Since the landfill is closed and was capped with final cover in 2009, it is anticipated that the groundwater quality should continue to improve with time.

Furthermore, upon Site closure, landfill sites are typically considered to have a 25-year 'contaminating' lifespan. The Proton Landfill is considered to be a small-scale landfill that had a low rate of waste placement, with the majority of waste placement having occurred greater than 25-years ago. As a result, its contaminating lifespan is anticipated to be significantly less than the typical 25-years. In addition, since the landfill site has been closed for greater than 10 years and the water quality noted at the most proximal well to the landfill (i.e. OW3 located within the landfill) has shown an overall decrease in leachate indicator parameter concentrations, it is expected that the landfill is past its peak contaminating period.

In 2015, two piezometers were installed between the landfill footprint and the eastern compliance boundary. Therefore, compliance with MECP Guideline B-7 is now monitored at piezometers PZ-01 and PZ-02, as well as well OW8, which is located directly to the southeast of the fill area. Review of the available data indicates that the water quality at the leachate well (i.e. OW3) is stable to decreasing, with limited exceedances of the RUC. While concentrations of the primary leachate indicator parameters are typically lower, water quality along the eastern compliance boundary at PZ-01, PZ-02 and OW8 is generally similar to that noted at OW3. Based on the concentrations noted and the limited volume of waste recently landfilled at the Site it is anticipated that concentrations will likely attenuate via natural groundwater degradation mechanisms.

Based on the on-going surface water quality sampling, there is no evidence of impacts to surface water related to the discharge of leachate-impacted groundwater to the wetland area downgradient of the Site. Potential impacts to surface water were historically noted at SW2, prior to Site closure, and appear to have been derived primarily from surface water run-off from the Site into the low-lying wetland. Impacts at this former SW2 monitoring location have not been noted following the capping of the fill area. Since the landfill site has been closed and capped for over 10 years, it is anticipated that potential impacts downgradient of the fill area would remain similar or would continue to improve with time.

7. POTENTIAL IMPACTS DUE TO LANDFILL GAS PRODUCTION

Landfill gas is produced by the degradation of organic compounds buried within a landfill. In particular, methane gas is produced during anaerobic decomposition of organic matter. Methane gas is a potential concern since it has the potential to migrate and accumulate in concentrations above the lower explosive limit (LEL) when it is produced in sufficient volumes. The LEL for methane is approximately 5% in air.

Methane gas is lighter than air and, therefore, typically vents from the subsurface to the air where soil permeability permits. Low permeability soils or frozen ground conditions can prohibit the natural venting of methane gas and result in the lateral migration of methane. The migration of methane gas from landfills in significant concentrations is typically observed to decrease with distance from the landfill footprint. In addition, based on the Guidance Manual for Landfill Sites Receiving Municipal Waste (MOE, November 1993), "*.. it is considered that methane gas migration, of any significance, may extend for a distance of ten (10) times the depth of the landfill between the ground surface and the water table.*".

At the Proton Landfill site, this methane migration distance corresponds to approximately 20 metres. It is noted that the distance between the fill area and the Township-owned lands, including the buffer area and the municipal right-of-way, is estimated to be 20 m at its closest point, therefore it is not anticipated that methane gas will migrate off-site.

The landfill contours and borehole logs indicate that, in general, the waste was historically placed at or above grade, resulting in the refuse pile being elevated above the adjacent lands and surrounding area. Based on the topography and physiography of the landfill property, which includes a pronounced ridge of till material that slopes downward to the wetland and creek system to the east of the landfill, the natural venting of methane gas is anticipated through the side slopes of the landfill and through the elevated ridge.

To further evaluate the potential for methane gas migration from the landfill, landfill gas monitoring has been completed at the site as part of the regular monitoring program. A methane monitoring probe (identified as LW-1) was installed within the refuse pile and extends through an estimated 4.7 m of placed refuse to the surface of the underlying native soils. This monitoring probe is screened in the garbage and represents a location that is considered most likely to have an accumulation of landfill gas.

Based on a review of the monitoring results, methane gas has consistently been measured above the lower explosive limit (LEL) at LW-1 where concentrations have been measured at up to 36% by volume.

As there are no structures on-site and the closest residence is located 300 m east of the fill area, the potential for gas accumulation is considered negligible. In addition, a commercial livestock barn, constructed with open walls, is located 120 m from the landfill boundary. Since the potential methane gas migration distance at the landfill is considered to be in the range of 20 metres, as noted above, and the current separation distances to any existing closed structures exceeds the potential distance of methane migration, methane gas migration from the Site is not considered to be a concern.

8. CONCLUSIONS

1. The closed Proton landfill accepted non-hazardous solid domestic waste until 2007. The Landfill footprint is situated within the approved 1.21 ha waste disposal site. The Site operated as a small-scale rural landfill that had a low rate of waste placement, with the majority of waste placement having occurred greater than 25 years ago. Final closure of the entire landfill area was completed in 2009.
2. No leachate seeps were observed during the reporting period and the ground cover system, site drainage and fencing continued to appear adequate.
3. The groundwater flow within the shallow overburden is generally to the northeast. Consistent with the existence of the surface water features within the wetland area to the north and east of the Site, the Site is on the edge of a recharge-discharge boundary, such that groundwater recharge (i.e., downward hydraulic gradients) is exhibited in the vicinity of the fill area and groundwater discharge (i.e., upwards gradients) is exhibited downgradient of the landfill, within the low-lying wetland area. As a result, it is inferred that groundwater recharge from the landfill footprint would likely become part of the shallow groundwater system and would subsequently discharge, in part, to the surface water features to the east of the property. Therefore, it is reasonable to expect that there would be limited impacts to the deeper groundwater system.
4. Within the landfill mound, the overall decrease in concentrations at well OW3 suggests that the landfill is past its peak contaminating period. Since the landfill is closed, it is anticipated that the groundwater quality should continue to improve with time.
5. Groundwater quality at the most downgradient compliance monitoring locations, situated greater than 30 meters from the compliance limit to the east, including PZ-01, PZ-02 and OW8, indicates that the water quality is similar to that noted at OW-3, with limited exceedances of the RUC. Based on the concentrations noted and the limited volume of waste recently landfilled at the Site, it is expected that concentrations will likely attenuate via natural groundwater degradation mechanisms. Since the landfill site has been closed and capped for over 10 years (i.e. since 2009), it is anticipated that groundwater quality will continue to improve with time and that the potential for leachate influence or impacts will remain

similar or continue to decrease.

6. On-going surface water quality monitoring indicates there is no evidence of impacts to surface water related to the discharge of leachate-impacted groundwater to the tributary downgradient of the Site.

7. Although methane gas has consistently been measured above the lower explosive limit (LEL) at the location of the gas probe LW-1, situated within the landfill mound, based on the potential methane gas migration distance, which is considered to be in the range of 20 metres, and the separation distance of greater than 100 meters to any existing structures, the risk for off-site methane gas migration is considered to be low.

9. RECOMMENDATIONS

The recommendations outlined below include general recommendations that outline the tasks/actions required to achieve on-going Site compliance as well as recommendations to revise the monitoring program for the Site which are based on those previously outlined in past reports:

1. It is recommended that visual inspections of the premises and monitoring wells continue to be conducted in conjunction with the water quality and gas monitoring programs for the Site.

2. We recommend the continuation of the updated groundwater monitoring program, as outlined in Schedule B of the ECA, which includes the collection of groundwater quality samples from OW2, OW3, OW4S, OW5S, OW6, OW7, OW8, OW9 and LW1, as well as piezometers PZ-01 and PZ-02. Water level monitoring should continue to occur on a once annual basis, in conjunction with the required monitoring program, and should be measured at all available monitoring locations.

3. Consistent with MECP concurrence and recommendations provided in correspondence dated April 17, 2019, the groundwater and surface water quality parameters should include the following:

Parameters	Groundwater and Leachate	Surface Water
Conductivity	X	X
pH	X	X
Alkalinity	X	X
Hardness	X	X
Barium	X	X
Boron	X	X
Calcium	X	X
Iron	X	X
Magnesium	X	X
Manganese	X	X
Potassium	X	X
Sodium	X	X
Chloride	X	X
Sulphate	X	X
Nitrate	X	X
Nitrite	X	X
Ammonia	X	X
Total Kjeldahl Nitrogen (TKN)	X	X
Total Dissolved Solids (TDS)	X	X
Dissolved Organic Carbon (DOC)	X	X
Total Phosphorus	---	X
Field Temperature	---	X

4. Methane gas monitoring at LW1 should continue to occur in conjunction with the water sampling program for the Site.

All of which is respectfully submitted,

GM BLUEPLAN ENGINEERING LIMITED
Per:

A.H. Nelson, M.Sc.

Per:

Alen Bringleson, B.E.S., C.E.T.