Even some of the most beautiful places in the world are not immune to littering. This is a dump at a mining town in the Arctic.

Pollution and Waste

Our world's population is exploding. Throughout history, our population has grown slowly but since modern medicine has stopped many deaths from disease and modern farming methods mean more food is available, death rates in underdeveloped countries are much lower than birth rates.

This increase in population, together with increasing living standards, puts more demands on our environment, meaning more raw materials (including non-renewables) are used up. More waste is being produced and unless it's handled properly will only cause more pollution.

Pollution means substances introduced by humans (either directly or indirectly), that results in harm to living resources, marine life, hazards to human health, hinders marine activities or spoils the quality for use of water. Human activity can pollute all these parts of the environment.

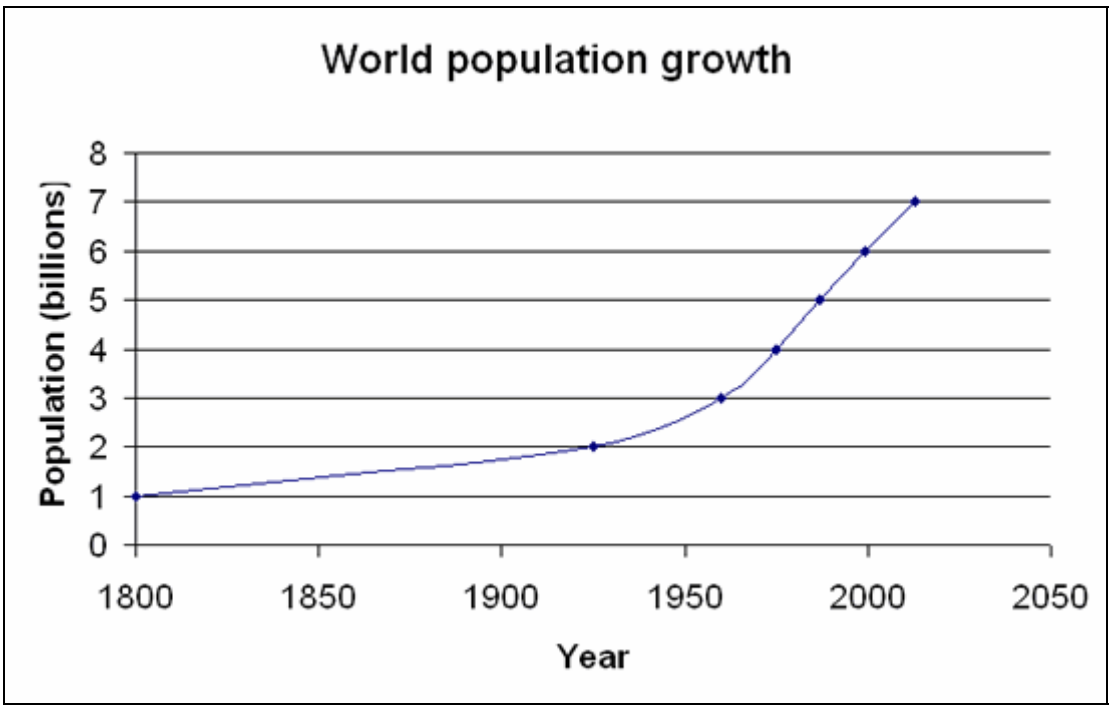
- Water – by sewage, fertilizers and toxic chemicals.
- Land – by pesticides and other toxic chemicals (which can be washed from land to water).
- Air – by smoke and gases (such as sulphur dioxide).

Nearly three-quarters of the earth's surface is covered by oceans. Our oceans form our largest ecosystem and any changes or damage within this can have important effects on us as humans.

Our oceans, unfortunately, aren't always as clean and litter-free as they should be. Humans, throughout history, have used the oceans to dispose of waste without thinking of future impacts.

Chemicals and other types of waste are dumped at sea (some illegally, but much with consent or as a result of accidents), but the majority is dumped on land and finds its way to the oceans.

Read on to discover how pollution and waste get into our oceans and what is being done about it.



This graph shows how the world's population has increased since 1800.

Smoke belching out of a chimney at a coal mine.

Pollution at sea

There are many different forms of pollution that end up in the sea, most with different reasons for being there.

Litter

Rubbish disposed of at sea – illegally – often finds it way on to beaches, so can be easily identified. Some waste would have been left on the beach by users; some is blown into rivers and streams, which will eventually find their way to sea. 50% of this litter is plastic, including bottles, bags, sheets and cotton wool sticks.

Plastics will be mechanically broken down over time, but only to a microscopic level. They cannot be broken down entirely – it would take thousands of years for a plastic bottle to completely decompose (which means for example that all drink bottles ever produced are still on our planet somewhere!) Even though we may not see them, they can cause a problem with organisms that live in the sea. These microscopic plastic pieces can be ingested by fish and make their way on to our dinner plates. Some of the larger pieces of plastic can entangle some of the larger animals that live in the sea. Turtles eat jellyfish and can often mistake plastic bags for their food. Disused fishing nets and lines can become wrapped around whales and dolphins, leading to death by drowning in some cases.

Can you think of more environmentally friendly alternatives to plastic items in everyday use?

There are some things you can do to help reduce the amount of litter in the sea. Firstly, putting your litter in a bin will help, especially if you are on a beach. There are also some “beachwatch” schemes and adopt-a-beach programmes in most countries, where a couple of times a year, volunteers will be asked to go to a particular beach and spend the day picking up litter. Finally, if we have to live with our plastic waste, then recycle it. That fleece you wear on cold winter days probably started life as a number of supermarket plastic bags that someone recycled.

If you live near the coast is there a scheme near you? If not what similar programmes exist to help clear up your local environment?

Sewage

Much non-industrial waste that ends up in drains or is flushed down the toilet ends up in sewage plants. Here it is treated by a variety of methods. First, all the solids, such as wood, paper, plastic and cloth, are removed, washed, dried and taken away for recycling or safe disposal. The remaining solids are separated from the liquid by being passed through settling tanks. The heavy, solid material settles at the bottom of these tanks and is taken away for further treatment. The bacteria is removed, methane is collected, which can be burned to produce electricity, and the remaining sludge can be spread on farmland as nutrient for crops.

The rest of the liquid is trickled over stones, on which micro-organisms are growing. These micro-organisms feed on the bacteria in the liquid and purify it. This method is called percolation filtration. Sewage plants can also aerate the liquid, by blowing air into tanks full of it, making the micro-organisms float freely and feed on the bacteria. This purified water is then discharged into rivers or into the sea.

Unfortunately, some countries still pump untreated sewage out to sea, or do not treat the sewage properly causing eutrophication in rivers. Raw sewage in the sea can lead to dirty beaches and sickness in swimmers and other coastal users. Eutrophication is a process where the addition of nutrients promotes growth in algae and other plant life in rivers. The plant material grows near the surface of the river, where there is the most light, but the growth can be so much that it blocks out light to the lower levels and river bed, preventing plant growth there. Eventually, this excess growth will start to die off and fall to the river bed. Here it will be decomposed by bacteria which will use up oxygen in the water. The lack of oxygen could lead to the death of many fish and possibly make the river toxic to other life. This process will also happen at sea near a sewage outflow. Far more people die each year as a result of the effects eutrophication can have on the food we eat, than die from shark attacks – this occurs through toxic shellfish poisoning, where a build up of dangerous bacteria occurs in food which enters the human cycle.

It is up to the governments of countries to regulate the disposal of sewage.

Find out what your government regulations are like. See if there's anything else they could be doing. What happens to the sewage from your home and how is it treated? You may live many miles from the sea, but if material from sewers, industry and farming seeps into streams or rivers it will eventually reach the sea. What policies exist in your country or region to reduce these inputs and how are they monitored?

Oil

Of all the pollutants in the world's oceans, oil is the one to have the most attention. It first caught the public's eye after the Second World War, when oil from sunken ships started appearing on beaches. You will probably have heard about disastrous oil spills in the news e.g. the Exxon Valdez oil spill on the coast of Alaska and the Sea Empress spill off the coast of Wales in the UK. Although these cases caused huge amounts of local damage, they are relatively small in comparison to the quantities of oil that reach the sea from other sources.

- Big spills: only 5% of marine oil pollution is due to major tanker accidents, but one big spill can disrupt sea and shore life for miles. The local impacts can be dramatic, destroying habitats and the economic life of a community, whether it be fishing or tourism.
- Down the drain: used engine and other oils poured down the drain or incorrectly disposed of, and the oil film deposited on the road by vehicles, gets washed into rivers and streams - eventually ending up in the ocean. It accounts for over 70% of the total input to the marine environment. Taking used engine oil to a recycling centre, regularly servicing your car for oil leaks, and disposing of cooking oils more carefully can all help. Even better, cut back on cooking oil and walk more often – good for the environment and your health!

- Up in smoke: pollution in the air from cars and factory settles on the land (or sea) and is washed via the rivers and drains into the oceans.
- Natural seeps: the earth's natural stores of oil seep into the oceans and were doing so long before humans inhabited the planet. In fact two to three times more oil is introduced into the environment in this way than through accidental spills.
- Offshore drilling: offshore oil production can cause oil pollution, from spills and waste from drilling.

The impact of such spills is varied, depending on the type of oil spilled and the area of the spill. Along the coastline, oil can foul beaches and destroy the species living on the shore. But the major threat is to seabirds and mammals. Bird feathers can be coated by the oil making flight impossible and leading to heat loss. This also affects seals and sea lions. The oil can get into the eyes and gut of these animals, leading to irritation.

Traditionally, huge efforts have been put into dealing with oils in the environment. Where a spill threatens our fragile habitat or our coastlines, every effort is made to clean up and replenish. However, oil is a natural product which does disperse and biodegrade quite quickly.

Current science-thinking is that if a spill happens in the open ocean, once the spill has been minimised (leaks stopped, oil transferred to an alternative ship and large pools pumped from the sea surface) letting nature take its course is often the environmentally safest thing to do.

As far as oil spills are concerned BP's Health, Safety, Security and Environment (HSSE) policy states that its goal is to have no accidents, no harm to people and no damage to the environment. The key element here is to avoid accidents in the first place, protecting people and the environment from our activities.

Radioactive waste

The dumping of radioactive waste at sea from ships was banned in 1993 under the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention, 1972). But there are still many barrels of radioactive waste and a number of nuclear submarines corroding on the seabed, the contents of which are already being spread around the world by ocean currents. Some of this waste may well end up on beaches and will remain radioactive for thousands of years.

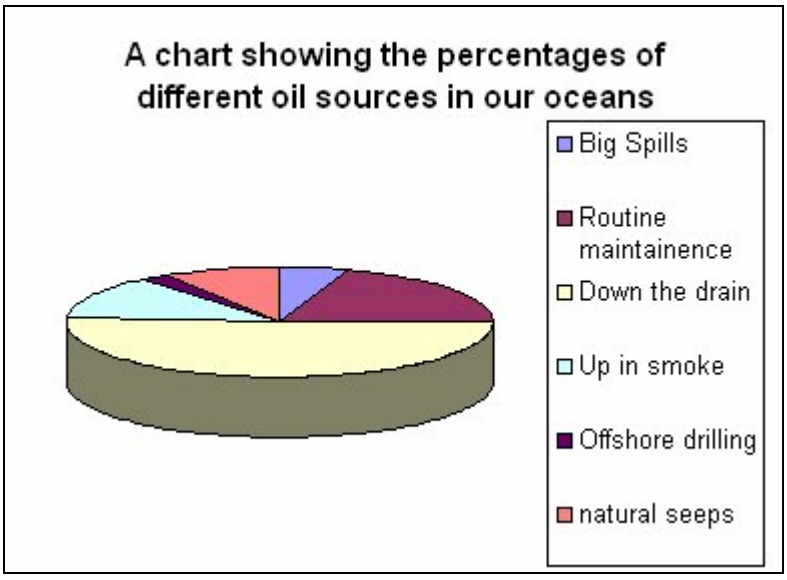
Discharging radioactive waste, however, is still continuing. Nuclear reprocessing plants regularly discharge hundreds of millions of litres of radioactive waste into the sea through discharge pipes. This process is legal, but shows a complete double standard in international legislation. The type of radiation emitted from radioactive substances differs from that emitted by the sun, because it ionises particles. In living organisms this can lead to mutation of DNA, which can be lethal or cause deformity or dysfunction.

You, as an individual, are probably not responsible for any radioactive waste disposal. However, there is something you can do – write to your local government representative and put pressure on them. Governments have the power to reduce waste and dictate how energy is produced. Renewable energy sources are much better than nuclear power – they produce no waste and have minimal impact on the environment.

Turtles can mistake litter for food. (Image: U.S. Fish and Wildlife Service)

Turtles and other marine animals can be accidentally caught up in fishing nets that are no longer being used. This is often called 'ghost fishing'. (Image:NOAA image library)

Litter and oil in a river



This chart shows the sources of oil in the sea.

Oil tanker accidents only contribute to 5% of the oil in the oceans, but the effect on the local ecosystem can be disastrous.

Pollution on land

Some forms of pollution that are found in the oceans can be found on land as well. Litter is a big problem in many countries, although many governments have introduced measures to keep the litter problem down. Landfill sites are overflowing and the incineration of waste just adds to the air pollution. At the moment, recycling is the only way to reduce this problem – apart from trying to produce as little waste as possible.

Pollution in the air

Air pollution is created by the destruction of forests, growth of certain crops and by the burning of fossil fuels. The combustion of sulphur-containing fossil fuels, such as coal, for industrial and domestic use produces a high level of smoke and sulphur dioxide. This became the biggest air pollution problem in the Industrial Revolution, but it has since been overtaken by car emissions. The petrol and diesel burnt by cars produces carbon monoxide (CO), nitrogen oxides (NOx) and particulates.

Nitrogen gas (N2) accounts for 78% of the planet's atmosphere. In this form it is very unreactive and so is not useable by plants or animals – but it is essential to the building blocks of life – it is at the core of protein and DNA. Nitrogen fixation is a process of converting this gaseous N2 into more usable forms such as nitrates (NO3) and ammonium (NH4). Plants can use these forms to produce proteins which can then be used by animals – we need plants more than they need us.

There are three ways in which this process takes place: (i) artificial production of fertilisers (ii) bacterial action and (iii) lightening.

Bacterial action is by far the most important process, though lightening was probably essential for early days of life on earth. Some bacteria (nitrogen fixing) turn nitrogen gas into nitrate. Others (putrefying and nitrifying) are the ultimate recyclers and decompose waste materials (dead plants and animals) into ammonia compounds and then nitrate, starting the cycle again. Some bacteria live in the soil, others in plant roots in a symbiotic relationship (each species benefits the other). Finally, to complete the cycle there are de-nitrifying bacteria, which turn nitrates back into N2 gas – not very helpful though they do help maintain a balance.

Lightening releases huge amounts of energy which momentarily splits the N2 molecules into nitrogen atoms. These bond with oxygen in the atmosphere to oxides of nitrogen which dissolve in the rain and fall to the ground. Here further reactions take place and nitrates are formed.

Artificial fertilisers can be produced using the Haber process. Large amounts of energy are used at high pressures to react nitrogen and hydrogen to produce ammonia. This uses lots of energy and thus adds its own pollution. Can you think of more environmentally friendly ways of fertilising the soil? What processes are involved?

Nitrogen dioxide (NO2) reacts with sunlight and other hydrocarbons to form ozone. In the outer atmosphere ozone is of great benefit as it very effectively blocks harmful U/V rays from the sun which cause cancer. However, this gas at ground level irritates the lungs which can affect respiration. It is ironic that part of our activity on this planet destroys the good ozone (high up) while another creates bad ozone by being in the wrong place. NO2 by itself can also affect respiration and bring on asthma in children.

Nitrogen oxides and sulphur dioxide (NOx and SO2) can mix with water droplets in the atmosphere, creating acids. These can be blown a great distance from the source of the emission and fall as rain, harming soil, eroding buildings and entering freshwater supplies. Large areas of forest have been destroyed as a result of this acid rain.

Carbon Monoxide (CO) is a toxic gas and one that interrupts the take-up of oxygen by haemoglobin in the blood. The CO attaches more easily to the haemoglobin depriving the body of oxygen, causes rapid deterioration of cells and in high enough concentrations leads to death.

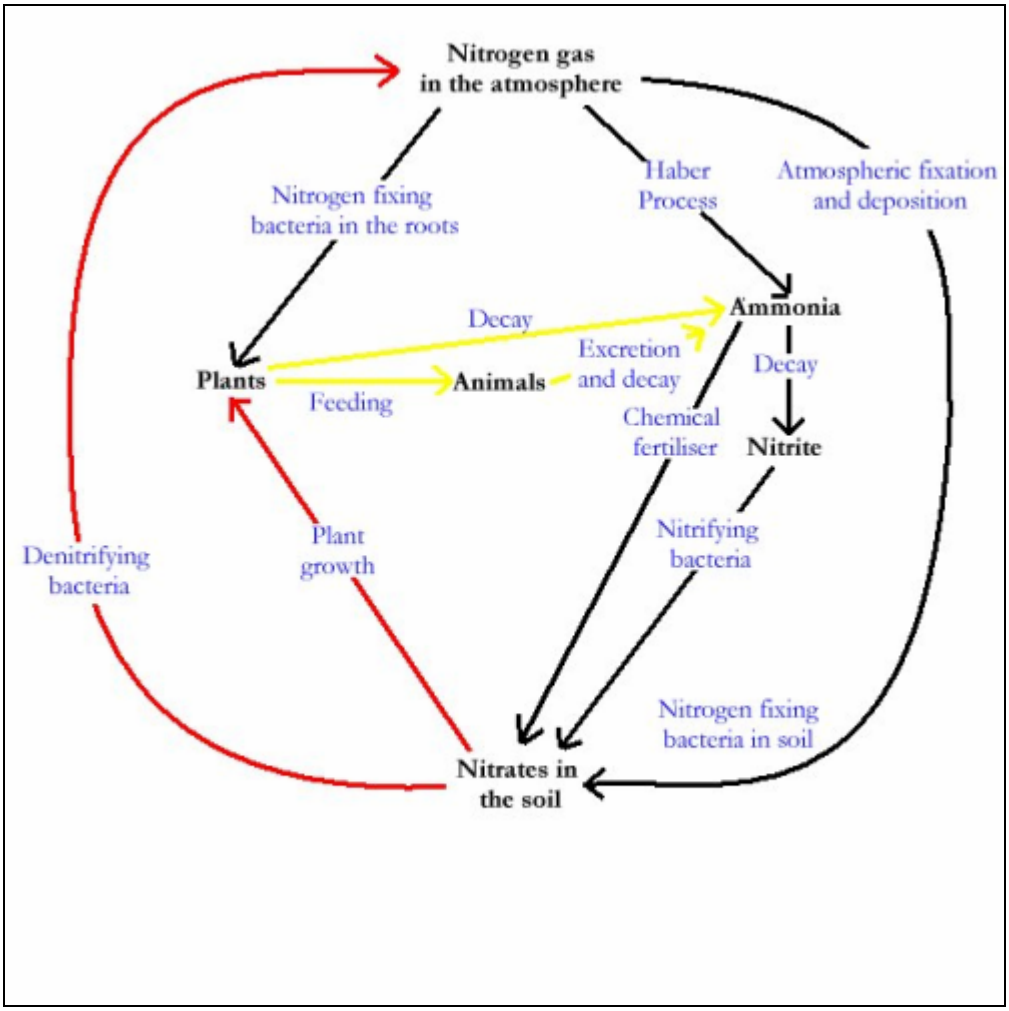
Carbon dioxide (CO2) is one of the key greenhouse gases discussed in Chapter 2. It is produced when we burn fossil fuels to power our cars or produce electricity. The biggest producer, at more than 15 tonnes per person, is the USA. Both Australia and Norway are also big users of fossil fuel because of their extremes of climate – one uses more heating than any other country, the other more air conditioning. It doesn't take too much to work out which is which!). France is one of the best European countries for CO2 emission – mainly because of extensive use of nuclear power stations (which produce 70% of the energy needed by the country). The developing countries of the world in Africa, Asia and South America produce about 10% per capita of the amount produced by the industrial nations, yet it is these regions that will be most effected (economically and physically) by global warming. Why will they be affected so much?

Governments across the world have met in a series of Climate Change Conferences and set targets for the reduction of emissions of CO2 from burning fossil fuels. There has been some disagreement about how much each country should do as its fair share, but almost all governments accept that they have to take some measures.

Particulates: these vary in chemical composition and physical properties, but they can be inhaled and carried deep into the lungs, causing inflammation. They can also carry carcinogenic (cancer-causing) compounds into the lungs. The above compounds and gases not only affect humans, but other land-dwelling animals as well.

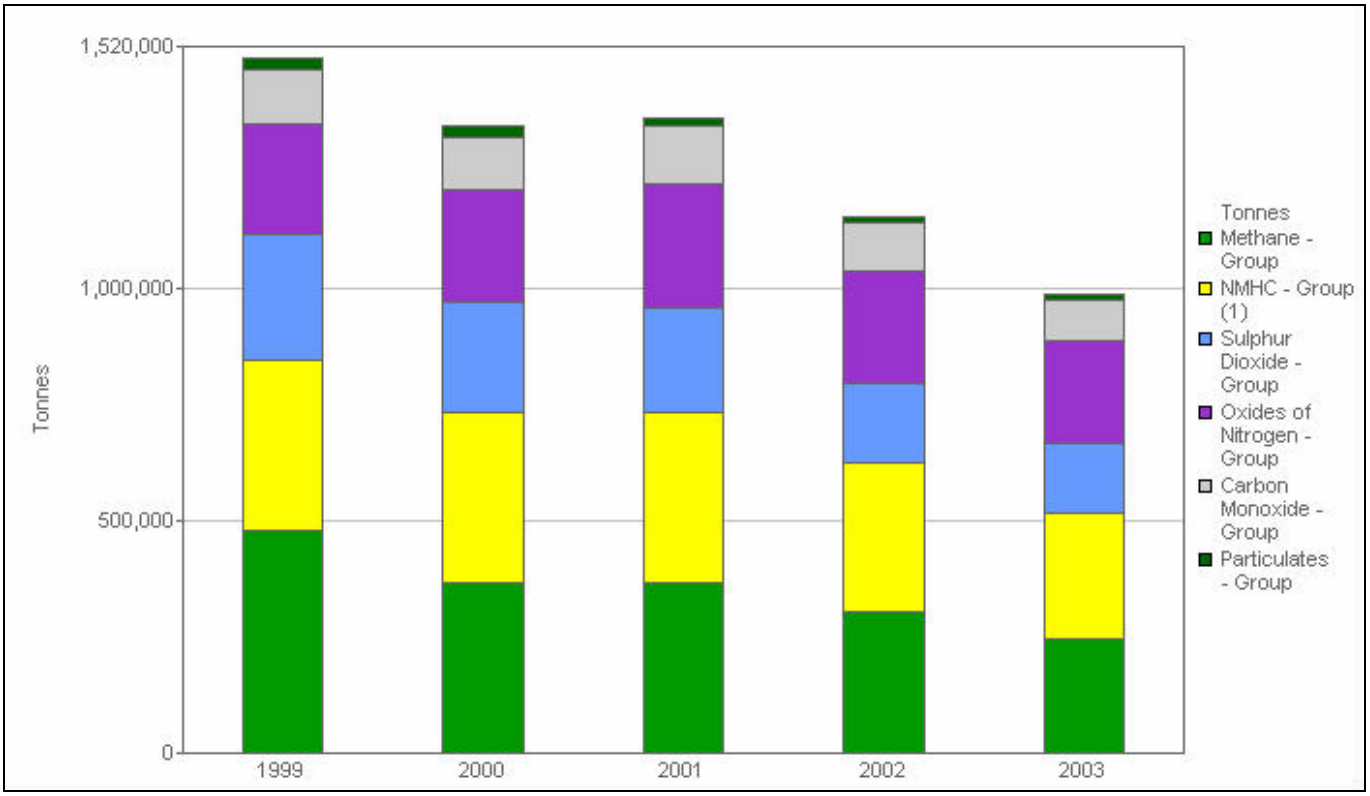
Radioactive pollution: Should there be any leak from nuclear power stations, such as in 1986 at Chernobyl in the Ukraine, dangerous radioactivity pollutes the air. This in turn absorbed by plants and passed on in the food chain.

Is there anything you could be doing to help reduce air pollution?



The nitrogen cycle

The burning of fossil fuels produces greenhouse gases, which are released into the atmosphere.



Every industry emits greenhouse gases, simply by using power, but BP has worked hard to reduce its emissions of other substances.

Waste management on land

We can dispose of our waste in a number of ways:

Landfill

Landfills are large areas of land where rubbish is buried. Bad management of these areas can lead to pollution of groundwater supplies and release of methane into the environment, which not only makes the surrounding area smell but is also a greenhouse gas, 50 times more potent than carbon dioxide. Most modern landfill sites are lined with plastic or clay to prevent toxic substances leaching into water. They also have methane wells to exhaust methane from the site. The methane is a by-product of the decomposition of materials in the landfill. It can be collected and piped to a generator to produce electricity.

Incineration

Incineration is the combustion of waste at high temperatures. This can destroy valuable resources that can be recycled (plastics, glass, tins, paper), and also exacerbates the climate change problem by introducing yet more CO2, among other compounds, into the atmosphere. Having said that, changes in technology (filters) over recent years and improved sorting of rubbish, have decreased the toxic contaminants that are input to the atmosphere by as much as 90% in some cases. The energy from this burning is also now put to better use, to generate power and heat hospitals.

Recycling

This is the collection and reuse of materials to make marketable products. The need for raw materials is reduced which saves the habitat damage, pollution and waste that is associated with the extraction of raw materials. Recycling materials reduces the emissions to air and water by both the production process and the disposal of it. It takes less energy to re-use something than to create it anew. Most countries have set up recycling schemes where households either have different bins for different materials, or there are various recycling collection points in town centres. Plastics, glass, paper and tins are the main items that can be recycled, and along with compostable materials, this represents about three-quarters of the average household waste bin.

Incinerators release CO2 into the atmosphere, but the energy produced by the burning is put to good use.

Many countries now encourage people to separate their litter so that as many items as possible can be recycled.

In some countries, you have to pay extra taxes to use the landfill sites. This encourages people to recycle their rubbish, instead of burying it.

Waste management at sea

We know that there is a lot of waste at sea and we know how it gets there. But how is the crew of BP Explorer managing their waste on the boat?

Litter: the crews take freeze-dried food with them on the race. The packets take up little space and are light – the lighter the boat the better. This means the only litter they'll have will be the food packages, or at least it should be. They keep these on board until the boat reaches the next port of call and then the packets will be disposed of.

When the boats return to England, how will this waste be treated? Landfill or recycle?

Sewage: all human waste is pumped directly into the sea – it is biodegradable and will provide food for marine organisms. The sewage does not create problems in terms of eutrofication, as it is such a small amount and is spread over a large area, mostly offshore. Sewage is natural and there is little we can do to reduce it. It only becomes a problem when large quantities are introduced into small areas. The ocean acts as a very good antiseptic for small amounts.

Oil: hopefully the crew are not using the engine much - to win, the crew need to SAIL round!

The crew of BP Explorer has to dispose of their non-biodegradable waste when they arrive at each port.

Waste management in your school

So now we know about the problems waste can create and how we can reduce it, what could you do to help?

Use more re-useables

Items that can be used more than once will cut down on waste. Refillable pens and pencils are a great way to start. Work on both sides of a sheet of paper – if you don't and you don't need to hand that paper in, then use it as scrap. When you're done with it, recycle!

Lunch

Only take the food you know you'll eat! More than 20% of the food we buy gets thrown away. If you can't finish all your lunch, bring it home and put it in the refrigerator to have the next day. Also, try to have fewer items in your lunch box that are packaged in materials that will be thrown away.

Jumble

Any items that you no longer want don't have to be thrown away. Instead, you could organise a jumble sale at school to pass these along. Someone else may have a great use for them!

Energy

Saving energy at school is another way to help the environment. Turning off lights when you're finished with them will save a lot of energy. The less electricity you use, the less has to be produced – less gases emitted to the atmosphere. Consider having an energy monitor, a member of the class, who's responsible for making sure that the light is turned off when no-one's in the room. Inform your teachers that having electrical equipment on stand-by often uses up as much energy as having them turned on. If you have a computer in your classroom, or if you ever use a computer, make sure that the teacher responsible for it actually turns it off before going home.

Waste

What does your school do with its waste, and what about at home? Plastics, glass, paper, cans can all be put into recycling bins – either in your home/school or at central collecting points. Can you find out what these waste products are turned into? Try to trace the fate of your plastic bottle or aluminium can after using it at lunch break.

More important – minimise rubbish in the first place. Do you need the plastic carrier bag the shop will give you to carry a loaf of bread? Look at how much unnecessary packaging is used for products. Some companies really concentrate on minimising packaging and using recycled/ recyclable materials – others do not. Use recycled products – kitchen roll, paper, glass etc.

Did you know...?

- Although radioactive waste is potentially harmful, radiation from radioactive sources can be useful:
    - alpha particles are used in smoke alarms
    - beta particles are used in medical treatments
    - gamma rays are used for sterilising medical equipment and treating cancer.
- More than 75 million tonnes of plastics are produced every year around the world – much ends up as waste which is not biodegradable.
- Recent research is looking into recycling types for road surfaces – by shredding the rubber and mixing with the surface, making it flexible and reducing noise and maintenance.
- The worst chemical industry catastrophe polluted the air around a pesticide factory in a city in India in the mid-1980s. More than 2,500 people died and land around the factory is still heavily contaminated twenty years on.
- In highly industrialised countries, an average family throws away more than one tonne of rubbish every year – most consists of paper, packaging and kitchen waste. Much of this could be recycled and used again.