STATE OF MAINE

DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF REMEDIATION AND WASTE MANAGEMENT
DIVISION OF TECHNICAL SERVICES

M E M O R A N D U M

TO: Linda Butler, Project Manager

FROM: Gail Lipfert, PhD, C.G. # GE506 Hydrogeologist

DATE: April 15, 2020

RE: Phase 14 Solid Waste Permit Application, Volume III, Crossroads Landfill, Waste Management Disposal Services of Maine (WMDSM), Norridgewock, Maine

CC: Chris Evans, C.G., Hydrogeology Unit supervisor, Kathy Tarbuck, P.E., Project Engineer

****

Overall, they have done a good job investigating this site, installing a sufficient number of borings and wells and supplying the information required in the rules. I think that the points where we have disagreements can probably be resolved by a conducting a pumping test in the area of Phase 14 with an emphasis on assessing the interaction of the till groundwater and the clay groundwater.

To make it easier for us to assess that comments have been adequately addressed, I am requesting a red-line strike-out version of Volume III when they respond to these comments.

1. 2.0 Site Specific Investigations. Please provide installation information regarding the VW (vibrating wire) and CPT (piezocone penetrating tests). Were the VW piezometers installed using typical drilling techniques? Are there soil boring logs? Please indicate where the data from the VW and CPT are located. Please include a description of both methods in this document.
2. 2.0, last bullet. Please include "(VW)" after "vibrating wire".
3. 2.1.1 Soil and Bedrock Borings,
    a. Second paragraph. "Golder advanced a soil boring at each piezometer/monitoring well location…" Please include the boring logs for the VW locations.
    b. Third paragraph. Please provide the boring logs and well construction diagrams for PZ-1M, PZ-5M, PZ-16M, PZ-17M, PZ-18M, and PZ-19M which are missing from Appendix A.
    c. We note that some of the soil borings (GB) are included in the Volume IV, the Engineering Report, but because these logs are soil descriptions which are used in the generation of the geologic maps in this volume, perhaps they should be included in this volume. Either put all the soil description logs together to make it easier to find them or provide a reference to where they can be found in this volume.
    d. If photos were taken of the soil or rock cores, please provide them in an appendix.

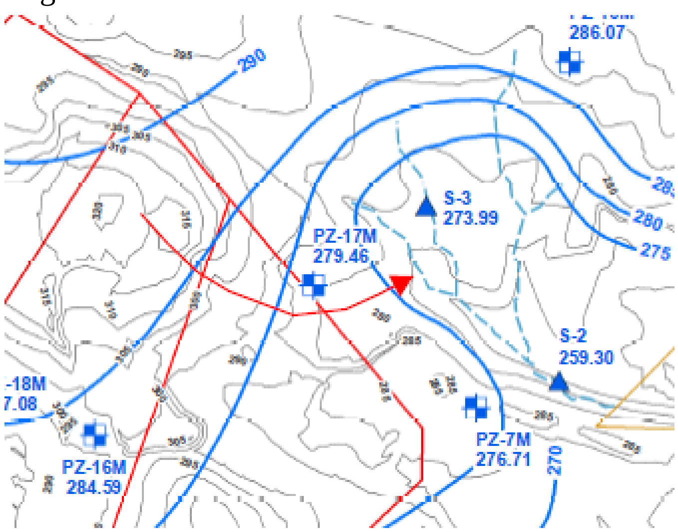
4. 2.1.3 Piezometer and Monitoring Well Installation.
    a. Does the description of piezometer installation also apply to the VW piezometers? Please describe the VW installation if it is different.
    b. They need to demonstrate that, the potentiometric heads measured in the piezometers with the 5-foot or 10-foot screens (which are sometimes across an entire unit), are comparable to heads measured with no greater than 2-foot screens. Piezometers are devices that measure the pressure, or the piezometric head, at a specific point in an aquifer and typically have no screen or very short screens. Ch. 405 (5)(A)(8) states that screens for piezometers must not exceed 2 feet and technical justification for the screen length must be provided if they do. In this investigation, the screen lengths for most of the piezometers are 5 feet in length, with only one having a screen of 2 feet, so piezometers have not been constructed according to Solid Waste Rules. The piezometers were constructed with 1-inch diameter PVC, so they don't meet the 2-inch diameter requirement of monitoring wells either.
    c. Please provide a justification for the monitoring well screen lengths. Ch. 405 (5)(A)(8) states that screens for monitoring wells must not exceed 10 feet in length, yet four of the bedrock wells have 20-foot screens.
    d. Please provide a justification for screening monitoring wells across unit boundaries. Ch. 405 (5)(A)(9) states that monitoring wells must not be screened across hydrogeologic unit boundaries, yet six of the wells in the sand unit are screened 0.2 to 1.6 feet into the clay.
5. 2.1.6 Slug Testing. Please identify the software used to assess the slug tests.
6. 3.3.5 Presumpscot Formation. Please provide references to the sources of the information presented in this section.
7. 4.0 Site Geology. Please describe the contouring program or method used to generate the contour maps of unit thicknesses and unit top elevations.
8. 4.1, Surficial Deposits, second bullet. PZ-4S is listed in Table 1 and Table 3a as being in the fine silty sand unit, but the well logs and Figure 15 indicate that it is in the stiff upper clay unit. Please correct these tables.
9. 4.2.2 Soft Lower Clay Facies. Please describe the differences between the two types of clay. We note that the laboratory test results for the soft lower clay facies are essentially the same as those for the stiff upper clay facies for all the parameters. The lack of any physical difference between the two facies makes us suspect that the field-observed difference in stiffness can be attributed to greater water content in the soft lower clay. This is supported by the lack of the soft lower clay facies at the higher points. If this difference between the stiff clay and the soft clay is attributed to their moisture content, will dewatering the area around the landfill result in converting some soft clay to stiff clay? Could this information impact design?
10. 4.3 Glacial Till, last paragraph, Figure 8b. The till thickness does not equal the difference between the top of till surface and the top of bedrock at some locations, such as MW14-01B, MW14-04B, and MW14-05D, so please check the thickness values used to create the isopach maps and correct the maps if needed.
11. 4.5 Geologic Cross-Sections,
    a. Third bullet. "The thickness of the glacial till is variable, but generally thickens to the south." We don't completely concur. Based on Figure 8b, the thickness of the

glacial till is quite variable and difficult to characterize, but it appears to thicken to the southwest and the northeast as well as to the south. Also, please describe the variability in numbers. We suggest changing this bullet to read, "The thickness of the glacial till is variable, ranging from 0.4 to 24.5 feet, and appears to thicken to the south, southwest and east."

   b. Fourth bullet (regarding the lower clay facies). Please describe the variability.
   c. Fifth bullet (regarding the stiff upper clay facies). Please describe the thickness.

12. 5.0 Site Hydrogeology,
   a. First bullet. Please present the evidence that the water in the silty fine sand is perched.
   b. Second bullet. Please present the evidence that the heads in the till are artesian.
   c. Third bullet. Please present the evidence that the till is confined.
   d. Fourth bullet. Please present the evidence that the bedrock and the till are in direct hydraulic communication.

13. 5.1.1.2 Phreatic Surface.
   a. Please clarify the phrase "from northeast to southwest/southeast". Northeast to southwest is an understandable direction, but northeast to southeast is not. We suspect that this phrase is intended to indicate that the direction is variable, that it is northeast to southwest and northwest to southeast.
   b. Fourth paragraph. MEDEP does not concur that "any phreatic groundwater that discharges to the streams in the area of S-2 originate north of S-2. Although examination of the potentiometric surfaces in Figures 12a and 12c shows that most of the flow comes from the north, there are some flow lines from northwest of S-2 that would pass through the footprint of Phase 14 on the way to S-2. See diagram below



   c. Fifth paragraph. This section asserts that the area of the proposed landfill expansion does not discharge to any of the stream locations. Please tell us where you think the groundwater from the proposed landfill area does discharge.

14. 5.1.1.3 Glacial Till,
   a. First paragraph. "…the overall direction of groundwater flow in the glacial till is from the northeast to south-southwest/southeast." See Comment 13a.

b. Second paragraph. MEDEP finds that, recharge of the till from the clay is possible. Section 5.1.1.2 states that the clay unit receives meteoric recharge as well as groundwater inflow from the northeast. If the clay is recharged locally, it is also possible that the glacial till beneath it can receive some recharge from the overlying clay.

c. Second paragraph. Please provide evidence to support confined groundwater conditions in the till.

15. 5.1.1.4 Bedrock,

a. First paragraph.

i. "northeast to southwest/southeast". See Comment 13a

ii. There are only four data points in Figure 14a that were used to generate the equipotential lines. In our opinion, the northward curve on the west side is unsupported by the data from the four data points. Please provide an explanation for the strong curvature to the lines in the western part of the map.

b. Second paragraph. This paragraph states that the bedrock is primarily recharged from the north-northeast.

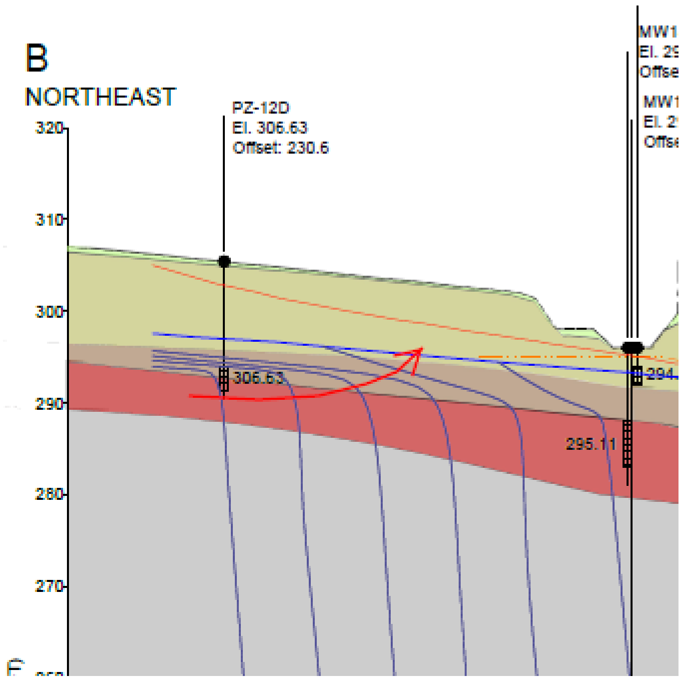
i. The modeled bedrock potentiometric surface from the 1992 modeling efforts show that groundwater in the Phase 14 area comes from the north-northwest. Please explain why the model does not agree with this paragraph and evaluate whether the model needs to be redone based on a revised conceptual site model.

ii. MEDEP does not concur that Figure 14b is an accurate representation of the potentiometric surface of the bedrock groundwater. This figure shows a curve in the contour lines that bend up around 310D and 617C. These two wells have screen depths of 172-184 and 150-199.5 ft, respectively, which are significantly deeper than the new Phase 14 bedrock wells which have screen depths varying from 36 to 92 ft. Because these two wells are measuring groundwater potential much deeper in the aquifer, they should not be used with wells of shallower depth in potentiometric maps. Also, there are several elevations on Figure 14b that don't match up with the equipotential lines, such as the Gerber pumping test locations, and were obviously not used in generating the lines. Please clearly identify data on equipotential maps that are not used in generating them. Also, it's not clear if 627A and 628A were used in generating this map. Please provide the screen depths of 627A and 628A and other wells which were used to generate these equipotential lines.

16. 5.1.2 Vertical Hydraulic Gradients, last paragraph. "…vertical groundwater flow through the Presumpscot clays is negligible due to the very low vertical hydraulic conductivity of the clays, which precludes recharge of the underlying glacial till and bedrock through the clays in the immediate area of Phase 14." MEDEP does not concur with this statement. Due to the low hydraulic conductivity, the flow of water through aquitards such as the Presumpscot Formation would be primarily vertical rather than horizontal, although the flow would be very slow in the absence of fractures. In the presence of fractures in the clay downward flow would be very rapid, so there may be areas where the till is recharged through the clay. For more information, please see K.R. Bradbury et al., 2006,

Contaminant Transport Through Aquitard: Technical Guidance for Aquitard Assessment, AWWA Research Foundation.

17. 5.2.2 Presumpscot Formation.
    a. Third paragraph. "…consistent with the finding that post-depositional features such as desiccation fissures, disruption by roots, frost fracturing, and expansion fracturing were infrequently observed…" Please address our concern that these were infrequently noted rather than infrequently observed. We noticed that no descriptions of the clay included anything other than color, stiffness, moistness, except for the descriptions of PZ-1 through PZ-5 which mentioned red mottling and partings. We also noted that these five borings were logged by STD (who also logged PZ-6), but other people logged the other borings, which only described color, stiffness and moistness. Is it possible a lack of post-depositional features was because they were not noted in the boring logs by the other loggers?
    b. Fifth paragraph. MEDEP requests a pumping test in the Phase 14 area to assess the vertical hydraulic conductivity. The estimates of vertical hydraulic conductivity were based on laboratory measurements, hence, the differences in hydraulic conductivity between the field-measured slug test results and the laboratory tests is more likely due to the difference in the testing methods rather than a difference in the horizontal or vertical hydraulic conductivity. Because of the possibility that undetected fractures in the clay can allow rapid transport of contaminants to aquifers beneath the clay, it is important to have a good estimate of the vertical hydraulic conductivity. The 1991 and 1992 pumping tests provided vertical hydraulic conductivity estimates in a more reliable method than the laboratory test, but they tested the soft gray clay only and not the stiff brown clay. The soft clay tested at the other phases varied from 21.5 to 78 feet thick, much greater than the 0 to 17.2 feet thickness within the footprint at Phase 14. The fact that the clay is much thinner at Phase 14 and that the gray clay is missing over about ¼ of the landfill footprint would warrant another pumping test in the Phase 14 area to assess potential fracturing and the vertical hydraulic conductivity in the stiff clay. It is recommended that multilevel monitoring equipment be installed within aquitards (K.R. Bradbury et al., 2006), with piezometers near the changes in lithology, not in the center of units, to evaluate them properly. So they may need to evaluate the need for installing more piezometers with properly short screens. Please submit a detailed plan for conducting a pumping test at Phase 14. We recommend pumping the till aquifer and monitoring wells and piezometers in the till and clay.
18. 5.3 Hydrostratigraphic Cross-Section. Water in the till to the NE appears to flow upward, discharging to the sand in an uphill area. Because there is no surface water body there, this representation is probably inaccurate. See diagram below. Please correct the cross-section.



19. 6.1 Identification of Potential Sensitive Receptors, third bullet. Please clarify that water is not flowing away from all the aquifers. Sand and gravel aquifers lie to the north and east of the Phase 14 area and groundwater flow "primarily to the south-southwest/southeast, away from the aquifers." Although the flow from the Phase 14 area is not towards the sand and gravel aquifers, it cannot be said to be flowing "away from" the aquifers. It is more accurate to state that groundwater flow is not towards the aquifers or does not intersect the aquifers.
20. 6.1, Identification of Potential Sensitive Receptors, fourth bullet. The groundwater divide is on Figure 14c, not 14b.
21. 6.1, Identification of Potential Sensitive Receptors. Please include fractured bedrock aquifers in this section. Ch. 400 defines sensitive receptors as including significant groundwater aquifers, such as bedrock aquifers.
22. 6.2 Potential Pathways, fourth bullet. MEDEP does not concur with the conceptual model for this pathway. This pathway assumes horizontal migration through the stiff upper clay, but due to the low hydraulic conductivity, transport through aquitards is typically vertical, not horizontal. The aquitard is thin in Pathway 1, which increases the probability of fractures and which allows for rapid transport through the aquitard to the underlying till. The gradient is downward at S-4, which indicates that phreatic water doesn't discharge there. Consider a vertical path through the clay, then a horizontal path through the till. This would have a different flow path to a discharge point, but it might be more realistic. Also, consider a short-circuited path through the clay through fractures and assess how that would impact the time of travel.
23. 6.2 Potential Pathways, fifth bullet. See Comment 22 and consider a vertical path through the clay, then a horizontal path through the till to the stream and assess how the presence of fractures would impact the time of travel.
24. 6.2 Potential Pathways, sixth bullet. MEDEP does not concur that "The assumption that a release would migrate straight downward through the two clay units is considered

conservative…" A near-vertical migration pathway through the clay is realistic and expected, not conservative.

25. 6.4 Time of Travel Results. MEDEP does not concur with the time of travel results. The time of travel results of 1,538 years to travel 650 feet would only be realistic if there were no fractures in the clay. Transport time through clay may be reduced to years in the presence of through-going fractures. Unless you can demonstrate that the clay is unfractured, please present time of travel results in the case of fractured clay. We should also consider that contamination can migrate by diffusion as well. Please include an assessment of transport by diffusion through the clay.
26. 6.4 Time of Travel Results. MEDEP does not agree with using the mean values of hydraulic conductivity (K) for assessing time of travel. We are interested in worse-case scenarios, so the highest K values are more appropriate. Please present a range of travel times based on the range of K values.
27. 6.4 Time of Travel Results, modeling results. Because the modeling was completed prior to the information obtained in this investigation, please evaluate the conceptual site model and the model parameters to determine if the model is still valid.
28. 7.1 Proposed Groundwater Water Quality Monitoring Program, first paragraph. Ch. 405 (2)(A)(1)(c) requires a minimum of two upgradient wells at new or expanded landfills. Please provide the location of another upgradient well.
29. 7.1 Proposed Groundwater Water Quality Monitoring Program, first paragraph. Ch. 405 (2)(A)(1)(b) requires that each hydrogeologic unit is monitored, yet no bedrock wells are selected as monitoring wells. Please provide locations for at least two bedrock monitoring wells and demonstrate that water released from the landfill would be intersected by these wells.
30. 7.1 Proposed Groundwater Water Quality Monitoring Program, last paragraph. We recommend completing two years of three sampling rounds, which would provide a better understanding of the natural data variability at the site. Four sampling rounds are proposed for the site characterization monitoring, but Ch. 405 (2)(C) states that the actual number of samples required depends on the rate of groundwater flow, data quality and variability of results, so this may need to be adjusted.
31. Ch. 401 (2)(B)(2)(a) requires the installation of water table observation wells. Please identify the water table wells.
32. Ch. 401 (2)(B)(2)(d) requires an isopach map of surficial deposits. Although isopach maps of the individual surficial units are submitted, it would be useful to have an isopach map of the complete overburden sequence.
33. Although it is not required in the Solid Waste Rules, it is currently standard practice to provide a brief conceptual site model for a hydrogeologic assessment. Please provide a CSM, basically a synopsis of the site hydrogeology, describing how water recharges, flows through, and discharges. Include all the units and receptors in the description.