Understanding Environmental Issues & Concepts

Environmental Management Terminology

Environment

There is a perception that the environment refers only to the natural, physical dimensions of the world in which we live. In reality the 'environment' is a complex set of interrelationships including:

- physical and natural systems;
- biological systems;
- socio-cultural dynamics;
- built environment; and
- aesthetic values.

ISO uses the following definition in the 14000 series of environmental standards – *"surroundings in which an organisation operates, including air, water, land, natural resources, flora, fauna, humans and their interrelation. Surroundings in this context extend from within the organisation to the global system."*

The European Economic Community has defined the environment as "*the combination of elements whose complex interrelationships make up the settings, the surroundings and the conditions of life of the individual and of society, as they are or as they are felt."*

Formal definitions tend to include all features of the surroundings of humanity that affect individuals and social groupings. Environmental investigations are concerned with people and their present and future activities, the surrounding atmosphere, the surrounding water bodies, the surrounding land and landscape and ecological systems.

Beneficial use of the environment is often included in definitions and refers to quality of life and includes activities such as:

- Aesthetics;
- Water for human and stock consumption and agricultural purposes;
- Recreational activities such as skiing and fishing; and
- Resource use such as mining.

Ecosystem

A dynamic entity of plant, animal, fungal and microorganism communities and associated non-living environment interacting as an ecological unit.

Matter and energy are taken up by organisms from the physical surroundings and passed from organism to organism through a food chain. Matter is progressively decomposed by each organism and returned to air and soil, or to water; energy is lost from each organism and dissipated as heat. Each ecosystem has input of mineral nutrients and gases from the weathering of rocks, from the atmosphere and from other ecosystems; and an input of energy as either organic matter or light or both. Much of the matter is recycled through the ecosystem and this can occur more than once.

Each ecosystem has an output of heat energy and gases to the atmosphere and often an output of nutrients and organic matter to other ecosystems. There are innumerable ecosystems - tidal, freshwater and terrestrial; forest ecosystems, grassland ecosystems and marine ecosystems.

Biodiversity

Biodiversity refers to the variety of life forms, including different animals, plants and microorganisms, the genes that contain and the ecosystems that they form.

Biodiversity can be considered at three different levels:

- Genetic diversity – variety of genetic information contained in individual animals, plants and microorganisms both within and between populations of species as well as between species;
- Species diversity – variety of living species; and
- Ecosystem diversity – variety of habitats, biotic communities and ecological processes.

Biodiversity is important as it probably provides greater resilience to ecosystems and organisms, as well as having important social and cultural values. Potential benefits include:

- Protection of water resources:
  - Natural vegetation cover in water catchments help maintain hydrological cycles, regulate and stabilise water runoff and act as a buffer against extreme events such as flooding and drought;
  - Removal of vegetation can result in siltation of catchment waterways, loss of water yield and quality and degradation of aquatic habitats;
  - Vegetation can regulate groundwater tables, preventing dryland salinity.
- Soils formation and protection:
  - Biodiversity assists in the formation and maintenance of soil structure and retention of soil moisture and nutrient levels;
  - Clearing vegetation results in salinisation of soils, leaching of nutrients, erosion and reduction of soil productivity.
- Pollution breakdown and absorption:
  - Some ecosystems, for example wetlands, are able to break down and absorb pollutants. Wetlands can be used to filter effluents to remove nutrients, heavy metals and suspended solids and destroy harmful microorganisms.
- Food:
  - While the majority of the world's population depends on less than 20 crop species, over 5000 species of plant have been used as food sources. Native plant gene pools are able to provide disease resistance, improved productivity and wider tolerance to differing environmental conditions.
- Medicinal resources:
  - Plants, animals and microorganisms are of importance in the development of new medically active compounds.
- Breeding stocks:
  - Natural areas provide habitat for commercially valuable resources such as mangroves which provide a breeding environment for fish and crustaceans.
- Recreation:
  - Tourism relies on biodiversity;
  - Recreational pursuits such as bushwalking, fishing and photography rely on natural habitats.
- Cultural values:
  - Aesthetic values of natural ecosystems contribute to the well being of the population;
  - Aboriginals, in particular, have a dependence on the land and sea for spiritual, social and recreational pursuits.

Pollution

Pollution occurs when a substance is released to the environment which causes a detrimental alteration to the physical, chemical, biological, and/or aesthetic characteristics of that environment.

The ISO 14000 series of standards defines pollution as *"release into the environment which is or can be harmful to the environment"*.

Community Perceptions

The community is generally sceptical of industry and business in regard to environmental responsibility. Community attitudes have been developed as a result of the growing list of environmental disasters that have made headlines in the media. This perception is compounded by clear evidence on a regular basis of discharges to air, water and land of polluting substances, and cases where organisations have been caught illegally discharging.

Community perception is a critical issue in the dynamics of environmental management. The community is the workforce, the shareholders, the local neighbours and the potential marketplace. Business can choose to respond to the environmental expectations of the community in a number of ways. This response can be pro-active or reactive. Those organisations that choose a pro-active approach and work with the community may find that they are able to save money and increase market share.

Corporate Environmentalism

There has been a clear change in community values in regard to the environment. The sort of value changes that are being recognised include:

- acceptance that we have an environmental crisis;
- putting an end to a consumer driven society with throwaway items;
- an end to the idea that resources are limitless; and
- an end to the idea that the environment will recover.

Corporate Environmentalism advocates that it is no longer acceptable to be in business just to make money for the shareholders. Corporate environmentalism accepts that profit must go together with a socially responsible attitude towards environmental protection. Some businesses will put profit after environment in their strategic directions.

Corporate environmentalism can be achieved by:

- Implementing a plan to achieve sustainable business practices;

- Establishing environmental performance standards in all sections of the business;
- Projecting an environmentally responsible image;
- Seeking environmental competitiveness in the marketplace;
- Being open and ethical in management style; and
- Seeking a balance between environmental standards and commercial return.

Consumers are expressing a preparedness to pay more for, or to prefer products that are developed in an environmentally responsible manner.

What are the Environmental Issues?

Environmental issues of concern can have impacts at a global, national/regional or local level. They arise from many different sources.

Global impacts are those which affect the world or a least a large portion of several regions. These impacts include resource depletion, global warming ozone depletion, acid rain and the effects of overpopulation. Many of these issues are transboundary in nature, with the cause generated in one area and impacting in another. Consequently, these impacts can only be resolved through the combined efforts of different countries.

National/regional impacts refer to those that may be specific to a country (or a number of neighbouring countries) or regional area. These impacts cover issues such as dryland salinity, air pollution, water pollution and soil contamination. As with global impacts, some of these issues may be transboundary in nature.

Local impacts are environmental impacts that affect a region, area or site, such as noise or odour pollution in a localised area. Local impacts may be restricted to being managed on site or extend to off site.

Global Impacts

The Enhanced Greenhouse Effect

The greenhouse effect is a naturally occurring process that involves the trapping of heat in the troposphere. This natural greenhouse effect is vital for the existence of life on earth. However, the environmental issue known as the enhanced greenhouse effect arises when additional heat-trapping gases (such as carbon-containing gases from human activities) are released into the troposphere, causing too much heat to be trapped and thus leading to an increase in global temperature.

The primary heat –trapping gas in the atmosphere is water vapour. However, because it is found in such high concentrations, human activities have very little impact on this chemicals' greenhouse effect. The concentration of carbon-containing substances, such as CO_2, are very small in comparison. It is, however, precisely because the natural concentrations are so small that the input from human sources can significantly affect these chemicals' greenhouse effect.

Greenhouse gases include CO_2, CH_4 and NO_x, CFCs and photochemically derived ozone in the lower atmosphere. Every year some 24 billion metric tons of carbon dioxide are released, and this is increasing by about 750 million tons a year. About 80% of this carbon dioxide is derived from the burning of fossil fuels.

Predicted impacts of global warming include an increase in the sea levels. Water expands when it is heated and this explains why global sea levels would rise if the oceans warm. Additional rises would also occur if heating at the poles causes some, or even complete, melting of ice sheets and glaciers. A one metre rise in sea levels would flood low-lying areas of major cities such as Shanghai, Cairo, Bangkok, and Venice and large areas of agricultural lowlands and deltas in Egypt, Bangladesh, India and China, where much of the world's rice is grown. Many South Pacific islands could be submerged. Measurements of global temperature have shown no conclusive evidence of the predicted warming although computer models of climate suggest that continued accumulation of greenhouse gases could warm the climate an average of 1°C to 5°C.

In December 1997 the world's leaders gathered in Japan to discuss methods to combat global warming. The Kyoto Protocol (The United Nations Framework Convention on Climate Change) was established. It was the first binding international agreement requiring industrialised nations to cut emissions of the main greenhouse gases. While the Kyoto Protocol was agreed by some countries in 1997, it is still to enter into force.

The Kyoto Protocol calls for cuts averaging just over 5 per cent from 1990 levels. Countries will have a number of options to enable them to meet this target including:

- trading emissions' entitlements;
- selling emissions' entitlements to private companies to trade;
- planting forests and other "sinks" that soak up carbon dioxide to offset against emissions; and
- spending money on cleaning up pollution in other countries.

In addition to these initiatives, strategies for reducing greenhouse gas production include:

- changing to cleaner fuel sources that produce less greenhouse gas
- integrated planning to reduce energy requirements
- developing cleaner energy generation techniques that result in fewer emissions

Ozone Depletion

The ozone layer is a thin, protective layer of ozone gas (O_3), which screens out 99% of the sun's harmful ultraviolet light. It is located between 20 and 50 kilometres above the earth's surface. The screening effect of the ozone layer protects organisms from damage caused by ultraviolet light, which is known to be carcinogenic and harmful to biological functions of many species.

Under normal conditions, ozone is destroyed and replenished in the stratosphere by natural atmospheric chemical reactions. In this process, the rates of creation and destruction are almost equal, and thus the percentage of ozone is maintained at a fairly stable level. However, there is evidence that we are upsetting this balance and reducing the levels of ozone in the stratosphere.

This is believed to be caused by the release of Chlorofluorocarbons, commonly referred to as CFCs, into the atmosphere. Under high-energy UV radiation, such as that in the upper layers of the atmosphere, CFCs break down to release Chlorine atoms. Chlorine atoms significantly speed up the breakdown of ozone, thus effecting the dynamic equilibrium that usually exists.

CFCs were originally created in the 1930s and were seen as a "dream chemical" because they are chemically stable, non-toxic, odourless and cheap to produce. Many uses were found for these chemicals as coolants, propellants, cleaners, fumigants as so on. Traditional CFC spray cans, refrigerants and air conditioning equipment, still used in many areas of the world today, all release CFCs into the atmosphere.

Models of atmospheric processes indicate that just to keep CFCs at 1987 levels would require an immediate 85% drop in total CFC emissions throughout the world. Many nations have already cut back on CFC emissions. This has been largely as a result of the 1987 Montreal Protocol, which aimed to reducing the concentration of ozone-depleting chemicals.

Even if all usage of ozone-depleting substances ceased immediately, it would take about 100 years for the planet to recover from the present ozone depletion At the time of the development of the Montreal Protocol it was assumed that use of ozone-depleting substances had peaked in 1988, but developing nations have until 2010 to phase out their use and concentrations of the gas in the atmosphere have increased over the last ten years.

In addition to the strategies already in place for managing CFCs, such as the initiatives under the Montreal protocol, replacement with less-reactive compounds, and gradual phasing-out of CFC usage world-wide, a range of technologies that could reduce CFCs in the atmosphere have been proposed. However, no viable solutions, other than reduction of emissions, have yet been proposed.

Acidification

Acid deposition refers to the deposition of all forms of acids from the air. When electric power plants and industrial plants burn coal or oil, their smokestacks emit large amounts of sulphur dioxide, suspended particulate matter, and nitrogen oxides. As emissions of sulphur dioxide and nitrous oxide from stationary sources are transported long distances by winds, they form secondary pollutants such as nitrogen dioxide, nitric acid vapour, and droplets containing solutions of sulphuric acid and sulphate and nitrate salts. These chemicals descend to the Earth's surface in liquid form as acid rain, fog, dew or snow and in dry form as gases, or solid particles. The combination of dry deposition and wet deposition of acids and acid-forming compounds onto the surface of the earth is known as acid deposition, or acid rain.

Acid deposition can have a number of harmful effects:

- killing fish, aquatic plants and micro-organisms in lakes and streams. When the pH falls below 6, many species of fish cannot reproduce;
- contaminating fish (with highly toxic methylmercury) which could then be eaten by humans;
- contributing to regional haze, mostly from fine particles of sulphate salts in the atmosphere;
- weakening or killing trees by leaching calcium, potassium and other plant nutrients from soil;
- stunting the growth of crops such as tomatoes, soybeans, spinach, carrots, broccoli and cotton; and leaching toxic metals such as copper and lead from city and home water pipes into drinking water.

As these problems are often trans-regional and affect many nations, an integrated approach to management is essential. Use of cleaner fuels, technologies to reduce emissions, and efficient land-use planning are all strategies that can assist in management of acidification issues. International assistance through setting standards and providing financial aid to enable countries to implement improvement initiatives are important ways of overcoming this problem.

Resource Depletion

Resource depletion involves a complex array of issues. The problem is one of distribution both between nations and between generations, along with rate and extent of depletion. Natural resources can be thought of as assets or stockpiles belonging to a state, country or the world. The un-balanced use or misuse of these results in what has been referred to as “the tragedy of the commons”, that is the misuse of global resources by a few within the global community, resulting in a spoiling of the resources for all.

Natural resources are commonly used as raw materials in many industries e.g. timber, fossil fuels, metals etc. To date, especially since industrialisation, there has been high use of many of these resources. This is of particular concern for resources that are non-renewable or slowly renewed. The stockpile of many resources has dwindled, leaving depleted resources for future generations.

Commonly the problem of resource depletion arises as those responsible for managing natural resources are not those who are responsible for managing the economy. A solution proposed by economists is to redefine property rights and making those property rights available through markets. This means putting a price on resources which have previously been considered ‘free’. By doing this more appropriate care may be taken of resources such as clean air and clean water.

This depletion of resources has led to the development of policies in sustainable development. Sustainable development is development which is consistent with the natural functioning of the biosphere and aims to achieve a balance between ecology, society and economy on a local, regional, national and global level. It is a way in which humans can manage an economy and resources to preserve its productiveness. By better managing our current resources it is hoped that the actions of present generations should not reduce the standard of living of future generations below that of the present generation.

Recent initiatives have included addressing hardwood timber and fauna species diversity.

Additional initiatives that can assist in responsible and sustainable use of resources are:

- Controlling population growth
- Integrated planning

- Eco-efficient design of products
- Eco-efficient processes for resource utilisation
- Re-use or recycling or non-renewable resources

Biodiversity Reduction

Biodiversity reduction is a major issue worldwide, with populations reducing in numbers, species becoming extinct, and ecosystems being degraded at an increasing rate. The genetic, species and ecosystem diversity of the earth and various regions usually fluctuates throughout the centuries, but the rate at which reduction is currently occurring appears to be unusual and is thought to be related to human activities.

Factors contributing to this decline include urban development, recreational and commercial fishing, aquaculture, forestry and harvesting of timber, agriculture, mining, water harvesting, introduction and spread of pests and weed, pollution, change in fire frequency and climate change.

Negative consequences include loss of economic opportunities from the commercial use or harvesting of renewable resources, disruption or destruction of ecological processes upon which life depends, loss of aesthetic and cultural experiences adding to the quality of human life.

Often biodiversity reduction is hard to manage, as it is symptomatic of other environmental problems. There are, however, a range of management strategies that can assist in preserving biodiversity. These include:

- Strategic planning to preserve areas capable of sustaining biodiversity
- Establishment of conservation plans for species that are “at risk”
- Initiatives to encourage communities to be aware of the biodiversity in their area and to assist in its preservation
- Research into the impacts of other environmental issues on biodiversity

National and Regional Impacts

Waste Disposal

Waste disposal is becoming increasingly difficult around the world as households, communities and industries produce increasing quantities of waste.

In developed countries, solid waste is commonly disposed of in sanitary landfills or incinerated, with a very small percentage recycled. Liquid waste is generally treated and discharged to water bodies. In developing countries, waste is rarely treated and sewerage and other liquid waste are likely to be discharged directly into water bodies. Solid waste is dumped in rivers or collected into rubbish dumps.

The environmental consequences of waste disposal can be high, particularly for the disposal of hazardous wastes. Hazardous wastes are waste products of industry that if not disposed of properly or when destroyed, may pose a threat to the environment. Hazardous wastes are generally stored until an appropriate disposal method can be developed. However, a large amount of hazardous wastes are dumped illegally.

In some states, hazardous wastes are classified into different types and waste tracking initiatives may be implemented to regulate the transportation and disposal of these wastes.

A very useful management tool that has been developed for dealing with wastes is the "waste hierarchy". In this system, when a waste must be produced, a series of options exist:

- Best option: Waste can be prevented
- Option 2: Waste can be reduced
- Option 3: Waste can be reused
- Option 4: Waste can be recycled
- Least preferred option: waste can be disposed

Adoption of the waste hierarchy at all stages of planning and production can greatly reduce the end amount of waste disposed of and can also reduce resource wastage.

Air Pollution

Human activities and natural sources emit many substances into the atmosphere. While industry is not the only contributor to air pollution, it is a significant source. Air pollution is usually concentrated in cities and industrial areas and affects the human population along with other species on a day to day basis. Pollution not only includes the visible 'smoke' released from a factory into the atmosphere, but also the dust associated with the production process and the 'invisible' chemical releases into the atmosphere which can cause serious environmental damage.

The main gases and particulates that are emitted and that have important environmental impacts include: carbon monoxide (CO), oxides of nitrogen (NO_x), sulfur dioxide (SO_2); halocarbons; such as halons (used in fire protection), chlorofluorocarbons (CFCs) and their replacements; lead; carbon dioxide (CO_2) and methane (CH_4). Other common air pollutants are ground level ozone and associated pollutants, together known as "photochemical smog" which is sometimes visible as a white haze in summer.

Over the past 10 years some aspects of the air quality in major cities have improved following the introduction of stricter controls on motor vehicles, especially the use of catalytic converters on all new cars and the introduction of unleaded petrol.

Odour problems may be encountered at properties located next to, or within close proximity to, industrial facilities. Although this may not be of direct concern to a person's health the odour may result in a substantial downgrading of their quality of life. For example, an abattoir located close to residential premises would have to give more consideration to the control of odour problems than one situated in the country. Integrated planning initiatives can be useful for ensuring compatible uses that do not negatively impact upon each other.

Industry sources of air pollution are often emissions from stacks. A variety of technologies are available to reduce the air pollution resulting from industry emissions, including filters, use of cleaner fuels, improved processes and monitoring of emission levels.

Water Pollution

Water pollution refers to both impacts on waterways, such as oceans, rivers and lakes, as well as groundwater.

Water pollutants from industry may be organic, infectious agents, inorganic discharges or thermal pollution, and may be in liquid, solid or gaseous form.

Many industries create water pollution, including agriculture and farming, development, mining, energy and manufacturing. Some of these industries are highly regulated and are therefore required to control their impacts more carefully than others. A variety of pollutants, classified in broad types, are shown below.

Organic: Feedlots, sewage treatment plants and some industries such as papermills and meat packing plants may release large quantities of organic pollutants. These substances stimulate bacterial growth. Bacteria, in turn, consume the organics, helping to purify the waters. However, during the degradation of organic pollutants, bacteria consume dissolved oxygen and as oxygen levels drop, fish and other aquatic organisms perish.

Infectious agents: Water may be polluted by pathogenic (disease causing) bacteria, viruses and protozoans. The major sources of infectious agents are:

- untreated or improperly treated sewage;
- animal wastes in fields and feedlots beside waterways;

- meat packing and tanning plants that release untreated animal wastes into water; and
- some wildlife species, which transmit waterborne diseases.

Inorganic discharges: These pollutants encompass a wide range of chemicals, including metals, acids and salts. Most states report that toxic metals, such as mercury and lead, are a major water pollution problem. Metals come from industrial discharge, urban runoff, mining, sewage effluent, air pollution fallout and some natural sources. Chemicals discharged into a waterway may reduce the water quality to such an extent that bathing, swimming and other recreational uses become dangerous and fish are no longer able to survive.

Thermal pollution: Rapid or even gradual changes in water temperature can disrupt aquatic ecosystems. Industries such as the power industry, steel mills, oil refineries and paper mills frequently bring about such change by using water to cool various industrial processes. Large quantities of heat can kill heat-intolerant plants and animals outright, disrupting the web of life dependent on the aquatic food chain. Sharp changes in water temperature cause thermal shock, a sudden death of fish and other organisms that cannot escape and is frequently experienced when power plants begin startup or temporarily shut down for repair.

Water pollution can be controlled or at least minimised for most industries. Introduction of stringent operating controls or guidelines, such as discharge limits on operating licences, can be a powerful agent for change. A range of techniques for reducing or filtering water pollutants are available, differing for different industries and applications. Implementation of these types of measures, in addition to regular monitoring of water quality, can ensure cleaner water ways and underground water supplies

Cultural Heritage

Over recent decades, recognition of the value of cultural heritage has increased. Although not necessarily a directly environmental issue, cultural heritage, especially in relation to indigenous peoples, is often grouped with environment in the broader sense, referring to the environment around us. Likewise, cultural heritage is also often included as one of the factors or criteria in environmental approvals processes.

Cultural heritage can refer to both indigenous and non-indigenous heritage.

Cultural heritage is an important and emotive issue. There are many areas of conflict, especially between business interests and preservation of cultural heritage. However, in many cases good communication and innovative techniques can enable the two to co-exist.

Certainly a major focus for effective management of cultural heritage issues must be communication. Effective communication assists in early recognition of cultural heritage areas, and enables the parties involved to come to mutually acceptable solutions. The best cultural heritage management always involves all stakeholders and attempts to establish on-going and open relationships between all involved.

Eutrophication

Nutrients, in small amounts are required for plant growth and are important in the natural food chain. In large amounts they can cause excessive plant and algal growth in waterways. An increase in nutrient levels can cause a sudden "burst" of growth resulting in a large biomass in the waterway. A large plant or algal biomass can "blanket" the water surface, adversely affecting the oxygen balance in the waterway, resulting in death of aquatic organisms, and eventually the production of an anaerobic environment. Such growth can also affect human uses of water for purposes such as drinking, recreation, stock water and irrigation.

Sources of nutrients in rivers include:

- run-off from urban and rural residential areas;
- erosion and run-off from grazing and cultivated land (especially fertilisers);
- discharges from sewage treatment plants and septic systems;
- run-off from intensive animal industries and forestry activities;
- tail-water from irrigation areas; and
- river and stream bank erosion.

Few management options are available for management of eutrophication. in estuarine and marine environments and prevention remains the best approach. Various options include:

- increased environmental flows down waterways;
- improved sewerage treatment e.g. tertiary treatment;
- improved agricultural practises;
- public education;
- product changes e.g. low phosphorous detergents; and
- retaining and developing natural buffer zones between land and rivers systems.

Marine Pollution

A large proportion of the pollutants which reach the marine environment originate on the land. Coastal outfalls discharge direct to estuaries, inshore waters, bays and open coastal waters. Urban stormwater is also a significant source of pollution and finds its way into coastal waters via drains. In one sense, rivers can be regarded as major sources of pollution of coastal waters, as they collect, carry and discharge waste water to the ocean from different sources within their catchment areas.

Marine pollution sources also include surface run-off from urban and rural areas (which often contain pesticides, herbicides, fertilisers and soil particles), seepage from septic systems, industrial discharges and boating activities. In addition, weather patterns can have pronounced effects on the quantities and locations of pollution.

Past and current practices of ocean dumping of waste also contribute to marine pollution. Disposal of the dredge spoil may contain concentrations of contaminants such as zinc and cadmium that can bioaccumulate in marine organisms. Dumping of dredging spoil can also damage seagrass beds.

Ballast waters transported into and discharged in foreign ports and coastal environs can be responsible for the introduction of exotic fish, invertebrates and toxic algae.

Due to the large percentage of marine pollution originating from land-based sources, innovative land use planning in coastal areas can have a positive affect in reducing pollution. Use of improved treatment technologies that decrease the quantity of nutrients and other substances discharged can also assist in reducing pollution entering waterways and the marine environment. For marine pollution sources, banning or limiting ballast waters and other pollutants from boating or dredging have also been successfully implemented in some areas.

River Salinity

Small quantities of salt occur naturally in all stream waters. Problems occur when salt levels are increased above the naturally occurring levels.

Agricultural and other developments in catchment areas can increase the salt content of river water. Water used for irrigation of crops leaches salt from the soil and subsoil and the resultant drainage water, when returned to the river, has a higher salinity. This often makes the water unsuitable for human or domestic stock use, and may affect the biota and species composition of the environment.

In addition, irrigation and the construction of dams can raise the level of ground-water in adjacent areas. The effects of this are:

- the increase in groundwater levels results in an increased flow of groundwater into rivers. Since the groundwater is often saline, an increase in river water salinity occurs; and
- groundwater level increases may result in increased salinity at the land surface and this can kill natural vegetation and crops.

Salinity problems can also occur as a result of clearing natural vegetation and the introduction of crops. The natural vegetation usually consists of trees with comparatively deep root systems that keep the water table low by evapotranspiration. Crops have a relatively shallow root system and allow the water table to rise. In many cases, the groundwater is saline and intersects with the surface in low areas, rendering these areas unsuitable for vegetation.

Other than reducing water usage, the only other way of slowing salinisation is by major revegetation. This however involves changing land use significantly over wide areas. Where commercial forestry is possible, the salinity trend may be reversed within a decade. In drier areas, the increase in salinisation will continue if current land uses are maintained. In agricultural areas, community education programmes are leading to more sustainable farming practices, such as reducing vegetation removal and ensuring vegetation is re-planted in some areas.

Acid Sulphate Soils

Acid sulphate soils are specific types of soils that contain iron sulphides. When exposed to the air, these iron sulphides are oxidized, generating sulphuric acid. Although the alkaline components of the soil itself allow some neutralisation of the acid, the remainder can leach through the soil causing acidification of water in the soil and other waters to which it may be exposed, corrosion of steel and concrete structures. The break down of the soil can also result in the release of toxic aluminum and heavy metals.

These iron sulphide layers of soil (potential acid sulphate soils or PASS) are usually found in low-lying coastal areas.

Potential acid sulphate soils usually occur under other layers of soil, thus it is not until the iron sulphide layers are disturbed and exposed to oxygen that they become a problem. The main causes of exposure of potential acid sulphate soils are development, dredging and agricultural industries that cause disturbance to soil layers.

Environmental impacts associated with acid sulphate soils include:

- Poor health or death of gilled species from acidic waters
- Fish kills resulting from acid and toxic by-products
- Nutrient deficiencies in effected organisms
- Corrosion and instability of built environment infrastructure
- Epizootic Ulcerative Syndrome (EUS) or "Redspot Disease"
- Increased Aluminium levels in waters resulting in human health problems

In most cases, effective identification, planning, management and monitoring can overcome the difficulties of utilising land in areas where acid sulphate soils are present. Strategies for management of these issues include:

- avoiding areas of acid sulphate soils
- neutralising by mixing with an alkaline substance such as lime
- separating and treating the acid sulphate soil or leachate
- burying the excavated material to avoid oxidation
- draining the land without exposing the acid sulphate soils using shallow drainage techniques

Soil Contamination

Contaminated soil can be broadly defined as soil where hazardous substances occur at concentrations above background levels. In terms of environmental management, contaminated soils are often defined as soils containing hazardous substances which assessment indicates pose, or are likely to pose an immediate or long-term hazard to human health, or the environment. Soil contamination is often closely linked to groundwater contamination, as soil is commonly the pathway through which the contaminants migrate before reaching the groundwater.

Specific industries and land uses which have been associated with site contamination include:

- agricultural activities;
- airports;
- asbestos production/disposal;
- chemicals manufacture;
- defence works;
- electrical manufacturing (transformers);
- electroplating and heat treatment premises;
- explosives industry;
- gas works;
- iron and steel works;
- landfill sites;
- mining / mineral processing; and
- oil production and storage.

Contaminants are usually physically or chemically attached to soil particles, or are trapped in the small air-pockets between soil particles depending on the nature of the materials. Materials which can cause contamination include:

- metals;
- inorganic compounds containing anions such as cyanide;
- organic chemicals;
- oils and tars;
- toxic, explosive and asphyxiant gases (including gases from the decomposition of wastes in landfills);
- combustible substances; and
- hazardous wastes

Disposal of untreated liquid or solid waste onto open ground represents a potential threat to the environment and in particular to the quality of soil in that area. Spills and leaks also have the potential to severely contaminate soils. Disposal of wastes containing heavy metals, such as lead, for example, can present a long term environmental threat due to the non-biodegradability and bio-accumulative properties of such compounds.

Contaminants are sometimes able to move within the soil profile. If contaminants migrate off-site entirely, any risk posed by the presence of these contaminants becomes the joint concern of the polluter and the neighbouring property. This may restrict the use of the site and ultimately reduce the value of land.

There are basically three methods for managing contaminated soils:

- Excavating the soil from the ground to be either treated or disposed
- Leaving the soil in the ground and treating it *in situ*
- Leaving the soil in the ground and containing it to prevent the contamination from becoming more widespread

The preferable method, though, is to prevent contamination in the first place. This can be achieved through a variety of methods, including:

- Improved material handling and storage
- Changing to processes or materials that result in less contamination
- Using cleaner production techniques
- Creating barriers, such as bunds, to prevent contaminants moving into soils
- Maintaining equipment so as to prevent contamination

Groundwater Contamination

Contamination of groundwater arises largely from soil contamination and is due primarily to the processes of leaching. This process involves percolating surface water transporting contaminants deeper down the soil profile, until they enter the water table. Direct groundwater contamination is less common but can occur.

Movement of the contaminant and its impact on the water table will be dependent on the characteristics of the contaminant and the soil profile. Volatile hydrocarbons, for example, may permeate soils faster than liquids due to gaseous particles entering the water table ahead of any fluid borne contaminant.

A common example of this would be leakage of hydrocarbons from an unmonitored underground storage tank. Once the groundwater becomes contaminated it can migrate off-site, either spreading the plume of contamination or diluting its effects sufficiently to no longer be of environmental concern. However, if the pollutant is maintained in high concentration, then the pollution problem can have far reaching effects and become increasingly more difficult to deal with.

A variety of techniques and strategies exist for preventing contamination of groundwater. As discussed above, minimising the contamination to soil can greatly reduce the potential for contamination of groundwater. Other prevention techniques include testing and maintaining underground storage or septic tanks, and changing disposal methods to avoid contaminating groundwater.

When groundwater contamination occurs, however, it can be very expensive and difficult to clean up. Few options for treating contaminated groundwater are viable and once contamination occurs, pumping or drawing through a treatment process prior to use is one of the few options available.

Local Impacts

Noise

Excessive noise emission from industrial premises is considered a type of pollution. Noise pollution is defined as a loud, harsh, or undesired sound and, as well as causing a nuisance, may have long-term physiological effects on humans. Prolonged exposure to noise is known to lead to a gradual deterioration of the inner ear and to subsequent deafness. Loud and prolonged noise can also adversely effect ecosystems, disturbing animals and causing populations to disperse. Excessive noise outside the production premises, which affects neighbouring properties, can result in complaints or continuing disputes and can create a poor public image for industries.

Noise pollution can come from many sources, but is particularly associated with certain industries. These include: iron and steel manufacture, motor vehicle production, metal products fabrication, printing and publishing, heavy construction, lumbering and wood commodity production, mechanised farming and textile manufacturing.

A variety of management strategies exist that can assist in managing noise pollution, both for workers directly affected, neighbouring communities and surrounding wildlife.

- ♦ Occupational noise can be decreased by reducing noise at the source, by shielding workers from the noise, or by protecting workers with devices to shield the ears
- ♦ Workers, neighbouring communities and wildlife can be protected by erecting buffers or barriers to block the noise
- ♦ Limiting operational hours can also reduce the effects on workers and neighbours.
- ♦ Correctly and regularly maintaining plant and equipment can reduce unnecessary noise substantially
- ♦ Integrated planning can reduce incompatible land uses

Visual

Visual aesthetics can often have an impact on people within a range of work, residential or recreational environments. Elements such as the presence of haze and smog can create a poor visual effect, not to mention health implications. The presence of a landfill, treatment plant or factory in an area where one may expect to find a more natural environment can be considered an eyesore. Industry, or even households, emitting large quantities of waste can reduce visual amenity.

As the public are becoming more environmentally aware, and more demanding in terms of visual amenity, industry is becoming more mindful of the visual impact of its infrastructure and activities. The awareness of and desire for a pleasing environment, free of visual pollution can be a motivating factor for people to seek to improve their environment.

There are many ways in which visual pollution can be reduced and visual amenity improved. These can involve industry, communities and individuals. In addition to this many government initiatives such as local and national parks or landscaping can also improve visual aspects of an area. Some methods of reducing visual pollution or improving amenity are shown below:

- Reducing the impacts of industry through screening or buffering
- Considering placement of unsightly industrial equipment
- Creating areas of natural environment providing where possible native plants and animals

Health Impacts

The health impacts of pollution from local areas may be significant. Within a local area, many sources can have a direct impact on the health of a community. Health impacts can occur through many different pathways. However, these pathways can be broadly categorised as dermal, ingestion and inhalation.

Environmental risks to health can be of varying types. Commonly they can occur as toxic substances or microbial organisms in water, air or soil. These cover a variety of types of pollution, such as those detailed in this course.

Adverse effects on human health can arise in many ways including:

- ♦ airborne contaminated particles or chemicals from nearby industrial plants being inhaled, digested or coming into contact with skin;
- ♦ air pollution, in general, resulting in respiratory conditions such as asthma;
- ♦ food poisoning from consumption of contaminated fish or oysters from polluted water;
- ♦ food products from contaminated soil being consumed by humans;
- ♦ exposure to increased UV due to reduction in the ozone layer, causing cancer; and
- ♦ mosquito-borne diseases resulting from changes to ecosystems.

Besides health impacts resulting from changes to the biophysical environment, health impacts may result indirectly from the result of the broader "environment", e.g. studies have shown that lower socio-economic status is linked to in increased morbidity and mortality.

A variety of strategies and techniques can be applied to manage these health risks.

Incidents of air pollution due to unusual weather patterns, consumption of contaminated produce, and coming into contact with hazardous chemicals are some of these. However, we are still prone to some serious health risks from environmental sources that are often overlooked.

Methods for management of these risks are diverse and usually involve two processes:

- ♦ Firstly, management of the environmental impact itself, for example techniques for managing air pollution covered in previous sections
- ♦ Secondly, management to prevent impacts on health, for example setting of standards of air quality in human environments

Economic Impacts

The economic impacts from environmental issues can be substantial and this should be acknowledged. Given our modern perspective of sustainability, which inter-links society, economy and environment, it is natural that economic impacts, whether positive or negative, may result from environmental issues.

Although sound environmental management may bring financial benefits, for example the cost-savings that can be made from reducing and recycling waste, poor environmental management may result in high costs. This is particularly true for contamination issues, where in many States the legislation is focused toward a "polluter pays" system.

The costs of contamination to both industry and the community are significant. Many costly remediation projects have been undertaken by industries forced to comply with applicable legislation. Sometimes companies go bankrupt in the process of cleaning up a site or have endured costly lawsuits in which they have been sued for the adverse health effects people have suffered as a result of their operations.

There are a wide variety of strategies for managing economic costs, a major one of which is to avoid the additional cost of prosecution or contamination by effectively managing other environmental issues. Other pro-active strategies include keeping up with the latest environmental technologies, legislative requirements and ensuring continual improvement in operations.

Environmental Law

The community is increasingly aware of the range and scope of local, regional and global environmental issues. As a result, governments have acted with legislation, treaties, rules and regulations that attempt to protect, conserve, remediate and control environmental impact.

There has also been recognition of the emerging number of global issues that can threaten the entire planet. These are the responsibility of all nations. Global environmental issues require international responses. International responses have taken a variety of forms. Broadly speaking, action has taken place through both International law and the increasing role of the United Nations in environmental management.

The United Nations

The United Nations established the United Nations Environment Program (UNEP) in 1972. This program, based in Nairobi has a mandate to "safeguard and enhance the environment for the benefit of future and present generations". In 1992 the United Nations Conference on Environment and Development (UNCED) held in Rio de Janerio, adopted Agenda 21. Agenda 21 represents the current consensus of opinions and actions necessary to push the world towards a goal of sustainable development. Agenda 21 does not in itself force change. It does flag a high level of political commitment for Ecological Sustainable Development (ESD).

The Commonwealth has challenged States' rights in relation to environmental jurisdiction through the High Court. A prominent example is the Gordon above Franklin - the Tasmanian Dam Case (Commonwealth vs Tasmania). The precedent established through these cases has gone a long way to clarify some boundaries in relation to jurisdiction in environmental matters.

Functional duplication still exists between various agencies. It is highly likely that industry sectors will have to comply with both federal and state based regulations. At times the regulations will not be complementary.

The Federal Government currently controls environmental matters through the following mechanisms:

- the control of federal government activities or activities on federally owned property;
- developing and enforcing legislation which affects the activities of governments and industry other than at a federal level;
- through passing legislation as a result of an expressed commitment to an international treaty or protocol; and

- through gaining control via high court precedent.

Many statutes, other than those that are regarded as environmental, contain requirements regarding environmental management and pollution control. This holds true with resource management laws such as the various mining and petroleum acts, forestry acts, and fishery acts. These industry-based acts must also be considered when determining levels of compliance with environmental legislation.

In an effort to reduce the complexity of environmental law and regulations, a number of recent initiatives are attempting to develop cooperative and coordinated approaches to policy making and administration of the environment. These are the Intergovernmental Agreement on the Environment (IGAE) and the National Environmental Protection Council (NEPC).

Intergovernmental Agreement on the Environment

Global environmental problems require regional and local solutions to implement international and national strategies.

The agreement establishes the roles of the parties and the ground rules under which the Commonwealth, State, Territory and local governments interact on the environment, including a broad set of principles to guide the development of environmental policies and sets out cooperative arrangements on a wide range of specific issues.

The major features of the IGAE are:

- delineation of responsibilities and interests of the local, State and Commonwealth government;
- mechanisms and procedures emphasise timely consultation, streamlining intergovernmental processes and the need to avoid duplication of decision making;
- consultation process for international conventions on the environment;
- commitment to eliminate functional duplication;
- establishment of principles for environmental policy development and implementation, including the adoption of the precautionary approach to environmental issues;
- national approach to data collection;
- joint collaborative efforts for land use decisions and approvals;
- common principles and processes for EIA;
- establishment of national environmental standards, guidelines and goals and formation of the National Environment Protection Agency;
- cooperative development of a National Greenhouse Response Strategy;
- implementation of the Convention on Biological Diversity;
- consultation processes for world heritage identification and nominations;

and

- cooperative arrangements for nature conservation.

Administrative Agencies

In broad terms each state has an agency which administers environmental protection legislation and educates the public in relation to environmental issues and strategies for improvement. The agency may also have a key role in developing environmental policy although this varies from state to state. Environment is administered from a federal perspective through the Department of Environment and Heritage.

Accountability

Changes to Corporations Law in 1998 require companies to disclose a certain amount of information relating to compliance with environmental laws and regulations. International trends have indicated that more detailed public reporting may be required in years to follow.

Environmental Due Diligence

Due diligence is a legal defense which is available during prosecution for an environmental offence:

Due diligence has been described as:

- the opposite of negligence;
- a comprehensive program of systematic vigilance to deal with likely risks arising out of operations; and
- using all reasonable foresight and care in planning and carrying out our activities so that harmful impacts on the environment is prevented or minimised.

Due Diligence, may be defined “as taking reasonable and practical measures to prevent environmental damage that an organisation can create by its activities, products and services." This management tool is an essential element in risk management.

Relevance of Due Diligence

Being able to demonstrate due diligence is important to you because:

- ♦ It provides a means of reducing prosecution of a company, its directors and managers;
- ♦ It can be used as a tool to reduce environmental risks and prevent expensive clean up costs; and
- ♦ As a defense to environmental offences, and allows mitigation factors to be considered in environmental prosecutions.

A landmark case involving the Canadian Government and Bata Industries heard by Justice Ormston in the Ontario Court of Justice in February 1992. Bata Industries had stored drums on an unsealed area causing pollution. Visiting environmental officers identified this problem and charges were laid against the directors and officers. Those charged included the Site Manager, the President of the Board and the Chairman of the Board. Only the Chairman of the Board was acquitted. The Site Manager and President of the Board were convicted.

The judge outlined what is deemed to be environmental due diligence:

- ♦ The directors should be aware of the standards of their industry for environmental risk; and
- ♦ The directors should immediately and personally react when the system has failed.

To be able to demonstrate due diligence the principles are:

- ♦ instruct on the need for a system;
- ♦ establish the system;
- ♦ operate the system;
- ♦ report on the system;
- ♦ know the standards;
- ♦ know the laws;
- ♦ deal personally with system failures.

Principles of Environmental Management

Ecologically Sustainable Development

Ecologically Sustainable Development (ESD) is "using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased."

The core objectives for ESD contained within the National Strategy for Ecologically Sustainable Development are:

Objective One: To enhance individual and community well-being and welfare by following a path of economic development that safeguards the welfare of future generations.

This objective acknowledges that only economically sound development will protect the environment. A strong and growing economy increases the size and range of industries. This leads to a wider range of jobs, which improves community well-being and can increase our capacity to undertake environmental protection.

Objective Two: To provide for equity within and between generations (intragenerational and intergenerational equity).

Intragenerational equity addresses the fair distribution of assets including natural, built and human capital within a generation. One of the key issues is the equity between developed and developing nations.

Intergenerational equity aims to ensure that our current activities do not exploit non-renewable resources at a rate exceeding replenishment rates and hence affecting the ability of future generations to meet their resource needs.

Objective Three: To protect biological diversity and maintain essential ecological processes and life support systems.

In addition to the core objectives contained within the National Strategy for ESD, four guiding principles are outlined:

- Integrating environmental and economic policies and activities;
- Dealing cautiously with risk i.e. adopting the Precautionary Principle;
- Recognising the global dimension; and
- Valuing environmental assets (internalisation of environmental costs).

Precautionary Principle

Issues relating to environmental management may be surrounded with some degree of uncertainty based on a lack of evidence or community perception.

"Where there are serious threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, public and private decisions should be guided by:

(i) careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment; and
(ii) an assessment of the risk-weighted consequences of various options".

There is a requirement to undertake protective action towards the environment should there be a possibility of serious or irreversible harm, and this action should be undertaken prior to the conclusive proof that this harm is created. However, this requirement is not easily applied as there is some scope for interpretation in terms of defining serious or irreversible damage and also for defining appropriate measures that should be undertaken to mitigate the environmental degradation.

The precautionary principle largely shifts the onus of proof from those who claim environmental damage may occur from an activity to those whose actions may create the environmental harm. In the course of development projects there is now the expectation that precautionary measures be implemented to minimise environmental harm.

Activities that are likely to cause serious or irreversible environmental harm include:

- Release of chemicals;
- Contamination of soil, water bodies and food chains;
- Loss of biodiversity;
- Damage to ecological processes; and
- Introduction of exotic organisms to ecosystems.

In applying the precautionary principle, the following issues should be considered:

- Is there a possibility of environmental damage?
- Is there scientific uncertainty surrounding the possibility of environmental damage?
- What measures should be implemented to minimise the potential for environmental damage?

Considerations that are normally made include:

- environmental effects on the community;
- environmental impact on the ecosystems;
- diminution of the aesthetic, recreational, scientific, or other environmental quality or value;
- effect upon a locality, place or building having aesthetic, anthropological, archaeological, cultural, historical, scientific or social significance or other special value for present or future generations;
- endangering of any species of fauna or flora;
- long-term effects on the environment;

- risks or hazards which might endanger the safety of the environment on some future occasion;
- curtailing of the range of beneficial use of the environment;
- effects of any pollution on the environment;
- environmental problems associated with the disposal of waste;
- cumulative environmental effects with other existing or likely future activities; and
- implications for resources, natural or otherwise, which are, or are likely to become, in short supply.

Eco-efficiency

Eco-efficiency is defined as using environmental resources more efficiently in economic processes.

The World Business Council for Sustainable Development (WBCSD) has identified seven components of Eco-efficiency:

- Reduce material intensity of goods and services;
- Reduce energy intensity of goods and services;
- Reduce toxic dispersion;
- Enhance material recyclability;
- Maximise sustainable use of renewable resources;
- Extend product durability; and
- Increase the service intensity of goods and services.

Environmental management systems, cleaner production and improved business practices may result in eco-efficiency being achieved.

Eco-efficiency can result in developing competitive advantage, arising from:

- more stringent environmental regulations;
- the application of the polluter pays principle;
- achieving cost reductions through process efficiencies;
- exposure to environmental liability risks;
- community pressure for better environmental performance;
- growing demand for 'environmentally friendly' goods and services; and
- requirements to meet international standards.

Cleaner Production

Cleaner production is “the continuous application of an integrated preventative environmental strategy applied to processes, products, and services to increase eco-efficiency and reduce risks for humans and the environment”.

Cleaner production aims to change the way in which organisations address their environmental performance by reducing levels of pollution, waste generated and resources used, whilst maintaining competitiveness and profitability. Rather than implementing "end-of-pipe" solutions, cleaner production focuses on eliminating pollution at its source. This requires more efficient processes and technology, recycling, reducing and/or substituting materials.

Cleaner production can result in increased profitability as well as environmental benefits.

Benefits of cleaner production:

- Improve production efficiency therefore reducing costs;
- Reduce waste of material inputs;
- Increase productivity and often improve products;
- Reduce energy consumption;
- Recover by-products which may be used or sold; and
- Minimise waste disposal and reduce charges for waste treatment.

Waste Minimisation

Waste minimisation is defined as the use of practices or processes which reduce as much as possible, the amount of waste generated, or the amount which requires subsequent treatment, storage or disposal. It includes any activity other than de-watering or compaction, that results in the reduction of the total volume quantity or toxicity of waste. There are two key aspects:

- Source reduction; and
- Recycling.

Environmental Risk Assessment

Environmental risk can be defined as the possibility of any type of event which could cause harm to the environment. All risks should be identified, including those not under the control of the organisation. Comprehensive identification of all risks is critical as a potential risk that is not identified will not be given further consideration under the risk management process and therefore will not be managed.

Potential risks resulting in environmental impact could include:

- breach of legal requirements;
- sub-contractors or suppliers in breach of legal requirements;
- human behaviour/error resulting in environmental impact;

- natural events such as flooding, storms, cyclones, earthquakes;
- technological failure;
- equipment failure;
- management activities and controls and procedures not being implemented;
- neighbouring organisations causing contamination and or pollution;
- community outrage and/or media involvement;
- professional liability; and
- security breach such as vandalism, sabotage.

As discussed earlier, the environment is all encompassing so environmental risk includes harm to people, property, the natural environment and beneficial uses derived from the natural environment.

When investigating environmental risks consideration may be given to the:

- extent of the change to the environment;
- frequency / probability for the event to take place; and
- likely sensitivity that will be generated as a result of the event.

Environmental Impact Assessment

"An examination, analysis and assessment of planned activities with a view to ensuring environmentally sound and sustainable development".

The Environmental Impact Assessment (EIA) process enables consideration of environmental factors in addition to the economic and technical aspects of a development proposal. The aim of an EIA is to determine potential environmental risks. The EIA can assist in determining whether a project should go ahead and, if so, whether any conditions should be imposed to prevent or minimise environmental harm.

Arising from the EIA, an Environmental Impact Statement (EIS) may be prepared. An EIS is a document prepared as part of the EIA process which includes a description of the project proposal, potential environmental impacts, alternatives to the project and suggested mitigation measures.

An EIA may be required under legislation or may be used in less formal circumstances. The EIA requirements differ between States and Commonwealth.

Benefits of undertaking an EIA include:

- Legitimation of projects that are unlikely to harm the environment;
- Stoppage of projects that are likely to cause environmental harm;
- Selection of improved project location; and
- Reformulation of plans, resulting in better environmental outcomes by:
  - Excluding environmentally damaging activities contained within the

project;

- Minimising adverse effects by scaling down the project;
- Repairing, rehabilitating or restoring parts of the environment affected by the project; and
- Creating environments similar to those adversely affected or destroyed by the project.

Although benefits may be gained by undertaking an EIA, the process is often criticised as being one which justifies decisions that have already been made. Another issue with the formal EIA process is that it only applies to significant projects.

Cost Benefit Analysis

A cost-benefit analysis (CBA) is a tool to assist in determining the advantages and disadvantages, in monetary terms, of a project being undertaken. CBA is often used in evaluating various options. For example, CBA has been used to evaluate various measures to reduce salinity problems in the Murray-Darling Basin.

In order for a cost-benefit analysis to be effectively applied, the following considerations must be made:

- clearly define the project;
- all impacts in terms of costs and benefits must be identified, including current and future costs and benefits for the life of the project;
- assign monetary values to the above identified costs and benefits; and
- aggregate the values to calculate an overall net present value.

Difficulties arise when attempting to assign future values and, for this reason, CBA is best used as a guide.

The User Pays Principle

The 'user pays principle' ensures that the resources are sold at a price that reflects the full social cost of the use or depletion of a resource, including environmental costs. This principle provides an incentive for sustainable use and discourages over use or depletion of non-renewable resources.

Economic instruments to encourage management of environmental performance are often more effective in preventing pollution and conserving resources. Incentives encourage organisations to investigate using products and processes that reduce environmental impacts. Numerous economic instruments exist including:

- Resource cost recovery – e.g. charges for water reflect the cost to the water authority of delivering the resource to the customer;
- Disposal cost recovery – e.g. the water authority charging each customer the actual cost of receiving, treating and disposing of effluent introduced into the water;

- Pollution charges - e.g. pollution licence charges reflecting not only the cost of issuing and administering the licence, but the cost to the community of the damage to the environment of the pollutants discharged under the licence;

- Security bonds - e.g. in the mining industry there is a requirement for a company to deposit a substantial sum of money with the licensing agency as a guarantee to ensure rehabilitation is undertaken to an agreed standard.
- Tradeable pollution rights - these allow a company to discharge a certain amount of one or more specified pollutants into the environment, based on a calculated ability of the environment to absorb those pollutants. These rights may be sold to other companies.

Environmental Performance Evaluation

Environmental performance evaluation (EPE) is a "process to facilitate management decisions regarding an organisation's environmental performance by selecting indicators, collecting and analysing data, assessing information against environmental performance criteria, reporting and communicating, and periodic review and improvement of this process".

Environmental performance evaluation is a management tool that can provide an organisation with objective information on an ongoing basis to determine if it is meeting the environmental criteria set by management. The information generated by EPE may also assist an organisation to:

- Determine any necessary actions to achieve its environmental performance criteria;
- Identify significant environmental aspects;
- Identify opportunities for better environmental management;
- Identify trends in its environmental performance;
- Increase the organisation's efficiency and effectiveness;
- Identify strategic opportunities.

Environmental Accounting

Traditionally, accounting practices do not take into consideration the benefits and costs of environmentally based initiatives. This can result in environmental projects being delayed or cancelled on the basis of financial factors. Environmental accounting attempts to assign a monetary value to natural resources as well as monitoring savings from introduction of environmental initiatives.

The Commission for the European Community has produced a report on

Environmental Indicators and Green Accounting (1996), which suggests that the following data is collected and reported:

- Value and quantity of natural resources;
- Flows of material through the economy, indicating where natural resources are used in the economy, and their final disposal back to the environment;
- Value of the economic activities and employment linked to environmental protection; and
- Expenditure for the protection of the environment by industry, government and households.

Life Cycle Assessment

Life Cycle Assessment involves "compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system through its life cycle".

LCA studies the environmental aspects and potential impacts throughout a product's life i.e. from cradle to grave. This includes the acquisition of raw materials, production, use and disposal. The scope of the LCA depends on the intended use of the outcome of the study.

Recognised limitations of LCA exist including:

- assumptions made within the LCA may be subjective e.g. in terms of setting the boundary of the study and sources of data;
- models used for analysis to assess environmental impacts are limited by their assumptions;
- application of the results from a global study may not be applicable for regional issues;
- lack of relevant data.

In general, the results of an LCA should be used as a part of a more comprehensive assessment.