fish to avoid the devices, and 2) no differential in head pressure, eliminating injuries from rapid changes in ambient pressure. However, because the technologies are new, it is important to monitor project effects to confirm whether there is the potential for, and if so the significance of, impacts on fish due to mortality

CONTENTS: Cultural and socio economic impacts: effect of developmental projects on cultural and social settings and economic profile of the community. Energy impact: EIA of hydro, thermal and nuclear power plants Public Participation in environmental decision making, Some Case Studies of EIA

SOCIAL-ECONOMIC-CULTURAL ENVIRONMENT Social-economic-cultural impacts from power generation and or transmission projects are highly variable and dependent on the project type, project size, project footprint, energy source(s), and existing land use patterns, proximity of population, local livelihoods, and presence of cultural and religious assets. Further, different types of impacts can occur during project preparation, construction, operation and decommissioning. Nonetheless, there are a set of impacts on the social-economic-cultural environment that are common to nearly all energy projects. These are summarized in Figure E-1. 4.1 Socio-Economic Conditions The social and economic impacts of energy generation and transmission projects can be both positive and negative. Socio-economic impacts can vary by location and size of the project, length of the project from construction to closure, manpower requirements, the opportunities the company has for the local community employment and involvement, and the existing character and structure of the nearby communities.

Positive impacts can potentially include: • Increased individual incomes ○ Direct employment on the project ○ Indirect employment generated by project activities ○ Increased purchases from local businesses ○ Other economic activities stimulated in the community as a result of the project • Employment opportunities for local residents (short- and long-term) • Increased tax base • Less expensive and more reliable electric power Negative impacts can potentially include: • Displacement and relocation of current settlements, residents or community resources • Displacement or disruption of people's livelihoods (e.g., fishing, hunting, grazing, farming, forestry and tourism) • Public finance requirements – more infrastructure and services needed to meet the demands of increased population (e.g., public education, policing, fire protection, water, sanitation, roads) • Increased traffic and truck trips (safety, noise, exhaust) • Reduction in quality of life for residents from visual and noise impacts • Impacts on public health (not applicable to all projects) ○ Water-related vector diseases (malaria, dengue, etc.) ○ Health impacts of pesticide and fertilizer use • Impacts on worker health and safety ○ Identification of hazardous jobs and number of workers exposed with duration of exposure ○ Occupational diseases due to exposure to dust and other project related activities such as handling of explosives, solvents, petroleum products, etc. ○ Identification of physical risks and safety aspects

Emissions, effluents, wastes and other physical factors resulting from construction and operation of the power plant or transmission line will depend on the fuel or energy source and the size and type of energy production and distribution. It is the combination of the characteristics of the fuel and energy sources and the technology used to convert the fuel energy into electrical power that defines the project footprint and potential environmental and social-economic impact

Thermal/Fossil Fuel Power (Coal, Petroleum or Natural Gas) Thermal/Fossil Fuel power production uses the combustion of fossil fuels to either directly or indirectly turn generators or alternators that produce electrical energy. The technologies can be divided into two basic categories, external combustion and internal combustion. These two technologies are discussed in the following subsections.

External Combustion External combustion means that combustion of the fuel is external to the machinery that turns the generator or alternator to produce electricity. The heat energy generated by the combustion of fuel is transformed into electrical energy indirectly, usually by means of heating boilers or boiler tubes to generate steam. The resulting steam is then used to power steam turbines or engines that turn generators or alternators, thus creating electrical energy. A steam turbine is a mechanical device that extracts thermal energy from pressurized steam and converts it into rotary motion. It has almost completely replaced the reciprocating piston steam engine because of its greater thermal efficiency and higher power to weight ratio. Because the turbine generates rotary motion, it is particularly suited to be used to drive an electrical generator – about 80 percent of all electricity generation in the world is by use of steam turbines.. The key differences are due to differences in fuel and combustion waste by products,

Internal Combustion Internal combustion means that the fuel is combusted internal to the engine, as in a confined chamber or cylinder and that resulting mechanical action directly turns generators or alternators.internal combustion engines used to generate electrical energy.

Thermal/Biomass power production uses the combustion of biomass or biofuels to either directly or indirectly turn generators or alternators that produce electrical energy. The technologies used to generate energy are the same as those for Thermal/Fossil Fuel power production, but the fuels and their generation are significantly different. Biomass and biofuels are a renewable energy source derived from living, or recently living organisms, such as wood, waste, plants and algae. It excludes organic material such as fossil fuel such which has been transformed by geological processes over long periods of time. Thermal/Biomass power production includes the external combustion of biomass such as wood, hemp, miscanthus, crop by-products (straw, field residues, rice husks, corn cobs, etc.), solid waste or biofuels to heat boilers or boiler tubes to generate steam. The steam is then used to turn generators or alternators. It also includes the use of biofuels to directly fuel internal combustion turbines or reciprocating engines hooked to turbines. The system components are the same with the exception of the fuel preparation and delivery. Biofuels are derived from conversion of biomass (organic material) into a combustible fuel. Biomass can be converted into biofuels via physical extraction (as in the case of some oils), decomposition, fermentation, thermal processes, or chemical processes. Biofuels may be gases such as methane or liquids such as ethanol or biodiesel. Most biofuel production comes from harvesting organic matter and then converting it to fuel but an alternative approach relies on the fact that some algae naturally produce ethanol and this can be collected without killing the algae. In addition to being used to power external combustion systems, biofuels can be used to power internal combustion, so that they can be used as fuel for the technologies

Hydropower is further subdivided into the categories of hydroelectric power and hydrokinetic power. Hydroelectric projects generate electricity from the flow of water with use of a dam or diversion, whereas hydrokinetic projects generate electricity from the movement of waves or currents without the use of a dam or diversion.

Geothermal Power There are three types of geothermal power plants: dry steam, flash steam, and binary cycle. Dry steam power plants pipe steam directly from underground wells to the power plant, where it is directed into a steam turbine/generator unit. These systems require sources of underground steam, which are not common. Flash steam power plants are the most common. They use geothermal reservoirs of water with temperatures greater than 182°C, which flows up through wells under its own pressure. As it flows upward, the pressure decreases and some of the hot water boils into steam. The steam is then separated from the water and used to power a steam turbine/generator.

Disposal of solid waste and spills of lubricants, fuels and chemicals (e.g., wood preservatives, herbicides) during land clearing, terrain shaping, construction (both onsite and offsite) and decommissioning and restoration creates the potential for soil and water contamination.

The types of solid waste generated during these activities include:

- Trees and other vegetation removed during site preparation
- Casting forms
- Defective or compromised building materials
- Waste concrete
- Waste from on-site maintenance and repair of machinery and equipment
- Waste from demolition of existing structures
- Packaging, pallets and crates
- Other wastes associated with onsite activities of workers in relation to the number of workers

Solid waste disposal and chemical and fuel leaks and spills at construction camps and during all types of power plant facility operation can also contaminate soil. Camps and facilities can generate human wastes and solid wastes generated by the workers. Construction camps often include storage and dispensing facilities for fuels, lubricants and chemicals used during construction. Most power plants also have onsite facilities for storage of lubricants and other chemicals and hazardous materials used at the plant on a regular basis.

During operation, and particularly during maintenance of machinery and equipment, the following solid and hazardous wastes may be generated:

• Used oil • Contaminated absorbent materials • Burned out light bulbs • Used batteries • Toxic and hazardous substances and associated wastes • Hazardous and toxic substance containers • Tires • Used parts, scraps and debris

Most power plants also have equipment onsite that contain hazardous substances, including insulating oils associated with transformers and switches. If these substances leak, they can contaminate soil. Insulating oils are used to cool transformers and switches and provide electrical insulation between live components. PCB's were widely used as insulating oils on large equipment up until 2000, when their use was discontinued due to potential harmful effects on human health and the environment. Modern transformers and switches use the highly refined standard mineral oil. Insulating oils are typically found in the largest quantities at electrical substations and maintenance shops. In addition to these generic impacts associated with energy projects, there are specific impacts associated with specific types of projects.

Several technologies generate unique solid wastes, the disposal of which can contaminate soil. These include: • Thermal/Combustion plants fueled by coal, oil, and biomass can generate: ○ Residues from onsite fuel washing or preparation

Ash and sludge resulting from combustion and collected by pollution control devices, which may contain mercury, selenium, arsenic or other metals, depending on fuel analysis • All types of Thermal plants requiring cooling systems can generate solid wastes removed from the

system. These wastes may be may be partially dehydrated or dried before disposal and include: ○ Cooling water sludge ○ Materials dredged cooling ponds and associated structures ○ Materials removed from cooling towers • Hydroelectric plants with reservoirs can generate solid wastes from dredged from the reservoir, or anywhere else where unwanted sediments may accumulate. • Solar Dish-Engine and many Thermal Solar and Geothermal plants will use and store heat transfer fluids. • Solar Photovoltaic plants can produce hazardous waste related to the decommissioning of solar photovoltaic cells. These cells may contain components made of hazardous materials. • Open-Loop Geothermal projects can also produce sludge deposited by geothermal water throughout the system that needs to be periodically collected and disposed of. Coal-fired and biomass-fired (including solid waste) thermal power plants generate the greatest amount of solid wastes due to the relatively high percentage of ash in the fuel. Coal combustion wastes include fly ash, bottom ash, boiler slag, and bed ash (the combination of fly ash and bottom ash generated in a fluidized-bed combustion boiler). Coal-fired plants can also generate flue gas desulfurization (FGD) sludge. Biomass contains less sulfur; therefore FGD may not be necessary. Fly ash removed from exhaust gases makes up 60 to 85 percent of the coal ash residue in pulverized- coal boilers and 20 percent in stoker boilers. Bottom ash includes slag and particles that are coarser and heavier than fly ash. Due to the presence of sorbent material, fluidized-bed combustion boiler wastes have a higher content of calcium and sulfate and a lower content of silica and alumina than conventional coal combustion wastes. Metals are constituents of concern in both coal combustion wastes and low-volume solid wastes. For example, ash residues and the dust removed from exhaust gases may contain significant levels of heavy metals and some organic compounds, in addition to inert materials. Ash residues are not typically classified as a hazardous waste due to their inert nature. However, where ash residues are expected to contain potentially significant levels of heavy metals, radioactivity, or other potentially hazardous materials, they should be tested at the start of plant operations to verify their classification as hazardous or non-hazardous according to local regulations or internationally recognized standards. Oil combustion wastes include fly ash and bottom ash and are normally only generated in significant quantities when residual fuel oil is burned in oil-fired steam electric boilers. Other thermal/combustion technologies (e.g., combustion turbines and diesel engines) and fuels (petroleum and diesel) generate little or no solid wastes. Gas-fired thermal power plants generate essentially no solid waste because of the negligible ash content, regardless of the combustion technology. Geothermal technologies generally do not produce a substantial amount of solid waste, but open-loop systems can generate large amounts of solid wastes as sulfur, silica, and carbonate precipitates in cooling towers, air scrubber systems, turbines, and steam separators. This sludge may be classified as hazardous depending on the concentration and potential for leaching of silica compounds, chlorides, arsenic, mercury, vanadium, nickel, and other heavy metals. These wastes may be dried and disposed of in landfills meeting hazardous waste requirements in which case they can impact have the potential to impact soil quality at the disposal as well as the potential for impacting soil quality during transport from the points of generation and treatment to the point of disposal

The disposal of solid wastes is not the only activity at power generation and transmission projects that can contaminate soil: • Thermal/Combustion plants produce air emissions which can be

deposited on soil downwind from the facility resulting in soil contamination • Thermal/Combustion plants fueled by oil and petroleum can store large volumes of fuel onsite, creating the potential for leaks and spills that can contaminate soil • Biomass projects can have impacts on soils on the farms or forests at which the biomass is produced, including potential salinization if the farms are irrigated and potential soil contamination if pesticides and fertilizers are improperly managed • Similar soil contamination impacts can be associated with Transmission Line projects, if herbicides are proposed for vegetative management and they are not managed correctly

Socio-Economic Conditions It includes descriptive and quantitative information for the area surrounding the project site on: • Population, including age, gender, ethnic composition, religions, languages spoken and educational level • Economic activities, including industrial and commercial activities, employers, employment, incomes and distribution of income, tax base and skills, services and goods availability in the communities • Crime rates • Literacy rates • Community organizations • Public Health and Safety ○ Diseases in the project area (including the sources of data and the methodology used to collect and analyze the data) ○ Existing practice for assessment of occupational health ○ Existing electromagnetic fields (primarily associated with high voltage electric power lines) ○ Local perceptions of the proposed project

Public participation and stakeholder involvement is an essential and integral part of the Environmental Impact Assessment (EIA) process and CAFTA-DR countries have adopted policies and regulations and procedures to require that this occurs throughout the EIA process. Reviewers should ensure that minimum requirements are met, that key stakeholders and important issues have not been ignored or under-represented, and that opportunities for effectively resolving underlying conflicts are provided. The process for engaging the public and other stakeholders fails if it is undertaken as an afterthought or poorly implemented or viewed as a one-time event. Opening up real opportunities for engagement by the public, local governments, and interested and affected institutions requires a degree of openness and disclosure which can be uncomfortable for some who fear that it might open the door to unnecessary complication, higher costs and loss of control. However, the clear lessons from failed public participation processes are just the reverse: if the public is engaged early, and in an open and transparent manner, the process can help to avoid both unnecessary conflict and potential financial hardship due to project delays and occasionally even permit denial.

Public participation requirements may include:

- General Requirements to include the public in the EIA process

- Public Notification: Rules about the use of media to announce the EIA process and the points of participation for the public and requirements for the Ministry or the owner/developer to

announce the public consultations in national and local media. Public participation and consultation ideally should be initiated at the scoping stage of the EIA process, before steps are taken to prepare the EIA document. This can be accomplished through a public notice of intent to prepare an EIA for a specific action. Such a notice of intent should include a description of the proposal and describe how the public may participate in the process

- Public Consultation: Rules about the consultations and observations that the public presents

- Public Disclosure: Requirements that the Ministry or the owner/developer publish the EIA for review during the public consultations

- Public Written Comment: Requirements for the public to have the opportunity to submit written comments to the Ministry and the owner/developer in addition to the consultations. Requirements may specify whether solicitation of comments from the public should take place in formal public hearings, or may allow or encourage informal workshops or information sessions

- Public Hearings: Most laws on public participation provide for the opportunity for a public hearing. This is a formal legal process with little opportunity, if at all, for give and take discussion on options, alternatives and assumptions. It is for that reason it is considered by most experts on public participation to be the least effective means for actual public involvement

- Consideration of Public Comments: Requirements for public comments to be considered in the review by the government if they have a sound basis

- Allocation of costs: Rules about who needs to pay, i.e. the owner/developer generally must pay for the consultations with some exception where the Ministry pays