- **What is Acid Rain?**

Acid rain is a result of air pollution, both from natural and man-made sources. Natural sources include things such as volcanoes and decaying vegetation while man-made sources arise primarily from fossil fuel combustion. When any type of fuel is burnt, lots of different chemicals are produced. Power stations, factories and cars all burn fuels and therefore they all produce polluting gases. Nitrogen oxides (NOx) and sulphur dioxide (SO2) contained in these emissions combine in the air with water vapour in the clouds to form a very weak acid. The rain that falls from these clouds is known as “acid rain”.

- **How acidic is acid rain?**

Acidity is measured using a scale called the pH scale. This scale goes from 0 to 14. 0 being the most acidic and 14 the most alkaline (opposite of acidic). Something with a pH value of 7 is termed neutral i.e. it is neither acidic nor alkaline.

Very strong acids will burn if they touch your skin and can even destroy metals. Acid rain is significantly weaker than this, never acidic enough to burn your skin.

Rain is always slightly acidic because it mixes with naturally occurring oxides in the air. Therefore, even in the most remote and pristine forests of our planet, the rain that falls will be slightly acidic.

Unpolluted rain would have a pH value of between 5 and 6. When the air becomes more polluted with nitrogen oxides and sulphur dioxide the acidity can increase to a pH value of 4.

Vinegar has a pH value of 2.2 and lemon juice has a value of pH2.3. The strongest ever recorded acid rain is only about as acidic as this and we know that these don't harm us – so why care about acid rain? Acid rain can decrease the pH of water leading to enhanced solubility of metals, with lead being the most serious.

- **What does acid rain mean for your rainwater harvesting system?**

The quality of water provided by a rain tank depends on the quality of water that enters the tank, the processes within the tank and any contamination as water passes to a supply point.

In terms of physical-chemical parameters, collected roof water, rainwater and urban storm water tend to exhibit quality levels that are generally comparable to the World Health Organisation (WHO) guideline values for drinking water.

Lead Concentration

The main concern with low pH rainwater (acid rain) though is that it increases the solubility of heavy metals such as lead, sometimes present in the roof material, into the water. Studies have shown that lead contaminations can sometimes be attributed to the composition of certain roofing materials and also dust particles from nearby roads settling on roofs - thus it is recommended that for roof water

collection systems, the type of roofing material should be carefully considered. In a survey of systems installed by Isla Urbana, 96% had concrete slabs as the material. The high pH prevailing in cement (concrete) limits the mobility of many heavy metals by decreasing their solubility. Thus in the Mexico City context, roof material is generally not a contributing factor to lead concentration.

- **Improving the quality of water supplied by your rainwater harvesting system**

1. **Leaf filter** – In the systems installed by Isla Urbana, leaf guards are fitted as standard as lead dissolution is increased in the presence of leaf debris.
2. **Gutter maintenance** – Gutters can be cleaned regularly to reduce the contaminants entering the tank.
3. **Tank maintenance** – The end-user should carry out an inspection for accumulated sediments, with annual cleaning recommended (in Mexico City, this is best suited to the dry season when the tank is likely to be empty).
4. **First flush -** First - flush diversion is a useful intervention to reduce contamination in rainwater systems. It uses the initial precipitation during a rainfall event to wash the roof before water is allowed into the tank. First flush systems are advantageous as they are not sensitive to particle size and they will remove dissolved contaminants as well as suspended ones, which is important if trace minerals such as lead and zinc are problematic. A sensible first flush diversion amount of 2mm was calculated by Martinson & Thomas (2003) in order to reduce the majority of contaminants in the rainfall. The *Tlaloque* used by Isla Urbana is capable of discarding a volume of 200L and based on average house roof size of 60m^2, this gives a diversion amount of 3.33mm – well above the amount recommended. Even if a larger roof size of 90m^2 is considered (+ standard deviation from the mean size), the diversion amount is 2.2mm, still above the recommended diversion amount. Due to the nature of rainfall in Mexico City where during the wet season it rains almost every day, it would not be necessary to discard 200L every time to achieve the same reduction in contaminants, only the first rains of the season when there will have been a build-up of dry deposition on the rood during the dry-season.
5. **Sedimentation floating outlets –** The highest quality water in a rain tank is in the layer close to the tank surface. The floating outlet used by Isla Urbana takes advantage of the tanks natural sedimentation process to supply only the highest quality water from the tank to the supply point.
6. **Filtration –** Isla Urbana systems typically come with two in-line filters. The first removes sediments less than 50 microns. The second is activated carbon, which removes even finer contaminants again.
7. **Disinfection –** Chlorine tablets in the *tinaco* then kill-off any bacteria present in the water.

- **Conclusion**

We have seen that acid rain is any rain with a pH less than 7 as a result of wet and dry deposition (deposited material) from the atmosphere containing higher than normal amounts of nitric and sulfuric acids. Unpolluted rain is still classified as acidic though as its pH is less than 7. While the acidic content of most carbonated drinks is more acidic than acid rain, the concern for the rainwater harvester lies in what effect a lower pH will have on their system. Lead contamination can occur from the rainwater mixing with metals present in the roof material and dry deposition present on the roof. In the context of Mexico City, contamination via roof material is largely negligible as the high pH of concrete, the most common roof material, restricts leads ability to dissolve and contaminate the water. The various processes outlined above including first flush, help to significantly reduce any further contaminants which may be present in the water, to such a degree that if correct maintenance is practiced the water is of drinkable quality.