November 20, 2020

Richard Hull
US Environmental Protection Agency, Region I
5 Post Office Square, Suite 100
Boston, Massachusetts 02109-3912

Re: Deep Bedrock Investigation – Response to Comments
Draft Deep Bedrock Investigation Pumping Test Work Plan
Coakley Landfill – North Hampton and Greenland, New Hampshire

Dear Mr. Hull:

On behalf of the Coakley Landfill Group (CLG), CES, Inc. (CES) has prepared the following response to comments made by the United States Environmental Protection Agency (USEPA) on the Draft Deep Bedrock Investigation Pumping Test Work Plan (Draft Work Plan). These comments were provided by the USEPA in its letter to the CLG dated November 6, 2020. The Draft Work Plan was submitted to the USEPA and New Hampshire Department of Environmental Services (NHDES) on October 21, 2020, and was developed in response to a request by the USEPA in its review of the Draft Deep Bedrock Investigation Work Plan Addendum (Work Plan Addendum). The Work Plan Addendum was submitted to the Agencies on April 6, 2020 with the request for the Draft Work Plan detailed in a June 17, 2020 letter from the USEPA to the CLG. The following response to comments has been provided with and incorporated into the Revised Deep Bedrock Investigation Pumping Test Work Plan (Revised Work Plan).

General Comments

USEPA

1. **The Work Plan should incorporate CLG's stated plan, as noted in the Response to Comments, to notify the owner of 178A Lafayette Road of the pending pumping test and to confirm if the owner resides at the address or if the property is rented. In the event it is rented, the renter should also be notified of the pending pumping test.**

CLG Response

The CLG will notify the owner and/or renter of the property located at 178A Lafayette Road of the proposed pumping test. In addition to the notification at 178A Lafayette Road, the CLG will notify those residents located immediately adjacent to the pumping test well (MW-6) due to the increased traffic that may be associated with the completion of the pumping test and the potential for additional noise that may result from the operation of generators and pumps.

USEPA

2. **EPA suggests that one of the intentions of the pumping tests is not to specifically confirm that identified transmissive fractures in bedrock monitoring wells do not provide likely migration pathways for off-site migration of Site contaminants to potential receptors, but rather to confirm the presence of transmissive fractures in bedrock and to identify the likelihood that these fractures may transmit contaminants to potential receptors.**

CLG Response
The Revised Work Plan has included revisions to the objectives for the pumping test to address this comment.

USEPA

3. **EPA concurs that one of the intentions of the pumping test is to evaluate inter-fracture groundwater flow and its relationship with overburden and shallow bedrock, but notes that many of the recommendations from the November 25, 2019, *Deep Bedrock Investigation Interim Report* and the July 17, 2020, *Deep Bedrock Investigation Work Plan Addendum* for addressing this data gap have not been implemented.**

CLG Response
The implementation schedule for remaining Deep Bedrock Investigation activities has been provided to the USEPA and NHDES on November 6, 2020 and is currently under review by the Agencies.

USEPA

4. **In the Response to Comments, CLG proposes to install a "Jaswell-type" seal at 34-37 feet below the top of casing to isolate the deeper fractures from the impacts of groundwater flow from the shallow fractures, rather than at 50-60 feet below the top of casing as suggested by EPA. The rationale for placing the packer seal at 50-60 feet below top of casing would be to isolate all the shallow fractures observed and shown in Zone 1 and Zone 2 in the borehole geophysics. Although shallow bedrock wells at the Site are often only 25-30 feet into bedrock, it is important to isolate the shallow fractures that may be influenced by overburden groundwater during the pumping test and to fully capture the characteristics of the deeper fractures to determine any influence on flowpaths in deep bedrock that may impact private bedrock wells placed at depths much deeper than 25-30 feet. Based on further review of the borehole geophysical logs, EPA recommends the seal be placed at 58-62 feet below top of casing.**

Additionally, EPA recommends the placement of a transducer between the bottom of the steel casing and the packer seal to measure any induced hydraulic effects in fracture Zones 1 and 2 (as identified by the downhole geophysical logging) during the pumping test.

The Work Plan shall also specify if the Jaswell-type seal will be permanent or temporary. Jaswell installations are typically permanent and could preclude the subsequent installation of PVC monitoring wells in MW-6 to facilitate long-term monitoring of individual fractures. Use of a temporary pneumatic packer to seal off the borehole for the pumping test is preferred over a Jaswell installation.

CLG Response

The Revised Work Plan has incorporated revisions to the placement of the seal and has included the placement of a transducer between the bottom of steel casing and top of the proposed seal. The Jaswell-type seal proposed is a temporary seal and will be removed after the groundwater recovery period following the completion of the constant rate pumping test. With regard to the use of a pneumatic packer, it is our experience that the use of a pneumatic packer may limit the size and type of pump that can be used for the pumping test and requires a maintained air supply (i.e., compressed gas). In addition, a pneumatic packer can be susceptible to failure that can occur due to rugosity of the borehole wall or failure of mechanical components (i.e., airlines and fittings). To limit potential issues/limitations associated with the use of a pneumatic packer and effects to the validity of pumping test in the event of a failure, the temporary Jaswell-type seal will be used.

Section 2.1 – Background Water Level Monitoring

USEPA

5. **Section 2.1 states that water level data will be collected during "baseline, background, pumping and recovery" periods. The Work Plan shall clarify the difference between baseline and background periods.**

CLG Response

The CLG has revised the text to only reference "background". The singular use of the term "baseline" was used interchangeably with "background" the Draft Work Plan.

USEPA

6. **Section 2.1 should specify that a barometric data logger will be used to record changes in barometric pressure during the pumping test. Changes in barometric pressure must be monitored to facilitate correction of the water level data and the use of a barometric probe and data logger set to record at the same frequency and times as the water level data loggers greatly simplifies the data correction. Note that all data loggers should be programed to begin recording at the same time to make data manipulation easier.**

CLG Response
The CLG intends to use a barometric data logger to record changes in barometric pressure during the pumping test. The barometric data logger for the site is currently deployed near MW-20S.

USEPA

7. **Section 2.1 indicates that groundwater levels will be measured in the monitoring wells identified in Table 1 for a minimum of two weeks prior to commencing the pumping test. In addition, EPA suggests that transducers be deployed in at least monitoring wells GZ- 105, FPC-8B, FPC-3B, FPC-2B, MW-2, MW-5S, MW-5D and MW-11 prior to the drilling and development of the new bedrock borehole near GZ-105 (MW-25) to record any influence from drilling and development of the new well.**

CLG Response
The CLG will instrument several wells during the installation of MW-25 using transducers currently installed at the site in existing deep bedrock wells. There are currently 6 transducers deployed at the site and it is proposed that monitoring during drilling be completed in GZ-105, FPC-3B, FPC-8A, MW-5S, MW-5D, and FPC-4B. Based on well construction details, MW-2 is a small diameter (1-inch diameter) well and will not allow for the deployment of the transducers available at the site. FPC-4B was selected over MW-11 due to a redundancy in data to the east of MW-25. As this activity is specific to the installation of MW-25, the installation of which is detailed in the Work Plan Addendum and not the Revised Work Plan as included below, text specific to the installation of transducers during well installation has not been included within the Revised Work Plan. This response to comment will serve to provide the intentions of the CLG to address this additionally requested investigative activity.

USEPA

8. **Table 1 does not include the yield for each monitoring well as requested by EPA and affirmed in CES Inc.'s July 17, 2020, *Deep Bedrock Investigation – Response to Comments on Draft Deep Bedrock Investigation Work Plan Addendum*.**

CLG Response
Based on further review of available geologic and hydrogeologic information for individual wells included on Table 1 following CES' July 17, 2020 Response to Comments (e.g., stratigraphy, low flow sampling pumping rates, duration of low flow pumping), values for well yield calculated from these data would not be representative of well yields for the aquifer at these locations. Therefore, individual yields at site monitoring wells have not been included on Table 1.

USEPA

9. **Not all wells listed in Table 1 are shown on Figure 1. A new figure should be developed, or Figure 1 modified, to show all the wells to be monitored during the pumping test.**

<u>CLG Response</u>
Figure 1 has been revised to include GZ-119.

USEPA

10. Table 1 indicates that shallow bedrock wells AE-3B, AE-4B, FPC-5B, and FPC-9B will be measured manually during the pumping test instead of with transducers. AE-3B and FPC-5B are located along strike of the predominant fracture set from MW-6 on the opposite side of the landfill. It will be important to get continuous data from these wells to assess the hydraulic effects of pumping in the shallow bedrock beneath the landfill. AE-4B is located along strike of the cross-set fractures that are theorized to be the primary migration pathway to the west. While this location may be redundant to MW-22D1, the critical nature of this pathway warrants duplicity in the data collection. FPC-9B is located east of the landfill, in an area with no other shallow bedrock wells. Monitoring wells AE-3B, AE-4B, FPC-5B, and FPC-9B should be monitored with data loggers to obtain high quality water level response data. Conversely, bedrock wells MW-23 and GZ-122 could be measured manually in lieu of a data logger given the distance from the pumping well.

<u>CLG Response</u>
*Table 1 has been modified to reflect these changes in placement of transducers in AE- 3B, AE-4B, FPC-5B, and FPC-9B***.**

USEPA

11. Table 1 lists four overburden wells that will be monitored using data loggers including GZ- 123, MW-20S, MW-21S, and MW-22S. These wells are all distant from the pumping wells and are unlikely to see measurable drawdown as a result of pumping and could be left out of the monitoring network. Conversely, MW-4, FPC-2A FPC-8A, and AE-2A are much closer to MW-6 and could see measurable drawdown justifying the use of data loggers at these locations.

<u>CLG Response</u>
Table 1 of the Revised Work Plan has been revised to reflect the change in wells proposed for instrumentation with data loggers.

<u>Section 2.2 – Variable Rate Pumping Test</u>

USEPA

12. Section 2.2 describes the step-drawdown test and proposes steps and sample rates of 5, 10, and 12 gpm. Stepped pumping rates are calculated from the specific capacity, transmissivity and estimated drawdown of MW-6 as determined during well redevelopment. The Work Plan does not specify whether the three rates mentioned are examples or the actual rates calculated and seem

to conflict with other pumping rates mentioned later in Section 2.2 (10, 15, and 20 gpm). The actual rates for the step-drawdown test should be provided in the Work Plan along with the calculations used to select them. Further, at least four steps (five would be preferred) should be employed to better define the performance curve for the well. The early steps will reach equilibrium very quickly, so that the additional steps should not extend the overall duration of the test.**

CLG Response

The Draft Work Plan has been revised to include four estimated pumping rates for establishment of the rate to be used during the constant rate test. The rates included in the Draft Work Plan were inclusive of contribution of water from fractures located above the interval now requested by the Agencies to be isolated during both the variable and constant rate tests. The workplan has been updated to specify the proposed pumping rates of 20, 15, 10, and 5 gpm and to explain the calculations used to determine those rates. The well development at 7 gpm stabilized to a change in head of less than 1 foot per 15 minutes after an hour during development, so it is not anticipated that the addition of a step at 5 gpm will substantially increase the overall duration of the test.

USEPA

13. **Section 2.2: Note that a totalizing flow meter should be employed to allow both instantaneous flow rate measurements and the calculation of longer-term averages during the pumping of MW-6.**

CLG Response

The Revised Work Plan has been edited to specify a totalizing in-line flowmeter rather than the in-line flowmeter proposed in the Draft Work Plan.

USEPA

14. **Section 2.2: A graph plotting drawdown versus pumping rate should be prepared using the step-drawdown test data and the resulting performance curve used to justify the selected rate for the constant-rate test. The graph will also allow quantification of the well efficiency which is useful in assessing how adequately the well is developed.**

CLG Response

A graph of drawdown versus pumping rate will be considered based on data generated during the variable rate pumping/step drawdown test to evaluate the rate selected for use during the constant rate test.

USEPA

15. **Section 2.2 shall specify the frequency for measuring water levels for wells that are equipped with data loggers and that are measured manually.**

CLG Response
The Revised Work Plan has been revised with Table 1 updated to include proposed manual measurement and transducer download frequency.

Section 2.3 – Constant Rate Pumping Test

USEPA

16. **Section 2.3 states that "all wells being monitored during the test will be considered when establishing steady state conditions" for the constant rate pumping test. Given that many of the observation wells will be instrumented to measure water levels during the test, versus measuring manually, the procedures that will be used for collecting the data to establish steady state conditions should be specified.**

CLG Response
Water level data will be collected from the monitoring well network at a frequency as proposed in ***Table 1****. It should be noted that due to safety reasons, wells located in heavily wooded portions of the site (e.g., MW-22D1/-D2, FPC-3A/-3B/-3C, etc.) will only be gauged during daylight hours. The frequency of measurements may be adjusted during the constant rate test based on observed drawdown (more frequent or less frequent to avoid aliasing).*

USEPA

17. **Section 2.3 indicates that the wells that will be revisited for heat pulse flowmeter measurements during the constant rate pumping test will include GZ-125, GZ-130, MW- 24, BP-4 and MW-25. CLG shall also conduct heat pulse flow metering in monitoring well GZ-108 if drawdown is observed in this monitoring well during the constant rate pumping test. CLG shall confirm the wells to be metered with EPA and NHDES prior to the initiation of heat pulse flow metering during the pumping test.**

CLG Response
In the event drawdown is observed in GZ-108 during the constant rate pumping test, it will be included for completion of heat pulse flowmeter measurements. Therefore, GZ-108 has been listed in the Revised Work Plan as a well to be revisited during the test to determine viability for flowmeter measurements.

USEPA

18. **Section 2.3 does not specify the manual or data logger water level reading frequency. The data loggers should be reprogrammed after completion of the background test and before the start of the constant-rate test and the frequency should be reduced from the 15-minute interval to 1-minute intervals or less. Consideration should be given to using a logarithmic scale for the data loggers closest to the pumping well to get more measurements during the initial portion**

of the test when drawdown expands rapidly.

CLG Response

Though not specified in the Draft Work Plan, transducers will be reprogrammed after completion of the background water level monitoring and prior to the start of the constant rate test. Logging frequency will be increased from the 15-minute rate used during background water level monitoring to 1-minute or less during the start of the constant rate test. A logarithmic scale will be used in those wells closed to MW-6 (e.g., MW-5S/-5D, MW-2) to monitor drawdown rates. It is anticipated, based on short term monitoring completed during the redevelopment of MW-6, that drawdown will occur more rapidly in those wells closest to MW-6 and a more frequent logging rate will aid in antialiasing drawdown data at the start of the test. Changes to address transducer logging intervals have been provided in the Revised Work Plan.

Section 2.4 – Groundwater Sampling

USEPA

19. **EPA concurs with the frequency of sampling and list of contaminants to be analyzed to assess groundwater quality proposed in Section 2.4, but because MW-6 is located close to the landfill, the CLG shall also add VOCs to the list of contaminants to be analyzed.**

CLG Response

The Revised Work Plan has been revised to include the analysis for volatile organic compounds (VOCs). This analysis will be included for samples collected as listed in the Revised Work Plan.

Section 2.5 – Investigation Derived Waste Management

USEPA

20. **Section 2.5 states that a sample of the treated effluent will be collected and submitted for analysis prior to discharge of the water to confirm that the treatment process is effectively removing site contaminants at the start of the pumping test. However, influent concentrations of contaminants to the treatment system may change as the pumping test progresses and the carbon could become clogged or channelized over time. EPA recommends that a second effluent sample be collected near the end of the pumping test to document that the treatment system operated effectively throughout the test.**

CLG Response

The addition of effluent sampling prior to the end of the constant rate test will be included in Section 2.5 of the Revised Work Plan.

CES INC

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REVISED DEEP BEDROCK INVESTIGATION PUMPING TEST WORK PLAN COAKLEY LANDFILL SUPERFUND SITE NORTH HAMPTON AND GREENLAND, NEW HAMPSHIRE

FOR

COAKLEY LANDFILL GROUP

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REVISED DEEP BEDROCK INVESTIGATION PUMPING TEST WORK PLAN
COAKLEY LANDFILL SUPERFUND SITE
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1.0 | INTRODUCTION

On behalf of the Coakley Landfill Group (CLG), CES, Inc. (CES) has prepared the following Revised Deep Bedrock Investigation Pumping Test Work Plan (Revised Work Plan) to provide an approach and protocols for the collection of pumping test data needed to supplement the Deep Bedrock Investigation at the Coakley Landfill Superfund Site (Site). This Revised Work Plan details select tasks included in the Deep Bedrock Investigation Work Plan Addendum (Work Plan Addendum) submitted on July 17, 2020 and conditionally approved by the United States Environmental Protection Agency (USEPA) on August 4, 2020. This Revised Work Plan is intended to outline those activities needed to complete the characterization of the deep bedrock hydrogeology and migration pathways and to address data gaps as detailed in the *Deep Bedrock Investigation Interim Report* (Interim Report). The Interim Report was submitted to USEPA and New Hampshire Department of Environmental Services (NHDES) on November 25, 2019, with comments to the Interim Report received from USEPA on February 6, 2020.

As discussed in the Work Plan Addendum, a pumping test will be completed to assess bedrock fracture connectivity and further evaluate the southern migration pathway in bedrock as detailed in the data gap analysis of the Interim Report. In addition to addressing this migration pathway, the pumping test is intended to assist in:

- Refining the Conceptual Site Model (CSM) and further the understanding of deep bedrock hydrogeology as it relates to anisotropy created by multiple bedrock fracture trends.
- Determining (along with other lines of evidence) whether transmissive fractures in bedrock monitoring wells, where present, provide likely migration pathways for off-site migration of Site contaminants to potential receptors.
- Evaluating inter-fracture groundwater flow and its relationship with overburden and shallow bedrock.

As detailed in the Work Plan Addendum, the pumping test will be completed in existing deep bedrock monitoring well MW-6 based on well construction details and observations made during well installation (**Attachment A**), distance from the landfill, location of available wells relative to mapped bedrock fracture and lineament data (**Figure 1**), and analytical data available for wells within the monitoring network.

Well redevelopment, borehole geophysics, and interval packer sampling activities were completed in MW-6 with results detailed in the *MW-6 Interval Packer Sampling Results and Pumping Test Viability* memorandum (Memorandum) submitted to the USEPA and NHDES on August 18, 2020. MW-6 was approved by the USEPA for use as the pumping test well on August 26, 2020 via email correspondence.

2.0 | PUMPING TEST ACTIVITIES

The following pumping test activities have been developed based on the current CSM, activities performed since completion of the Interim Report and Work Plan Addendum (i.e., MW-6 investigation activities), and regular correspondence between the CLG, USEPA, and NHDES.

2.1 Background Water Level Monitoring

A suite of existing monitoring wells will be selected for water level monitoring prior to, during, and following the completion of the pumping test. As part of the design, a list of wells has been included with Work Plan as **Table 1.** Wells deemed critical for water level monitoring will be instrumented with in-well data loggers, while an additional set of wells will be monitored manually as part of the test protocol. Background, pumping, and recovery water level data will be collected as part of the implementation of the pumping test. During the collection of background water level data, notice to the resident and/or owner of the residential parcel at 178A Lafayette Road will be notified of the proposed pumping test activities. In addition to this location, notice will be provided to those located along Granite Drive (near MW-6) at residences that may be impacted by increased traffic and noise that may result from the completion of the proposed pumping test activities.

For a minimum of two weeks prior to commencing the pumping tests, background groundwater levels will be monitored to assess ambient groundwater levels that may affect the interpretation of data prior to and following the variable rate and constant rate pumping tests. Overburden and bedrock wells selected for monitoring are included on **Table 1** with those wells identified as being “Instrumented” considered characteristic of background conditions. To complete the background water level monitoring, pressure transducers will be placed in those monitoring wells considered to represent background conditions to monitor pressure and temperature changes, as identified in the current monitoring well network on **Figure 1**. Pressure transducers will be synchronized to reflect the current time of day prior to installation. Manual groundwater level measurements will be recorded immediately upon installation of the transducers to correlate pressure readings to groundwater levels. Pressure transducers in background wells will be set to record groundwater elevations (pressure) on a linear time scale at 15-minute intervals. Additionally, the day prior to the variable rate pumping test, groundwater levels in surrounding monitoring wells will be recorded and used to establish static aquifer conditions. Pressure transducers will be left in selected wells throughout the duration of the pumping tests to measure effects of pumping on water levels. These measurements will be supplemented with the collection of barometric pressure data using a barometric pressure logger. These data are used to apply barometric corrections to water level transducer data. **Table 1** lists the wells within the monitoring well network and includes their respective distance from the pumping well (MW-6).

In addition to the use of existing groundwater monitoring wells, the use of a newly installed open deep bedrock boring located west of MW-6 (near existing GZ-105) will be used. This well has not been installed at the time of this Work Plan development but is being installed to investigate the vertical extent of landfill related constituents in deep bedrock and conditions along an inferred southern migration pathway. Based on the current bedrock monitoring well nomenclature, this new well will be identified as MW-25. This well location was staked in the field on October 14, 2020 during a Site meeting held between the USEPA, NHDES, and CES. Wells included as part of the monitoring may include wells identified during the residential water supply well records investigation, if any, detailed in Section 2.8 of the Work Plan Addendum. These will be limited to out of service wells identified during the evaluation and will be subject to well owner approval.

2.2 Variable Rate Pumping Test

A variable rate pumping test (step drawdown test) will be performed on MW-6 to evaluate the well's performance under controlled variable pumping conditions, assess aquifer characteristics, and determine the long-term constant pumping test rate. The specific capacity and transmissivity for the pumping well, estimated from groundwater drawdown measurements recorded during well redevelopment, will be used to estimate proposed pumping rates for each variable rate to be used during the three varying flow rates (e.g., 5, 10, 15, and 20 gallons per minute [gpm]) will be used during the step drawdown pumping test. Each pumping rate will be maintained until drawdown has equalized or until well capacity has been reached, as potential exists for the well capacity to be reached before a higher flow rate can be initiated. The variable rate step drawdown test will be performed in advance of the constant rate pumping test.

Prior to the initiation of the variable rate pumping test, a temporary Jaswell-type seal will be installed in MW-6 to isolate shallow bedrock fractures from those located at depth to better evaluate response to pumping within the deeper bedrock interval. The flexible rubber seal is approximately 12-inches in height and designed to isolate specific sections of borehole. The seal is affixed to 4-inch diameter PVC pipe and pushed into the borehole to the interval requiring isolation. This allows for pumps/pump controls, water level monitoring instrumentation, and pump discharge piping to be placed through the 4-inch diameter piping while maintaining the seal at the desired depth. The seal can then be removed at the conclusion of testing and allow for the 6-inch diameter borehole to be constructed as a permanent monitoring well, if needed. Based on observations made during the installation of MW-6 (bedrock at 6 feet below ground surface[bgs]), USEPA recommendations, and the results of borehole geophysical logging and interval packer sampling (**Attachment A**), the seal will be placed from 58 to 62 feet below top of casing (56 to 60 feet bgs). It should be noted that depths based on borehole geophysical data and interval packer sampling results are referenced to feet below top of casing while construction information of MW-6 as noted during installation (depth to bedrock and casing length) is referenced to feet bgs. This placement isolates fractures that may be influenced by overburden groundwater (likely transmissive interval) within Zone 2 (31-42 ft below top of casing) from the deeper zones targeted for the tests and maintains isolation of the deeper bedrock fractures intercepted by the well. Following seal installation, water levels will be monitored above and below the seal for stabilization prior to initiating the variable rate test and monitored using pressure transducers as noted below. This will be completed prior to the background water level monitoring described in **Section 2.1**.

Setting the seal as described above will focus the pumping stress from the fractures located in the lowermost section of the borehole (Zone 3 [65.5 ft to 71.5 ft] through Zone 8 [163.6 ft to 169.5 ft]). The deepest fractures located in Zone 8 have an estimated transmissivity of 0.04 ft^2/day while the estimated transmissivities for Zone 6 (112.5 ft to 118.5 ft) and Zone 7 (142.5 ft to 148.5 ft) are 0.30 ft^2/day and 0.39 ft^2/day, respectively. Shallower fracture Zone 3 and Zone 4 (85 ft to 96 ft) have estimated transmissivities of 4.18 and 4.43 ft^2/day, respectively. Although the drawdown did not reach steady state during the packer sampling, the estimated transmissivity values can illustrate the expected differences in production rates of the different fracture zones. The estimated transmissivities illustrate how the primary driver of offsite transport of the contaminants of concern, would be from fractures between 30 feet to 107 feet below grade. Meanwhile the potential contaminant mass being transported in the deeper fractures below Zone 5, is much lower. Setting the packer near 35 feet below grade would allow for the identification of potential interconnections between the fractures with the greatest potential for contaminant mass transport. Meanwhile, static water levels of the deeper fractures identified during packer sampling, between Zone 6 and Zone 8, indicate that any decrease in head, would also initiate discharge from these lower fractures and an associated reduction in head of other bedrock wells connected to these fractures.

The variable rate pumping test will be performed using a 4-inch submersible well pump placed near the bottom of the open hole section of MW-6, below the sealed interval. The pump discharge will be controlled using gate and/or ball-style valves with discharge rate monitored using a totalizing in-line flowmeter calibrated for the flow rates anticipated during the test. Pressure transducers will be placed within stilling tubes placed above and below the seal and used to monitor water levels during the test. These readings will be supplemented with manual readings during test execution.

The pumping rates provided here were calculated by using the drawdown data from the redevelopment of MW-6 (completed prior to borehole geophysics) to determine the specific capacity for the entire well. Drawdown data from well redevelopment was used since drawdown data from the interval packer sampling did not always reach steady state conditions during the sampling process. As stated in the *MW-6 Interval Packer Sampling Results and Pumping Test Viability Memorandum* (CES, 2020), the calculated values for both specific capacity and transmissivity (Table 2 of Viability Memorandum) are estimates based on information recorded in the field. Variations in specific capacity and transmissivity within a single well can be attributed to differences in packer length, number of fractures within each interval, amount of inter-fracture flow around the packer interval, and integrity of the packer seal. Therefore, the accuracy of the specific capacities and transmissivities may not provide the accuracy required to estimate an aggregate capacity for the open hole portion of the well-used during the tests. Instead, the development data provides four hours of continuous drawdown readings at a constant pumping rate providing a more robust dataset to calculate specific capacity and yield of the well as a whole. The packer sampling data does; however, provide a qualitative understanding of fracture characteristics with the capacity and transmissivity of the fracture intervals decreasing with depth.

Where:
Specific Capacity = Pumping Rate/Total Drawdown
0.22 gpm/ft = 7.0 gallons per minute / 32.45 feet of drawdown

With MW-6 being 180 feet deep, the pump is proposed to be set at a depth of 175 feet below top of casing. With a static water elevation that averages 10-feet below top of casing and keeping a 10-foot safety window of water head above the pump, allows for roughly 155 feet of available static water column within the well.

With the estimated specific capacity calculated to be 0.22 gpm/ft and 155 feet of available water, this would allow for a maximum pumping rate of 34.1 gpm.

Where:
Well Yield = Available Water X Specific Capacity
34.1 gpm = 155 ft x 0.22 gpm/ft

However, the Zone 2 fracture zone will be isolated as detailed above and will not contribute to recharge to the well. The estimated transmissivity of Zone 2 (Table 2 of Viability Memorandum) contributes roughly one third of the total transmissivity of all the fractures in the well. As such, the maximum pumping rate should be roughly two thirds of the maximum pumping rate calculated from the capacity measured from well redevelopment. As a result, the maximum pumping rate would be approximately 22.7 gpm/ft. Additionally, it is expected that the specific capacity may decrease with increased pumping rate, so the final proposed maximum pumping rate for the variable rate/step drawdown test will be 20 gpm. The pumping rates used during this test will be 5, 10, 15, and 20 gpm.

The step drawdown data will be used to further refine the maximum discharge for the constant rate test, determining hydraulic conductivity from the Jacobs Method, and to calculate the pumping rate for the constant rate test.

The pumping rate and water quality field parameters (pH, temperature, turbidity, oxidation reduction potential [ORP], and conductivity) will be recorded at 5-minute intervals for the first 15-minutes of the test; then at 15-minute intervals for the first hour, and hourly thereafter at each pumping rate. Parameters will be monitored in accordance with the project Sampling and Analysis Plan (SAP). Monitoring of the pumping rate will allow for adjustments to the rate if it has drifted from the target rate and confirm that the pumping rate is maintained as the dynamic head increases with groundwater elevation drawdown. Adjustments to the pumping rate will be recorded along with the measured rate and water levels during the pumping test.

Water levels will be monitored hourly for those wells located nearest MW-6, including those instrumented with water level transducers. The gauging frequencies have been included on **Table 1**; however, due to changes in the pumping rates that occur during the variable rate pumping test, transducer readings over the duration of the test will be more frequent (i.e., 30 seconds) to capture changes in water levels that may results following an increase in pumping rate at MW-6. Conversely, based on observed changes in water levels during the test, the frequency of manual measurements may be adjusted to coincide with downloading of transducers.

2.3 Constant Rate Pumping Test

Following completion of the variable rate pumping test on MW-6, and once groundwater has returned to static conditions as determined by background water level monitoring, a constant rate pumping test will be designed and performed to determine boundary effects, aquifer parameters, and interconnectedness of bedrock fractures. The constant rate test will include installation of a pump capable of pumping groundwater at a controlled rate based on the results of the variable rate pumping test. It is anticipated that a pumping rate will be selected to achieve the greatest stress on the bedrock aquifer while accounting for the anticipated 96-hour pumping test duration. The depth of the pump placement may depend on the results of well development or the variable rate pumping test; however, the depth is currently anticipated to be 5-feet from the bottom of the well. To obtain accurate monitoring data during the groundwater recovery period after the pump test has been completed, a check valve will be installed at the base of the discharge pipe to reduce backflow of water into the well. Once the submersible pump has been installed, a 1-inch diameter PVC screen will be installed near the top of the pump to allow for monitoring groundwater levels while reducing the effects of pumping turbulence on measurements. Pumping rates and volumetric totals will be monitored using a digital totalizer/flowmeter, allowing for accurate measurement of flow rates and discharge volumes. These will be calibrated for the flow rate determined for use during the constant rate test.

The pump discharge will be connected to piping plumbed to a temporary polyethylene or steel storage tank staged near the well. The tank will be used as a flow equalization tank to buffer flow prior to treatment and discharge to the Coakley Landfill via spray irrigation following treatment. The management of water generated during the constant rate test is discussed further in **Section 2.5**, below. The flow into the tank will be managed such that discharge of the tank is occurring at a similar or greater rate.

Pressure transducers will be used to monitor groundwater levels within existing monitoring wells to record the influence of pumping. Transducers installed in each well will record data, including pressure and temperature, during the constant rate test. Following the background water level monitoring and that recorded during the variable rate test, the transducers will be reset to record at 1-minute intervals. Logging intervals for those wells located closest to MW-6 (i.e., MW-2, MW-5S/-5D, MW-11, etc.) will be set to a logarithmic scale to record more frequently at the onset of the test with a reduction in frequency as the test progresses. This will allow for more measurements during a period of the test when drawdown is more rapid and will reduce the likelihood for aliasing of the water level data due to insufficient recording rates. The frequency of manual readings and transducer downloads have been included on **Table 1** and it should be noted that the frequency of some wells may vary due to safety considerations (wells located in dense woods) or due to locations within private property (MW-23 and MW-24). The constant pumping rate, as determined from reducing the variable rate pumping test data, may be adjusted and noted if excessive drawdown (groundwater level within 10 feet from the pumping depth) is observed. The test is anticipated to be a minimum of 96-hours in length and will be based on observed steady state drawdown conditions in observation wells and conference with the USEPA and NHDES. A specific list of observation wells used to establish these steady conditions has not been included with the Work Plan as all wells being monitored during the test will be considered when establishing steady state conditions. It should be noted that a drawdown response is not anticipated to be observed in all wells (i.e., overburden) as a result of the pumping stress applied to the deep bedrock aquifer. Instrumented wells are only a subset of those that will be monitored during the constant rate test and will include a newly installed well west of MW-6 in proximity to current shallow bedrock monitoring well GZ-105. Based on the current bedrock monitoring well nomenclature, this well will be identified as MW-25. As stated in **Section 2.1**, water levels in all wells will be measured daily and will supplement readings recorded by deployed pressure transducers.

The pumping rate and water quality field parameters (pH, temperature, turbidity, ORP, and conductivity) will be recorded at 5-minute intervals for the first 15-minutes of the test; then at 15-minute intervals for the first hour, and hourly thereafter. Monitoring of the pumping rate will allow for adjustments to the rate if it has drifted from the target rate and confirm that the pumping rate is maintained as the dynamic head increases with groundwater elevation drawdown. Adjustments to the pumping rate will be recorded along with the measured rate and water levels during the pumping test.

Every effort will be made to schedule the pumping test to avoid significant forecasted precipitation events as to limit external influences on the interpretation of water levels recorded during the test. In addition, observations that could cause fluctuations in water level that include but are not limited to variations or adjustments in pumping rates, minor precipitation events, and presence of sediment in the discharged water will be recorded on the field log during the test.

During the pumping test, CES will contract with Northeast Geophysical Services (NGS) to collected real time heat pulse flow meter data from multiple bedrock wells (e.g., GZ-125 and GZ-130) to measure variations in ambient flow rate within the borehole resulting from inter-fracture flow during pumping. These wells will be from those previously investigated during the reconnaissance well investigation and those surveyed subsequent to that investigation (i.e., new bedrock boring near GZ-105 [MW-25]). Wells will be selected based on the drawdown observed during the constant rate test. These data will be compared to ambient heat pulse flow meter information recorded during previously recorded heat pulse flowmeter measurements and used to evaluate inter-fracture groundwater flow, if any, resulting from the pumping stress applied during the test. Based on the current monitoring well network, it is anticipated that the wells that will be revisited for heat pulse flowmeter measurements will include GZ-108, GZ-125, GZ-130, MW-24, BP-4, and MW-25. However, the wells included as part of the additional flowmeter measurements will be determined based on drawdown observed, if any, during the constant rate pumping test. Real-time data recorded during the pumping test (e.g., observed drawdown) will be used to establish the wells to be included for flowmeter measurements with preference given to those wells exhibiting greater amounts of drawdown. Due to the time required for recording of heat pulse flowmeter measurements within each well, location/access to each well, and duration of the test, some wells (i.e., those closest to the pumping well and exhibiting drawdown) will be measured sooner following the start of the test.

At the conclusion of the constant rate pumping test as determined through concurrence with the USEPA and NHDES, deployed transducers will be reset to record in step-test mode to allow for capturing the recovery period of the groundwater aquifer. The recovery test will continue until the aquifer has returned to 90 percent of the measured pre-test level or for 48 hours based on manual water level measurements. Additionally, groundwater levels in wells immediately surrounding the pumping well will be recorded manually at least one minute prior to shutdown of the pumping well and will continue for 30 minutes after the pump has been turned off when the frequency of readings will be reduced. The pump will remain in the test well until the aquifer recovery monitoring is complete. Groundwater level measurements will also be collected from transducers during the recovery period from monitoring wells considered to represent background conditions, to assess potential natural ambient water level fluctuations, and for use in correlation with pre-test water level measurements. A synoptic round of water levels will be completed prior to the startup of the pumping test, daily during the test, prior to shutdown of the event, and immediately prior to removing deployed pressure transducers.

2.4 Groundwater Sampling

In addition to water quality parameters monitored during the completion of both the variable rate and constant rate pumping tests, samples of untreated groundwater effluent will be collected to assess for changes in groundwater quality as a result of artificial aquifer stress induced by pumping. The samples will be collected from a sample port located on the pump discharge line, prior to the equalization tank. This port will be installed and used to provide water to the flow through cell of the multi-parameter water quality instrument. The flow through cell will be disconnected from the port and the sample collected in accordance with water sampling procedures outlined in the project SAP. Groundwater samples will be collected for analysis of volatile organic compounds (VOCs), PFAS, 1,4-dioxane, arsenic, manganese, and general landfill parameters (ammonia, chemical oxygen demand, chloride, hardness, and nitrate). These samples will be collected prior to the variable rate test, during the constant rate test (every 18 hours), and at the conclusion of the constant rate test following a return to static groundwater conditions. This sampling schedule will result in a minimum of seven samples for analysis. Sampling, chain of custody procedures, and analysis will be completed in accordance with the project SAP (CES, 2018). Tier 1 validation will not be performed on these data.

2.5 Investigation Derived Waste (IDW) Management

Water generated during the variable rate and constant rate pumping tests will be treated using a mobile treatment system that includes inline duplex particulate filtration and granular activated carbon (GAC) vessels. The GAC filtration units have been sized to allow for adequate empty bed contact time (EBCT) to ensure removal of PFAS and other site contaminants to levels that are below the HA/AGQS and applicable Maximum Contaminant Concentrations (MCLs). The system will include two sets of particulate pre-filtration and two GAC vessels. Each vessel will contain 1,000 pounds of virgin coal based GAC. The system design allows for one vessel to be taken offline, if needed, and backflushed with the remaining vessel remaining in service until maintenance has been completed. Concentrations of other Site contaminants (arsenic, manganese, and 1,4-dioxane) were used in the treatment design. Prior to discharge of water generated during the variable rate test, a sample of treated effluent will be collected and submitted for analysis of the parameters listed in **Section 2.4**. An additional sample of effluent will be collected prior to completion of the pumping test to evaluate the system effectiveness of contaminant removal.

Treated effluent water will be stored in one or more smaller frac tanks (e.g., 5,000 gallon) located between MW-6 and the landfill based on availability of space. These smaller tanks will provide storage capacity for the treated effluent discharged to the landfill via spray irrigation. The rate and areas of application will be based on the anticipated total volume of water generated. This estimated volume will be based on the pumping rate as determined from the variable rate test and minimum 96-hour constant rate pumping test duration. Once the pumping rate has been established, the application rate for the spray irrigation will be calculated. It is also anticipated that the application area at the landfill will be changed throughout the duration of the pumping tests to minimize the amount of water applied to a single area of the cap.

The application of treated pumping test effluent to the cap is designed to reduce and/or eliminate the likelihood of influence in groundwater monitoring wells located north of the site and monitored during the test. The landfill cap and stormwater management system, as detailed in the Stormwater Investigation Report submitted to the USEPA and NHDES on September 24, 2019, is designed to manage the infiltration of water through an engineered cover and water collection system. System outfalls (e.g., underdrain pipe and perimeter ditches) will be monitored during the test for discharge. In the event discharge is observed, changes in application rate and area will be applied. Based on the design of the landfill cap system, application to the southernmost portion of the landfill cap will result in the greatest delay between application, infiltration, and transport to one of the previously identified system outfalls.

3.0 | REFERENCES

CES, Inc. (2018), Sampling and Analysis Plan, Coakley Landfill Superfund Site, North Hampton and Greenland, New Hampshire (July 2018).

CES, Inc. (2019), Deep Bedrock Investigation Interim Report, Coakley Landfill Superfund Site, North Hampton and Greenland, New Hampshire (November 2019).

CES, Inc. (2020), Surface Water Evaluation Scope of Work, Coakley Landfill Superfund Site, North Hampton and Greenland, New Hampshire (January 2020).

CES, Inc. (2020), Deep Bedrock Investigation Work Plan Addendum, Coakley Landfill Superfund Site, North Hampton and Greenland, New Hampshire (July 2020).

CES, Inc. (2020), MW-6 Interval Packer Sampling Results and Pumping Test Viability, Coakley Landfill Superfund Site, North Hampton and Greenland, New Hampshire (August 2020).

United States Environmental Protection Agency, Ground Water Issue – Suggested Operating Procedures for Aquifer Pumping Tests (USEPA, 1993).

Weston, Inc. (1988), Remedial Investigation – Coakley Landfill, North Hampton, New Hampshire (October 1988).

TABLE 1

PUMPING TEST MONITORING WELL NETWORK CONSTRUCTION DETAILS

Table 1
Pumping Test Monitoring Well Network - Well Construction Details
Coakley Landfill Superfund Site
North Hampton and Greenland, New Hampshire

Monitoring Well ID	Easting NH State Plane (feet)	Northing NH State Plane (feet)	Installation Date	Distance From Pumping Well	Instrumented Manual	Monitoring Frequency	Monitored Lithologic Unit	Well Diameter Material	Measuring Point Elevation (amsl)	Well Depth (feet)	Screen Length (feet)	Top of Screen (feet BGS)	Bottom of Screen (feet BGS)	Top of Screen Elevation (amsl)	Bottom of Screen Elevation (amsl)	Top of Rock (feet BGS)	Bedrock Penetration (feet)	Bottom of Well Screen to Bedrock (feet)
OVERBURDEN																		
AE-1A	1212067.000	182760.000	3/26/1999	1108.38	Manual	2 Hours	Till	2" PVC	127.00	65.0	10	55.0	65.0	72.0	62.0	65.0	NA	0.0
AE-2A	1210855.000	183533.000	7/27/1999	933.19	Instrumented	2 Hours	Till	2" PVC	79.60	20.0	10	10.0	20.0	69.6	59.6	20.0	NA	0.0
AE-3A	1211380.240	184301.830	3/24/1999	1744.11	Manual	2 Hours	Till	2" PVC	85.00	20.0	10	10.0	20.0	75.0	65.0	20.0	NA	0.0
AE-4A	1209659.376	183794.215	9/15/2003	1767.96	Manual	2 Hours	Outwash	2" PVC	76.45	15.0	10	5.0	15.0	71.4	61.4	15.0	NA	0.0
FPC-11A	1211838.000	182249.000	6/23/1992	939.55	Manual	2 Hours	Till	2" PVC	117.95	52.0	5	47.0	52.0	71.0	66.0	52.0	NA	0.0
FPC-11C	1211844.318	182255.162	6/24/1992	943.08	Manual	2 Hours	Till	2" PVC	117.86	33.0	15	18.0	33.0	99.9	84.9	52.0	NA	19.0
FPC-2A	1210459.000	182018.000	4/3/1992	779.15	Instrumented	2 Hours	Outwash	2" PVC	78.40	16.0	10	6.0	16.0	72.4	62.4	16.0	NA	0.0
FPC-3A	1210138.665	182155.832	5/4/1992	945.14	Manual	2 Hours	Till	2" PVC	73.17	73.0	10	62.0	72.0	11.2	1.2	73.0	NA	1.0
FPC-3C	1210149.489	182151.021	5/5/1992	937.97	Manual	2 Hours	Outwash	2" PVC	72.36	28.5	10	18.5	28.5	53.9	43.9	70.0	NA	41.5
FPC-4A	1209460.058	182867.634	6/4/1992	1531.57	Manual	2 Hours	Till	2" PVC	75.42	13.0	5	8.0	13.0	67.4	62.4	14.0	NA	1.0
FPC-5A	1210979.690	184509.920	3/17/1992	1903.12	Manual	2 Hours	Till	2" PVC	73.80	70.0	10	60.0	70.0	13.8	3.8	89.5	NA	19.5
FPC-6A	1210817.000	185095.000	8/1/2003	2492.82	Manual	4 Hours	Till	1.5" PVC	79.20	2.8	1	1.8	2.8	77.5	76.5	6.0	NA	3.3
FPC-7A	1211925.710	185037.990	5/11/1992	2612.54	Manual	4 Hours	Till	2" PVC	87.60	22.0	5	17.0	22.0	70.6	65.6	23.0	NA	1.0
FPC-8A	1210524.000	183210.000	4/9/1992	749.71	Instrumented	M- 2 Hours, T- Every 6 Hours	Till	2" PVC	73.80	33.0	10	23.0	33.0	50.8	40.8	33.0	NA	0.0
FPC-9A	1212479.830	183576.850	5/28/1992	1795.21	Manual	2 Hours	Till	2" PVC	114.10	68.0	10	58.0	68.0	56.1	46.1	68.0	NA	0.0
FPC-9C	1212488.260	183577.230	5/27/1992	1802.51	Manual	2 Hours	Till	2" PVC	114.60	25.0	10	15.0	25.0	99.6	89.6	62.0	NA	37.0
GZ-112	1212647.479	186083.748	1/22/1987	3860.75	Manual	4 Hours	Till	2" PVC	92.00	38.0	5	33.0	38.0	59.0	54.0	38.0	NA	0.0
GZ-114	1212489.540	185382.297	1/13/1987	3164.57	Manual	4 Hours	Outwash	2" PVC	90.76	13.0	10	3.0	13.0	87.8	77.8	39.0	NA	26.0
GZ-115	1212483.775	185379.971	1/13/1987	3159.76	Manual	4 Hours	Till	2" PVC	88.87	38.0	25	13.0	38.0	75.9	50.9	39.0	NA	1.0
GZ-117	1212943.191	183054.176	2/3/1987	2023.99	Manual	4 Hours	Till	2" PVC	118.10	40.5	10	30.5	40.5	87.6	77.6	93.5	NA	53.0
GZ-120	1211570.848	179844.064	2/4/0987	2827.51	Manual	6 Hours	Outwash	2" PVC	87.16	20.0	10	10.0	20.0	77.2	67.2	43.0	NA	23.0
GZ-129	1209442.812	179241.468	2/20/1987	3695.36	Manual	4 Hours	Outwash	2" PVC	81.67	26.0	10	16.0	26.0	65.7	55.7	26.0	NA	0.0
MW-10	1211132.540	184167.680	4/15/1996	1569.37	Manual	2 Hours	Outwash	2" PVC	79.10	10.0	5	5.0	10.0	74.1	69.1	22.0*	NA	12.0
MW-1	1211262.260	183730.250	6/5/1985	1161.00	Manual	6 Hours	Marine	2" PVC	116.90	18.0	10	8.0	18.0	108.9	98.9	UNK	NA	UNK
MW-3S	1211924.455	183393.409	6/7/1985	1237.38	Manual	4 Hours	Till	1" PVC	TBD	34.0	5	29.0	34.0	TBD	TBD	39.0	NA	TBD
MW-3D	1211951.574	183434.086	6/7/1985	1284.25	Manual	4 Hours	Outwash	1" PVC	TBD	23.0	10	13.0	23.0	TBD	TBD	39.0	NA	TBD
MW-4	1211572.000	182884.000	6/14/1985	663.42	Instrumented	M-Hourly, T- Every 6 Hours	Till	2" PVC	129.12	38.0	10	28.0	38.0	101.1	91.1	38.0	NA	0.0
MW-9	1211047.000	183778.000	4/15/1996	1173.75	Manual	2 Hours	Outwash	2" PVC	81.70	10.0	5	5.0	10.0	76.7	71.7	21.0	NA	11.0
OP-2	1211936.000	184139.000	5/7/1993	1811.67	Manual	4 Hours	Outwash	1.25" PVC	100.00	12.0	5	7.0	12.0	93.0	88.0	27.0*	NA	15.0
OP-5	1212016.540	183457.150	6/11/1993	1349.02	Manual	4 Hours	Outwash	1.25" PVC	108.40	23.0	10	13.0	23.0	95.4	85.4	30.0*	NA	7.0
BEDROCK																		
AE-1B	1212062.335	182772.106	3/25/1999	1105.50	Manual	M- 2 Hours, T- Every 6 Hours	Shallow Bedrock	2" PVC	126.80	85.5	10	75.5	85.5	51.3	41.3	65.0	20.5	NA
AE-2B	1210849.472	183530.669	7/27/1999	931.57	Instrumented	M- 2 Hours, T- Every 6 Hours	Shallow Bedrock	2" PVC	79.50	50.0	10	40.0	50.0	39.5	29.5	22.0	28.0	NA
AE-3B	1211387.700	184304.170	3/23/1999	1748.16	Instrumented	M- 2 Hours, T- Every 6 Hours	Shallow Bedrock	2" PVC	86.20	40.0	12	28.0	40.0	58.2	46.2	17.0	23.0	NA
AE-4B	1209665.598	183789.704	9/16/2003	1760.32	Instrumented	M- 2 Hours, T- Every 6 Hours	Shallow Bedrock	2" PVC	76.71	44.0	10	34.0	44.0	42.7	32.7	15.0	29.0	NA
BP-4	1212023.740	183528.420	5/17/1993	1400.45	Instrumented	4 Hours	Deep Bedrock	6" Open	107.40	99.0	65.4	33.6	99.0	73.8	8.4	33.0	66.0	NA
FPC-11B	1211841.159	182252.081	6/19/1992	941.31	Instrumented	2 Hours	Shallow Bedrock	2" PVC	117.90	73.0	15	58.0	73.0	59.9	44.9	49.0	24.0	NA
FPC-2B	1210453.809	182014.953	4/3/1992	784.86	Instrumented	2 Hours	Shallow Bedrock	2" PVC	77.98	37.8	15	22.8	37.8	55.2	40.2	16.0	21.8	NA
FPC-3B	1210144.391	182152.754	4/27/1992	941.59	Instrumented	2 Hours	Shallow Bedrock	1.5" PVC	72.22	95.5	15	80.5	95.5	-8.3	-23.3	70.0	25.5	NA
FPC-4B	1209466.270	182866.570	6/3/1992	1525.26	Instrumented	M- 2 Hours, T- Every 6 Hours	Shallow Bedrock	2" PVC	75.83	33.5	15	18.5	33.5	57.3	42.3	14.0	19.5	NA
FPC-5B	1211039.760	184491.360	5/14/1992	1885.85	Instrumented	M- 2 Hours, T- Every 12 Hours	Shallow Bedrock	2" PVC	74.00	110.3	15	95.3	110.3	-21.3	-36.3	89.5	20.8	NA
FPC-6B	1210813.672	185078.807	3/24/1992	2476.87	Manual	4 Hours	Shallow Bedrock	2" PVC	76.11	28.5	15	13.5	28.5	62.6	47.6	6.0	22.5	NA
FPC-7B	1211921.040	185048.080	5/8/1992	2620.23	Instrumented	M-4 Hours, T- Every 12 Hours	Shallow Bedrock	2" PVC	85.30	45.0	15	30.0	45.0	55.3	40.3	23.0	22.0	NA
FPC-8B	1210494.038	183186.946	4/8/1992	749.91	Instrumented	M- 2 Hours, T- Every 6 Hours	Shallow Bedrock	2" PVC	73.60	55.7	15	40.7	55.7	32.9	17.9	33.0	22.7	NA
FPC-9B	1212479.400	183567.730	5/26/1992	1789.93	Instrumented	M- 2 Hours, T- Every 6 Hours	Shallow Bedrock	2" PVC	116.00	87.0	15	72.0	87.0	44.0	29.0	62.0	25.0	NA
GZ-105	1210081.131	182980.334	5/7/1987	963.47	Instrumented	M-2 Hours, T- Every 6 Hours	Shallow Bedrock	1.5" PVC	73.60	50.0	20	30.0	50.0	43.6	23.6	32.0	18.0	NA
GZ-108	1212934.566	184930.702	3/18/1987	3043.49	Instrumented	M-4 Hours, T- Every 6 Hours	Deep Bedrock	6" Open	119.80	155.0	140	15.0	155.0	104.8	-35.2	2.0	153.0	NA
GZ-109	1212936.338	183058.186	4/8/1987	2018.20	Instrumented	M-4 Hours, T- Every 6 Hours	Deep Bedrock	6" Open	119.36	252.0	149	103.0	252.0	16.4	-132.6	91.0	161.0	NA
GZ-110	1212658.160	186092.918	3/24/1987	3873.66	Instrumented	M-4 Hours, T- Every 12 Hours	Deep Bedrock	6" Open	91.26	188.0	131	57.0	188.0	34.3	-96.7	38.0	150.0	NA
GZ-116	1212510.429	185387.724	3/31/1987	3179.40	Instrumented	M-4 Hours, T- Every 12 Hours	Deep Bedrock	6" Open	89.50	163.0	141	22.0	163.0	67.5	-73.5	5.0	158.0	NA
GZ-119	1214266.933	185679.262	3/30/1987	4507.16	Manual	6 Hours	Deep Bedrock	6" Open	119.59	183.0	150	33.0	183.0	86.6	-63.4	31.0	152.0	NA
GZ-122	1211559.197	179846.499	4/22/1987	2822.67	Manual	6 Hours	Deep Bedrock	6" Open	87.06	190.0	138	52.0	190.0	35.1	-102.9	37.0	153.0	NA
GZ-125	1210383.426	180898.597	4/13/1987	1805.90	Instrumented	M-Hourly, T- Every 6 Hours	Deep Bedrock	6" Open	87.99	200.0	142	58.0	200.0	30.0	-112.0	47.0	153.0	NA
GZ-130	1209451.614	179232.720	3/17/1987	3699.71	Instrumented	M-4 Hours, T- Every 12 Hours	Deep Bedrock	6" Open	82.72	178.0	156	22.0	178.0	60.7	-95.3	22.0	156.0	NA
MW-11	1210942.281	183164.739	4/26/1996	558.56	Instrumented	M-Hourly, T- Every 6 Hours	Shallow Bedrock	2" PVC	92.70	52.0	20	32.0	52.0	60.7	40.7	19.0	33.0	NA
MW-2	1210950.883	182894.175	6/10/1985	287.93	Instrumented	M-Hourly, T- Every 6 Hours	Shallow Bedrock	1" PVC	94.54	20.0	10	10.0	20.0	84.5	74.5	4.0	16.0	NA
MW-5D	1211084.398	182959.140	6/22/1993	370.65	Instrumented	M-Hourly, T- Every 6 Hours	Deep Bedrock	2" PVC	99.72	163.5	20	143.5	163.5	-43.8	-63.8	12.0	151.5	NA
MW-5S	1211085.022	182946.718	8/9/1993	359.06	Instrumented	M-Hourly, T- Every 6 Hours	Shallow Bedrock	2" PVC	101.96	78.0	30	48.0	78.0	54.0	24.0	12.0	66.0	NA
MW-6	**1210969.256**	**182606.830**	**6/19/1985**	**Pumping Well**	**Instrumented**	**M-Hourly, T- Every 6 Hours**	**Deep Bedrock**	**6" Open**	**101.15**	**184.0**	**159**	**25.0**	**184.0**	**76.2**	**-82.9**	**6.0**	**178.0**	**NA**
MW-8	1211031.776	183703.934	4/25/1996	1098.88	Instrumented	M-2 Hours, T- Every 6 Hours	Shallow Bedrock	2" PVC	85.02	65.0	20	45.0	65.0	40.0	20.0	21.0	44.0	NA
MW-20D1	1211600.583	187113.008	8/28/2019	4550.19	Instrumented	M-4 Hours, T- Every 12 Hours	Deep Bedrock	1" PVC	75.51	75.0	10	65.0	75.0	10.5	0.5	10.0	65.0	NA
MW-20D2	1211600.583	187113.008	8/28/2019	4550.19	Instrumented	M-4 Hours, T- Every 12 Hours	Deep Bedrock	1.5"PVC	75.49	234.0	10	224.0	234.0	-148.5	-158.5	10.0	224.0	NA
MW-21D1	1210561.223	184799.194	8/28/2019	2230.01	Instrumented	M-2 Hours, T- Every 12 Hours	Shallow Bedrock	1" PVC	78.66	30.0	10	20.0	30.0	58.7	48.7	10.0	20.0	NA
MW-21D2	1210561.223	184799.194	8/28/2019	2230.01	Instrumented	M-2 Hours, T- Every 12 Hours	Deep Bedrock	1.5"PVC	78.71	307.0	10	297.0	307.0	-218.3	-228.3	10.0	297.0	NA
MW-22D1	1209547.564	183731.517	8/28/2019	1812.77	Instrumented	M-2 Hours, T- Every 12 Hours	Deep Bedrock	1" PVC	76.75	85.0	10	75.0	85.0	1.8	-8.3	15.0	75.0	NA
MW-22D2	1209547.564	183731.517	8/28/2019	1812.77	Instrumented	M-2 Hours, T- Every 12 Hours	Deep Bedrock	1.5"PVC	76.78	220.0	10	210.0	220.0	-133.2	-143.2	15.0	210.0	NA
MW-23	1211981.286	187030.754	7/1/2013	4538.21	Manual	4 Hours	Deep Bedrock	6" Open	80.69	282.0	234	48.0	282.0	32.7	-201.3	34.0	248.0	NA
MW-24	1212301.205	182943.883	Unknown	1373.93	Instrumented	M-2 Hours, T- Every 12 Hours	Deep Bedrock	6" Open	118.70	142.6	62	80.6	142.6	38.1	-23.9	UNK	UNK	NA

NOTES:
NH State Plane = New Hampshire State Plane North American Datum 1983 (feet)
All elevations in Feet Above Mean Sea Level
* - Estimated value based on adjacent bedrock groundwater monitoring wells.
This table does not include the installation of a new deep bedrock boring proximal to GZ-105 as outlined in the Deep Bedrock Investigation Work Plan Addendum.
MSC - Marine Silt Clay
TBD - To be determined. Locations will be surveyed relative to closest monitoring wells prior to onset of background water level monitoring efforts.
A new bedrock well will be installed in the area west of MW-6/east of GZ-105 prior to the pumping test. The well will be constructed 250-ft into bedrock.
M - Manual Frequency
T - Transducer Frequency

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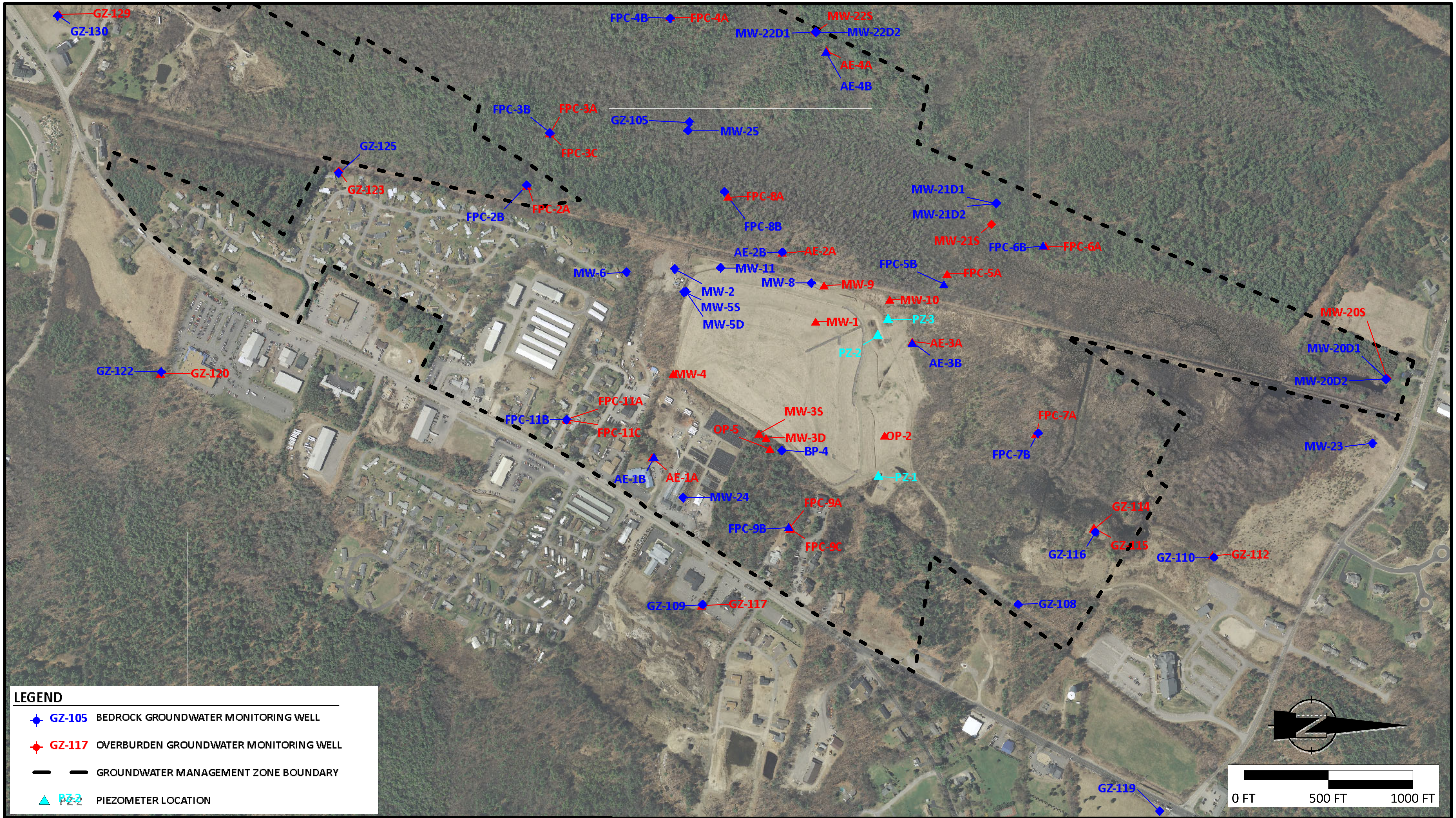
FIGURE 1

SITE PLAN AND MONITORING WELL NETWORK



PROJECT TITLE: COAKLEY LANDFILL SUPERFUND SITE
NORTH HAMPTON & GREENLAND, NEW HAMPSHIRE

SHEET TITLE: SITE PLAN AND MONITORING WELL NETWORK

DWG: FIGURE 1

JN: 10424.016

SCALE: AS SHOWN

BY: CFB

DATE: 2020-09-25

APPROVED BY: SLY

CHECKED BY: CFB

REV:

REV DATE:

ISSUE:

ISSUE DATE:

NOTE:

1. THIS SITE PLAN IS BASED ON EXISTING SAMPLING LOCATIONS AS PER THE COAKLEY LANDFILL SUPERFUND SITE REVISED SAMPLING AND ANALYSIS PLAN DATED JULY 18, 2018.
2. GMZ BOUNDARY IS BASED UPON "GMZ BOUNDARY PLAN" DATED MAY 9, 2008 INCLUDED IN THE 2008 GMP APPLICATION PREPARED BY HANCOCK ASSOCIATES AND 2013 GMZ EXPANSION AREA ESTABLISHED BY THE 2013 GMP DATED JANUARY 7, 2014.
3. GIS DATA COURTESY OF NEW HAMPSHIRE ONLINE GRANITE DATABASE.
4. MAP IS PROJECTED USING THE NEW HAMPSHIRE STATE PLANE PROJECTION, US FEET AND REFERENCES THE NORTH AMERICAN VERTICAL DATUM OF 1983.

CES INC
Engineers • Environmental Scientists • Surveyors

CES INC

ATTACHMENT A

MW-6 BORING LOG, WELL CONSTRUCTION INFORMATION, AND BOREHOLE GEOPHYSICAL RESULTS

MW-6

NHWS & PCC BEDROCK WELL LOG

SITE: Coakley Landfill, North Hampton

Boring No: MW6
Sheet: 1 of: 2
Date: 6/19/85

Drilling Company: Tasker Well Company — Boring Location: Granite Post Green
Foreman: Danny Tasker — Ground/Casing Elevation:
Geologist/Engineer: M. S. Robinette — Starting Date: 6/19/85 — Ending Date: 6/19/85

SAMPLER

Type chips
air rotary - mudded
hole top 27 feet

Groundwater Readings

Date	Depth to Water	Ref. Pt.	Time/Stabilization

SAMPLE

Depth	Advancement Time	No.	Depth	Fracture/Water Bearing?	LOG	Description	Construction
	11:44	1		Losing water		sandy overburden w/boulders	Locking Cap; steel casing
		2				weathered, fractured biotite gneiss - much iron staining	
	12:00						
	12:07	3					
20						feldspar, bio-gneiss	
	12:43	4					
	13:15						
		5					
40							
		6				biotite gneiss grading to pegmatite	open hole, bedrock
60							
	13:42			fracture - 2 1/2			
	13:46	7		gpm		blow test - 7 1/2 gpm; packer test - 10 1/2 gpm at 25 psi	
80	13:57	8					
		9		fracture/yes		peg. zone/musc.	
		10					
				fracture/yes		ironstained bio-gneiss	
		11					
100	14:22			fracture/yes		pegmatite zone - qtz/feld/musc.	
		12		fracture/yes			
120							

REMARKS: 0-25 ft. 8 3/4" hole
Bedrock interpreted to be the Rye Fm.

NHWS & PCC BEDROCK WELL LOG

SITE

Coakley Landfill

North Hampton

Boring No: MW6

Sheet: 2 of: 2

Date: 6/19/85

Drilling Company: Tasker Well Company

Boring Location: Granite Post Green

Foreman: Danny Tasker

Ground/Casing Elevation:

Geologist/Engineer: M. S. Robinette

Starting Date: 6/19/85

Ending Date: 6/19/85

SAMPLER

Type chips

air rotary

Groundwater Readings

Date	Depth to Water	Ref. Pt.	Time/Stabilization

SAMPLE

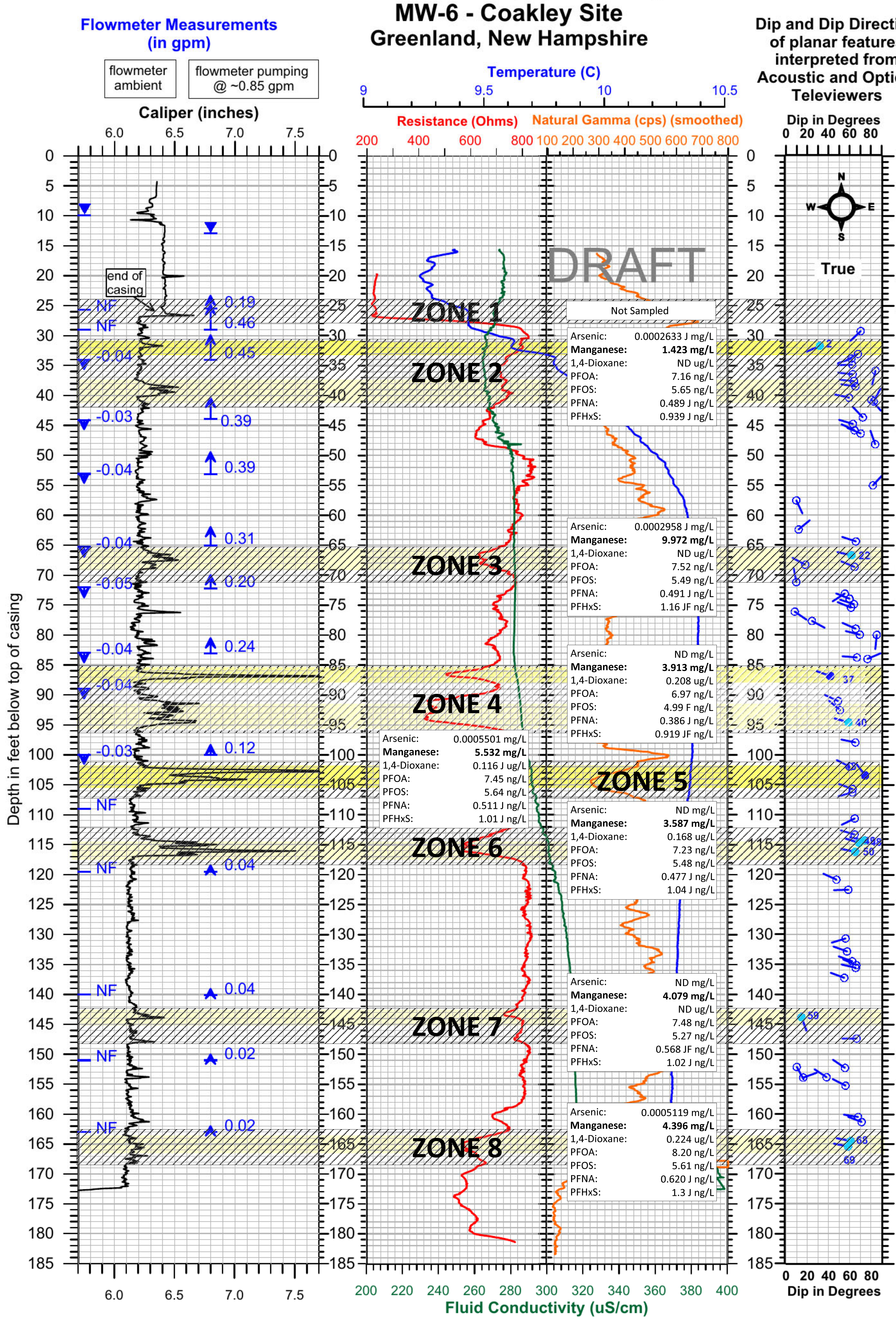
Depth	Advancement Time	No.	Depth	Fracture/Water Bearing?	LOG	Description	Construction
120	15:40					very fractured - pegmatite zone - qtz., garnet tr. biotite, chlorite much iron staining	
		13					
140		14					
				fracture			
		15		fracture			
				fracture			
		16		fracture			
160	16:25						
		17		fracture			
180		18				Bottom of hole	
200							
220							
240							

REMARKS: Well tested (blow test) at 8 1/2+ gpm.
Set 27'6" of 6" casing with drive shoe.
Open hole, locking cap.
Packer test at 74' - 10 1/2 gpm at 25 psi.

Northeast Geophysical Services

PLATE M-1
Borehole Geophysical Log
MW-6 - Coakley Site
Greenland, New Hampshire

Date logged: 5/22/20



= Likely transmissive zone

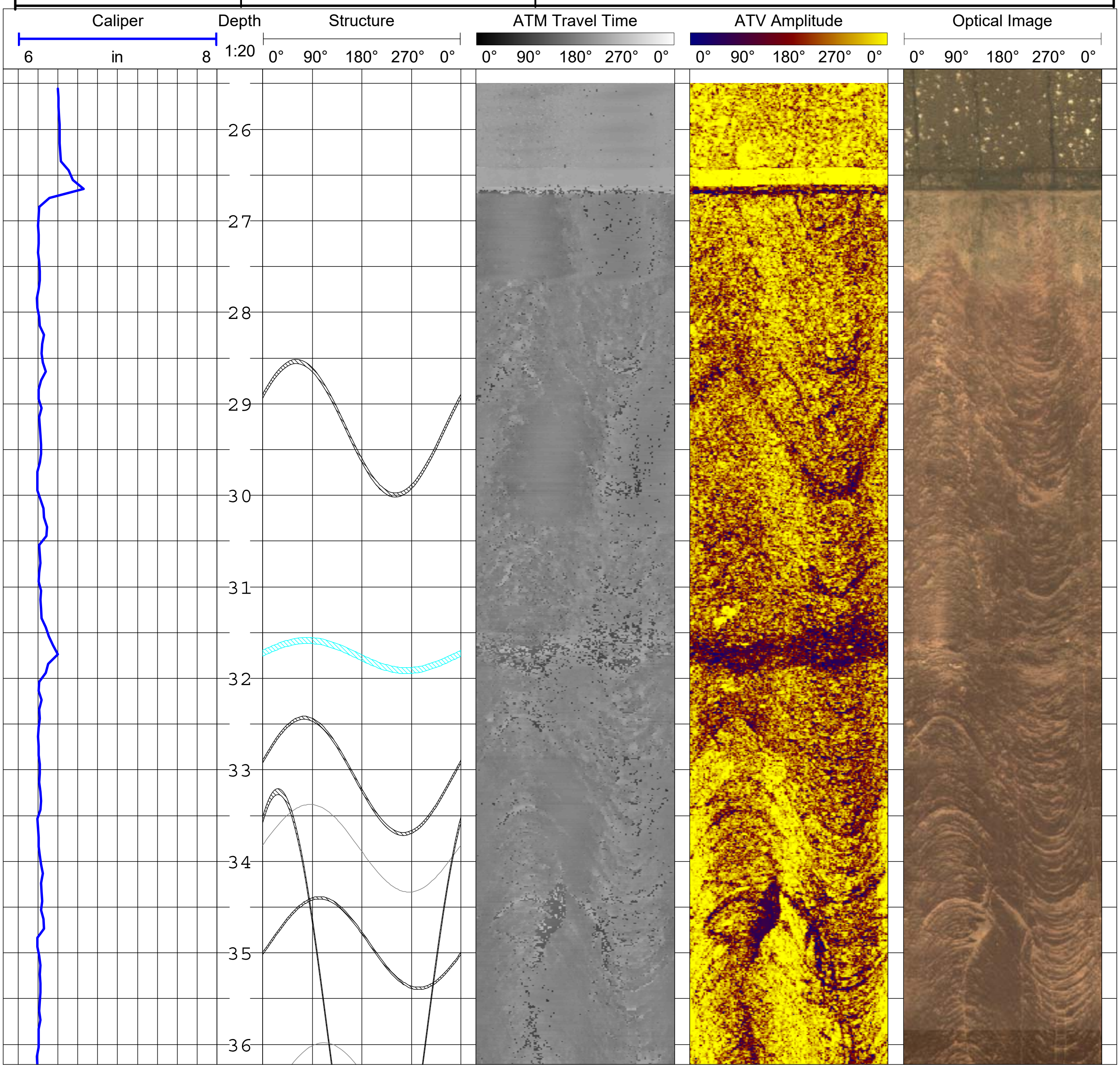
= Possible transmissive zone

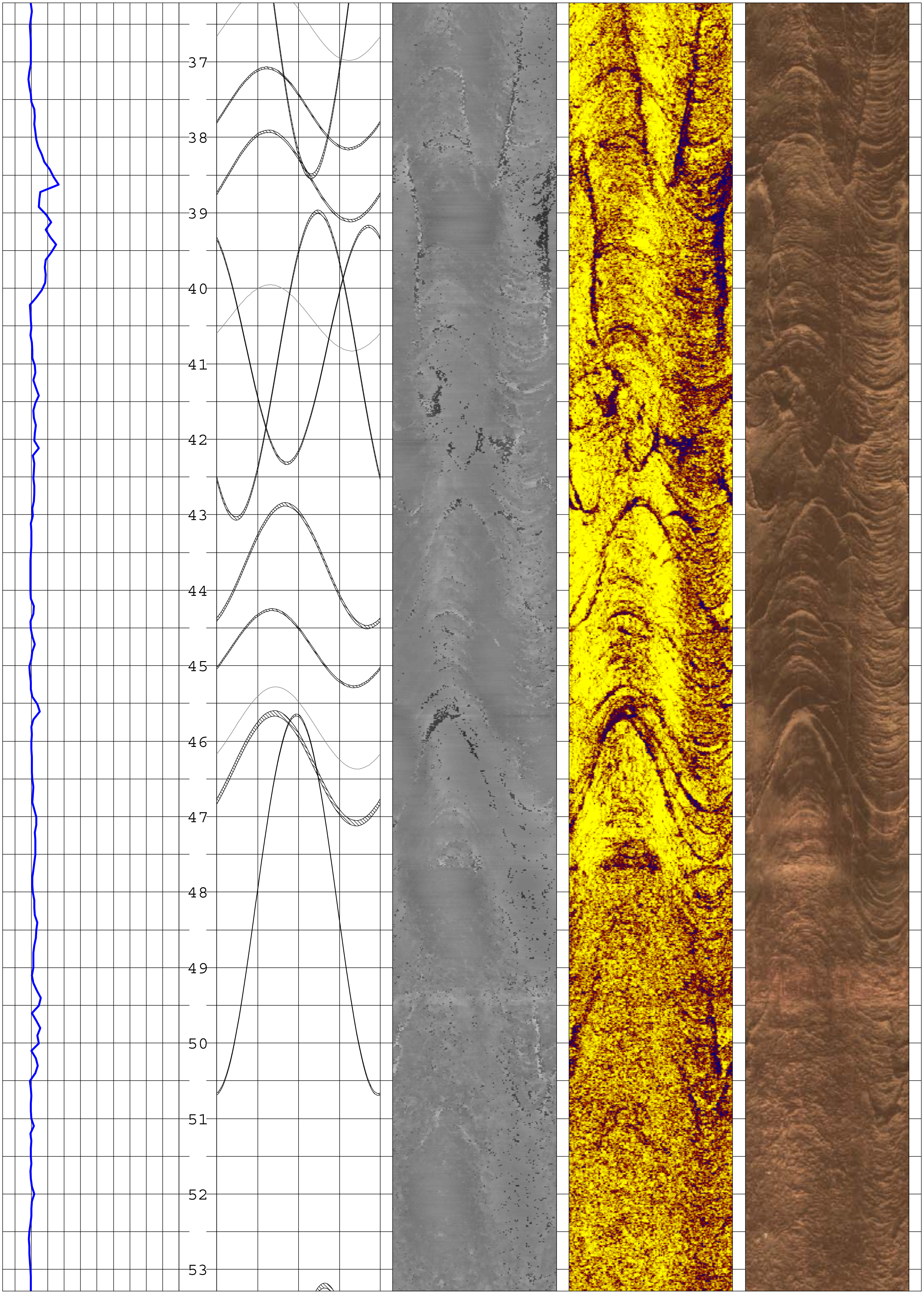
PLATE M-1
Borehole Geophysical Log
MW-6 - Coakley Site
Greenland, New Hampshire

Tadpole tail indicates dip direction.
The solid tadpoles with a feature number are the ones interpreted to be likely or possibly transmissive.

Northeast Geophysical Services
4 Union Street Bangor, Maine 04401
Tel. 207-942-2700
email: ngsinc@negeophysical.com

Log:	**Caliper & Televiewer Logs**		
Well:	**MW-6**		
Site:	Coakley Landfill		
Date:	5/22/20	**Location:**	North Hampton
Casing Depth:	26.7 ft.	**For:**	CES
Casing Type:	6 inch steel	**Logged by:**	R Rawcliffe
Boring Depth:	184.2 ft.	**Orientation:**	magnetic
Meas. From:	top of casing	**Structure Plots:**	black = planar features (faults, foliation, bedding, joints, etc) light blue = possibly transmissive fracture dark blue = likely transmissive fracture
Stickup:	2.0 ft.		
Water Level:	9.93 ft.		

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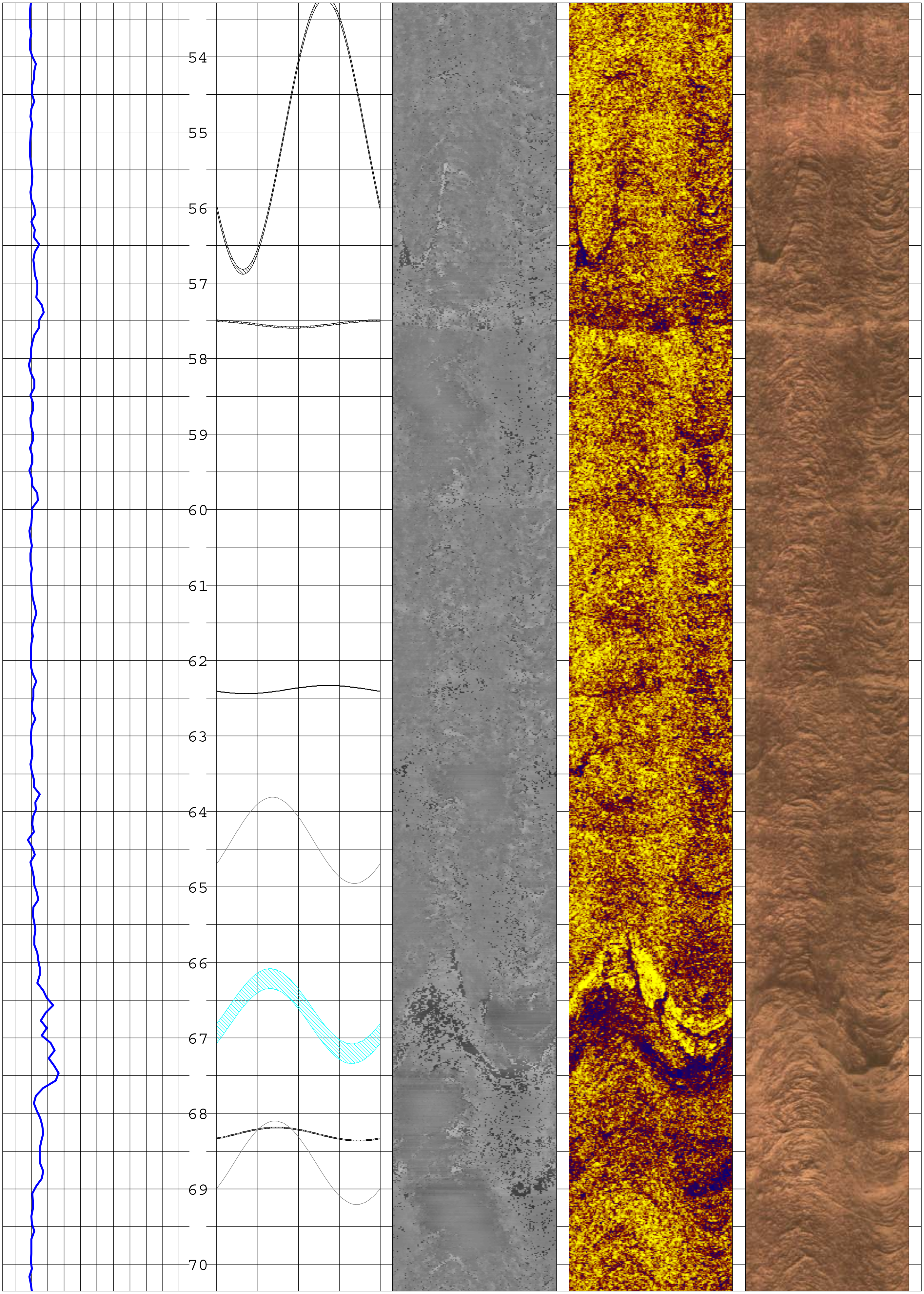
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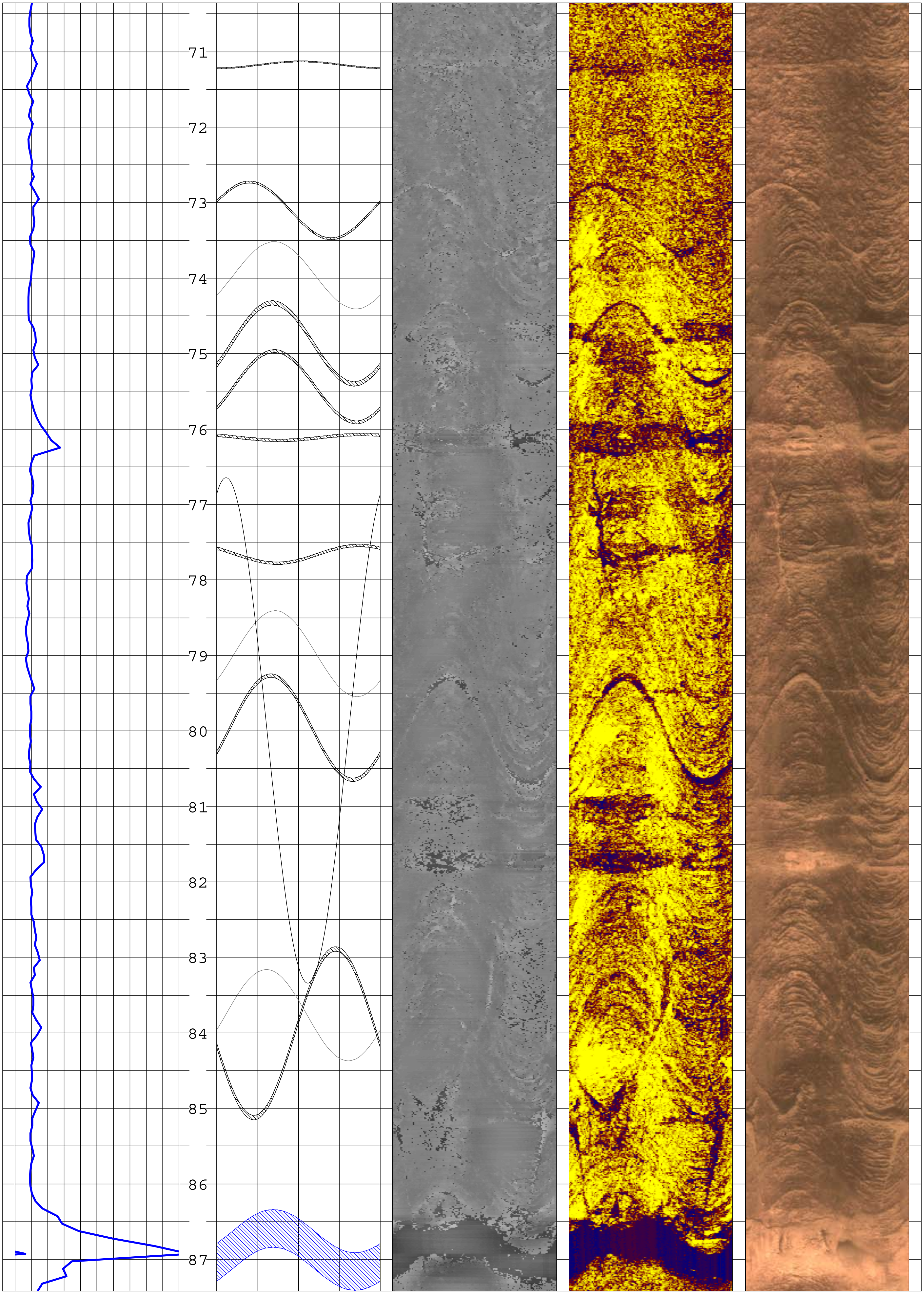
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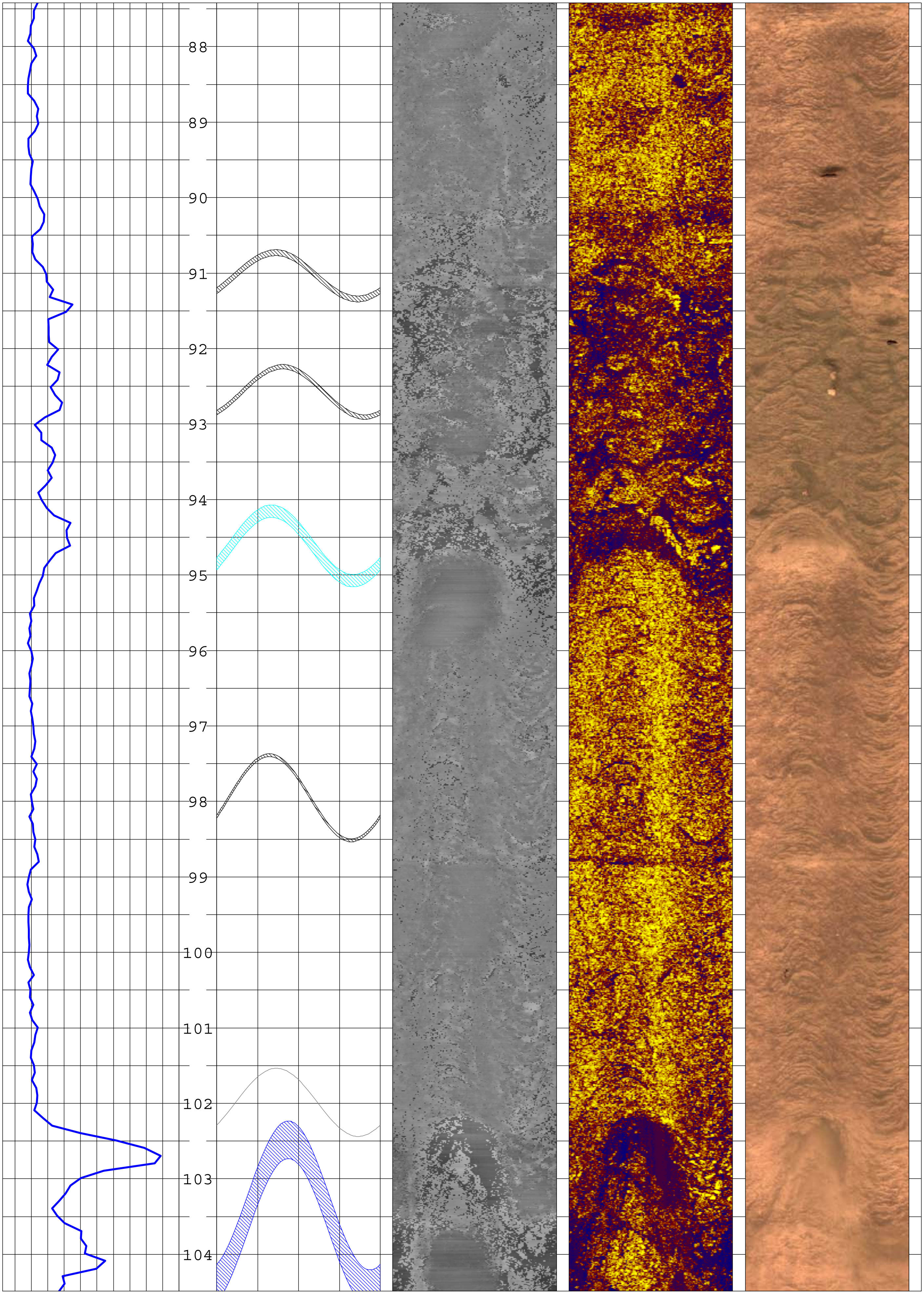
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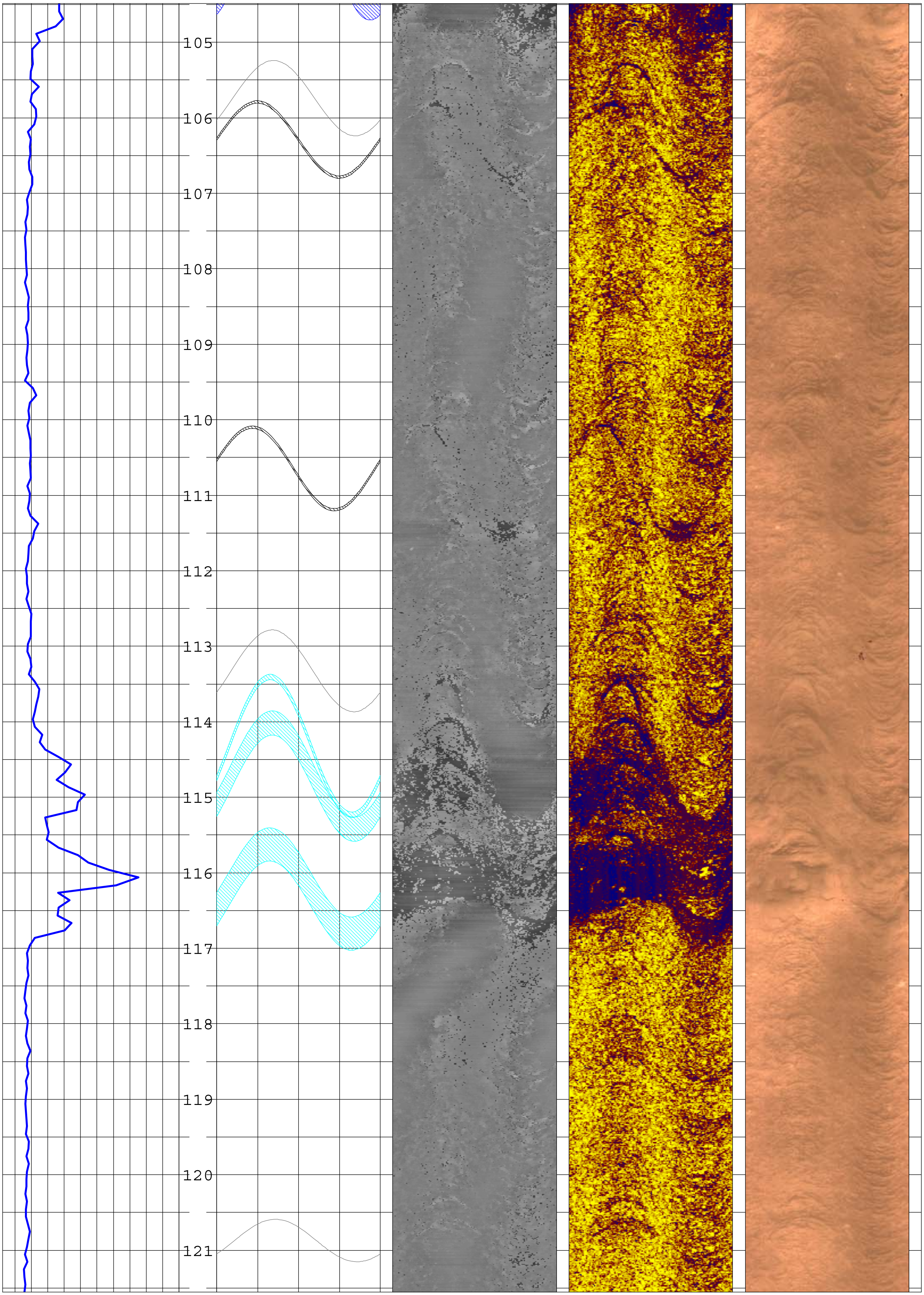
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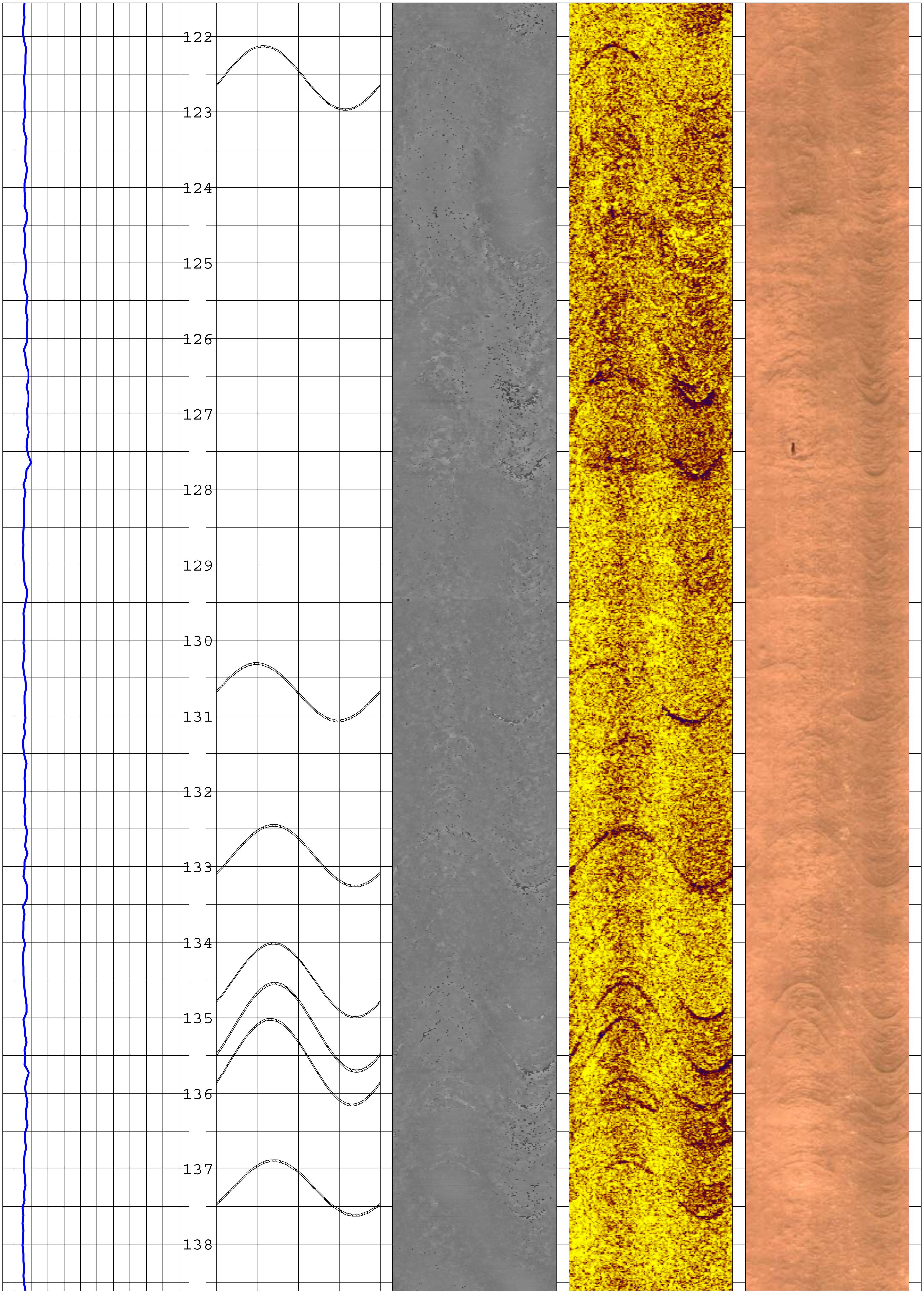
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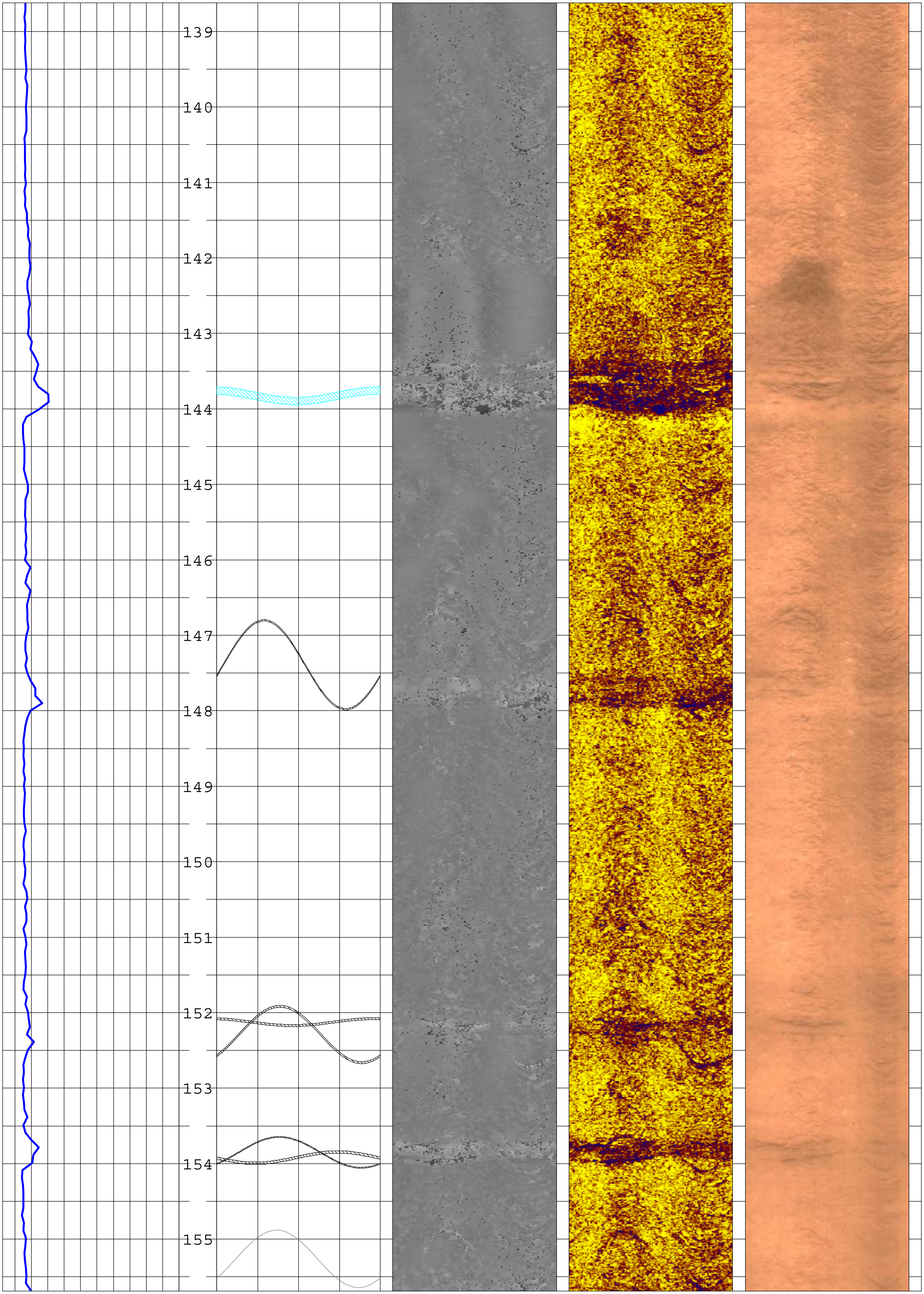
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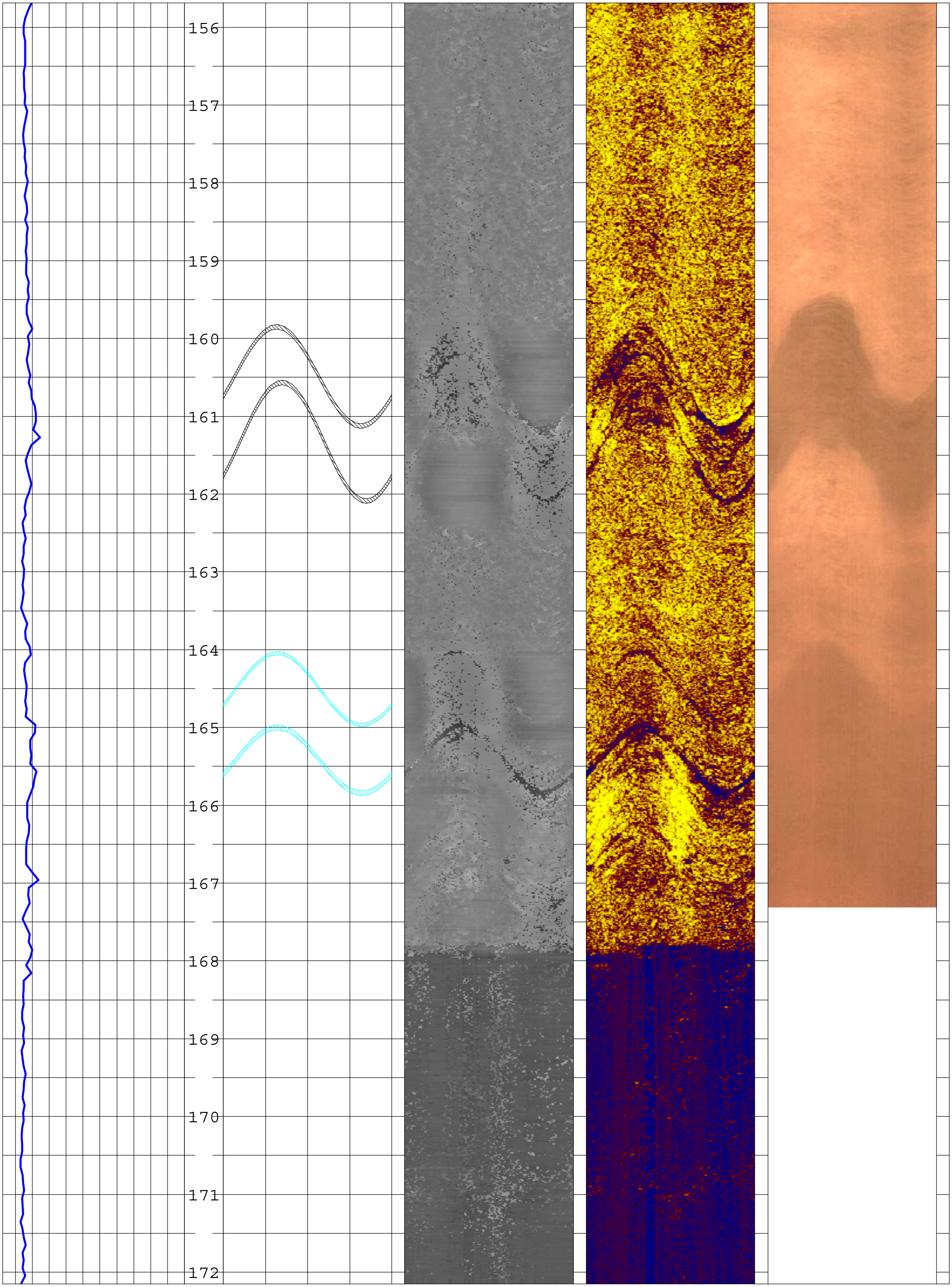
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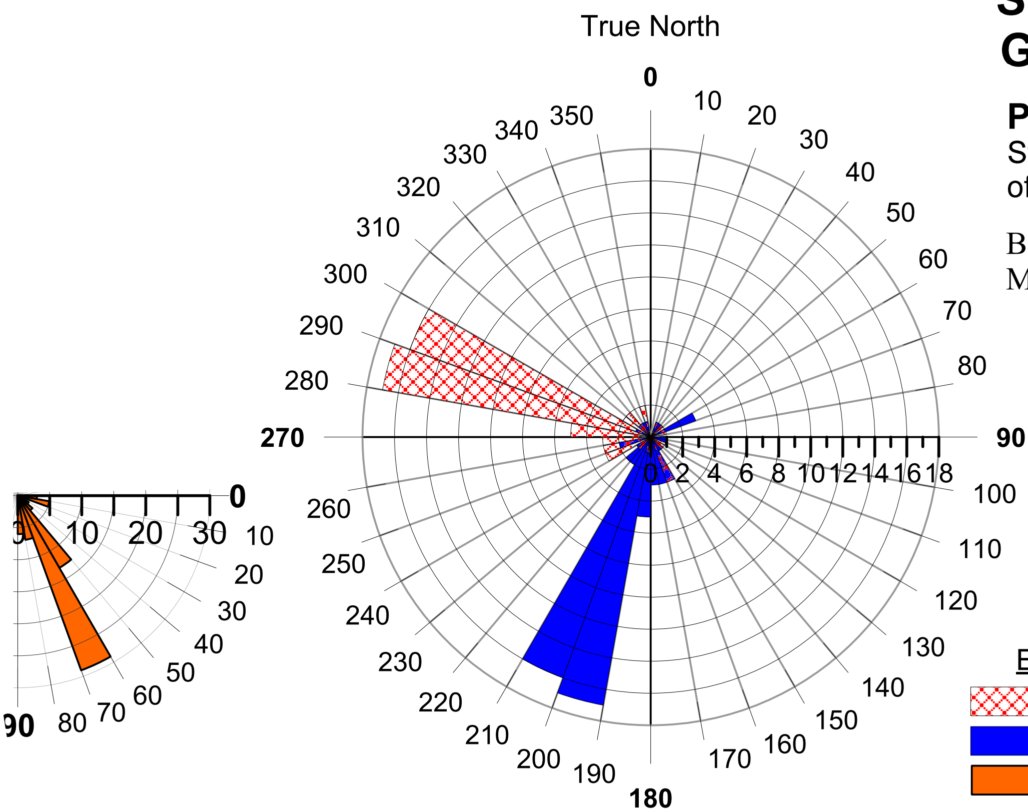
Northeast Geophysical Services

MW-6
Coakley Landfill Superfund Site
Greenland, NH

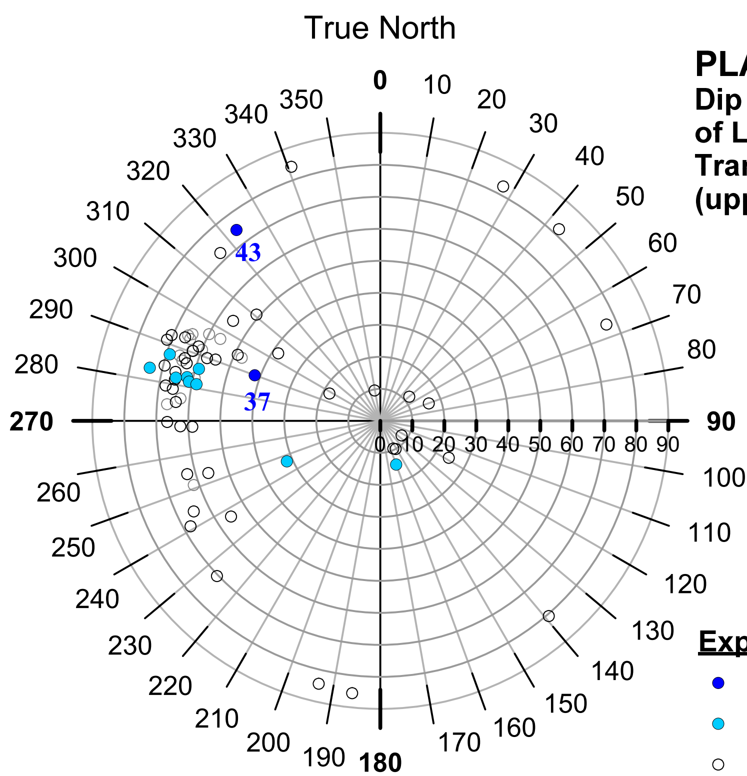
PLATE M-2
Strike and Dip Direction
of all features

Based on 69 measurements in
MW-6 borehole



Explanation
- Dip direction of feature
- Strike of feature
- Dip Amount (Tilt)

PLATE M-3
Dip Amount and Dip Azimuth of Likely and Possibly Transmissive Fractures (upper hemisphere plot)



Explanation -
- Likely transmissive
- Possibly transmissive
- Aperture > 1 mm
- Aperture < 1 mm

Declination: 14.9 degrees west

TABLE M-1 Planar features interpreted from acoustical and optical televiewers
Coakley Landfill Superfund Site - Greenland, NH **May, 2020**
Declination: 14.9 degrees west

Borehole	Feature # Number	Feature depth Feet	Dip Degrees	Dip Azimuth magnetic	Strike magnetic	Dip Azimuth True	Strike True	Aperture mm	Category Type
MW-6	1	29.3	70	241	151	226	136	5	101
MW-6	2	31.8	32	261	171	246	156	17	108
MW-6	3	33.1	68	256	166	241	151	4	101
MW-6	4	33.9	62	266	176	251	161	<1 mm	100
MW-6	5	34.9	62	283	193	268	178	4	101
MW-6	6	35.9	84	208	118	193	103	2	101
MW-6	7	36.5	63	291	201	276	186	<1 mm	100
MW-6	8	37.6	64	290	200	275	185	4	101
MW-6	9	38.5	66	294	204	279	189	5	101
MW-6	10	40.4	59	298	208	283	193	<1 mm	100
MW-6	11	40.8	81	154	64	139	49	2	101
MW-6	12	41.0	83	43	313	28	298	2	101
MW-6	13	43.7	72	331	241	316	226	4	101
MW-6	14	44.8	63	301	211	287	197	4	101
MW-6	15	45.8	65	310	220	295	205	<1 mm	100
MW-6	16	46.4	70	307	217	292	202	7	101
MW-6	17	48.2	84	356	266	341	251	1	101
MW-6	18	55.0	82	58	328	43	313	3	101
MW-6	19	57.5	10	170	80	155	65	6	101
MW-6	20	62.4	12	65	335	50	320	2	101
MW-6	21	64.4	66	303	213	288	198	<1 mm	100
MW-6	22	66.7	62	298	208	283	193	38	108
MW-6	23	68.3	18	313	223	298	208	5	101
MW-6	24	68.7	65	308	218	293	203	<1 mm	100
MW-6	25	71.2	10	4	274	349	259	5	101
MW-6	26	73.1	55	252	162	237	147	4	101
MW-6	27	74.0	60	307	217	292	202	<1 mm	100
MW-6	28	74.9	64	303	213	288	198	8	101
MW-6	29	75.4	61	307	217	292	202	6	101
MW-6	30	76.1	8	139	49	124	34	11	101
MW-6	31	77.7	24	133	43	118	28	9	101
MW-6	32	79.0	66	309	219	294	204	<1 mm	100
MW-6	33	80.0	70	299	209	284	194	5	101
MW-6	34	80.0	86	201	111	186	96	<1 mm	101
MW-6	35	83.8	67	289	199	274	184	<1 mm	100
MW-6	36	84.0	77	82	352	67	337	4	101
MW-6	37	86.9	42	305	215	290	200	113	107
MW-6	38	91.0	49	310	220	295	205	16	101
MW-6	39	92.6	51	325	235	311	221	11	101
MW-6	40	94.6	59	301	211	286	196	26	108
MW-6	41	98.0	65	296	206	281	191	5	101
MW-6	42	102.0	60	312	222	297	207	<1 mm	100
MW-6	43	103.5	75	338	248	323	233	41	107
MW-6	44	105.7	63	305	215	290	200	<1 mm	100
MW-6	45	106.3	63	269	179	255	165	5	101
MW-6	46	110.7	65	259	169	244	154	5	101
MW-6	47	113.3	65	302	212	287	197	<1 mm	100
MW-6	48	114.3	74	298	208	283	193	6	108
MW-6	49	114.7	69	302	212	288	198	36	108
MW-6	50	116.2	65	297	207	282	192	56	108
MW-6	51	120.9	48	309	219	294	204	<1 mm	100
MW-6	52	122.6	59	283	193	268	178	3	101
MW-6	53	130.7	56	268	178	253	163	5	101
MW-6	54	132.9	58	305	215	290	200	4	101
MW-6	55	134.5	62	305	215	290	200	3	101
MW-6	56	135.1	66	308	218	293	203	4	101
MW-6	57	135.6	66	298	208	283	193	3	101
MW-6	58	137.3	55	305	215	290	200	4	101
MW-6	59	143.8	15	175	85	160	70	29	108
MW-6	60	147.4	67	285	195	270	180	2	101

TABLE M-1 Planar features interpreted from acoustical and optical televiewers
Coakley Landfill Superfund Site - Greenland, NH **May, 2020**
Declination: 14.9 degrees west

Borehole	Feature # Number	Feature depth Feet	Dip Degrees	Dip Azimuth magnetic	Strike magnetic	Dip Azimuth True	Strike True	Aperture mm	Category Type
MW-6	61	152.1	10	166	76	151	61	9	101
MW-6	62	152.3	56	319	229	304	214	5	101
MW-6	63	153.9	38	318	228	303	213	4	101
MW-6	64	153.9	16	85	355	70	340	9	101
MW-6	65	155.3	56	312	222	297	207	<1 mm	100
MW-6	66	160.5	68	294	204	279	189	6	101
MW-6	67	161.3	71	306	216	291	201	5	101
MW-6	68	164.5	61	296	206	282	192	5	108
MW-6	69	165.4	59	296	206	281	191	9	108