#1

CAA: Clean Air Act

TDS: Total Dissolved Solids

NOAEL: No Observable Adverse Effects Level

IPCC: Intergovernmental Panel on Climate Change

MCL: Maximum Contaminant Level

#2:

Contaminant 1: Petroleum Compounds (Organic chemicals)

Source 1: Underground storage tanks. Many of these tanks are at automobile service stations that store gasoline, diesel fuel and other petroleum products.

Contaminant 2: Nitrates

Source 2: Found in agricultural fertilizers.

Benefit 1: It minimizes adverse impacts of wastes.

Benefit 2: It reduces the use of natural resources to make new products.

#3:

Pathogens are disease causing agents such as bacteria, viruses, protozoa and parasitic worms called helminths. These microorganisms can enter the water ways from inadequately treated sewage discharges, storm water drains, septic systems and run off from pastures and animal feedlots. They can cause human illnesses ranging from typhoid, cholera, diarrhea etc.

MCL stands for **Maximum Contaminant Levels** given in units of mg/L of water. They were established by the US Environmental Protection Agency (EPA) for a variety of organic and inorganic chemicals along with specified treatment technologies that must be used to protect against disease causing microorganisms.

#4

Mercury is an extremely toxic metal that is classified as a carcinogen. Mercury can get into the human body in several ways such as ingestion, inhalation and dermally. Once inside the human body it will bio accumulate. If the concentration of methyl mercury becomes too high, this can cause several neurological disorders such as a loss of coordination, difficulty in seeing, hearing impairments, paresthesia, blindness and death

5)

a)

How is Chronic Daily Intake calculated?
CDI (*mg/kg-day*) = (Average daily dose (*mg/day*)) / (Body weight (*kg*))

What is the potency factor?
PF $(mg/kg\text{-}day)^{-1}$ = Incremental Cancer Risk for a Chronic Daily Intake of 1 mg/kg-day

Chronic daily intake (CDI) is the daily average dose that a person intakes, and it depends on the body weight. Potency factor (PF) is a measurement of how much risk is increased if you intake 1 milligram/Kg – day.

b)

When assessing the risk, there is a key value called the uncertainty factor (UF). It can be affected by a lack of NOAEL data or an extrapolation of NOAEL from animal testing data. Uncertainty in risk assessment results from the lack of knowledge on toxicity to the target population for a substance.

6)

a)

- *Population Growth per year* – This reflects the size of the population and effect of population growth. Increasing population generates greater demand for food, clothing, shelter, and other human needs.
- *GDP per Capita* **–** This measures average affluence. As this term grows, an individual's demand for goods and services also grows.
- *Energy Intensity (energy use / per GDP)* – This is most related to technology and technological change.

b) **Bioaccumulation** refers to the accumulation of substances, such as pesticides, or other organic chemicals in an organism.
Example 1:

A mouse eats crops sprayed with DDT. An eagle then eats the infected mouse. The eagle is infected with the toxins. The eagle's system is then damaged and its eggs shells will become softer and the chick inside will either die, or be born without being properly developed.

Example 2:
A more simple example might be a bird flying over a factory and getting some acid. Then, a bigger bird eats that bird, then a different animal eats that bird, and eventually, the acid is collected and brings viruses or/and death.

#7:

The Hazard Quotient is defined as the ratio of the average daily dose (ADD) of a chemical divided by the reference dose. The average daily dose is similar to the chronic daily intake (CDI) used for carcinogenic risk of assessments. The HQ is a conservative estimate of the dosage that produces no adverse effects. If HQ is less than 1 it means that no adverse effects from the exposure.

4 steps:

1- Hazard Assessment
2- Dose-Response Assessment
3- Exposure Assessment
4- Risk Characterization

#9:

Assuming a typical water consumption of 2.0 L/day for 70 kg adults:

Zinc RfD = 3 x 10^{-1}mg/Kg-da

Formaldehyde = 0.2 mg/Kg-da

Chloroform = 1 x 10^{-2} mg/Kg-da

Zinc ADD = [2.0 (mg/L) * 2 (L/day)]/ 70 Kg = 5.7 *10^{-2} mg/Kg-da

Formaldehyde ADD = [2.5 (mg/L) * 2 (L/day)]/ 70 Kg = 7.1*10^{-2} mg/Kg-da

Chloroform ADD = [70 (ug/L) * 2 (L/day)*1 (mg/1000ug)]/ 70 Kg = 2.0*10^{-3} mg/Kg-da

Zinc HQ= **[**5.7 *10^{-2} mg/Kg-da] / 3 x 10^{-1}mg/Kg-da = 0.19

Formaldehyde HQ= **[**7.1*10^{-2} mg/Kg-da] / 0.2 mg/Kg-da = 0.355

Chloroform HQ= [$2.0*10^{-3}$ mg/Kg-da] / 1×10^{-2} mg/Kg-da = 0.2

HI = sum of HQ's = 0.19 + 0.355 + 0.2 = 0.745

The overall hazard index is less than 1 so there is no obvious health concern from these exposure levels.

#10

$$CDI = \frac{100 * (2 * 10^{-4}) * 4 * 350 * 12}{15 * 70 * 365 * 24}$$
$$CDI = 3.65 * 10^{-5}$$

$$Cancer\ Risk = CDI * PF$$
$$Cancer\ Risk = (3.65 * 10^{-5}) * (6.1 * 10^{-3})$$
$$Cancer\ Risk = 2.28 * 10^{-7} < 1 * 10^{-6}$$

It is thus okay to use the park.

#11

a) Population growth, economic growth, and technological change

b)

$$P = 1{,}000{,}000 * (1 + 0.05)^{10} = 1{,}628{,}894.62$$
$$\%\ increase = \frac{1{,}000{,}000}{1{,}628{,}894.62} * 100 = 61.39\%$$

Bonus

a) It is formed by complex chemical reactions in the atmosphere involving nitrogen oxide (NOx) and hydrocarbon gases, triggered by summer sunlight. As a result, we get what is known as "photochemical smog" that contains a lot of ozone. It attacks lung tissues. Ambient levels of ozone affect not only asthmatics but also healthy people. It interferes with the ability of plants to produce and store food, which cause half a billion dollars per year of agricultural crop loss in the USA. Reduction of the atmospheric ozone concentrations require a reduction in NOx and hydrocarbon emissions.

b) Over-enrichment of nutrients in lakes, rivers, or streams that leads to a condition called eutrophication. Some lakes are naturally eutrophic, but in many other cases the excess nutrient input results from anthropogenic origins such as municipal wastewater discharges, industrial effluents and runoff from fertilizers and manure spread on agricultural areas. Nutrient enrichment seriously degrades aquatic ecosystems and impairs the use of water for drinking, industry, agriculture and recreation.