**Drumlin Environmental, LLC**
*Hydrogeologic and Engineering Consultants*

**Soil Metrics, LLC**

# MEMORANDUM

**To:** Paula Scott & Hampden Environmental Trust
**From:** Matt Reynolds & Steve Rabasca
**Date:** July 12, 2021
**Subject**: Pine Tree Landfill –Post-Closure Monitoring Review & Update

This memorandum has been prepared to provide the Town with an overview of conditions at the Pine Tree Landfill (PTL) as summarized in the 2020 Annual Report and April 2021 Water Quality Data Results letter prepared by New England Waste Services of ME (NEWSME) and their engineer Sevee & Maher Engineers, Inc. (SME).

Figure 1-1 from Attachment C of the 2020 Annual Report (prepared by SME) is attached to this memorandum for reference and shows the configuration of the landfill and location of the monitoring points and other site features. Consistent with previous update memoranda, this update does not include detailed graphs and figures, however, we would be glad to prepare these if it would assist the Town and/or address specific questions.

## I. Review of Landfill Closure Status

The Pine Tree Landfill consists of multiple waste disposal cells constructed through time. The original landfill, referred to as the Conventional Landfill, was an unlined waste disposal area that occupied approximately 19.8 acres in an abandoned gravel pit. Secure I was a clay-lined 1.6-acre landfill located in the northwest corner of the Conventional Landfill. Secure II was an 8.7-acre clay-lined landfill located to the north of the Conventional and Secure I landfills. Secure III was constructed in multiple phases between 1991 and 2010 and covers the Conventional, Secure I and Secure II landfills. Secure III was designed with double liner systems, leak detection and leachate collection.

PTL completed closure of the Secure III landfill in 2010 in accordance with the October 2006 Schedule of Compliance agreed to by the Maine Department of Environmental Protection (MDEP) and the Town of Hampden. The Schedule of Compliance included a requirement to implement corrective actions and to monitor water quality, gas, settlement, etc. for a 30-year post-closure period in accordance with the Environmental Monitoring Plan (EMP) for the site. Water quality monitoring conducted during 2016 to 2020 (years 6 to 10 of the 30-year post-closure monitoring period) is discussed further in Section IV below.

In 2007, NEWSME constructed a landfill Gas-to-Energy (GTE) facility on the PTL site. From 2008 through early 2021, methane collected from the landfill was directed to the

GTE where it was used for fuel to run turbines that generated electricity. Over time, the concentration of methane in the landfill gas has diminished, which is an anticipated phenomenon. In 2021, PTL ended use of the GTE due to the reduction in methane content in the landfill gas and the economics of operating the GTE. After shutting down the GTE, gas generated by the landfill is burned by flaring. Prior to shutting down the GTE, PTL applied for and received a modified air emissions license from the MDEP for the site.

## II. Corrective Action Summary

Prior to closure, corrective actions systems were implemented to control and/or mitigate impacts to groundwater and surface water. These include the following.

- Gas collection systems were installed in the Conventional Landfill and Secure Landfills to collect a portion of the landfill gas generated by decomposition of waste. As noted above, both gas collection systems were connected to the GTE plant and are now connected to flares.
- The Secure III landfill liner system functions as a cover for the Conventional Landfill and the cover system for the Secure III Landfills was completed in 2010;
- The perimeter drain (PDPS) borders the west, south and east sides of the Conventional Landfill and intercepts and collects some shallow groundwater;
- Six groundwater extraction wells have been installed near the edge of the landfill (shown as red symbols on Figure 1-1). Wells EW-2R and EW-3R are located adjacent to the southeast corner of the landfill. Wells EW-5R, EW-6R, EW-101 and EW-102 are located adjacent to the northeast corner of the landfill. The volume of leachate and groundwater extracted by these wells and the PDPS during 2013 to 2020 are summarized below.

| Year | Northeast (EW-5R, -6R, -101, -102) | South (EW-2R, -3R) | PDPS | Total (gallons) |
|---|---|---|---|---|
| 2013 | 2,687,000 | 1,121,000 | 3,721,000 | 7,529,000 |
| 2014 | 1,857,000 | 506,000 | 3,802,000 | 6,165,000 |
| 2015 | 3,112,039 | 781,344 | 3,356,269 | 7,249,652 |
| 2016 | 2,328,767 | 475,324 | 2,705,609 | 5,509,700 |
| 2017 | 1,429,545 | 155,070 | 3,056,334 | 4,640,949 |
| 2018 | 1,771,445 | 265,776 | 4,097,318 | 6,134,539 |
| 2019 | 834,552 | 5 | 4,189,334 | 5,023,891 |
| 2020 | 2,291,583 | 818,824 | 3,811,390 | 6,921,797 |

During 2018, PTL had increased the total pumping after several years of lower pumping. During 2019, pumping from multiple extraction wells was lower while repairs were made. This allowed the pumping rates to be increased in 2020 back closer to the rates that had been achieved in 2013 and 2015. In the 2019 Annual Report, SME had recommended that extraction well pumping rated be increased to volumes consistent with the rates pumped during the early 2010s. In the 2020 Annual Report SME notes that *"optimizing groundwater extraction"* from the extraction wells *"will play a key role in achieving the PTL on-site threshold criteria"*.

- PTL also collects gas migrating away from the landfill in collection wells located west and south of the landfill. This external landfill gas (LFG) collection system consists of 6 gas collection wells (shown as blue symbols on Figure 1-1) and a passive gas collection trench. The gas extracted from the collection wells during 2013 to 2020 is summarized below.

| Year | PTGW08-1 (MMSCF/Tons) | PTGW08-11 (MMSCF/Tons) | PTGW08-12 (MMSCF/Tons) | PTGW08-13 (MMSCF/Tons) |
|---|---|---|---|---|
| 2013 | 20.8/218 | 2.0/17 | 0.5/2 | 0.6/4 |
| 2014 | 19.7/220 | 2.6/22 | 0.1/0.3 | 0.4/6 |
| 2015 | 19.2/200 | 2.5/19 | 2.1/10 | 1.7/8 |
| 2016 | 13.9/144 | 2.8/18 | 1.1/2.6 | 0.1/0.2 |
| 2017 | 8.6/101 | 3.5/23 | 1.8/12 | 0.2/0.1 |
| 2018 | 12.6/138 | 7.1/49 | 5.5/33 | 3.7/17 |
| 2019 | 14.0/143 | 1.3/7 | 3.2/13 | 0.8/4 |
| 2020 | 11.7/126 | 0.6/4 | 1.8/8 | 1.4/3 |

Notes: 1. MMSCF = Million Standard Cubic Feet. Tons = Tons of Methane Extracted
2. Estimate of Tons is Based on Volume Extracted and Percent Methane
3. No Gas Was Extracted from PTGW08-3, -9 during 2013 to 2020 Due to Low Gas & Methane

Gas is generated in the landfill as organic materials decompose. As time passes, percentage of methane within the gas has decreased, as expected. This decrease is likely to vary depending on the type of waste in different areas of the landfill. Comparison 2013 and 2020 data show that methane in the landfill gas extracted at PTGW08-11 has decreased from 41% to 29% and at RTGW08-13 has decreased from approximately 30% to approximately 10%. In contrast, the methane percentage has remained fairly stable in PTGW08-1 (~ 51%) and PTGW08-12 (~20%).

The gas extraction in well PTGW08-1 increased in 2019 compared to 2017 and 2018, but decreased in 2020. Despite the lower rate of gas extraction in PTGW08-1 in recent years, there has not been a trend of increasing methane concentration in MW-916 or MW-197 east of the landfill. Methane concentrations to the southwest of the landfill (near PTGW08-12 and -13) have been variable.

## III. Water Quality Target Criteria

The MDEP Closure Order identified 5 specific criteria for determining "successful corrective action" at PTL under the MDEP Solid Waste Regulations. These criteria incorporate the state Maximum Exposure Guideline (MEG) values and the federal Maximum Contaminant Level (MCL) and Ambient Water Quality Criteria (AWQC) values.

The five criteria are as follows.

- Groundwater Quality on the PTL Property:
  - Specific Conductance must be less than 500 umhos/cm

- Groundwater Quality off of the PTL Property:
  - Groundwater must be below the applicable MCLs and MEGs;
  - Specific Conductance must be less than 400 umhos/cm
  - Dissolved Methane must be below 700 ug/L

- Surface Water Quality:
  - Surface water quality must meet the federal AWQC and Maine water quality classification established in 38 MRSA Section 465 and 465-B.

These criteria must be met at the PTL monitoring locations before the end of the 30-year post-closure period for the MDEP to determine that corrective actions have been successful. The 30-year post-closure period began in 2011, so 2020 represents year 10 of 30. Tracking data against these criteria allows PTL, the MDEP and the Town to judge whether the existing corrective actions have the potential to be sufficient to meet these criteria over time, or whether supplemental corrective actions may be necessary in the future.

## IV. Water Quality Overview

In accordance with the Post-Closure Environmental Monitoring Plan, water quality is currently monitored two times each year at a network of sampling locations around PTL. These monitoring points are located in different regions around the landfill and include groundwater monitoring wells, residential wells and surface water. Table 1 summarizes the current sampling regime, specific conductance range and water quality trends for the data from 2014 through April 2021. The attached Figure 1-1 shows the location of the monitoring wells discussed below.

**Table 1**
**PTL 2014 to April 2021 Water Quality Monitoring Summary**

| Monitoring Pt[3] | 2016-2020 Analysis[1] (Frequency/yr) | Specific Cond. Range[2] (umhos/cm) | Predominant Specific Cond. Or TDS 5-Year Trend |
|---|---|---|---|
| South/Southwest | | | |
| **200*** | F, L (2) | 347 - 691 | None |
| 641 | F, L (2), M (1) | 815 – 1368 | None |
| **MW-906B*** | F, L (2) | 338 - 513 | None |
| MW02-801A | F, L (2), M (1) | 1896 – 3530 | Down |
| MW02-801B | F (2) | 676 – 3700 | None |
| MW03-802A | F, L (2), M (1) | 470 – 845 | Up |
| MW03-802B | F, L^ (2), M (1) | 804 – 1587 | None |
| MW03-803A | F, L^ (2), M (1) | 1264 – 1867 | Up |
| MW03-803B | F, L (2), M (1) | 1157 – 1591 | Up |
| West & North | | | |
| MW03-804A | F (2) | 682 – 1070 | None |
| P-914A | F, L (2) | 683 – 976 | Up |
| P-914B | F (2) | 589 – 963 | Up |
| 516B-B | F, L (2) | 981 – 1169 | None |
| Northeast & East | | | |
| MW98-601A | F (2) | 1672 – 2880 | Down |
| MW96-601B | F (2) | 1117 – 1730 | None |
| **MW01-602B*** | F (2) | 259 - 679 | None |
| MW97-123 | F, L (2) | 780 – 1425 | None |
| 509A | F (2) | 739 – 1234 | None |
| 509B | F, L (2) | 698 – 1249 | None |
| P-911B | F (2) | 691 – 959 | None |
| 916 | F, L (2), M (1) | 257 – 1160 | None |
| 917 | F, L (2), M (1) | 354 – 1042 | None |
| Residential | | | |
| **DW04-109*** | F (2), L (1), M (2) | 192 – 793 | None |
| DW-103 | F (2), L (1), M (2) | 355 – 485 | Up |
| Surface Water | | | |
| SW-A | F, L (2) | 85 – 180 | None |
| SW-C | F, L (2) | 66 – 200 | None |
| SW-D | F, L (2) | 197 – 890 | None |
| SW-E | F, L (2) | 241 – 1046 | None |

Notes: 1. Analyses: F=Field Parameters, L=Laboratory Parameters, M= Methane, L^= Supplemental
2. SC Range Reflects Data from 2014 to April 2021
3. Wells in **BOLD*** are close to or below Corrective Action Criteria for Specific Conductance.
4. Values in RED Represent a New Low or High Concentration measured in 2020 or April 2021.

## Comparison of Recent Data (2014 to April 2021) to the Target Criteria

Specific Conductance.

- Prior to 2013, all on-site groundwater was above the 500 umhos/cm criteria. Since 2014, three on-site wells have begun to approach or meet the 500 umhos/cm criteria.

- MW-906B has had specific conductance below 500 umhos/cm since July 2014.

- MW-200 was below the 500 umhos/cm target criteria for 9 of the 17 sampling events since April 2014. In 2014 the specific conductance in MW-200 was below 500 in all three sampling events. Since then, this has occurred only one time per year.

- MW01-602B was below 500 umhos/cm for 9 of 17 sampling events since April 2014, including both events in 2014 and 2015.

- Groundwater at off-site well DW04-109 has been below the 400 umhos/cm specific conductance target criteria during all sampling rounds in since April 2015. Groundwater at the off-site well DW-103 had a specific conductance of 355 uhmos/cm in April 2021 and has had an average annual specific conductance between 426 umhos/cm and 467 umhos/cm since 2014.

- MW-916, which is an off-site well with a specific conductance target criteria of 400 umhos/cm, was below this concentration for 7 of 8 events between October 2013 and April 2016, but has been above 400 umhos/cm since then. The specific conductance in MW-916 rose to 1160 umhos/cm in October 2018, but has decreased since then and averaged 612 umhos/cm in 2020. Well MW-917, which is also east of the landfill, experienced a specific conductance of 1042 umhos/cm in October 2018, but had an average specific conductance of 860 umhos/cm in 2020.

Methane in Off-Site Wells.

- Both off-site residential well DW-103 and DW04-109 have been below the 700 ug/L methane off-site target criterion September 2014.

- Wells MW-917 and MW-917 have also been below the 700 ug/L methane criterion since 2014.

Drinking Water Criteria (MCLs & MEGs) in Off-Site Wells.

- At the off-site residential well DW-103, the arsenic concentration was 0.011 mg/L in October 2020. This is slightly above the primary drinking water MCL and MEG for arsenic of 0.01 mg/L. Groundwater was above the secondary MCL and MEG for iron, manganese and sodium.

- At the off-site well DW04-109, arsenic was below the detection limit in October 2020. Groundwater was above the secondary MCL and MEG for iron and manganese in 2020

- At MW-916, arsenic was below the MCL and MEG in 2020. At MW-917, groundwater was above the MCL and MEG for arsenic in 2020. Secondary drinking water criteria of iron and manganese are also exceeded at MW-916 and MW-917.

Surface Water Criteria.

- Surface water meets the applicable classification criteria and AWQC standards.

## Discussion of Data Trends

As shown in Table 1, over the past 5 years there has been a downward (improving) trend in specific conductance or total dissolved solids (TDS) in two of the monitoring locations (MW96-601A and MW02-801A) in the monitoring network at the PTL site. There were also new low specific concentrations measured at 10 of the 20 on-site monitoring wells in 2020 and April 2021. This improving trend has generally been gradual and at many locations, the specific conductance remains significantly above the target criteria of 500 umhos/cm.

Table 1 also shows that over the past 5 years where are upward trends in specific conductance or TDS at five locations and new high specific conductance values at five locations in 2020. The area where there has been a persistent upward trend in specific conductance has been to the southwest of landfill in wells MW03-802A and MW03-803A & B. New high specific conductance concentrations were measured in the 802A and 803B wells in 2020. Since 2018, gas extraction at PTGW08-12 and -13, in the vicinity of the 802 and 803 wells, dropped from 33 tons of methane to 8 tons at PTGW08-12 and from 17 tons to 3 tons at PTGW08-13. In June 2016, PTL discovered leachate leaking from a cover defect onto soils in this area. This condition was repaired promptly. However, this cover repair does not appear to have been sufficient to reverse the upward trend. Based on water quality data, it is difficult to attribute the upward trend to the leachate leak that was identified and repaired in 2016 (i.e., 5 years ago). Lower rates of methane removal and other, as yet unidentified, factors are likely to contribute to this trend.

Figure 2 shows the specific conductivity data and linear trend since 2008 for three example monitoring wells at the PTL site where the 5-year trend is steady or downward. A similar graph was included in the review of the 2018 Annual Report. Since that time, the trend at wells MW02-801A and well 97-123 have remained similar. Well MW02-801A has shown a steady downward trend and if this trend continues, would reach the target criteria before 2040. Well 641 has a downward trend that has become more gradual over time. However, the current specific conductivity is low enough that slow improvement suggests that the criteria may be able to be achieved. Well 97-123 northeast of the landfill shows a more gradual downward trend that suggests the potential to remain above the Corrective Action Criteria after 30 years.

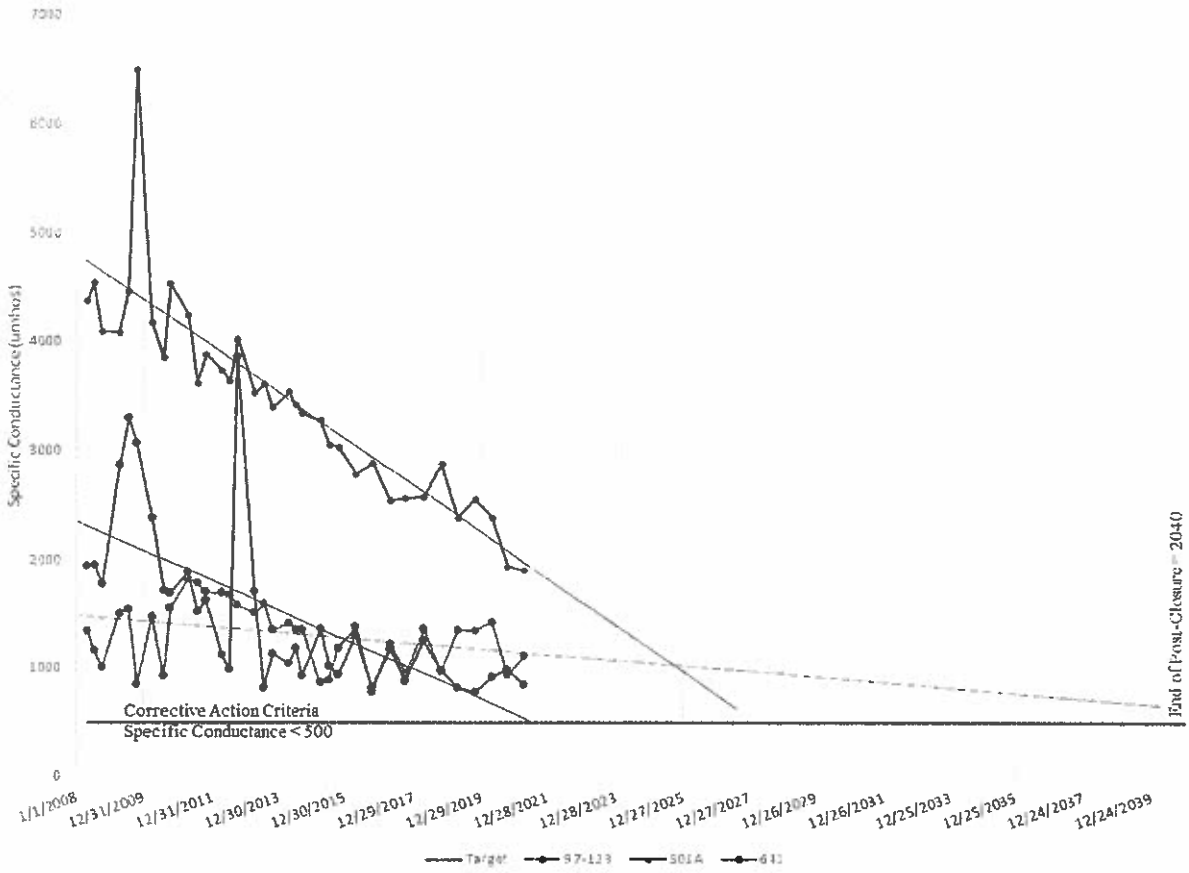



**Figure 2 – Water Quality Trends**

An important achievement in 2020 was to increase the pumping from the extraction wells to near their early post-closure rates. In the 2020 Annual Report, SME notes that optimizing operation of these wells will be important to reaching the corrective action target criteria. The wells in the locations shown in Figure 2 will benefit from the influence of the extraction wells.

There are also wells on the southwest and west sides of the landfill where there continues to be an upward trend, as discussed above. These wells are outside the influence of the extraction wells, so the only active corrective action measures currently acting to improve water quality at these wells is gas extraction wells PTGW08-12 and -13. Since 2018, there has been diminishing gas removal from these wells. Considering that 2020 completes 10 of the 30-year post closure period, PTL should consider additional active corrective measures to address conditions in the vicinity of the wells with persistent upward trends.

## V. Geotechnical Monitoring

The geotechnical monitoring program for the landfill continued in 2020 and was summarized in a report prepared by Dr. Richard Wardwell, PE, (REW) dated March 2021. The focus of the geotechnical monitoring will shift going forward from labor

intensive surveying of foundation and surface monuments, to physical observations of the performance of the cover system. This will include periodic inspections of the vegetative layer and surveying of slopes and grades of drainage swales and internal piping system that is necessary to assure the cover system is performing as designed. The intensive monitoring of the foundation and surface monuments for the overall surface topography were suspended after the 2020 surveying event. These surveys can be reinstated in the future if observations indicate that there is unusual movement occurring, because the system of monuments will be left in-place. The specific monitoring conducted in 2020 included the following:

- Periodic observations of the landfill cover
- A terrace survey (slopes and grades of the various terraces used to convey cover surface water).
- Monitoring of the foundation waste mass stability with vertical deflection monitors (last survey August 2020)
- Monitoring of surface monuments to detect movements indicative of cover instabilities (last survey August 2020)
- Data evaluation, interpretation and reporting .

Cover System Stability and Cover Strain Monitoring: The cover system stability and strain monitoring has been monitored principally over the last decade by survey measurements of the surface and foundation monuments. The last survey conducted in August 2020 indicated that the decade long trends in the settlement show a diminishing rate of settlement. This diminishing rate is consistent with typical waste consolidation. The rate of settlement year to year has declined by over an order of magnitude since the measurements were initially performed. A typical plot of this settlement is shown on the attached Figure 4-6 from the 2021 report by REW. There have been no large anomalous drops in settlement observed over the last decade plus of monitoring. Strain rates on the liner system continue to be well below tolerable limits. The REW report recommends that the survey monitoring be discontinued based on this long-term body of data. We agree with this change in the plan. As suggested in the latest monitoring report, should site observations show areas of concern, the survey monitoring can be reestablished at any time.

Terrace Swale Survey and Monitoring: Sevee & Maher performed a terrace survey in February 2021 to monitor the grades of the many surface water drainage swales that convey surface water off the cap safely. These surveys have been on-going since 2011. The latest survey identified seven new sag areas. These sag areas are locations in the swales where surface water can pond locally. The survey data indicates that while surface water can pond locally, these sags are not deep enough to result in any surface water spilling over the tops of the swale berms and that all stormwater will remain in the trenches. The swale survey also included observations of the overall cap condition. No cover integrity issues were noted.

In summary, there were no significant issues reported related to the geotechnical performance of the landfill in this latest monitoring report.

Leachate Recirculation in 2020:

PTL continued the leachate recirculation program in 2020 at a limited rate due in part to limited staffing. The volume of recirculated leachate was 169,316 gallons in 2020 and consisted primarily of condensate from the GTE plant. This volume was lower than in 2018 and 2019, when over 350,000 gallons were recirculated, and significantly lower than in years prior to 2017, when between 2,000,000 and 6,000,000 gallons of leachate were recirculated.

Overall, the energy extracted, in the form of methane gas, from the entire landfill has decreased significantly from 263,077 million BTUs (MMBTUs) in 2010 to 70,213 MMBTUs in 2020. A decrease in energy production was anticipated as moisture in the landfill decreases following placement of the final cover and lower moisture slows the microbial activity that breaks down waste to methane. However, the energy extracted from the portion of the landfill where leachate has been recirculated has remained relatively steady, with only a small decrease between 2013 and 2020. This suggests that leachate circulation has had the intended effect of maintaining a higher moisture content and methane generation.

As noted above, the GTE plant was shut down in 2021. Associated with this shutdown, PTL has indicated that leachate recirculation will be very limited in 2021 and unlikely to continue in future years.

## VI. Proposed Monitoring Changes

When the Environmental Monitoring Plan was developed in 2010 as part of the final closure process, PTL proposed phased modifications to the monitoring program. From 2011 to 2015, water quality sampling was conducted three times per year. From 2016 to 2020, water quality sampling was reduced to twice per year. PTL proposed to further reduce water quality sampling to once per year from 2021 through the remainder of the post-closure period. The MDEP determined that twice-per-year sampling should continue in 2021 and that the MDEP would review the 2020 Annual Report and consider possible modifications to the monitoring frequency. Rather than a wholesale change to once-per-year sampling, we recommend reducing the monitoring frequency to once-per-year in some wells (e.g. 906B, where the target criteria are consistently achieved), but maintaining a twice per year frequency in other wells (e.g., wells with rising trends).

PTL has also proposed to reduce the frequency of gas probe monitoring from 4 times per year to 2 times per year. Maintaining and improving the zero or negative pressure at the landfill's external gas probes is a required component of successful corrective action and important to improving water quality. In 2020, zero or negative pressure was demonstrated for approximately 52 percent of the measurements. We recommend maintaining the current monitoring frequency to assist in monitoring and management of the gas collection system.

## VII. Summary

Overall, the water quality monitoring data from PTL reflected in the 2020 Annual Report and April 2021 data summary indicate that there continues to be gradual improvement at many monitoring locations. Data from 2020 represents the 10th year of the 30-year post-closure monitoring period and is not required to meet the target criteria. As has been the case for the past few years, one of the twenty-two on-site monitoring wells consistently meets the corrective action criteria and two other locations meet the criteria approximately 50 percent of the time.

Despite the improving trend in some wells, there are seven monitoring wells that continue to have significantly elevated concentrations of landfill-related compounds and a specific conductance above 1000 umhos/cm. Additionally, groundwater in several wells southwest of the landfill continue to exhibit increasing concentration trends. Repairs made to the cover system in this area and a reduction in leachate recirculation has not reversed the rising trend in these wells. This suggests that the cover defect detected and repaired in 2016 is unlikely to be the sole source of impact in this area and PTL should begin the process of identifying, designing and implementing additional corrective actions in this area.

There was a significant increase in the pumping rates at the existing extraction wells at PTL during 2020. In the 2020 Annual Report SME noted, and we would agree, that diligent operation and optimization of the groundwater extraction system will be critical in improving water quality in the areas of influence of these extraction wells.

We hope that the information summarized in this memorandum is helpful to the Town. We would be glad to discuss any questions or comments that the Town may have.

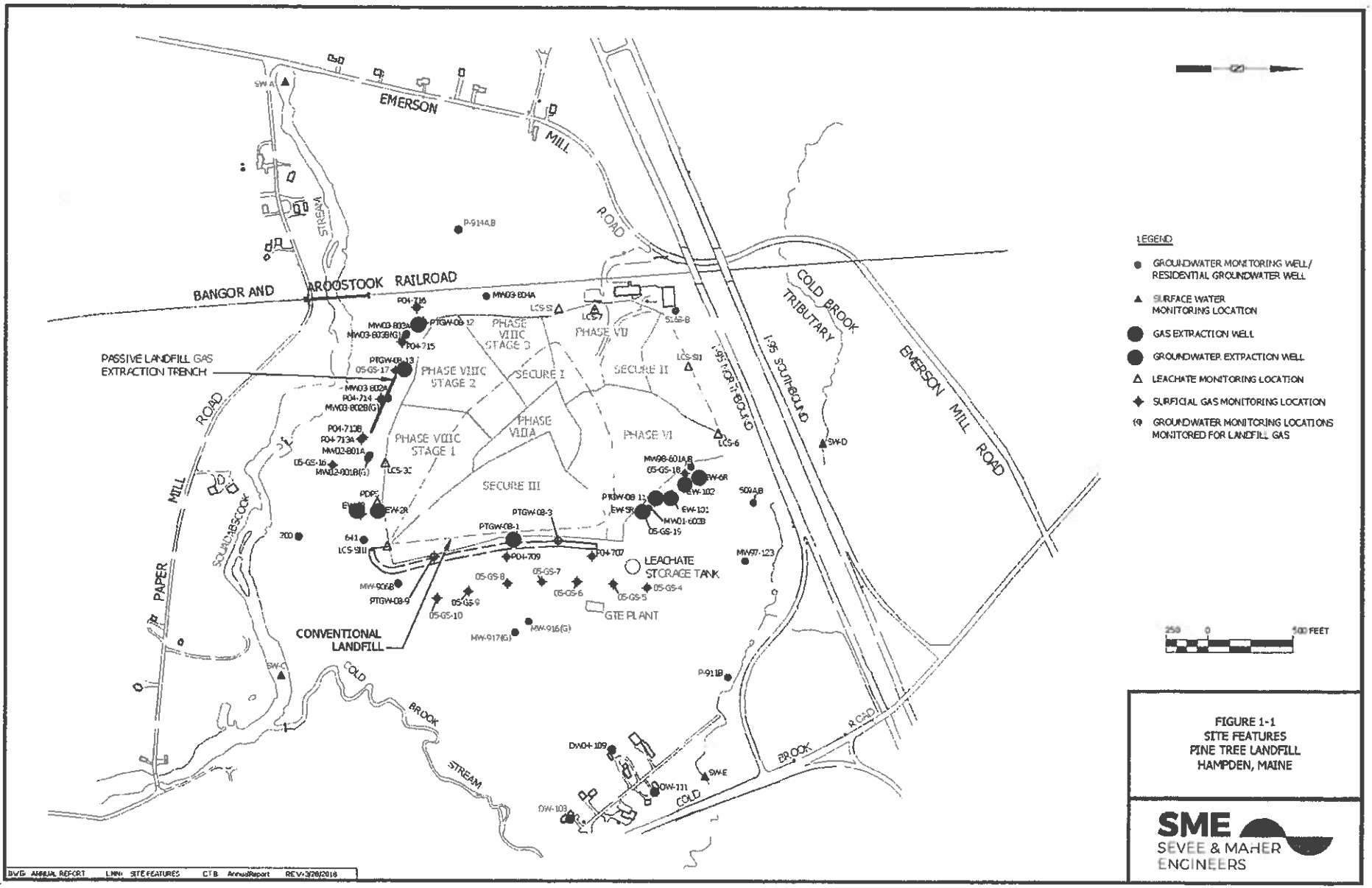
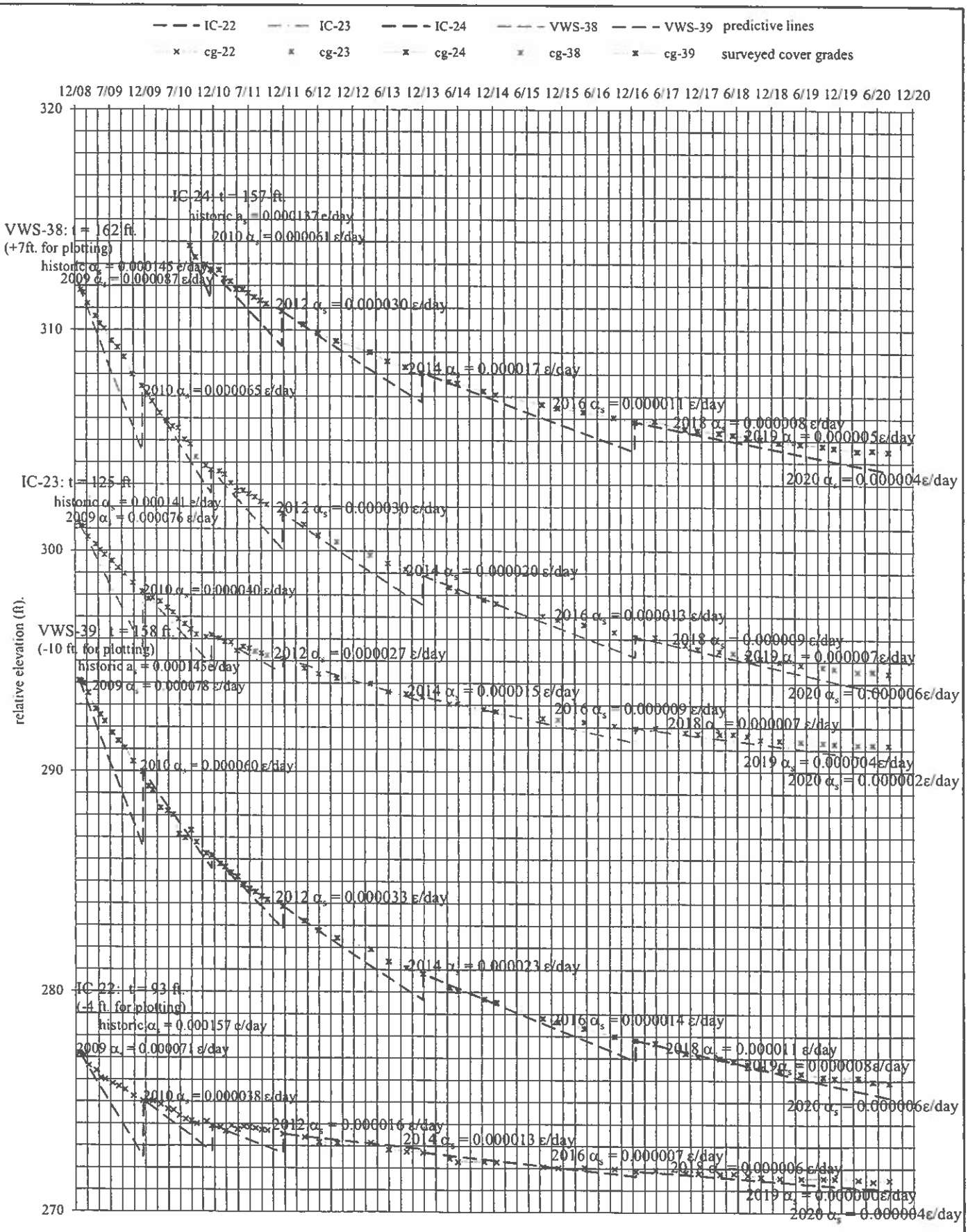



FIGURE 1-1
SITE FEATURES
PINE TREE LANDFILL
HAMPDEN, MAINE

SME
SEVEE & MAHER ENGINEERS

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| | | | |
|---|---|---|---|
| Project: 2020 Geotechnical Monitoring Report | Title: Phase VIII-C/Stage 3 Post-Closure Grades | | By: REW |
| | | | Checked: REW |
| | | | Date: Mar-21 |
| Client: Pine Tree Landfill, Hampden, ME | Proj. No: 1750 | Scale: as noted | Fig. No: 4-6 |