# ENGLISH SUMMARY OF AMENDMENT APPLICATION

In December of 2013, the municipal landfill located in the City of Iqaluit, Nunavut caught fire by spontaneous combustion. The local fire department fought the fire and extinguished it, or so they thought. The fire continued smouldering below the surface during the cold winter months. In May, when the snow and ice cover on the waste pile began melting, and oxygen rushed toward the smouldering waste, the fire erupted again. The City lacked the resources and expertise to combat the fire, so it was decided to allow it to burn itself out. However, by August it was obvious that the fire was not going to go out on its own within a reasonable period of time, and a more proactive approach was needed. Experts for extinguishing landfill fires were brought in from Alberta, and on September 1, 2014 they began fighting the fire. By September 16, 2014 the fire had finally been extinguished.

Combatting and extinguishing the fire resulted in the generation of approximately 8 million litres of contaminated water, which was contained within 3 holding basins. Following the extinguishing of the fire, testing of this water in September of 2014 showed that it was contaminated by several different kinds of metals, toxic levels of ammonia nitrogen, BOD[1], as well as elevated levels of suspended solids. In August of 2015, following a competitive proposal process, the City of Iqaluit awarded Qikiqtaaluk Environmental (QE) the contract to treat the contaminated water. At the time the contract was awarded, only 6 weeks remained to order supplies, ship them by marine vessel to Iqaluit and treat the water prior to freeze-up.

The treatment unit used to treat the contaminated water is comprised of 3 steps. The first step involves a pretreatment for metals and suspended solids. The second step is a 2-stage aerated bioreactor to treat first the BOD and then the ammonia nitrogen. Finally the water is pH[2] adjusted, and passed through a 2-stage filter to remove any organic contamination found in the water.

The pretreatment is accomplished by raising the pH to precipitate the metals, and through the addition of polymers to flocculate and separate the suspended solids. This can normally be done in a closed loop; however, this requires treating the water the equivalent of 2 times to ensure that the water has been completely treated. The other preferred option is to treat the water as it is pumped from one basin to another. This is not always possible, such as when the basins are full; in this case the first option is retained.

The bioreactor is installed in a basin with an approximate volume of 4.5 million cubic litres. The pretreatment cannot be done in the bioreactor, as the lime and polymers would have a negative effect on the biological processes required to treat the water.

In the bioreactor a water heater is used to raise the water temperature in the basin to above 15°C. Biological activity doubles for every 10°C increase in temperature, and there is little or no activity between 0 and 10°C. A blower injects air into the water through evenly spaced bubblers that release microbubbles into the water, increasing the available $0_2$[3] in the water. Curtains are used to separate the treatment areas with small settling sections between the BOD and ammonia nitrogen treatment areas, and at the end of the bioreactor.

Water samples were collected weekly and sent to a laboratory in Ottawa, so as to follow the progression of the treatment system. Daily on-site measurements were also taken. However, it was found that the on-site measurements for COD[4] and N[5] showed little correlation to the laboratory results.

Target treatment values were determined in cooperation with Environment and Climate Change Canada. The treatment targets are presented in Table 1, following.

1 Biochemical oxygen demand
2 Measure of acidity or alkalinity
3 Oxygen
4 Chemical oxygen demand
5 Nitrogen

**TABLE 1**
Target Treatment Values

| Parameter | Target Value |
|---|---|
| Total ammonia ($NH_3$+$NH_4^+$) | Total ammonia values as presented in the *Canadian Guidelines for the Protection of Aquatic Life – Table 2* (example at pH[1] 7 and 15°C: 7 mg/L) |
| $BOD_5$[2] | 25 mg/L BOD or levels which are non-acutely toxic |
| TSS[3] | Lowest possible; suggest 15 to 25 mg/L |
| pH | 6 to 8 |
| Aluminum | No limit established |
| Arsenic | 125 µg/L[4] |
| Cadmium | 1.2 µg/L |
| Chromium | < 100 µg/L |
| Copper | 4.8 µg/L |
| Iron | No limit established |
| Mercury | 16 µg/L |
| Nickel | 74 µg/L |
| Zinc | 120 µg/L |
| Dioxins and furans | 39 ppq[5] TEQs[6] |
| Total Oil and Grease | 5 mg/L |

1 Measure of acidity or alkalinity
2 Biochemical oxygen demand over 5 days
3 Total suspended solids
4 Micrograms per litre
5 Parts per quadrillion
6 Toxic equivalent

For the water to be considered acceptable for discharge, water samples needed to be sent to a qualified laboratory for toxicity testing with Rainbow Trout. Due to the remote location, this means that samples have to be shipped from Iqaluit to Ottawa, and then forwarded by refrigerated truck to the laboratory in Guelph. Shipping instructions state that the samples are to remain refrigerated at all times.

The treatment system in 2015 (pretreatment only) and 2016 obtained significant levels of contaminant removal; the table below summarizes these results.

| Parameter | Average Removal |
|---|---|
| Total Suspended Solids | 95% |
| Arsenic | 92% |
| Cadmium | 94% |
| Chromium | 97% |
| Copper | 92% |
| Iron | 99.6% |

| Parameter | Average Removal |
|---|---|
| Nickel | 86% |
| Zinc | 99.6% |
| Ammonia nitrogen | 65% |
| Biochemical Oxygen Demand | 99% |
| Oil & Grease | 88% |

All of the work done to treat the water to date has been done under a state of emergency. From this point forward, all operations are subject to normal permitting processes. This is the reason that this amendment application is being submitted.