NEW ENGLAND
CLEAN ENERGY
CONNECT

February 9, 2024

Ms. Dawn Hallowell
Licensing Director
Maine Department of Environmental Protection
17 State House Station
Augusta, ME 04333

Mr. Shawn Mahaney
U.S. Army Corps of Engineers
Maine Project Office
442 Civic Center Drive, Suite 350
Augusta, Maine 04330

RE: New England Clean Energy Connect; Minor Revision of Department Order #L-27625-26- A-N, L-27625-TB-B-N, L-27625-2C-C-N, L-27625-VP-D-N, L-27625-IW-E-N; USACE Permit NAE-2017-01342

Dear Ms. Hallowell and Mr. Mahaney:

NECEC Transmission LLC (NECEC LLC) is hereby submitting a minor revision application to the Site Location of Development Act (Site Law) permit and the Natural Resources Protection Act (NRPA) permit for the New England Clean Energy Connect (NECEC) Project approved on May 11, 2020. This application is for a minor revision to the Horizonal Directional Drill (HDD) crossing approval beneath the Upper Kennebec River, between West Forks Plantation and Moxie Gore, further described below. NECEC LLC is also providing this revision application to the United States Army Corps of Engineers (USACE) for its consideration under Department of the Army Permit NAE-2017-01342, pursuant to special condition 8.

NECEC LLC's application will decrease environmental impact, does not expand the Project, does not change the nature of the Project, and does not modify any Maine Department of Environmental Protection (MDEP) findings with respect to any licensing criteria.

With respect to the USACE permit, the proposed minor revision does not meet the thresholds for re-initiation of consultation under either Section 106 of the National Historic Preservation Act or Section 7 of the Endangered Species Act. No new historic properties have been discovered and no new effects to historic resources are anticipated. Similarly, both the defined Action Area and the assessment of effects to threatened and endangered species and critical habitat, previously considered and evaluated during informal Section 7 consultation, remain unchanged; there will be no different or additional effects.

The minor revisions included in this application are summarized below:

- HDD bore hole components;
- Use of the West Forks Plantation HDD exit point as both an entry and exit point and the Moxie Gore entry point as both an entry and exit point;
- HDD drilling from both sides of the river using an intersect method;
- Adjustment of the drill alignment's horizontal bend radius from 1,500 to 2,200 feet;
- Extension of HDD drill length on the West Forks Plantation side to accommodate an increase in HDD drill depth and horizontal bend radius, resulting in a 225-foot shift of the HDD entry and exit location to the west (farther from the river);
- Extension of HDD drill length on the Moxie Gore side to accommodate an increase in HDD drill depth, resulting in a 50-foot shift of the HDD entry and exit location to the east (farther from the river);
- Expansion of the temporary workspace on both sides of the river from 100 feet by 150 feet to 250 feet by 150 feet to facilitate HDD drilling from both sides; and
- Installation of temporary non-potable water supply wells within each of the HDD temporary work pads.

In addition to the Minor Revision Application Form, this application includes:

- Revised development description;
- Updated technical ability;
- Revised noise study;
- Updated basic standards submissions;
- Revised groundwater impacts;
- Revised water supply impacts;
- Revised wastewater disposal plan;
- Revised solid waste disposal plan;
- Revised estimation of air emissions
- Revised project plans; and
- Revised construction plan

The Site Law and NRPA applications sections affected by these changes are summarized below:

Site Law and NRPA Project Descriptions – Section 1 and Chapter 1
An overview of revisions associated with the refinement of the HDD crossing after the selection of The HDD Company for this work scope. These revisions will decrease construction time and reduce the risk of inadvertent release of drilling fluids.

Site Law Technical Ability – Section 4
A demonstration of updated technical ability based on selection of The HDD Company for this work scope.

Site Law Noise – Section 5
Noise modeling was updated based on the additional drilling rig on the West Forks Plantation side, the revised location of the drilling rig on the Moxie Gore side, and site-specific equipment and its associated noise levels, resulting in lower anticipated noise levels.

Site Law Basic Standards Submissions – Section 14
A summary of the Inadvertent Drilling Fluid Release Contingency Plan, developed per requirements in Central Maine Power Company's (CMP) and NECEC LLC's October 19, 2018 application amendment. This Plan is included under separate cover in NECEC LLC's Condition Compliance Application.

Site Law Groundwater – Section 15
An evaluation of potential groundwater impacts due to the proposed addition of temporary non-potable water supply wells at each of the HDD temporary work pads that will eliminate or significantly reduce the need for water tanker truck travel resulting in reduced environmental impact.

Site Law Water Supply – Section 16
An analysis of potential impacts to water supply due to the proposed addition of temporary non-potable water supply wells at each of the HDD temporary work pads. These wells will reduce or eliminate water tanker truck traffic, thereby minimizing the potential for erosion and sedimentation, fugitive dust, vehicle/wildlife collisions, tanker truck accidents and associated risk of petroleum releases, and road wear and tear.

Site Law Wastewater Disposal – Section 17
An overview of updates to the wastewater disposal plan due to drilling from both sides of the river which will reduce the risk of inadvertent release of drilling fluids.

Site Law Solid Waste – Section 18
An overview of updates to the solid waste plan due to drilling from both sides of the river.

Site Law Air Emissions – Section 21
A discussion of the project's air quality impacts. These impacts will be reduced from permitted levels through the use of onsite water supply wells as the sole or primary source of HDD water, and the resulting elimination or reduction of water tanker traffic. HDD drilling from both sides of the river may also reduce the duration of HDD construction, further reducing air emissions.

NRPA and Site Law Project Plans – Chapter 5 and Section 27
Set of engineered plans for the full HDD work scope.

NRPA Construction Plan – Chapter 7
Detailed HDD Execution Plan provided by The HDD Company, the contractor selected for this work scope.

If you have any questions regarding this submittal, please give me a call at (207) 242-1682 or email me at gerry.mirabile@cmpco.com.

Sincerely,



Gerry J. Mirabile
Director – NECEC Permitting and Compliance
AVANGRID Networks, Inc.

Enclosures
cc: DEP.LandApplication@maine.gov
NECECEA@hq.doe.gov
NECEC Service List
File: New England Clean Energy Connect

DEPARTMENT OF ENVIRONMENTAL PROTECTION
Bureau of Land and Water Quality

FOR DEP USE

#L- _____
ATS #_____
Fees Paid _____
Date Received _____

MINOR REVISION APPLICATION

For Site Location, Natural Resources Protection Act & Stormwater Projects

This form shall be used for minor revisions to a project that has received previous Site Law, NRPA or Stormwater Law approval from the Department, where the revision(s) significantly decreases or eliminates an environmental impact, does not significantly expand the project, does not change the nature of the project or does not modify any Department findings with respect to any licensing criteria. If significant project changes are proposed, then an amendment application will be required by the Department.

Please contact the DEP for current fee schedule information. The fee schedule is updated every November 1. The fee is payable to "Treasurer, State of Maine", and **MUST** accompany the application.

Please type or print in black ink only

1. Name of Applicant:	NECEC Transmission LLC	**5. Name of Agent:**	Burns & McDonnell/James Morin
2. Applicant's Mailing Address:	One City Center 5th Floor, Portland, Maine 04101	**6. Agent's Mailing Address:**	27 Pearl Street, Portland, Maine 04101
3. Applicant's Daytime Phone #:	(207) 242-1682	**7. Agent's Daytime Phone #:**	207-229-6752
4. Applicant e-mail address (REQUIRED):	gerry.mirabile@cmpco.com	**8. Agent e-mail address (REQUIRED):.**	jmorin@burnsmcd.com
LOCATION OF ACTIVITY			
9. Name of Project:	New England Clean Energy Connect (NECEC) – HDD Under the Upper Kennebec River		
10. Name of Town where project is located:	West Forks Plantation and Moxie Gore	**11. County:**	Somerset
REQUIRED INFORMATION:			
12. Existing DEP permit number:	See attached cover letter for Order #'s	**13. DEP Project Manager for previous application (if known):**	Dawn Hallowell
14. Description of Proposed Change: (Use additional sheet, if necessary)	Adjustments in horizontal directional drilling (HDD) path (see attached for details).		

Provide all documentation necessary to support the proposed change. This documentation should include, as appropriate, revised site plans, construction drawings, and technical data such as HHE-200 forms. (If you are unsure of what information to include, please contact the original DEP project manager, or the Division of Land Resource Regulation in the appropriate regional office for assistance.)

This completed application form, fee and all supporting documents summarized above shall be sent to the appropriate DEP Office in Augusta, Portland or Bangor.

Bureau of Land and Water Quality 17 State House Station Augusta, ME 04333 Tel: (207) 287-3901	Bureau of Land and Water Quality 312 Canco Road Portland, ME 04103 Tel: (207) 822-6300	Bureau of Land and Water Quality 106 Hogan Road Bangor, ME 04401 (207) 941-4570

CERTIFICATIONS / SIGNATURES on PAGE 2

IMPORTANT: IF THE SIGNATURE BELOW IS NOT THE APPLICANT'S SIGNATURE, ATTACH LETTER OF AGENT AUTHORIZATION SIGNED BY THE APPLICANT.

By signing below the applicant (or authorized agent), certifies that he or she has read and understood the following :

CERTIFICATIONS / SIGNATURES

"I certify under penalty of law that I have personally examined the information submitted in this document and all attachments thereto and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe the information is true, accurate, and complete. I am aware there are significant penalties for submitting false information, including the possibility of fine and imprisonment. I authorize the Department to enter the property that is the subject of this application, at reasonable hours, including buildings, structures or conveyances on the property, to determine the accuracy of any information provided herein.

Further, I hereby authorize the DEP to send me an electronically signed decision on the license I am applying for with this application by e-mailing the decision to the electronic address located on the front page of this application (see #4 and #8)"

Signed: Gerry Michile **Title:** Director - NECEC Permitting & Compliance **Date:** February 9, 2024

Notice of Intent to Comply with Maine Construction General Permit	**If over one acre of new disturbance will result as part of the proposed minor revision, please sign here acknowledging that with this minor revision form and signature below, I am filing notice of my intent to carry out work which meets the requirements of the Maine Construction General Permit. I have read and will comply with all of the MCGP standards.** **Signed_____ Date:_____**

NOTE: If a Notice of Intent is required, you must file a Notice of Termination (NOT form available from the Department) within 20 days of completing permanent stabilization of the project site.

NECEC Minor Revision – Site Location of Development

Table 1 - Summary of Site Law Application Changes		
Site Law Sections & Title	*Affects Site Law Approval? (Yes/No)*	*Information Provided Below*
Section 1 - Development Description	**Yes**	**See 1.0**
Section 2 - Title, Right or Interest	No	
Section 3 - Financial Capacity	No	
Section 4 - Technical Ability	**Yes**	**See 4.0, Exhibit 4-1**
Section 5 - Noise	**Yes**	**See 5.0**
Section 6 - Visual Quality and Scenic Character	No	
Section 7 - Wildlife and Fisheries	No	
Section 8 - Historic Sites	No	
Section 9 - Unusual Natural Areas	No	
Section 10 - Buffers	No	
Section 11 - Soils	No	
Section 12 - Stormwater Management	No	
Section 13 - Urban Impaired Streams	No	
Section 14 - Basic Standards Submissions	**Yes**	**See 14.0, Exhibit 14-1**
Section 15 - Groundwater	**Yes**	**See 15.0**
Section 16 - Water Supply	**Yes**	**See 16.0, Exhibit 16-1**
Section 17 - Wastewater Disposal	**Yes**	**See 17.0, Exhibit 17-1**
Section 18 - Solid Waste	**Yes**	**See 18.0, Exhibit 17-1**
Section 19 - Flooding	No	
Section 20 - Blasting	No	
Section21 - Air Emissions	**Yes**	**See 21.0**
Section 22 - Odors	No	
Section 23 - Water Vapor	No	
Section 24 - Sunlight	No	
Section 25 - LUPC Certification	No	
Section 26 - Notices	No	
Section 27 - Project Plans	**Yes**	**See 27.0, Exhibit 27-1**

1.0 DEVELOPMENT DESCRIPTION

NECEC Transmission LLC ("NECEC LLC")'s engineered design for the Horizonal Directional Drill ("HDD") crossing beneath the Upper Kennebec River, between West Forks Plantation ("West Forks") and Moxie Gore, has progressed from Issued for Permit ("IFP") design level to the Issued for Construction ("IFC") design level. No new environmental impacts will result from this refined design. To the contrary, the revisions proposed herein will result in decreased environmental impact. Further, NECEC LLC has selected a very well qualified and capable HDD contractor, The HDD Company, Inc. ("The HDD Company"), to install this underground crossing. This minor revision application encompasses refinements of the HDD crossing methods identified and developed after this contractor selection and design refinement.

This minor revision application addresses the HDD activity and installation on the western side of the Kennebec River in West Forks and the HDD activity and installation on the eastern side of the Kennebec River in Moxie Gore. As described more fully below, the modifications to the project design decrease environmental impact, do not significantly expand the New England Clean Energy Connect project ("Project"), do not change the nature of the Project, and do not modify any Department findings with respect to any licensing criteria.

Modifications to the project design include the following:

- HDD bore hole components;
- Use of the West Forks HDD exit point as both an entry and exit point and the Moxie Gore entry point as both an entry and exit point;
- HDD drilling from both sides of the river using an intersect method;
- Adjustment of the drill alignment's horizontal bend radius from 1,500 to 2,200 feet;
- Extension of HDD drill length on the West Forks side to accommodate an increase in HDD drill depth and horizontal bend radius, resulting in a 225-foot shift of the HDD entry and exit location to the west (farther from the river);
- Extension of HDD drill length on the Moxie Gore side to accommodate an increase in HDD drill depth, resulting in a 50-foot shift of the HDD entry and exit location to the east (farther from the river);
- Expansion of the temporary workspace on both sides of the river from 100 feet by 150 feet to 250 feet by 150 feet to facilitate HDD drilling from both sides; and

- Installation of temporary non-potable water supply wells within each of the temporary work pads.

1.1 HDD Bore Hole Components

The permitted (IFP) design included five HVDC electrical conductors to be installed within a 36-inch diameter steel conduit, through a 48-inch diameter HDD bore hole. The IFP design's 36-inch diameter steel conduit did not provide sufficient flexibility to mirror the curvature of the bore hole, resulting in selection of the alternate conduit. While the HDD bore diameter remains at 48 inches (+/- 5%), the proposed IFC design includes seven Fusible PVC ("FPVC") conduits of approximately 11-inch outside diameter ("OD") each, which are much more flexible and have smooth inner walls to facilitate pulling conductors and fiber optic lines during installation.

The use of each of the seven FPVC conduits are described below:

- Four will house HVDC cables;
- One will house an HVDC backup cable;
- One will house fiberoptic communication lines and grounding wire, as necessary; and
- One will be empty and available as a spare.

1.2 HDD Drill Entry, Exit, and Intersect Method (West Forks and Moxie Gore Operations)

The HDD will consist of directionally drilling a small diameter pilot hole along the designated path adjacent to and beneath the Kennebec River, then progressively enlarging the bore hole using larger drill bits. The addition of a second drilling rig on the Moxie Gore side of the Kennebec River will allow for the drilling of the bore hole to occur simultaneously from opposite directions, with the bore holes meeting at a point beneath the river. Once the initial intersect of the pilot holes is achieved, the West Forks drill stem will be withdrawn while the Moxie Gore stem will continue through, creating a single continuous drill-string through the bore hole.

The intersect drilling method not only decreases construction time, but also reduces the environmental risk of inadvertent drilling fluid release ("IDFR") by requiring lower downhole annular pressures to achieve circulation/mud returns to the drill rig.

1.3 HDD Drill Length and Depth (West Forks Operations)

The additional HDD drill length together with a 225-foot shift of the HDD entry/exit point to the west (farther from the river) allows for the increase in HDD drill depth and depth of cover, thereby reducing the environmental risk of a potential IDFR to the surface. The extended segment of HDD drill length

will be located in uplands, away from any protected natural resources. The increased length and depth is proposed as a response to additional subsurface studies, and will minimize the risk of a potential IDFR or hole collapse. The depth to rock discovered during the subsurface investigations also required the shift of the entry/exit point to allow for a superior approach angle, also reducing the risk of an IDFR. This extension also allows for an increase in the HDD bend radius to 2,200 feet, reducing wear and tear on drilling equipment and decreasing the risk of tool or drill stem failure during construction of the bore hole. While the 11-inch FPVC conduit can handle a bending radius tighter than 1,500 feet, the constraints of the steel tooling required for drilling operate better with a larger radius, minimizing stress on this tooling and decreasing the risk of tool or drill stem failure down-hole.

1.4 HDD Drill Length and Depth (Moxie Gore Operations)

The additional HDD drill length and a 50-foot shift of the HDD entry/exit point to the east (farther from the river) allows for the increase in HDD drill depth and depth of cover, thereby reducing the environmental risk of potential IDFR to the surface. The extended segment of HDD drill length will be located in uplands, away from any protected natural resources. The increased length and depth is proposed in response to additional subsurface studies, and will further reduce the risk of a potential IDFR or hole collapse. The depth to rock discovered during the subsurface investigations also required the shift of the entry/exit point to allow for a superior approach angle, thereby reducing the risk of an IDFR.

1.5 HDD Temporary Work Pad and Off-Right-of-Way Access Road (West Forks Operations)

The permitted (IFP) design included a 100-foot by 150-foot temporary work pad on the west side of the Kennebec River just east of the West Forks Termination Station. Following evaluation of this conceptual design, the drilling contractor determined the need for an increase in the size, type, and quantity of equipment necessary for safe installation activities. The MDEP approved FAR II-1-0061, shifted the temporary work pad to the northwest and increased the temporary work pad size from a 100-foot by 150-foot temporary receiving platform to 150-foot by 250-foot platform/work pad for both drilling and receiving activities. The attached drawings depict this approved change.

The access included in the IFP design was exclusively through the West Forks Termination Station and could not safely accommodate construction of the West Forks Termination Station with simultaneous

access to the relocated work pad for HDD drilling. The MDEP approved FAR II-1-0060 which provided additional alternate access into the West Forks HDD temporary work pad.

1.6 HDD Temporary Work Pad (Moxie Gore Operations)

The IFP design included a 125-foot by 150-foot temporary work pad on the east side of the Kennebec River just west of the Moxie Gore Termination Station. Following evaluation of this conceptual design, the drilling contractor determined the need for an increase in the size, type, and quantity of equipment necessary for safe installation activities. The MDEP approved FAR II-1-0062 increased the temporary work pad size from 125-feet by 150-feet to 150-feet by 250-feet for both drilling and receiving activities. The attached drawings depict this approved change.

1.7 Temporary Water Supply (West Forks and Moxie Gore Operations)

Temporary non-potable water supply wells will be installed within both HDD temporary work pads. These wells will be the sole or primary water supply necessary for HDD operations. If well yields are insufficient to supply the necessary water volume, supplemental water will be transported to the HDD site(s) by tanker trucks. These wells will be properly abandoned in place during site restoration, in a manner that protects the groundwater from contamination. Grounding rods may be installed in each water supply well prior to their abandonment, as additional grounding protection for the HDD termination stations.

The West Forks and Moxie Gore HDD installations are estimated to require a combined total of approximately 1,000,000 gallons of water. Solids and liquids from the drilled bore hole will be separated, and liquids will be reused as much as possible to minimize well water usage.

4.0 TECHNICAL ABILITY

NECEC LLC implemented a stringent contractor vetting and evaluation process resulting in the selection of The HDD Company, a well-qualified and highly capable HDD contractor.

The HDD Company's experience with HDD spans over 25 years, during which time the company has earned the reputation for completing difficult crossings, several of which expanded the limits of previous HDD construction. The HDD Company project team has over 100 years of combined experience in domestic and international HDD drilling. The HDD Company is part of a larger firm, The Crossing Group; combined these companies operate 17 large diameter directional drilling machines, (including a 1.2 million-pound Direct Pipe unit) working throughout the United States and Canada for national and international companies.

The HDD Company's technical expertise, combined with Central Maine Power Company's extensive experience and expertise in construction of transmission lines,[1] demonstrate that NECEC LLC has the technical ability to design, construct, operate, and maintain the proposed development, including the HDD crossing.

See Exhibit 4-1 for qualifications of The HDD Company's key personnel that will provide direct oversight of the Upper Kennebec River HDD crossing.

[1] CMP provides technical services to NECEC LLC, which includes the development, construction, operation and maintenance of the NECEC Project. *See* September 25, 2020 Application for Partial Transfer of MDEP Site Law and NRPA Permits and Water Quality Certification and related attachments at "Technical Ability."

5.0 NOISE

Burns & McDonnell developed a noise model to analyze noise impacts from HDD operations at the West Forks and Moxie Gore locations. Expected sound pressure levels from HDD activities were modeled using industry-accepted sound modeling software, Computer Aided Noise Abatement (CadnaA). The software is a scaled, three-dimensional program which considers each piece of equipment emitting sound on a site and predicts sound pressure levels over an area of interest and at points of interest.

The HDD contractor provided estimated mitigated sound levels for equipment to be used for this project, specifically the drilling rig, excavator, sump pumps, mud pumping unit, solids control unit, and associated equipment. Some of the HDD equipment sound levels are considerably lower than what was originally estimated in the October 2018 amendment application. Equipment noise levels will be mitigated through the use of sound blankets, low-noise equipment, and temporary sound barriers. The site-specific equipment included in the model is listed in Table 5-1. Unmitigated equipment sound levels are provided for information purposes only, however HDD operations will utilize the equipment specified as the "Estimated Mitigated" equipment. Additional equipment will be used during drilling operations such as pipe racks and operator trucks. However, sound emitted by these sources is minimal and variable.

Table 5-1 HDD Equipment on Temporary Work Pads

Equipment	Estimated Unmitigated Sound Level (dBA)	Estimated Mitigated Sound Level (dBA)
Drilling Rig	109 dBA outside drill cab	77 dBA outside drill cab
Excavator	81-85 dBA outside ops cab	57-60 dBA outside ops cab
Sump Pumps	89 dBA at 23 feet	62 dBA at 23 feet
Mud Pumping Unit	74 dBA [(a)]	52 dBA [(a)]
Solids Control Unit	90 dBA at 25 feet	63 dBA at 25 feet
Forklift	75 dBA (cab) to 106 dBA	53 dBA (cab) to 106 dBA
Gen Set	72-75 dBA at 23 feet	50-53 dBA at 23 feet
Compressor	76 dBA at 23 feet	53 dBA at 23 feet
Goliath Hammer	109 dBA at 12.5 feet	77 dBA at 12.5 feet
Backhoe	78-80 dBA at 50 feet	55-56 at 50 feet

(a) The Mud Pumping Unit sound levels were provided without a specified distance. Based on standard industry practice it is assumed the sound level measurement distance is 3 feet from equipment

Reflections and shielding were considered for sound waves encountering physical structures, that is, sound levels around the HDD locations can be influenced by the sound reflections from physical structures nearby. Some structures to be constructed onsite (e.g., structural steel, bus work) were considered acoustically transparent and were not included. Trees and other vegetation (i.e., shrubs) were not included in the model to avoid overestimating potential attenuation in the model. Terrain was included to account for surface effects such as ground absorption, and the large elevation difference between the drilling sites and the Kennebec River.

Predictive sound modeling was completed for the drilling operations using contractor provided mitigated equipment sound levels for the project-specific equipment. This mitigation is a combination of low-noise equipment and temporary construction noise barriers used to limit noise emissions from the HDD operations. The expected HDD sound levels with mitigation for the Moxie Gore and West Forks HDD drilling operations are depicted in Figure 5-1 and Figure 5-2. The figures depict in 5-dBA contours the sound anticipated to be generated from HDD construction equipment.

5.1 Noise (HDD Operations)

Table 5-2 shows the sound level impacts at the edges of the right-of-way (i.e., at the closest receiving property line) and on the Kennebec River. These sound levels are for the HDD equipment only and do not include any sound generated by other background sources such as local fauna and flowing river water.

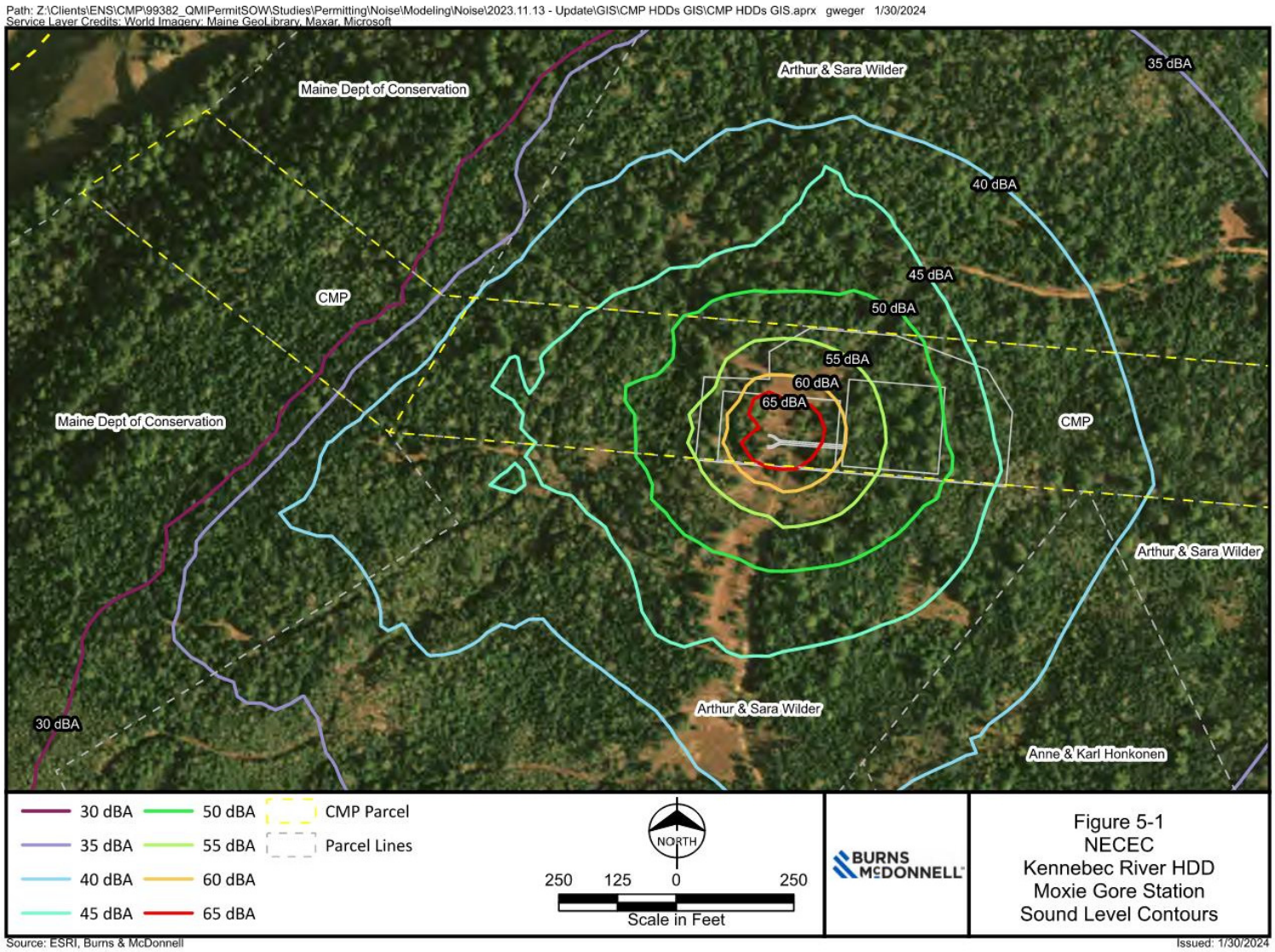
Table 5-2: Modeled HDD Construction Sound Levels

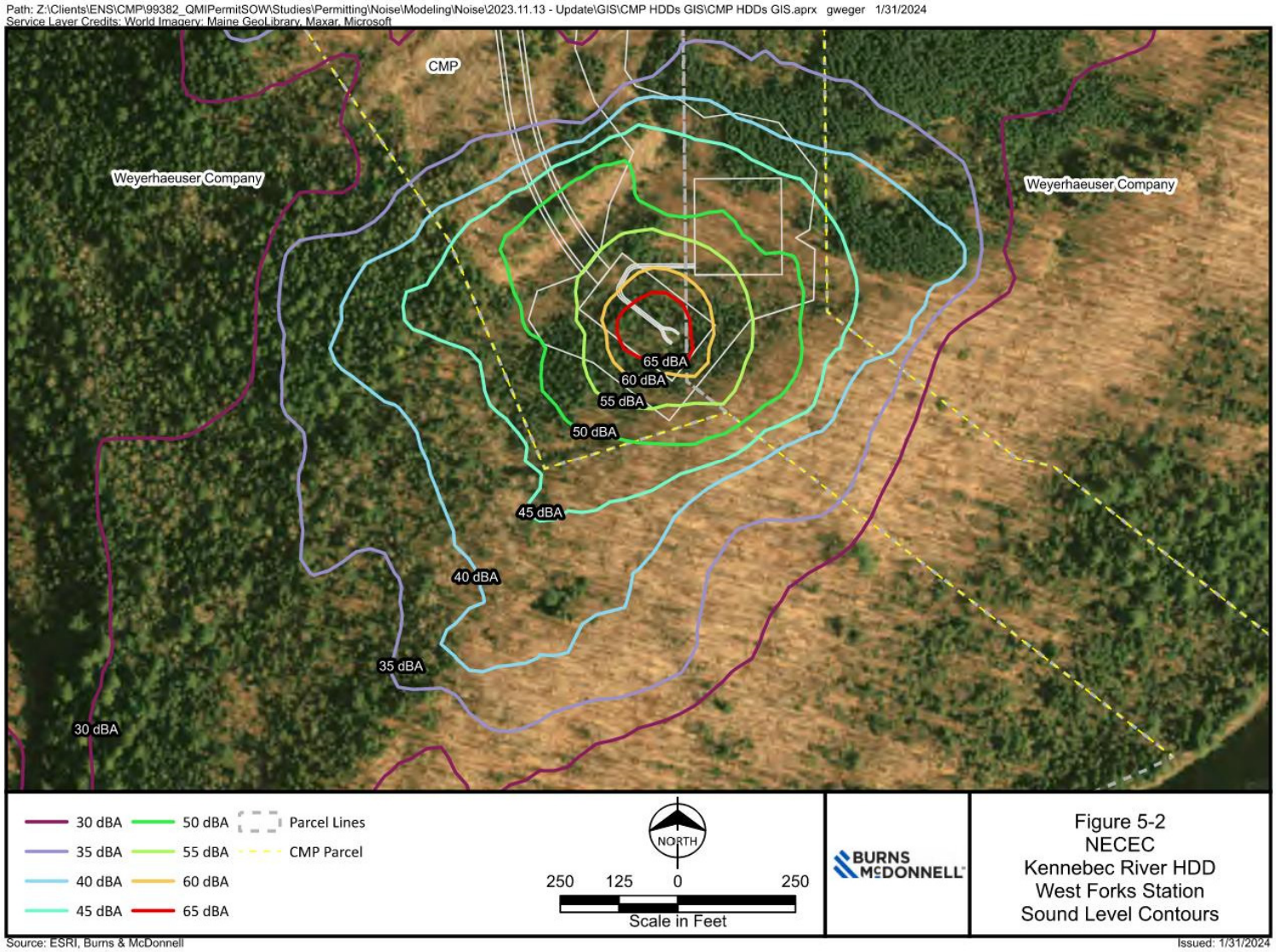
Modeled Receptor	Modeled Sound Level (dBA) – West Forks	Modeled Sound Level (dBA) – Moxie Gore
Max on Kennebec River	23	24
Max at closest Receiving Property Line	54	66

Maine DEP Ch 375 10(1)(a) limits nighttime (defined as 7:00 p.m. to 7:00 a.m.) construction operation sound levels to 75 dBA at any receiving property line of the development or contiguous property owned by the developer, and to 50 dBA at any protected location not predominantly zoned commercial, transportation, or industrial. The closest receiving property line is a property without a residence and is not considered a protected location, therefore the 50 dBA limit does not apply.

Sound generated by HDD operations are modeled to be below the Maine DEP sound level limits, including at the property boundary (the protected location) and along the Kennebec River. It is expected HDD operations may be audible on the Kennebec River to rafters to a small degree at the estimated ~24 dBA level. However, the impacts would be minor; for comparison, normal human speech is 60 dBA and a whisper is about 30 dBA. The natural background sounds of river flow may additionally reduce any HDD-related noise distractions.

Based on the mitigated sound level information provided by the HDD contractor and the results of the sound study modeling, it is expected that construction sound levels will meet the Maine DEP sound level requirements and are lower than currently permitted.


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Arthur & Sara Wilder
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65 dBA
CMP Parcel
Parcel Lines
NORTH
250 125 0 250
Scale in Feet
BURNS McDONNELL
Figure 5-1
NECEC
Kennebec River HDD
Moxie Gore Station
Sound Level Contours
Source: ESRI, Burns & McDonnell
Issued: 1/30/2024


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Scale in Feet
BURNS McDONNELL
Figure 5-2
NECEC
Kennebec River HDD
West Forks Station
Sound Level Contours
Source: ESRI, Burns & McDonnell
Issued: 1/31/2024

14.0 BASIC STANDARDS SUBMISSIONS

As explained in the October 2018 application amendment, during the HDD process there is a small possibility of drilling fluids reaching the ground surface (referred to as IDFR) by following a bedrock fracture. The October 2018 application amendment outlined the minimum requirements for a site-specific inadvertent fluid release plan to be prepared by the selected HDD contractor. The HDD Company has prepared an Inadvertent Drilling Fluid Release Contingency Plan, which addresses all requirements set forth in the October 2018 Site Location of Development Application Amendment for the Kennebec River Horizontal Directional Drill which is included as Exhibit 14-1. This Plan is included under separate cover in the NECEC's Condition Compliance Application (the HDD Condition Compliance Submission). The HDD Condition Compliance Submission also addresses Special Conditions 28 and 37 of the May 11, 2020 DEP Order regarding the location of the disposal area for the cuttings from the drilling operation.

15.0 GROUNDWATER

Temporary non-potable water supply wells will be installed within both HDD temporary work pads. These wells will be the sole or primary water supply necessary for HDD operations. If well yields are insufficient to supply the necessary water volume, supplemental water will be transported to the HDD site(s) by tanker trucks.

These wells will reduce environmental impacts by eliminating or significantly reducing the need for water tanker truck traffic to and from the drill sites, and associated vehicle emissions, and will also eliminate potential delays in water delivery to the sites. The reduction in vehicular traffic has several additional benefits including: lowering HDD access road wear and tear, thereby preserving the condition of the roads and minimizing the potential for erosion and sedimentation and fugitive dust; increasing worker and wildlife safety by reducing the potential for vehicle/wildlife collisions; and, reducing the potential for tanker truck accidents that could cause the release of petroleum products to the environment.

The proposed wells are not located over a sole source or significant sand and gravel aquifer. The nearest sand and gravel aquifer (Aquifer ID 2985) is located approximately 2,800 feet south of the HDD drill sites. It is anticipated that HDD drilling operations and fugitive dust control measures will require approximately 4,000 to 24,000 gallons of water per day, or approximately 1,000,000 gallons total. This is only an estimate, as actual water supply requirements will not be confirmed until drilling commences. Solids and liquids from bore holes will be separated, and liquids will be reused as much as possible to minimize the amount of water required.

Saltwater intrusion, temporary lowering of groundwater levels, and land subsidence are not expected to be a problem due to the proposed wells' distance from the ocean, surrounding geology, and location in a very sparsely populated location. Exhibit 16-1 evaluates surficial deposits, bedrock types, and existing water supply well yields in the vicinity of the proposed wells, and concludes that the surrounding geology and groundwater supply may be sufficient for the proposed temporary water supply wells to supply the water quantity required for HDD operations.

To prevent the potential introduction of pollutants to groundwater, following successful completion of the HDD installation the temporary water supply wells will be properly capped and abandoned as follows:

Water well abandonment procedures

The water supply wells will be abandoned in accordance with Maine Department of Health and Human Services ("Maine DHHS") 144A CMR 232 Chapter 7. This regulation requires that any such work be performed by a licensed Master Well Driller employed by a well drilling company licensed in the State of Maine. A 'Well Abandonment Record,' using the format established by the Maine Department of Environmental Protection, Bureau of Remediation and Waste Management, will be completed and signed by the licensed Well Driller. An inspector will observe the water well abandonment procedure on behalf of the Project, and will verify and document the following:

a. the depth and diameter of the well;
b. the type and volume of sealing material used; and
c. that the abandonment procedures, including volume of material used, incidences of bridging, corrective actions taken, and end results, comply with all relevant DHHS and DEP requirements.

Well abandonment will begin by opening the well casing and removing submersible pumps, liner pipes, and any other equipment other than the casing. The well depth will be obtained from the information recorded during well drilling, on the casing or pressure tank, or by direct measurement. The volume of required grout or bentonite fill material will be calculated based on the measured or recorded dimensions of the well hole and used to fill the well. The actual volume of fill material will be recorded in the Well Abandonment Record. The immediate area surrounding the well will be excavated so the casing can be cut off at the elevation to which the casing is backfilled, approximately 18 to 24 inches below finished grade. Clean fill will be used to bury the casing and the disturbed area will be seeded. As previously noted in Section 1.7, prior to proper abandonment these wells may also be utilized to improve grounding of the HDD termination stations.

The completed Well Abandonment Record and the report of the inspector will be furnished to the DEP Project Manager, if requested.

16.0 WATER SUPPLY

Temporary non-potable water supply wells will be installed within both HDD temporary work pads. These wells will be the sole or primary water supply necessary for HDD operations. These wells will reduce environmental impacts by eliminating or significantly reducing the need for water tanker truck traffic to and from the drill sites, and associated vehicle emissions; reducing HDD access road wear and tear, preserving the condition of these roads and minimizing the potential for erosion and sedimentation and fugitive dust; increasing worker and wildlife safety by reducing the potential for vehicle/wildlife collisions; and, reducing the potential for tanker truck accidents that could cause the release of petroleum products to the environment.

If well yields are insufficient to supply the necessary water volume, supplemental water will be transported to the HDD site(s) by tanker trucks. Water required for HDD construction purposes is anticipated to be 4,000 to 24,000 gallons per day, or approximately 1,000,000 gallons total for the duration of the HDD drilling operation, some of which may be utilized for dust control. This is only an estimate, as actual water supply requirements will not be confirmed until drilling commences. Solids and liquids from bore holes will be separated, and liquids will be reused as much as possible to minimize the amount of water required.

17.0 WASTEWATER DISPOSAL

As referenced in Section 14.0 above, the HDD process uses a drilling fluid primarily comprised of water with the addition of naturally occurring clay called sodium montmorillonite (bentonite). Drilling fluid is used throughout the HDD operations to lubricate and cool tooling, support the borehole against collapse and fluid loss, and carry cuttings from the bore hole. Bentonite is a non-toxic, non-reactive, inert material that allows the HDD contractor to monitor and adjust the viscosity of the drilling fluid to achieve the desired carrying and lubricating properties. There is a small risk of drilling fluids reaching the ground surface by following a bedrock fracture, referred to as IDFR. The HDD contractor will only use drilling fluid whose composition complies with all federal, state, and local environmental regulations. The project modifications proposed, such as the increase in drill depth, will further minimize the potential of an IDFR. The HDD Company has also prepared a comprehensive Inadvertent Drilling Fluid Release Contingency Plan which includes stringent and standard best practices operating and monitoring protocols that will minimize the potential for adverse water quality impacts from HDD operations.

Throughout the drilling operations, cuttings will be separated from the returned drilling fluids using onsite solids control units. Approximately 110,000 to 130,000 gallons of drilling fluid will be generated. The HDD Company intends to store returned drilling fluid in 21,000-gallon Frac tanks onsite. To further minimize the potential for adverse water quality impacts from the HDD process, the HDD Company intends to separate the cuttings and solidify the drilling fluid on site through the Solids Control Unit. Most of the drilling fluid will be solidified onsite and transported for disposal to the Hyland Landfill in Angelica, New York, which is owned and operated by Casella Waste Systems, Inc. Any drilling fluid not solidified onsite will be transported offsite in 5,000-gallon tanker trucks to Casella's Hyland Landfill in Angelica, New York. Casella has stated that this is an appropriately state-licensed facility, has adequate capacity to receive the quantity of solidified waste material and waste liquid generated by the HDD operation, and is willing to receive these wastes. Please see the attached letter from Casella included in Exhibit 17-1. The Project will ensure that the disposal of all liquid drilling wastes complies with all permits and applicable federal, state, and local regulations. No HDD wastes will be disposed of on-site.

18.0 SOLID WASTE

HDD installation will consist of drilling a bore hole on each side of the river using a bentonite-based drilling fluid. Drilling fluid will be mixed using bentonite and water at both sites. A system will be established to retain, process, and recirculate drilling fluids throughout HDD activities. Cuttings from the borings will be removed from the drilling fluid through the Solids Control Unit. The total estimated solid spoil generated by HDD operations is expected to be approximately 1,900 to 3,000 cubic yards of spoils. The spoils will be temporarily stored in roll off dumpsters at each of the sites, and periodically transported from the sites in dump trucks as drilling progresses.

The State of Maine does not regulate uncontaminated soil, rock, or water. However, the addition of bentonite results in the drill mud being classified as a solid waste material. Drilling fluid additives may be used as necessary. SDS sheets for bentonite and any potential additives are included in the Execution Plan (Exhibit 7-1) and also as Attachment B of the IDFR which is included in the HDD Condition Compliance Submission. The specific brand of additive used may be different than those included in the SDS sheets.

The HDD Company intends to transport solid waste from cuttings to the Waste Management Disposal Services of Maine (WM of Maine), Crossroads Landfill located in Norridgewock, Maine. WM of Maine has stated that this is an appropriately state-licensed facility, has adequate capacity to receive the quantity of solid waste generated by the HDD operation, and that they are willing to receive the waste generated. The HDD Company will comply with the landfill operator and all local and state analytical requirements. Please see the attached letter from WM of Maine included in Exhibit 17-1. This letter will also be included in the NECEC's Condition Compliance Application (the HDD Condition Compliance Submission) to address Special Condition 28 and 37 of the May 11, 2020, DEP Order regarding the location of the disposal area for the cuttings from the drilling operation.

21.0 AIR EMISSIONS

The clearing, construction, maintenance, and operation of the NECEC Project, including those activities associated with the minor HDD modifications described herein, will not result in or create significant air emissions. Minimal additional intermittent air emissions will result from the operation of HDD equipment during HDD operations. However, these emissions will be reduced from permitted levels through the use of onsite water supply wells as the sole or primary source of HDD water, and the resulting elimination or reduction of water tanker traffic. HDD drilling from both sides of the river may also reduce the duration of HDD construction, further reducing air emissions.

27.0 PROJECT PLANS

The NECEC Kennebec River Underground Cable & HDD Plans are provided as Exhibit 27-1.

Exhibit 4-1: HDD Company Key Personnel Document

Appendix J - Key Personnel

Contents

Operations Manager – Steve South
General Superintendent – Chris Crough
Rig Managers – • Casey Wainman
• Barry Briggs
• Chris O'Dwyer
Technical Services – Steve Sooley

STEVEN SOUTH

Operations Manager

Steven South has over 22 years of experience in Horizontal Directional Drilling. He joined The Crossing Company in 1999 as a Driller and was promoted to Rig Manager in 2002. As a Rig Manager, Steve managed the execution of several high profile projects including Jackknife Creek for Anadarko Canada, which involved the first ever use of "Blow-Out Preventors" in HDD to control risks associated with shallow natural gas. The project also involved several other "firsts" and significant achievements including deep set and telescopic casing string to 300m depth, and deep pressure cementing. Steve's HDD construction expertise and leadership skills resulted in Steve being promoted to Field Superintendent in early 2007.

Some of the projects that attest to Steve's technical ability and effective leadership are the Albian Sands Expansion Project in Fort McMurray, Alberta and the Phoenix Expansion Project in Arizona, U.S. The Albian Sands Project involved the application of 4 drilling rigs operating 24 hours per day, 7 days per week to complete 14 HDD crossings. In Arizona, Steve worked with Transwestern Pipelines Company and Rockford Pipeline to complete a high risk crossing of the Gila River. Following completion of the project, the customer commented:

"Rockford is very pleased with the performance of your company at the Gila River HDD. Your rig supervisors, Dave Rominick and Steve South, demonstrated their thorough knowledge of the art of horizontal drilling and a knack for innovative solutions to difficult challenges. They also maintained a positive and helpful attitude toward Rockford, the client, and the numerous agencies and third parties that were involved.

This HDD was turned down by numerous other directional drilling companies. The combination of the overlaying sand and gravel layers and the solid bedrock beneath presented many problems to be overcome. Installing sleeves, a difficult task in itself, on both the entrance and exit sides, proved to be instrumental in achieving success. Again, we thank you for your efforts, and appreciate the talent and work ethic of both Dave and Steve."

Most recently, Steve has been supporting The HDD Company throughout the U.S. and was mentioned in the following review from an employee on the project:

I had the pleasure of working on Rig 10 the past few months. It was my first time being on a drill rig and went into it eyes wide open. Your management team of Dave Tetz and Steve South were second to none. The way they ran the entire operation was phenomenal. Steve kept the rig and fellow employees well informed and up to task. I've been part of many heavy highway projects and the way this job was ran, even when something went wrong was very professional.

Steven South

1807-8th Street | Nisku, AB T9E 7S8
Tel: 780.955.5051 Fax: 780.955.5056

Professional Experience

Field Superintendent – The Crossing Company **2007 to Present**

As field Superintendent, Steve is responsible for the coordination of the field activities in a multi-rig operation and for the economic provision and efficient deployment of resources. Steve's principal accountabilities include:

- Demonstrate and promote safety leadership. Attend rig safety meetings and coach Rig Managers in conducting such meetings.
- Plan and manage the efficient and timely provision of support services and supplies to rig operations and to plan and provide logistical support.
- Work with the client's field management to co-ordinate and optimize field activities in a manner which achieves cohesion of the inputs to field operations and creates a spirit of teamwork. Liaise with client's other contractors who are involved in field operations to achieve cohesion in concurrent/simultaneous operations and cross-company teamwork & effectiveness.
- Apply his experience directly in the event of non-routine activities on the rigs and to co-ordinate activities in the event of an incipient or actual emergency or incident.
- Take personal responsibility for and demonstrate leadership in HSE.
- Conduct regular inspections of rigs and follow-up on all remedial actions.
- Establish a culture of continuous improvement in field operations and demonstrate results in this regard. Work with the client's field management and other service providers in the field to develop improved practices which will positively impact on field operations.
- Coach all subordinates in performing their duties and manage their professional development.

Rig Manager – The Crossing Company **2002 to 2008**

- Provide leadership in Safety Excellence, ensuring compliance with client safety program, corporate safety program and OH&S legislation. Contribute affirmatively to The Crossing Company's corporate culture of safety, quality and operational excellence.
- Provide mentorship and direction to the Driller in relation to crew training, task assignment and supervision.
- Oversee maintenance of drilling rig and associated equipment to ensure maximum operating readiness and sustainability, minimizing opportunities for equipment downtime. Ensure equipment is maintained to a state of repair consistent with The Crossing Company's high standards.
- Organize and supervise all mobilization and demobilization operations of the drilling rig and associated equipment. Supervise all rigging and towing operations involved in mobilization and demobilization operations, ensuring safe transportation through rough and steep terrain.

- Direct, monitor and control all drilling operations to ensure compliance with the Construction Plan, and technical and environmental specifications. Work closely with The Crossing Company's Project Manager and Client Representative to ensure effective communication and execution of the Construction Plan and Management of Change.
- Coordinate the acquisition and supply of goods and services in a manner consistent with project cost accounting procedures in close cooperation with the Project manager and Client Representative.

Driller – The Crossing Company **1999 to 2003**

As a Driller, Steve was responsible for training, directing and supervising the rig crew and the use of the rig equipment, in accordance with The Crossing Company's operational policies so as to safely and efficiently execute the HDD Construction Plan. Steve's principal accountabilities as a Driller included:

- Demonstrate and promote safety leadership. Conduct and record Tool Box Talks for the rig crew and achieve the participation and contribution of crew members.
- Conduct safety inspections of rig equipment and hold training drills as directed by Rig Manager. Ensure that all activities, including those of third party contractors, are conducted using safe working practices and using the designated Personal Protection Equipment (PPE).
- Plan the tour operations and conduct pre-job briefings or J.S.A.'s for the crew on activities. Train and direct the crew in fulfilling their designated duties.
- Monitor and adjust the drilling parameters and take necessary actions to optimize the drilling process and safeguard the integrity of the project. Operate the rig equipment within its designed parameters in a manner to optimize the drilling process and associated activities.
- Assign crew members to conduct specific tasks during periods of routine activity and during special operations such as rigging-up/down and rig-moving.
- Keep accurate and complete records in a manner consistent with corporate standards.
- Transport crew to and from work site.

Driller – Canadian Horizontal Drilling **1997 to 1999**

Roughneck – D&K Directional Drilling **1996 to 1997**

NOTABLE COMPLETED PROJECTS FOR HDD COMPANY

(Additional Projects will be provided upon request)

Project: **EQT**

2018

General Contractor: EQT
Contact: Nick Ponzo/ Mark Torbic 412-215-8195
Project Name: EQT/Mountain Valley Pipeline Pigg River Crossing
Totaling (1) 42: Steel Pipeline Installation
Varying Lengths: 3726'
Formation: Mica Shist (Mohns 4-7)
HDD Rigs: Vermeer 750K, 140K
Position: Field Superintendent

Project: **ETC Rover**

2018

General Contractor: Precision Pipeline
Contact: Steven Grice 716-491-1895
Project Name: ETC Rover Pipeline Replacement Line A & B
Totaling (12) 42" Steel Pipeline Installation Projects
Varying Lengths: 1,800' to 2,400'
Formation: Sandstone/Shale Rock
HDD Rigs (4) Vermeer 750, HDD Co. 900, American Auger 660, American Auger 440
Position: Field Superintendent

Select Completed Projects

Owner	HDD Crossing	Drill Detail
Husky Oil Operations	Husky Direct Intake	NPS8, 2018: 738m
Husky Oil Operations	Husky Direct Intake	NPS24, 2018: 742m
Pembina	Unnamed Stream	NPS12, 2017: 758m
Pembina	Paddle River	NPS24, 2017: 621m
Pembina	Iosegun River	NPS24, 2016: 1044m
Crew Energy	Pine River NW-Entry	NPS8, 2016: 2300m
TCPL	Deep Valley Creek	NPS24, 2016: 1355.8m
AltaGas	Townsend Creek	NPS8, 2016: 562m
Ikkuma Resources	Wanyandie Creek	NPS6, 2015: 1582.2m
Husky Oil Operations	NSR	NPS16, 2015: 1231.8m
TCPL	Ruth Lake	NPS12/6, 2015: 783m
Bellatri	Rose Creek	NPS6, 2015: 853m
Pembina Pipeline Corp	Trib 114 to Smoky	NPS12, 2015: 1224m
Encana	Kiskatinaw River	NPS8, 2015: 1036m
Pembina Pipeline Corp	Simonette River	NPS12 ¾, 2015: 819m
Tangle Creek Energy	Athabasca River	NPS4, 2014: 408m
Pembina Pipeline Corp	Wapiti River South Slope	NPS12, 2014: 847m
Inter Pipeline	Petroleum Way	NPS24, 2014: 1357m
ARC Resources	Kiskatinaw River	NPS10, 2014: 963m
Encana	Waskahigan River	NPS8/4, 2014: 668m
Stony Mountain Pipeline	House River	NPS20, 2014: 1003m
Suncor	Horse River	NPS16, 2014: 1000m
Crew Energy	Septimus Creek	NPS10, 2014: 1382m
Devon	Saint John Creek	NPS18, 2013: 1302m
Seven Generations	Smoky River	NPS6/8, 2013: 1894m
Stony Mountain Pipeline	Athabasca River	NPS20, 2013: 1269m
Progress Energy	Sikanni Chief River	NPS24, 2012: 1626m
Bellatrix	North Saskatchewan River	NPS0/8/8, 2012: 1752m
CNRL	Peace River	NPS16, 2011: 1765m
Alta Gas	Pouce Coupe River HDD	NPS10, 2010: 1619m
Transwestern Pipeline	Gila River	NPS36, 2009: 1120m
Focus Energy	Tommy Lakes - Intersect	NPS6, 2008: 1678m
Pembina Pipelines	North Saskatchewan River	NPS12, 2007: 1615m
Storm Energy	Peace River - Intersect	NPS12, 2007: 1300m
Shell Canada	Jackpine Creek	NPS48, 2007: 724m
Talisman Energy	Kakwa River	NPS8/8/6/6/4, 2006: 1221m
Anadarko Canada	Jackknife Creek- Intersect	NPS8, 2005: 1120m

Training and Certification

- Petroleum Safety Training (PST)
- Standard First Aid
- H_2S Alive
- WHMIS 2015
- OSSA Fall Protection
- Global Ground Disturbance Level II
- ACSA Leadership Development Workshop
- ACSA Leadership for Safety Excellence
- Confined Space Entry and Rescue
- Construction Safety Training System (CSTS)
- Pipeline Construction Safety Training (PCST)
- OSSA Regional Orientation Program
- Transportation of Dangerous Goods (TDG)
- ASCA Safety Culture, A Roadmap to Zero
- Accident/Incident Investigation
- Butt Fusion
- Electronic General Safety Orientation (EGSO)
- CannAmm Supervisor Drug & Alcohol Awareness Training
- ABSA Special Oilwell Boiler Certificate

CHRISTOPHER CROUGH

Drilling Rig Superintendent / Rig Manager

Chris Crough has over 15 years of experience in Horizontal Directional Drilling. He joined The HDD Company in 2009 after working in various capacities for six years with our parent company, The Crossing Company in Canada. Currently, Chris has dual roles as Drilling Rig Superintendent / Rig Manager and The HDD Company's General Drilling Superintendent depending on the company's workload of drilling projects. Chris has worked in all drilling positions from rig hand to rig manager and has been a team leader in several significant 42" rock project undertaken by The HDD Company.

Employee Resume

CHRIS CROUGH

155 Garwood Crescent d
Wetaskiwin, AB T9A
780-352-6006

Professional Experience

EMPLOYMENT:

2009 to Present **HDD Company Inc. El Dorado Hills, CA**
Superintendent/ Driller /Operator

January 2007 to 2009 **The Crossing Company Inc. Nisku, AB**
Rig Manager

- Operated and drilled on rigs with capacities from 100K pounds of thrust and pull to 600K pounds of thrust and pull within The Crossing Company's HDD fleet.
- Became a Rig Manager on August 18, 2008 and managed Rig #1 a Maxi drilling rig.
- Given the opportunity on September 11, 2008 to join The HDD Company the North American Division of The Crossing Company.
- Became the Rig Manager of Rig 4 high angle on February 18, 2010
- Became a Rig Manager for Rig 2 (300K pound drilling rig) on August 16, 2010 for the HDD Company in Albany Oregon.

2000 to 2006 **Canadian Horizontal Drilling Wetaskiwin, AB**
Driller

- Drilled primarily on there 300,000 pound rig
- Relief tool pushed in 2005
- Was also introduced to small utility rigs from 12,000 to 80,000 pound Vermeer

1992 to 1997 **Phil Crough & Sons Trucking Wetaskiwin, AB**
Operator

- Operate 416 cat backhoes
- Drive tandem gravel and A-Frame rail picker trucks
- Drive and operate single axle vacuum trucks
- Operate transits on grade and height elevations

REFERENCES:

Lynn Kubicek
Rig Manager for the Crossing Company Rig 5
Phone 780-387-4336
Cell 780-405-7358

Dave Rominick
Rig Manager for the Crossing Company Rig
Phone 780-913-1009

Frans Erikson
Steering Hand for Canadian Horizontal
Phone 7780-352-7596

NOTABLE COMPLETED PROJECTS *(Additional Projects will be provided upon request)*

Project: **ETC Rover**
2018
General Contractor: Precision Pipeline
Contact: Steven Grice 716-491-1895
Project Name: ETC Rover Pipeline Replacement Line A & B
Totaling (12) 42" Steel Pipeline Installation Projects
Varying Lengths: 1,800' to 2,400'
Formation: Sandstone/Shale Rock
HDD Rigs (4) Vermeer 750, HDD Co. 900, AA 660, AA 440
Position: Rig Manager/Project General Superintendent

Project: **Lavalin LLC**
2017
Owner: Northwest Natural
Position: Rig Manager
Contact Brian Conrad 503-721- 2550
Project Name: North Mist Expansion Project
(8) 16" 24, 976' Steel Pipeline HDD Installations w/2.5" HDPE Piggy-backed
Formation: Shale/Sandstone, Silts, Sands, and Clays.
Position: Rig Manager/Project General Superintendent

Project: **TE SUBCOM**
2017
General Contractor: The HDD Company Inc.
Contact: Randy Ashley 603-502-8725
Project Name: MAREA fiber optic
Length & Diameter: Four "drill and leave" bores 3280' each
Formations: Sand & Gravel
HDD Rig: American Augers 440K
Position: Rig Manager/Project General Superintendent

Project: **DAKOTA ACCESS PIPELINE**

2016

General Contractor: Precision Pipeline (Oz Directional Drilling)
Contact: Steve Grice 716-491-1895 or Jim Cunningham 217-251-8440
Project Name: Illinois River Crossing
Length & Diameter: 6500' x 30" steel (intersect)
Formations: Sands , Silts, Gravel
HDD Rig: American Augers 440K
Position: Driller/Rig Manager

Project: **CITY OF CARSBAD, CALIFORNIA**

2016

General Contractor: Pulice Construction, Inc.
Contact: Don Gordon
Project Name: Agua Hedionda Sewer Lift Station
Length & Diameter: 1825' of 36" DR-11 HDPE Pipe
Formations: Claystone and Sandstone
HDD Rig: American Augers 440K
Position: Driller / Rig Manager

Project: **KINDER MORGAN ENERGY PARTNERS, L.P.**

2015

Contact: Renee Coleman 714-560-4771
General Contractor: W.A. Rasic Construction Company
Contact: Jack Quick 562-928-6111
Project Name: 16" LS-1 & 20" LS-108 Pipelines HDD
Location: Pomona, California
Length & Diameter: 1,422 'of 20" and 1614' of 24" Steel Pipe
Formations Sands and Silts
HDD Rig: American Augers 380K
Position: Driller / Rig Manager

Project: **PACIFIC GAS & ELECTRIC COMPANY**

2015

General Contractor: Barnard Pipeline, Inc
Contact: Dan Link 406-679-0134
Project Name: R-405 I-400/I-401 Pipeline Replacement
Location: Capay , California
Length & Diameter: **2560' of 36" Steel and 2560' of 42" Steel**
Formations: Siltstone, Mudstone, Sands and Gravels
HDD Rig: American Augers 440K
Position: Driller / Rig Manager

Project: **NEC CORPORATION OF AMERICA / GOOGLE**

2015

Contact: Ingo Lahnemann 570-836-7371
General Contractor: The HDD Company, Inc.
Contact: Rick Evans 530-676-5705
Project Name: FASTER Cable Project
Location: Bandon, Oregon
Length & Diameter: **5,000' of 5" Steel Pipe**
Formations: Sandstone and Siltstone
HDD Rig: Vermeer 330K
Position: Driller / Rig Manager

Project: **PACIFIC GAS & ELECTRIC COMPANY**

2015

General Contractor: Black & Veatch Construction, Inc.
Contact: Dave Turkington 925-556-2216
Project Name: ZA - 230KV UG Line
Location: San Francisco, California
Length & Diameter: **12" & 3" HDPE Bundle**
Formations: Serpentine Rock and Bay Mud
HDD Rig: American Augers 380K
Position: Driller / Rig Manager

Project: **VICTORVILLE VALLEY WASTEWATER RECLAMATION AUTHORITY**

2014

General Contractor: James W. Fowle5r
Contact: Spencer McClymont 503-623-5373
Engineering Firm: URS
Contact: Bob Sachse 619-733-5354
Project Name: Upper Narrows
Location: Victorville, California
Length & Diameter: **(2) bores 1941' of 16" SDR 18**
Formations: Sand, Silts and Gravel
HDD Rig: American Augers 440K
Position: Driller / Rig Manager

Project: **NW NATURAL**

2014

Contact: Craig Gagner 503-721-2550
Project Name: Monmouth Bare
Project Location: Albany, Oregon
Length & Diameter: **(3) 3420', 3510' and 3560' of 12" Steel Pipe**
Formations: Clay and Mudstone
HDD Rig: American Augers 380K
Position: Driller / Asst. Rig Manager

Project: **Pacific Gas and Electric Company I-880 Bore**

2014

Owner: **Pacific Gas and Electric Company**
General ARB, Inc
Contact: Mark Borgess 925-422-3563
Length & Diameter: 1300' of 36" Steel Pipe
Formations: Sand
HDD Rig: American Augers 440K
Tracking System: Tensor Wireline System
Driller / Asst. Rig Manager

Project: **PNG – TP 1160 Pipeline Replacement**

2013

Position: Operator
Owner: Peoples Gas
General Contractor: Mascaro Corporation
Contact: Brad McKibben 412-321-7901
Length & Diameter: 2167' of 20" Steel Pipe
Formations: Limestone and Sandstone
HDD Rig: HDD Company 900K "American Auger Components"
Tracking System: Tensor Wireline System
Position: Driller / Asst. Rig Manager

Project: **Phase III A/B Corvallis Loop**

2013

Owner: NW Natural
Contact: Craig Gagner 503-721-2550
Length & Diameter: (2) bores 6425' and 1764' of 12" Steel Pipe
Formations: Clay and Siltstone
HDD Rig: American Augers 380k
Tracking System: Tensor Wireline System
Position: Driller / Asst. Rig Manager

Project: **Perrydale / Rickreall Bore Project**

2013

Owner: NW Natural
Contact: Craig Gagner 503-721-2550
Length & Diameter: (3) bores 5289', 3599' and 5886' of 12" Steel Pipe
Formations: Clay
HDD Rig: HDD Company 900K "American Auger Components"
Tracking System: Tensor Wireline System
Position: Driller / Asst. Rig Manager

Project: **Targa Sound Terminal Job# 8631004**

2012

Owner: Targa Sound Terminal
Contact: Kelly Varnado 713-584-1570
General Contractor: Rockford Corporation
Contact: Tim Alwin 360-864-8866
Project Location: Port of Tacoma, Washington

Length & Diameter: **(4) bores 7644', 3500', 2100',and 1200' of 10" Steel Pipe**
Formations: Sand and Silt
HDD Rig: American Augers 440K
Position: Driller / Asst. Rig Manager

Project: **OOI RSN**
2011
Owner: L-3 COMMUNICATIONS MARIPRO
Contact: Geoff Ball 805-879-0105
Project Location: Pacific City, Oregon
Length & Diameter: **2 Beach approaches 5000' each leave drill pipe in hole as conduit**
Formations: Sand and Silt
HDD Rig: American Augers 440K
Position: Driller / Asst. Rig Manager

Project: **Integrated Wetlands Waste Discharge**
2010
Owner ATI WAH CHANG
Contact: Mike Smee 541-971-7927 or
Doug Pennington 541-990-7704
Project Name: Integrated Wetlands Waste Discharge
Project Location: Albany, Oregon
Length & Diameter: **1100' of 18" HDPE Under a Wetlands and Creek**
Formations: Gravel and Silt
HDD Rig: American Augers 440K
Position: Driller

Project: **Western Terminus Pipeline Project**
2010
Owner: LIVERMORE – AMADOR WATER MANAGEMENT AGENCY
General Contractor: K J Woods
Contact: Ron Zelaya 510-303-9591
Engineer: Brown & Caldwell
Construction Manager: Covello Group
Contact: Mike Jaeger 925-382-1950
Project Location: San Leandro, California
Length & Diameter: 1178' of 42" HDPE under wetland
Formations: Bay Mud (Clay)
HDD Rig: American Augers 440K
Position: Driller

Project: **Travis Junction 16" Jet Fuel Pipeline**
2010
Owner: KINDER MORGAN
Contact: Andy Diaz 951-712-8790 (andy_diaz@kindermorgan.com)
Project Location: Travis AFB, Fairfield, California

Length & Diameter **5400' of 16" Steel Pipe under Wetlands**
Formations: Clay, Sand and Silts
HDD Rig: American Augers 440K
Position: Driller

Project: **Line-406001 RSN**

2010

Owner: PACIFIC GAS & ELECTRIC COMPANY
General Contractor: Diamond D General Engineering
Contact: Donald Swank 661-599-0092
Contact: Scott Klapp w/ GTS 530-514-7309
Project Location: Woodland, California
Length & Diameter**: (2) bores 1498' & 1290' of 30" Steel Pipe under I-5, I-505 and a canal**
Formations: Clay, Sand and Gravel
HDD Rig: American Augers 440K
Position: Driller

Project: **North Albany Force Main Improvement**

2009

Owner: City of Albany
Engineer: CH2M Hill
Contact: Craig Massey 541-768-3478
Length & Diameter: 1780' of 24" HDPE
Formations: Silt and Clay
HDD Rig: HDD Company 900K "American Auger Components"
Tracking System: Tensor Wireline System
Position: Driller

Project: **Nacimento Water Line Project**

2009

General Contractor: Teichert Construction
Contact: Chad Fisher 559-647-0788
Length & Diameter: 1850' of 31" Steel Pipe and
Sandstone and 1300' of 31" Steel Pipe - Mudstone
Formations: Silt and Clay
HDD Rig: HDD Company 900K "American Auger Components"
Tracking System: Tensor Wireline System
Position: Driller

Project: **Big Gulch Sanitary Sewer Emergency Repair**

2009

Owner: Mukilteo Water and Wastewater District
Contact: Rick Matthews 425-355-3355
Length & Diameter: 2560' of 21.5" FPVC
Formations: Mudstone – Glacial Till
HDD Rig: American Auger 380K
Tracking System: Tensor Wireline System
Position: Driller

CASEY WAINMAN

Driller / Rig Manager

Casey Wainman has over nine years of experience in Horizontal Directional Drilling from performing duties as a rig laborer and welder to managing The HDD Company's most power drilling rig having approximately 900,000 pounds thrust and pulling capabilities

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Barry Briggs

Rig Manager

Professional Experience

Rig Manager – The Crossing Company **2021 to Present**

As Rig Manager, Barry is responsible for overall management of rig operations to ensure the accomplishment of planned objectives with regards to revenue, expenses, rig operations, development and performance of personnel, safety and environmental management, and equipment maintenance while creating a high degree of customer satisfaction. Barry's principal accountabilities as a Rig Manager include:

- Provide leadership in Safety Excellence, ensuring compliance with client safety programs, corporate safety programs and OH&S legislation. Contribute affirmatively to The HDD Company's corporate culture of safety, quality and operational excellence.
- Provide mentorship and direction to the Driller and Locator in relation to crew training, task assignment and supervision.
- Oversee maintenance of drilling rig and associated equipment to ensure maximum operating readiness and sustainability, minimizing opportunities for equipment downtime. Ensure equipment is maintained to a state of repair consistent with The HDD Company's high standards.
- Organize and supervise all mobilization and demobilization operations of the drilling rig and associated equipment. Supervise all rigging and towing operations involved in mobilization and demobilization operations, ensuring safe transportation through rough and steep terrain.
- Direct, monitor and control all drilling operations to ensure compliance with the Construction Plan, and technical and environmental specifications. Work closely with The HDD Company's Operations Manager and Client Representative to ensure effective communication and execution of the Construction Plan and Management of Change.
- Coordinate the acquisition and supply of goods and services in a manner consistent with project cost accounting procedures in close cooperation with the Operations Manager and Client Representative.

Booker Drilling, Offshore Rigs, Neighbors Drilling, REM, Laney Directional Drilling **1983 – 2021**

Select Completed Projects

Owner / Location	HDD Crossing	Drill Detail
XcL Midstream / West Virginia	Fish Creek, (6) crossings	NPS4 & NPS12: 1,500’ – 3,100’
OSU / Oregon	PacWave South, (1) crossing	NPS30: 2,500’
North Dakota	(2) crossings	NPS36: 4,000’
Pennsylvania	(4) crossings	NPS24: 2,500’
Marathon / Wyoming	(1) crossing	NPS24: 3,100’
Enbridge / Michigan – Indiana	(5) crossings	NPS42
Exxon	(1) crossing	NPS10: 7,200’
Mississippi	(1) crossing	NPS24: 7,000’
WHC Houston	Ship Channel, (1) crossing	NPS30: 8,400’
Kinder Morgan / Texas	Land to Barge, (1) crossing	5,000’
Kinder Morgan / Texas	Barge to Barge, (1) crossing	3,500’
Kinder Morgan / Texas	Barge to Land, (1) crossing	5,000’
Marathon / Texas	(1) crossing	NPS36: 6,000’
Inos / Texas	(1) crossing	NPS30: 6,250’
Texas	(3) crossings	NPS42: 2,500’ – 3,500’
NextEra / Florida	(6) crossings	NPS36: 3,000’ – 4,500’
South Carolina	(1) crossing	NPS48: 6,000’
United Pegasus / Texas	Multiple crossings	NPS24 – NPS42: 2,000’ – 3,000’
Louisiana	(1) crossing	NPS30: 6,200’
Energy Transfer / Ohio	Rover Pipeline, (2) crossings	NPS42: 4,000’
Texas	(3) crossings	3,000’ – 4,000’
Arkansas	Bald Knob, (1) crossing	NPS42: 5,200’

More projects available upon request

Casey Wainman

131 Fairview Blvd.
Farwell, MI 48622
(989) 429-6911

Professional Experience

EDUCATION Farwell High School - Farwell, MI 48622
Graduated 2002

- Welding Skills include: Arc, Tig and Mig welding. Also experienced in using plasma cutter, torch, ban saw, air arc, shear, iron worker and drill press
- Related Welding Skills include: Blueprint reading
- Computer Skills Include: Microsoft Word, Microsoft Excel and Microsoft Power Point

WORK EXPERIENCE

June 2014 to Present **Rig Manager**
HDD Company, Inc – El Dorado Hills, C

Daily responsibilities include:

- Oversee all aspects of HDD operations while on location.
- Safety training for all aspects of work. From new green hands to experienced employees new to the rig and location.
- Production Leader- Make sure project is completed on schedule. Without any extra costs to client or company.
- Heavy duty Mechanic- Ensure drilling rig and components are running at maximum performance and efficiency. Troubleshoot for any issue to prevent any downtime.
- Drilling Rig Operator
- Welder and Heavy Equipment Operator

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2009-2014 **Driller / Mechanic Welder**
HDD Company - El Dorado Hills, CA

Daily responsibilities include:

- Drilling Operator on a 200 ton, 450 ton# and 30 ton American Auger Drill Rig. Operated Ellis Williams Triplex, Operated 150 bbl Mud Tank and solid control equipment. Maintaining Drilling Fluids, and maintenance of all equipment
- Primary control of the drilling apparatus
- Setting up all drilling equipment
- Ensuring proper operation of all drilling equipment
- Supervising all crewmembers, ensuring full compliance with company operational procedures and safety program
- First line supervision of equipment maintenance procedures
- Recording and communicating drilling data to ensure compliance with Quality Assurance program

NOTABLE COMPLETED PROJECTS FOR THE HDD COMPANY

(Additional Projects will be provided upon request)

Project Name: **ETC Rover Pipeline**
2017-2018 General Contractor: Precision Pipeline
Contact: Steven Grice 715-491-1895
Project Name: ETC Rover
Project Location: Ohio
Start Date: March 2017 Completed April 2018
4 Rigs : Line A & B (12) bores +/- 21,754' x 42" steel pipe
Bores range from 1800' to 2400'
Formations: Sandstone, mudstone, alluvial
Position: Rig Manager

Project Name: **Dakota Access Pipeline Illinois River Crossing**
2016 General Contractor: Precision Pipeline (Oz Directional Drilling)
Contact: Steve Grice 716-491-1895 or Jim Cunningham 217-251-8440
Length & Diameter: 6500’ x 30” steel (intersect)
Formations: Sands, Silts, Gravel
Position: Rig Manager/Driller

Project Name: **Pacific gas & Electric Line 407 phase 2**
2016 Position: Operator / Superintendent
General Contractor: Barnard Pipeline
Contact: Dan Link 530-669-5810
Length & diameter:
1. Sacramento River: 3555’ x 30” steel
2. Knights Landing: 2302’ x 30” steel

Project Name: **Pacific Gas & Electric Line 400 Replacement**
2015 Position: Operator / Superintendent
General Contractor: Barnard Pipeline
Contact: Dan Link 530-669-5810
Length & Diameter: 2560' x 42" steel under Cache Creek
Formations: Sandstone / Siltstone
Position: Rig Manager/Driller

Project Name: **Mayport Naval Base**
2014 General Contractor: L-3 Communications - Maripro
Contact: Geoff Ball 805-879-0105
Length & Diameter: 4000' x 5" Drill & leave Outfall into the Atlantic Ocean
Formations: Sands and Silts
Position: Driller

Project Name: **Martin Slough Interceptor Project**
2014 Owner: City of Eureka
General Contractor: Wahlund Construction
Contact: Ken Wahlund 707-268-0150
Length & Diameter: (1) bore 4400' of 26" and (1) 2100' of 26"
Formations: Sands and Gravels
Position: Driller

Project Name: **PNG – TP 1160 Pipeline Replacement**
2013 Owner: Peoples Gas
General Contractor: Mascaro Corporation
Contact: Brad McKibben 412-321-7901
Length & Diameter: 2167' of 20" Steel Pipe
Formations: Limestone and Sandstone
Position: Driller

Project Name: **Enterprise ATEX Segment 1 Mariner West Project**
2013 Owner: Liquid Enterprise Pipeline
Contact: John Ward 850-257-3062
General Contractor: Southeast Construction
Contact: Todd Barton 520-423-2131
Length & Diameter: 3620' and 2700' of 20" Steel Pipe
Formations: Shale and Sandstone
Position: Driller

Project Name: **Linde 24" Stainless Steel Bore**
2013 Owner: Linde Inc.
General Contractor: Rockford Corporation
Contact: Josh Stinson 530-647-0224
Length & Diameter: 800' of 24" Stainless Steel
Formations: Clay
Position: Rig Laborer/Welder

Project Name: **Hwy 221 Water Transmission Main Upgrade**
2012 Owner: City of Napa
Owner Contact: Michael Hether 707-257-9336
Length & Diameter: (6) bores 1750', 1600', 950', 700' and 100' of 24" Steel
Formations: Clay, Cobble and Sand
Position: Rig Laborer/Welder

Project Name: **Central Valley Gas Storage**
2011 Owner: Central Valley Gas Storage
General Contractor: Associated Pipe Line Contractors
Contact: Tom Wilson 713-789-4311
Length & Diameter: 5485' of 24" O.D. (5 Bores)
Formations: Clay
Position: Rig Laborer/Welder

Project Name: **OOI - RSN**
2011 Owner: University of Washington
General Contractor: L-3 Maripro
Contact: Geoff Ball 805-879-0105
Length & Diameter: Two 5000' x 5" beach approaches off the Oregon Coast
Formations: Sand and Silts
Position: Rig Laborer/Welder

Project Name: **Hale Passage Cable Crossing**
2011 Position: Laborer
Owner: Peninsula Light Company
Contact: Dennis Walden 253-853-1386 or Jafar Taghaui 253-83-1386
Length & Diameter: 3550 ' of 12" steel with five 3" and one 2" HDPE Conduits
Formations: Glacial Till
Position: Rig Laborer/Welder

Project Name: **Western Terminus Project #2010-10**
2010 Owner: Livermore-Amador Valley Water Management Agency
General Contractor: KJ Woods
Contact: Mike Jaeger 925-382-1950
Length & Diameter: 1178' of 42" HDPE under wetlands
Formations: Bay Mud (Clay)
Position: Rig Laborer

Project Name: **Travis Junction 16" Jet Fuel Pipeline**
2010 Owner: Travis Air Force Base
General Contractor: Kinder Morgan
Contact: Mike Jaeger Andy Diaz 951-712-8790
Length & Diameter: 5400' of 16" Steel Pipe under wetlands
Formations: Clay, Sands and Silt
Position: Rig Laborer

Project Name: **Line-406**
2010 Position: Laborer
Owner: Pacific Gas & Electric
General Contractor: Southwest Contractors
Contact: Leroy Hahn 661-588-0484
Length & Diameter: 2 Bores 1498' and 1290' of 30" steel under 1-5, 1-505
Formations: Clay, Sands and Gravel

Project Name: **Plains Pipeline**
2010 Position: Laborer
Owner: Plains Pipeline
General Contractor: Southwest Contractors
Contact: Leroy Hahn 661-588-0484
Length & Diameter: 2 Bores 1150' of 10" steel and 1200' of 8" steel
Formations: Sand

Project Name: **Hueneme Outfall Replacement**
2009 Owner: Calleguas Muni Water District
General Contractor: Manson Construction Inc.
Contact: Brad Hunter 562-762-5241
Length & Diameter: 2500’ of 36” HDPE
Formations: Sand, Cobble, Boulder
Position: Rig Laborer

Project Name: **Nacimiento Water Line**
2009 Owner: County of San Luis Obispo, CA
General Contractor: Teichert Construction Sacramento, CA
Contact: Chad Fisher 916-837-6176
Length & Diameter: Two holes 1850’ and 1350’ of 30” Steel pipe
Formations: Sandstone, Soft shale, Cobble
Position: Rig Laborer

Chris O’Dwyer

Rig Manager/Driller

Chris O’Dwyer has over 9 years of experience in Horizontal Directional Drilling. He started his career in HDD as a Roughneck and worked his way through the operational ranks, earning a promotion to Driller in 2011 and finally to Rig Manager in 2014. Chris has managed drilling crews and been personally responsible for drilling some of the largest and most technically demanding crossings in western Canada.

Chris O'Dwyer

1807-8th Street | Nisku, AB T9E 7S8
Tel: 780.955.5051 Fax: 780.955.5056

Professional Experience

Rig Manager – The Crossing Company **2014 to Present**

As a Rig Manager Chris is in charge of the overall management of rig operations to ensure the accomplishment of planned objectives with regards to: revenue, expenses, rig operations, development and performance of personnel, safety and environmental management and equipment maintenance while creating a high degree of customer satisfaction. Chris's principal accountabilities include:

- Provide leadership in Safety Excellence, ensuring compliance with client safety program, corporate safety program and OH&S legislation. Contribute affirmatively to The Crossing Company's corporate culture of safety, quality and operational excellence.
- Provide mentorship and direction to the Driller in relation to crew training, task assignment and supervision.
- Oversee maintenance of drilling rig and associated equipment to ensure maximum operating readiness and sustainability, minimizing opportunities for equipment downtime. Ensure equipment is maintained to a state of repair consistent with The Crossing Company's high standards.
- Organize and supervise all mobilization and demobilization operations of the drilling rig and associated equipment. Supervise all rigging and towing operations involved in mobilization and demobilization operations, ensuring safe transportation through rough and steep terrain.
- Direct, monitor and control all drilling operations to ensure compliance with the Construction Plan, and technical and environmental specifications. Work closely with The Crossing Company's Project Manager and Client Representative to ensure effective communication and execution of the Construction Plan and Management of Change.
- Coordinate the acquisition and supply of goods and services in a manner consistent with project cost accounting procedures in close cooperation with the Project manager and Client Representative.

Driller – The Crossing Company **2011 to 2014**

Responsible for training, directing and supervising the rig crew and the use of the rig equipment, in accordance with The Crossing Company's operational policies so as to safely and efficiently execute the HDD Construction Plan. Chris's principal accountabilities as a Driller included:

- Demonstrate and promote safety leadership. Conduct and record Tool Box Talks for the rig crew and achieve the participation and contribution of crew members.
- Conduct safety inspections of rig equipment and hold training drills as directed by Rig Manager. Ensure that all activities, including those of third party contractors, are conducted using safe working practices and using the designated Personal Protection Equipment (PPE).
- Plan the tour operations and conduct pre-job briefings or J.S.A.'s for the crew on activities. Train and direct the crew in fulfilling their designated duties.

- Monitor and adjust the drilling parameters and take necessary actions to optimize the drilling process and safeguard the integrity of the project. Operate the rig equipment within its designed parameters in a manner to optimize the drilling process and associated activities.
- Assign crew members to conduct specific tasks during periods of routine activity and during special operations such as rigging-up/down and rig-moving.
- Keep accurate and complete records in a manner consistent with corporate standards.
- Transport crew to and from work site.

Tankhand/Lead Roughneck – The Crossing Company **2007 to 2011**

As a Tankhand, Chris was responsible for assisting the Driller by maintaining all equipment related to the circulating system, and maintaining the properties of the drilling fluid. As a Lead Roughneck, Chris was responsible for ensuring that all engines and other machinery were properly maintained, operating and functioning properly. He was also responsible for assisting the Driller in training and supervising Roughnecks, making and breaking drill-pipe connections during drilling, reaming and tripping operations, ensuring that the rig, associated equipment and work site was kept clean and in order, doing repair work and conducting preventative maintenance on the rig and associated equipment. The Lead Roughneck position is also responsible for notifying the Driller of any observations of inadequacies associated with the state of repair or operating behavior of the equipment.

Roughneck – Beaver Drilling **2006**

The Crossing Company Completed Projects

Owner	HDD Crossing	Drill Detail
Ledcor	130 Ave, Clover Bar Creek and Pipelines	NPS20, 2015: 582m
NEP	Ravine Crossing	NPS6, 2015: 716m
TCPL	Highway 63-PPC	NPS12/6, 2015: 333m
Bellatrix	Rose Creek	NPS6, 2015: 853m
Enbridge	Hangingstone River_HPP	NPS16, 2015: 368m
Inter Pipeline	Hangingstone River_IPL	NPS16, 2015: 485m
Tournament Exploration Ltd	Baptiste River	NPS8, 2014: 854m
Progress Energy	Beatton River Exit	NPS10/8, 2014: 1000m
Spectra Energy	South Slope	NPS20, 2014: 978m
Crew Energy	Septimus Creek	NPS10, 2014: 1382m
Encana	Beaverlodge River	NPS4/6/8/10, 2013: 585m
Pennwest	Violet Grove Slope	NPS6, 2013: 656m
Seven Generations	Kakwa RIver	NPS6/8, 2013: 1640m
Progress Energy	Sikanni Chief	NPS24, 2012: 1626m
CNRL	Peace River	NPS16, 2011: 1765m
Storm Exploration	Kiskatinaw River HDD	NPS8, 2010: 944m
Alta Gas	Pouce Coupe	NPS16/4/4, 2010: 1619m
Talisman	Burnt River	NPS6/6/2, 2009: 1178m
ProEx Energy	Trib to Buckinghorse River	NPS6/6, 2008: 949m
Focus Energy	Tommy Lakes Hill Drill	NPS6, 2008: 1475m

The HDD Company (some) Completed Projects

Owner	Crossing	Diameter / Length
City of Albany, OR	Willamette River	24” x 1780’
Niska Gas Storage, Gridley, CA	Various Canals	24” x 1230’, 1470’, 1122’
Nacimiento Water District, CA	Salinas River	32” x 1300’
Northwest Natural Gas, Corvallis, OR	Willamette and Mary’s Rivers	12” x 6320’
ETC Rover Pipeline, Ohio	Sandusky River	42” x 1818’

Training and Certification

- Petroleum Safety Training
- Standard First Aid
- H_2S Alive
- Ground Disturbance Level 2
- Confined Space Entry and Rescue
- ACSA Construction Safety Training System (CSTS)
- Oil Sand Safety Association – Orientation
- ABSA Special Oilwell Boiler Certificate
- Fall Protection
- Level B Trainee Crane Operator Certificate
- Leadership for Safety Excellence (ASCA)

Steve Sooley

Technical Services Specialist

Steve Sooley has over 6 years of experience in Horizontal Directional Drilling. He started his career in HDD as a Roughneck and worked his way through the operational ranks, culminating in his promotion to Technical Services Specialist in 2011.

Steve Sooley

1807-8th Street | Nisku, AB T9E 7S8
Tel: 780.955.5051 Fax: 780.955.5056

Professional Experience

Technical Services Specialist – The Crossing Company **2011 to Present**

As a Technical Services Specialist, Steve is responsible for providing the directional drilling services on HDD projects. Reporting to the Rig Manager and Project Manager, the essential job functions are:

- Review drill path design and communicate with the Rig Manager, Project Manager and client representatives to discuss all changes deemed necessary.
- Conduct a land survey of the construction RoW along the intended line of drill and erect surface navigation coils and solenoid(s). Create the overall navigation plan.
- Interpret the MWD information and apply drilling expertise, problem solving ability and drilling experience to ensure the drill path is drilled according to the Construction Plan.
- Provide As-Built summary describing location of survey and geometry of drill path.

Lead Roughneck – The Crossing Company **2010 to 2011**

As a Lead Roughneck, Steve was responsible for ensuring that all engines and other machinery were properly maintained, operating and functioning properly. He was also responsible for assisting the Driller in training and supervising Roughnecks, making and breaking drill-pipe connections during drilling, reaming and tripping operations, ensuring that the rig, associated equipment and work site is kept clean and in order, doing repair work and conducting preventative maintenance on the rig and associated equipment. The Lead Roughneck position is also responsible for notifying the Driller of any observations of inadequacies associated with the state of repair or operating behavior of the equipment.

Completed Projects

Owner	HDD Crossing	Drill Detail
Crew Energy	Pine River NW-Entry	NPS8, 2016: 2300m
Ikkuma Resources	Wanyandie Creek	NPS6, 2015: 1582.2m
Ledcor	CP Rail and CN Yard	NPS36, 2015: 459m
Pembina Pipeline Corp	Morse River	NPS10, 2015: 652m
Bellatrix	Rose Creek	NPS6, 2015: 853m
Pembina Pipeline Corp	Trib 114 to Smoky	NPS12, 2015: 1224m
Pembina Pipeline Corp	Simonette River	NPS12¾, 2015: 819m
Tangle Creek Energy	Athabasca River Entry	NPS4, 2014: 413m
Crew Energy	Septimus Creek	NPS10, 2014: 1382m
Stony Mountain Pipeline	House River	NPS20, 2014: 1003m

Suncor	Horse River	NPS16, 2014: 1000m
Shell	Quest North Saskatchewan River	NPS12, 2013:666m
Pennwest	Unnamed Creek	NPS6, 2013: 656m
Northwest Redwater Partnership	North Saskatchewan River	NPS16, 2013: 578m
Seven Generations	Smoky River	NPS6/8, 2013: 1894m
Devon	Saint John Creek	NPS18, 2013: 1302m
Pembina Pipeline	Alces River HDD	NPS6, 2012: 933m
Encana	Dawson Creek Hill	NPS8, 2012: 840m
Bellatrix Exploration	North Saskatchewan River	NPS10/8/8, 2012: 1752m
Paramount Resources	Kakwa River	NPS8, 2011: 936m
CNRL	South Slope	NPS16, 2011: 1013m
Alta Gas	Pouce Coupe	NPS16/4/4, 2010: 1619m

Training and Certification

- Standard First Aid
- H_2S Alive
- WHMIS
- Petroleum Safety Training (PST)
- Anchor, Descent and Rope Ascent Training
- Construction Safety Training System (CSTS)
- Ground Disturbance for Supervisors and Level II
- Pipeline Construction Safety Training (PCST)

Exhibit 14-1: October 2018 Site Location of Development Application Amendment for the Kennebec River Horizontal Directional Drill

NEW ENGLAND
CLEAN ENERGY
CONNECT

Site Location of Development Application Amendment for the Kennebec River Horizontal Directional Drill

New England Clean Energy Connect (NECEC)

CENTRAL MAINE
POWER

Prepared for:
Maine Department of Environmental Protection
Land Use Planning Commission
United States Army Corps of Engineers

October 19, 2018

1.0 DEVELOPMENT DESCRIPTION

Central Maine Power Company ("CMP") is amending its Site Location of Development ("Site Law") and Natural Resources Protection Act ("NRPA") Applications, filed September 27, 2017, to include a Horizonal Directional Drill ("HDD") crossing beneath the Upper Kennebec River, between West Forks Plantation ("Plt") and Moxie Gore. This document amends the September 27, 2017 Site Law application.

HDD is an installation method of underground utilities, which uses a drill rig to bore along an engineered alignment under and/or around various obstacles, such as a river crossing. HDD installation requires some temporary trenching in the transmission line segment between where the conductors exit the ground and where they come up into their respective termination stations. The crossing location of the Upper Kennebec River, designated as an Outstanding River Segment (38 M.R.S. § 480-P, referencing 12 M.R.S. § 403(7)), is a recreational resource used by whitewater rafters and anglers that provides regional and local economic benefit to Maine. This underground transmission line solution will fully preserve the scenic character of this section of the Kennebec River by eliminating the visual impacts of an overhead transmission line crossing from recreational users of the river.

The HDD crossing proposed for the Kennebec River consists of three main components: 1) the HDD bore, a subgrade conduit containing the HDVC line; 2) two termination stations, one on each side of the river, where the transmission lines transition from underground to overhead; and 3) trenching, a direct buried conduit used to carry the transmission cables from the HDD bore to the termination station. Construction of the HDD crossing will require a temporary drilling/receiving platform on each side of the river, which will be used to set up the drill rig and advance the HDD bore hole. These areas will be restored to pre-existing contours and revegetated after HDD is complete. Attachment 1 provides the Engineered HDD and Termination Station Plans.

The duration of construction associated with the entire HDD installation is anticipated to require 6-8 months, followed by 6 months of activity associated with the construction of the termination stations. More detail on the construction sequence is provided in the Construction Plan (Chapter 7.0) in the NRPA application amendment being submitted concurrently with this filing. Each component is described in further detail below.

1.1 HDD Bore

The HDD bore will travel underground approximately 3,000 feet from the Moxie Gore Termination Station on the east side of the Kennebec River to the West Forks Termination Station on the west side of the river. Five HVDC electrical conductors will be installed within a 36-inch steel conduit, through a 48-

inch bore hole. The depth of the HDD bore beneath the riverbed will range from approximately 55 to 75 feet.

The bore will begin with a pilot hole of 8-10 inch diameter on the east side of the Kennebec River. This hole will be enlarged by using progressively larger diameter drill heads to ream the hole, initially in a west to east direction and then east to west, continuing in this alternating progression until the desired borehole diameter is achieved. Steel casing will then be pulled though the borehole from west to east, to both retain the borehole in its full diameter, and to protect the electrical conductors and associated conduits to be located within the larger conduit.

Because the HVDC line will be underground from the entry point on the east side to the exit point on the west side, 1,450 feet of forested buffer on the east side and 1,160 feet of forested buffer on the west side will be retained on the Kennebec River banks and adjacent uplands, eliminating the visual impacts to recreational users of the river.

1.2 Termination Stations

Termination stations will be required on each side of the Kennebec River to transition the HVDC transmission lines from below ground to overhead. The Moxie Gore Termination Station (east side) and the West Forks Termination Station (west side) will be identical in size and structure, each designed with a minimal foot print of 135 feet by 135 feet. These yards will be fenced and finished with a crushed stone surface, typical of CMP's substation yards. The yard will consist of electrical equipment and associated foundations (conduit riser, bus support, equipment support, transmission dead-end structures, etc.) arranged to perform the required functionality in a compact footprint. The termination stations will be passive and will contain no sound producing or light emitting equipment. Permanent access will be attained by using existing land management roads on both sides of the river. These roads will require modifications and upgrades to accommodate construction equipment and maintenance vehicles. A short section of permanent gravel road will be constructed at both termination stations, extending the existing land management roads by approximately 156 feet and 728 feet at the Moxie Gore and West Forks termination stations, respectively. The permanent access at each termination station site will be maintained to allow access for routine and/or emergency maintenance of the termination station and overhead HVDC line.

1.3 Trenching

Trenching will be required to install buried conduit, used to carry the transmission cables from the HDD bore entry and exit points to the conduit risers within the termination stations. The buried conduit allows

for transition from the HDD to the cable riser structures. Specifically, it allows for separation of four DC cables (conductors) plus the spare cable (5 total) into their respective riser structures and terminators. The vault system designed into the trench allows for intermediate splicing in the event of an underground cable terminator failure. On the west side of the Kennebec River the trench avoids a small radius compound (i.e., horizontal plus vertical) bend in the HDD, which significantly simplifies the drilling effort. Trenching must be located between the borehole and the termination station because in the trenched section, poles converge or diverge from one bundle into separate components.

Three cable trenches extending approximately 350 feet will be required between each termination station and their respective HDD points of entry or exit. Typical trench dimensions will be 4 to 8 feet wide by 5 to 10 feet deep. Trenches will be temporary and will be backfilled and revegetated after construction. To eliminate the potential for roots to interfere with the underground cables, CMP will prevent large tree growth within the trenched sections and will maintain vegetation in these areas consistent with the NECEC Post-Construction Vegetation Maintenance Plan (August 2018).

1.4 Temporary Drilling/Receiving Platforms

A temporary drilling platform will be established on the east side of the Kennebec River just west of the Moxie Gore Termination Station and trenched buried conduit. A 125-foot by 150-foot level graded working area will be used for the HDD drill rig. This temporary work area will be arranged in conjunction with the contractor to promote a safe and efficient workflow. The drill rig will be set behind an excavated pit that will collect and retain the drilling fluid (mud). The pit is estimated to be approximately 15 feet wide by 25 feet long and 5 feet deep. The drill fluid and cuttings will be collected in this pit and removed as necessary to keep drilling operations active. The receiving pit will be a similar but slightly smaller pit. Both pits will be installed before drilling operations begin.

Similarly, a temporary receiving platform and smaller receiving fluid pit will be established on the west side of river east of the West Forks Termination Station and trenched buried conduit. The full length of conduit must be constructed on the receiving end of the bore and pulled through the bore hole in one consistent motion. To ensure the casing does not buckle, sufficient equipment including cranes, backhoes, staging and roller stands must be provided to suspend the casing at an elevation consistent with the bore hole entry angle and allowable bending radius of the casing. A construction area approximately equal to the length of the bore path and approximately 50 feet wide will be required in-line with the bore entry hole. This ROW is required for the fabrication of the casing and equipment used to suspend it in a catenary as it is pulled into the HDD bore. It is anticipated that the ROW will run within the current transmission ROW and no additional land will be impacted.

Both the drilling and receiving platforms and pits are temporary and will be used during the HDD installation. Once construction is complete, these areas will be restored to preconstruction contours and revegetated. Vegetation in these areas will be maintained consistent with the NECEC Post-Construction Vegetation Maintenance Plan (August 2018).

2.0 TITLE, RIGHT OR INTEREST

The proposed HDD and termination stations are located within the 300 foot -wide corridor previously acquired by CMP. Documentation of title, right or interest was provided for this area in the original Site Law application submitted by CMP on September 27, 2017.

3.0 FINANCIAL CAPACITY

The HDD project modification does not affect the financial capacity demonstration in Section 3.0 of the NECEC Site Law Application (September 27, 2017) or the updated Section 3.0 filed with the MDEP as part of CMP's Response to Additional Questions letter (July 31, 2018). Additionally, construction of the HDD alternative at the Kennebec River does not affect the line items or capital cost total detailed in the NECEC Project Capital Cost Estimate Table included with the cost estimate letter filed with the MDEP on December 12, 2017.

4.0 TECHNICAL ABILITY

CMP has consulted nationwide HDD contractors on the technical aspects of this crossing of the Kennebec River utilizing HDD methods. Their input and comments were incorporated into the design of the proposed underground Kennebec River crossing. CMP will select one of these highly qualified HDD contractors for the final design and construction of the Kennebec River HDD crossing. Along with CMP's extensive experience in construction of transmission lines, detailed in the September 2017 application, and CMP's stringent contractor evaluation process that will result in selection of a qualified and highly capable HDD contractor, CMP has the technical ability to design, construct, operate, and maintain the proposed development, including the HDD crossing. See Exhibit 4-1 for qualifications of representative HDD contractors.

Exhibit 4-1: Representative HDD Contractor Qualifications

Trenchless Design

BRIERLEY ASSOCIATES
Creating Space Underground

At Brierley Associates

Our nationwide and international experience allows us to understand the challenges involved with pipeline design and underground construction.

Our team is experienced in all aspects of trenchless pipe installation, feasibility and risk assessment, alignment selection, permit support, geotechnical site characterization, shaft design, value engineering, contractor procurement, construction management and dispute resolution.

We "Create Space Underground"



Trenchless Technologies

Brierley Associates supports owners, engineering design professionals and trenchless/geotechnical contractors with all aspects of trenchless technology. Our geologists, trenchless and underground engineers know how to deliver efficient, effective and constructible designs for:

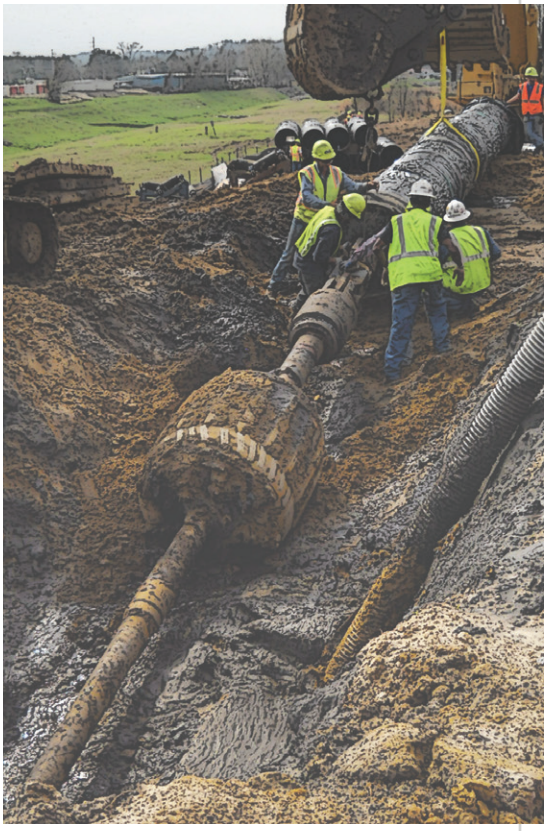
- Microtunneling
- Auger Boring
- Pipe Jacking
- Pipe Ramming
- Direct Pipe
- Horizontal Directional Drilling (HDD)
- Guided Boring Method (GBM)
- Hand Mining
- Pipe Rehabilitation, Relining and Bursting

Method Selection

Understanding the appropriate trenchless method, ground conditions and behavior is paramount to the success of your project. To mitigate risks that could be associated with trenchless installations, Brierley Associates evaluates…

- Site Geometry and Access
- Ground Conditions
- Pipe Materials
- Existing Infrastructure
- Project Cost and Schedule
- Permit Requirements
- Construction Risk and Third Party Impacts
- Ground Improvement Needs

Brierley Associates is federally certified by the Small Business Administration.



BrierleyAssociates.com

Constructability, Efficiency And Practicality

BRIERLEY ASSOCIATES
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Business and Engineering Focus

Tunnels, Shafts and Caverns
Trenchless Technology
Geostructural Design
Geotechnical Engineering
Dams
Design-Build
Abandoned Mine Land Mitigation

Market Sectors

Water, Wastewater, Stormwater
Transportation
Power Transmission
Mining and Resource Extraction
Deep Excavations for Vertical Construction
Natural Gas and Petroleum

Services

Subsidence Risk Assessment of Abandoned Mines
Pre-Bid, Design and Construction Engineering
Geologic Mapping and Evaluations
Tunnel Inspection and Rehabilitation
Blasting Design and Vibration Analysis
Ground Improvement and Grouting Design
Temporary Works Design
Value Engineering
Dispute Resolution
Construction Management
3D Finite Element Modeling
BIM
Feasibility Analysis and Peer Review

BrierleyAssociates.com

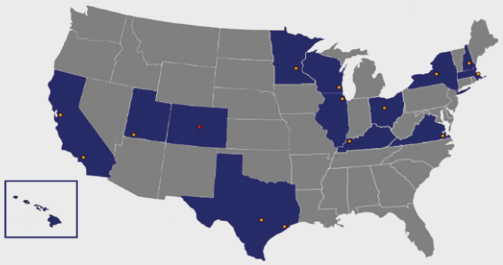
Brierley Associates operating philosophy is based on partnership and honesty with each other, our clients and peers.

Brierley Associates understands that planning, design, and construction of subsurface projects is a complex mixture of client needs, risk allocation, design criteria, and subsurface conditions.

At **Brierley Associates** we enjoy what we do and spend a great deal of time doing it.

All of us at **Brierley Associates** share a common business vision; one that is dedicated to the service of our clients, as we *"Create Space Underground."*

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Creating Space Underground - Coast to Coast

BRIERLEY ASSOCIATES
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HORIZONTAL DIRECTIONAL DRILLING

Brierley Associates has provided specialized Geotechnical, Tunnel, Trenchless, and Geostructural Engineering and Design services for over 20 years. Brierley Associates is privately owned by its founders and senior personnel. Brierley Associates has over 60 professionals serving owners, A/E firms, and contractors in the industry. Our firm's unique and broad experience in heavy civil underground construction projects with complex geologic conditions and geotechnical issues allow us to provide our clients with constructible and economic solutions to complex issues. Brierly specializes in horizontal directional drilling in the following areas:

GROUND CHARACTERIZATION:

Identification of the pertinent soil/rock properties to aid in excavation considerations such as bit consideration, whether or not a mud motor needs to be used, and drilling fluid additives, etc. After a thorough subsurface investigation or a complete review of existing geotechnical data, we are able to create a geologic profile that can be incorporated into the construction documents that will inform all parties of what is to be expected during the horizontal directional drilling program.

TRENCHLESS PIPE DESIGN:

Based on the size (length and diameter) along with the pressure capacity of the specific project, Brierley Associates can tailor the installation, from a standpoint of installation stresses, corrosion and abrasion considerations, etc. to steer the project towards success. Additionally, we can offer comparisons of pipe materials (e.g., PVC vs. HDPE vs. DIP, etc.) and develop a list of pros and cons for each material considered.

HDD DRILL PATH DEVELOPMENT:

Through the use of computer aided drafting (CAD), current state of successful practice and knowledge of the existing obstructions a design path that meets owner's requirements and contractor's methods can be developed.

SPECIFICATION CONSIDERATION:

For a project where an existing specification dictates performance or design based, we can develop a work plan for/ with the contractor. Additionally, we can author a specification for the Horizontal Directional Drilling and associated portions of the project.

FRACOUT MITIGATION:

Permit requirements may require that unintentional release of drilling fluids to the surface not be allowed. We can develop a fracout plan that details the methods to reduce fracout risk in both design and contractor's approach. Additionally we can provide methods to control and contain the fracout as necessary.

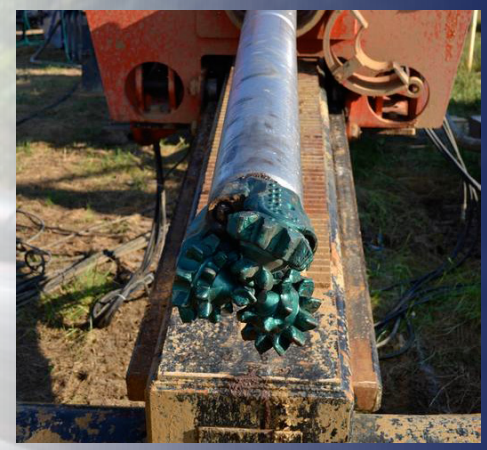
FIELD OVERSIGHT:

We are capability to provide field oversight of install tasks (excavation, installation and grouting) to protect the interests of all parties involved. Our field oversight offers an avenue of open communication between the owner and can contractor while taking into consideration an understanding of all parties concerns.











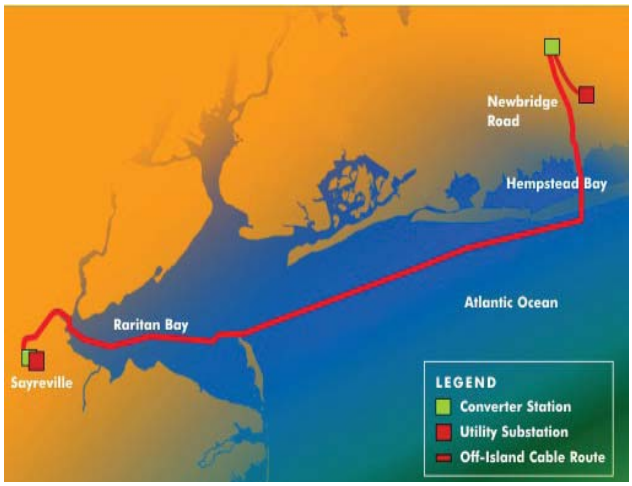
Neptune Regional Transmission System

Long Island, New York

Owner
Neptune Regional Transmission System

Project Features

• Installation of 500 kV high-voltage direct current electric cable
• Detailed design of 23 HDD cable crossings, ranging in length from 450 to 3,000-ft
• Installation of cables below highways, wetlands and marine environments.
• Innovative grout reduced thermal loads and lowered duct costs.



Key Personnel:
Nick Strater, PG
Brian Dorwart, PE, PG

The Neptune Regional Transmission Project involved installation of a 500 kV high-voltage, direct current electric transmission cable connecting power generation resources in New Jersey to electric consumers on Long Island, NY. The majority of the route - more than 50 miles - was located in New York Harbor and the Atlantic Ocean. However, 14 miles was buried in the existing right-of-way of the Wantagh State Parkway. The alignment of the 14 mile reach crossed numerous highways, wetlands and marine inlets. Horizontal Directional Drilling (HDD) was selected as the construction method of choice to complete these crossings with minimal disruptions to traffic, and disturbance to the environment. In addition, HDD was also selected as the construction method to make the cable shore landings on Long Island, and in Sayreville New Jersey, to minimize shoreline disturbance.

Representatives of Brierley Associates were engaged by the Project Owner to design the HDD crossings, and to provide construction consultation. Representatives of Brierley also developed a thermal grout design to backfill the HDD duct, and worked with the contractor to formulate a grout installation process that would not collapse the cable duct. In each case, a Brierley representative also provided field oversight of thermal grout installation.



Force Main Installation by HDD

Anne Arundel County, MD

Owner:
Anne Arundel County DPW
2662 Riva Dr # 130, Annapolis, MD 21401
Phone:(410) 222-7500

Project/Client Reference:
GHD
Thor Young, P.E.
16701 Melford Blvd., Suite 330, Bowie, Maryland 20715

Key Characteristics

-Interbedded coastal plain deposits consisting of silt, clay and sand

-Environmentally sensitive corridor with residences

-HDD actvities under South River limited to October 1 through December 15

Design Phase
Begin – Spring 2014
Complete – Summer 2015

Construction Phase
Begin – Summer 2015
Completed 2017

Construction Cost
$31.5 Million

Professional Fees:
$160,000

Key Personnel:
Nick Strater
Brian Dorwart
Tom Pullen
Nathan Stubley
Colby Jesset
James Duffy



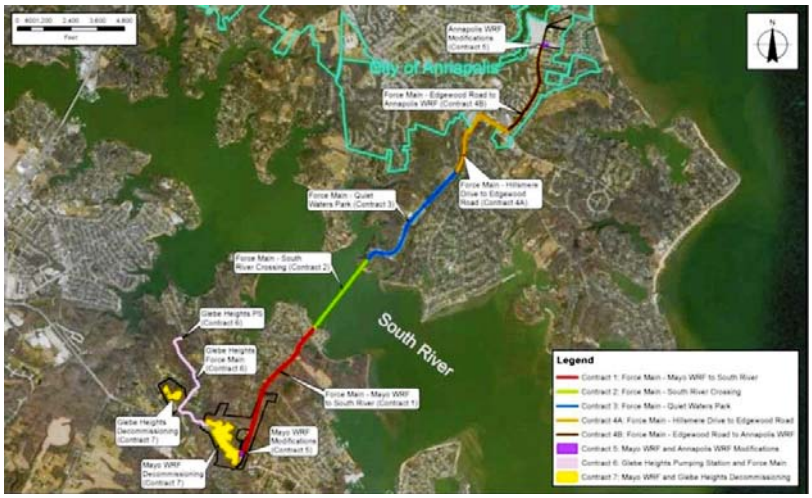
The Mayo Water Reclamation Facility operated by Anne Arundel County receives septic tank effluent via a pump station system from Mayo peninsula residents. Since pump station capacity has been reached the County imposed a moratorium on future development.

GHD was selected by Anne Arundel County to assist with alternative analysis, project planning and design. GHD in-turn subcontracted with Brierley Associates to assist with trenchless concept development and design. The approved selected alternative involves construction of approximately 28,000-ft of new force main to convey wastewater from the Mayo area northward to the existing Annapolis Water Reclamation Facility (WRF). Once the new force main is in service, the Mayo WRF will be converted into a regional sewer pumping station.



Due to the length of this project, construction has been divided into five separate contracts. The first of these contracts (shown in bright green on the map below) is the 4,100-ft alignment beneath the South River. Given the sensitive ecosystem, Horizontal Directional Drilling (HDD) was selected as the mean to install this first section.

Brierley Associates led the HDD design team that was challenged by subsurface ground conditions consisting of deep, very soft soils. To mitigate the potential of inadvertent drill fluid losses, a bore depth of over 100-ft deep below river bottom, was chosen. Through our design analysis we selected 24-in diameter, DR-7 HDPE that was capable of withstanding the installation forces.



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Exelon/BGE, 1500-103 BGE Russett to Tipton Duct Bank, Laurel, MD.

Owner:
Baltimore Gas & Electric/Excelon

Client:
Black & Veatch

Owner Contact:
Jim Casey, PMP
Principal Project Manager
Phone 410-470-6708

Project Dates:
2014 - 2016

Key Personnel:
Nick Strater
Brian Dorwart
Colby Jesset

Baltimore Gas and Electric recently required installation of a new underground 230kV electric cable distribution system in south-central Maryland. The cable alignment passed through numerous upland wetlands, and crossed the Little Pawtuxtent River, which is a tributary to Chesapeake Bay. The Patuxent River was designated as a scenic river by the Maryland General Assembly, and is targeted for protection by the Maryland Department of the Environment (MDE). To minimize environmental disturbance, and to meet MDE permit requirements, five (5) separate sections of the cable alignment were designated for trenchless construction during project planning.

Brierley Associates was responsible for design of five (5) trenchless crossings, each involving three (3) parallel HDD installations of electric cable duct bundle. Each bundle consisted of 5, 10-in HDPE duct. Drill paths range from about 1,200 to 2,200 feet in length, located below wetlands, and the Pawtuxtent River. Provided drill path geometry, pull force and annular pressure calculations, and construction oversight.

Brierley Associates provided field oversight of the Contractor's activities, collected and assessed annular drill fluid monitoring data to help reduce the risk of fracout. Provided consultation to Owner and Contractor during construction.



City of Middletown Force Main HDD Installation

Middletown, CT

Owner:
City of Middletown

Client:
Maguire Group Inc.

Project Delivery Method:
Design-Bid-Build

Project Dates:
Design Start –2012
Construction Ongoing

Key Personnel
Nick Strater
Brian Dorwart

The project involves Installation of two parallel sewer force mains in Middletown, CT, to the west of the Connecticut River. The force main alignment extends from a new pump station located between Route 9 and the Route #17 North off ramp, northward to a treatment facility located to the north of the intersection of Route 9 and Main Street. The alignment also crosses the Sebethe River, and an existing railroad.

To minimize surface disturbance, the project includes two parallel, 2,950-ft long HDD pipe installations adjacent to Route 9 and an active railroad, and two parallel, 1,350-ft long HDD installations below the Sebethe River. The pipe selected for the HDD sections consists of 24-in fusible PVC.



Brierley Associates was contracted to provide design of the HDD installations. For each of the four (4) bores, Brierley developed a plan and profile HDD alignment, evaluated pipe installation stresses, and assessed risk of inadvertent drill fluid loss during construction. Brierley also assisted in the development of specifications for the product pipe and the HDD process.

Project construction began during Fall of 2014, and is scheduled to be completed during 2015. Brierley Associates is providing technical assistance to the construction manager for the HDD installations. In addition to submittal review, our field representatives are documenting the subusrface conditions encoutnered during drilling , and verifying that the pilot hole geometry is consistent with the design drawings.

Brierley is also monitoring pullback of the product pipe, to help ensure the installation loads do not exceed the limitations of the product pipe.



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Creating Space Underground



Mears Group, Inc.

A QUANTA SERVICES COMPANY

HORIZONTAL DIRECTIONAL DRILLING




DANGER
WATCH YOUR HANDS AND FINGERS
DANGER
PELIGRO

WE DO MORE THAN JUST DRILL

The Mears reputation as a leading horizontal directional drilling (HDD) company has been earned by working hard and smart for our customers, gaining their confidence in our capabilities by completing complex and innovative projects. Our professional construction and engineering teams have experience, expertise and ingenuity that is well-known to the oil and gas, electrical and water/wastewater industries.

Mears is part of a professional network of companies under Quanta Services, Inc. (a Fortune 500 Company). As part of this network, Mears is able to provide customers with the nation's largest pool of skilled workers, equipment and specialized services to deliver infrastructure solutions to the power and pipeline industries all across the world.





HORIZONTAL DIRECTIONAL DRILLING

Changing regulations, safety and quality standards and environmental concerns are an ever-present challenge to pipeline, power and utility companies responsible for installing and maintaining pipelines, cables and conduits. Led by a team of in-house engineers, project managers, steering technicians, international logistics and field personnel, Mears navigates the concerns of our customers through even the most complex projects.

With support from our Certified Equipment Managers, our fleet of horizontal directional drilling rigs and support equipment can complete projects with pipe diameter up to 60-inches, and our drilling capabilities include continuous lengths of over 11,000 feet.

Our experience also includes:

- Conventional HDD Crossings
- Marine Crossings (Water-to-Water and Shore Approaches)
- Hard Rock Drilling
- Design/Build
- Engineering, Procurement and Construction
- Direct Pipe®



MEARS' COMMITMENT TO SAFETY, QUALITY & ENVIRONMENT

Our **Safety Management System (SMS)** has allowed Mears to maintain the highest standards in health and safety, and it is our company policy to provide and maintain safe and healthy conditions for all employees, customers and the public. Our commitment to safety is at the core of our company values and forms a foundation for operational excellence. The **OHSAS 18001:2007** standard has elevated our safety practices to an even higher level for our employees and customers.

Mears' **Quality Management System (QMS)** is thoroughly designed and implemented to ensure client expectations and needs are exceeded. Guided by the **ISO 9001:2008** standard, Mears Group monitors and documents quality performance, effectiveness and compliance.

Additionally, our maintenance program, run by AEMP Certified Managers (CEMs), helps reduce downtime on projects and increases overall productivity by keeping equipment in optimum running condition.

The **Environmental Management System (EMS)** was established to strengthen Mears' commitment to protecting the environment by conducting our business operations in an environmentally responsible and sustainable manner. We recognize that by reducing and, when possible, eliminating waste, the environmental impact of our activities is significantly decreased.

To further our commitment to protecting the environment, Mears attained the **ISO 14001:2004** certification, and continues to place the value of environmental management as central to our corporate success.







DESIGN/BUILD

At Mears, we offer our clients the opportunity to have their project designed and built as one turnkey operation. Benefits of design/build project delivery include:

- Reduced owner risk
- Shortened project schedules
- Single point of contact
- Increased cooperation
- Reduced owner resources
- An environment of design and construction innovation

ENGINEERING, PROCUREMENT & CONSTRUCTION

Mears' engineering, procurement and construction (EPC) services provide a single source of contact and responsibility to our clients, saving them time and money. Through our EPC process, Mears' engineers, construction teams and subcontractors can communicate clearly and consistently with each other, ensuring that informative and collaborative decisions are made throughout the project. Additionally, having a single source of responsibility on a job enhances the safety and productivity of the project.





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MEARS GROUP, INC.

HORIZONTAL DIRECTIONAL DRILLING
5051 Westheimer Rd., Suite 1650
Houston, TX 77056
281-448-2488
www.mearsHDD.net

Certified in Safety, Quality, and Environmental: OHSAS 18001:2007, ISO 9001:2008 and ISO 14001:2004



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PROJECT FACT SHEET

St. Lucie to Turnpike 230 kV Transmission Line Project

Awards/Recognition	*2017 ISTT No-Dig Project of the Year Award* *2016 NASTT Trenchless Technology Project of the Year Award*
Location	Port St. Lucie, FL
Date Completed	June 2016
Project Type	Electric
Equipment	Mears' 140,000 lb. rig and 1.1 Million lb. rig
Owner/Client	Florida Power & Light (FP&L)
Length, Pipe Diameter, Pipe Material	Two (2) HDD River Crossings: 30-inch FPVCP Casings installed at 7,020-feet with four 10 inch and two 3 inch high density polyethylene (HDPE) conduits surrounded by NoSet™ (a specially formulated thermal grout/slurry).
Type of Crossing	River
Project Summary	Record Breaking 30 inch Fusible PVC® Casing Installation/Successful Research & Development of XLPE Cable Installation of Lengths over 7,000 feet Two 30 inch Fusible PVC® casing pipes (FPVCP) were installed in two parallel HDD bores 60 feet below the Indian River. 7,020 foot of FPVCP casing was inserted through each of the bores representing the longest lengths that any FPVCP pipe has been installed in an uncased HDD application of any diameter. Each casing ultimately housed four 10 inch and two 3 inch high density polyethylene (HDPE) conduits in a specially formulated thermal grout/slurry. The project required complex HDD equipment site set-ups to accommodate the necessary rigs and support equipment. Mears' 1.3M lb. drilling rig was set-up at the entry side, with a Mears' 140,000 lb. drilling rig at the exit side on Hutchinson Island near the nuclear power plant. Support equipment included three mud recycling systems and pumping equipment that were staged approximately 2,000 feet from the drill exit site. Due to the distance between all equipment and activity, special remote controllers and constant communication between the team members were necessary to keep the operation running smoothly.







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HDD Division
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PROJECT FACT SHEET

Hayes-Yorktown 230kv Transmission Line Crossing - EPC

Location	Yorktown, VA & Gloucester, VA
Date Completed	January 2013
Project Type	Electric Transmission Line
Equipment	70,000 lb. rig, 140,000 lb. rig, 330,000 lb. rig
Owner/Client	Dominion Virginia Power
Engineer	Haley & Aldrich – HDD & Civil; EHV Power – Electrical; Antares Offshore – Structural; RCI – Offshore Consultant
Length, Pipe Diameter, Pipe Material	Two approx. 6,900-feet, two approx. 5,800-feet and two approx. 2,900-feet - for a total of approximately 35,200-feet., 8-inch steel bundled with 3-inch HDPE
Type of Crossing	Water-to-water, River Crossing
Project Summary	This project consisted of an installation of a 230 kV power line requiring a detailed, multi-disciplined approach necessary to design and construct a three mile river crossing project with multiple horizontal directional drilling (HDD) segments for an electric transmission system. The project was completed by the engineering, procurement and construction (EPC) method involving a large group of engineers and contractors to bring together the specialized technical resources required. Six HDD crossings were required for the parallel system of 8-inch steel and four temporary platforms constructed in the river to allow for HDD operations. This resulted in four shore approaches (two at each side of the river) and two water-to-water crossings between the platforms. After the HDD work was completed, electric cables were pulled through each pipe segment. The cables were then spliced on each shore and on each of the platforms. After the system was tested, the pipelines were lifted off the platforms and lowered into pre-excavated trenches within the York River and backfilled.





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Phone: 800-632-7727 ▪ 281-448-2488

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MICHELS®

Horizontal Directional Drilling



Michels® Leads the Way in HDD

Michels® Corporation is regarded as the North American leader in Horizontal Directional Drilling (HDD), and we are determined to stay on top. Our record-setting drills are supported by an unrivaled fleet of 84 drilling rigs of all sizes, including the largest fleet of 1.2 million pound thrust/pull force capacity rigs in the world.

Michels has successfully completed HDD crossings in all 50 states, Canada, along the U.S.-Canada and U.S.-Mexico borders, and internationally. Our highly respected HDD staff includes some of the most knowledgeable, talented, and experienced leaders in the industry. They work together to set industry records, develop new methods, and design and fabricate equipment to expand the possibilities for using HDD in increasingly challenging situations.

- **Largest fleet of 1.2 million pound thrust/ pull force capacity rigs in the world**
- **Completed crossing spans greater than 15,000 feet in single pull, capable of installing pipe up to 60 inches in diameter**
- **Trenchless technology protects natural resources such as wetlands by drilling beneath them**
- **Land-to-water and water-to-water crossings, impervious to shoreline erosion, ice movement, dredging, anchors and watercraft**



Water-to-Water Crossings

STATEMENT OF QUALIFICATION
MICHELS DIRECTIONAL CROSSINGS

Michels Directional Crossings, a division of Michels Corporation, has been utilizing Horizontal Directional Drilling (HDD) technology for trenchless installation of underground utilities since 1986. Michels Corporation has been in business and performing underground utility construction since 1960 and has since diversified and expanded into one of the most highly preferred HDD companies in North America as well as internationally. HDD is a trenchless method of underground utility construction where a conduit is installed from one surface location to another below the ground surface utilizing a guided directional drilling system. Michels has successfully completed thousands of HDD crossings throughout the United States, including Hawaii and Alaska, and several foreign destinations including the Caribbean and the Middle East. Since starting directional drilling operations, our HDD capacity has expanded in virtually every aspect of the technology, setting new industry standards year after year. As an industry leader, Michels continually tests and expands the HDD construction limits with our largest capacity equipment, while at the same time providing extremely reliable services for HDD projects of a less challenging nature, greatly succeeding at both ends of the spectrum. No HDD project is considered too large, too small, too difficult, or too distant for Michels.

When limitations to equipment capacity are exceeded, Michels' custom fabricates larger rigs, several of which are the largest rigs currently available anywhere in the world. When multiple rigs are required to complete a project on schedule, Michels provides virtually unlimited support and resources with our 84 owned & operated HDD rigs, each with highly experienced support crews. When unforeseen conditions are encountered on a project, Michels provides complete 24-hour machine shop fabrication support for manufacturing or repairing specialized equipment and down-hole drilling tools capable of overcoming some of the most difficult drilling conditions. The resources available to Michels Directional Crossings as a division of a much larger utility contractor provides our drilling division with unprecedented capabilities in the HDD industry and gives us a leg-up on our competition.

Michels' resources are matched only by our experience in HDD crossing technology. Michels has directionally drilled and installed virtually every type of utility under most conceivable crossing conditions, and many under inconceivable conditions. Michels drilling superintendents each have a minimum of 5 years experience and some have as many as 30 years experience. An HDD utility crossing typically crosses underneath locations where surface obstructions prevent traditional construction via conventional trenching methods or where disturbance to the surface is simply not feasible. From some of the hardest solid bedrock conditions, to massive boulders and cobbles, to soft silts, seashells, sands, and clays, Michels has successfully completed crossings up to 50" in diameter and crossed spans of over 15,700 Ft in length.

Michels HDD Crossing Length Summary
-Longest Pulled length: 15,700 Feet (6")
-Longest Drilled Rock: 12,902 Feet (8")
-Longest/Largest Drilled Rock: 9,040 Feet (36")
-Over 65 Greater Than 5,000 Feet
-Over 130 Greater Than 4,000 Feet
-Over 285 Greater Than 3,000 Feet
-Over 570 Greater Than 2,000 Feet
-Thousands Less Than 2,000 Feet

Michels HDD Crossing Diameter Summary
-Largest: 49.75"(3,200 Feet)
-Over 150 Greater Than 40"
-Over 545 Greater Than 30"
-Over 900 Greater Than 16"
-Over 980 Greater Than 12"
-Thousands Less Than 12"

Types of Crossings Performed By Michels

- River, stream, and canal crossings
- Water body crossings (lakes, ponds, tidal bays etc.)
- Environmentally sensitive areas including wetlands
- Heavily congested surface areas (roadways, railroad tracks, airport facilities, industrialized areas)
- Aesthetically sensitive locations (historical or archeological significant grounds and structures or pristine residential areas)
- Land to marine conduit transition locations (beach approaches)

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- Water-to-Water crossings
- Hazardous waste contaminated areas
- Geologically unstable areas (landslides)
- Heavily laced utility corridors
- Pilot hole intersect and dual assist crossings

Larger diameter long length crossings are considered less risky and more feasible due to Michels' addition of the Herrenknecht Pipe Thruster to the assist arsenal. Over the past several years Michels has acquired (1) 300 Ton (1) 500 Ton and (2) 750 Ton Pipe Thrusters. Michels' deployment of this piece of equipment to large diameter long length crossings has proven dividends when required to assist with providing additional force necessary for assist with pull back alleviating stress and fatigue on downhole tooling which could otherwise fail if overstressed. Projects aided by thruster assistance include:

- Energy Transfer- DAPL (2017) 30" Coated Steel; 7,531'; Lake Oahe & Missouri River; Stiff Clay, Coal Seams, Fractured Rock, Dirt & Cobble
- Spectra Energy (2016) 36" Coated Steel; 3,829'; Flint River; Sands & Silts
- TransCanada (2016) 42" Steel Casing; 7,200'; Athabasca River; Oil Sands, Sands & Silts over Hard Limestone, Sandstone
- Texas Eastern Transmission (2016) 30" Coated Steel; 5,378'; Hudson River, New York, NY; No Blow count silt and Marine Sediments
- JEA Jacksonville Electric (2012) 36" Coated Steel; 6,575'; St. Johns River, Jacksonville, FL; Sands, Silts, Layered Limestone

Michels has diversified and adapted HDD techniques to successfully complete a relatively new technology called pilot hole intersect. This new technically advanced form of directional drilling allows never before attempted lengths to be completed and increases the possibility of reducing the risk for over-pressurizing the underlying geological formation. This not only mitigates the pressure beneath sensitive areas but reduces the risk for inadvertent returns in these locations. Pilot-hole-intersect technology is most valuable when drilling complex scenarios such as:

- Sensitive Levee crossing where requirements call for reduced downhole pressure when traversing beneath levee.
- Substantial elevation difference of more than 40' from entry to exit.
- Longer crossings where conventional HDD is greatly challenged.
- Unstable upper formation detrimental to drilled hole integrity at both entry and exit locations. This allows installation of conductor casing from both locations and a drill rig staged from both sides.

<u>Pilot Hole Intersect – Most Notable Listed (145 such completed through April of 2017)</u>

- Transcontinental Gas (2017) 30" Stl; 2,278'; Chattahoochee River; GA; Gneiss Bedrock
- ETC-Energy Transfer (2017) 30" Stl; 7,531'; Lake Oahe/Missouri River; ND; Stiff Clay/Fractured rock/Coal Seams
- Alliant Energy (2016) 16" Stl; 6,693'; Wapsipinicon River; IA; Sand, Gravel, Clay, Rock
- ETC-Energy Transfer (2016) 30" Stl; 7,282'; Mississippi River; IL; Limestone w/zones of Chert
- ETC-Energy Transfer (2016) 30" Stl; 6,328'; Big Sioux SD/IA; Sand, Clay, Claystone Rock
- Paradigm Midstream (2016) 16" Stl; 11,397'; Lake Sakakawea SOUTH, ND; Stiff Clay w/Coal Seams
- Paradigm Midstream (2016) 16" Stl; 11,229'; Lake Sakakawea NORTH, ND; Stiff Clay w/Coal Seams
- Energy Transfer (2016) 30" Stl; 6,120'; Lake Whitney, TX; Sand, Fat Clay, Claystone/Mudstone
- TransCanada (2016) 42" Stl; 3,399'; McKay River Alberta; Clay, silts over Sandstone
- Martin Operating Partners (2016) 12" Stl; 11,548'; Union Canal & Martin Barge Canal, TX; Sands, swelling Clay
- TransCanada (2016) 42" Stl; 7,228'; Athabasca River, Fort McMurray Alberta; Sandstone, Mudstone
- Enterprise Products (2015) 24" Stl; 7,432'; Houston Ship Channel, TX; Swelling Clays and Sands
- Enterprise Products (2015) 24" Stl; 5,908'; Tabbs Bay, TX; Clay, Sand, Swelling Clay
- Magellan Midstream (2015) 12" Stl; 11,563'; Holland Bottoms Wetlands, AR; Sands, Silts, Clay & Limestone
- Enbridge Energy (2015) 36" Stl; 5,128'; Lake Ave & RR, Sauk Village, IL; Cobble/Rock
- Sunoco Logistics (2015) 10" Stl; 4,654'; Allegheny River, PA; Rock Shale/Sandstone 4,500-18,338 psi
- Phillips-66 (2015) 18" Stl; 12,459'; Houston Ship Channel, TX; Sands, silts and swelling clays

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- City of Lake Oswego (2014) 36” Stl; 3,805’; Lake Oswego, OR; Willamette River; Cobbles over Basalt
- Williams-WPX Energy (2014) 6” Stl; 6,999’; Aztec, NM; Navajo Reservoir/San Juan River; Sand, sandstone/cobble
- Phillips-66 – (2014) 8” Stl; 7,321’; MP49.3 Landslide Area; Billings, MT; Clay, Bentonite, Mudstone
- Enbridge Energy - Flanagan South – (2014); 36” Stl, 9,040’; Quincy, IL; Mississippi River & Levees; Packed Sand & Gravel with areas of Shale
- InterPipeline Ltd, Canada – (2013); 42” Stl; 4,284’; Vermillion River, Alberta, Clay Till w/Boulder Layer above Clay Shale
- Kinder Morgan/Tennessee Gas – (2013); 30” Stl; 4,988’; Monksville Reservoir; NJ (Diorite/Gneiss/Granite)
- Jamaican Bay – (2013); 2 xings 12” Stl and 26” Stl; 6,215’; Brooklyn/Queens, NY (Silts, Sand, Seashells)
- SCANA – (2013); 8” Stl; Land to Water 7,304’; Water to Water 7,177’; SC (Sands and Clay)
- Texas Eastern Spectra Energy NJ/NY Expansion Project – (2013); 30” Stl; 6,544’; East 1st Street; NY (Diabase)
- Texas Eastern Spectra Energy NJ/NY – (2013); 30” Stl; 8,101’; Kill Van Kull; NY (Siltstone/Sandstone 15,000PSI)
- Texas Eastern Spectra Energy NJ/NY–(2013); 30” Stl; 4,441’; Goethals Bridge Tidal Area; NY (Rock, Siltstone/Sandstone/Diabase)
- Texas Eastern Spectra Energy NJ/NY – (2013); 30” Stl; 4,861’; 18th Street/Long Slip; NJ (Hard Rock, Diabase)
- Texas Eastern Spectra Energy NJ/NY – (2013); 30” Stl; 5,378’; Hudson River; NJ/NY (Very Soft Silty Clay, W.O.H. Blow Counts)
- AT&T Communication – (2012); 8” Stl; 10,053’ Potomac River; VA/MD (Soft Silty Clay)
- ConocoPhillips – (2012), 8” Stl; 2-Xings 4,475’ and 12,902’ MP-57 and MP-66; Wyola, MT (Clay, Shale, Gypsum)
- Shell Appalachian Pipeline – (2012), 8” Stl; 2,645’ High Elevation Change; Tioga Junction, PA (Sandstone/Shale)
- West Shore Pipeline (Buckeye) – (2012), 16” Stl; 5,754’; New Berlin, WI (Heavy Grey Clay, Cobble, Limestone)
- JEA – Jacksonville Electric Authority (2012), 36” Stl; 6575’; Jacksonville, FL (Sand, Marl and Limestone Layers)
- Progress Energy (2012) Cape Fear River, (2-separate) 8” Stl; 6,675’; Wilmington, NC (Limestone/Sand)
- TransCanada/Keystone (2012) S. Saskatchewan River, 36” Stl; 4,505’; Medicine Hat, Alberta, Canada (Clay over sandstone, cobbles sand, gravel)
- National Fuel/Empire Pipeline (2011) Chemung River, 24” Stl; 2,645’; Corning, NY (80’ of Nasty Overburden of Clay, Silt, Cobbles and Boulders over Shale/Limestone Bedrock)
- ConocoPhillips Pipeline (2011) Grand Lake, 10” Stl; 3,447’; Wyandotte, OK (20’ Layer of Gravel and Sand over Dolomitic Limestone with Shale up to 22,000 psi)
- Enterprise Pipeline (2011) Atchafalaya River and Levee System, 36” Stl; 4,992’; Melville, LA Corps Levee Crossing Requirements Met (Clay with Gravel, fine and coarse)
- Enterprise Pipeline (2011) Old River & I-49, 42” Stl; 5,732’; Melrose, LA (Silts, Sands, Hard Sticky Clay)
- Florida Gas Transmission (2011) Military Canal, 24” Stl; 6,091’; Homestead, FL (Sandy Limestone, Limestone with pockets of Sand)
- Tennessee Gas Pipeline (2011) Lake Conway, 30” Stl; 5,786’; Vernon, NJ. (Some of the Hardest Rock in NJ consisting of Amphibolite, Seyenite Gneiss with Quartz Veins, (Magnetic) Granite, up to 52,000psi)
- BC Hydro (2011) False Creek, 230kV (7)10” HDPE (5)4” HDPE Grout Pipes; Vancouver, BC (Sand, Gravel and Cobble over Bedrock; Sandstone/Siltstone/Mudstone)
- Enterprise Products (2011) Missouri River, (3-separate) 8” Stl; 7,020’; Decatur, NE (Sands, Gravel)
- Energy Transfer (2010) Saline Bayou, 42” Stl; 5,248’ Crowson, LA (Sand, Dense Silt)
- Carolina Gas Transmission (2010) Cooper River, 16” Stl; 9,932’; Charleston, SC (Hard Clay)
- Fayetteville Express (2010) Little Red River, 42“Stl; 3,497’ ; Plainview, AR (Hard Sandstone/Limestone)
- Rockies Express Pipeline (2009) Illinois River, 42“Stl; 2,975’ ; Milton, IL; (Gravel, Limestone/Shale)
- PSE&G (2009) Newark Bay, 16” Stl; 6,230’ ; Elizabeth, NJ (Rock, Dolerite/Shale)
- Enbridge Pipeline (2008) Kishwaukee River, 42”Stl; 2,564’ ; Belvidere, IL (Running Sands)
- PG&E (2008) Stone Lakes NWR, 24” Stl; 6,518’ ; Walnut Gove, CA (Clays, Sands, Sediments)
- Brunswick Pipeline (2008) St. Johns River, 30”Stl; 4,272’ ; St John, New Brunswick (Cobbles and Boulders over Fractured Diorite/Granite up to 30,000 psi)
- ExxonMobile (2008) Old River, 42” Stl; 6,017’; Port Arthur, TX (Silty Sands/Clay Very Dense)
- King County, WA (2007) High School & 6th St., 32” Stl w/28” HDPE 3,947’; Bellevue, WA (Sand/Gravel)
- PG&E (2007) Old River, 24” Stl; 6,779’ ; Sacramento, CA (Clayey Silt, Silty Sand)
- PG&E (2007) Latham Slough, 24” Stl; 6,418’ ; Sacramento, CA (Clayey Silt, Silty Sand)

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- Enbridge Pipeline (2007) Flambeau River, 20” Stl; 2,280’ ; Ladysmith, WI (Mica Schist/Gneiss Bedrock)
- Niu Valley (2007) Niu Stream/Kalanianaole Hwy, 20” HDPE 3,250’ ; Honolulu, HA (Silt/Sand/Coral)
- City of Coronado, CA (2007) San Diego Bay, 30” HDPE, 3,086’; San Diego, CA (Sandy Clay)
- Okaloosa Gas District (2006) Choctawhatchee Bay, 10” Stl; 8,400’ ; Santa Rosa Beach, FL (Sand)
- Gaz Metropolitan (2005) St. Lawrence Seaway, 20” Stl; 7,455’ ; Trois-Rivieries, Canada (Limestone)
- SCG&E (2004) Cooper River, (2ea) Parallel 8” Stl; 7,074’; Charleston, SC (Cooper Marl Clay)
- Maritimes & NE (2003) Georges Island Water to Water, 30” Stl; 5,174’; Salem, MA (Meta Siltstone/Sandstone, Granite, Gneiss, Schist)
- Williams Gas Pipeline (2002) McClane Park, 30” Stl; 4,212’ ; Tumwater,WA (Fine-Coarse Gravel/Sand)
- North Carolina Gas (2000) Rock Creek/Hendrix Swamp, 30” Stl; 1,280’; Concord, NC (Granodiorite)
- Alliance Pipeline (1999) Peace River, 24” Stl; 3,557’ ; Taylor, British Columbia (Rock, Mudstone)

Crossings have been successfully completed by Michels for most of the major utilities in the United States with 100% satisfaction. Pipeline (Natural Gas & Fuel Products), Civil (Water & Sewer Force Mains), Telecommunications (Fiber Optics & Telephone Duct Banks), & Electrical (Cable Duct Banks) are the most common types of utilities installed by Michels. Michels is recognized by each of these utility industries as a leader in HDD technology, especially when it comes to completing the most difficult projects on schedule & within budget as exemplified by successful completion of numerous milestone projects in each of these industries.

Pipeline

- Cheniere Energy (2017) 48” Stl; 4-xings 2,263’- 3,291’; TX (Clay and Sand)
- Energy Transfer Co. DAPL Pipeline (2016-2017) 30” Stl; 16-xings 1,278’- 7,531’; IA/SD/ND (Clay, Sand, Cobble, Rock, Claystone and Fractured Rock)
- Vermont Gas(2016)12”Stl;10-xings 492’–3,144’;VT (Clay, Sand, Rock-Dolomite & Pink Quartzite up to 40,000 psi)
- Paradigm Midstream (2016) 16” Stl; 2-xings 11,229’ and 11,397’ Lake Sakakawea, ND; Clay, Claystone
- NICOR-AGL Resources (2015) (1)24”Stl 1,898’; (4)36”Stl; 1,755’-3,031’; IL; Fat Clay, Sand, Gravel
- Enbridge Energy (2015) 36” Stl 8-xings; 1,803’-5,128’; IN/IL; Clay, Sand, Cobble, Gravel, Rock
- Enterprise Products Pipeline (2015) 24” Stl; 3-xings 3,716’, 5,908’, 7,432’ (Corps Levee); TX; Clay/Sand
- Enbridge Pipeline, Canada (2015) (1)42”, (9)36” Stl; 1,411’-3,412’; Toronto, Canada; Clay/Sand/Cobble/Boulder
- Alabama Power (2014) 24” Stl; 4-xings 1,935’, 1,961’, 2,020’, 2,884’; AL (Fractured Rock, Karst Formation)
- Gulf South Pipeline (2014) 30” & 24” Stl; 6-xings 1,692’, 1,376’, 2,003’, 2,750’, 2,890’, 3,030’; MS (Clay, Gumbo)
- Enbridge Energy-Flanagan South (2013-2014) 36” Stl; 12-xings (1) 9,040’, (11) 1270’ – 5,690’; IL/MO (Dirt & Shale/Limestone)
- Kinder Morgan/Tennessee Gas (2013) 30” Stl; 3-xings 1,881’, 2,344’, 4,987’; PA/NJ (Sand, Cobbles; Quartz and Pegmatite, Granite/Gneiss Hard Rock.
- Texas Eastern Spectra Energy NJ/NY (2013) 30” Stl; 3-xings 8,101’, 4,861’, 5,378’; NY/NJ (Hard Rock to W.O.H. Blow Count Silt)
- Texas Eastern Spectra Energy NJ/NY (2013) 42” Stl; 2-xings 4,441’, 3,211’; NY/NJ (Siltstone up to 8,100 PSI)
- TransCanada/Keystone (2012-2013) 20-Xings 36” Stl; 1,500’ - 4,350’; TX, OK (Sandy Clays TX, Shale/ Sandstone OK)
- St. Clair Pipelines L.P. Union Gas (2012) 20” Stl; 3,048’ St. Clair River, Marysville, MI (Sands, Silts, Clay)
- Shell Appalachian Pipeline (Tioga Junction, PA) – (2012) 8”/16”/20” stl; Multiple Xings 2,500-3,900’; Gravel, Rock
- ConocoPhillips – (2012) - 8” Stl; 2-Xings 4,475’ and 12,902’ MP-57 and MP-66; Wyola, MT (Clay, Shale, Gypsum)
- Enterprise Pipeline (2011) – 9 Crossings (3) 36” and (6) 42”; All Crossings Pilot Hole Intersect and Several Completed using Gyroscope. Longest 36” KC RR @ 5,325 Ft; Longest 42” Old River/I-49 @ 5,735 Ft; Louisiana
- Tennessee Gas Pipeline (2011) – 30” Steel 5,786 Ft; New Jersey; (Hard Rock; Gneiss, Amphibolite, Magnetic)
- Enbridge Energy (2009) – 33 Crossings (12) 20” and (21) 36”; 1,000 Ft to 5,230 Ft; Minnesota (Clays, Gravel)
- Rockies Express (2008-2009) – 18 Crossings 42” 3,960 Ft; MO, IL, OH (Mixed Variation Gravel, Cobble & Rock)
- Exxon Mobil (2008) – 4 Crossings 42”; Crossings Pilot Hole Intersected; 3,700 Ft to 6,020 Ft; Texas; (Sand, Clay)
- Exxon Mobil (2008) – 13 Crossings x 42“ to 6,017 Ft; Texas; (Sands, Silts & Clay)

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- Guardian Pipeline (2008) – 3 Crossings x 30“ to 3,078 Ft; Wisconsin; (Gravels & Clay)
- PG&E (2007) – 7 Crossings x 24“ to 6,779 Ft; California; (Clay, Silts and Sands)
- Enbridge Pipeline (2007)– 10 Crossings x 42“ & 20“ to 2,776 Ft; Wisconsin; (Limestone)
- Florida Gas (2007) – 12 Crossings x 36“ up to 3,505 Ft; Florida (sands, silts, Limestone)
- Northern Natural Gas (2007) – 11 Crossings x 24“ to 2,795 Ft; Minnesota; (Sands, Clay)
- Dominion Transmission (2007) – 6 Crossings 36” up to 4,652 Ft; Maryland (Range from Clayey Silt, to Cobble, Boulders and 27,000 psi Sandstone/Siltstone)
- Dominion Transmission (2007) – 3 Crossings 24” up to 3,382 Ft; Pennsylvania (Limestone/Dolomite/Shale)
- Gulf South Pipeline (2007) - 13 Crossings 42” up to 3,954 Ft; Louisiana (Poor Graded Sand/Well Graded Sand/Sandy Lean Clay)
- Okaloosa Gas (2006) – 1 Crossing x 10“ to 8,400 Ft; Florida; (Compacted Sand, Shells)
- Gaz Metro (2005) – 1 Hole Intersect Crossing x 20“ to 7,456 Ft; Quebec, Canada; (Limestone and Shale)
- Eastern NC Gas (2004) – 1 Crossing x 6“ to 15,713 Ft; North Carolina (Fine Sand, Silty Clay & Shell Fragments)
- Maritimes & Northeast Pipeline (2002-2003) – (1-Intersect) 7-Crossings x 24” or 30“ to 5,286 Ft; 3ea Land to Land/2ea Land to Water and 2ea Water to Water Xings; Massachusetts (Granite, Gneiss and Schist)
- Guardian Pipeline (2002) – 4 Crossings x 36“ to 3,045 Ft; Illinois; (Gravels Shale/Limestone Bedrock)
- Vector Pipeline (2000) – 6 Crossings x 42“ to 2,230 Ft; Michigan (Sandstone, Sands and Gravels)
- Alliance Pipeline (1999) – 6 Crossings x 36“ to 3,633 Ft; Illinois to Minnesota (Limestone, Sands/Gravels)
- Williams Transco (1998) – 1 Crossing x 24“ to 6,041 Ft; North Carolina (Granite and Sandstone)
- Pacific Pipeline (1998) – 6 Crossings x 20“ to 5,107 Ft; California (Granodiorite, Sands and Gravels)
- PNGTS Pipeline (1998) – 12 Crossings x 24” or 30“ to 2,868 Ft; New Hampshire to Maine (Gneiss, Schist and Phyllite)
- Northern Border Pipeline (1998) – 6 Crossings x 36“ to 3,727 Ft; Illinois to Iowa (Limestone, Sand/Gravel)
- Michigan Consolidated Gas (1996) – 12 Crossings x 36“ to 2,600 Ft; Michigan (sands, gravels, cobbles)
- Florida Gas Transmission (1994) – 32 Crossings x 22” thru 36“ to 4,044 Ft; Mississippi to Florida (Limestone, Sands and Gravels)
- ANR Pipeline/Empire State Pipeline (1993) – 4 Crossings x 24“ to 4,590 Ft; New York to Ontario, Canada (Limestone, Sands and Gravels)

Civil

- JEA-Jacksonville Electric (2016) - Design Build 42” Stl w/36” HDPE Water Main; 3,983 Ft; Jacksonville, FL (Sand Limestone cap w/Marl-Layered Limestone)
- Select Energy Services (2014) - 24” HDPE Intake; 1,060’; Charleston, ND; Lake Sakakawea Intake; Sandy Clay, Cobble
- Hampton Roads Sanitation (2014) - 28” HDPE Sewer; 1,740’; Norfolk, VA; Lafayette River; Cooper Marl
- City of Corpus Christi (2014) – 48” Steel Water Main; 2-Xings 2,060 Ft & 1,692 Ft; Corpus Christi, TX
- Virginia DOT (2013) – 48” HDPE Sewer Force Main; 2-Xings 1,943 Ft and 819 Ft; Virginia Beach, VA
- JEA-Jacksonville Electric (2012) - Design Build 36” Stl Water Main; 6,575 Ft; Jacksonville, FL (Sand/Marl-Layered Limestone)
- Memorial University of Newfoundland (2010) – 14” HDPE Intake 1,554 Ft; Newfoundland, Canada; (Hard Sandstone)
- Atlantic City Municipal Authority (2010) – 42” HDPE 1,010 Ft; New Jersey (Sand and Clay)
- City of Moncton (2009) - 36” HDPE Water Main to 1,873 Ft; New Brunswick, Canada (Mudstone/Sandstone)
- NAVFAC Mid Atlantic (2009) – 20”, 22”, 26” & 30” HDPE Sewer Force Mains to 4,968 Ft; NC (Sand/Shell)
- Guam Water Authority (2008) – (1) 34” HDPE (1) 42” HDPE Sewer Outfalls x 2,200 Ft; Guam; (Limestone/Sand)
- San Luis Obispo Cnty Flood Control & Water Conservation (2008) – (1)18” (3)24” to 3,000 Ft; California; (Stiff Clay Gravel and Cobble)
- US Dept of Navy (2008) – 30” HDPE Force Main x 1,572 Ft; Ford Island, Hawaii; (Coralline Gravel/Limestone)
- King County (2007) – 32“ Steel w/ 28“ HDPE Force Main Crossing to 3,947 Ft; Washington; (Sands & Gravels)
- City of Coronado (2007) – 30“ HDPE Force Main Crossing x 3,086 Ft; California; (Clay & Sands)
- City of Honolulu (2007) – 2 Steel w/ HDPE Force Main Xings x 50“ to 3,100 Ft; Hawaii;(Coral, Sand & Gravel)
- Metropolitan Utilities District of Omaha (2005) – 2 Steel Water Mains x 48” to 2,950 Ft; Nebraska; (Gravel)

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- City of Corpus Christi, TX (2005) – 1 Steel Water Main Xing x 42” 3,283 Ft, Texas; (Clay)
- Army Corps of Engineers (2004) 1 HDPE Intake 10” 3,522 Ft; North Dakota (Silty Sands, Clay)
- City of Marysville (2004) – (2) 36” HDPE Wastewater Force Main to 2,648 Ft; Washington; (Alluvial Deposits)
- Ojai Valley Sanitary District (2003) – 36” Steel w (2)10” (1)12” 3,150 Ft; California; (Boulders over Sandstone)
- Covert Generating PSE&G (2002) – (1)20” HDPE Diffuser 3,232 Ft and (2) 42” HDPE Intakes 2,372 Ft; Michigan (Sand)
- City of Grand Forks (2002) – (1) 36” and (2) 30” Steel Water Intakes up to 2,850 Ft; North Dakota; (Clay Silt)
- Superior Water & Power (2000) – 1 Steel Water Main Xing x 24“ to 4,500 Ft; Wisconsin; (Sands and Gravels)
- St. Charles County (1998) – 1 Steel Water Main Xing x 42“ to 3,500 Ft; Missouri; (Limestone, Sands and Gravels)
- Nueces River Authority (1998) – 2 Steel Water Main Xings x 50“ to 2,360 Ft; Texas; (Silts and Sands)
- Massachusetts Water Resources (1997) – 1 HDPE Force Main Xing x 42“ to 2,025 Ft; Massachusetts; (Silts, Sands and Gravels)
- St. Peter Sanitary District (1997) – 1 HDPE Force Main Xing x 14“ to 3,333 Ft; Minnesota; (Sands and Gravels)
- Missouri American Water Works (1997) – 1 Steel Water Main Xing x 36“ to 4,605 Ft; Missouri; (Silts, Sands and Gravels)
- Public Utility Agency Of Guam (1994) – 1 HDPE Offshore Sewer Outfall x 28“ to 1,760 Ft; Guam; (Coral Reef)
- City Of Norfolk (1992) – 1 Steel Water Main Crossing x 48“ to 2,100 Ft; Virginia; (Silts and Sands)

Telecommunications

- AT&T (2012) – 8” Steel 10,053’; Potomac River, VA/MD
- AT&T – Over 800 Crossings Including Beach Approaches Throughout United States to 4,500 Ft
- U.S. Sprint – Over 200 Crossings Including Beach Approaches Throughout United States to 3,500 Ft
- MCI – Over 100 Crossings Throughout United States to 4,000 Ft
- Level 3 Communications – Over 50 Crossings Throughout United States to 3,800 Ft With up to 42x1.25“ Ducts
- MFN – Over 10 Crossings Throughout U.S., including 5,111 Foot Hudson R. to Manhatten, NY With 21x1.25“ Ducts

Electrical

- Dept of Navy (Land-to-Water) – 2016; 12” Steel; 1,178 and 1,023’; ME; Granite 20,000 – 30,000 psi
- Dominion – 2016; 4-10”/2-4” HDPE Bundle; 3,737’; VA; Gray Clay
- Wisconsin Public Service – 2015; 4-4” HDPE; 764; WI; Clay
- SCANA – 2013; 5-Xings 8” Stl; 2 each Land to Land 2,500’, 4,911’; 2 each Land to Water 3,580’, 7,304’; and 1 each Water to Water 7,424’; SC (Sands and Clay)
- Progress Energy Cape Fear River, (2-separate) 8” Stl; 6,675’; Wilmington, NC (Limestone/Sand)
- BC Hydro – 32” Bundle (7)10” HDPE (6)4” HDPE 230kV included thermal Grouting; 2,785 Ft; Vancouver, BC; Gravel Cobble over Mudstone/Sandstone
- Long Island Power Authority – Bundle (3)12” HDPE for 23 Drills Totaling 21,200 Ft; New York, Sandy Silt
- United Illuminating – 8 x 5“ HDPE bundle to 600 Ft; Interstate-95; Connecticut; Schist bedrock
- South Carolina Gas & Electric – 2 parallel 8” Stl 7,075 Ft 20’ Apart; South Carolina; Cooper Marl Clay
- Israel Electric Corp – (1)12” Stl and (3)30” Stl to 2,836 Ft; Israel; Sand
- NSP – 20“ Steel With 4 x 6“ HDPE bundle to 1,200 Ft; Mississippi R.; Minnesota; Sands
- Com Electric – 18“ Steel With 3 x 6“ HDPE bundle to 1,500 Ft; Maryland; Sands & Gravel
- Niagara Mohawk Power – 16” Steel 1,167 Ft; New York; Gravel, Cobble over Rock

Michels has recently mastered new technology (Pilot-Hole Intersect and Gyroscope tracking) expanding our capabilities for performing some of the most complex directional drills as seen by the lists compiled above.

Michels has also taken our experience to the water, completing several difficult land-to-water and water-to-water installations. Michels is not a marine contractor however, we have built sound relationships with several respected marine contractors for completion of these difficult Marine crossings.

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Land-to-Water *(L-W)* and Water-to-Water *(W-W)* Xings (Marine Support)

- Dept of Navy *(L-W)* – 2016; 12" Steel; 1,178 and 1,023'; ME; Granite 20,000 – 30,000 psi
- Spectra Energy Transmission – (2015); 16" Steel; 1,508'; *L-W* (Boulder, Cobble above Dense Rock); Salem, MA;
- Select Energy Services – (2014); 24" HDPE; 1,061'; *L-W* (Sands and Fat Clay); Charleston ND;
- SCANA – (2013); 8" Stl; 2 each *L-W* 3,580', 7,304'; and 1 each *W-W* (Sands and Clay) 7,424'; SC; Gray Bay and Hamlin Sound, SC;
- Enbridge – (2011); 12" Stl; 1,612'; Cameron, *W-W* (sands, silts, clays), LA;
- Memorial University of Newfoundland (2010) – (1)14" HDPE 1,554 Ft; Water Intake *L-W* (Red/Purple Sandstone); Newfoundland;
- National Gas Co. of Trinidad & Tobago (2010) – (1)36" Stl 2,207 Ft, (1)34" HDPE 2,005' Sewer Outfalls *L-W (*Limestone); Guam;
- Guam Water Authority (2008) – (1)42" HDPE 2,207 Ft, (1)34" HDPE 2,005' Sewer Outfalls; *L-W* (Limestone); Guam;
- BP Billiton Petroleum (2006) – (1)30" Steel 6,028 Ft; *L-W* (Silt, Sand, Clay); Trinidad & Tobago;
- BG ECMA Dolphin Deep (2005) – (1)24" Steel 3,402 Ft; *L-W* (Silt, Sand, Clay); Trinidad & Tobago;
- Eastern North Carolina Gas (2004) – (1)6" Steel 15,684 Ft Pulled; *L-W* (Silt, Clay); Outer Banks, NC;
- Army Corps of Engineers (2004) – (1)10" HDPE 3,522 Ft; *L-W* (Fat Swelling Clay); Parshall, ND;
- Israel Electric Corp (2004) – (1)12" Stl and (3)30" Stl to 2,836 Ft; *L-W* (Sand); Israel;
- Coastal Corporation – (2003); 3-Xings 12" Stl; 3 each 2,735' Arthur Kill River, 1,668' N Shooters Island, 3,524' South Reach Channels; *L-W* (Red Sandstone); Linden, NJ/Bayonne, NY;
- Maritimes & NE – (2003); 4-Xings 30" Stl; 2 each 5,174' Georges Island, 5,286' Beverly Harbor; *W-W* (Meta-Siltstone/Sandstone, Diorite, Granodiorite/Schist Bedrock) Salem, MA; and 2 each *L-W* 4,829 Salem Landing, 3,068' Weymouth; MA;
- Covert Generating PSE&G (2002) – (1)20" HDPE Diffuser 3,232 Ft and (2) 42" HDPE Intakes 2,372 Ft; *L-W* (Sand); Lake Michigan, MI;
- Forest Oil (2002) – (4) 12" Steel Oil Transport Lines 1,750 Ft; *L-W* (Gravel/Cobble Overburden Over Sand); Traders Bay, Alaska;
- City of Grand Forks (2002) – (1) 36" and (2) 30" Steel Water Intakes up to 2,850 Ft; *L-W* (Clay Silt); Red Lake River and Red River of the North, North Dakota;
- Gulfstream Natural Gas (2001) – (1) 38" 1.25" wt Steel; Gas Pipeline 4,009 Ft; *L-W* (Limestone, sands, silts) Shooters Island, FL; Stolt Offshore;
- Public Utility Agency Of Guam (1994) – 1 HDPE Offshore Sewer Outfall x 28" to 1,760 Ft; *L-W* (Coral Reef); Ocean; Guam

Michels' broad range of HDD experience and capacity allows us to accurately estimate the resources required to complete a crossing and provide the utility owner with a reliable expectation of project costs and schedule. The accuracy of an estimate depends directly on the amount and quality of information provided regarding a given crossing. The more accurate and complete the information is, the more accurate the required resources can be estimated. The following is the type of information that helps Michels evaluate any given HDD crossing:

- Design Entry Angle, Minimum Depth, Exit Angle, Land Contours & Geometry of Alignment (Plan & Profile)
- Length of Crossing, Diameter of Utility, Tolerance Of Placement, Carrier Pipe Specification
- Ground Conditions (Soil-USCS Classification & Blow Count Density; Rock-Type, Unconfined Compressive Strength, Rock Quality, Rock Characteristics)
- Special Restrictions to Working Conditions (Time Constraints, Available Work Areas, Proposed Access)

Michels crews and equipment can be mobilized anywhere in the world to complete a wide range of HDD crossings.

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2018	NEXUS GAS	MICHELS PIPELINE	MEL JOHNSON NEXUS GAS MATTHEW WESTPHAL LATEX	(216) 393-6403 MEL (920) 539-1001 MATTHEW	36" STEEL	2,974'	WETLAND MP8.1 CHAMBERSBURG, OH
2018	NEXUS GAS	MICHELS PIPELINE	MEL JOHNSON NEXUS GAS MATTHEW WESTPHAL LATEX	(216) 393-6403 MEL (920) 539-1001 MATTHEW	36" STEEL	4,034'	MAUMEE RIVER MP181.7 WATERVILLE, OH
2018	NEXUS GAS	LATEX CONSTRUCTION	DEREK WELLS NEXUS GAS DAVE WILLIAMS LATEX	(903) 714-9053 DEREK (770) 760-0820 DAVE	36" STEEL	3,199'	VERMILLION RIVER MP104.4 OBERLIN, OH
2018	WILLIAMS TRANSCONTINENTAL GAS	LATEX CONSTRUCTION	MARK WUOLLET WILLIAMS SHAWN POMERLEAU LATEX	(713) 215-3743 MARK (207) 595-2379 SHAWN	42" STEEL	3,980'	SUSQUEHANNA RIVER MP 99.6 CATAWISSA, PA [1,6,7,11]
2018	HARBOUR RESOURCE PARTNERS (HRP)	MICHELS CANADA	JEREMY KLARENBACH - HRP MIKE VIDOMSKI - MICHELS CANANDA	(780) 232-3804 JEREMY (920) 955-2120 MIKE	42" STEEL	3,087'	VICTORIA HARBOR VICTORIA, BRITISH COLUMBIA, CANADA [1,4,7]
2018	ENBRIDGE	STRIKE USA	JERRELL BRYAN ENBRIDGE	(601) 504-0376	42" STEEL	3,717'	BAHIA GRANDE CHANNEL #2 LOS FRESNOS, TX [6,7]
2018	ENBRIDGE	STRIKE USA	JERRELL BRYAN ENBRIDGE	(601) 504-0376	42" STEEL	4,869'	BAHIA GRANDE CHANNEL #1 LOS FRESNOS, TX [6,7]
2017	ENBRIDGE	STRIKE USA	JERRELL BRYAN ENBRIDGE	(601) 504-0376	48" STEEL	3,235'	ARROYO COLORADO CANAL VILLA DEL SOL, TX [7]

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2017	ENBRIDGE	STRIKE USA	JERRELL BRYAN ENBRIDGE	(601) 504-0376	48" STEEL	3,085'	RANCHO VIEJO FLOODWAY LOS FRESNOS, TX [7]
2017	ENERGY TRANSFER COMPANY - ROVER PL	PRECISION PIPELINE	LEON BANTA ENERGY TRANSFER	(281) 620-3954	36" STEEL	5,841'	OHIO RIVER - MP 33.8 SARDIS OH & PADIN CITY WV [1,6,7,9]
2017	ENBRIDGE	STRIKE USA	JERRELL BRYAN ENBRIDGE	(601) 504-0376	48" STEEL	3,649'	IBWC NORTH FOODWAY SEBASTIAN, TX
2017	ENBRIDGE	STRIKE USA	JERRELL BRYAN ENBRIDGE	(601) 504-0376	48" STEEL	3,595'	ROAD 771 & CANAL SAN BENITO, TX
2017	TRANSCANADA/COLUMBIA PL	PRICE GREGORY	JORDAN CRANE TRANSCANADA	(281) 908-5104	36" STEEL	6,238'	OHIO RIVER BURLINGTON, OH/WESTMORELAND WV [1,6,7,9,11]
2017	ENERGY TRANSFER COMPANY - ROVER PL	PUMPCO	SETH WILLOUGHBY ENERGY TRANSFER COMPANY	(281) 840-1482	36" STEEL	7,194'	OHIO RIVER - MP 16.07 [1,6,7,9,11] TORONTO, OH & NEW CUMBERLAND, WV
2017	DEPARTMENT OF NAVY	HEALY TIBBITTS BUILDERS, INC	STANLEY SHEN DEPARTMENT OF NAVY ART LAMBERT HEALY TIBBITTS	ART LAMBERT (808) 487-3664	30" STEEL	3,483'	FORD ISLAND TO LANDING C HONOLULU, HI [1,6,7,11]
2017	ENERGY TRANSFER COMPANY-DAPL	PRECISION PIPELINE	JACK EDWARDS ENERGY TRANSFER COMPANY	(832) 421-5691	30" STEEL	7,531'	LAKE OAHE & MISSOURI RIVER CANNONBALL, ND [1,6,7,9]
2017	CHENIERE ENERGY	ASSOCIATED PIPELINE	SCOTT TIMPONE CHENIERE ENERGY	(713) 375-5723	48" STEEL	3,291'	POND: METER TO LNG FACILITY PORTLAND, TX

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2016	SPECTRA ENERGY TRANSMISSION	MPG PIPELINE	BRUCE AINSWORTH MPG PIPELINE	(713) 955-9910	36" STEEL	3,829'	FLINT RIVER ALBANY, GA [6,9,11]
2016	ENERGY TRANSFER COMPANY-DAPL	PRECISION PIPELINE	JACK EDWARDS ENERGY TRANSFER COMPANY	(832) 421-5691	30" STEEL	7,282'	MISSISSIPPI RIVER SANDUSKY, IA & NAUVOO, IL [1,7]
2016	ENERGY TRANSFER COMPANY-DAPL	MICHELS PIPELINE	JACK EDWARDS ENERGY TRANSFER COMPANY	(832) 421-5691	30" STEEL	6,328'	BIG SIOUX RIVER DAYTON TOWNSHIP, SD/IA [1,2,6,7]
2016	TRANSCANADA PIPELINE	BANISTER PIPELINES	YANIC GAUVIN-CLOUTIER BANISTER PIPELINE	(905) 795-3399	36" STEEL	4,311'	MAJOR MACKENZIE ROAD ONTARIO, CANADA [1,4,6,7]
2016	ENERGY TRANSFER COMPANY-DAPL	MICHELS PIPELINE	JACK EDWARDS ENERGY TRANSFER COMPANY	(832) 421-5691	30" STEEL	5,714'	JAMES RIVER PLEASANT VIEW, SD [6]
2016	ENERGY TRANSFER COMPANY-DAPL	MICHELS PIPELINE	JACK EDWARDS ENERGY TRANSFER COMPANY	(832) 421-5691	30" STEEL	2,991'	PCN-3/WETLAND REDFIELD, SD [2]
2016	ENERGY TRANSFER COMPANY-DAPL	PRECISION PIPELINE	JACK EDWARDS ENERGY TRANSFER COMPANY	(832) 421-5691	30" STEEL	3,352'	CLIFF CROSSING WATFORD CITY, ND [7,9]
2016	TRANSCANADA PIPELINE	BANISTER PIPELINES	YANIC GAUVIN-CLOUTIER BANISTER PIPELINE	(905) 795-3399	36" STEEL	3,901'	RUTHERFORD ROAD ONTARIO, CANADA [1,4,7]
2016	JEA - JACKSONVILLE ELECTRIC AUTHORITY	HASKELL DESIGN BUILD PROJECT	ELIZABETH A. DiMEO JEA	(904) 665-8139	42" STEEL WITH 36" HDPE	3,983'	ST. JOHN'S RIVER JACKSONVILLE, FL [1,10,11]
2016	ENERGY TRANSFER	STRIKE USA	WAYNE KLEMCKE ENERGY TRANSFER	(281) 744-8835	30" STEEL	6,119'	LAKE WHITNEY KOPPERL, TX [1,6,7]

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2016	TRANSCANADA PIPELINE	MICHELS CANADA	RICHARD PATRY TRANSCANADA PIPELINE	(587) 434-2683	30" STEEL	5,154'	LEIGE LATERAL-HOUSE RIVER WOOD BUFFALO, ALBERTA, CANADA [4]
2016	TRANSCANADA	MICHELS CANADA	JESSE BAJNOK TRANSCANADA	(403) 920-7607	42" STEEL	3,399'	MCKAY RIVER FORT MCMURRAY, AB, CANADA [1,4]
2016	TRANSCANADA	MICHELS CANADA	JESSE BAJNOK TRANSCANADA	(403) 920-7607	42" STEEL	3,885'	DOVER RIVER FORT MCMURRAY, AB, CANADA [1,4]
2016	ENBRIDGE	MICHELS CANADA	MATHEW BARIL ENBRIDGE	(780) 222-3197	36" STEEL	3,160'	CHRISTINA RIVER FORT MCMURRAY, AB, CANADA [1,4,7]
2015	TRANSCANADA	MICHELS CANADA	JESSE BAJNOK TRANSCANADA	(403) 920-7607	42" STEEL	7,205'	ATHABASCA RIVER FORT MCMURRAY, AB, CANADA [1,4,6,7]
2015	ENBRIDGE	MICHELS CANADA	TYLER HORTON ENBRIDGE	(416) 753-7811	36" STEEL	3,133'	PAMONA CREEK, TORONTO, ONTARIO, CANADA [4,7]
2015	ENBRIDGE ENERGY	PRICE GREGORY	CHRISTOPHER HAUX ENBRIDGE ENERGY	(218) 393-4192	36" STEEL	3,461'	KENNEDY AVE & GRIFFITH TERMINAL GRIFFITH, IL
2015	ENBRIDGE	MICHELS CANADA	TYLER HORTON ENBRIDGE	(416) 753-7811	36" STEEL	3,412'	E. DON RIVER TORONTO, ONTARIO, CANADA [2,4,7]
2015	ENBRIDGE	MICHELS CANADA	TYLER HORTON ENBRIDGE	(416) 753-7811	36" STEEL	2,992'	ALDEN ROAD TORONTO, ONTARIO, CANADA [4,7]
2015	ENBRIDGE ENERGY	PRICE GREGORY	CHRISTOPHER HAUX ENBRIDGE ENERGY	(218) 393-4192	36" STEEL	3,011'	HIGHWAY 41 & RR GRIFFITH, IL [6,7]

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2015	ENBRIDGE ENERGY	PRICE GREGORY	CHRISTOPHER HAUX ENBRIDGE ENERGY	(218) 393-4192	36" STEEL	5,128'	LAKE AVE & RR SAUK VILLAGE, IL [6]
2015	ENBRIDGE	MICHELS CANADA	TYLER HORTON ENBRIDGE	(416) 753-7811	36" STEEL	3,363'	STEELES AVENUE TORONTO, ONTARIO, CANADA [4,7,11]
2015	NICOR-AGL RESOURCES	PRECISION PIPELINE	ROBERT GRAHAM AGL RESOURCES	(630) 918-0265	36" STEEL	3031'	BNSF RR & AURORA ROAD AURORA, IL [2]
2015	TRANSCANADA	MICHELS CANADA	JESSE BAJNOK TRANSCANADA	(403) 920-7607	42" STEEL	3,114'	BEAVER LAKE FORT MCMURRAY, AB, CANADA [1,4]
2015	TRANSCANADA	MICHELS CANADA	JESSE BAJNOK TRANSCANADA	(403) 920-7607	42" STEEL	3,776'	MACKAY RIVER FORT MCMURRAY, AB, CANADA [4]
2014	LAKE OSWEGO-TIGARD WATER PARTNERSHIP	FRANK COLUCCIO CONSTRUCTION COMPANY	JOEL KOMAREK CITY OF LAKE OSWEGO	(503) 697-6588	36" STEEL	3,805'	WILLAMETTE RIVER LAKE OSWEGO, OR [1,3,7]
2014	ENBRIDGE ENERGY (FLANAGAN SOUTH PIPELINE)	MICHELS PIPELINE	DOUG RYDER ENBRIDGE ENERGY	(218) 464-5831	36" STEEL	9,040'	MISSISSIPPI RIVER & LEVEES QUINCY, IL/MO [6,7,8]
2013	ENBRIDGE ENERGY (FLANAGAN SOUTH PIPELINE)	MICHELS PIPELINE	DOUG RYDER ENBRIDGE ENERGY	(218) 464-5831	36" STEEL	5,687'	MISSOURI RIVER NEW FRANKFURT, MO [6,7,8]

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2013	SPRAGUE-ROSER CONTRACTING CO. LTD/ REGIONAL MUNICIPALITY OF WOOD BUFFALO	MICHELS CANADA	CRAIG CORNELL SPRAGUE-ROSER	(780) 463-5862	30" STEEL	4,400'	SALINE CREEK FORT MCMURRAY, AB, CANADA [1,4,6]
2013	ENBRIDGE ENERGY (FLANAGAN SOUTH PIPELINE)	MICHELS PIPELINE	DOUG RYDER ENBRIDGE ENERGY	(218) 464-5831	36" STEEL	3,544'	ILLINOIS RIVER HAVANA, IL [6,7,8]
2013	INTER PIPELINE LIMITED	MICHELS CANADA	KEVIN GEORGE INTER PIPELINE LIMITED	(403) 717-5747	42" STEEL	4,284'	VERMILLION RIVER VERMILLION, AB, CANADA [1,4,6,7]
2013	KINDERMORGAN/TN GAS	MICHELS PIPELINE	MARK HAMARICH KINDERMORGAN	(713) 819-7033	30" STEEL	4,987'	MONKSVILLE RESERVOIR W MILFORD, NJ[1,6,7,11]
2013	INTER PIPELINE LIMITED	MICHELS CANADA	KEVIN GEORGE INTER PIPELINE LIMITED	(403) 717-5747	42" STEEL	3,392'	N. SASKATCHEWAN RIVER ELK POINT, AB, CANADA [1,4]
2013	TRANSCANADA - KEYSTONE	MICHELS PIPELINE	DARRYL SANDQUIST TRANSCANADA	(403) 920-6941	36" STEEL	4,304'	BOIS D' ARC CREEK DIRECT, TX [6,7]
2013	TRANSCANADA - KEYSTONE	MICHELS PIPELINE	DARRYL SANDQUIST TRANSCANADA	(403) 920-6941	36" STEEL	3,892'	RED RIVER BENNINGTON OK/TX [1,6,7]
2013	TEXAS EASTERN TRANSMISSION	MICHELS DIRECTIONAL CROSSINGS	ED GONZALES TEXAS EASTERN TRANSMISSION	(201) 427-7550	42" STEEL	3,008'	I-95 & TIDAL WETLANDS LINDEN, NJ [1,6,7]
2013	TRANSCANADA - KEYSTONE	MICHELS PIPELINE	DARRYL SANDQUIST TRANSCANADA	(403) 920-6941	36" STEEL	3,077'	UP RR & JEFFERSON ST TUSHKA, OK [6]

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2013	TRANSCANADA - KEYSTONE	MICHELS PIPELINE	DARRYL SANDQUIST TRANSCANADA	(403) 920-6941	36" STEEL	3,239'	CLEAR BOGGY CREEK TALOAH, OK [7]
2013	TEXAS EASTERN TRANSMISSION	MICHELS DIRECTIONAL CROSSINGS	ED GONZALES TEXAS EASTERN TRANSMISSION	(201) 427-7550	30" STEEL	6,544'	EAST 1ST STREET BAYONNE, NJ[1,6]
2013	TEXAS EASTERN TRANSMISSION	MICHELS DIRECTIONAL CROSSINGS	ED GONZALES TEXAS EASTERN TRANSMISSION	(201) 427-7550	30" STEEL	4,905'	MERSELES STREET HAMILTON PARK, NJ[1,6,11]
2013	TEXAS EASTERN TRANSMISSION	MICHELS DIRECTIONAL CROSSINGS	ED GONZALES TEXAS EASTERN TRANSMISSION	(201) 427-7550	42" STEEL	4,441'	GOETHALS BRIDGE & TIDAL WETLANDS STATEN ISLAND, NY[1,6]
2013	TRANSCANADA - KEYSTONE	SUNLAND CONSTRUCTION	GARRET P. GUIDRY SUNLAND CONSTRUCTION	(337) 685-2167 EXT 122	36" STEEL	4,213'	MENARD CREEK RYE, TX
2013	TRANSCANADA - KEYSTONE	MICHELS PIPELINE	DARRYL SANDQUIST TRANSCANADA	(403) 920-6941	36" STEEL	3,607'	JOHNSON CREEK NEW SOMMERFIELD, TX[1]
2013	TRANSCANADA - KEYSTONE	MICHELS PIPELINE	DARRYL SANDQUIST TRANSCANADA	(403) 920-6941	36" STEEL	4,005'	CANADIAN RIVER ATWOOD, OK[1]
2013	TRANSCANADA - KEYSTONE	MICHELS PIPELINE	DARRYL SANDQUIST TRANSCANADA	(403) 920-6941	36" STEEL	3,571'	LUFKIN CULTURAL SITE & ANGELINA RIVER EDEN, TX
2013	TEXAS EASTERN TRANSMISSION	MICHELS DIRECTIONAL CROSSINGS	ED GONZALES TEXAS EASTERN TRANSMISSION	(201) 427-7550	30" STEEL	8,101'	KILL VAN KULL BERGEN PT. NJ/NY[1,6]
2013	TEXAS EASTERN TRANSMISSION	MICHELS DIRECTIONAL CROSSINGS	ED GONZALES TEXAS EASTERN TRANSMISSION	(201) 427-7550	30" STEEL	4,861'	18TH STREET/LONG SLIP NEWPORT, NJ [1,3,6,7,9,11]

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2013	TRANSCANADA - KEYSTONE	MICHELS PIPELINE	DARRYL SANDQUIST TRANSCANADA	(403) 920-6941	36" STEEL	4,342'	DEEP FORK RIVER OKLAHOMA CITY, OK
2013	TRANSCANADA - KEYSTONE	MICHELS PIPELINE	DARRYL SANDQUIST TRANSCANADA	(403) 920-6941	36" STEEL	3,314'	EAST FORK ANGELINA RIVER REKLAW, TX [7]
2013	TRANSCANADA - KEYSTONE	MICHELS PIPELINE	DARRYL SANDQUIST TRANSCANADA	(403) 920-6941	36" STEEL	2,908'	NECHES RIVER & UP RR CLARKS FERRY, TX [6]
2013	TEXAS EASTERN TRANSMISSION	MICHELS DIRECTIONAL CROSSINGS	ED GONZALES TEXAS EASTERN TRANSMISSION	(201) 427-7550	42" STEEL	3,211'	ARTHUR KILL STATEN ISLAND, NJ/NY [1,7]

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5.0 NOISE

CMP's consultant, Burns & McDonnell, developed a noise model to analyze noise impacts from HDD operations during construction of CMP's transmission lines under the Kennebec River. Using industry-accepted sound modeling software, Computer Aided Noise Abatement (CadnaA), the expected sound pressure levels from the HDD activities were predicted. The software is a scaled, three-dimensional program which takes into account each piece of equipment emitting sound on a site and predicts sound pressure levels over an area of interest.

General sound levels for the drilling rig, mud pump, shaker, and generator from other HDD projects were used to estimate sound level impacts. The equipment included in the model is listed in Table 5-1. There would be additional equipment used in drilling such as pipe racks and operator trucks. However, sound emitted by these sources is variable and minimal compared to the drilling rig, pumps, and generator.

Table 5-1 HDD Entry and Exit Location Equipment

HDD Entry		HDD Exit	
Equipment	**Sound Power Level (dBA)**	**Equipment**	**Sound Power Level (dBA)**
Drilling Rig	118.4	--	--
600 hp Mud Pump	114.8	600 hp Mud Pump	114.8
500 hp Generator	111.6	--	--
Shale Shaker	94.7	--	--

Reflections and shielding were considered for sound waves encountering physical structures. Sound levels around the HDD locations can be influenced by the sound reflections from physical structures nearby. The order of reflections for the model was set at two. Some structures onsite were considered acoustically transparent (e.g., structural steel, bus work) and were not included. Trees and other vegetation (i.e., shrubbery) were not included in the model to avoid taking too much attenuation into account in the model. Terrain was included to account for surface effects such as ground absorption, and the large elevation difference between the drilling sites and the Kennebec River.

Predictive modeling was completed for the drilling operations. The expected sound levels of the operations can be seen in Figure 5-1 below, which shows a graphical representation in 5 dBA contours of the sound generated from the HDD construction equipment. The model utilized equipment sound levels from past projects with similar HDD equipment. Table 5-2 shows the sound level impacts at the edges of

the right-of-way and on the Kennebec River. The sound levels shown are for the HDD equipment only and do not include any sound generated by background sources.

Table 5-2: Modeled HDD Construction Sound Levels

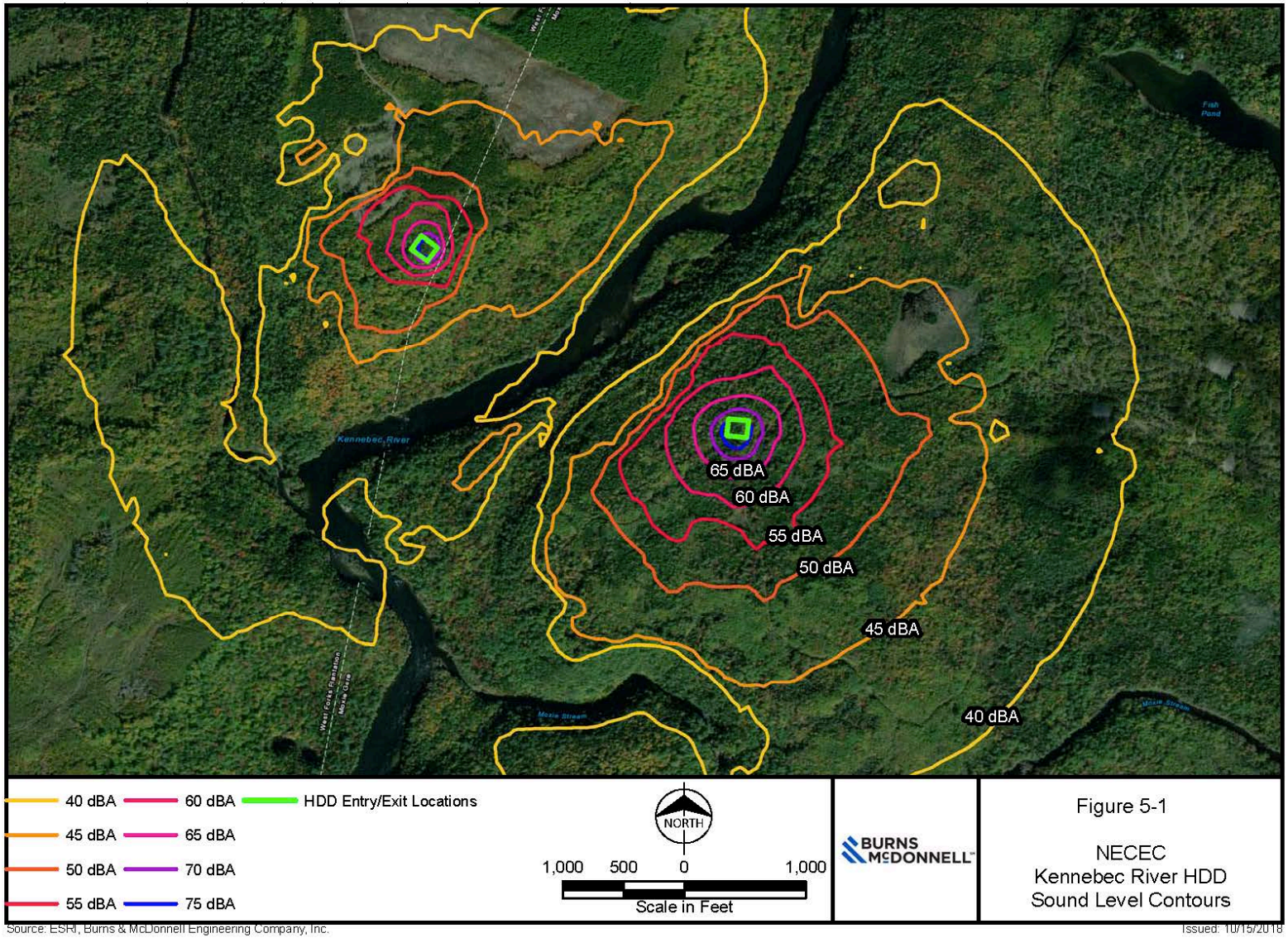
Modeled Receptor	Modeled Sound Level (dBA)
Max on River	40.7
Max at HDD Entry ROW	80.1
Max at HDD Exit ROW	70.8

HDD installation will require construction activity 24 hours a day. Maine DEP Ch. 375.10(1)(a) limits nighttime construction operation sound levels to 75 dBA at any property line of the development or contiguous property owned by the developer, and to 50 dBA at any protected location not predominantly zoned commercial, transportation, or industrial.

The HDD operations are predicted to be below the Maine DEP sound level requirements along the Kennebec River. It is expected that HDD operations may be audible on the Kennebec River to rafters. However, the impacts would be minimal, and the river would not be used during nighttime hours.

Maine DEP Ch. 375.10(2)(a)(III) permits higher levels of nighttime construction sound when a duly issued permit authorizing nighttime construction sound in excess of the Maine DEP limits has been granted by the local municipality when the duration of the nighttime construction activity is less than or equal to 90 days. In this case, the "local municipality" is LUPC.

Sound levels along the Kennebec River would be below those required by the Maine DEP for protected locations. In addition, there are no residences within a ½-mile radius of either drilling location. The construction permit would need to allow for increased sound level limits along the right-of-way for a short period of time during HDD operations.


65 dBA
60 dBA
55 dBA
50 dBA
45 dBA
40 dBA
Kennebec River
40 dBA
45 dBA
50 dBA
55 dBA
60 dBA
65 dBA
70 dBA
75 dBA
HDD Entry/Exit Locations
NORTH
1,000 500 0 1,000
Scale in Feet
BURNS McDONNELL
Figure 5-1
NECEC
Kennebec River HDD
Sound Level Contours
Source: ESRI, Burns & McDonnell Engineering Company, Inc.
Issued: 10/15/2018

6.0 VISUAL QUALITY AND SCENIC CHARACTER

Terrence J. DeWan and Associates ("TJDA") evaluated the proposed HDD project modification to determine whether the proposed Moxie Gore or West Forks Termination Stations would be visible from the Kennebec River. The evaluation included developing a three-dimensional model of the termination stations, with data provided by TRC, and inserting that data into the 3D Studio Max model previously developed for the overhead crossing option. TRC provided the overall project file including a 3D model of the structures, drilling platforms, and clearing limits within the corridor. Previous field investigations determined that the actual average tree height on the hillsides on either side of the river is 75 feet; and was modeled as such.

TJDA evaluated potential visibility from six locations where photographs were previously taken by both TJDA and Power Engineering. (Photosimulations of the overhead crossing were previously developed and submitted from 5 of the 6 locations evaluated for the termination station visibility.) From 4 of the 6 locations evaluated, the existing terrain would block all potential views of the termination stations. From two locations located south and west of the termination stations, the modeling indicated the potential for a portion of the termination stations to be visible above the existing terrain. However, when 75-foot tree 'cylinders' were added to the model, the Termination Stations were completely screened from the river viewpoints.

Included with this submission in Exhibit 6-1 are computer model illustrations that demonstrate that both the Moxie Gore and West Forks Termination Stations will be screened by the 75-foot vegetation on the hillsides above the rivers. From each viewpoint analyzed we have included a panoramic photograph of existing conditions, a normal existing conditions view, a computer model showing just terrain and the respective termination station, a computer model showing the addition of 75-foot trees, and then a combined overlay to show how the model and photograph are registered.

Exhibit 6-1: Photosimulations

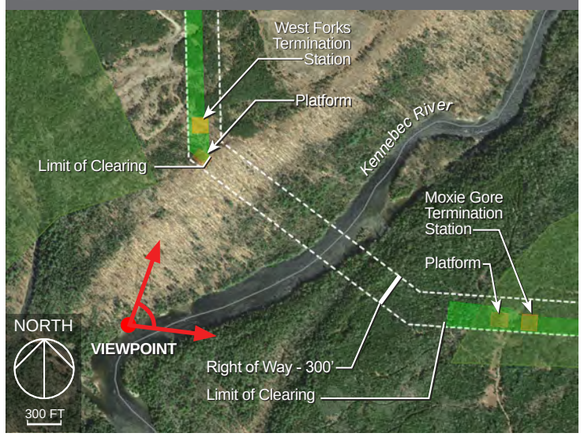
MOXIE GORE TERMINATION STATION VISIBILITY EVALUATION
KENNEBEC RIVER, Looking East

NEW ENGLAND CLEAN ENERGY CONNECT

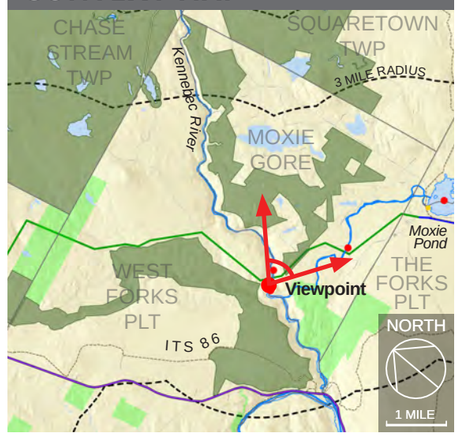


Existing Conditions: Panoramic view looking from north to east from the Kennebec River, approximately 3,600 feet west of the proposed Moxie Gore Termination Station. The Moxie Gore Termination Station will not be visible from the river. A forested buffer of approximately 1,000 in length will be preserved within the corridor between the southeast shoreline and the Station.

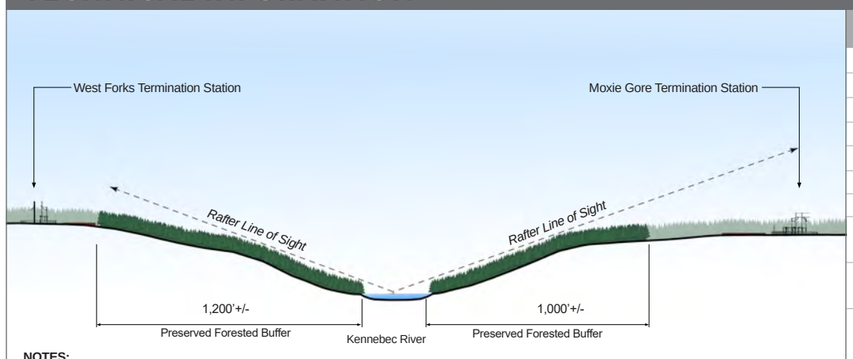
LOCATION MAP



CONTEXT MAP



TECHNICAL INFORMATION



NOTES:
-Looking north at proposed Termination Stations; West Forks Station (west side) and Moxie Gore Station (east side)
-Base information from TRC.
-Average height of vegetation within the forested buffer is 75'.

Photograph / Photosimulation Information	
Location	45.371014°, -69.949912°
Viewing Direction	Northeast to East
Horizontal Angle of View	84°
Date and Time	08/15/16 at 1:30 pm
Camera Focal Length	50 mm
Camera Make/Model	Canon EOS 5D Mark III
Photo Source	Powers Engineering
Proposed Structures Visible	None

CENTRAL MAINE POWER

tjd&a

MOXIE GORE TERMINATION STATION VISIBILITY EVALUATION
KENNEBEC RIVER, Looking East

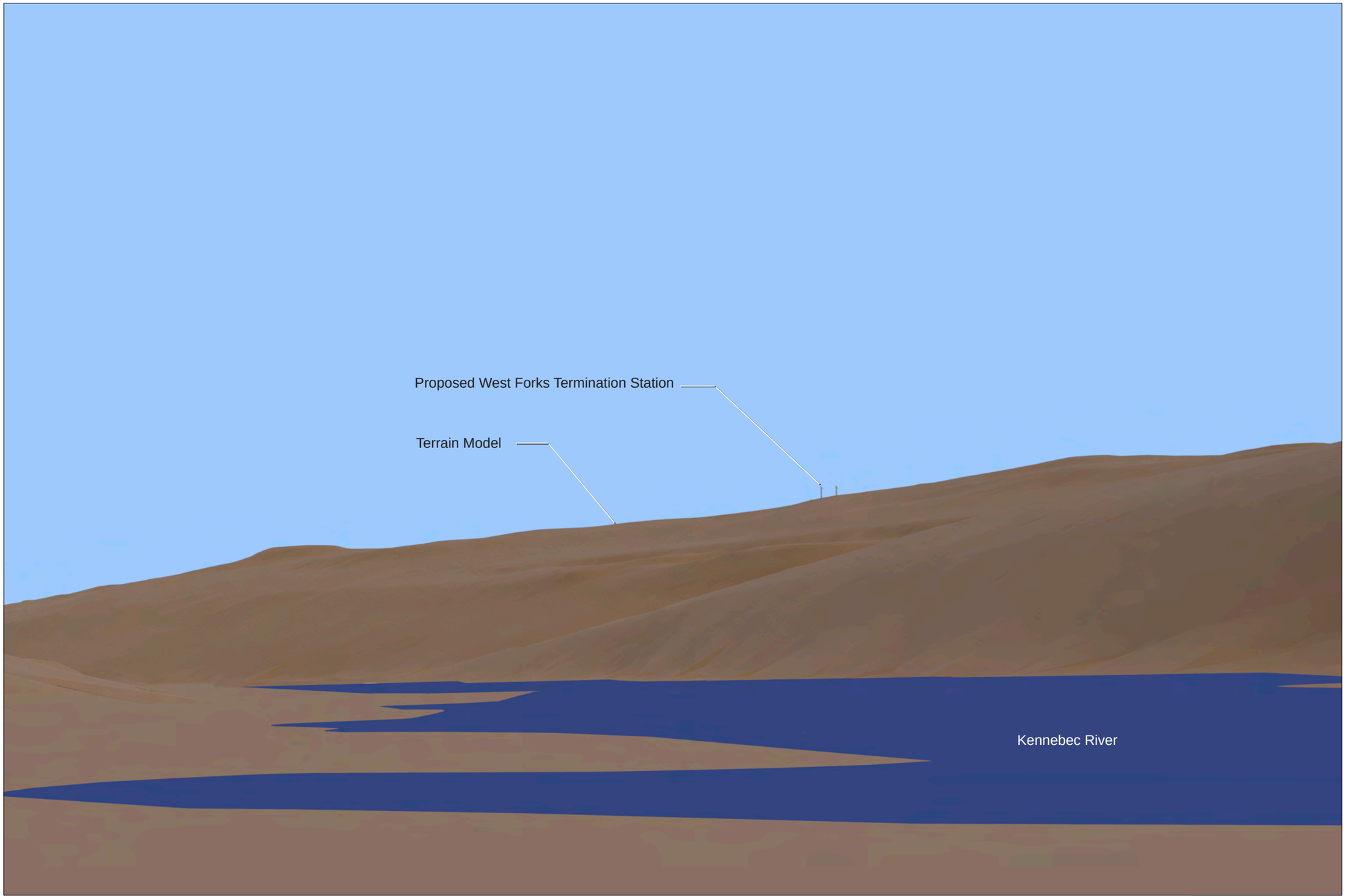
NEW ENGLAND CLEAN ENERGY CONNECT



Existing Conditions B: Normal view looking east from the Kennebec River, approximately 3,600 directly west of the proposed Moxie Gore Termination Station

MOXIE GORE TERMINATION STATION VISIBILITY EVALUATION
KENNEBEC RIVER, Looking East

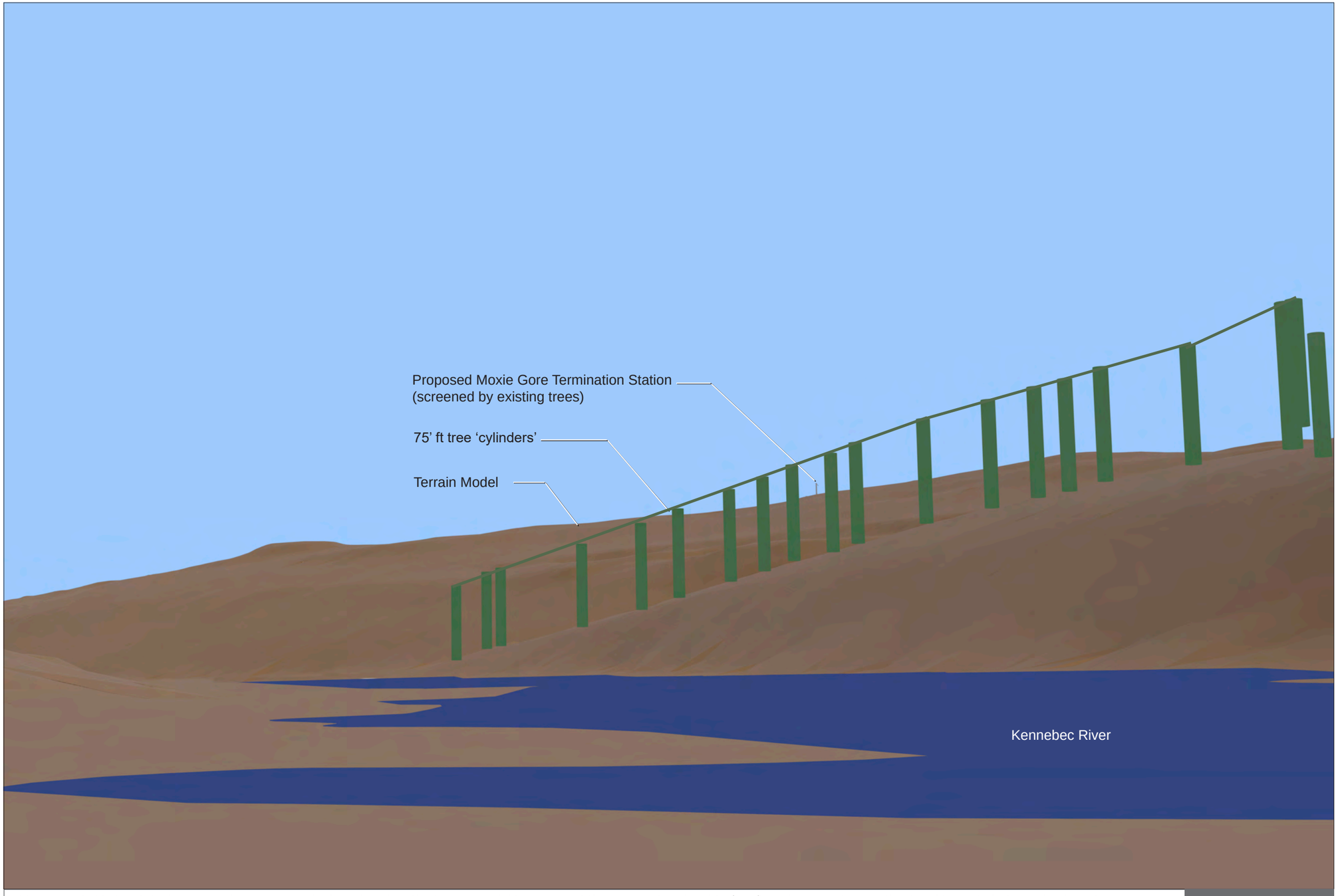
NEW ENGLAND CLEAN ENERGY CONNECT



COMPUTER MODEL B-1: This image is generated from a 3D Model developed for the Project and shows the existing terrain when looking from the viewpoint depicted in the Existing Conditions B photograph. Modeling indicates a portion of the proposed Moxie Gore Termination Station would be visible from this location if there was no vegetation on the hillside. The existing terrain would block the lower portion of the Station.

MOXIE GORE TERMINATION STATION VISIBILITY EVALUATION
KENNEBEC RIVER, Looking East

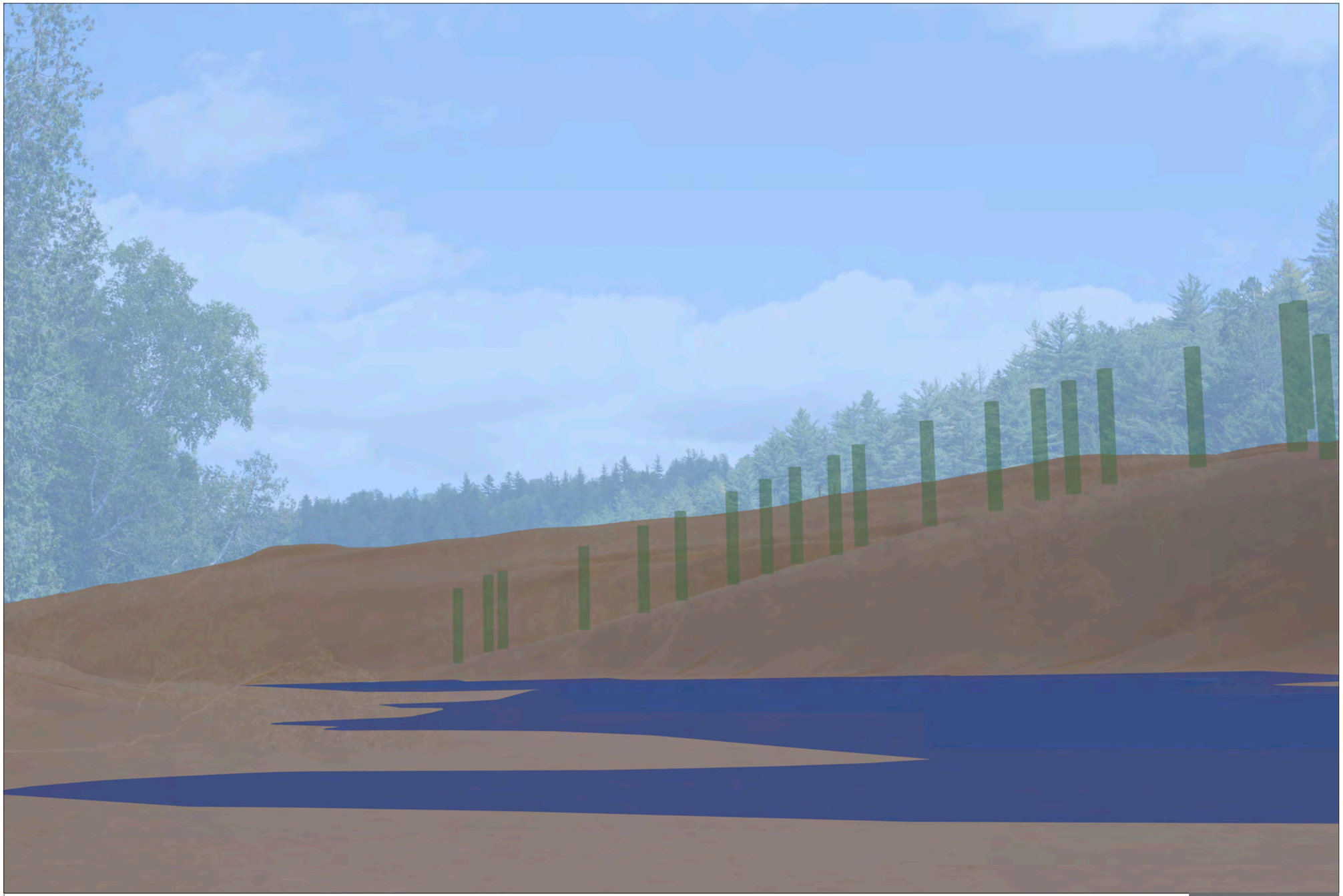
NEW ENGLAND CLEAN ENERGY CONNECT



COMPUTER MODEL B-2: This image shows green cylinders placed on the terrain model to represent the average tree height of 75 ft as shown on the Existing Conditions B photograph. These tree representations are placed between the river’s edge and the clearing limits surrounding the proposed Moxie Gore Termination Station. The modeling indicates that the 75 ft trees will screen the Termination Station from the River.

MOXIE GORE TERMINATION STATION VISIBILITY EVALUATION
KENNEBEC RIVER, Looking East

NEW ENGLAND CLEAN ENERGY CONNECT



COMPUTER MODEL B-3: This image shows the computer model (terrain and 75' tree cylinders) overlaid and registered with the Existing Conditions photo. The preserved vegetation on the hillside will completely screen the Moxie Gore Termination Station from the Kennebec River.

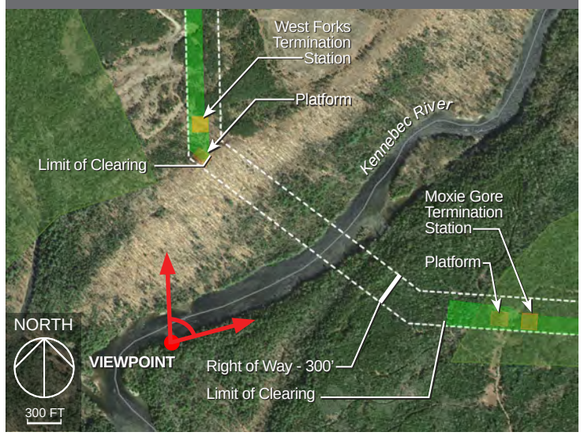
WEST FORKS TERMINATION STATION VISIBILITY EVALUATION
KENNEBEC RIVER, Looking North

NEW ENGLAND CLEAN ENERGY CONNECT



Existing Conditions: Panoramic view looking from north to east from the Kennebec River, approximately 1,900 feet south of the proposed West Forks Termination Station. The West Forks Termination Station will not be visible from the river. A forested buffer of approximately 1,200 in length will be preserved within the corridor between the northwest shoreline and the Station. This photograph was used in the previously submitted Photosimulation 11.

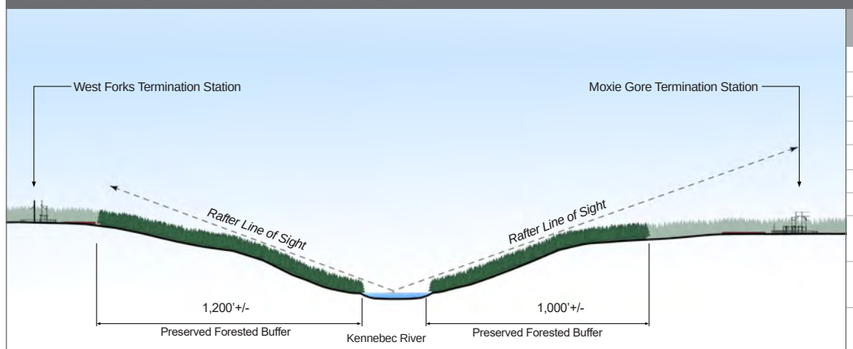
LOCATION MAP



CONTEXT MAP



TECHNICAL INFORMATION



NOTES:
-Looking north at proposed Termination Stations; West Forks Station (west side) and Moxie Gore Station (east side)
-Base information from TRC.
-Average height of vegetation within the forested buffer is 75'.

Photograph / Photosimulation Information	
Location	45.374107°, -69.940380°
Viewing Direction	North to East
Horizontal Angle of View	84°
Date and Time	08/15/16 at 1:21 pm
Camera Focal Length	50 mm
Camera Make/Model	Canon EOS 5D Mark III
Photo Source	Powers Engineering
Proposed Structures Visible	None

CENTRAL MAINE POWER

tjd&a

WEST FORKS TERMINATION STATION VISIBILITY EVALUATION
KENNEBEC RIVER, Looking North

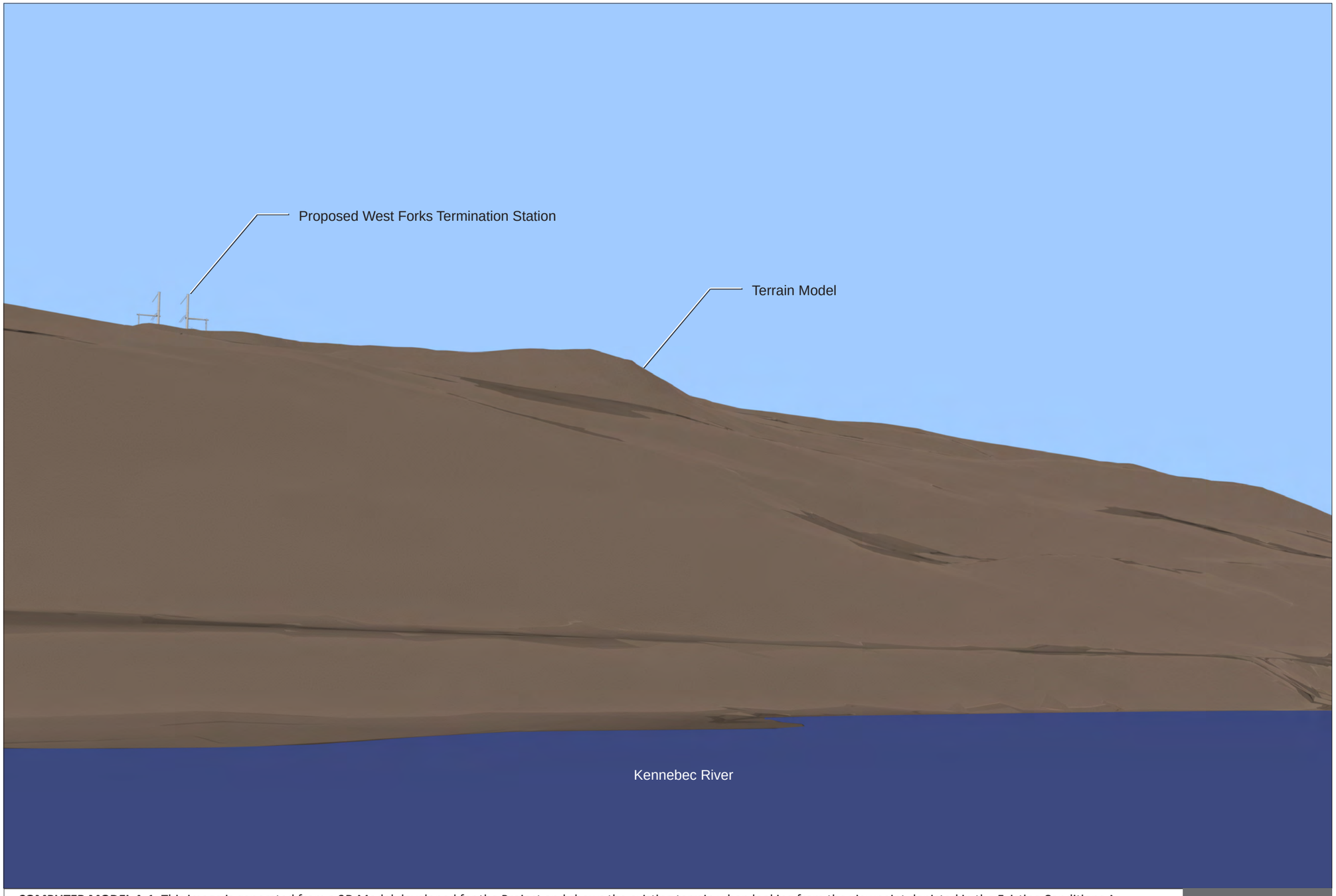
NEW ENGLAND CLEAN ENERGY CONNECT



Existing Conditions A: Normal view looking northeast from the Kennebec River, approximately 1,900 directly south of the proposed West Forks Termination Station

WEST FORKS TERMINATION STATION VISIBILITY EVALUATION
KENNEBEC RIVER, Looking North

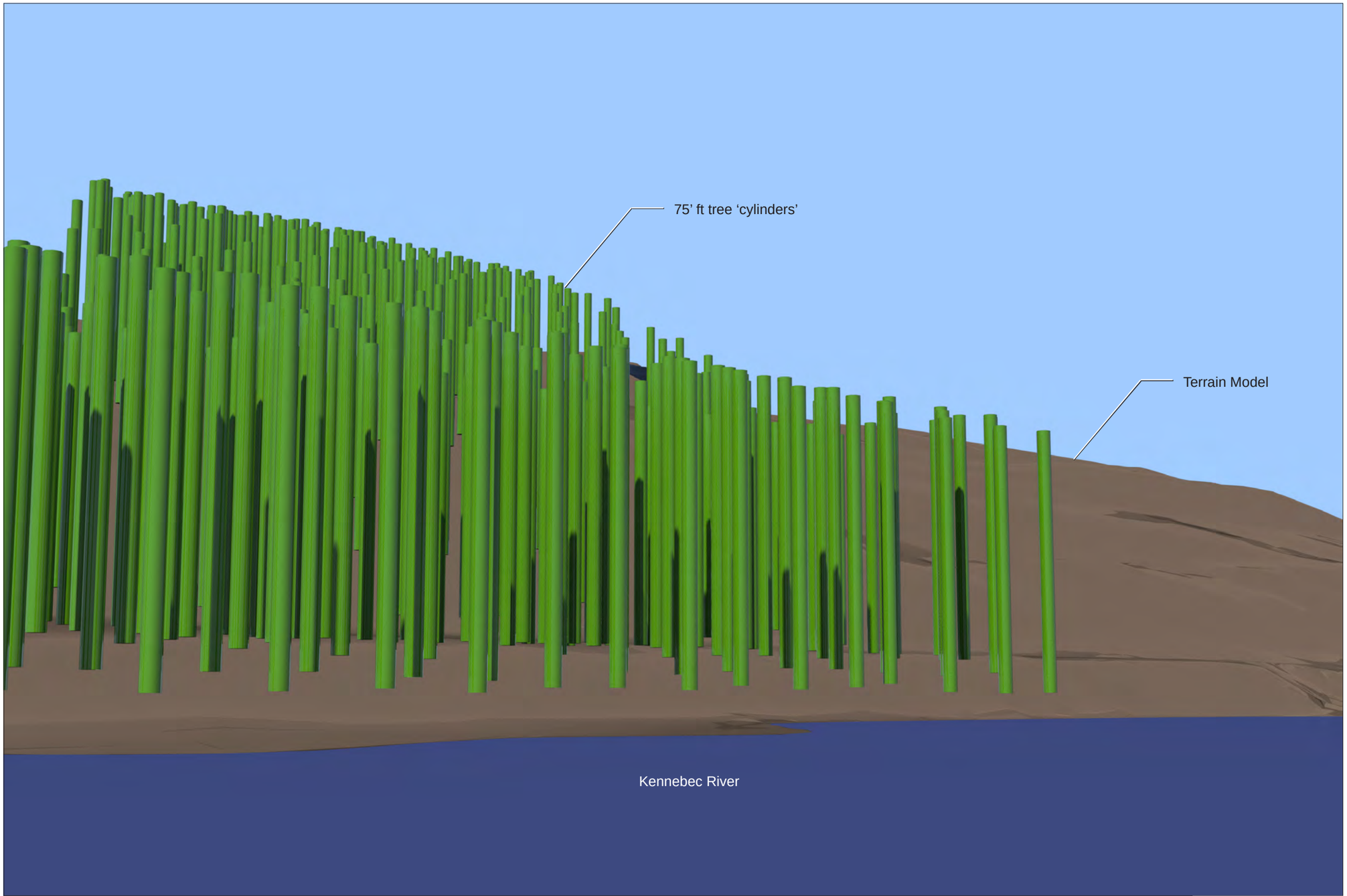
NEW ENGLAND CLEAN ENERGY CONNECT



COMPUTER MODEL A-1: This image is generated from a 3D Model developed for the Project and shows the existing terrain when looking from the viewpoint depicted in the Existing Conditions A photograph. Modeling indicates a portion of the proposed West Forks Termination Station would be visible from this location if there was no vegetation on the hillside. The existing terrain would block the lower portion of the Station.

WEST FORKS TERMINATION STATION VISIBILITY EVALUATION
KENNEBEC RIVER, Looking North

NEW ENGLAND CLEAN ENERGY CONNECT



COMPUTER MODEL A-2: This image shows green cylinders placed on the terrain model to represent the average tree height of 75 ft as shown on the Existing Conditions A photograph. These tree representations are placed between the river’s edge and the clearing limits surrounding the proposed West Forks Termination Station. The modeling indicates that the 75 ft trees will screen the Termination Station from the River.

TERMINATION STATIONS VISIBILITY EVALUATION, KENNEBEC RIVER, Looking North

NEW ENGLAND CLEAN ENERGY CONNECT



COMPUTER MODEL A-3: This image shows the computer model (terrain and 75’ tree cylinders) overlaid and registered with the Existing Conditions photo. The preserved vegetation on the hillside will completely screen the West Forks Termination Station from the Kennebec River.

7.0 WILDLIFE AND FISHERIES

7.1 Introduction

The HDD crossing includes the construction of two termination stations, one on each side of the river, a section of underground conduit, and a temporary work area for the HDD drill rig set-up (See Section 1.0 Development Description, above, for further detail).

No additional natural resource surveys were needed to document the in-corridor natural resource impacts in the area of the HDD improvements. Surveys which were conducted as part of the September 27, 2017 permit applications included the entire 300-foot wide corridor, as well as an additional 100 feet on each side of the corridor. The HDD construction and long-term operation will require upgrades to existing access roads such as road base improvements, widening, minor tree clearing and trimming, or turning radius expansions to make roads accessible for heavy construction equipment. In October 2018, natural resource surveys were conducted in the vicinity of the off-ROW access road improvements. On the east side of the river, two portions of the old gravel access road have reverted to wetland. The gravel road base will be upgraded in these locations.

7.2 Habitat Type Conversion

A change in the clearing area limits, as proposed in the September 27, 2017 Site Law application, will be required for the HDD installation and the construction and operation of the termination stations, trenched areas, and access road improvements. Some additional clearing will be required adjacent to the termination stations, temporary HDD drill pad and for access roads; and some tree clearing will be reduced within the river buffers due to the underground design of the HDD. Overall, the HDD design change will result in a net reduction of 7.16 acres of forest clearing.

The termination stations will alter wildlife habitat in those locations, but the effects of such changes will be minimal, as the footprints of the termination station yards are modest and there is sufficient similar habitat in the vicinity of both sites. The termination stations have been sited so that no permanent impact to wetlands will occur.

The cleared areas required for the trenching and HDD drill pad will be allowed to revegetate to early successional habitat (scrub-shrub) and will be maintained according to CMP's Post Construction Vegetation Management Plan ("VMP") (revised August 2018).

The changes in forest conversion associated with the HDD crossing does not change the discussion in the September 27, 2017 Site Law Application, Section 7.4.1.1. In summary, this section of the application concludes:

In general, given the existing landscape characteristics of the overall NECEC Project area, construction and maintenance of the transmission line corridors will result in habitat conversion that is already common to the area, i.e. forested to scrub-shrub. It is anticipated that local wildlife populations will adapt and respond to any additional alterations much as they already do to uses within the vicinity of the transmission line corridor. Impacts of habitat conversion along the proposed transmission line corridor are expected to be minimal, beneficial to some species while detrimental to other species.

7.3 Significant or Sensitive Wildlife Habitats

The September 27, 2017 NECEC Site Law Application, Section 7.0, identifies four major categories of protected significant or sensitive wildlife habitats within the NECEC transmission line corridors or substation areas. These resources include: bald eagle nest sites, deer wintering areas ("DWAs"), inland wading bird and waterfowl habitat ("IWWH"), and significant vernal pool habitat ("SVPH"). Project changes as a result of the HDD proposal will not change impact to any IWWHs or SVPHs, and therefore are not discussed further within this application amendment. Project changes which may impact wildlife and fisheries, either directly or indirectly, are discussed below.

7.3.1 Bald Eagle Nest Sites

Based on a review of GIS information provided by the United States Fish and Wildlife Service ("USFWS"), there are no documented bald eagle nest sites within 660 feet of the HDD development. As committed to in the September 27, 2017 Site Law application, in order to identify potential new and unmapped bald eagle sites within the area of the Kennebec River HDD, as well as within all other areas of the NECEC transmission line corridor, CMP will perform an aerial survey each spring prior to construction. This aerial survey will focus on target areas near waterbodies that support eagle activity, including the Kennebec River. Surveys will be conducted in cooperation with MDIFW.

If an eagle nest is identified within 660 feet of the HDD development, potential disturbance to eagle nests will be avoided by timing construction to coincide with times of the year when the nests are not occupied. Based on recommendations from MDIFW, CMP will avoid construction of the NECEC between March 1 and August 31 within 660 feet of known nest sites. Exceptions to this timing restriction may be requested of MDIFW in site-specific locations.

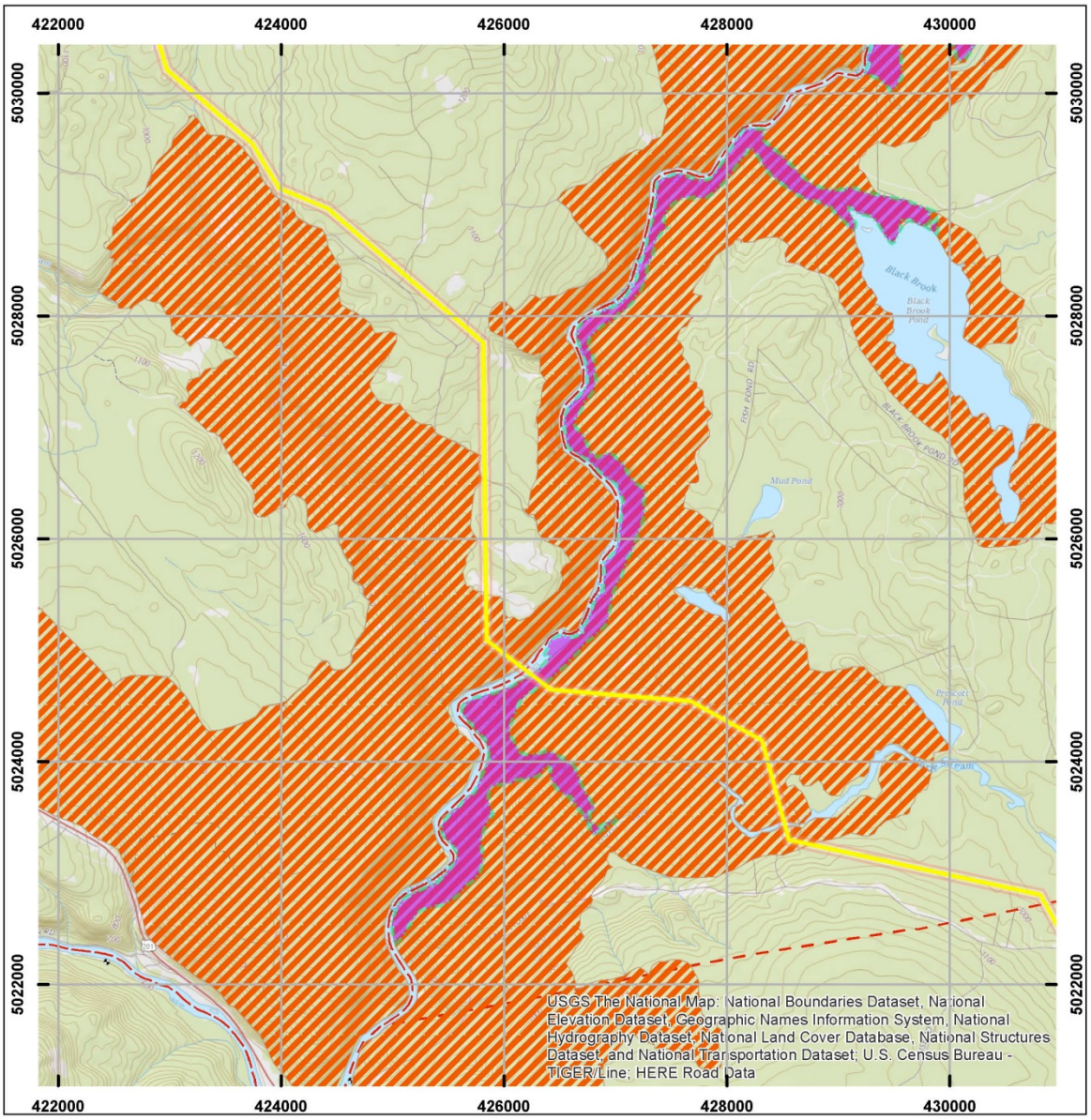
7.3.2 Deer Wintering Areas

The HDD development is located within a deer wintering area ("DWA"). The DWA, shown in Figure 7-1 below, is "non-regulatory, but still important for consideration in planning to accommodate needs of

wintering deer" according to Bob Cordes, MDIFW (email correspondence 8/15/17). Project impacts within the project modification area include 5.75 acres of tree clearing, and 0.84 acres of permanent impact from construction of the termination stations. When compared with the overhead alternative proposed within the September 27, 2017 Site Law Application, the HDD design change will reduce the impact of tree clearing within the DWA by 7.16 acres.

Unavoidable impacts will occur within this DWA due to the construction of the HDD development. The HDD minimizes impact to the DWA by retaining approximately 1,450 feet and 1,160 feet of forested buffer on the east and west sides of the Kennebec River, respectively. Intact, mature riparian buffers or vegetation bridges provide good travel corridors for wintering deer and are particularly valuable in this portion of Maine, which experiences high snow depths in winter.

All DWAs crossed by the Project are classified by the MDIFW as indeterminate in value, which means that they are recognized as candidate Significant Wildlife Habitat under the NRPA, but currently have no formal value rating. Although not required by NRPA, they have been considered for habitat enhancement within the NECEC Compensation Plan (updated October 19, 2018). Within this plan, CMP commits to the enhancement of wildlife habitat in and around DWAs, "to revegetate disturbed soils in upland areas with a Wildlife Seed Mix, promoted by SAM and developed with Maine Seed Company. This wildlife friendly seed mix will offer nutrition to deer and other wildlife such as moose, rabbits, ruffed grouse, geese, and wild turkeys during late fall and early spring when woods forage is sparse. The tender shoots derived from SAM's seed mix offer forage that is high in calories and protein, and deer find them to be highly digestible." See the Compensation Plan, updated and filed on October 19, 2018, for further details.



Environmental Review of Fish and Wildlife Observations and Priority Habitats

Project Name: ER Tool Test (Version 1)

Maine Department of Inland Fisheries and Wildlife

Miles

0 0.275 0.55 1.1 1.65 2.2

Projection: UTM, NAD83, Zone 19N

Date: 20170815

Figure 7-1

Legend

LUPC Zoned P-FW sub-district

DWA_NUMBER

060065 *Non-Regulatory Biologically Important Wintering Deer Areas*



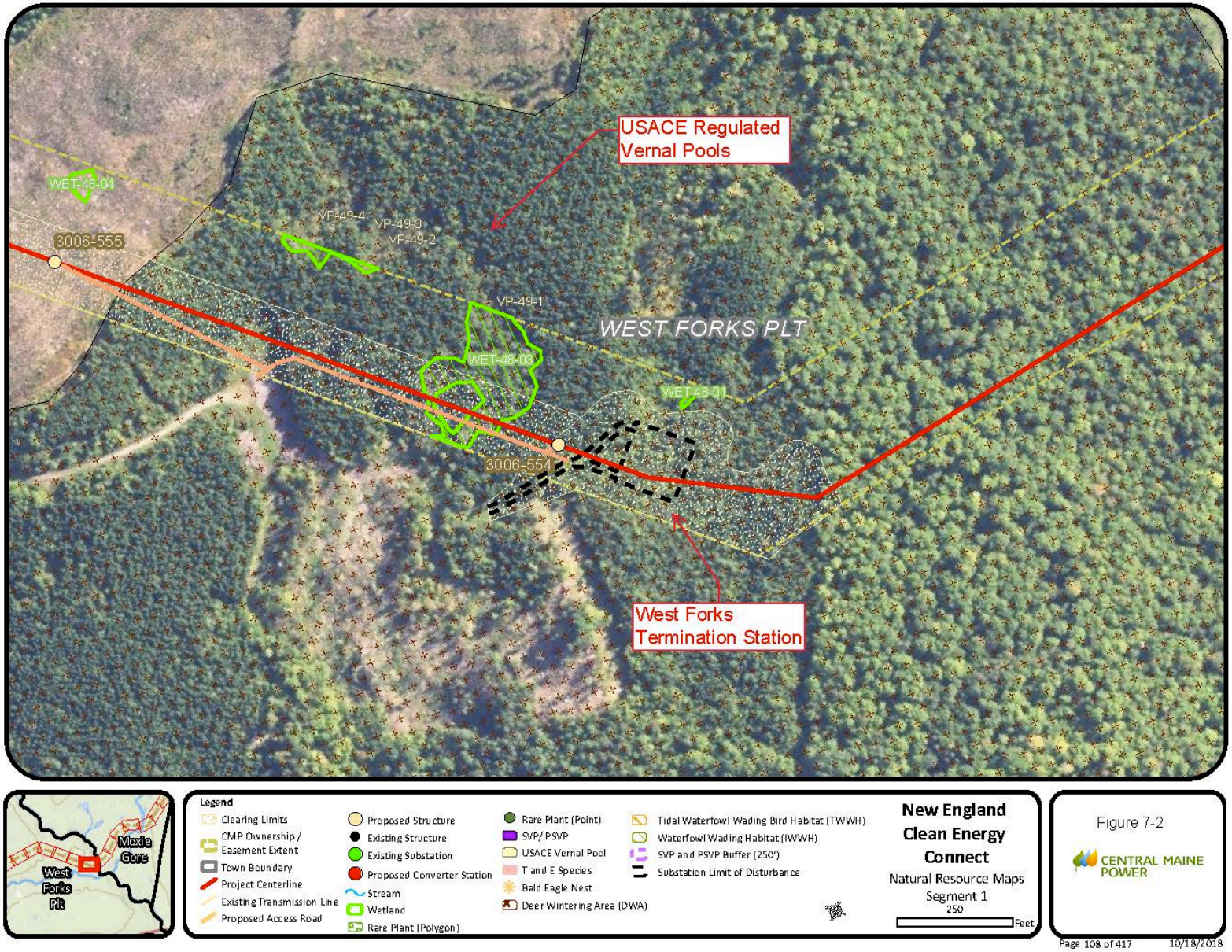
7.3.3 Vernal Pools

As noted in Section 7.1, no significant vernal pool habitats, defined in NRPA Chapter 335, will be impacted by the HDD development.

Three vernal pools regulated by the United States Army Corps of Engineers ("USACE") under the provisions of Section 404 of the Clean Water Act, that do not meet the NRPA definition, exist in the vicinity of the HDD development. The USACE regulates activities within a distance of 750 feet from the vernal pool depression, also referred to as the "vernal pool management area," which includes the pool depression, the envelope (area within 0 to100 feet of the vernal pool depression edge), and the critical terrestrial habitat (area within 100 to 750 feet of the vernal pool depressions edge).

The three vernal pools identified, depicted on Figure 7-2 below, are not located within CMP's corridor, but were inventoried as part of the field survey efforts in 2015, 2016, and 2017. There will be an additional clearing impact of 0.89 acres within the 750 foot vernal pool management area as a result of the HDD design change.

Impacts associated with the HDD development have been evaluated and considered in the NECEC Compensation Plan (updated October 19, 2018). Additionally, an updated USACE Vernal Pool Table (Exhibit 7-6) is being provided concurrently with this filing as a component of CMP's October 19, 2018 supplemental application materials submittal.


USACE Regulated Vernal Pools
WET-48-04
VP-49-4
VP-49-3
VP-49-2
3006-555
VP-49-1
WEST FORKS PLT
WET-48-03
WET-48-01
3006-554
West Forks Termination Station
Moxie Gore
West Forks Plt
Legend
Clearing Limits
CMP Ownership / Easement Extent
Town Boundary
Project Centerline
Existing Transmission Line
Proposed Access Road
Proposed Structure
Existing Structure
Existing Substation
Proposed Converter Station
Stream
Wetland
Rare Plant (Polygon)
Rare Plant (Point)
SVP/ PSVP
USACE Vernal Pool
T and E Species
Bald Eagle Nest
Deer Wintering Area (DWA)
Tidal Waterfowl Wading Bird Habitat (TWWH)
Waterfowl Wading Habitat (IWWH)
SVP and PSVP Buffer (250')
Substation Limit of Disturbance
New England Clean Energy Connect
Natural Resource Maps
Segment 1
250
Feet
Figure 7-2
CENTRAL MAINE POWER
Page 108 of 417
10/18/2018

7.3.4 RTE Wildlife and Species of Special Concern

CMP conducted a review of all state listed and federally listed species and species of special concern (collectively, "RTE" or "RTE species") which may potentially occur within the vicinity of the NECEC Project components in the Site Law application filed on September 27, 2017. This application amendment will address potential impacts to those species as a result of the HDD development. Based on this review, state and federally listed bat species require additional discussion due to the tree clearing associated with the termination stations and clearance requirements. Other RTE or Special Concern species did not require further consideration due to the lack of habitat or documented occurrence in the vicinity of the HDD development, and are addressed fully in the September 27, 2017 Site Law Application.

7.3.4.1 Bats

Of the eight bat species that occur in Maine, three are protected under MESA: little brown bat (State Endangered), eastern small footed-bat (State Threatened), and Northern Long-eared bat (State Endangered). The Northern Long-eared bat ("NLEB") is also federally listed as Threatened under the ESA. The remaining five species are of Special Concern and are considered in the NECEC Project's protection of bat species: big brown bat, red bat, hoary bat, silver-haired bat, and tri-colored bat. MDIFW species profiles indicate that, except for the eastern small-footed bat, which is found within the southern half of the state, bat species are widely distributed throughout Maine and can be found in nearly all areas (MDIFW 2017). Based on information provided by MDIFW, there are no documented occurrences of these species' individuals within the NECEC Project corridor, however there is presumed occurrence of roosting bats in the northern hardwood and conifer forests consistent with areas found along the NECEC route and in the vicinity of the HDD development.

The NECEC will not adversely affect any of the eight (8) bat species that could be present along the Project route. As discussed in the September 27, 2017 NECEC Site Law Application, the primary threat to bats is White Nose Syndrome (WNS), particularly in the northeast where some bat species populations have declined up to 99 percent (USFWS 2017). The White Nose Syndrome Zone (WNSZ) includes the entire State of Maine and most areas of the eastern and midwestern United States. The NECEC is wholly located within the WNSZ but not near any known hibernacula or maternity roost trees.

The HDD development will result in a net reduction of 7.16 acres of additional tree clearing. According to the USFSW January 5, 2016, intraService Programmatic Biological Opinion (BO) in the Final 4(d) Rule, tree clearing in areas not near known hibernacula or known maternity roost trees is not a major contributor to the species decline, but because populations of bats are depressed by WNS, human activities that were not previously

believed to be significant may be so now (USFWS 2017). In WNS affected areas, MDIFW recommends, although does not require, an attempt to minimize tree removal during the maternity season when the pups are not able to fly and escape a falling tree. Maternity roost season occurs between June 1 and July 31 in Maine. Removal of trees outside this period, when most bats can fly and are more dispersed, is less likely to result in a direct injury or mortality. As a conservation effort to protect all federal and state protected bat species, the NECEC will suspend tree clearing activities during the maternity roost season of June 1 to July 31. CMP will maintain this commitment to any new tree clearing required as part of the HDD development.

7.4 Fisheries Resources

There are no direct or indirect impact to fisheries resources associated with the HDD development.

8.0 HISTORIC SITES

The NECEC cultural resources survey corridor includes the development area associated with the HDD and termination stations proposed on either side of the Project's Kennebec River crossing in Moxie Gore and West Forks Plt. The archaeological analysis of this area as part of the Project's sensitivity assessment (Freedman et al. 2017) identified the areas on both sides of the river for archaeological investigation. These investigations (Clement et al. 2018a; Clement et al. 2018b) did not identify archaeological resources that could be impacted by the HDD project modifications.

Architectural review of the Project corridor identified a single resource near the south bank of the river (Lost Camp; Dunham et al. 2018a). This resource has been recommended NRHP eligible, however a finding of no adverse effect is being recommended. Although the camp is within the NECEC direct area of potential effects it will not be directly impacted by construction activities. Crossing of the river through HDD will not have visual effects on this resource.

9.0 UNUSUAL NATURAL AREAS

CMP consulted with both federal and state agencies to determine the location of any rare, threatened, or endangered ("RTE") plant species and unusual natural communities in the vicinity of the NECEC Project. The locations of federal and state botanical resources, including RTE plants and rare and exemplary natural communities in Maine, are mapped by the U.S. Fish and Wildlife Service ("USFWS") and the Maine Natural Areas Program ("MNAP"). In addition, CMP completed a field survey for rare plants and exemplary natural communities in July 2018, following the recommendations of USFWS and MNAP. No RTE species or exemplary natural communities were identified within the HDD and termination station development areas.

10.0 BUFFERS

The HDD project modification will result in an increase to the forested buffers on both the east and west sides of the Upper Kennebec River, thereby avoiding visibility of the Project by recreational uses on the river (see discussion in Section 6.0). There are no other protected natural resources requiring buffers within or adjacent to the HDD and termination station development areas.

The HDD project modification will increase the buffers on the east and west side of the river by 1,150 feet and 660 feet, respectively. The total vegetated buffer retained is 1,450 feet and 1,160 feet on the east and west sides of the river, respectively.

Trenching will be required from the HDD entry and exit points to the termination stations. To eliminate the potential for roots to interfere with the underground cables, CMP will prohibit tree growth on top of the trench area and maintain the vegetation growth consistent with the NECEC Post-Construction Vegetation Maintenance Plan (August 2018).

11.0 SOILS

A Class B high intensity soil survey was conducted by Robert Vile Soil Consulting within a 5 +/- acre area at both the proposed Moxie Gore and West Forks termination stations on October 12 and 13, 2018 (Exhibit 11-1). In addition, CMP evaluated the local geology to evaluate the feasibility of HDD at this location. Soils information and a discussion of the local geology are provided below.

The soil report for the Moxie Gore Termination Station identified two different soil series within the survey area: Peru and Brayton Series. Brayton soils are considered hydric, while Peru are non-hydric. The Brayton soils were identified within a wetland area that is outside of the HDD and termination station project modification area.

The soil report for the West Forks Termination Station identified three different soil series on the parcel: Tunbridge, Lyman, and Brayton. Brayton soils are considered hydric, while Tunbridge and Lyman are non-hydric. The Brayton soils were identified within a wetland area that is outside of the HDD and termination station project modification area.

Robert Vile Soil Consulting provided a letter opinion, based on the Class B High Intensity Soil Surveys, which addresses the potential construction limitations at the termination station sites (included in Exhibit 11-1). In the locations where soils have limitations, proper engineering techniques will be implemented to overcome the limitations of the soils. This may include the removal of native soils and the importation of adequate soils.

CMP's consultant, TRC, evaluated the local geology and the general risks and challenges of HDD in the context of the Upper Kennebec River compared to other locations (Exhibit 11-2). TRC concluded that based on the review of the available information regarding the geology of the Upper Kennebec River crossing site, HDD is a feasible technology for the installation of the power transmission lines under the river.

Exhibit 11-1: Class B High Intensity Soil Surveys

Class B High Intensity Soil Survey

For

Central Maine Power Company Proposed Electrical Substation

Moxie Gore, ME

Soil Survey completed by Robert Vile Soil Consulting Inc

October 16, 2018

Robert Vile
Licensed Site Evaluator
Certified Soil Scientist

P.O. Box 114, Cates Rd.
Dixmont, ME 04932

Telephone:
(207)234-2451

Date: October 16, 2018

To: Sackett & Brake Survey, Inc.
P.O. Box 207
Skowhegan, Me. 04976

Re: Soil Suitability for a proposed CMP Electrical Substation in Moxie Gore, Me.

Findings: On October 12, 2018 I conducted a Class B High Intensity Soil Survey on the above captioned +- 5 acre parcel. Two different soil series were identified on the parcel. Most of the site is Peru soils. These soils are moderately well drained glacial till soils with little disadvantages for development. The natural slopes on the property are gentle for the most part. The only steep area is just above a small wetland area that contains the Brayton soil series. The forested wetland will require proper permitting if plans are to fill in or disturb the soils in the wetland area. In general I would say the site is suitable for the proposed project.

Sincerely,

Robert G. Vile jr.
C.S.S. # 201
L.S.E. S204

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Telephone:
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Date: October 16, 2018

To: Sackett & Brake Survey, Inc.
P.O. Box 207
Skowhegan , Me. 04976

Re: Class B High Intensity Soil Survey of a +- 5 Acre parcel of land located in Moxie Gore, Me. for a Central Maine Power proposed electrical substation.

Findings: On October 12,2018 I investigated the above captioned parcel. The purpose of the investigation was to conduct a Class B High Intensity Soil Survey of the site. The boundaries of the survey were marked by Land surveyors. Soils were described by means of hand shoveled test pits and many soil auger borings do to difficult access for an excavator. The soil test pit locations as well as a two foot contour map at a scale of 1" = 50' were provided by Sackett & Brake Survey, Inc. This soil survey was conducted for the use in planning a Central Maine Power Company proposed electrical substation. This Class B High Intensity Soil Survey was mapped following these minimum standards described in Guidelines For Maine Certified Soil Scientists For Soil Identification And Mapping:

Class B (High Intensity)

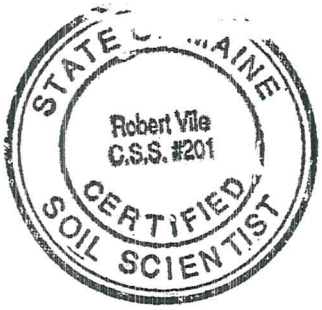
1. Map units will not contain dissimilar limiting individual inclusions larger than one acre. Dissimilar limiting inclusions may total more than one acre per map unit delineation, in the aggregate, if not continuous.
2. Scale of 1"=200' or larger.
3. Ground control-test pits for which detailed data is recorded are located by means of compass by chaining, pacing, or taping from known survey points; or other methods of equal or greater accuracy.
4. Base map with 5-foot contour lines.

Two different Soil Series were identified on the parcel. Peru and Brayton soil series. The Peru soils are classified as Coarse-loamy , isotic, frigid Aquic Haplorthods by Soil Taxonomy. These soils are moderately well drained soils that formed in lodgment till on the upland portions of this parcel. Peru soils are deeper than 40 " to bedrock. These soils exist in the forested uplands on this property with slopes ranging from 2 to 40 % . Some what firm basil till was found about 30" below the mineral surface and seasonal water table depths ranged from 18"-24". A typical pedon for this series is described at Test Pit #3. Please see attached test pit logs. Peru soils are a Class C Hydrologic Soil Group.

Surface run-off is medium and permeability is moderate in the upper horizons and moderately slow in the lower horizons. There is no hazard to flooding in the areas mapped Peru on this site. Inclusions which may exist within the Peru map units include the somewhat poorly drained Colonel Series or the Tunbridge Series. The Peru soils will have a very little negative impact on the proposed development.
The Brayton soils are classified Loamy,mixed,active,nonacid,frigid,shallow Aeric Endoaquepts by Soil Taxonomy. These soils are deep, poorly drained glacial till found in a lowland depression on this parcel. Brayton soils are hydric soils and occur within the wetland area on this site. The Brayton soils have thick organic horizons and are very bouldery on this parcel. Seasonal water tables are at the mineral surface and ponding is possible within the wetland area. Brayton soils occur on 0-3% slopes at this site. A typical pedon for this series is described at Test Pit # 1. Please see attached test pit logs. Brayton soils are a Class C Hydrologic Soil Group. Surface run-off is slow to none on this site. Inclusions within the Brayton map unit may be the very poorly drained Peachem Soil Series. The limiting factor of the Brayton soils for this project is the high seasonal water table and they are found in the forested wetland.
The accompanying soil profile descriptions, soil survey map and this soil narrative report dated October 16, 2018 were done in accordance with the standards adopted by the Maine Association of Professional Soil Scientists and presented in the " Guidelines for Maine Certified Soil Scientists for Soil Identification and Mapping" latest revision and prepared by Robert G. Vile jr. " Certified Soil Scientist # 201.
If you have any questions regarding the investigation please feel free to contact me at the above number.

Sincerely,

Robert G. Vile jr.
C.S.S. # 201
L.S.E. S204



FORM F 1/01

SOIL PROFILE / CLASSIFICATION INFORMATION

DETAILED DESCRIPTION OF SUBSURFACE CONDITIONS AT PROJECT SITES

Project Name: Electrical Substation

Applicant Name: Central Maine Power Co.

Project Location (municipality): Moxie Gore

Exploration Symbol: #1 ■ Test Pit ☐ Boring

15" Organic horizon thickness Ground surface elev. ____

Depth below mineral soil surface (inches)	Texture	Consistency	Color	Mottling
0–6	Boulder	Friable	Black	wet
6–12	Organic material		↓	
12–18	Sandy Loam		Grey	
18–24	Gravelly Sandy Loam	15" limit of excavation (free water)		
24–30				
30–36				
36–42				
42–48				

soil data by S.E.: Soil Profile 3; Classification Condition E; Slope Percent 0; Limiting Factor Depth 0; ■ Groundwater ☐ Restrictive Layer ☐ Bedrock

soil data by S.S.: Soil series/phase name: Brayton; ■ Hydric ☐ Non-hydric; Hydrologic Soil Group C

Exploration Symbol: #2 ■ Test Pit ☐ Boring

2" Organic horizon thickness Ground surface elev. ____

Depth below mineral soil surface (inches)	Texture	Consistency	Color	Mottling
0–6	Gravelly Fine Sandy Loam	Friable	Reddish Grey / Strong Brown / Yellowish Brown	None
6–12				
12–18				
18–24	Stony Gravelly Loam		Light Olive Brown	Common Distinct
24–30		Firm in place		
30–36				
36–42				
42–48				

soil data by S.E.: Soil Profile 3; Classification Condition C; Slope Percent ____; Limiting Factor Depth 18"; ■ Groundwater ☐ Restrictive Layer ☐ Bedrock

soil data by S.S.: Soil series/phase name: Peru; ☐ Hydric ■ Non-hydric; Hydrologic Soil Group C

Exploration Symbol: #3 ■ Test Pit ☐ Boring

2" Organic horizon thickness Ground surface elev. ____

Depth below mineral soil surface (inches)	Texture	Consistency	Color	Mottling
0–6	Stony Gravelly Fine Sandy Loam	Friable	Grey / Strong Brown / Yellowish Brown	None
6–12				
12–18				
18–24				
24–30			Light Olive Brown	Common Distinct
30–36		Firm in Place		
36–42				
42–48				

soil data by S.E.: Soil Profile 3; Classification Condition C; Slope Percent ____; Limiting Factor Depth 24"; ■ Groundwater ☐ Restrictive Layer ☐ Bedrock

soil data by S.S.: Soil series/phase name: Peru; ☐ Hydric ■ Non-hydric; Hydrologic Soil Group C

Exploration Symbol: #4 ■ Test Pit ☐ Boring

0" Organic horizon thickness Ground surface elev. ____

Depth below mineral soil surface (inches)	Texture	Consistency	Color	Mottling
0–6	Stony Gravelly Sandy Loam	Friable	Yellowish Brown	None
6–12				
12–18				
18–24				
24–30			Light olive Brown	Common Distinct
30–36		Firm in place		
36–42				
42–48				

soil data by S.E.: Soil Profile 3; Classification Condition C; Slope Percent ____; Limiting Factor Depth 24"; ■ Groundwater ☐ Restrictive Layer ☐ Bedrock

soil data by S.S.: Soil series/phase name: Peru; Hydrologic Soil Group

INVESTIGATOR INFORMATION AND SIGNATURE

Signature: Robert G. Vile jr.

Date: 10-15-18

Name Printed/typed: Robert G. Vile jr.

Cert/Lic/Reg. # 55 401

Title: ■ Licensed Site Evaluator ☐ Certified Geologist ■ Certified Soil Scientist ☐ Other:

STATE OF MAINE — Robert Vile C.S.S. #201 — CERTIFIED SOIL SCIENTIST — affix professional seal

LOCATION PERU NH+MA ME NY VT

Established Series
Rev. HRM-RFL-DHZ
06/2016

PERU SERIES

The Peru series consists of moderately well drained soils that formed in loamy lodgment till on hills and mountains in glaciated uplands. They are moderately deep to a dense substratum and very deep to bedrock. Estimated saturated hydraulic conductivity is moderately high or high in the solum, and moderately low or moderately high in the dense substratum. Slope ranges from 0 to 60 percent. Mean annual precipitation is about 1180 mm, and mean annual temperature is about 6 degrees C.

TAXONOMIC CLASS: Coarse-loamy, isotic, frigid Aquic Haplorthods

TYPICAL PEDON: Peru fine sandy loam, on a north facing, 15 percent slope in a very stony wooded area. (Colors are for moist soil unless otherwise noted.)

Oe--0 to 3 cm; black (10YR 2/1) moderately decomposed plant material; very friable; very strongly acid (pH 4.9); abrupt smooth boundary. (O horizon thickness is 0 to 10 cm.)

A--3 to 13 cm; dark brown (7.5YR 3/2) fine sandy loam, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; many very fine and fine and few coarse roots; 5 percent rock fragments; very strongly acid (pH 4.8); abrupt wavy boundary. (0 to 10 cm thick)

E--13 to 15 cm; light brownish gray (10YR 6/2) fine sandy loam; weak medium granular structure; friable; common fine roots; 5 percent rock fragments; very strongly acid (pH 4.8); abrupt broken boundary. (0 to 10 cm thick)

Bs1--15 to 18 cm; dark brown (7.5YR 3/4) fine sandy loam; weak fine granular structure; friable; common fine and few coarse roots; 5 percent rock fragments; very strongly acid (pH 5.0); abrupt broken boundary.

Bs2--18 to 33 cm; strong brown (7.5YR 4/6) fine sandy loam; weak fine granular structure; friable; common fine and few coarse roots; 5 percent rock fragments; very strongly acid (pH 5.0); clear wavy boundary.

Bs3--33 to 46 cm; dark yellowish brown (10YR 4/6) fine sandy loam; weak medium subangular blocky structure; friable; common fine roots; 5 percent rock fragments; strongly acid (pH 5.2); abrupt wavy boundary. (Combined thickness of the Bs horizon is 7 to 38 cm).

BC--46 to 54 cm; dark yellowish brown (10YR 4/4) fine sandy loam; weak fine subangular blocky structure; friable; few fine roots; common fine faint olive brown (2.5Y 4/3) iron depletions in the matrix; 5 percent rock

fragments; strongly acid (pH 5.2); abrupt smooth boundary. (0 to 38 cm thick)

Cd1--54 to 94 cm: olive brown (2.5Y 4/3) fine sandy loam; 85 percent moderate medium plates and 15 percent sandy lenses; firm; common medium faint olive gray (5Y 4/2) iron depletions in the matrix; 5 percent rock fragments; strongly acid (pH 5.2); clear wavy boundary.

Cd2--94 to 165 cm; olive gray (5Y 4/2) fine sandy loam; 95 percent moderate thick plates and 5 percent sandy lenses; firm; common medium faint olive brown (2.5Y 4/3) masses of iron accumulation on faces of peds; 5 percent rock fragments; strongly acid (pH 5.2).

TYPE LOCATION: Merrimack County, New Hampshire; Town of New London; located about 275 meters west of County Road on Northwood Lane, and 35 meters south of the road; USGS Sunapee Lake North, NH topographic quadrangle; latitude 43 degrees 24 minutes 04 seconds N. and longitude 72 degrees 01 minutes 17 seconds W., NAD 83.

RANGE IN CHARACTERISTICS: The thickness of the mineral solum and depth to densic materials from the mineral surface range from 50 to 100 cm. Depth to bedrock is greater than 150 cm. Texture is typically fine sandy loam, sandy loam, or loam in the fine-earth fraction but includes silt loam and very fine sandy loam in the upper part of the solum. The weighted average of clay in the particle-size control section is 10 percent or less. The silt content in the solum and underlying till averages less than 50 percent, but ranges to 50 percent or more in the upper 25 cm of the solum. Rock fragments are dominantly gravel with some cobbles and stones and typically range from 5 to 30 percent throughout the mineral soil. Some pedons have horizons with less than 5 percent rock fragments. Reaction ranges from extremely acid to slightly acid in the solum, and from very strongly acid to slightly acid in the substratum.

The O horizons, where present, consist of slightly, moderately, and/or highly decomposed organic material. The Oe and Oa horizons have hue of 2.5YR to 10YR, value of 2 to 4, and chroma of 1 to 4.

The A, or Ap horizon where present, has hue of 5YR to 10YR and value and chroma of 2 to 4.

The E horizon is neutral or has hue of 5YR to 2.5Y, value of 4 to 7, and chroma of 0 to 2.

The Bhs horizon, where present, is up to 13 cm thick and has hue of 2.5YR to 10YR, a value of 2 to 3, and a chroma of 1 to 3.

The Bs horizon has hue of 5YR to 10YR, value of 3 to 5, and chroma of 3 to 8.

The BC horizon has hue of 10YR to 5Y, value of 3 to 6, and chroma of 2 to 6.

Some pedons have an E or E' horizon below the B horizon. It has hue of 10YR to 5Y, value of 4 to 6, and chroma of 2 or 3. Typically, it has a coarser texture than the overlying horizon.

Some pedons have a friable C horizon up to 20 cm thick that has color and texture similar to the underlying Cd horizon.

The Cd horizon has hue of 10YR to 5Y, value of 3 to 6, and chroma of 2 to 4. Consistence is firm or very firm. Arrangement of soil particles into plates is considered to be geogenic. Loose or fri ble segregated sand lenses with a horizontal orientation compose up to 20 percent of the densic materials. The lenses are typically coarse, medium, or fine sand ranging from 2 to 25 mm thick.

COMPETING SERIES: These are the [illegible], [illegible], [illegible], [illegible], Ragmuff, Skerry, Sunapee, and Worden series. Chesuncook soils have a weighted average of more than 10 percent clay in the particle-size control section. Crary soils have a mantle of eolian or water deposited sediments ranging from 40 to 100 cm thick over till. Dixmont and Sunapee soils are formed in loamy supraglacial till and do not have densic materials within 100 cm of the mineral soil surface. Howland soils have a weighted average of more than 50 percent silt in the particle-size control section. Ragmuff soils are moderately deep to bedrock. Skerry soils have more than 20% sandy lenses in the Cd horizon. Worden soils are somewhat poorly drained.

GEOGRAPHIC SETTING: Peru soils are on nearly level to steep slopes in glaciated uplands. Typically they are on linear or convex areas of backslopes, footslopes, and toeslopes, but they also occur in concave positions. The soils formed in loamy lodgment till derived mainly from schist, gneiss, phyllite, and granite. Slope ranges from 0 to 60 percent. The mean annual precipitation is 790 to 1640 mm, and the mean annual temperature is 2 to 7 degrees C. The frost-free period ranges from 90 to 160 days. Elevation ranges from about 2 to 800 meters above sea level.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Berkshire, Brayton, Cabot, Colonel, Lyman, Marlow, Monadnock, Peacham, Pillsbury, Sunapee, and Tunbridge soils. Berkshire, Lyman, Monadnock, Sunapee, and Tunbridge soils are formed in supraglacial till and do not have densic materials. Additionally, Lyman soils are shallow to bedrockk, and Tunbridge soils are moderately deep to bedrock. Peru soils are in a drainage sequence with the well drained Marlow soils, somewhat poorly drained Colonel soils, poorly drained Brayton, Cabot, and Pillsbury soils, and very poorly drained Peacham soils.

DRAINAGE AND SATURATED HYDRAULIC CONDUCTIVITY: Moderately well drained. Estimated saturated hydraulic conductivity is moderately high or high in the solum, and moderately low or moderately high in the dense substratum.

USE AND VEGETATION: Most areas are wooded. The common trees are sugar maple, eastern white pine, balsam fir, red spruce, white spruce, white ash, yellow birch, paper birch, eastern hemlock, American beech, and red pine. Areas cleared of stones are used mainly for hay and pasture and some cultivated crops.

DISTRIBUTION AND EXTENT: Maine, Massachusetts, New Hampshire, New York, and Vermont. The soils of this series are extensive.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Amherst, Massachusetts.

SERIES ESTABLISHED: Berkshire County, Massachusetts, 1923.

REMARKS: 1. Dixfield soils were recorrelated to Peru soils as part of the national Soil Data Join Recorrelation initiative. Revisions to the Peru Range in Characteristics incorporate values from the Dixfield Official Series Description. As a result of this revision to Peru, the Dixfield series status has been changed to

inactive.

2. Diagnostic horizons and features recognized in this pedon are:

a. Ochric epipedon - the zone from 0 to 15 cm (Oe, A, and E horizons).
b. Spodic horizon - the zone from 15 to 33 cm (Bs1 and Bs2 horizons).
c. Aquic conditions - redoximorphic features at 43 cm below the mineral soil surface (BC, Cd1, and Cd2 horizons).
d. Densic materials - the zone from 54 to 165 cm (Cd1 and Cd2 horizons).

ADDITIONAL DATA: Characterization data for Peru and similar soils is available through the National Cooperative Soil Survey Soil Characterization Database: http://ncsslabdatamart.sc.egov.usda.gov/

National Cooperative Soil Survey
U.S.A.

LOCATION BRAYTON ME+CT MA NY VT

Established Series
Rev. KJL-DEW-ANA
09/2013

BRAYTON SERIES

The Brayton series consists of very deep, poorly drained soils on toeslopes and depressions of glaciated uplands. These soils formed in dense till. Saturated hydraulic conductivity is moderately high or high in the solum and moderately low or moderately high in the dense substratum. Slope ranges from 0 to 25 percent. Mean annual temperature is about 7 degrees C, and mean annual precipitation is about 1092 mm.

TAXONOMIC CLASS: Loamy, mixed, active, nonacid, frigid, shallow Aeric Endoaquepts

TYPICAL PEDON: Brayton fine sandy loam, in a gently sloping, very stony forested area. (Colors are for moist soil unless otherwise stated.)

Oi--0 to 2 cm; slightly decomposed leaves, needles and twigs.

Oa--2 to 13 cm; black (5YR 2/1) highly decomposed organic material; weak very fine granular structure; very friable, many very fine, fine and medium, and common coarse roots; extremely acid; abrupt wavy boundary. (Combined thickness of the O horizons is 0 to 15 cm.)

A--13 to 18 cm; very dark gray (10YR 3/1) fine sandy loam, gray (10YR 6/1) dry; weak fine and medium granular structure; very friable; many very fine, fine and medium, and common coarse roots; 10 percent rock fragments; extremely acid; abrupt wavy boundary. (0 to 15 cm thick)

Eg--18 to 25 cm; gray (10YR 5/1) gravelly fine sandy loam; few medium distinct pinkish gray (5YR 6/2) masses of iron accumulation and few fine faint gray (10YR 6/1) iron depletions; weak very fine subangular blocky structure; friable; many very fine and fine, and common medium roots; 20 percent rock fragments; extremely acid; abrupt wavy boundary. (0 to 10 cm thick)

Bg--25 to 41 cm; grayish brown (2.5Y 5/2) fine sandy loam; weak very fine and fine subangular blocky structure; friable; common very fine and fine roots; many medium prominent dark yellowish brown (10YR 4/6) masses of iron accumulation and few fine faint gray (10YR 6/1) iron depletions; 10 percent rock fragments; strongly acid; clear wavy boundary. (13 to 51 cm thick)

BC--41 to 58 cm; light olive brown (2.5Y 5/4) fine sandy loam; weak thin platy structure; firm; many medium faint dark yellowish brown (10YR 4/4) masses of iron accumulation and few fine prominent gray (10YR 6/1) iron depletions; 10 percent rock fragments; moderately acid; clear wavy boundary. (0 to 25 cm thick)

Cd1--58 to 74 cm; olive (5Y 5/3) fine sandy loam; moderate thin and medium platy; very firm; many medium prominent yellowish brown (10YR 5/6) and common medium prominent dark yellowish brown masses of iron accumulation, few fine prominent gray (10YR 6/1) iron depletions; 10 percent rock fragments; slightly acid; clear wavy boundary.

Cd2--74 to 165 cm; olive (5Y 4/3) fine sandy loam; massive; very firm; common medium distinct dark yellowish brown (10YR 4/4) masses of iron accumulation, few fine prominent gray (10YR 6/1) iron depletions; 10 percent rock fragments; slightly acid.

TYPE LOCATION: Hancock County, Maine; town of Mariaville; off Maine Route 181, about 1.3 miles north of the bridge spanning the West Branch of Union River, about 500 feet southeast of highway; USGS Amherst topographic quadrangle; lat. 44 degrees 46 minutes 47 seconds N. and long. 68 degrees 22 minutes 15 seconds W., NAD 27.

RANGE IN CHARACTERISTICS: The combined thickness of the A, E, B and BC horizons is 25 to 50 cm. Depth to bedrock from the mineral soil surface is more than 152 cm. Reaction ranges from extremely acid to moderately acid in the A and Eg horizons and from strongly acid to slightly acid in the B and BC horizons. One or more subhorizons in the subsoil below a depth of 25 cm have pH greater than 5.5. The Cd layer ranges from moderately acid to neutral. Rock fragments in the mineral soil range from 5 to 35 percent by volume. The proportions of rock fragments are about 80 percent gravel, 15 percent cobbles, and 5 percent stones. Some pedons have channers and flagstones. Stones and boulders cover from 0 to 25 percent of the surface. Textures of the solum are silt loam, loam, very fine sandy loam, fine sandy loam, or sandy loam in the fine-earth fraction with less than 10 percent clay. The substratum textures are loam, very fine sandy loam, fine sandy loam, or sandy loam in the fine-earth fraction with less than 10 percent clay. Consistence is very friable to firm in the solum and firm or very firm in the dense substratum.

The O horizon, where present, is fibric, hemic and/or sapric material.

The A or Ap horizon, where present, has hue of 10YR to 5Y, value of 2 to 4, and chroma of 1 to 4. Structure is granular.

The Eg horizon, where present, has hue of 10YR to 5Y, value of 5 or 6, and chroma of 1 or 2.

The B horizon has hue of 10YR to 5Y, value of 4 to 6, and chroma of 1 to 4. It has subangular blocky, granular or platy structure.

The BC horizon, where present, has hue of 10YR to 5Y, value of 4 to 6, and chroma of 2 to 4. It has subangular blocky or platy structure.

One or more subhorizon in the subsoil has matrix chroma of 2 or less. The combined thickness of the B and BC horizons is at least 6 inches.

The Cd layer has hue of 10YR to 5Y, value of 3 to 6, and chroma of 1 to 4. It is prismatic parting to platy, platy or it is massive. Aggregations bounded by planes or zones of weakness are considered inherent in the parent material.

COMPETING SERIES: This is the [illegible] series. Aurelie soils have 18 to 27 percent clay throughout the particle size control section. Monarda and Pillsbury are in closely related families. They have pH less than 5.5 in the subsoil below a depth of 25 cm and Monarda soils have 10 to 18 percent clay in the particle-size control section.

GEOGRAPHIC SETTING: Brayton soils are in depressions and on toeslopes of glaciated uplands. Slopes range from 0 to 25 percent. The soils formed in dense till derived mainly from granite, phyllite, schist, slate, and shale of Wisconsin age. The climate is humid and cool temperate. Mean annual temperature ranges from 3 to 8 degrees C, and mean annual precipitation commonly ranges from 864 to 1219 mm but includes up to 1524 mm in the coastal area of Mt. Desert Island, Maine. The frost-free season ranges from 90 to 160 days. Elevations range from about 2 to 762 m above mean sea level.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Colonel, Dummerston, Dixfield, Fullam, Hubbardton, Lyman, Macomber, Marlow, Peru, Skerry, Taconic, Tunbridge, and Peacham soils. The Colonel, Dixfield, Lyman, Marlow, Peru, Skerry, and Tunbridge soils have spodic horizons, are better drained, and are on higher topographic positions. Peacham soils have a histic epipedon and are in lower topographic positions. The Dummerston, Fullam, Hubbardton, Macomber, and Taconic soils are better drained and are on higher topographic positions.

DRAINAGE AND SATURATED HYDRAULIC CONDUCTIVITY: Poorly drained. A perched water table is above the dense substratum from autumn through spring. Estimated saturated hydraulic conductivity is moderately high or high in the solum and moderately low or moderately high in the dense substratum.

USE AND VEGETATION: Most areas of this soil are forested. Some areas are cleared and used for hay and pasture. Forest vegetation is mainly red spruce, white spruce, black spruce, balsam fir, eastern white pine, red maple, northern white cedar, and paper birch, yellow birch and hemlock.

DISTRIBUTION AND EXTENT: Connecticut, Maine, Massachusetts, New York, and Vermont. The series is of moderate extent.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Amherst, Massachusetts.

SERIES ESTABLISHED: Essex County, New York, 1954.

REMARKS: After reviewing location, geographic coordiantes changed from USGS Amherst topographic quadrangle; lat. 44 degrees 46 minutes 48 seconds N. and long. 68 degrees 22 minutes 19 seconds W., NAD 27.

Diagnostic horizons and features recognized in this pedon include:
1. Ochric epipedon - the zone from 0 to 18 cm (Oi, Oa and A horizons).
2. Cambic horizon - the zone from 25 to 58 cm (Bg and BC horizons).
3. Densic contact - very firm, dense basal till at a depth of 58 cm.
4. Aeric Feature - both value and chroma of 3 or more in the zone from 41 to 58 (BC horizon).
5. Aquic conditions - redox depletions throughout the subsoil. (Eg, Bg and BC horizons).

The Aurelie series is included in the competing soils section with a previous revision.

Previous remarks June, 2004 revision:
The type location is changed with this revision based on consensus that placement in the shallow family is reflective of the dominant characteristics of the series. It is acknowledged that historically the series exceeded 50 cm to densic contact in some places. The series is re-classified from Epiaquepts to Endoaquepts in accordance with Soil Taxonomy which, in reference to applying keys, stipulates that diagnostic horizons and properties below a densic contact are excluded. It is assumed the depth to bedrock from the mineral surface of this pedon exceeds 152 cm. This soil was previously type located in New York and classified as Coarse-loamy, mixed, nonacid, frigid Aeric Fragiaquepts. The classification was changed as a result of the Northeast Fragipan Study. This series also included somewhat poorly drained soils but has since been restricted to poorly drained.

ADDITIONAL DATA: Source of the data used in establishing taxonomic class and range in characteristics is Maine Agricultural Experiment Station Technical Bulletin 94, September 1979.
Soil Interpretation Record Numbers for the Brayton Series are: Brayton, ME0100; Brayton, stony, ME0101; Brayton bouldery, ME0123; Brayton, variant ME0090.

National Cooperative Soil Survey
U.S.A.

ROBERT VILE SOIL CONSULTING, INC.
P.O. BOX 114 DIXMONT, MAINE 04932

CLASS B HIGH INTENSITY SOIL SURVEY

FOR:

CENTRAL MAINE POWER COMPANY

LOCATION:

CENTRAL MAINE POWER COMPANY CORRIDOR
MOXIE GORE, SOMERSET COUNTY, MAINE

FIELD SURVEY: ROBERT VILE	OCTOBER 16, 2018
CERTIFIED SOIL SCIENTIST #201	SCALE 1"=50'

GRAPHIC SCALE

50 0 25 50 100 200

(IN FEET)
1 inch = 50 ft.

LEGEND

- = 3/4" IRON REBAR SET WITH RED PLASTIC CAP INSCRIBED S.W. GOULD PLS 2318 (unless otherwise noted).
- = UTILITY POLE
- = WETLANDS
- = INDEX CONTOUR (NAVD 88 FEET)
- = INTERMEDIATE CONTOUR (NAVD 88 FEET)

NOTES

NOTE...1 BOUNDARY AND TOPOGRAPHIC INFORMATION PROVIDED BY SACKETT & BRAKE SURVEY, INC.

NOTE...2 WETLAND DELINEATION PERFORMED BY ROBERT VILE.

SOILS LEGEND

Br - Brayton Series - Poorly Drained
Pr - Peru Series - Moderately Well Drained

Slope Phases

A : 0% to 3% Slope
B : 3% to 8% Slope
C : 8% to 15% Slope
D : 15% to 40% Slope

Br/A — Soil Series / Slope Phase

TP : Soil Test Pit
: Soil Boundary

STATE OF MAINE
Robert Vile
C.S.S. #201
CERTIFIED SOIL SCIENTIST

ROBERT VILE
CSS#201

2018245(MG)-SOILS

2018245 FULL restore.dwg 2018245 MOXIE 10/16/2018 15:15:09 1 : 1

Class B High Intensity Soil Survey

For

Central Maine Power Company Proposed Electrical Substation

West Forks Plantation, ME

Soil Survey completed by Robert Vile Soil Consulting Inc

October 16, 2018

Robert Vile
Licensed Site Evaluator
Certified Soil Scientist

P.O. Box 114, Cates Rd.
Dixmont, ME 04932

Telephone:
(207)234-2451

Date: October 16, 2018

To: Sackett & Brake Survey, Inc.
P.O. Box 207
Skowhegan, Me. 04976

Re: Soil Suitability for a proposed CMP Electrical Substation in West Forks Plt., Me.

Findings: On October 12 and 13, 2018 I conducted a Class B High Intensity Soil Survey on the above captioned +- 5 acre parcel. Three different soil series were identified on the parcel. Tunbridge , Lyman and Brayton. The Tunbridge and Lyman soils have bedrock as the limiting factor. The Brayton soils occupy a small forested wetland area in the proposed site. If this area will be filled or disturbed then proper permitting will be required. Because of the natural sloping topography of the site it will be a cut and fill site. The shallow to ledge areas will require blasting but will produce some excellent material to fill the lower areas. The site has potential for the proposed substation.

Sincerely,

Robert G. Vile jr.
C.S.S. # 201
L.S.E. S204

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Certified Soil Scientist

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Dixmont, ME 04932

Telephone:
(207)234-2451

Date: October 16, 2018

To: Sackett & Brake Survey, Inc.
P.O. Box 207
Skowhegan , Me. 04976

Re: Class B High Intensity Soil Survey of a +- 5 Acre parcel of land located in West Forks Plantation, Me..for a Central Maine Power proposed electrical substation.

Findings: On October 12 and October 13,2018 I investigated the above captioned parcel. The purpose of the investigation was to conduct a Class B High Intensity Soil Survey of the site. The boundaries of the survey were marked by Land surveyors. Soils were described by means of hand shoveled test pits and many soil auger borings do to difficult access for an excavator. The soil test pit locations as well as a two foot contour map at a scale of 1" = 50' were provided by Sackett & Brake Survey, Inc. This soil survey was conducted for the use in planning a Central Maine Power Company proposed electrical substation. This Class B High Intensity Soil Survey was mapped following these minimum standards described in Guidelines For Maine Certified Soil Scientists For Soil Identification And Mapping:
Class B (High Intensity)

1. Map units will not contain dissimilar limiting individual inclusions larger than one acre. Dissimilar limiting inclusions may total more than one acre per map unit delineation, in the aggregate, if not continuous.
2. Scale of 1"=200' or larger.
3. Ground control-test pits for which detailed data is recorded are located by means of compass by chaining, pacing, or taping from known survey points; or other methods of equal or greater accuracy.
4. Base map with 5-foot contour lines.

This parcel is bedrock controlled. Three different Soil Series were identified on the parcel. Tunbridge , Lyman and Brayton soil series.
The Tunbridge soils are classified Coarse-loamy, isotic, frigid Typic Haplorthods by Soil Taxonomy. These soils are moderately deep, well drained soils formed in supraglacial till on the forested upland portions of the parcel. Tunbridge soils have bedrock between 20" and 40" on this site. They exist on slopes ranging from 3 to 40% on this site. No restrictive layers or seasonal water table was observed in these soils. A typical pedon for this series is described at Test Pit #1. Please see attached test pit logs. Tunbridge soils are

a Class C Hydrologic Soil Group. Surface run-off is medium and permeability is moderately high or high throughout the profile. There is no hazard of flooding on these soils. Inclusions within the Tunbridge mapping unit include the Lyman series and the Peru soil series. The limiting factor of the Tunbridge soils for this project will be the depth to ledge. Blasting may be required.

The Lyman soils are classified Loamy, isotic, frigid Lithic Haplorthods by Soil Taxonomy. These soils are somewhat excessively drained , shallow to bedrock and formed in loamy supraglacial till. They occur on the forested uplands on this parcel. These soils have bedrock between 6 to 19" on this parcel with several bedrock outcrops. There is no seasonal watertable or restrictive layer associated with these soils. A typical pedon for this series is described at soil test boring # 5. Please see attached test pit logs. Lyman soils are a Class C/D Hydrologic Soil Group. Surface run-off is very high to high within these map units. Permeability is moderately high to high in the Lyman soils. There is no hazard of flooding within these map units. Inclusions within the Lyman map unit include the Tunbridge series where bedrock is found 20" or deeper below the mineral surface. The limiting factor with the Lyman series for this project is ledge. Blasting may be required.

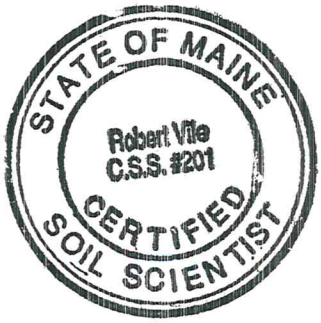
The Brayton soils are classified Loamy,mixed,active,nonacid,frigid,shallow Aeric Endoaquepts by Soil Taxonomy. These soils are deep, poorly drained glacial till found in a lowland depression on this parcel. Brayton soils are hydric soils and occur within the wetland area on this site. The Brayton soils have thick organic horizons and are very bouldery on this parcel. Seasonal water tables are at the mineral surface and ponding is possible within the wetland area. Brayton soils occur on 0-3% slopes at this site. A typical pedon for this series is described at Test Pit # 4. Please see attached test pit logs. Brayton soils are a Class C Hydrologic Soil Group. Surface run-off is slow to none on this site. Inclusions within the Brayton map unit may be the very poorly drained Peachem Soil Series. The limiting factor of the Brayton soils for this project is the high seasonal water table and they are found in the forested wetland.

The accompanying soil profile descriptions, soil survey map and this soil narrative report dated October 16, 2018 were done in accordance with the standards adopted by the Maine Association of Professional Soil Scientists and presented in the " Guidelines for Maine Certified Soil Scientists for Soil Identification and Mapping" latest revision and prepared by Robert G. Vile jr. " Certified Soil Scientist # 201.

If you have any questions regarding the investigation please feel free to contact me at the above number.

Sincerely,

Robert G. Vile jr.
C.S.S. # 201
L.S.E. S204



FORM F 1/01

SOIL PROFILE / CLASSIFICATION INFORMATION

DETAILED DESCRIPTION OF SUBSURFACE CONDITIONS AT PROJECT SITES

Project Name: Electrical Substation

Applicant Name: Central Maine Power Co.

Project Location (municipality): West Forks PLT,

Exploration Symbol: #1 ■ Test Pit ☐ Boring

2 " Organic horizon thickness Ground surface elev. _____

Depth below mineral soil surface (inches)

	Texture	Consistency	Color	Mottling
0–6	gravely	friable	Grey	
6–12	SANDY	friable	Strong Brown	
12–18	LOAM	friable	Strong Brown	NONE
18–24	↓	↓	Yellowish Brown	
24–30			Light olive Brown	
30–36	/	36" HAND Dig	Refusal	
36–42		/	/	
42–48				

soil data by	Soil Profile	Classification Condition	Slope Percent	Limiting Factor Depth	
S.E.	2	A III		36"	☐ Groundwater ☐ Restrictive Layer ■ Bedrock

soil data by	Soil series/phase name:		Hydrologic Soil Group
S.S.	Tunbridge	☐ Hydric ■ Non-hydric	C

Exploration Symbol: #2 ■ Test Pit ☐ Boring

2 " Organic horizon thickness Ground surface elev. _____

Depth below mineral soil surface (inches)

	Texture	Consistency	Color	Mottling
0–6			Strong	
6–12	gravely	friable	Brown	
12–18	Fine	friable		NONE
18–24	SANDY		Yellowish	
24–30	LOAM		Brown	
30–36	/	24" Refusal	HAND Dig	
36–42		/	/	
42–48				

soil data by	Soil Profile	Classification Condition	Slope Percent	Limiting Factor Depth	
S.E.	2	A III		24"	☐ Groundwater ☐ Restrictive Layer ■ Bedrock

soil data by	Soil series/phase name:		Hydrologic Soil Group
S.S.	Tunbridge	☐ Hydric ■ Non-hydric	C

Exploration Symbol: #3 ■ Test Pit ☐ Boring

2 " Organic horizon thickness Ground surface elev. _____

Depth below mineral soil surface (inches)

	Texture	Consistency	Color	Mottling
0–6	gravely		Dark Brown	
6–12			Strong Brown	
12–18	Fine	Friable		NONE
18–24	SANDY LOAM		Yellowish Brown	
24–30	/	24" HAND Dig	Refusal	
30–36				
36–42		(	?	
42–48				

soil data by	Soil Profile	Classification Condition	Slope Percent	Limiting Factor Depth	
S.E.	2	A III		24"	☐ Groundwater ☐ Restrictive Layer ■ Bedrock

soil data by	Soil series/phase name:		Hydrologic Soil Group
S.S.	Tunbridge	☐ Hydric ■ Non-hydric	C

Exploration Symbol: #4 ■ Test Pit ☐ Boring

6 " Organic horizon thickness Ground surface elev. _____

Depth below mineral soil surface (inches)

	Texture	Consistency	Color	Mottling
0–6	Bouldery		DARK Grayish Brown	COMMON
6–12	Fine	FRIABLE		DISTINCT
12–18	SANDY LOAM		olive grey	
18–24				
24–30		18" Free water in Pit		
30–36				
36–42				
42–48				

soil data by	Soil Profile	Classification Condition	Slope Percent	Limiting Factor Depth	
S.E.	3	E		0	■ Groundwater ☐ Restrictive Layer ☐ Bedrock

soil data by	Soil series/phase name:		Hydrologic Soil Group
S.S.	Brayton	■ Hydric ☐ Non-hydric	D

INVESTIGATOR INFORMATION AND SIGNATURE

Signature: Robert G Vile jr

Date: 10-15-18

Name Printed/typed: Robert G. Vile jr.

Cert/Lic/Reg. # 55 201

Title: ■ Licensed Site Evaluator ■ Certified Soil Scientist ☐ Certified Geologist ☐ Other:

STATE OF MAINE — Robert Vile C.S.S. #201 — CERTIFIED SOIL SCIENTIST

affix professional seal

FORM F 1/01

SOIL PROFILE / CLASSIFICATION INFORMATION

DETAILED DESCRIPTION OF SUBSURFACE CONDITIONS AT PROJECT SITES

Project Name: Electrical Substation

Applicant Name: Central Maine Power Co.

Project Location (municipality): West Forks Plt.

Exploration Symbol: #5 ☐ Test Pit ☒ Boring

2 " Organic horizon thickness Ground surface elev. _____

Depth below mineral soil surface (inches)	Texture	Consistency	Color	Mottling
0–6	Fine Sandy Loam	Friable	Dark Yellowish Brown	None
6–12	/	8" Ledge	/	/
12–18	/	/	/	/
18–24				
24–30				
30–36				
36–42				
42–48				

soil data by	Soil Profile	Classification Condition	Slope Percent	Limiting Factor Depth	Groundwater / Restrictive Layer / Bedrock
S.E.	2	A1		8"	☐ ☐ ■

soil data by	Soil series/phase name:	Hydric / Non-hydric	Hydrologic Soil Group
S.S.	Lyman	☐ ■	C/D

Exploration Symbol: #6 ☐ Test Pit ☒ Boring

2 " Organic horizon thickness Ground surface elev. _____

Depth below mineral soil surface (inches)	Texture	Consistency	Color	Mottling
0–6			Strong	
6–12	Gravelly		Brown	
12–18	Fine	Friable		
18–24	Sandy /		Yellowish Brown	None
24–30	Loam			
30–36			Light Olive Brown	
36–42	/	36" Refusal	/	/
42–48	/	/	/	/

soil data by	Soil Profile	Classification Condition	Slope Percent	Limiting Factor Depth	Groundwater / Restrictive Layer / Bedrock
S.E.	2	A1		36"	☐ ☐ ■

soil data by	Soil series/phase name:	Hydric / Non-hydric	Hydrologic Soil Group
S.S.	Tunbridge	☐ ■	C

Exploration Symbol: _____ ☐ Test Pit ☐ Boring

_____ " Organic horizon thickness Ground surface elev. _____

Depth below mineral soil surface (inches)	Texture	Consistency	Color	Mottling
0–6				
6–12				
12–18				
18–24				
24–30				
30–36				
36–42				
42–48				

soil data by	Soil Profile	Classification Condition	Slope Percent	Limiting Factor Depth	Groundwater / Restrictive Layer / Bedrock
S.E.					☐ ☐ ☐

soil data by	Soil series/phase name:	Hydric / Non-hydric	Hydrologic Soil Group
S.S.		☐ ☐	

Exploration Symbol: _____ ☐ Test Pit ☐ Boring

_____ " Organic horizon thickness Ground surface elev. _____

Depth below mineral soil surface (inches)	Texture	Consistency	Color	Mottling
0–6	/			
6–12				
12–18				
18–24				
24–30				
30–36				
36–42				
42–48				

soil data by	Soil Profile	Classification Condition	Slope Percent	Limiting Factor Depth	Groundwater / Restrictive Layer / Bedrock
S.E.					☐ ☐ ☐

soil data by	Soil series/phase name:	Hydric / Non-hydric	Hydrologic Soil Group
S.S.		☐ ☐	

INVESTIGATOR INFORMATION AND SIGNATURE

Signature: Robert G. Vile jr. Date: 10-15-18

Name Printed/typed: Robert G. Vile jr. Cert/Lic/Reg. # SS 201

Title: ■ Licensed Site Evaluator ☐ Certified Geologist ■ Certified Soil Scientist ☐ Other:

STATE OF MAINE — Robert Vile C.S.S. #201 — CERTIFIED SOIL SCIENTIST

DEP Form F Rev. 1/01

LOCATION TUNBRIDGE VT+MA ME NH NY

Established Series
Rev. RLM-SHG-RFL
01/2016

TUNBRIDGE SERIES

The Tunbridge series consists of moderately deep, well drained soils on glaciated uplands. They formed in loamy supraglacial till. Saturated hydraulic conductivity is moderately high or high throughout the mineral soil. Slope ranges from 0 to 80 percent. Mean annual precipitation is about 1180 mm, and mean annual temperature is about 6 degrees C.

TAXONOMIC CLASS: Coarse-loamy, isotic, frigid Typic Haplorthods

TYPICAL PEDON: Tunbridge fine sandy loam, on a west-facing, 58 percent slope under mixed northern hardwoods. (Colors are for moist soil.)

Oe--0 to 8 cm; black (7.5YR 2.5/1) moderately decomposed plant material; many very fine and fine roots; clear wavy boundary.

Oa--8 to 13 cm; black (10YR 2/1) highly decomposed plant material; many very fine and fine and common medium roots; abrupt wavy boundary. (Combined thickness of the O horizons is 0 to 15 cm.)

E--13 to 20 cm; dark gray (10YR 4/1) fine sandy loam; weak fine subangular blocky structure; friable; common fine and medium roots; 5 percent gravel and 5 percent cobbles; very strongly acid (pH 4.8); abrupt wavy boundary. (0 to 20 cm thick)

Bhs--20 to 28 cm; dark reddish brown (5YR 2.5/2) fine sandy loam; weak fine subangular blocky structure; friable; common fine and medium roots; 10 percent gravel and 2 percent cobbles; very strongly acid (pH 4.8); gradual wavy boundary.

Bs--28 to 66 cm; dark reddish brown (5YR 3/3) and reddish brown (5YR 4/4) fine sandy loam; weak fine subangular blocky structure; friable; common fine, many medium, and common coarse roots; 10 percent gravel and 3 percent cobbles; strongly acid (pH 5.2); abrupt smooth boundary. (Combined thickness of the Bhs and Bs horizons is 10 to 60 cm.)

BC--66 to 71 cm; dark yellowish brown (10YR 3/4) fine sandy loam; weak fine subangular blocky structure; friable; few medium roots; 5 percent gravel; strongly acid (pH 5.4); abrupt wavy boundary. (0 to 40 cm thick)

R--71 cm; granite bedrock.

from strongly acid to slightly acid in the substratum. Rock fragments range from 5 to 35 percent throughout the mineral soil. They are mostly gravel, channers, and cobbles, but the range includes stones. The weighted average of clay in the particle-size control section is 1 to 10 percent. The silt content in the solum and substratum is typically less than 50 percent. Stony and bouldery phases of the Tunbridge series are recognized.

The O horizons, where present, consist of slightly, intermediately, and/or highly decomposed plant material.

Some pedons have an A or Ap horizon that is neutral or has hue of 5YR to 10YR, value of 2 to 5, and chroma of 0 to 4. It is typically loam, very fine sandy loam, fine sandy loam, or sandy loam in the fine-earth fraction, but the range includes silt loam. It is up to 15 cm thick.

The E horizon has hue of 5YR to 10YR, value of 4 to 6, and chroma of 1 or 2. It is typically loam, very fine sandy loam, fine sandy loam, sandy loam, loamy fine sand, or loamy sand in the fine-earth fraction, but the range includes silt loam.

Some pedons have a BE horizon that has hue of 5YR to 10YR, value of 4 to 6, and chroma of 2 to 4. Textures are similar to the E horizon.

The Bhs horizon has hue of 5YR to 10YR, with value and chroma of 3 or less.

The Bs horizon has hue of 5YR to 2.5Y, value of 3 or more and chroma of 4 or more.

The BC horizon has hue of 7.5YR to 2.5Y, value of 3 to 5, and chroma of 3 to 8.

The B horizons are typically loam, very fine sandy loam, fine sandy loam, or sandy loam in the fine-earth fraction, but the range includes silt loam. Some BC horizons have a texture of loamy sand.

Some pedons have a C horizon that has hue of 10YR to 5Y, value of 3 to 6, and chroma of 2 to 6. It is typically loam, very fine sandy loam, fine sandy loam, or sandy loam in the fine-earth fraction, but the range includes silt loam and loamy sand. It is up to 45 cm thick.

Bedrock is slightly weathered schist, gneiss, phyllite, granite, or meta-anorthosite.

COMPETING SERIES: These are the Bangor, Berkshire, Dekapen, Elliottsville, Groveton, Houghtonville, Penquis, Potsdam, Revel, and Welcome series. Bangor, Berkshire, Dekapen, Groveton, Houghtonville, Potsdam, and Welcome soils have a depth to bedrock greater than 100 cm below the mineral soil surface. Elliottsville soils have a weighted average of more than 10 percent clay in the particle-size control section. Revel soils have a paralithic contact between 50 and 100 cm and average 35 to 65 percent weathered gravel in the

particle-size control section. Penquis soils contain pararock fragments of calcareous metasiltstone and metasandstone, or metalimestone throughout the soil.

GEOGRAPHIC SETTING: Tunbridge soils are on nearly level to very steep glaciated uplands. They are on the tops and sides of hills and mountains. Slope ranges from 0 to 80 percent. The soils formed in loamy supraglacial till of Wisconsin age derived mainly from micaceous schist, gneiss, phyllite, granite, and meta-anorthosite. The mean annual precipitation is 790 to 2420 mm, and the mean annual temperature is -3 to 7 degrees C. The frost-free period is from 60 to 160 days. Elevation ranges from about 2 to 800 meters above mean sea level.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the [illegible], Rawsonville, Marlow, Peru, and Sunapee soils. The very deep to bedrock Becket, Berkshire, Colonel, Marlow, Peru, and Sunapee soils are typically on footslopes and backslopes in lower positions than nearby Tunbridge soils. Additionally, Becket, Colonel, Marlow, and Peru soils formed in loamy lodgment till. Rawsonville soils are in positions similar to Tunbridge soils and have 6 percent or more organic carbon in a layer 10 cm or more thick within the spodic horizon. Tunbridge soils are often closely intermingled with shallow Lyman soils in places where local relief is controlled by the underlying bedrock.

DRAINAGE AND SATURATED HYDRAULIC CONDUCTIVITY: Well drained. Saturated hydraulic conductivity is moderately high or high throughout the mineral soil.

USE AND VEGETATION: Most areas are wooded. The common trees are American beech, white ash, yellow birch, paper birch, northern red oak, sugar maple, eastern white pine, eastern hemlock, red spruce, white spruce, and balsam fir. Some areas have been cleared and are primarily used for hay and pasture. A few cleared areas are used for cultivated crops.

DISTRIBUTION AND EXTENT: Vermont, Maine, Massachusetts, New Hampshire, and New York. MLRAs 143, 144A, and 144B. The series is extensive.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Amherst, Massachusetts.

SERIES ESTABLISHED: Orange County, Vermont, 1975.

REMARKS: 1. Tunbridge is the official State Soil of Vermont.

2. Albic horizons may be difficult to locate because tree throws and other disturbances have destroyed them in many areas of Tunbridge soils. Albic horizons are often thin, may be discontinuous, and located within 10 cm of the soil surface.

3. The use of the Tunbridge series in MLRA 144A is in question. Tunbridge has a frigid temperature regime which is not typical in 144A.

4. The diagnostic horizons and features recognized in this pedon are:
a. Ochric epipedon - the zone from 0 to 20 cm (Oe, Oa, E horizons).
b. Albic horizon - the zone from 13 to 20 cm (E horizon).

c. Spodic horizon - the zone from 20 to 66 cm (Bhs, Bs horizons).

ADDITIONAL DATA: Laboratory characterization data for Tunbridge and similar soils is available through the National Cooperative Soil Survey Soil Characterization Database: http://ncsslabdatamart.sc.egov.usda.gov/

National Cooperative Soil Survey
U.S.A.

LOCATION LYMAN MA+ME NH NY VT

Established Series
Rev. WHT-CAW-RFL-GWS
02/2016

LYMAN SERIES

The Lyman series consists of shallow, somewhat excessively drained soils on glaciated uplands. They formed in loamy supraglacial till. Estimated saturated hydraulic conductivity is moderately high or high throughout the mineral soil. Slope ranges from 0 to 80 percent. Mean annual precipitation is about 1175 mm, and mean annual temperature is about 5 degrees C.

TAXONOMIC CLASS: Loamy, isotic, frigid Lithic Haplorthods

TYPICAL PEDON: Lyman loam, on a northwest facing, 55 percent slope in a very rocky forested area. (Colors are for moist soil.)

Oe --0 to 3 cm; moderately decomposed plant material. (O horizon thickness is 0 to 15 cm.)

A--3 to 8 cm; black (N 2/0) loam; weak fine granular structure; very friable; many fine and medium roots; extremely acid; abrupt wavy boundary. (0 to 10 cm thick)

E--8 to 13 cm; reddish gray (5YR 5/2) fine sandy loam; weak fine granular structure; very friable; many fine and medium roots; 10 percent gravel; extremely acid; abrupt broken boundary. (0 to 25 cm thick)

Bhs--13 to 18 cm; very dusky red (2.5YR 2.5/2) loam; weak fine granular structure; friable; many fine and medium roots; 10 percent fine gravel; extremely acid; abrupt broken boundary.

Bs1--18 to 28 cm; dark red (2.5YR 3/6) loam; weak fine and medium granular structure; friable; many fine and medium roots; 10 percent fine gravel; few mica flakes; very strongly acid; clear wavy boundary.

Bs2--28 to 46 cm; brown (7.5YR 4/4) grading with depth to brown (10YR 5/3) channery loam; weak coarse subangular blocky structure parting to medium and fine granular; friable; many fine and medium roots; 15 percent channers of schist and quartzite; common flakes of mica; very strongly acid; abrupt smooth boundary. (Combined thickness of the Bhs and Bs horizons is 10 to 43 cm.)

R--46 cm; dark gray mica schist bedrock.

TYPE LOCATION: Franklin County, Massachusetts; Town of Monroe; located about 550 meters west southwest of the village of Monroe Bridge and about 55 meters south of the Deerfield River; USGS Rowe, MA topographic quadrangle; lat. 42 degrees 43 minutes 12.53 seconds N. and long. 72 degrees 56 minutes 52.71

seconds W., NAD 83.

RANGE IN CHARACTERISTICS: The thickness of the mineral solum ranges from 25 to 50 cm, and corresponds to the depth to bedrock. The weighted average of clay in the particle-size control section is 1 to 10 percent. Reaction ranges from moderately acid to extremely acid throughout, unless limed. Rock fragments range from 0 to 35 percent throughout the mineral soil. They are mostly gravel and channers, but the range includes cobbles and stones.

Some pedons have Oi, Oe, and/or Oa horizons that consist of slightly, moderately, or highly decomposed organic material, respectively.

The A horizon is neutral or has hue of 5YR to10YR, value of 2, 2.5, or 3, and chroma of 0 t0 2. Some pedons have an Ap horizon with value and chroma of 2 to 4. Ap horizons are typically 15 cm or more thick. The A or Ap horizon is sandy loam, fine sandy loam, very fine sandy loam, loam, or silt loam in the fine-earth fraction.

The E horizon has hue of 5YR to 10YR, value of 4 to 6, and chroma of 1 or 2. It is loamy sand, loamy fine sand, sandy loam, fine sandy loam, very fine sandy loam, loam, or silt loam in the fine-earth fraction.

The Bhs horizon has hue of 2.5YR to 10YR, with value and chroma of 3 or less.

The Bs horizon has hue of 2.5YR to 10YR, value of 3 to 5, and chroma of 3 to 8.

Some pedons have a BC horizon with hue of 10YR to 5Y, value of 3 to 5, and chroma of 3 or 4. Texture of the B and BC horizons is sandy loam, fine sandy loam, very fine sandy loam, loam or silt loam in the fine-earth fraction. Some pedons have a loamy sand BC horizon.

Bedrock is slightly weathered schist, gneiss, phyllite, or granite.

COMPETING SERIES: These are the , , and series. Abram soils have bedrock at a depth of less than 25 cm from the mineral soil surface. Creasey soils have sandstone or conglomerate bedrock. Monson soils average more than 10 percent clay in the particle-size control section.

GEOGRAPHIC SETTING: Lyman soils are on nearly level to very steep glaciated uplands. They are on the tops and sides of hills and mountains. Slope ranges from 0 to 80 percent. The soils formed in loamy supraglacial till of Wisconsin age derived mainly from micaceous schist, gneiss, phyllite, and granite. The mean annual precipitation is 790 to 2420 mm, and the mean annual temperature is -3 to 9 degrees C. The frost-free period is from 60 to 160 days. Elevation ranges from about 2 to 800 meters above mean sea level.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the , , , , Marlow, Peru, Skerry, Sunapee, and Tunbridge soils. The very deep to bedrock Becket, Berkshire, Colonel, Marlow, Peru, Skerry, and Sunapee soils are typically on footslopes and backslopes in lower positions than nearby Lyman soils. In addition, Becket, Colonel, Marlow, Peru, and Skerry soils are formed in loamy lodgment till. Hogback soils are in positions similar to Lyman soils and have 6 percent or more organic carbon in a layer 10 cm or more thick within the spodic horizon. Lyman soils are often closely intermingled with the moderately deep Tunbridge soils in places where local relief is controlled by the underlying bedrock.

DRAINAGE AND SATURATED HYDRAULIC CONDUCTIVITY: Somewhat excessively drained. Potential runoff is very high. Estimated saturated hydraulic conductivity is moderately high or high in the mineral soil.

USE AND VEGETATION: Most areas are wooded. The common trees are American beech, white ash, yellow birch, paper birch, northern red oak, sugar maple, eastern white pine, eastern hemlock, red spruce, white spruce, and balsam fir. Some areas have been cleared and are primarily used for hay and pasture. A few cleared areas are used for cultivated crops.

DISTRIBUTION AND EXTENT: Northern New England, western Massachusetts, and northern New York. Principally in the Green and White Mountains, the Adirondack Mountains, the Berkshire uplands, and eastern and western Maine. MLRAs 143, 144A, and 144B. The series is extensive.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Amherst, Massachusetts.

SERIES ESTABLISHED: Grafton County, New Hampshire, 1935.

REMARKS: 1. The use of the Lyman series in MLRA 144A is in question. Lyman has a frigid temperature regime which is not typical in 144A.

2. Diagnostic horizons and features recognized in this pedon are:
a. Ochric epipedon - the zone from 0 to 13 cm (Oe, A, and E horizons).
b. Albic horizon - the zone from 8 to 13 cm (E horizon).
c. Spodic horizon - the zone from 13 to 46 cm (Bhs, Bs1, and Bs2 horizons).
d. Lithic feature - bedrock at 43 cm from the mineral soil surface.

ADDITIONAL DATA: Characterization data for Lyman and similar soils is available through the National Cooperative Soil Survey Soil Characterization Database: http://ncsslabdatamart.sc.egov.usda.gov/

National Cooperative Soil Survey
U.S.A.

LOCATION BRAYTON ME+CT MA NY VT

Established Series
Rev. KJL-DEW-ANA
09/2013

BRAYTON SERIES

The Brayton series consists of very deep, poorly drained soils on toeslopes and depressions of glaciated uplands. These soils formed in dense till. Saturated hydraulic conductivity is moderately high or high in the solum and moderately low or moderately high in the dense substratum. Slope ranges from 0 to 25 percent. Mean annual temperature is about 7 degrees C, and mean annual precipitation is about 1092 mm.

TAXONOMIC CLASS: Loamy, mixed, active, nonacid, frigid, shallow Aeric Endoaquepts

TYPICAL PEDON: Brayton fine sandy loam, in a gently sloping, very stony forested area. (Colors are for moist soil unless otherwise stated.)

Oi--0 to 2 cm; slightly decomposed leaves, needles and twigs.

Oa--2 to 13 cm; black (5YR 2/1) highly decomposed organic material; weak very fine granular structure; very friable, many very fine, fine and medium, and common coarse roots; extremely acid; abrupt wavy boundary. (Combined thickness of the O horizons is 0 to 15 cm.)

A--13 to 18 cm; very dark gray (10YR 3/1) fine sandy loam, gray (10YR 6/1) dry; weak fine and medium granular structure; very friable; many very fine, fine and medium, and common coarse roots; 10 percent rock fragments; extremely acid; abrupt wavy boundary. (0 to 15 cm thick)

Eg--18 to 25 cm; gray (10YR 5/1) gravelly fine sandy loam; few medium distinct pinkish gray (5YR 6/2) masses of iron accumulation and few fine faint gray (10YR 6/1) iron depletions; weak very fine subangular blocky structure; friable; many very fine and fine, and common medium roots; 20 percent rock fragments; extremely acid; abrupt wavy boundary. (0 to 10 cm thick)

Bg--25 to 41 cm; grayish brown (2.5Y 5/2) fine sandy loam; weak very fine and fine subangular blocky structure; friable; common very fine and fine roots; many medium prominent dark yellowish brown (10YR 4/6) masses of iron accumulation and few fine faint gray (10YR 6/1) iron depletions; 10 percent rock fragments; strongly acid; clear wavy boundary. (13 to 51 cm thick)

BC--41 to 58 cm; light olive brown (2.5Y 5/4) fine sandy loam; weak thin platy structure; firm; many medium faint dark yellowish brown (10YR 4/4) masses of iron accumulation and few fine prominent gray (10YR 6/1) iron depletions; 10 percent rock fragments; moderately acid; clear wavy boundary. (0 to 25 cm thick)

Cd1--58 to 74 cm; olive (5Y 5/3) fine sandy loam; moderate thin and medium platy; very firm; many medium prominent yellowish brown (10YR 5/6) and common medium prominent dark yellowish brown masses of iron accumulation, few fine prominent gray (10YR 6/1) iron depletions; 10 percent rock fragments; slightly acid; clear wavy boundary.

Cd2--74 to 165 cm; olive (5Y 4/3) fine sandy loam; massive; very firm; common medium distinct dark yellowish brown (10YR 4/4) masses of iron accumulation, few fine prominent gray (10YR 6/1) iron depletions; 10 percent rock fragments; slightly acid.

TYPE LOCATION: Hancock County, Maine; town of Mariaville; off Maine Route 181, about 1.3 miles north of the bridge spanning the West Branch of Union River, about 500 feet southeast of highway; USGS Amherst topographic quadrangle; lat. 44 degrees 46 minutes 47 seconds N. and long. 68 degrees 22 minutes 15 seconds W., NAD 27.

RANGE IN CHARACTERISTICS: The combined thickness of the A, E, B and BC horizons is 25 to 50 cm. Depth to bedrock from the mineral soil surface is more than 152 cm. Reaction ranges from extremely acid to moderately acid in the A and Eg horizons and from strongly acid to slightly acid in the B and BC horizons. One or more subhorizons in the subsoil below a depth of 25 cm have pH greater than 5.5. The Cd layer ranges from moderately acid to neutral. Rock fragments in the mineral soil range from 5 to 35 percent by volume. The proportions of rock fragments are about 80 percent gravel, 15 percent cobbles, and 5 percent stones. Some pedons have channers and flagstones. Stones and boulders cover from 0 to 25 percent of the surface. Textures of the solum are silt loam, loam, very fine sandy loam, fine sandy loam, or sandy loam in the fine-earth fraction with less than 10 percent clay. The substratum textures are loam, very fine sandy loam, fine sandy loam, or sandy loam in the fine-earth fraction with less than 10 percent clay. Consistence is very friable to firm in the solum and firm or very firm in the dense substratum.

The O horizon, where present, is fibric, hemic and/or sapric material.

The A or Ap horizon, where present, has hue of 10YR to 5Y, value of 2 to 4, and chroma of 1 to 4. Structure is granular.

The Eg horizon, where present, has hue of 10YR to 5Y, value of 5 or 6, and chroma of 1 or 2.

The B horizon has hue of 10YR to 5Y, value of 4 to 6, and chroma of 1 to 4. It has subangular blocky, granular or platy structure.

The BC horizon, where present, has hue of 10YR to 5Y, value of 4 to 6, and chroma of 2 to 4. It has subangular blocky or platy structure.

One or more subhorizon in the subsoil has matrix chroma of 2 or less. The combined thickness of the B and BC horizons is at least 6 inches.

The Cd layer has hue of 10YR to 5Y, value of 3 to 6, and chroma of 1 to 4. It is prismatic parting to platy, platy or it is massive. Aggregations bounded by planes or zones of weakness are considered inherent in the parent material.

COMPETING SERIES: This is the [illegible] series. Aurelie soils have 18 to 27 percent clay throughout the particle size control section. Monarda and Pilsbury are in closely related families. They have pH less than 5.5 in the subsoil below a depth of 25 cm and Monarda soils have 10 to 18 percent clay in the particle-size control section.

GEOGRAPHIC SETTING: Brayton soils are in depressions and on toeslopes of glaciated uplands. Slopes range from 0 to 25 percent. The soils formed in dense till derived mainly from granite, phyllite, schist, slate, and shale of Wisconsin age. The climate is humid and cool temperate. Mean annual temperature ranges from 3 to 8 degrees C, and mean annual precipitation commonly ranges from 864 to 1219 mm but includes up to 1524 mm in the coastal area of Mt. Desert Island, Maine. The frost-free season ranges from 90 to 160 days. Elevations range from about 2 to 762 m above mean sea level.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Colonel, Dummerston, Dixfield, Fullam, Hubbardton, Lyman, Macomber, Marlow, Peru, Skerry, Taconic, Tunbridge, and Peacham soils. The Colonel, Dixfield, Lyman, Marlow, Peru, Skerry, and Tunbridge soils have spodic horizons, are better drained, and are on higher topographic positions. Peacham soils have a histic epipedon and are in lower topographic positions. The Dummerston, Fullam, Hubbardton, Macomber, and Taconic soils are better drained and are on higher topographic positions.

DRAINAGE AND SATURATED HYDRAULIC CONDUCTIVITY: Poorly drained. A perched water table is above the dense substratum from autumn through spring. Estimated saturated hydraulic conductivity is moderately high or high in the solum and moderately low or moderately high in the dense substratum.

USE AND VEGETATION: Most areas of this soil are forested. Some areas are cleared and used for hay and pasture. Forest vegetation is mainly red spruce, white spruce, black spruce, balsam fir, eastern white pine, red maple, northern white cedar, and paper birch, yellow birch and hemlock.

DISTRIBUTION AND EXTENT: Connecticut, Maine, Massachusetts, New York, and Vermont. The series is of moderate extent.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Amherst, Massachusetts.

SERIES ESTABLISHED: Essex County, New York, 1954.

REMARKS: After reviewing location, geographic coordiantes changed from USGS Amherst topographic quadrangle; lat. 44 degrees 46 minutes 48 seconds N. and long. 68 degrees 22 minutes 19 seconds W., NAD 27.

Diagnostic horizons and features recognized in this pedon include:
1. Ochric epipedon - the zone from 0 to 18 cm (Oi, Oa and A horizons).
2. Cambic horizon - the zone from 25 to 58 cm (Bg and BC horizons).
3. Densic contact - very firm, dense basal till at a depth of 58 cm.
4. Aeric Feature - both value and chroma of 3 or more in the zone from 41 to 58 (BC horizon).
5. Aquic conditions - redox depletions throughout the subsoil. (Eg, Bg and BC horizons).

The Aurelie series is included in the competing soils section with a previous revision.

Previous remarks June, 2004 revision:
The type location is changed with this revision based on consensus that placement in the shallow family is reflective of the dominant characteristics of the series. It is acknowledged that historically the series exceeded 50 cm to densic contact in some places. The series is re-classified from Epiaquepts to Endoaquepts in accordance with Soil Taxonomy which, in reference to applying keys, stipulates that diagnostic horizons and properties below a densic contact are excluded. It is assumed the depth to bedrock from the mineral surface of this pedon exceeds 152 cm. This soil was previously type located in New York and classified as Coarse-loamy, mixed, nonacid, frigid Aeric Fragiaquepts. The classification was changed as a result of the Northeast Fragipan Study. This series also included somewhat poorly drained soils but has since been restricted to poorly drained.

ADDITIONAL DATA: Source of the data used in establishing taxonomic class and range in characteristics is Maine Agricultural Experiment Station Technical Bulletin 94, September 1979.
Soil Interpretation Record Numbers for the Brayton Series are: Brayton, ME0100; Brayton, stony, ME0101; Brayton bouldery, ME0123; Brayton, variant ME0090.

National Cooperative Soil Survey
U.S.A.

ROBERT VILE SOIL CONSULTING, INC.
P.O. BOX 114 DIXMONT, MAINE 04932

CLASS B HIGH INTENSITY SOIL SURVEY

FOR:

CENTRAL MAINE POWER COMPANY

LOCATION:
CENTRAL MAINE POWER COMPANY CORRIDOR
WEST FORKS, SOMERSET COUNTY, MAINE

FIELD SURVEY: ROBERT VILE	OCTOBER 16, 2018
CERTIFIED SOIL SCIENTIST #201	SCALE 1"=50'

GRAPHIC SCALE

50 0 25 50 100 200

(IN FEET)
1 inch = 50 ft.

LEGEND

= 3/4" IRON REBAR SET WITH RED PLASTIC CAP INSCRIBED K.A. SARGENT PLS 2450 (unless otherwise noted).

= UTILITY POLE

= WETLANDS

= INDEX CONTOUR (NAVD 88 FEET)

= INTERMEDIATE CONTOUR (NAVD 88 FEET)

NOTES

NOTE...1 BOUNDARY AND TOPOGRAPHIC INFORMATION PROVIDED BY SACKETT & BRAKE SURVEY, INC.

NOTE...2 WETLAND DELINEATION PERFORMED BY ROBERT VILE.

SOILS LEGEND

Br - Brayton Series - Poorly Drained
Tb - Tunbridge Series - Well Drained
Ly - Lyman Series - Well Drained

Slope Phases

A : 0% to 3% Slope
B : 3% to 8% Slope
C : 8% to 15% Slope
C : 15% to 40% Slope

Br/A = Soil Series / Slope Phase

TP : Soil Test Pit

: Soil Boundary

STATE OF MAINE
Robert Vile
C.S.S. #201
CERTIFIED
SOIL SCIENTIST

ROBERT VILE
CSS#201

2018245(WF)-SOILS

2018245 FULL restore.dwg 2018245 WEST FORKS 10/16/2018 15:16:01 1 : 1

Exhibit 11-2: Geotechnical Feasibility Review Memorandum

249 Western Avenue
Augusta, ME 04330

207.621.7000 PHONE
207.621.7001 FAX

www.trcsolutions.com

Sent Via ProjectWise

October 17, 2018

Adam Desrosiers
Program Manager – NECEC Project
83 Edison Dr.
Augusta, ME 04336

RE: NECEC Kennebec River Crossing – HDD Conceptual Design
Geotechnical Feasibility Review
TRC Job No. 315641

Dear Mr. Desrosiers,

TRC is pleased to provide Avangrid (CMP) with the following information regarding the geotechnical feasibility of the proposed NECEC Kennebec River crossing. This review was performed to assess the suitability of using Horizontal Directional Drilling (HDD) for the Kennebec River crossing from the eastern termination station located in Moxie Gore, Somerset County, Maine to the western termination station in West Forks Plantation, Somerset County, Maine.

Bedrock Geology

According to the geologic map for the area[1], the project site is generally underlain by Devonian, massive, dark gray slate of the Carrabassett Formation. This slate may locally contain alternating thin beds of graywacke and pelite. The slate is steeply dipping (dip from 53º to 89º) with the bedding planes orientation (strike) approximately southwest to northeast.

The geologic map for the area indicates the easternmost portion of the crossing area may be underlain by Silurian, thinly bedded, gray-brown, dolostone, limestone, and calcareous siltstone of the Forks Formation, which grades upward into variegated, medium bedded, calcareous sandstone and phyllite. Silurian volcanic rock may be encountered near the contact with the Carrabassett Formation.

A copy of the bedrock geology map is included as an attachment.

1 Burroughs, W. and Marvinney, R.G., 1981, *Reconnaissance Bedrock Geology of the Forks Quadrangle, Maine*, Open File No. 81-10, Maine Geological Survey, Department of Conservation.

Surficial Materials Geology

The surficial materials at site appear to be soils of the Monson-Elliottsville-Knob Lock (MEK) complex or the Danforth-Elliottsville (DE) association[2]. Soils in the MEK complex are generally clayey silts with sand and the underlying bedrock is fairly shallow (i.e. two to seven feet below the ground surface). Soils in the DE association are generally gravelly, sandy silt or gravelly, silty sand and the underlying bedrock is expected to be more than seven feet below the ground surface.

Within the Kennebec River, the surficial materials are expected to consist of coarse sand to boulders. Based on observations from aerial photographs of the area, this stretch of the river is rapids, so surficial materials are expected to be less than five to ten feet beneath the water surface and the bedrock is expected to be fairly shallow.

Rock Mechanical Classification for HDD

When considering the overall effect on the drillability of bedrock, the following rock characteristics are considered to be important in understanding the feasibility of HDD:

- Hardness
- Abrasiveness
- Texture
- Structure
- Breaking characteristics

These characteristics are typically determined from the following rock properties obtained in a geotechnical investigation:

- Rock Quality Designation (RQD) – correlates with abrasiveness, texture, structure, and breaking characteristics,
- Core Run Percent Recovery – correlates with texture, structure, and breaking characteristics,
- Unconfined Compressive Strength (UCS) – correlates with texture and breaking characteristics, and
- Mohs Hardness – correlates with hardness and abrasiveness.

Although UCS values for bedrock in the Carrabassett and Forks Formations was not available, typical values for similar rocks in Vermont[3] indicate that the UCS will be in the range of 4,000 to 10,500 pounds per square inch (psi), with the expected UCS to be about 6,000 to 8,000 psi.

Based on past experience with similar formations, the RQD and core recovery have been in the range of 50% to 80% and 12 to 50 inches, respectively, for NQ or NX rock cores (approximately 2 inches in diameter) obtained with a five-foot long core barrel.

---

[2] NRCS. 2018. Soil Map—Somerset County Area and Parts of Franklin and Oxford Counties, Maine, Web Soil Survey National Cooperative Soil Survey, U.S. Department of Agriculture, Natural Resources Conservation Service

[3] Thomas, E.J. and Eliassen, T.D. 2015. *Unconfined Compressive Strengths of Vermont Rock, State of Vermont*, Agency of Transportation, Construction and Materials Bureau, Geotechnical Engineering Division.

The majority of rock in the Carrabassett and Forks Formations is expected to be relatively unweathered and the hardness is expected to be moderately soft to hard.

Based on the estimated rock properties and characteristics for the bedrock that will be encountered by HDD for the Kennebec River crossing, HDD appears to be feasible. However, Maine Directional Boring Contractors notes on their website that a tricone bit may be required to drill through the bedrock[4].

HDD in Maine

An internet search identified several HDD contractors in New England, including contractors in Maine. Their websites indicate that they have experience performing HDD in Maine's geology and with HDD through bedrock in particular.

These firms include:

- Enterprise Trenchless Technologies, Inc.
- Maine Boring Contractors
- Henniker Directional Drilling, LLC
- Northeast Directional Drilling.

Conclusions

Based on our review of the available information regarding the geology of the NECEC Kennebec River crossing site, HDD appears to be a feasible technology for the installation of the power transmission lines under the river. Although the surficial and bedrock geology do not appear to impose constraints on using HDD, site-specific information regarding the soils and, especially, the underlying bedrock at the site will need to be obtained. Therefore, a suitable geotechnical investigation, including borings with rock cores adjacent to the proposed HDD alignment, should be conducted and testing of the rock materials should be performed. In this investigation, rock coring should be conducted to a depth of at least 20 feet below the depth of the alignment to properly characterize the bedrock.

We sincerely appreciate this opportunity and hope the information provided herein is in line with your expectations. Should you have any questions regarding this information, please feel free to contact me at (207) 620-3886 or via email at wnarinvancourt@trcsolutions.com.

Sincerely,

Wade A. Narin van Court, PhD, PE
Geotechnical Engineer

Attachments:
Reconnaissance Bedrock Geology of the Forks Quadrangle, Maine

[4] http://maineboringcontractors.com/services/hard-rock-maine-directional-boring/

12.0 STORMWATER MANAGEMENT

The stormwater narrative, calculations and plans for the Moxie Gore and West Forks termination stations are provided as Exhibit 12-1.

Exhibit 12-1: Stormwater Plans

STORMWATER MANAGEMENT REPORT

Prepared for the

CENTRAL MAINE POWER COMPANY
NEW ENGLAND CLEAN ENERGY CONNECT
KENNEBEC RIVER CROSSING TRANSITION STATIONS

Location

West Forks Plantation &
Moxie Gore,
Maine 04985

Owner

Central Maine Power Company
83 Edison Drive
Augusta, Maine 04336

Prepared by

6 Ashley Drive
Scarborough, ME 04074
(207) 274-2631
October 2018

DRAFT

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Appendix 12-4	Buffer Declaration of Restrictions

12.2.1 *Kennebec River Crossing HDD Transition Stations Project*

The purpose of this section is to describe and quantify the pre- and post-development stormwater characteristics and to demonstrate that construction of the new HDD Transition Stations will comply with the applicable Maine Department of Environmental Protection (MDEP) Chapter 500 stormwater management requirements. The stormwater management system for this development must meet the Basic Standards, General Standards, and Flooding Standards of Chapter 500.

The HDD Transition Stations will be located within the transmission line right of way on both sides of the Kennebec River Gorge. A transition station is required for each side of the crossing to convert the transmission line from overhead to underground. The eastern transition station will be located in Moxie Gore, Somerset County, Maine, as shown on the plans. The western transition station will be located in West Forks Plantation, Somerset County, Maine, as shown on the plans. The transition stations will be identical in size, measuring 135 feet x 135 feet and will be built to substation yard specifications. Each transition station will have a gravel access road constructed which will connect to existing logging roads. The West Forks transition station (West Forks Station) will occupy approximately 0.77 acre of the 300-foot wide right of way owned by Central Maine Power Company (CMP). The Moxie Gore transition station (Moxie Gore Station) will occupy approximately 0.72 acre within the transmission right of way owned by CMP.

The new transition stations will be located on sites that are primarily thickly wooded with some scrub/shrub vegetation.

At the West Forks Station, approximately 2.48 acres of right of way will be disturbed during construction. The land disturbance will be required for the access road, transition station and the temporary working platform/laydown yard for the HDD receiving site.

Following construction, approximately 1.43 acres of the disturbed area will be restored and revegetated. Approximately 1.03 acres will remain as a permanently developed area and will contain the new transition station yard, access road, and associated impervious areas (foundations and steel structures).

For the Moxie Gore Station, approximately 2.30 acres of right of way will be disturbed during construction. The land disturbance will be required for the access road, transition station and the temporary working platform for the HDD drill operations site.

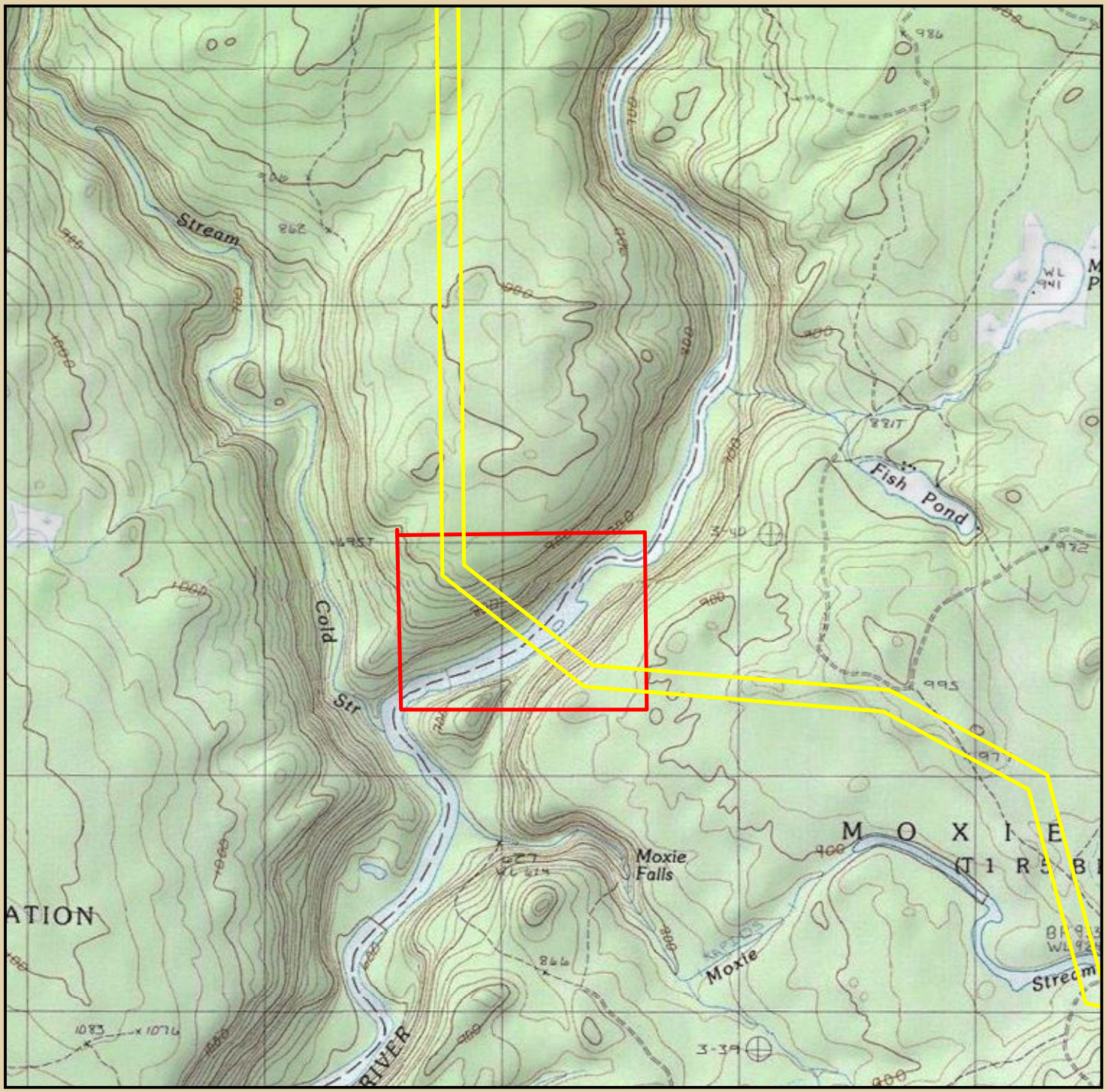
Following construction, approximately 1.44 acres of the disturbed area will be restored and revegetated. Approximately 0.86 acre will remain as a permanently developed area and will contain the new transition station yard, access road, and associated impervious areas (foundations and steel structures).

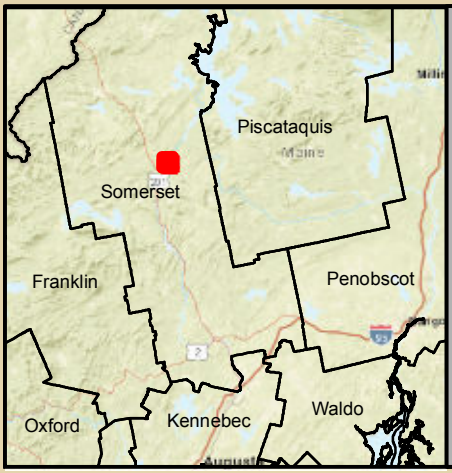
12.2.1.1 Surface Water on or Abutting the Site

There are no water bodies on the project site. The Kennebec River is approximately 1,500 feet from both sites.

Exhibit 12-1

Figure 12-1. Site Location Map





NECEC Project Area

HDD Crossing Location

N

0 0.25 0.5

Miles

Sources: ESRI, CMP, MEGIS, TRC

Map Coordinate System:
NAD 1983 UTM Zone 19N

CENTRAL MAINE POWER

New England Clean Energy Connect

Location of the Kennebec Gorge HDD Crossing

Created:
10/5/2018

TRC

14 Gabriel Drive
Augusta, ME 04330

12.2.1.2 Downstream Ponds and Lakes

The transition stations are not located in the watershed of a "Lake Most at Risk from Development" or an "Urban Impaired Stream," as defined in Chapter 502. The two sites are located on either side of the Kennebec River as shown on Exhibit 12-1.

12.2.1.3 General Topography

The topography of the land surface for the West Forks Station site ranges from 5 to 28 percent slope, generally draining from northeast to southwest. Elevations across the site range from approximately 972 to 900 feet above mean sea level

The topography of the land surface for the Moxie Gore Station site ranges from 3 to 25 percent slope, generally draining from east to west. Elevations across the area site range from approximately 911 to 872 feet above mean sea level.

Contour information for both sites were obtained from LiDAR data provided by CMP.

12.2.1.4 Flooding

There are no apparent flooding concerns for the two Transition Stations locations. Based on the available FEMA information the stations are located within an unmapped area of Maine.

12.2.1.5 Alterations to Natural Drainage Ways

Alterations to natural drainage ways are not required.

12.2.1.6 Alterations to Land Cover Within the Watershed

The West Forks Station and associated access road will consist of approximately 0.17 acre of new impervious areas (gravel roads, foundations, and concrete pads). The crushed stone switchyard will cover approximately an additional 0.47 acre.

The Moxie Gore Station and associated access road will consist of approximately 0.09 acre of new impervious areas (gravel roads, foundations, and concrete pads). The crushed stone switchyard will cover approximately an additional 0.47 acre.

A summary of the pre- and post-development cover types within the subcatchment analyzed is presented in Table 12-1.

Table 12-1. West Forks Station - Watershed Cover Types

Cover Type	Pre-development Area, acres	Post-development Area, acres	Net Change, acres
Foundations/Pads	0.00	0.01	0.01
Gravel	0.00	0.15	0.15
Yard Surface (crushed stone)	0.00	0.47	0.47
Woods	5.89	4.92	(-)0.97
Brush	0.14	0.48	0.34
Total Area	**6.03**	**6.03**	**0.00**

Table 12-2. Moxie Gore Station - Watershed Cover Types

Cover Type	Pre-development Area, acres	Post-development Area, acres	Net Change, acres
Foundations/Pads	0.00	0.01	0.01
Gravel	0.25	0.38	0.13
Yard Surface (crushed stone)	0.00	0.47	0.47
Woods	11.57	10.71	(-)0.86
Brush	0.58	0.83	0.25
Total Area	**12.40**	**12.40**	**0.00**

12.2.1.7 Modeling Assumptions

The stormwater runoff was estimated using HydroCAD, Version 10.0. HydroCAD is based on methodologies developed by the United States Department of Agriculture Soil Conservation Service (USDA-SCS), namely *Urban Hydrology for Small Watersheds*, Technical Release 55 and Technical Release 20 (TR-55 and TR-20), in combination with other hydraulic and hydrologic calculations. Based on site specific information and rainfall data, the program estimates inflow and outflow hydrographs for a subcatchment. The USDA-SCS is now called the Natural Resources Conservation Service (USDA-NRCS).

The pre- and post-development subcatchment boundaries and hydrologic flow lines used to determine the times of concentration are indicated on the Pre- and Post-Development Drainage Plans located in Appendix 12-2. Within the areas proposed to be developed, the subcatchment boundaries were determined from the surveyed (LiDAR) one-foot contours. Subcatchment boundaries outside areas proposed for development were determined from two-foot contours extrapolated from the USGS topographic quadrangle map. The times of concentration were determined from the surveyed contour information.

The pre- development stormwater analysis for the West Forks Station consists of one subcatchment (1S) totaling approximately 6.03 acres in size. The Post-development consists, of two subcatchments (1S & 1SA) totaling approximately 6.03 acres in size. For the pre-development stormwater analysis for Moxie Gore Station there is one subcatchment (2S) totaling approximately 12.40 acres in size. The Post-development consists, of two subcatchments (2S & 2SA) totaling approximately 12.40 acres in size.

Both sites use study points (SPx) as the boundary node for the subcatchment for the pre- and post-development analysis. Control points are located at the down slope intersection of the Tc hydrologic flow lines and the subcatchment boundaries.

The results of the pre- and post-development site runoff analyses are shown and compared in Tables 12-3 through 12-8, located in Section 12.5: Runoff Analysis.

Storm events modeled for the pre- and post-development analyses assumed precipitation events with a 24-hour duration having a type II distribution and rainfall amounts of 2.44, 3.80, and 4.23 inches, with return frequencies of 2-, 10-, and 25-years, respectively. The storm type and rainfall amounts are based on the NOAA Atlas 14, Volume 10, Version 2, Point Precipitation Frequency Estimates.

Additional assumptions made to complete the pre- and post-development runoff analysis are provided in Section 12.5.

12.3 MAPS

12.3.1 *USGS Quadrangle Map with Site Boundaries (Exhibit 12-1)*

An excerpt from the USGS Quadrangle map (scale 1:24,000) with the site boundaries shown is provided as Exhibit 12-1.

12.3.2 *Watershed Map (Exhibit 12-3)*

A watershed map is provided as Exhibit 12-3.

12.3.3 *NRCS Soils Map*

An excerpt from the USDA-NSCS Soils Survey Map is provided in Appendix 12-1.

12.4 DRAINAGE PLANS

The Pre-Development Watershed Plans and the Post-Development Watershed Plans for the proposed project are provided in Appendix 12-2. The plans include contours, land cover types, soil groups, subcatchment boundaries and analysis points, hydrologic flow lines, time of concentration flow lines, existing features, and drainage ways where applicable. The Post-Development Watershed Plans include the locations of proposed buildings, roads, and stormwater management structures.

12.5 RUNOFF ANALYSIS

The pre- and post-development stormwater analysis calculations are provided in Appendix 12-1. The runoff routing calculations were performed with the use of HydroCAD Version 10.0 software. The analyses include computations for determining the runoff curve numbers (CN values) for the pre- and post-development subcatchments and the HydroCAD output, which includes peak discharge calculations for the 24-hour storms of 2- 10-, and 25-year frequencies and routing calculations.

A summary of the pre- and post-development peak runoff at the control points is provided in Table 12-3 through 12-8.

Exhibit 12-4

Figure 12-4. NRCS Soils Survey Map

Table 12-3. Pre-Development Peak Runoff by Subcatchment

West Forks Station Discharge Rates, cfs		
Storm Frequency	Boundary Node SP1	Total
2-Year	0.85	0.85
10-Year	4.02	4.02
25-Year	5.30	5.30

Table 12-4. Post-Development Peak Runoff by Subcatchment

West Forks Station Discharge Rates, cfs		
Storm Frequency	Boundary Node SP1	Total
2-Year	0.79	0.79
10-Year	3.78	3.78
25-Year	4.99	4.99

Table 12-5. Net Change in Peak Runoff by Subcatchment

West Forks Station Discharge Rates, cfs		
Storm Frequency	Boundary Node SP1	Total
2-Year	(-)0.06	(-)0.06
10-Year	(-)0.24	(-)0.24
25-Year	(-)0.31	(-)0.31

Table 12-6. Pre-Development Peak Runoff by Subcatchment

Moxie Gore Station Discharge Rates, cfs		
Storm Frequency	Boundary Node SP2	Total
2-Year	1.83	1.83
10-Year	7.94	7.94
25-Year	10.38	10.38

Table 12-7. Post-Development Peak Runoff by Subcatchment

Moxie Gore Station Discharge Rates, cfs		
Storm Frequency	Boundary Node SP2	Total
2-Year	1.76	1.76
10-Year	7.70	7.70
25-Year	10.10	10.10

Table 12-8. Net Change in Peak Runoff by Subcatchment

Moxie Gore Station Discharge Rates, cfs		
Storm Frequency	Boundary Node SP2	Total
2-Year	(-)0.07	(-)0.07
10-Year	(-)0.24	(-)0.24
25-Year	(-)0.28	(-)0.28

West Forks Station

The calculations show a net decrease to peak runoff rates in every storm event for the West Forks Station from the pre-development condition to the post developed condition.

Moxie Gore Station

The calculations show a net decrease to peak runoff rates in every storm event for the Moxie Gore Station from the pre-development condition to the post developed condition.

A summary of each node is as follows:

Study Point SP1 (West Forks Station)

Node SP1 is located on the southwest side of the CMP right of way. Node SP1 shows a 6 percent decrease in runoff following a 25-year, 24-hour storm event in the post-development condition. Most of the decrease can be attributed to the runoff curve number being lower because of the increased infiltration of stormwater into the gravel/crushed stone surface of the switchyard placed on top of the existing soils.

Study Point SP2 (Moxie Gore Station)

Node SP2 is located on the South side of the CMP right of way. Node SP2 shows a 3 percent decrease in runoff following a 25-year, 24-hour storm event in the post-development condition. Most of the decrease can be attributed to the runoff curve number being lower because of the increased infiltration of stormwater into the gravel/crushed stone surface of the switchyard placed on top of the existing soils.

Curve Number Computations

A summary of the land cover types, hydrologic soil group (HSG), and curve numbers for the pre- and post-development subcatchments are provided in the stormwater calculation package in Appendix 12-1. Cover types for the impacted area were determined from the topographic field survey and a site visit and are indicated on the Pre- and Post-Development Watershed Plans.

The soils and hydrologic soil group information for the project study area are based on the Web Soil Survey mapping obtained from the USDA-NRCS *Soil Survey of Somerset County Area, Maine dated September 2017*. The soils and hydrologic soil groups within the runoff analysis areas are shown on the Pre- and Post-Development Watershed Plans.

The runoff curve numbers were developed from Appendix A-12: "Runoff Curve Numbers for use in TR-55 and TR-20" of the MDEP *Maine Stormwater Best Management Practices Manual, Volume III* and HydroCAD, based on the observed cover types and hydrologic soil groups. The only curve number that is not referenced directly from TR55 and TR20 is the one used for the switchyard. An engineering study was conducted by TRC Environmental Corporation (TRC), detailing the "typical" cross section and surface materials of a switchyard covered with gravel and crushed stone to calculate its permeability rate. The study was reviewed by John Simon, a USDA-NRCS engineer in Maine. The conclusions of this report were used as the basis of an agreement between CMP and MDEP that a CN value of 55 may be used for switchyards that are mapped as HSG "A", "B", "C", and a CN value of 60 must be used when the area is mapped as HSG "D". A copy of the letter agreement is included at the back of the stormwater calculations (Appendix 12-1).

12.5.1 *Time of Concentration Calculations*

Times of concentration were calculated using USDA-SCS TR-55 methodologies for each subcatchment considering the hydrologic flow lengths, slope, vegetative cover, surface roughness, and each stage-storage relationship. The type and length of each hydrologic flow line for determining time of concentration and travel times in the area to be developed are indicated on the Pre- and Post-Development Drainage Plans. The maximum sheet flow length used for this analysis was 150 feet. For flow lengths beyond 150 feet were assumed to be shallow concentrated flows. Shallow concentrated flow lengths varied for each subcatchment and were extended until they reached the end of the subcatchment or concentrated flow channel. A summary of the input data used to estimate the time of concentration for each subcatchment is provided in the calculation package.

12.5.2 *Travel Time Calculations*

The travel time for each subcatchment was calculated using a spreadsheet based on equations prepared by the USDA-NRCS. These times were then input directly into HydroCAD. The calculation spreadsheets are included in Appendix 12-1.

12.5.3 *Peak Discharge Calculations*

Peak discharge calculations are included in the HydroCAD output. A summary comparison of pre- and post-development peak discharge calculations at each boundary node is presented in Section 12.5, above.

12.5.4 *Reservoir Routing Calculations*

Reservoir routing calculations are included in the HydroCAD output. The "dynamic storage-indication" method was used in the post development analysis. This method recalculates the water surface elevation based on the downstream tailwater condition when performing the routing calculations.

12.6 FLOODING STANDARD

12.6.1 *Variance Submissions*

A variance from the peak flow standard is not necessary for the proposed transition stations. As determined in the pre-application meeting with MDEP staff and documented in the CMP/MDEP agreement letter, water quantity control is not necessary since there is a decrease in runoff, compared to the existing conditions, due to the greater infiltration properties (lower CN value) of the gravel and crushed stone switchyard surface, as compared to the native soils. In addition, the proposed stormwater management system will include several forested treatment buffers adjacent to the level spreaders to retain the pre-development flow regime. As stated previously, the runoff from the developed site will not adversely affect downstream properties.

12.6.2 *Sizing of Storm Drains and Culverts*

The calculations for the sizing of proposed culverts under the access road and other conveyance structures are presented in the stormwater calculation package (Appendix 12-1). The proposed culverts, conveyance swales and level spreader are designed to manage the limited runoff from the access road and switchyard without creating erosive velocities. Detailed drawings for the proposed on-site conveyance structures, including vegetated drainage swales, culverts with inlet and outlet protection, the level spreader and the forested buffers, are shown on the Post-Development Watershed Plan, Site Grading Sections & Details drawings located in Appendix 12-2. Stabilization methods are designed, and will be constructed and maintained in accordance with CMP's *Environmental Guidelines for Construction and Maintenance Activities on Transmission Line and Substation Projects*, dated June 2018 (the CMP's Environmental Guidelines), which is consistent with the *Maine Erosion and Sedimentation Control BMPs*, dated March 2016. Please refer to Section 14: Basic Standards Submissions for a detailed description of the site-specific erosion control measures and practices to be utilized during construction of the switchyard.

12.6.3 *Stormwater Ponds*

Stormwater ponds are not required for runoff treatment or attenuation. As discussed with MDEP staff, facilities (such as substations and termination stations) built to the specifications in the 2008 CMP/MDEP agreement letter will meet the required General Standards and will not necessitate any further treatment of runoff. The use of vegetated swales in conjunction with the level spreaders and forested buffers will be used to collect and treat the runoff from the termination station access roads. The use of on-site vegetated buffers will be maximized to allow for improved natural sheet flow.

12.6.4 *Infiltration Systems*

No infiltration systems are proposed for this project.

12.6.5 *Drainage Easement Declarations*

The proposed stormwater buffers are located entirely on CMP property associated with the Site Location of Development Act (SLODA) permit issued for this project. As a result, any alteration of these buffer areas will require review and approval by the MDEP. No drainage easements are needed. All vegetated buffers shown on the plans will be protected by deed restrictions (Declaration of Restrictions, per MDEP Chapter 500) applied to these areas.

12.7 STORMWATER QUALITY TREATMENT PLAN

12.7.1 *Basic Standards Submissions*

In accordance with the Basic Standards, the proposed switchyard, access road, and associated features will be constructed and stabilized using erosion and sedimentation (E&S) Best Management Practices (BMPs). The site will receive routine maintenance to ensure their continued function and to prevent or correct erosion problems. A level spreader is provided at the northwest corner of the switchyard to return concentrated flows from collector swales along the sides of the yard to non-erosive sheet flows. During and after construction at the Transition Stations, CMP's E&S Plan will be utilized to prevent erosion from occurring, as well as to correct any problems that may develop. The CMP's Environmental Guidelines updated and provided to the MDEP in June 2018, incorporates the applicable procedures of the *Maine Erosion and Sediment Control BMPs*, dated March 2016. The CMP's Environmental Guidelines contains the details and specifications for general stabilization measures to be used during construction and stabilization of the switchyard. These measures will be used to protect exposed soils during construction and during the service life of the project.

The stabilization measures for the site will include temporary and permanent erosion and sedimentation controls; appropriate design of swales, culverts, and erosion protection for earthen cut and fill slopes; and provisions for future maintenance of the site. The vegetated swales, culverts, buffers and level spreader design calculations are included in Appendix 12-3.

12.7.2 *General Standard Submissions*

Since the proposed development is part of a Site Law project compliance with the General Standards is required. Runoff from the gravel access roadway will be treated by the use of level spreaders and vegetated treatment buffers. MDEP staff has stated that as long as the facilities are built to the specifications in the 2008 CMP/MDEP agreement letter, the General Standard requirements will be met for these termination stations and no further water quality treatment of stormwater from the yard itself is required.

12.7.3 *Phosphorus Control Plan*

The transition station are not located in a lake watershed. Therefore, a Phosphorus Control Plan is not required for this application.

12.7.4 *Off-Site Credits*

Off-site credits for total suspended solids (TSS) or phosphorus are not required for the proposed switchyard.

12.7.5 *Runoff Treatment Measures*

The drainage design for this project includes vegetated conveyance swales along the access road that will collect and direct runoff to level spreaders which are adjacent to a forested buffer per the MDEP manual *Design of Stormwater Best Management Practices,* October 2016. The level spreader will convert the channelized flow to sheet flow prior to the runoff leaving the site. The transition stations will provide water quality treatment because they will be built in accordance with the materials and specifications shown on the drawings; *i.e.*, 6 inches of crushed stone on top of 18 inches of the Maine Department of Transportation (MDOT) 703.06 Type A gravel fill. The cross section and materials incorporated in this design exceed the specifications in the CMP/MDEP agreement letter.

12.7.6 *Control Plan for Thermal Impacts to Coldwater Fisheries*

Due to the use of vegetated buffers for treatment of runoff, there will be no thermal impacts.

12.7.7 *Control Plan for Other Pollutants*

A control plan for other pollutants in stormwater runoff is not required.

12.7.8 *Engineering Inspection of Stormwater Management Facilities*

CMP ensures that a qualified engineer will inspect the construction site periodically to verify that the transition stations, stormwater conveyance swales and level spreader are constructed in accordance with the plans and specifications shown on the design drawings, and that these structures are functioning properly. These inspections will commence with the initial earth moving activities on the site and will continue, as needed, during any period when construction activity affecting the stormwater management system occurs, until the site is permanently stabilized.

Additional inspections of the site will be conducted during and after construction to evaluate and maintain the condition and effectiveness of stormwater management structures and erosion and sedimentation control measures. BMPs for erosion control and stormwater pollution prevention during construction will include weekly (minimum) or more frequent inspections and maintenance of items such as temporary and permanent erosion control measures; stabilization of the switchyard site, road ditches, and the ROW; and to correct any erosion or sedimentation that is occurring. The inspection and maintenance of erosion control measures are described in more detailed in CMP's Environmental Guidelines (Update provided to MDEP in June 2018).

12.8 COMPONENTS OF KENNEBEC RIVER GORGE HDD TRANSITION STATIONS POST-CONSTRUCTION STORMWATER MAINTENANCE PLAN

Both of the transition stations will be owned, operated, and maintained by Central Maine Power Company.

12.8.1 *Facilities to be Maintained*

The stormwater management facilities to be maintained at the West Forks and the Moxie Gore Stations include:

- Stormwater conveyance swales and level spreader associated with the access road and transition stations;
- Culverts with inlet and outlet protection;
- Permanent access roads;
- Transition station surface (crushed stone);
- Revegetated areas and embankments; and
- Water quality treatment buffers.

12.8.2 *General Inspection and Maintenance Requirements*

The proposed facility will be operated and maintained in a manner consistent with good utility practices, including monthly on-site substation inspections and maintenance of stormwater management system components, as needed. A post-construction maintenance and inspection log is provided in Appendix 12-3.

Maintenance issues associated with specific areas and facilities at the substation are identified in the following sections.

12.8.2.1 Drainage Conveyance Systems

The vegetated swales, level spreader, and culverts will be inspected on a quarterly basis. Any signs of existing or developing blockage of flow, trash, erosion, channeling or excessive buildup of sediment will be removed/repaired, as needed. Vegetated swales and other vegetated structures will be mowed or otherwise maintained to control the growth of woody vegetation within the channel, but no more than once per year.

12.8.2.2 Roadways

The access roadway will typically require little on-going maintenance, owing to the limited use by heavy vehicles. These areas will be inspected quarterly, and signs of existing or developing erosion, rutting, trash or unwanted vegetation will be removed/repaired as needed.

12.8.2.3 Transition Station Surface

The transition station surfaces will be inspected quarterly. Any signs of existing or developing erosion, rutting, trash, or unwanted vegetation within the switchyard will be removed/repaired as needed.

12.8.2.4 Revegetated Areas and Embankments

Revegetated areas and embankments will be inspected quarterly. Any signs of erosion or inadequate revegetation of these areas will be corrected as needed.

12.8.2.5 Water Quality Treatment Buffers

Quarterly inspections of the water quality treatment buffers will be made to ensure the integrity of the undisturbed, forested buffers. Any signs of developing erosion will be repaired and revegetated as needed.

APPENDIX 12-1

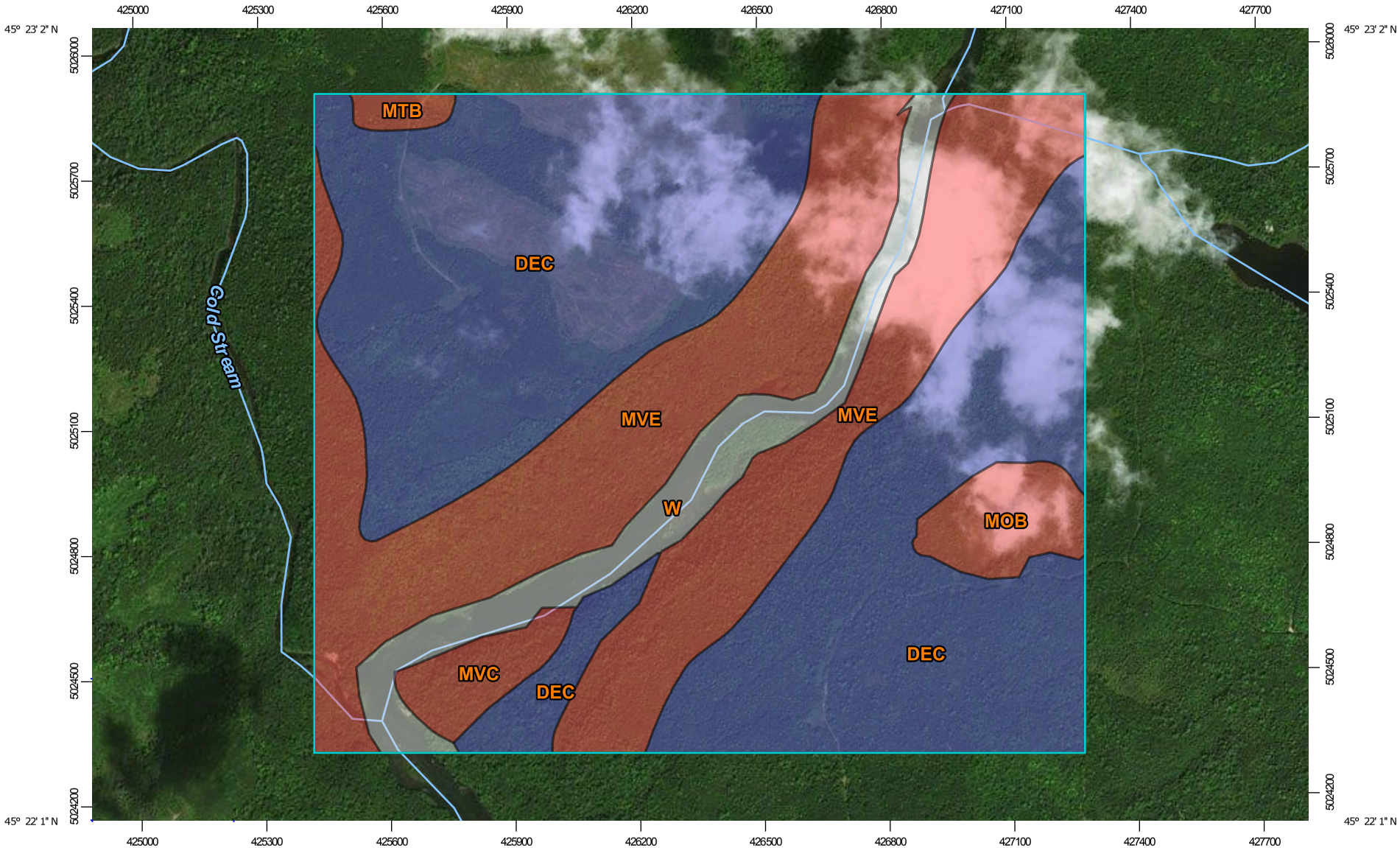
Stormwater Calculation Package

CENTRAL MAINE POWER COMPANY
NECEC
KENNEBEC RIVER GORGE TRANSITION STATIONS
STORMWATER CALCULATIONS
OCTOBER 2018

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Hydrologic Soil Group—Somerset County Area and Parts of Franklin and Oxford Counties, Maine
(Kennebec Crossing)



Map Scale: 1:13,400 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 150 300 600 900

Feet
0 500 1000 2000 3000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Somerset County Area and Parts of Franklin and Oxford Counties, Maine
Survey Area Data: Version 22, Sep 11, 2017

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Aug 24, 2014—Sep 21, 2016

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
DEC	Danforth-Elliottsville association, 3 to 15 percent slopes	B	393.6	54.1%
MOB	Monarda-Burnham complex, 0 to 3 percent slopes, very stony	D	21.1	2.9%
MTB	Monarda-Telos complex, 0 to 8 percent slopes, very stony	D	4.9	0.7%
MVC	Monson-Elliottsville-Knob Lock complex, 8 to 30 percent slopes, very rocky	D	15.6	2.1%
MVE	Monson-Elliottsville-Knob Lock complex, 30 to 60 percent slopes, very rocky	D	238.4	32.8%
W	Water bodies		53.4	7.3%
Totals for Area of Interest			**727.1**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

NOAA Atlas 14, Volume 10, Version 2
Location name: Town of Moxie Gore, Maine, USA*
Latitude: 45.3731°, Longitude: -69.9425°
Elevation: 618.28 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.255** (0.203-0.317)	**0.309** (0.245-0.383)	**0.396** (0.313-0.493)	**0.468** (0.368-0.586)	**0.567** (0.430-0.739)	**0.644** (0.477-0.856)	**0.720** (0.517-0.990)	**0.815** (0.552-1.14)	**0.941** (0.611-1.36)	**1.04** (0.656-1.53)
10-min	**0.362** (0.288-0.449)	**0.437** (0.347-0.543)	**0.560** (0.443-0.698)	**0.663** (0.521-0.830)	**0.803** (0.609-1.05)	**0.912** (0.676-1.21)	**1.02** (0.732-1.40)	**1.16** (0.782-1.62)	**1.33** (0.866-1.93)	**1.47** (0.929-2.16)
15-min	**0.426** (0.338-0.528)	**0.514** (0.408-0.639)	**0.659** (0.521-0.822)	**0.780** (0.613-0.976)	**0.945** (0.717-1.23)	**1.07** (0.795-1.43)	**1.20** (0.861-1.65)	**1.36** (0.920-1.91)	**1.57** (1.02-2.27)	**1.73** (1.09-2.55)
30-min	**0.570** (0.453-0.708)	**0.689** (0.547-0.856)	**0.883** (0.698-1.10)	**1.04** (0.820-1.31)	**1.26** (0.959-1.65)	**1.44** (1.06-1.91)	**1.61** (1.15-2.21)	**1.82** (1.23-2.55)	**2.10** (1.36-3.03)	**2.31** (1.46-3.40)
60-min	**0.715** (0.569-0.888)	**0.864** (0.686-1.07)	**1.11** (0.875-1.38)	**1.31** (1.03-1.64)	**1.58** (1.20-2.07)	**1.80** (1.33-2.39)	**2.01** (1.44-2.76)	**2.28** (1.54-3.19)	**2.62** (1.70-3.80)	**2.89** (1.83-4.26)
2-hr	**0.947** (0.757-1.17)	**1.11** (0.888-1.37)	**1.38** (1.10-1.71)	**1.60** (1.27-2.00)	**1.91** (1.46-2.48)	**2.15** (1.61-2.85)	**2.38** (1.73-3.28)	**2.72** (1.85-3.78)	**3.15** (2.06-4.53)	**3.49** (2.22-5.10)
3-hr	**1.10** (0.886-1.36)	**1.28** (1.03-1.58)	**1.58** (1.26-1.94)	**1.82** (1.45-2.25)	**2.15** (1.66-2.79)	**2.41** (1.82-3.19)	**2.67** (1.95-3.66)	**3.05** (2.08-4.22)	**3.55** (2.32-5.07)	**3.93** (2.50-5.71)
6-hr	**1.40** (1.13-1.71)	**1.63** (1.31-1.99)	**1.99** (1.61-2.44)	**2.30** (1.84-2.83)	**2.72** (2.10-3.49)	**3.05** (2.31-3.99)	**3.37** (2.48-4.59)	**3.84** (2.64-5.28)	**4.47** (2.94-6.33)	**4.94** (3.17-7.13)
12-hr	**1.73** (1.41-2.09)	**2.03** (1.65-2.46)	**2.52** (2.04-3.06)	**2.93** (2.36-3.58)	**3.49** (2.71-4.44)	**3.92** (2.98-5.09)	**4.36** (3.20-5.85)	**4.94** (3.41-6.73)	**5.71** (3.77-8.02)	**6.29** (4.05-9.00)
24-hr	**2.08** (1.70-2.50)	**2.44** (2.00-2.94)	**3.04** (2.48-3.68)	**3.54** (2.87-4.30)	**4.23** (3.30-5.33)	**4.76** (3.63-6.11)	**5.29** (3.89-7.01)	**5.94** (4.12-8.03)	**6.81** (4.52-9.49)	**7.47** (4.83-10.6)
2-day	**2.46** (2.03-2.94)	**2.86** (2.35-3.41)	**3.51** (2.88-4.21)	**4.05** (3.30-4.88)	**4.79** (3.76-5.98)	**5.36** (4.11-6.81)	**5.94** (4.38-7.78)	**6.61** (4.61-8.85)	**7.49** (5.00-10.3)	**8.16** (5.30-11.5)
3-day	**2.74** (2.27-3.25)	**3.15** (2.61-3.76)	**3.84** (3.17-4.59)	**4.41** (3.61-5.29)	**5.19** (4.09-6.44)	**5.79** (4.45-7.32)	**6.39** (4.73-8.32)	**7.08** (4.96-9.44)	**7.99** (5.36-11.0)	**8.68** (5.65-12.1)
4-day	**2.97** (2.47-3.53)	**3.41** (2.83-4.05)	**4.13** (3.41-4.92)	**4.72** (3.88-5.65)	**5.54** (4.38-6.85)	**6.17** (4.75-7.77)	**6.80** (5.04-8.81)	**7.51** (5.27-9.97)	**8.44** (5.67-11.6)	**9.14** (5.97-12.8)
7-day	**3.60** (3.01-4.24)	**4.08** (3.41-4.82)	**4.88** (4.06-5.77)	**5.54** (4.57-6.59)	**6.44** (5.11-7.91)	**7.14** (5.52-8.91)	**7.84** (5.82-10.1)	**8.57** (6.05-11.3)	**9.54** (6.44-13.0)	**10.3** (6.73-14.2)
10-day	**4.19** (3.52-4.93)	**4.71** (3.95-5.55)	**5.57** (4.64-6.57)	**6.27** (5.20-7.43)	**7.24** (5.76-8.85)	**7.99** (6.19-9.92)	**8.74** (6.50-11.1)	**9.48** (6.71-12.4)	**10.4** (7.07-14.1)	**11.2** (7.34-15.4)
20-day	**6.00** (5.07-7.01)	**6.61** (5.57-7.72)	**7.59** (6.38-8.89)	**8.40** (7.02-9.89)	**9.53** (7.62-11.5)	**10.4** (8.09-12.7)	**11.3** (8.38-14.1)	**12.0** (8.54-15.6)	**12.9** (8.80-17.3)	**13.6** (9.00-18.6)
30-day	**7.49** (6.35-8.70)	**8.16** (6.91-9.49)	**9.25** (7.81-10.8)	**10.2** (8.52-11.9)	**11.4** (9.17-13.7)	**12.4** (9.66-15.1)	**13.3** (9.95-16.6)	**14.1** (10.1-18.2)	**15.0** (10.3-20.0)	**15.8** (10.4-21.4)
45-day	**9.30** (7.92-10.8)	**10.1** (8.56-11.7)	**11.3** (9.59-13.1)	**12.4** (10.4-14.4)	**13.8** (11.1-16.5)	**14.9** (11.7-18.1)	**16.0** (12.0-19.8)	**16.8** (12.1-21.6)	**17.8** (12.2-23.6)	**18.6** (12.3-25.2)
60-day	**10.8** (9.22-12.4)	**11.6** (9.94-13.4)	**13.0** (11.1-15.1)	**14.2** (12.0-16.5)	**15.8** (12.8-18.8)	**17.0** (13.4-20.6)	**18.3** (13.7-22.5)	**19.1** (13.8-24.6)	**20.3** (13.9-26.8)	**21.1** (14.1-28.5)

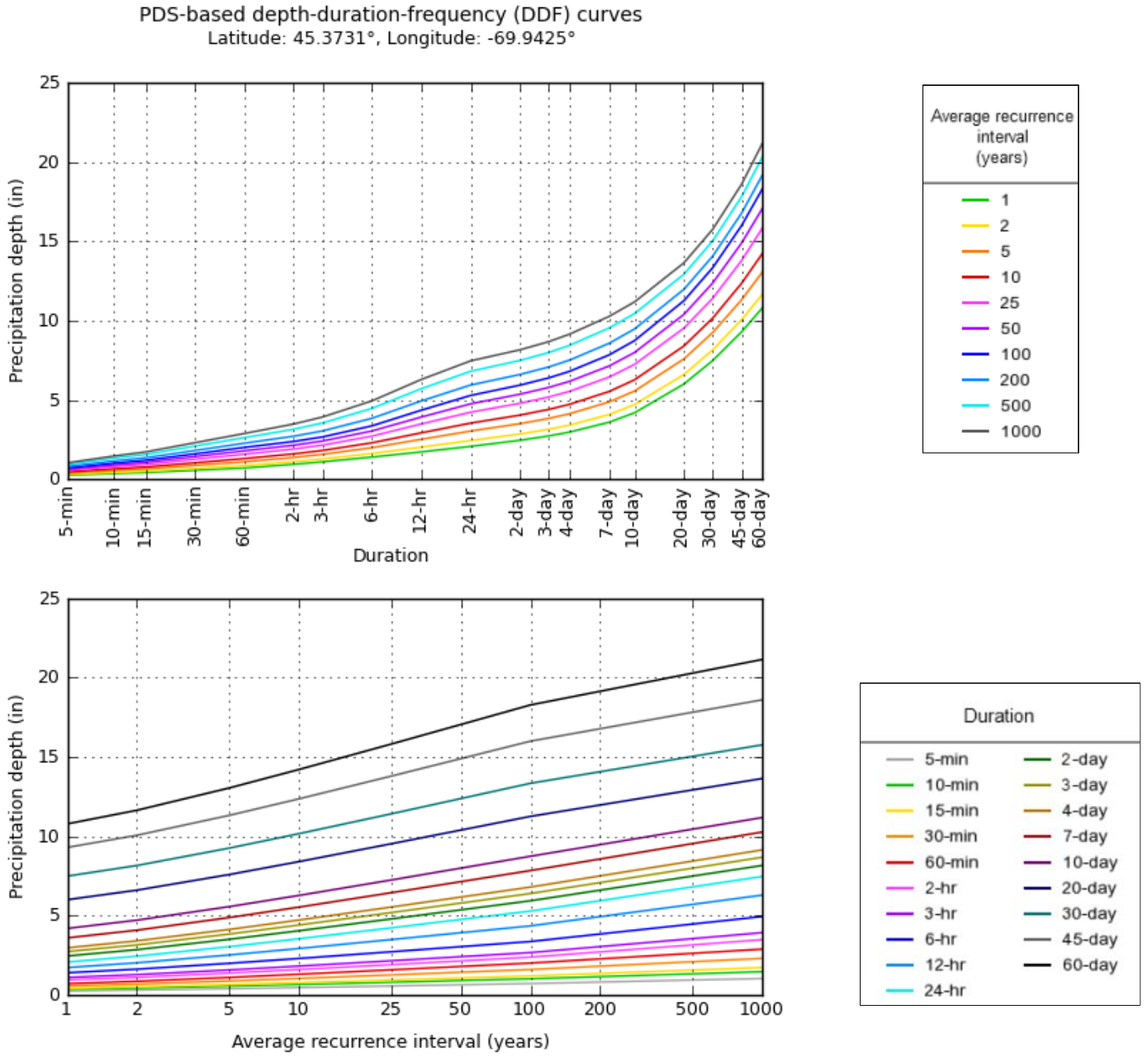
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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PF graphical



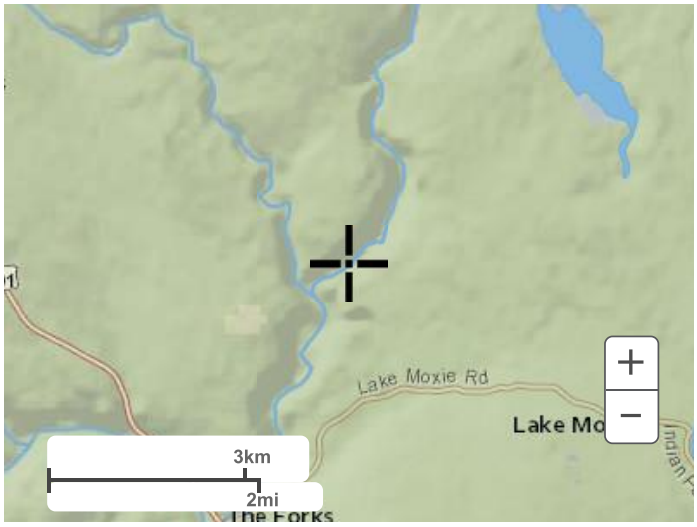
NOAA Atlas 14, Volume 10, Version 2

Created (GMT): Thu Sep 20 13:33:41 2018

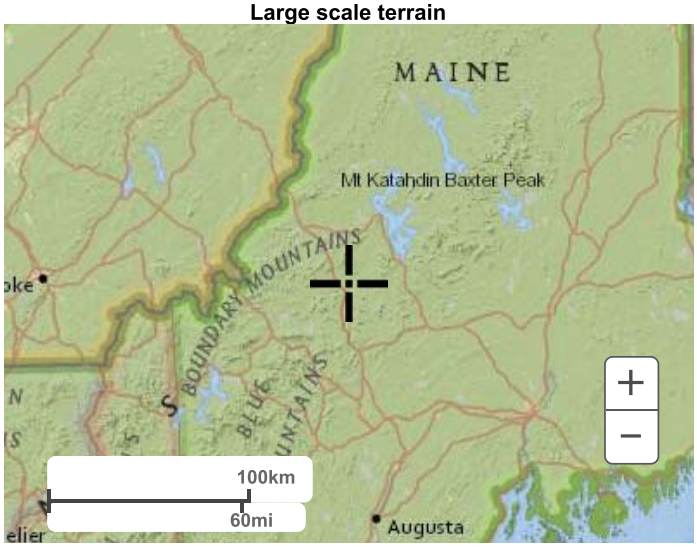
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Maps & aerials

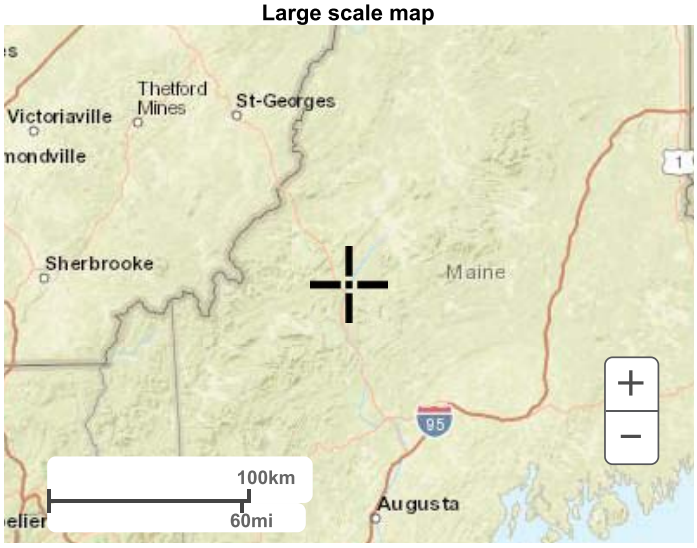
Small scale terrain



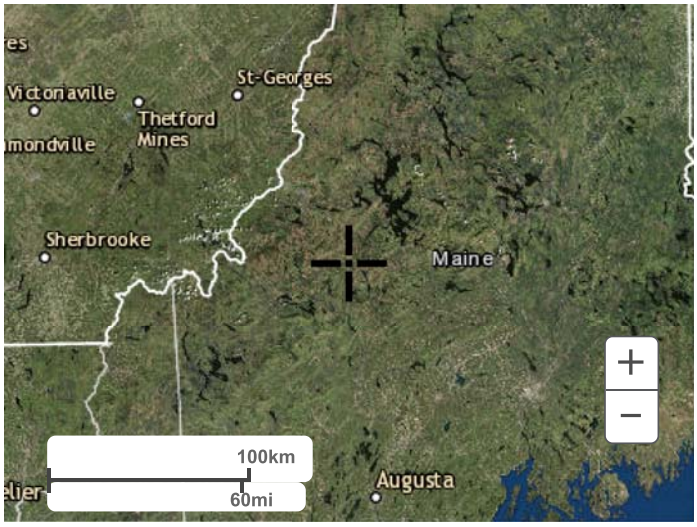
Large scale terrain



Large scale map



Large scale aerial



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National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

PROJECT:	**Avangrid - CMP**	**Calculated By:**	PGT
	Kennebec River Crossing Transition Stations	**Date:**	10/17/2018
TRC Proj. No.:	**306390.0000.00000**	**Checked By:**	DTB
	Time of Concentration Summary	**Date:**	

Time of Concentration Equations:

1. Where $T_t := \frac{0.007 \cdot (N \cdot L)^{0.8}}{P_2^{0.5} \cdot S^{0.4}}$ from SCS TR-55. For Sheet Flow (300 feet or less)

2. Where $V := 20.3282 \cdot \sqrt{S}$ from the SCS Upland Method *Channel Flow Chart* For Shallow Concentrated Flow (Paved surfaces)

3. Where $T_t := \frac{L}{3600 \cdot V}$ from the SCS Upland Method *Channel Flow Chart* Travel time equation

4. Where $V := 16.1345 \cdot \sqrt{S}$ from the SCS Upland Method *Channel Flow Chart* For Shallow Concentrated Flow (Unpaved surfaces)

5. Where: $v = 7\sqrt{s}$ from the SCS Upland Method *Channel Flow Chart* For Shallow Concentrated Flow (Short Grass Pasture)

6. Where: $v = 5\sqrt{s}$ from the SCS Upland Method *Channel Flow Chart* For Shallow Concentrated Flow (Woodland)

7. Where $V := 12 \cdot \sqrt{S}$ from the SCS Upland Method *Channel Flow Chart* For Channel Flow - Waterways and Swamps, No Channels

8. Where $V := 15 \cdot \sqrt{S}$ from the SCS Upland Method *Channel Flow Chart* For Channel Flow - Grassed Waterways and Roadside Ditches

9. Where $V := 21 \cdot \sqrt{S}$ from the SCS Upland Method *Channel Flow Chart* For Channel Flow - Small Tributary & Swamp w/Channels

10. Where $V := 35 \cdot \sqrt{S}$ from the SCS Upland Method *Channel Flow Chart* For Channel Flow - Large Tributary

11. Where $V := 60 \cdot \sqrt{S}$ from the SCS Upland Method *Channel Flow Chart* For Channel Flow - Main River

12. Where $V := \frac{1.49 \cdot R^{.667} \cdot \sqrt{S}}{N}$ For Channel Flow - Culvert Flow

13. Where P_2 = 2-Year, 24 Hour Rainfall (in) (Somerset, County: P_2= 2.44 inches)

Mannings Roughness Coefficients Table

Surface Description	n - value
Smooth surfaces	0.011
Crush Stone/Substation Yards	0.025
Fallow	0.050
Cultivated: Residue<=20%	0.060
Cultivated: Residue>=20%	0.170
Grass: Short	0.150
Grass: Dense	0.240
Grass: Bermuda	0.410
Range	0.130
Woods: Light underbrush	0.400
Woods: Dense underbrush	0.800

PROJECT:	**Kennebec River Gorge Transition Stations**		**Calculated By:**	PGT
	West Forks Plantation		**Checked By:**	DTB
TRC Proj. No.:	**306390.0000.00000**		**Date:**	10/17/18
Subcatchment:	**PRE & POST DEV 1S**		**Revised:**	

Time of Concentration Determination Worksheet, SCS Methods

	Seg 1	Seg 2	Seg 3	Seg 4	Seg 5	Seg 6	Seg 7		
SHEET FLOW									
Manning's No.	0.8	0.4							
Length, ft	117	33							
P2 , in	2.44	2.44							
Slope, ft/ft	0.1227	0.1824							
T_t[1], hr	0.392	0.070							0.4614
SHALLOW CONCENTRATED FLOW									
Paved									
Length, ft									
Slope, ft/ft									
Velocity[2], ft/sec									
T_t[3], hr									0.0000
Unpaved									
Length, ft									
Slope, ft/ft									
Velocity[2], ft/sec									
T_t[3], hr									0.0000
Short Grass Pasture									
Length, ft									
Slope, ft/ft									
Velocity[4], ft/sec									
T_t[3], hr									0.0000
Woodland									
Length, ft		551							
Slope, ft/ft		0.081							
Velocity[5], ft/sec		1.4265							
T_t[3], hr		0.107							0.1073
CHANNEL FLOW									
Waterways & Swamps, No Channels									
Length, ft									
Slope, ft/ft									
Velocity[6], ft/sec									
T_t[3], hr									0.0000
Grassed Waterways/Roadside Ditches									
Length, ft									
Slope, ft/ft									
Velocity[7], ft/sec									
T_t, hr									0.0000
Small Tributary & Swamp w/Channels									
Length, ft									
Slope, ft/ft									
Velocity[8], ft/sec									
T_t, hr									0.0000
Large Tributary									
Length, ft									
Slope, ft/ft									
Velocity[8], ft/sec									
T_t, hr									0.0000
Culvert									
Diameter, ft									
Area, ft^2									
Wetted Perimeter, ft									
Hydraulic Radius, R, ft									
Slope, ft/ft									
Manning's No.									
Velocity[12], ft/sec									
Length, L, ft									
T_t, hr									0.0000

HR	0.569
Min	**34.12**

PROJECT:	**Kennebec River Gorge Transition Stations**	**Calculated By:**	PGT
	West Forks Plantation	**Checked By:**	DTB
TRC Proj. No.:	**306390.0000.00000**	**Date:**	10/17/18
Subcatchment:	**POST DEV** **T Yard** 1SA	**Revised:**	

Time of Concentration Determination Worksheet, SCS Methods

	Seg 1	Seg 2	Seg 3	Seg 4	Seg 5	Seg 6	Seg 7		
SHEET FLOW									
Manning's No.	0.0111								
Length, ft	140								
P2 , in	2.44								
Slope, ft/ft	0.02								
T_t[1], hr	0.030								0.0305
SHALLOW CONCENTRATED FLOW									
Paved									
Length, ft									
Slope, ft/ft									
Velocity[2], ft/sec									
T_t[3], hr									0.0000
Unpaved									
Length, ft									
Slope, ft/ft									
Velocity[2], ft/sec									
T_t[3], hr									0.0000
Short Grass Pasture									
Length, ft									
Slope, ft/ft									
Velocity[4], ft/sec									
T_t[3], hr									0.0000
Woodland									
Length, ft									
Slope, ft/ft									
Velocity[5], ft/sec									
T_t[3], hr									0.0000
CHANNEL FLOW									
Waterways & Swamps, No Channels									
Length, ft									
Slope, ft/ft									
Velocity[6], ft/sec									
T_t[3], hr									0.0000
Grassed Waterways/Roadside Ditches									
Length, ft									
Slope, ft/ft									
Velocity[7], ft/sec									
T_t, hr									0.0000
Small Tributary & Swamp w/Channels									
Length, ft									
Slope, ft/ft									
Velocity[8], ft/sec									
T_t, hr									0.0000
Large Tributary									
Length, ft									
Slope, ft/ft									
Velocity[8], ft/sec									
T_t, hr									0.0000
Culvert									
Diameter, ft									
Area, ft^2									
Wetted Perimeter, ft									
Hydraulic Radius, R, ft									
Slope, ft/ft									
Manning's No.									
Velocity[12], ft/sec									
Length, L, ft									
T_t, hr									0.0000

HR	0.030
Min	**1.83**

(6 Minutes Minimum)

PROJECT:	**Kennebec River Gorge Transition Stations**						**Calculated By:**		PGT
	Moxie Gore						**Checked By:**		DTB
TRC Proj. No.:	**306390.0000.00000**						**Date:**		10/17/18
Subcatchment:	**PRE & POST DEV 2S**						**Revised:**		

Time of Concentration Determination Worksheet, SCS Methods

	Seg 1	Seg 2	Seg 3	Seg 4	Seg 5	Seg 6	Seg 7		
SHEET FLOW									
Manning's No.	0.8								
Length, ft	150								
P2 , in	2.44								
Slope, ft/ft	0.1187								
T_t[1], hr	0.484								0.4841
SHALLOW CONCENTRATED FLOW									
Paved									
Length, ft									
Slope, ft/ft									
Velocity[2], ft/sec									
T_t[3], hr									0.0000
Unpaved									
Length, ft									
Slope, ft/ft									
Velocity[2], ft/sec									
T_t[3], hr									0.0000
Short Grass Pasture									
Length, ft									
Slope, ft/ft									
Velocity[4], ft/sec									
T_t[3], hr									0.0000
Woodland									
Length, ft		569							
Slope, ft/ft		0.053							
Velocity[5], ft/sec		1.1500							
T_t[3], hr		0.137							0.1374
CHANNEL FLOW									
Waterways & Swamps, No Channels									
Length, ft			178						
Slope, ft/ft			0.0087						
Velocity[6], ft/sec			1.119						
T_t[3], hr			0.044						0.0442
Grassed Waterways/Roadside Ditches									
Length, ft									
Slope, ft/ft									
Velocity[7], ft/sec									
T_t, hr									0.0000
Small Tributary & Swamp w/Channels									
Length, ft									
Slope, ft/ft									
Velocity[8], ft/sec									
T_t, hr									0.0000
Large Tributary									
Length, ft									
Slope, ft/ft									
Velocity[8], ft/sec									
T_t, hr									0.0000
Culvert									
Diameter, ft									
Area, ft^2									
Wetted Perimeter, ft									
Hydraulic Radius, R, ft									
Slope, ft/ft									
Manning's No.									
Velocity[12], ft/sec									
Length, L, ft									
T_t, hr									0.0000

HR	0.666
Min	**39.95**

PROJECT:	**Kennebec River Gorge Transition Stations**	**Calculated By:**	PGT
	Moxie Gore	**Checked By:**	DTB
TRC Proj. No.:	**306390.0000.00000**	**Date:**	10/17/18
Subcatchment:	**POST DEV T Yard**	**Revised:**	

Time of Concentration Determination Worksheet, SCS Methods

	Seg 1	Seg 2	Seg 3	Seg 4	Seg 5	Seg 6	Seg 7		
SHEET FLOW									
Manning's No.	0.0111								
Length, ft	140								
P2 , in	2.44								
Slope, ft/ft	0.02								
T_t[1], hr	0.030								0.0305
SHALLOW CONCENTRATED FLOW									
Paved									
Length, ft									
Slope, ft/ft									
Velocity[2], ft/sec									
T_t[3], hr									0.0000
Unpaved									
Length, ft									
Slope, ft/ft									
Velocity[2], ft/sec									
T_t[3], hr									0.0000
Short Grass Pasture									
Length, ft									
Slope, ft/ft									
Velocity[4], ft/sec									
T_t[3], hr									0.0000
Woodland									
Length, ft									
Slope, ft/ft									
Velocity[5], ft/sec									
T_t[3], hr									0.0000
CHANNEL FLOW									
Waterways & Swamps, No Channels									
Length, ft									
Slope, ft/ft									
Velocity[6], ft/sec									
T_t[3], hr									0.0000
Grassed Waterways/Roadside Ditches									
Length, ft									
Slope, ft/ft									
Velocity[7], ft/sec									
T_t, hr									0.0000
Small Tributary & Swamp w/Channels									
Length, ft									
Slope, ft/ft									
Velocity[8], ft/sec									
T_t, hr									0.0000
Large Tributary									
Length, ft									
Slope, ft/ft									
Velocity[8], ft/sec									
T_t, hr									0.0000
Culvert									
Diameter, ft									
Area, ft^2									
Wetted Perimeter, ft									
Hydraulic Radius, R, ft									
Slope, ft/ft									
Manning's No.									
Velocity[12], ft/sec									
Length, L, ft									
T_t, hr									0.0000

HR	0.030
Min	**1.83**

(6 Minutes Minimum)

PRE-DEVELOPMENT
MODEL



Subcat Reach Pond Link

Routing Diagram for 2018-09-20 West Forks PLT Pre-Dev Model
Prepared by TRC, Printed 10/17/2018
HydroCAD® 10.00-20 s/n 01402 © 2017 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.720	67	Brush, Poor, HSG B (1S, 2S)
0.250	96	Gravel surface, HSG B (2S)
17.460	66	Woods, Poor, HSG B (1S, 2S)
18.430	**66**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
18.430	HSG B	1S, 2S
0.000	HSG C	
0.000	HSG D	
0.000	Other	
18.430		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.720	0.000	0.000	0.000	0.720	Brush, Poor	1S, 2S
0.000	0.250	0.000	0.000	0.000	0.250	Gravel surface	2S
0.000	17.460	0.000	0.000	0.000	17.460	Woods, Poor	1S, 2S
0.000	**18.430**	**0.000**	**0.000**	**0.000**	**18.430**	**TOTAL AREA**	

Time span=0.00-72.00 hrs, dt=0.02 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: (WEST FORKS Runoff Area=6.030 ac 0.00% Impervious Runoff Depth=0.30"
Tc=34.1 min CN=66 Runoff=0.85 cfs 0.152 af

Subcatchment 2S: (MOXIE GORE) Runoff Area=12.400 ac 0.00% Impervious Runoff Depth=0.33"
Tc=40.0 min CN=67 Runoff=1.83 cfs 0.343 af

Reach SP1: (SP1) Inflow=0.85 cfs 0.152 af
Outflow=0.85 cfs 0.152 af

Reach SP2: (SP2) Inflow=1.83 cfs 0.343 af
Outflow=1.83 cfs 0.343 af

Total Runoff Area = 18.430 ac Runoff Volume = 0.495 af Average Runoff Depth = 0.32"
100.00% Pervious = 18.430 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: (WEST FORKS PLANTATION)

Runoff = 0.85 cfs @ 12.40 hrs, Volume= 0.152 af, Depth= 0.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type II 24-hr 2-Year Rainfall=2.44"

Area (ac)	CN	Description
5.890	66	Woods, Poor, HSG B
0.140	67	Brush, Poor, HSG B
6.030	66	Weighted Average
6.030		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
34.1					**Direct Entry, See Spreadsheet**

Summary for Subcatchment 2S: (MOXIE GORE)

Runoff = 1.83 cfs @ 12.48 hrs, Volume= 0.343 af, Depth= 0.33"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type II 24-hr 2-Year Rainfall=2.44"

Area (ac)	CN	Description
11.570	66	Woods, Poor, HSG B
0.250	96	Gravel surface, HSG B
0.580	67	Brush, Poor, HSG B
12.400	67	Weighted Average
12.400		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
40.0					**Direct Entry, See Spreadsheet**

Summary for Reach SP1: (SP1)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 6.030 ac, 0.00% Impervious, Inflow Depth = 0.30" for 2-Year event
Inflow = 0.85 cfs @ 12.40 hrs, Volume= 0.152 af
Outflow = 0.85 cfs @ 12.40 hrs, Volume= 0.152 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs

Summary for Reach SP2: (SP2)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 12.400 ac, 0.00% Impervious, Inflow Depth = 0.33" for 2-Year event
Inflow = 1.83 cfs @ 12.48 hrs, Volume= 0.343 af
Outflow = 1.83 cfs @ 12.48 hrs, Volume= 0.343 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs

Time span=0.00-72.00 hrs, dt=0.02 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: (WEST FORKS Runoff Area=6.030 ac 0.00% Impervious Runoff Depth=0.97"
Tc=34.1 min CN=66 Runoff=4.02 cfs 0.487 af

Subcatchment 2S: (MOXIE GORE) Runoff Area=12.400 ac 0.00% Impervious Runoff Depth=1.02"
Tc=40.0 min CN=67 Runoff=7.94 cfs 1.058 af

Reach SP1: (SP1) Inflow=4.02 cfs 0.487 af
Outflow=4.02 cfs 0.487 af

Reach SP2: (SP2) Inflow=7.94 cfs 1.058 af
Outflow=7.94 cfs 1.058 af

Total Runoff Area = 18.430 ac Runoff Volume = 1.544 af Average Runoff Depth = 1.01"
100.00% Pervious = 18.430 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: (WEST FORKS PLANTATION)

Runoff = 4.02 cfs @ 12.33 hrs, Volume= 0.487 af, Depth= 0.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type II 24-hr 10-Year Rainfall=3.80"

Area (ac)	CN	Description
5.890	66	Woods, Poor, HSG B
0.140	67	Brush, Poor, HSG B
6.030	66	Weighted Average
6.030		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
34.1					**Direct Entry, See Spreadsheet**

Summary for Subcatchment 2S: (MOXIE GORE)

Runoff = 7.94 cfs @ 12.40 hrs, Volume= 1.058 af, Depth= 1.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type II 24-hr 10-Year Rainfall=3.80"

Area (ac)	CN	Description
11.570	66	Woods, Poor, HSG B
0.250	96	Gravel surface, HSG B
0.580	67	Brush, Poor, HSG B
12.400	67	Weighted Average
12.400		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
40.0					**Direct Entry, See Spreadsheet**

Summary for Reach SP1: (SP1)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 6.030 ac, 0.00% Impervious, Inflow Depth = 0.97" for 10-Year event
Inflow = 4.02 cfs @ 12.33 hrs, Volume= 0.487 af
Outflow = 4.02 cfs @ 12.33 hrs, Volume= 0.487 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs

Summary for Reach SP2: (SP2)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 12.400 ac, 0.00% Impervious, Inflow Depth = 1.02" for 10-Year event
Inflow = 7.94 cfs @ 12.40 hrs, Volume= 1.058 af
Outflow = 7.94 cfs @ 12.40 hrs, Volume= 1.058 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs

Time span=0.00-72.00 hrs, dt=0.02 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: (WEST FORKS Runoff Area=6.030 ac 0.00% Impervious Runoff Depth=1.23"
Tc=34.1 min CN=66 Runoff=5.30 cfs 0.616 af

Subcatchment 2S: (MOXIE GORE) Runoff Area=12.400 ac 0.00% Impervious Runoff Depth=1.29"
Tc=40.0 min CN=67 Runoff=10.38 cfs 1.332 af

Reach SP1: (SP1) Inflow=5.30 cfs 0.616 af
Outflow=5.30 cfs 0.616 af

Reach SP2: (SP2) Inflow=10.38 cfs 1.332 af
Outflow=10.38 cfs 1.332 af

Total Runoff Area = 18.430 ac Runoff Volume = 1.948 af Average Runoff Depth = 1.27"
100.00% Pervious = 18.430 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: (WEST FORKS PLANTATION)

Runoff = 5.30 cfs @ 12.32 hrs, Volume= 0.616 af, Depth= 1.23"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type II 24-hr 25-Year Rainfall=4.23"

Area (ac)	CN	Description
5.890	66	Woods, Poor, HSG B
0.140	67	Brush, Poor, HSG B
6.030	66	Weighted Average
6.030		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
34.1					**Direct Entry, See Spreadsheet**

Summary for Subcatchment 2S: (MOXIE GORE)

Runoff = 10.38 cfs @ 12.40 hrs, Volume= 1.332 af, Depth= 1.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type II 24-hr 25-Year Rainfall=4.23"

Area (ac)	CN	Description
11.570	66	Woods, Poor, HSG B
0.250	96	Gravel surface, HSG B
0.580	67	Brush, Poor, HSG B
12.400	67	Weighted Average
12.400		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
40.0					**Direct Entry, See Spreadsheet**

Summary for Reach SP1: (SP1)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 6.030 ac, 0.00% Impervious, Inflow Depth = 1.23" for 25-Year event
Inflow = 5.30 cfs @ 12.32 hrs, Volume= 0.616 af
Outflow = 5.30 cfs @ 12.32 hrs, Volume= 0.616 af, Atten= 0%, Lag= 0.0 min

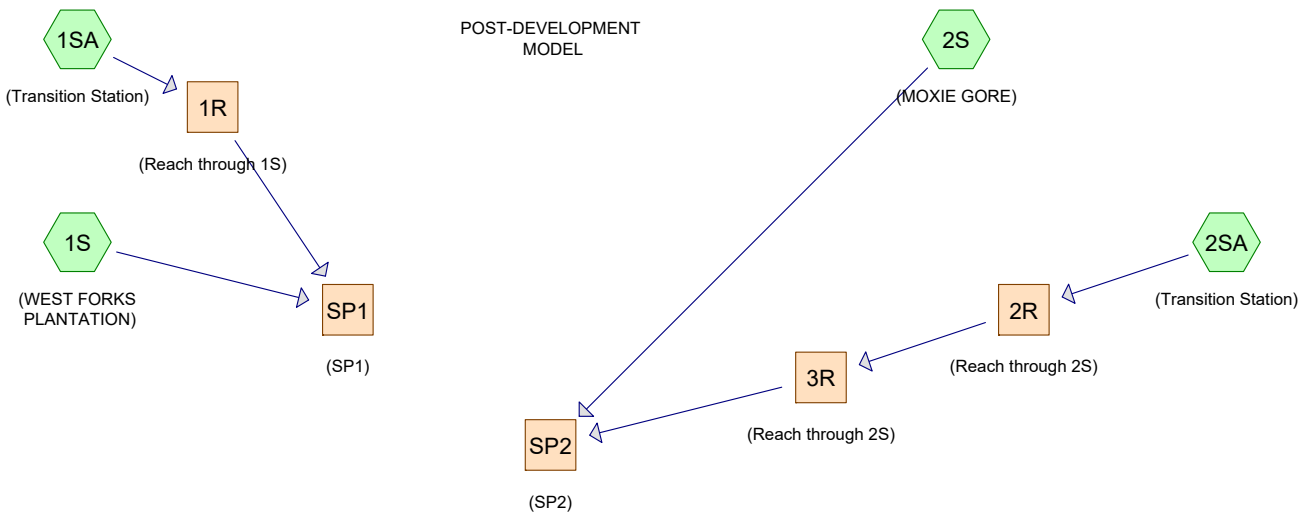
Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs

Summary for Reach SP2: (SP2)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 12.400 ac, 0.00% Impervious, Inflow Depth = 1.29" for 25-Year event
Inflow = 10.38 cfs @ 12.40 hrs, Volume= 1.332 af
Outflow = 10.38 cfs @ 12.40 hrs, Volume= 1.332 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs



Subcat Reach Pond Link

Routing Diagram for 2018-10-17 West Forks PLT Post-Dev Model
Prepared by TRC, Printed 10/17/2018
HydroCAD® 10.00-20 s/n 01402 © 2017 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.340	56	Brush, Fair, HSG B (1S)
0.970	67	Brush, Poor, HSG B (1S, 2S)
0.020	98	Foundations, HSG B (1SA, 2SA)
0.530	96	Gravel surface, HSG B (1S, 2S)
0.940	55	Substation Surface (1SA, 2SA)
15.630	66	Woods, Poor, HSG B (1S, 2S)
18.430	**66**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
17.490	HSG B	1S, 1SA, 2S, 2SA
0.000	HSG C	
0.000	HSG D	
0.940	Other	1SA, 2SA
18.430		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.340	0.000	0.000	0.000	0.340	Brush, Fair	1S
0.000	0.970	0.000	0.000	0.000	0.970	Brush, Poor	1S, 2S
0.000	0.020	0.000	0.000	0.000	0.020	Foundations	1SA, 2SA
0.000	0.530	0.000	0.000	0.000	0.530	Gravel surface	1S, 2S
0.000	0.000	0.000	0.000	0.940	0.940	Substation Surface	1SA, 2SA
0.000	15.630	0.000	0.000	0.000	15.630	Woods, Poor	1S, 2S
0.000	**17.490**	**0.000**	**0.000**	**0.940**	**18.430**	**TOTAL AREA**	

Time span=0.00-72.00 hrs, dt=0.02 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: (WEST FORKS Runoff Area=5.550 ac 0.00% Impervious Runoff Depth=0.30"
Tc=34.1 min CN=66 Runoff=0.78 cfs 0.140 af

Subcatchment 1SA: (Transition Station) Runoff Area=0.480 ac 2.08% Impervious Runoff Depth=0.09"
Tc=6.0 min CN=56 Runoff=0.01 cfs 0.003 af

Subcatchment 2S: (MOXIE GORE) Runoff Area=11.920 ac 0.00% Impervious Runoff Depth=0.33"
Tc=40.0 min CN=67 Runoff=1.76 cfs 0.330 af

Subcatchment 2SA: (Transition Station) Runoff Area=0.480 ac 2.08% Impervious Runoff Depth=0.09"
Tc=6.0 min CN=56 Runoff=0.01 cfs 0.003 af

Reach 1R: (Reach through 1S) Avg. Flow Depth=0.00' Max Vel=0.47 fps Inflow=0.01 cfs 0.003 af
n=0.030 L=331.0' S=0.1043 '/' Capacity=147.87 cfs Outflow=0.01 cfs 0.003 af

Reach 2R: (Reach through 2S) Avg. Flow Depth=0.01' Max Vel=0.23 fps Inflow=0.01 cfs 0.003 af
n=0.030 L=235.0' S=0.0067 '/' Capacity=11.79 cfs Outflow=0.01 cfs 0.003 af

Reach 3R: (Reach through 2S) Avg. Flow Depth=0.00' Max Vel=0.27 fps Inflow=0.01 cfs 0.003 af
n=0.030 L=747.0' S=0.0358 '/' Capacity=86.69 cfs Outflow=0.00 cfs 0.003 af

Reach SP1: (SP1) Inflow=0.79 cfs 0.144 af
Outflow=0.79 cfs 0.144 af

Reach SP2: (SP2) Inflow=1.76 cfs 0.333 af
Outflow=1.76 cfs 0.333 af

Total Runoff Area = 18.430 ac Runoff Volume = 0.477 af Average Runoff Depth = 0.31"
99.89% Pervious = 18.410 ac 0.11% Impervious = 0.020 ac

Summary for Subcatchment 1S: (WEST FORKS PLANTATION)

Runoff = 0.78 cfs @ 12.40 hrs, Volume= 0.140 af, Depth= 0.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type II 24-hr 2-Year Rainfall=2.44"

Area (ac)	CN	Description
4.920	66	Woods, Poor, HSG B
0.140	67	Brush, Poor, HSG B
0.340	56	Brush, Fair, HSG B
0.150	96	Gravel surface, HSG B
5.550	66	Weighted Average
5.550		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
34.1					**Direct Entry, See Spreadsheet**

Summary for Subcatchment 1SA: (Transition Station)

Runoff = 0.01 cfs @ 12.41 hrs, Volume= 0.003 af, Depth= 0.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type II 24-hr 2-Year Rainfall=2.44"

	Area (ac)	CN	Description
*	0.470	55	Substation Surface
*	0.010	98	Foundations, HSG B
	0.480	56	Weighted Average
	0.470		97.92% Pervious Area
	0.010		2.08% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, 6 minutes (Minimum)**

Summary for Subcatchment 2S: (MOXIE GORE)

Runoff = 1.76 cfs @ 12.48 hrs, Volume= 0.330 af, Depth= 0.33"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type II 24-hr 2-Year Rainfall=2.44"

	Area (ac)	CN	Description
	10.710	66	Woods, Poor, HSG B
	0.380	96	Gravel surface, HSG B
	0.830	67	Brush, Poor, HSG B
	0.000	48	Brush, Good, HSG B
*	0.000	55	Station Surface
	0.000	98	Roofs, HSG B
	11.920	67	Weighted Average
	11.920		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
40.0					**Direct Entry, See Spreadsheet**

Summary for Subcatchment 2SA: (Transition Station)

Runoff = 0.01 cfs @ 12.41 hrs, Volume= 0.003 af, Depth= 0.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type II 24-hr 2-Year Rainfall=2.44"

	Area (ac)	CN	Description
*	0.470	55	Substation Surface
*	0.010	98	Foundations, HSG B
	0.480	56	Weighted Average
	0.470		97.92% Pervious Area
	0.010		2.08% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, 6 minutes (Minimum)**

Summary for Reach 1R: (Reach through 1S)

Inflow Area = 0.480 ac, 2.08% Impervious, Inflow Depth = 0.09" for 2-Year event
Inflow = 0.01 cfs @ 12.41 hrs, Volume= 0.003 af
Outflow = 0.01 cfs @ 12.91 hrs, Volume= 0.003 af, Atten= 12%, Lag= 30.2 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Max. Velocity= 0.47 fps, Min. Travel Time= 11.8 min
Avg. Velocity = 0.47 fps, Avg. Travel Time= 11.8 min

Peak Storage= 4 cf @ 12.91 hrs
Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 0.50' Flow Area= 15.0 sf, Capacity= 147.87 cfs

30.00' x 0.50' deep channel, n= 0.030 Short grass
Length= 331.0' Slope= 0.1043 '/'
Inlet Invert= 936.00', Outlet Invert= 901.49'



Summary for Reach 2R: (Reach through 2S)

Inflow Area = 0.480 ac, 2.08% Impervious, Inflow Depth = 0.09" for 2-Year event
Inflow = 0.01 cfs @ 12.41 hrs, Volume= 0.003 af
Outflow = 0.01 cfs @ 12.96 hrs, Volume= 0.003 af, Atten= 13%, Lag= 32.8 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Max. Velocity= 0.23 fps, Min. Travel Time= 17.3 min
Avg. Velocity = 0.19 fps, Avg. Travel Time= 20.4 min

Peak Storage= 6 cf @ 12.96 hrs
Average Depth at Peak Storage= 0.01'
Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 11.79 cfs

2.00' x 1.00' deep channel, n= 0.030 Short grass
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 235.0' Slope= 0.0067 '/'
Inlet Invert= 890.80', Outlet Invert= 889.22'



Summary for Reach 3R: (Reach through 2S)

Inflow Area = 0.480 ac, 2.08% Impervious, Inflow Depth = 0.09" for 2-Year event
Inflow = 0.01 cfs @ 12.96 hrs, Volume= 0.003 af
Outflow = 0.00 cfs @ 14.10 hrs, Volume= 0.003 af, Atten= 18%, Lag= 68.8 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Max. Velocity= 0.27 fps, Min. Travel Time= 45.4 min
Avg. Velocity = 0.27 fps, Avg. Travel Time= 45.4 min

Peak Storage= 13 cf @ 14.10 hrs
Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 0.50' Flow Area= 15.0 sf, Capacity= 86.69 cfs

30.00' x 0.50' deep channel, n= 0.030 Short grass
Length= 747.0' Slope= 0.0358 '/'
Inlet Invert= 889.22', Outlet Invert= 862.45'



Summary for Reach SP1: (SP1)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 6.030 ac, 0.17% Impervious, Inflow Depth = 0.29" for 2-Year event
Inflow = 0.79 cfs @ 12.40 hrs, Volume= 0.144 af
Outflow = 0.79 cfs @ 12.40 hrs, Volume= 0.144 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs

Summary for Reach SP2: (SP2)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 12.400 ac, 0.08% Impervious, Inflow Depth = 0.32" for 2-Year event
Inflow = 1.76 cfs @ 12.48 hrs, Volume= 0.333 af
Outflow = 1.76 cfs @ 12.48 hrs, Volume= 0.333 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs

Time span=0.00-72.00 hrs, dt=0.02 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: (WEST FORKS Runoff Area=5.550 ac 0.00% Impervious Runoff Depth=0.97"
Tc=34.1 min CN=66 Runoff=3.70 cfs 0.448 af

Subcatchment 1SA: (Transition Station) Runoff Area=0.480 ac 2.08% Impervious Runoff Depth=0.49"
Tc=6.0 min CN=56 Runoff=0.32 cfs 0.020 af

Subcatchment 2S: (MOXIE GORE) Runoff Area=11.920 ac 0.00% Impervious Runoff Depth=1.02"
Tc=40.0 min CN=67 Runoff=7.63 cfs 1.017 af

Subcatchment 2SA: (Transition Station) Runoff Area=0.480 ac 2.08% Impervious Runoff Depth=0.49"
Tc=6.0 min CN=56 Runoff=0.32 cfs 0.020 af

Reach 1R: (Reach through 1S) Avg. Flow Depth=0.01' Max Vel=0.72 fps Inflow=0.32 cfs 0.020 af
n=0.030 L=331.0' S=0.1043 '/' Capacity=147.87 cfs Outflow=0.20 cfs 0.020 af

Reach 2R: (Reach through 2S) Avg. Flow Depth=0.12' Max Vel=0.93 fps Inflow=0.32 cfs 0.020 af
n=0.030 L=235.0' S=0.0067 '/' Capacity=11.79 cfs Outflow=0.26 cfs 0.020 af

Reach 3R: (Reach through 2S) Avg. Flow Depth=0.01' Max Vel=0.35 fps Inflow=0.26 cfs 0.020 af
n=0.030 L=747.0' S=0.0358 '/' Capacity=86.69 cfs Outflow=0.07 cfs 0.020 af

Reach SP1: (SP1) Inflow=3.78 cfs 0.468 af
Outflow=3.78 cfs 0.468 af

Reach SP2: (SP2) Inflow=7.70 cfs 1.037 af
Outflow=7.70 cfs 1.037 af

Total Runoff Area = 18.430 ac Runoff Volume = 1.504 af Average Runoff Depth = 0.98"
99.89% Pervious = 18.410 ac 0.11% Impervious = 0.020 ac

Summary for Subcatchment 1S: (WEST FORKS PLANTATION)

Runoff = 3.70 cfs @ 12.33 hrs, Volume= 0.448 af, Depth= 0.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type II 24-hr 10-Year Rainfall=3.80"

Area (ac)	CN	Description
4.920	66	Woods, Poor, HSG B
0.140	67	Brush, Poor, HSG B
0.340	56	Brush, Fair, HSG B
0.150	96	Gravel surface, HSG B
5.550	66	Weighted Average
5.550		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
34.1					**Direct Entry, See Spreadsheet**

Summary for Subcatchment 1SA: (Transition Station)

Runoff = 0.32 cfs @ 12.00 hrs, Volume= 0.020 af, Depth= 0.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type II 24-hr 10-Year Rainfall=3.80"

	Area (ac)	CN	Description
*	0.470	55	Substation Surface
*	0.010	98	Foundations, HSG B
	0.480	56	Weighted Average
	0.470		97.92% Pervious Area
	0.010		2.08% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, 6 minutes (Minimum)**

Summary for Subcatchment 2S: (MOXIE GORE)

Runoff = 7.63 cfs @ 12.40 hrs, Volume= 1.017 af, Depth= 1.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type II 24-hr 10-Year Rainfall=3.80"

	Area (ac)	CN	Description
	10.710	66	Woods, Poor, HSG B
	0.380	96	Gravel surface, HSG B
	0.830	67	Brush, Poor, HSG B
	0.000	48	Brush, Good, HSG B
*	0.000	55	Station Surface
	0.000	98	Roofs, HSG B
	11.920	67	Weighted Average
	11.920		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
40.0					**Direct Entry, See Spreadsheet**

Summary for Subcatchment 2SA: (Transition Station)

Runoff = 0.32 cfs @ 12.00 hrs, Volume= 0.020 af, Depth= 0.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type II 24-hr 10-Year Rainfall=3.80"

	Area (ac)	CN	Description
*	0.470	55	Substation Surface
*	0.010	98	Foundations, HSG B
	0.480	56	Weighted Average
	0.470		97.92% Pervious Area
	0.010		2.08% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, 6 minutes (Minimum)**

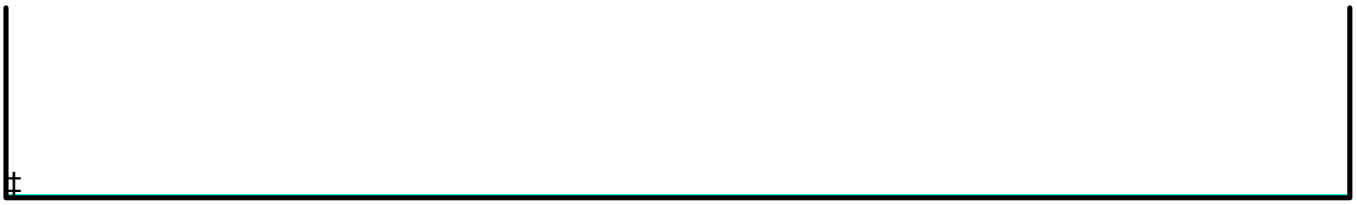
Summary for Reach 1R: (Reach through 1S)

Inflow Area = 0.480 ac, 2.08% Impervious, Inflow Depth = 0.49" for 10-Year event
Inflow = 0.32 cfs @ 12.00 hrs, Volume= 0.020 af
Outflow = 0.20 cfs @ 12.07 hrs, Volume= 0.020 af, Atten= 38%, Lag= 4.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Max. Velocity= 0.72 fps, Min. Travel Time= 7.7 min
Avg. Velocity = 0.47 fps, Avg. Travel Time= 11.7 min

Peak Storage= 91 cf @ 12.07 hrs
Average Depth at Peak Storage= 0.01'
Bank-Full Depth= 0.50' Flow Area= 15.0 sf, Capacity= 147.87 cfs

30.00' x 0.50' deep channel, n= 0.030 Short grass
Length= 331.0' Slope= 0.1043 '/'
Inlet Invert= 936.00', Outlet Invert= 901.49'



Summary for Reach 2R: (Reach through 2S)

Inflow Area = 0.480 ac, 2.08% Impervious, Inflow Depth = 0.49" for 10-Year event
Inflow = 0.32 cfs @ 12.00 hrs, Volume= 0.020 af
Outflow = 0.26 cfs @ 12.04 hrs, Volume= 0.020 af, Atten= 20%, Lag= 2.6 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Max. Velocity= 0.93 fps, Min. Travel Time= 4.2 min
Avg. Velocity = 0.31 fps, Avg. Travel Time= 12.7 min

Peak Storage= 65 cf @ 12.04 hrs
Average Depth at Peak Storage= 0.12'
Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 11.79 cfs

2.00' x 1.00' deep channel, n= 0.030 Short grass
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 235.0' Slope= 0.0067 '/'
Inlet Invert= 890.80', Outlet Invert= 889.22'



Summary for Reach 3R: (Reach through 2S)

[61] Hint: Exceeded Reach 2R outlet invert by 0.01' @ 12.34 hrs

Inflow Area = 0.480 ac, 2.08% Impervious, Inflow Depth = 0.49" for 10-Year event
Inflow = 0.26 cfs @ 12.04 hrs, Volume= 0.020 af
Outflow = 0.07 cfs @ 12.35 hrs, Volume= 0.020 af, Atten= 73%, Lag= 18.4 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Max. Velocity= 0.35 fps, Min. Travel Time= 35.4 min
Avg. Velocity = 0.28 fps, Avg. Travel Time= 44.9 min

Peak Storage= 147 cf @ 12.35 hrs
Average Depth at Peak Storage= 0.01'
Bank-Full Depth= 0.50' Flow Area= 15.0 sf, Capacity= 86.69 cfs

30.00' x 0.50' deep channel, n= 0.030 Short grass
Length= 747.0' Slope= 0.0358 '/'
Inlet Invert= 889.22', Outlet Invert= 862.45'



Summary for Reach SP1: (SP1)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 6.030 ac, 0.17% Impervious, Inflow Depth = 0.93" for 10-Year event
Inflow = 3.78 cfs @ 12.32 hrs, Volume= 0.468 af
Outflow = 3.78 cfs @ 12.32 hrs, Volume= 0.468 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs

Summary for Reach SP2: (SP2)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 12.400 ac, 0.08% Impervious, Inflow Depth = 1.00" for 10-Year event
Inflow = 7.70 cfs @ 12.40 hrs, Volume= 1.037 af
Outflow = 7.70 cfs @ 12.40 hrs, Volume= 1.037 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs

Time span=0.00-72.00 hrs, dt=0.02 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: (WEST FORKS Runoff Area=5.550 ac 0.00% Impervious Runoff Depth=1.23"
Tc=34.1 min CN=66 Runoff=4.88 cfs 0.567 af

Subcatchment 1SA: (Transition Station) Runoff Area=0.480 ac 2.08% Impervious Runoff Depth=0.67"
Tc=6.0 min CN=56 Runoff=0.49 cfs 0.027 af

Subcatchment 2S: (MOXIE GORE) Runoff Area=11.920 ac 0.00% Impervious Runoff Depth=1.29"
Tc=40.0 min CN=67 Runoff=9.98 cfs 1.280 af

Subcatchment 2SA: (Transition Station) Runoff Area=0.480 ac 2.08% Impervious Runoff Depth=0.67"
Tc=6.0 min CN=56 Runoff=0.49 cfs 0.027 af

Reach 1R: (Reach through 1S) Avg. Flow Depth=0.01' Max Vel=0.90 fps Inflow=0.49 cfs 0.027 af
n=0.030 L=331.0' S=0.1043 '/' Capacity=147.87 cfs Outflow=0.35 cfs 0.027 af

Reach 2R: (Reach through 2S) Avg. Flow Depth=0.16' Max Vel=1.09 fps Inflow=0.49 cfs 0.027 af
n=0.030 L=235.0' S=0.0067 '/' Capacity=11.79 cfs Outflow=0.42 cfs 0.027 af

Reach 3R: (Reach through 2S) Avg. Flow Depth=0.01' Max Vel=0.43 fps Inflow=0.42 cfs 0.027 af
n=0.030 L=747.0' S=0.0358 '/' Capacity=86.69 cfs Outflow=0.13 cfs 0.027 af

Reach SP1: (SP1) Inflow=4.99 cfs 0.594 af
Outflow=4.99 cfs 0.594 af

Reach SP2: (SP2) Inflow=10.10 cfs 1.307 af
Outflow=10.10 cfs 1.307 af

Total Runoff Area = 18.430 ac Runoff Volume = 1.901 af Average Runoff Depth = 1.24"
99.89% Pervious = 18.410 ac 0.11% Impervious = 0.020 ac

Summary for Subcatchment 1S: (WEST FORKS PLANTATION)

Runoff = 4.88 cfs @ 12.32 hrs, Volume= 0.567 af, Depth= 1.23"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type II 24-hr 25-Year Rainfall=4.23"

Area (ac)	CN	Description
4.920	66	Woods, Poor, HSG B
0.140	67	Brush, Poor, HSG B
0.340	56	Brush, Fair, HSG B
0.150	96	Gravel surface, HSG B
5.550	66	Weighted Average
5.550		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
34.1					**Direct Entry, See Spreadsheet**

Summary for Subcatchment 1SA: (Transition Station)

Runoff = 0.49 cfs @ 11.99 hrs, Volume= 0.027 af, Depth= 0.67"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type II 24-hr 25-Year Rainfall=4.23"

	Area (ac)	CN	Description
*	0.470	55	Substation Surface
*	0.010	98	Foundations, HSG B
	0.480	56	Weighted Average
	0.470		97.92% Pervious Area
	0.010		2.08% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, 6 minutes (Minimum)**

Summary for Subcatchment 2S: (MOXIE GORE)

Runoff = 9.98 cfs @ 12.40 hrs, Volume= 1.280 af, Depth= 1.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type II 24-hr 25-Year Rainfall=4.23"

	Area (ac)	CN	Description
	10.710	66	Woods, Poor, HSG B
	0.380	96	Gravel surface, HSG B
	0.830	67	Brush, Poor, HSG B
	0.000	48	Brush, Good, HSG B
*	0.000	55	Station Surface
	0.000	98	Roofs, HSG B
	11.920	67	Weighted Average
	11.920		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
40.0					**Direct Entry, See Spreadsheet**

Summary for Subcatchment 2SA: (Transition Station)

Runoff = 0.49 cfs @ 11.99 hrs, Volume= 0.027 af, Depth= 0.67"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type II 24-hr 25-Year Rainfall=4.23"

	Area (ac)	CN	Description
*	0.470	55	Substation Surface
*	0.010	98	Foundations, HSG B
	0.480	56	Weighted Average
	0.470		97.92% Pervious Area
	0.010		2.08% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, 6 minutes (Minimum)**

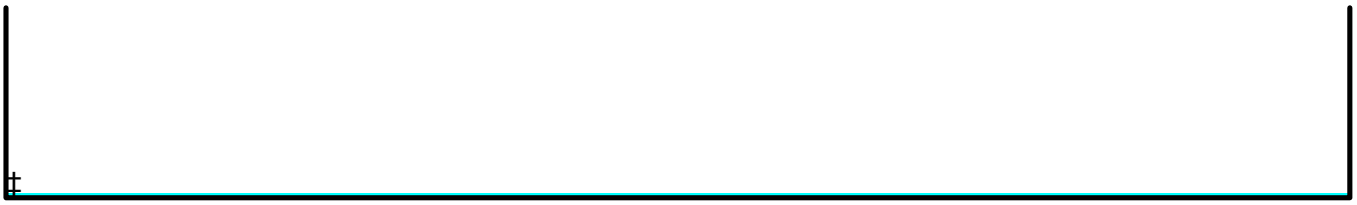
Summary for Reach 1R: (Reach through 1S)

Inflow Area = 0.480 ac, 2.08% Impervious, Inflow Depth = 0.67" for 25-Year event
Inflow = 0.49 cfs @ 11.99 hrs, Volume= 0.027 af
Outflow = 0.35 cfs @ 12.05 hrs, Volume= 0.027 af, Atten= 28%, Lag= 3.3 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Max. Velocity= 0.90 fps, Min. Travel Time= 6.1 min
Avg. Velocity = 0.48 fps, Avg. Travel Time= 11.6 min

Peak Storage= 129 cf @ 12.05 hrs
Average Depth at Peak Storage= 0.01'
Bank-Full Depth= 0.50' Flow Area= 15.0 sf, Capacity= 147.87 cfs

30.00' x 0.50' deep channel, n= 0.030 Short grass
Length= 331.0' Slope= 0.1043 '/'
Inlet Invert= 936.00', Outlet Invert= 901.49'



Summary for Reach 2R: (Reach through 2S)

Inflow Area = 0.480 ac, 2.08% Impervious, Inflow Depth = 0.67" for 25-Year event
Inflow = 0.49 cfs @ 11.99 hrs, Volume= 0.027 af
Outflow = 0.42 cfs @ 12.03 hrs, Volume= 0.027 af, Atten= 14%, Lag= 2.2 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Max. Velocity= 1.09 fps, Min. Travel Time= 3.6 min
Avg. Velocity = 0.34 fps, Avg. Travel Time= 11.6 min

Peak Storage= 90 cf @ 12.03 hrs
Average Depth at Peak Storage= 0.16'
Bank-Full Depth= 1.00' Flow Area= 4.0 sf, Capacity= 11.79 cfs

2.00' x 1.00' deep channel, n= 0.030 Short grass
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 235.0' Slope= 0.0067 '/'
Inlet Invert= 890.80', Outlet Invert= 889.22'



Summary for Reach 3R: (Reach through 2S)

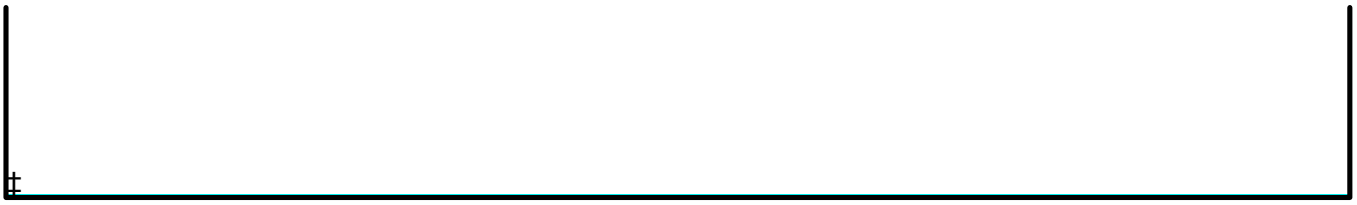
[61] Hint: Exceeded Reach 2R outlet invert by 0.01' @ 12.22 hrs

Inflow Area = 0.480 ac, 2.08% Impervious, Inflow Depth = 0.67" for 25-Year event
Inflow = 0.42 cfs @ 12.03 hrs, Volume= 0.027 af
Outflow = 0.13 cfs @ 12.23 hrs, Volume= 0.027 af, Atten= 70%, Lag= 12.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Max. Velocity= 0.43 fps, Min. Travel Time= 29.0 min
Avg. Velocity = 0.28 fps, Avg. Travel Time= 44.1 min

Peak Storage= 217 cf @ 12.23 hrs
Average Depth at Peak Storage= 0.01'
Bank-Full Depth= 0.50' Flow Area= 15.0 sf, Capacity= 86.69 cfs

30.00' x 0.50' deep channel, n= 0.030 Short grass
Length= 747.0' Slope= 0.0358 '/'
Inlet Invert= 889.22', Outlet Invert= 862.45'



Summary for Reach SP1: (SP1)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 6.030 ac, 0.17% Impervious, Inflow Depth = 1.18" for 25-Year event
Inflow = 4.99 cfs @ 12.32 hrs, Volume= 0.594 af
Outflow = 4.99 cfs @ 12.32 hrs, Volume= 0.594 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs

Summary for Reach SP2: (SP2)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 12.400 ac, 0.08% Impervious, Inflow Depth = 1.26" for 25-Year event
Inflow = 10.10 cfs @ 12.40 hrs, Volume= 1.307 af
Outflow = 10.10 cfs @ 12.40 hrs, Volume= 1.307 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs

PROJECT:	**CMP**	**Calculated By:**	PGT
	Kennebec HDD Transition Stations	**Checked By:**	PMM
TRC Proj:		**Date:**	October 17, 2018
		Revised:	

VEGETATED BUFFER AND STONED BERMED LEVEL SPREADER SIZING

Use of stone bermed level lip spreader in lieu of ditch turnout level spreaders.

Design Criteria:

Per BMP manual Volume III chapter 5.2.2 Buffer with Stone Bermed Level Lip Spreader
Reference Tables 5-4, 5-5 and 5-6

The given road section is: 15 ft wide gravel road
12 ft wide ditch section (3 ft bottom including side slopes)

Sub-Watershed 1S - West Forks Station

Vegetated Buffer B-1

Required Length of flow path through a meadow buffer (0-8% slope) = 150 ft
Provided is a 150 ft long meadow buffer. (average slope exceeds 8%)

Treatment for roadway		
Impervious areas		
15 x 65 =	975	0.02 Ac
15 x 368 =	5520	0.13 Ac
Concrete foundations		0.01 Ac
Total Impervious Area		**0.16 Ac**
Pervious area		
12 x 164	1968	0.05 Ac
12 x 307 =	3684	0.08 Ac
Total Landscaped Area		**0.13 Ac**

Level Spreader LS-1

Using Hydrologic Soil group B Soils

Per acre of impervious area =	100 Ft
Per acre of Lawn area =	30 Ft
Length for Impervious area =	16 LF
Length for Lawn area =	4 LF
Total length required =	**20 LF**
Provided =	**30 LF**

Note: Buffer slope is 16% so additional length of level spreader is provided to compensate for the increased slope.

PROJECT:	**CMP**	**Calculated By:**	PGT
	Kennebec HDD Transition Stations	**Checked By:**	PMM
TRC Proj:		**Date:**	October 17, 2018
		Revised:	

Sub-Watershed 2S - Moxie Gore Station

Vegetated Buffer B-2

Required Length of flow path through a meadow buffer (0-8% slope) = 150 ft
Provided is a 150 ft long meadow buffer.

Treatment for roadway			
Impervious areas			
15 x 88 =	1320	0.03	Ac
15 x150 =	2250	0.05	Ac
Concrete foundations		0.01	Ac
Total Impervious Area		**0.09**	**Ac**
Pervious area			
12 x 65	780	0.02	
12 x 320 =	3840	0.09	Ac
Total Landscaped Area		**0.11**	**Ac**

Level Spreader LS-2

Using Hydrologic Soil group B Soils		
Per acre of impervious area =	75	Ft
Per acre of Lawn area =	25	Ft
Length for Impervious area =	7	LF
Length for Lawn area =	3	LF
Total length required =	**10**	**LF**
Provided =	**30**	**LF**

Note: Runoff from transition station yard contributes to level spreader but no water quality treatment is needed.

STATE OF MAINE
DEPARTMENT OF ENVIRONMENTAL PROTECTION

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GOVERNOR

DAVID
COM

June 5, 2008

Roy Koster
Central Maine Power
83 Edison Drive
Augusta, ME 04336

RE: DEP Stormwater Management Regulations and how they apply to Central Maine Power Company Substations and Switchyards

Dear Mr. Koster:

I am writing to provide clarification on how substations and switchyards designed by Central Maine Power Company (CMP) can meet DEP Stormwater Management rules, Chapter 500 and the Site Location of Development Law. This letter supersedes a previous DEP letter on this subject dated February 29, 2008 and is a follow-up to further discussions between CMP and DEP staff.

Based on the report prepared by John Simon of Balance Engineering, dated March 8, 2008, regarding the stormwater runoff coefficient at CMP substations and switchyards, the required gravel fill and surface nature of these structures performs differently than most common construction practices and a modeling variance will be allowed for CMP substations and switchyards as follows:

When Flooding Standard requirements apply to a CMP project, modeling must demonstrate that peak runoff from the substation structure does not exceed predevelopment flow rates at the property line. Because of the permeability plus storage within the gravel fill and roughness of the crushed rock surface, the curve number (CN) specified in John Simon's report (March 2008) may be used for the substation area. As reported, a CN of 55 may be used for substations and switchyards that are built on areas that are mapped as HSG "A", "B", and "C", and a CN of 60 must be used when the area is mapped as HSG "D" for the HydroCAD model. However, all impervious surfaces will have to be added for an averaged curve number.

The General Standards of Chapter 500 (water quality) will be considered as met by the CMP substation/switchyard design specifications as long as the structure includes the typical CMP substation profile overlaying the natural ground surface. The soil layers within the CMP substation profile consist of 4 inches of crushed stone, 50:50 mix of 1.5"

USTA
ATE HOUSE STATION
USTA, MAINE 04333-0017
287-7688 FAX: (207) 287-7826
BLDG., HOSPITAL ST.

BANGOR
106 HOGAN ROAD
BANGOR, MAINE 04401
(207) 941-4570 FAX: (207) 941-4584

PORTLAND
312 CANCO ROAD
PORTLAND, MAINE 04103
(207) 822-6300 FAX: (207) 822-6303

PRESQUE ISLE
1235 CENTRAL DRIVE, SKYW
PRESQUE ISLE, MAINE 0476
(207) 764-0477 FAX: (207) 76

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and 0.75" diameter stone overlaying 18 inches or more of gravel fill, MDOT 703.06 Type A. Saturation within the granular fill will detain and provide treatment for the one-inch design standard under that requirement. Groundwater can never be any higher than 18 inches below the top of the gravel fill. Other treatment considerations will need to be provided for all impervious structures anticipated on the substation and switchyard and for the roadway.

The Basic Standards of Chapter 500 (erosion and sedimentation control, inspection and maintenance, and housekeeping) will be met by the standard CMP substation and switchyard design specification and erosion control/construction plan as developed by CMP for each Stormwater Management application. These are minimum erosion control measures that will need to be maintained until the site is fully stabilized. However, based on site and weather conditions during construction, additional erosion control measures may be needed.

While there are several ways to approach the design standards discussed above, these must be considered the minimum requirements in meeting the Stormwater Management and Site Location of Development Laws. However, in some situations where the local hydrology and site conditions warrant more resource protection, additional BMPs may be required. Also, the access drive and associated roadside swales are included in the disturbed area for permitting purposes and the treatment of these areas must be addressed separately from the substation or switchyard and be treated with standard practices. The natural hydrology of these areas will need to be maintained and will have to meet all applicable standards as established in Chapter 500 (page 11, Section 5).

I hope this addresses your request and will make the DEP permitting process more straight forward. If you have further questions, please contact Marianne Hubert at (207) 287-4140.

Sincerely,

Don Witherill, Director
Watershed Management Division
Bureau of Land and Water Quality

Cc: Marianne Hubert, PE, DEP program manager
Andy Fisk, DEP L&W Bureau Director
Dan Butler, PE, TRC
Gerry Mirabile, CMP

APPENDIX 12-2

315641 SW-1 West Forks Pre-Development Watershed Plan

315641 SW-2 West Forks Post-Development Watershed Plan

315641 SW-3 Moxie Gore Pre-Development Watershed Plan

315641 SW-4 Moxie Gore Post-Development Watershed Plan

APPENDIX 12-3

Post-Construction Stormwater Inspection and Maintenance Log

CMP West Forks Station				
Stormwater Management System Inspection & Maintenance Log				
	Schedule		**Inspector Initials and Date**	**Inspector Comments**
	Quarterly Inspection	**Maintenance**		
Revegetated Areas and Embankments:				
Inspect all revegetated areas and embankments.	**X**			
Replant bare areas or areas with sparse growth.		**As Required**		
Armor areas with rill erosion with an appropriate lining or divert the erosive flows to on-site areas able to withstand concentrated flows.		**As Required**		
Drainage Conveyance Systems:				
Inspect swales and level spreaders for evidence of erosion, debris, woody growth, and excessive sediment.	**X**			
Remove any obstructions and accumulated sediments or debris.		**As Required**		
Control vegetated growth and woody vegetation.		**As Required**		
Repair any erosion of the swale lining.		**As Required**		
Mow vegetated swales.		**Annually**		
Clean-out any accumulation of sediment within the spreader bays.		**As Required**		
Remove woody vegetation growing through riprap.		**As Required**		
Repair any slumping side slopes.		**As Required**		
Replace riprap where underlying filter fabric is showing or where stones have dislodged.		**As Required**		
Culverts:				
Inspect culvert inlet, outlet, and structure.	**X**			
Remove accumulated sediments and debris at the inlet, at the outlet, and within the conduit.		**As Required**		
Repair any erosion damage at the culvert's inlet and outlet.		**As Required**		

CMP West Forks Station				
Stormwater Management System Inspection & Maintenance Log				
	Schedule		**Inspector Initials and Date**	**Inspector Comments**
	Quarterly Inspection	**Maintenance**		
Roadway Surfaces:				
Inspect access road surfaces and shoulders for erosion, false ditches, and excess accumulation of sand that could impede water flow.	**X**			
Remove excess sand either manually or with a front-end loader.		**As Required**		
Grade gravel roads and shoulders.		**As Required**		
Transition Station Yard:				
Inspect for existing or developing erosion, rutting, trash, and unwanted vegetation.	**X**			
Correct any erosion/rutting and/or remove trash or vegetation.		**As Required**		
Water Quality Treatment Buffers:				
Inspect treatment buffers for evidence of erosion, concentrated flow, or encroachment by development.	**X**			
Manage the buffer's vegetation consistent with the requirements in any deed restrictions.		**As Required**		
Repair any sign of erosion within a buffer.		**As Required**		
Inspect and repair down-slope of all level spreaders and turn-outs for erosion.	**X**			

CMP West Forks Station				
Stormwater Management System Inspection & Maintenance Log				
	Schedule		**Inspector Initials and Date**	**Inspector Comments**
	Quarterly Inspection	**Maintenance**		
Maintenance Needed and When:				

CMP Moxie Gore Station				
Stormwater Management System Inspection & Maintenance Log				
	Schedule		**Inspector Initials and Date**	**Inspector Comments**
	Quarterly Inspection	**Maintenance**		
Revegetated Areas and Embankments:				
Inspect all revegetated areas and embankments.	**X**			
Replant bare areas or areas with sparse growth.		**As Required**		
Armor areas with rill erosion with an appropriate lining or divert the erosive flows to on-site areas able to withstand concentrated flows.		**As Required**		
Drainage Conveyance Systems:				
Inspect swales and level spreaders for evidence of erosion, debris, woody growth, and excessive sediment.	**X**			
Remove any obstructions and accumulated sediments or debris.		**As Required**		
Control vegetated growth and woody vegetation.		**As Required**		
Repair any erosion of the swale lining.		**As Required**		
Mow vegetated swales.		**Annually**		
Clean-out any accumulation of sediment within the spreader bays.		**As Required**		
Remove woody vegetation growing through riprap.		**As Required**		
Repair any slumping side slopes.		**As Required**		
Replace riprap where underlying filter fabric is showing or where stones have dislodged.		**As Required**		
Culverts:				
Inspect culvert inlet, outlet, and structure.	**X**			
Remove accumulated sediments and debris at the inlet, at the outlet, and within the conduit.		**As Required**		
Repair any erosion damage at the culvert's inlet and outlet.		**As Required**		

CMP Moxie Gore Station				
Stormwater Management System Inspection & Maintenance Log				
	Schedule		**Inspector Initials and Date**	**Inspector Comments**
	Quarterly Inspection	**Maintenance**		
Roadway Surfaces:				
Inspect access road surfaces and shoulders for erosion, false ditches, and excess accumulation of sand that could impede water flow.	**X**			
Remove excess sand either manually or with a front-end loader.		**As Required**		
Grade gravel roads and shoulders.		**As Required**		
Transition Station Yard:				
Inspect for existing or developing erosion, rutting, trash, and unwanted vegetation.	**X**			
Correct any erosion/rutting and/or remove trash or vegetation.		**As Required**		
Water Quality Treatment Buffers:				
Inspect treatment buffers for evidence of erosion, concentrated flow, or encroachment by development.	**X**			
Manage the buffer's vegetation consistent with the requirements in any deed restrictions.		**As Required**		
Repair any sign of erosion within a buffer.		**As Required**		
Inspect and repair down-slope of all level spreaders and turn-outs for erosion.	**X**			

CMP Moxie Gore Station				
Stormwater Management System Inspection & Maintenance Log				
	Schedule		**Inspector Initials and Date**	**Inspector Comments**
	Quarterly Inspection	**Maintenance**		
Maintenance Needed and When:				

APPENDIX 12-4

Buffer Declaration of Restrictions

3. Meadow buffer

DECLARATION OF RESTRICTIONS (Non-Wooded Meadow Buffer)

THIS DECLARATION OF RESTRICTIONS is made this _____day of _____, 20___, by _____, _____
(name) (street address)
_____, _____County, Maine,_____, (herein referred to as the
(city or town) (county) (zip code)
"Declarant"), pursuant to a permit received from the Maine Department of Environmental Protection under the Stormwater Management Law, to preserve a buffer area on a parcel of land near _____, _____ .
(road name) (known feature and/or town)

WHEREAS, the Declarant holds title to certain real property situated in _____, Maine
(town)
described in a deed from _____ to _____, dated
(name) (name of Declarant)
_____, 20____, and recorded in Book ____ Page ____ at the _____County Registry of Deeds, herein referred to as the "property"; and

WHEREAS, Declarant desires to place certain restrictions, under the terms and conditions herein, over a portion of said real property (hereinafter referred to as the "Restricted Buffer") described as follows: (Note: Insert description of restricted buffer location here)

WHEREAS, pursuant to the Stormwater Management Law, 38 M.R.S. Section 420-D and Chapter 500 of rules promulgated by the Maine Board of Environmental Protection ("Stormwater Management Rules"), Declarant has agreed to impose certain restrictions on the Restricted Buffer Area as more particularly set forth herein and has agreed that these restrictions may be enforced by the Maine Department of Environmental Protection or any successor (hereinafter the "MDEP"),

NOW, THEREFORE, the Declarant hereby declares that the Restricted Buffer Area is and shall forever be held, transferred, sold, conveyed, occupied and maintained subject to the conditions and restrictions set forth herein. The Restrictions shall run with the Restricted Buffer Area and shall be binding on all parties having any right, title or interest in and to the Restricted Buffer Area, or any portion thereof, and their heirs, personal representatives, successors, and assigns. Any present or future owner or occupant of the Restricted Buffer Area or any portion thereof, by the acceptance of a deed of conveyance of all or part of the Covenant Area or an instrument conveying any interest therein, whether or not the deed or instrument shall so express, shall be deemed to have accepted the Restricted Buffer Area subject to the Restrictions and shall agree to be bound by, to comply with and to be subject to each and every one of the Restrictions hereinafter set forth.

1. **Restrictions on Restricted Buffer Area**. Unless the owner of the Restricted Buffer Area, or any successors or assigns, obtains the prior written approval of the MDEP, the Restricted Buffer Area must remain undeveloped in perpetuity. To maintain the ability of the Restricted Buffer Area to filter and absorb stormwater, and to maintain compliance with the Stormwater Management Law and the permit issued thereunder to the Declarant, the use of the Restricted Buffer Area is hereinafter limited as follows.

   a. No soil, loam, peat, sand, gravel, concrete, rock or other mineral substance, refuse, trash, vehicle bodies or parts, rubbish, debris, junk waste, pollutants or other fill material will be placed, stored or dumped on the Restricted Buffer Area, nor may the topography or the natural mineral soil of the area be altered or manipulated in any way;

   b. A dense cover of grassy vegetation must be maintained over the Restricted Buffer Area, except that shrubs, trees and other woody vegetation may also be planted or allowed to grow in the area. The Restricted Buffer Area may not be maintained as a lawn or used as a pasture. If vegetation in the Restricted Buffer Area is mowed, it may be mown no more than two times per year.

   c. No building or other temporary or permanent structure may be constructed, placed or permitted to remain on the Restricted Buffer Area, except for a sign, utility pole or fence (whether constructed of wood, steel or other materials) and appurtenant equipment such as guys and guy anchors;

   d. No trucks, cars, dirt bikes, ATVs, bulldozers, backhoes, or other motorized vehicles or mechanical equipment may be permitted on the Restricted Buffer Area, except for vehicles used in mowing;

   e. Any level lip spreader directing flow to the Restricted Buffer Area must be regularly inspected and adequately maintained to preserve the function of the level spreader.

   Any activity on or use of the Restricted Buffer Area inconsistent with the purpose of these Restrictions is prohibited. Any future alterations or changes in use of the Restricted Buffer Area must receive prior approval in writing from the MDEP. The MDEP may approve such alterations and changes in use if such alterations and uses do not impede the stormwater control and treatment capability of the Restricted Buffer Area or if adequate and appropriate alternative means of stormwater control and treatment are provided.

2. **Enforcement**. The MDEP may enforce any of the Restrictions set forth in Section 1 above.

3. **Binding Effect**. The restrictions set forth herein shall be binding on any present or future owner of the Restricted Buffer Area. If the Restricted Buffer Area is at any time owned by more than one owner, each owner shall be bound by the foregoing restrictions to the extent that any of the Restricted Buffer Area is included within such owner's property.

4. **Amendment**. Any provision contained in this Declaration may be amended or revoked only by the recording of a written instrument or instruments specifying the amendment or the revocation signed by the owner or owners of the Restricted Buffer Area and by the MDEP.

5. **Effective Provisions of Declaration**. Each provision of this Declaration, and any agreement, promise, covenant and undertaking to comply with each provision of this Declaration, shall be deemed a land use restriction running with the land as a burden and upon the title to the Restricted Buffer Area.

6. **Severability**. Invalidity or unenforceability of any provision of this Declaration in whole or in part shall not affect the validity or enforceability of any other provision or any valid and enforceable part of a provision of this Declaration.

7. **Governing Law**. This Declaration shall be governed by and interpreted in accordance with the laws of the State of Maine.

_____
(NAME)

STATE OF MAINE, _____, County, dated _____, 20__ .
(County)

Personally appeared before me the above named _____, who swore to the truth of the foregoing to the best of (his/her) knowledge, information and belief and acknowledged the foregoing instrument to be (his/her) free act and deed.

_____
Notary Public

_____

13.0 URBAN IMPAIRED STREAMS

The Urban Impaired Streams Watersheds GIS data, updated February 6, 2016, provided by MDEP's Bureau of Land Resources, was reviewed in relation to the NECEC Project locations. This review indicated that no components of the Project will be constructed in or near an Urban Impaired Stream and/or Watershed. Additionally, a review of the MDEP Chapter 502- Direct Watersheds of Lakes Most at Risk from New Development and Urban Impaired Streams List confirmed these findings.

14.0 BASIC STANDARD SUBMISSIONS

As described in CMP's September 27, 2017 Site Law application submittal, CMP will use the best practices described in its standard manual, "Environmental Guidelines for Construction and Maintenance Activities on Transmission Line and Substation Projects" ("Environmental Guidelines"). This manual contains effective and proven erosion and sedimentation control requirements, standards, and methods that will be used to protect soil and water resources during construction of the various NECEC Project components, including the HDD installation and termination station construction. Methods for erosion control, consistent with CMP's Environmental Guidelines, are depicted in the permitting plan set included as Exhibit 12-1 in the Stormwater Section of the Site Law application. Information regarding best practices for construction dewatering and avoiding and responding to releases of HDD drilling fluids is provided below.

CMP will implement specific dewatering control measures where applicable (e.g. trench de-watering). Construction dewatering procedures will include, but are not limited to, the following:

- Open excavations and/or trenches will be dewatered and kept free of standing water and muddy conditions as necessary for the safe and proper execution of the work.
- All trench excavations and trenches will be dewatered prior to the placement of backfill.
- Construction dewatering will be conducted in a way to prevent sedimentation associated with the management of water removed during construction from excavations, trenches, cofferdams, and other work areas that trap stormwater and groundwater. To facilitate this, pump hose intakes will be elevated from the trench bottom using a floatation device to prevent sediments from the trench bottom from being discharged.
- Dewatering of excavations and or trenches will involve pumping the water to a discharge point, which will include measures/devices to slow water velocities and trap any suspended sediment. Such measures/devices may include but are not limited to a dirt bag with a sand berm and hay bale barrier, hay bale corral lined with geotextile fabric, and/or sediment basin of appropriate size with a well-vegetated upland buffer. An erosion control mix berm may also be incorporated with silt fence or hay bale corral.
- Dewatering activities will not result in the direct discharge of water into any streams or wetlands and will be conducted in accordance with the Project's site-specific erosion and sedimentation control plan (see Exhibit 12-1). Discharge from dewatering activity is not permitted within 75' of

a stream or wetland. Wooded buffers and flat to moderate slopes provide the best opportunity for filtration and absorption.

- Dewatering will not occur during heavy rain or when the infiltrative capacity of the soil is exceeded.
- Inspection of all dewatering activity and discharge points will be done on a daily basis, with more frequent oversight as site conditions warrant.

The typical HDD consists of three main steps: drilling a pilot hole, back reaming, and pulling of the casing and conduit into the hole. The pilot hole involves drilling the entire length of the bore with a small diameter drill head. Once the pilot hole has been established a reamer is placed on the drill head and then is pulled back through the bore hole to widen the hole. Finally, the casing is attached to the drill head and pulled back through the bore hole. Typically, the drilling fluid is composed of water and clay particulates consisting of bentonite. The main component of bentonite is montmorillonite clay. This clay has a high shrink-swell capacity. Bentonite attracts water and bonds to it and therefore is capable of absorbing up to seven times its weight in water and swelling up to eighteen times its dry volume. The bentonite and water work together to lubricate and cool the drill head, seal and fill pore spaces surrounding the hole, and prevent the drill hole from collapsing. It also suspends the cuttings of the native soil and removes them.

During the HDD process there is a small possibility of drilling fluids reaching the ground surface by following a vertical bedrock fracture. This is referred to as an inadvertent release. CMP has developed an Inadvertent Fluid Release Prevention, Monitoring, and Contingency Plan ("Plan") (see Exhibit 14-1) that outlines the details of the HDD process, the monitoring and prevention procedures, and the measures that would be in place to respond to an inadvertent release of drilling fluids.

The Plan includes:

- Typical scenarios under which inadvertent release of drilling fluid could occur, and measures to prevent it;
- The required reporting process to Project personnel, CMP and state regulatory agencies;
- Procedural measures that would be taken to mitigate for a release;
- The type of drilling operation adjustments that could be made to minimize or prevent any additional releases; and
- equipment or supplies available to contain an inadvertent release, and the disposal process for all collected directional drilling fluids.

Exhibit 14-1: Inadvertent Fluid Release Prevention, Monitoring, and Contingency Plan

REQUIREMENTS FOR INADVERTENT FLUID RELEASE PREVENTION, MONITORING, AND CONTINGENCY PLAN FOR HDD OPERATIONS

Prepared for the

CENTRAL MAINE POWER COMPANY
NEW ENGLAND CLEAN ENERGY CONNECT
KENNEBEC RIVER CROSSING

Location

West Forks Plantation &
Moxie Gore,
Maine 04985

Owner

Central Maine Power Company
83 Edison Drive
Augusta, Maine 04336

Prepared by

6 Ashley Drive
Scarborough, ME 04074
(207) 274-2631
October 2018

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Requirements for Inadvertent Fluid Release Prevention, Monitoring, and Contingency Plan for HDD Operations

This document lists the minimum requirements for a site-specific inadvertent fluid release plan that shall be prepared by the Horizontal Directional Drilling (HDD) Contractor selected for this project. The purpose of this plan is to prevent any inadvertent fluid releases, to quickly identify any inadvertent fluid releases that do occur, and to contain, minimize, and remediate any environmental impacts associated with any release of HDD drilling fluids.

The final inadvertent fluid release pprevention, mmonitoring, and contingency plan will be provided to the Owner, and relevant regulatory agencies before the commencement of drilling activities.

1 PROJECT SUMMARY

Avangrid – Central Maine Power Company (CMP) (Owner) intends to contract for HDD services for the NECEC Kennebec River Crossing project.

This project generally consists of installation of a HVDC electric power transmission line under the Kennebec River in the area of Moxie Gorge. This section of the Kennebec River is designated as an Outstanding River Segment and requires measures to prevent and minimize environmental impacts. As part of this project the Owner requires development of an inadvertent fluid release prevention, monitoring, and contingency plan (Plan) and implementation of the plan during all HDD operations for the Kennebec River Crossing.

The HDD drill site will be on the east side of the river at the Moxie Gore termination station and the receiving site is on the west of the river at the West Forks termination station. There is a vertical drop of more than 300 feet from the termination stations to the river valley and the HDD is approximately 3,000 feet in horizontal length.

2 PLAN SUBMITTAL REQUIREMENTS

The Contractor shall submit for Owner approval a Plan that includes the address of the regulatory agencies and the 1-800 spill hotline number for reporting releases of drilling fluids into water resources, a description of the means, methods, materials and equipment the Contractor will use prior to, during and after the HDD operations required for this project. The Contractor shall revise and resubmit the Plan if site conditions warrant any changes. Written approval of the Plan by the Maine Department of Environmental Protection and the Owner shall be obtained prior to the start of work.

3 RELEASE PREVENTION

The Contractor is responsible for the engineering design of the HDD for this project and this Inadvertent Fluid Release Plan shall be prepared in conjunction with their detailed design.

This plan shall document preventative measured incorporated into the design. This includes but is not limited to measures such as:

- Subsurface and geotechnical investigations that were performed.
- Engineering standards employed.
- Design assumptions used.
- Calculations made to estimate soil/bedrock fracturing under planned fluid pressures.
- HDD alignment changes required (increased depth, poor soil avoidance, etc.) based on site conditions.
- Design features used for this project that were used successfully on similar projects or that are used to remedy prior problems.
- Drilling fluid composition for anticipated soil conditions.

4 DRILLING FLUID

The Contractor's Plan shall discuss the purpose and use of drilling fluids in HDD operations, including, but is not limited to:

- A description of how the drilling fluids remove cuttings and spoils from the bore hole, lubricate and cool the drill head and keep the bore hole from collapsing.
- A description of mud motors and how the drilling fluids are pumped through the drill steel and out of the drill head.
- A description of how the high-pressure fluid used during drilling creates a chance of an inadvertent release of drilling fluids due to weak spots/seams in the overlying soils that cannot contain the fluid pressure and allows migration of the fluids to the surface.
- A description of the chemical composition and characteristics of drilling fluid and any/all additives. Drilling fluid is comprised of water and naturally occurring clay called sodium montmorillonite (bentonite). Bentonite is a non-toxic, non-reactive, inert material that allows the HDD Contractor to monitor and adjust the viscosity of the drilling fluid to achieve the desired carrying and lubricating properties.
- Documentation that the drilling fluid composition complies with all Federal, State, and local environmental regulations.
- Documentation that no contamination is introduced into the soil during the drilling, reaming, or conduit installation processes.

4.1 Additives

The Plan will include how and why additives are used in the drilling fluid to adjust the viscosity, improve hole integrity, prevent, or reduce fluid release, and how adjustments to the drilling fluid characteristics are made during the drilling operations. The Plan will describe the names and chemical compositions of additives proposed for this project including clays, organic fibers, modified starches and non-reactive polymers. Petroleum-based additives shall not be used. Safety Data Sheets for all additives used will also be included in the Plan.

Additives that are not listed in the approved Plan shall not be used.

4.2 Disposal

The Plan shall describe drilling fluid and spoils collection, segregation, transportation and disposal. Recycling and reuse of drilling fluids shall be used to limit disposal quantities. Prior to drilling operations, the HDD contractor shall identify one or more licensed landfills or off-site facilities for disposal of the cuttings, spoils and excess drilling fluid, and shall include the names and licenses of these facilities in this Plan.

The HDD contractor will dispose of all fluids in a manner that is in compliance with all permits and applicable Federal, State, and local regulations.

5 DESIGN CONSIDERATIONS

The Owner and its Consultants will undertake several steps during design to minimize the occurrence of an inadvertent release of drilling fluid.

5.1 Identify Soil and Subsurface Conditions

The Owner and its Consultants will undertake geotechnical investigations to identify the materials being drilled through, resistance to drilling operations, and resistance to fluid migration. The Owner will provide the geotechnical report to the Contractor for their use in designing the HDD for this project.

5.2 Drill Design

The Contractor shall prepare detailed design calculations and plans identifying the drill path, expected spoils volumes, pipe installation stresses and fluid pressures.

5.3 Additional Modeling for Kennebec River Crossing

For the HDD crossing of the Kennebec River, the drilling fluid will need to circulate at a high pressure. The Contractor shall perform site-specific modeling to estimate the ability of the overlying soils to withstand fluid migration (Hydrofracture Modeling). These models shall be

used in conjunction with the expected fluid pressures to determine the appropriate installation depth.

5.4 Drill Fluid Return Estimates

The Plan shall describe how a complete recovery of all circulating drilling fluids is not expected due to naturally occurring voids and low-density areas within the soil which will be filled by the fluids immediately adjacent to the borehole during the drilling process. The plan shall estimate typical expected fluid return volumes along the borehole alignment during all the HDD phases, including pilot hole, 1st reaming, 2nd reaming etc. so that abnormal/low fluid returns can be monitored and evaluated/investigated.

6 MONITORING AND ACTION PLAN

The Plan shall include the Contractors monitoring of HDD activities along the drilling path and downstream of the drilling path, including on the river, and the Contractors actions required for various site conditions. The Plan shall describe how HDD operations will be coordinated/scheduled with the Harris Hydropower Dam owner (Brookfield Renewables) to facilitate inadvertent fluid release monitoring during periods of low river flow. The Monitoring and Action Plan shall include but is not limited to the following:

Table 5-1:

Drilling Fluid Monitoring and Action Plan Summary		
Condition	Status	Actions
Condition 1: Normal Drilling Conditions	Normal drilling fluid circulation is	• Perform routine collection of drilling fluid at endpoints • Perform routine drilling data collection

Drilling Fluid Monitoring and Action Plan Summary		
Condition	Status	Actions
	maintained	• Conduct routine visual monitoring for surface releases along drill path
Condition 2: Loss or Reduction of Circulation	Loss or significant reduction of fluid circulation	• Notify Owner • Adjust drilling parameters to regain circulation • Increase visual monitoring for surface release • Continue drilling if no release is detected
Condition 3: Drilling Fluid Release and Remediation	Drilling fluid release is confirmed	• Notify Owner • Monitor and document release area • Contain and collect release if feasible • Suspend HDD operations if containment is not feasible

6.1 Condition 1: Normal Drilling Conditions

The HDD Contractor shall maximize recirculation of drilling fluid surface returns and provide solids control and fluid cleaning equipment of a configuration and capacity that can process surface returns and produce drilling fluid suitable for reuse.

The Contractor shall at all times provide and maintain instrumentation which accurately locates the pilot hole, measures drill string axial and torsional loads, and measures the drilling fluid discharge rate and pressure.

The Owner and authorized regulatory agency representatives shall have access to these instruments and their readings upon request. A log of all recorded readings shall be maintained by the Contractor at the drill rig site and shall become part of the construction record.

Routine visual monitoring under Condition 1 shall consist of periodic visual examination by the HDD Contractor personnel along the drilled alignment. Due to the land cover and terrain at the Kennebec River crossing these visual inspections will be made on foot.

These examinations shall be made periodically on a time interval not to exceed one hour. The name of the inspector, time of the examination, and observations shall be kept in a log at the drill rig site and shall be available for inspection.

6.2 Condition 2: Loss or Reduction of Circulation

Condition 2 actions shall be implemented if the drilling fluid fails to circulate as expected. Drilling fluid circulation shall be evaluated on the basis of comparing actual quantities against the planned quantities for the volume of fluid being recovered, drilling fluid pressures, and location of fluid recovered.

The Contractor shall continuously compare estimated fluid returns with measured returns to monitor for drilling fluid loss and inadvertent fluid release. The following minimum actions shall be implemented if a loss or significant reduction of drilling fluid circulation occurs.

6.2.1 HDD Contractor will notify the Owner who may notify regulatory agency representatives that drilling is continuing under Condition 2.

6.2.2 The Contractor shall increase monitoring frequency from Routine to Focused monitoring. Focused monitoring consists of continuous monitoring of the drill alignment by personnel with no other duties. Sufficient personnel will be used to ensure that each portion of the alignment is inspected at least once every 30 minutes.

6.2.3 HDD Contractor shall immediately take steps to restore circulation. These steps shall include, but are not be limited to:

- Size the hole. Sizing (Swabbing) involves withdrawing the drill string to mechanically clean the drilled hole.

- Adjust drilling fluid viscosity and gelling properties to encourage annular flow and stabilize the entire structure.

6.2.4 The HDD Contractor shall consider the following adjustments in addition to the above steps.

- Adding additional pre-approved filling or stabilizing materials to potentially seal fissures in the soil.
- Adjust the drill cutting heads and speeds for potential soil pockets.

Once circulation is restored, drilling shall continue under Condition 2 for a period of not less than eight (8) drilling hours. If a release is not identified, and loss or significant reduction of drilling fluid circulation does not re-occur, the HDD Contractor shall notify the Owner, who may notify regulatory agency representatives that drilling under Condition 1 has resumed.

The HDD Contractor will keep the Owner notified about changes to circulation status, including if circulation has been restored or partially restored. The Owner may notify regulatory agency representatives about these changes.

6.3 Condition 3: Drilling Fluid Release, Containment and Remediation

This section covers the general principles for Condition 3 and drilling fluid containment. More detailed requirements for containment and equipment are included in Section 6 of this plan. If a drilling fluid release is detected the Contractor shall at a minimum take the following immediate actions.

6.3.1 The HDD Contractor shall immediately notify the Owner that a fluid release has been detected. The Owner will notify regulatory agency representatives as soon as possible, however no later than 24 hours after a fluid release has been detected.

6.3.2 HDD Contractor shall immediately begin containment efforts. See Section 6 for discussion of containment methods and equipment requirements.

6.3.3 The Contractor shall take steps to reduce released fluid volumes and pressures that include but are not limited to:

- Size and swab the bore hole
- Adjust drilling fluid viscosity and gel properties to restore circulation
- Add additional pre-approved filling or stabilizing materials to potentially seal fissures in the soil.

6.3.4 Once containment has been established HDD drilling will continue under Condition 3. If the amount of the release occurring exceeds that which can be contained and collected, drilling operations will be suspended until released volumes can be properly contained.

6.3.5 The Contractor shall continue Focused Monitoring, as discussed in section 5.2.2, as well as downstream of the drilling alignment, to ensure additional fluid releases have not occurred.

6.3.6 All measures necessary will be undertaken to prevent release of drilling fluid to the Kennebec River.

If the amount of any drilling fluid release, either on land or within the waters, exceeds that which can be feasibly contained and collected, drilling operations will be suspended and the HDD Contractor shall notify the Owner, who will notify regulatory agency representatives that drilling cannot continue until effective fluid containment measures are developed and implemented without a continuous release of drilling fluid. Drilling will not resume until the Owner and regulatory agencies have approved a plan for continuing with limited releases or recovering drilling equipment and halting drilling activities.

Drilling fluid returns may stop as the drilling fluid consistency changes. If drilling fluid stops returning the surface containment measures shall be maintained in place and drilling will continue under Condition 2.

The HDD Contractor shall keep the Owner and regulatory agency representatives notified when fluid circulation has been restored, as well as the status of any additional releases and their containment.

7 CONTAINMENT METHODS AND EQUIPMENT

The Contractors Plan shall describe containment methods and equipment required based on the potential locations of the release and potential volume of fluid.

The Plan shall describe in detail site specific containment methods, equipment requirements, equipment staging, communication responsibilities, contractors' personnel training and staffing during a release incident. The equipment required to response to an inadvertent fluid release shall be on site, accessible and ready for deployment during all drilling activities.

7.1 Kennebec River Crossing, In Water

The Plan shall describe river low-flow and high-flow conditions and how release monitoring will be coordinated with and shall occur during low river flow conditions. The Plan will document the communication process such as chain of command, responsible parties, and reporting and remediation time frames.

The Plan shall describe how drilling fluid is heavier than water and is typically released at low velocities and settles in low areas. The Plan shall detail how to place barriers around a release in the river, how to divert the river flow away from the release site, how to create a sump within the river diversion, how to pump the released fluid out of the sump, how to collect and transport fluid for disposal, how the inadvertent fluid release site is restored, and how the river diversion is removed.

The Contractors Plan shall describe containment material and equipment staging near the river bank above high water levels. This list of additional containment materials should include barriers, sump pumps, power sources, and hoses and containment tanks that will be staged at the HDD entry or exit points within 1,000 feet of the river.

Specific barriers and equipment shall be identified by the HDD Contractor for the Kennebec River crossing.

7.2 Kennebec River Crossing, On Land

The Plan shall describe spill prevention materials for the HDD entry and exit points.

The HDD Contractor shall discuss how a fluid release containment sump will be constructed on land in soil areas and in shallow bedrock areas, and describe how contained fluids are managed, transported and disposed of.

Any fluid released before a containment can be established shall be contained with temporary barriers such as sand bags, silt fence or filter bags, and then swept back into the containment sump or contained in low areas and vacuumed into holding tanks.

Specific barriers and equipment shall be identified by the HDD Contractor in this Plan.

8 REMEDIATION

The Contractor shall develop and provide a site specific plan for remediation of fluid releases in water and on land to the Owner and regulatory agencies for their review and approval, as part of this Plan, before commencement of drilling activities.

If a fluid release occurs, the HDD Contractor shall contain all fluids, remove drilling fluid that can be vacuumed or swept up, and shall restore the release site.

8.1 Kennebec River Crossing, In Water

The Plan shall discuss removal of drilling fluid from the collection sump and the level of remediation that will be achieved. The Plan will document the communication process and remediation efforts with ample documentation for the Owner and regulatory agencies. The Owner and/or regulatory agencies shall observe the Contractors remediation activities.

After the sump and containment have been remediated and removed the Contractor shall inspect the riverbed a minimum of 500 feet downstream from the fluid release site looking for pockets of

slower moving water where drilling fluid may have collected. Any pockets located shall be evaluated to determine if drilling fluid is present and, if so, whether and how it can be removed.

8.2 Kennebec River Crossing, On Land

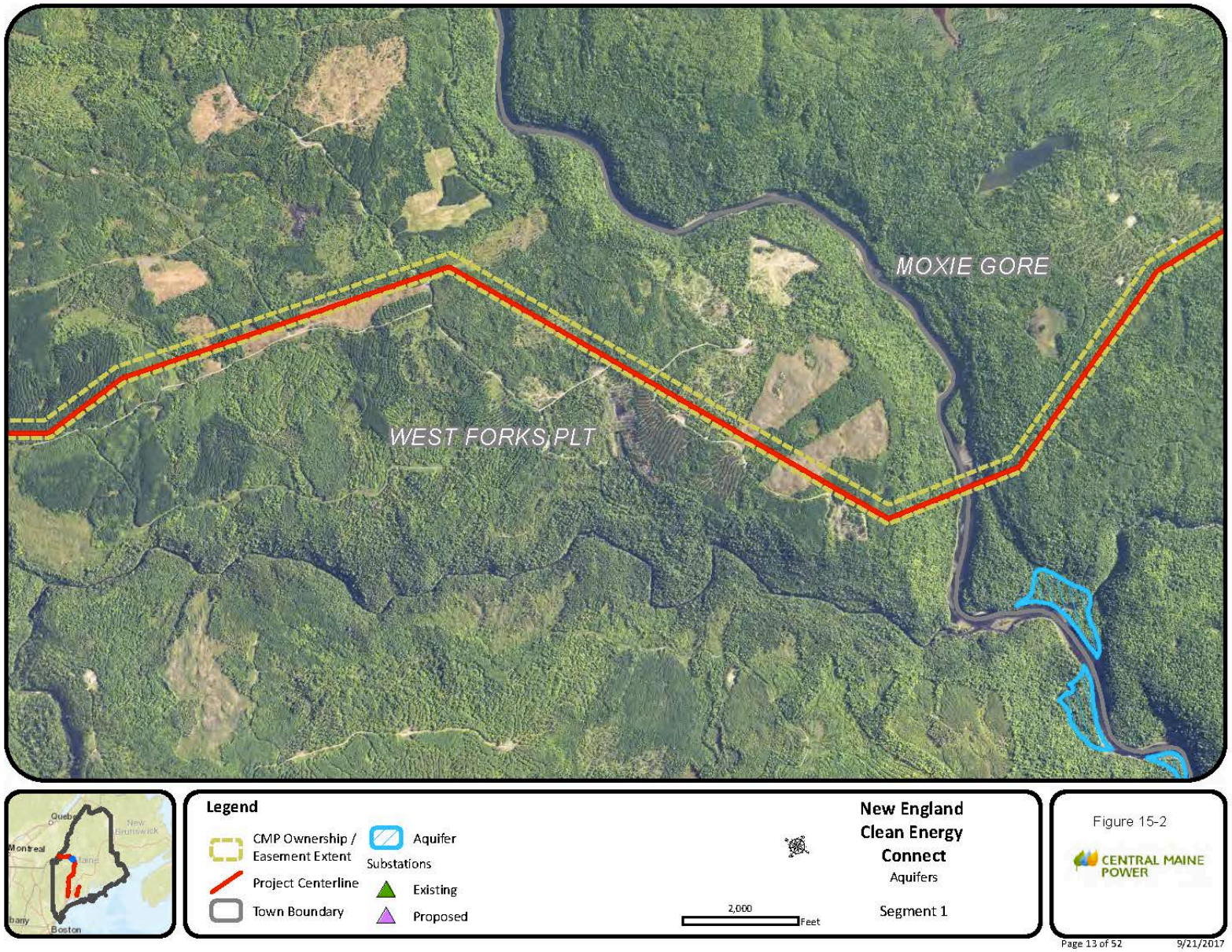
On land the drilling fluid shall be collected into a sump and removed by pumping or vacuuming. Repeated flushes with clean potable water shall be used to remove drilling fluid from vegetation. The Plan will outline the procedures necessary for stabilizing and restoring all disturbed areas to pre-existing conditions.

15.0 GROUNDWATER

The HDD development area does not traverse sole source or significant sand and gravel aquifers. However, an aquifer exists approximately 1,800 feet southwest of the HDD crossing (see Figure 15.1).

The HDD process will not require the use of groundwater from aquifers, so there will be no impact to groundwater quantity.

As referenced in Section 14.0 above, the HDD process uses a drilling fluid which is comprised of mostly water with the addition of naturally occurring clay called sodium montmorillonite (bentonite). Bentonite is a non-toxic, non-reactive, inert material that allows the HDD contractor to monitor and adjust the viscosity of the drilling fluid to achieve the desired carrying and lubricating properties. The HDD contractor will only use fluid with a composition which complies with all federal, state, and local environmental regulations. To further minimize the potential for adverse water quality impacts from the HDD process a licensed landfill or off-site facility will receive the cuttings, spoils, and excess drilling fluid. CMP will ensure that the disposal of all drilling fluids is done in a manner that is in compliance with all permits, and applicable federal, state, and local regulations. As a result, there will be no impact to groundwater quality resulting from the HDD installation of the transmission line.


MOXIE GORE
WEST FORKS PLT
Legend
CMP Ownership / Easement Extent
Project Centerline
Town Boundary
Aquifer
Substations
Existing
Proposed
2,000
Feet
New England Clean Energy Connect
Aquifers
Segment 1
Figure 15-2
CENTRAL MAINE POWER
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9/21/2017

16.0 WATER SUPPLY

300,000 to 400,000 gallons of water will be required to complete the proposed HDD bore. Over the course of a typical day of HDD operations, it is anticipated that 4,000 to 10,000 gallons of water will be required. Due to the elevation gain and distance from the river, it will not be practical to pump the necessary water out of the Kennebec River. The most effective means for obtaining water will be to pump the water out of another nearby body of water and haul it to the HDD work site. Typical small water tank trucks can haul between 2,000 and 4,000 gallons per trip, so it will be feasible to support the water needed by trucking. In accordance with MDEP regulations, for Class A, B, & C waters, there are no restrictions on withdrawal as long as water quality are flows are maintained (Chapter 587 (5 A-C)). For great ponds, water levels cannot be lowered by more than 1 foot between April and July, and by more than 2 feet between August and March (Chapter 587 (6A 1-3)). The HDD contractor will develop a detailed plan which will comply with these and all other regulatory requirements. The contractor's detailed plan will also address any reporting requirements, which vary depending on pumping method, quantity obtained, location of withdrawal, etc. See 38 M.R.S. § 470-B

17.0 WASTEWATER DISPOSAL

No wastewater facilities or wastewater holding tanks are proposed at the Moxie Gore and West Forks Termination Stations. Dewatering associated with the HDD installation will be completed as described in Section 14.0 Basic Standards Submissions.

18.0 SOLID WASTE

A system will be established to retain, process, and recirculate drilling fluids throughout HDD activities. Cuttings from the boring will be removed from the drilling fluid through gravity separation, cyclonic separation, or with a shaker table. The cuttings will be temporarily stored on site in a cutting pit, or a dumpster. The cuttings will be removed from site and disposed of at an approved location. About 1,000 cubic yards of drilling spoils will be generated for appropriate disposal. The State of Maine does not regulate uncontaminated soil, rock, or water.

However, the addition of bentonite results in the drill mud being classified as a solid waste material. Typically, the disposal of this inert material outside of a certified solid waste disposal facility is acceptable, however MDEP may require testing of the material to confirm it is not hazardous before removal from site can occur.

19.0 FLOODING

There are no Federal Emergency Management Agency ("FEMA") mapped 100-year flood zones within the HDD and termination station development areas. Additionally, according to the Land Use Planning Commission ("LUPC") zoning maps, the HDD drilling pad and termination stations on both the east and west sides of the river are not located in a Flood Prone Protection (P-FP) subdistrict. Therefore, the installation of transmission line structures will not directly impact or increase the risk of flooding along the proposed Project route.

20.0 BLASTING

Blasting, if required, will follow the requirements specified in Section 20.0 of CMP's September 27, 2017 Site Law application, further supplemented by CMP's September 6, 2018 response to the MDEP's review memorandum generated by John Hopeck, Ph.D (Division of Environmental Assessment) dated July 31, 2018.

21.0 AIR EMISSIONS

The termination stations will have no air emission producing equipment.

22.0 ODORS

The clearing, construction, maintenance, and operation of the NECEC Project will not result in or create significant odors. Limited and short-term odors may be caused as a result of tree harvesting and the operation of construction equipment.

23.0 WATER VAPOR

The HDD installation and the construction, operation, and maintenance of the termination stations will not generate water vapor. Therefore, the Project will not alter the existing cloud cover or rainfall characteristics of the area.

24.0 SUNLIGHT

The HDD installation and the construction of the termination stations will not block access to direct sunlight for any adjacent buildings that may utilize solar energy through active or passive solar systems. Based on the dispersed and minor nature of termination station equipment, there is no potential for shading of adjacent properties or structures.

25.0 LUPC CERTIFICATION

25.1 Introduction

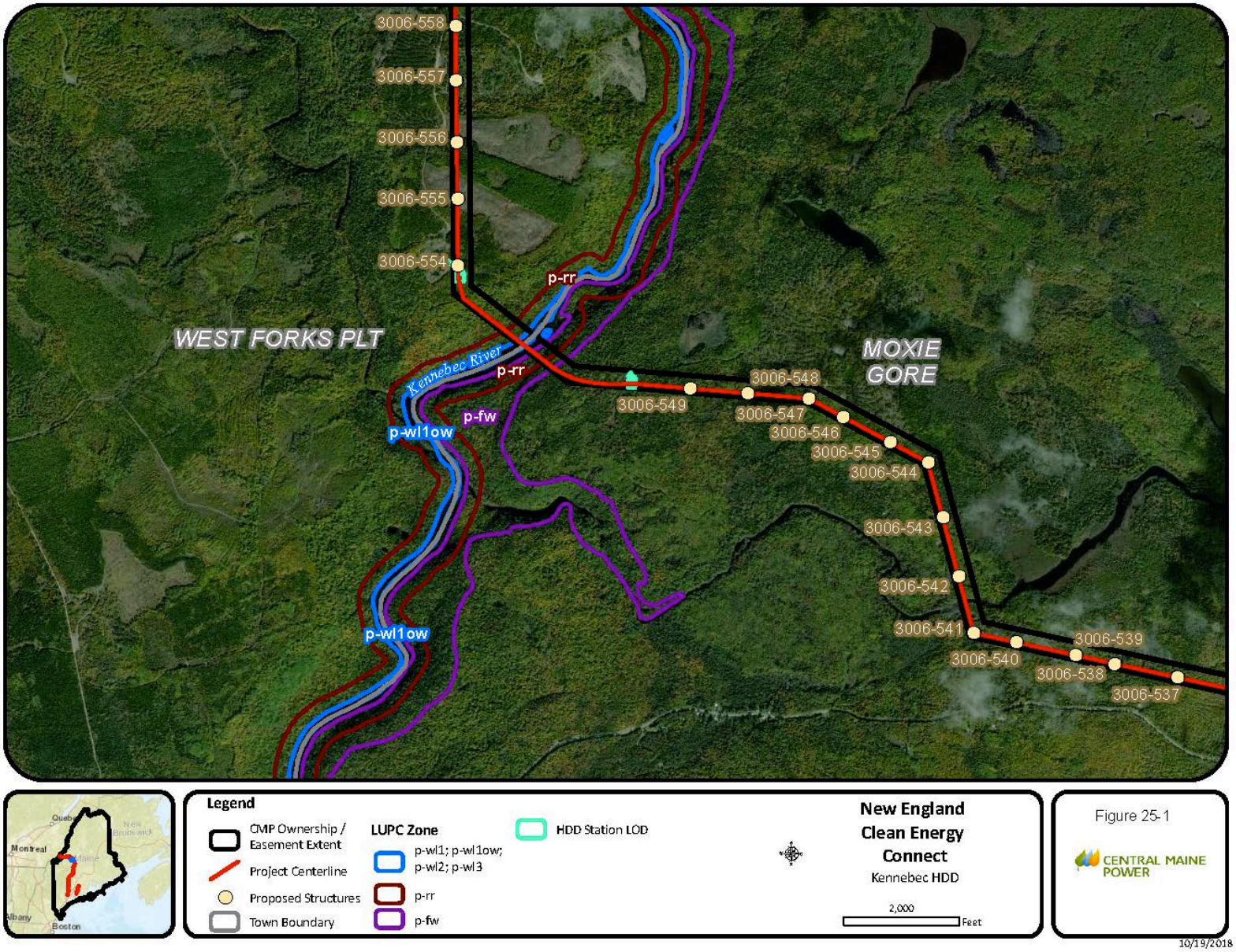
The LUPC Certification section of CMP's September 27, 2017 Site Law application demonstrated that the NECEC Project is an allowed use in the subdistricts for which it is proposed, and that the Project complies with all applicable LUPC land use standards not considered by MDEP in its review of the Project. CMP has now determined that an HDD underground crossing of the Kennebec River would avoid recreational and visual impacts, adverse or otherwise, and is financially practicable. The discussion provided herein is specific to the HDD installation beneath the Kennebec River and associated termination stations proposed on each side of the Upper Kennebec River in Moxie Gore and the West Forks Plt. The information provided below updates Section 25 of the September 27, 2017 Site Law application specific to the proposed underground crossing using HDD technology. Section 2.4.1 *et seq.* of the September 27, 2017 NRPA application, which references the information in Section 25 of the Site Law application, is being concurrently amended in the NRPA application amendment.

25.2 Project Description

Section 1.0 of this application amendment includes a detailed description of the HDD and termination station project modifications. Permanent access will be attained by using existing land management roads on both sides of the river. These roads will require modifications and upgrades to accommodate construction equipment and maintenance vehicles. A short section of permanent gravel road will be constructed at both termination stations, extending the existing land management roads by approximately 156 feet and 728 feet at the Moxie Gore and West Forks termination stations, respectively. See Section 25.4.3 for more information regarding vehicular access.

25.3 LUPC Zoning Compliance

The HDD drilling and receiving platforms and the termination station development areas on both the Moxie Gore and West Forks Plt sides of the river are located within CMP's 300-foot-wide corridor in the General Management (M-GN) subdistrict. As a result of the HDD bore, the HVDC transmission line will pass underground beneath the Fish and Wildlife Protection (P-FW), Wetland Protection (P-WL1), and Recreation Protection (P-RR) subdistricts at the Kennebec River (see Figure 25-1). Although the underground crossing will be below, and therefore not within, these subdistricts, the HDD crossing nonetheless will satisfy LUPC's special exception criteria, as discussed below.


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p-rr
WEST FORKS PLT
Kennebec River
p-rr
p-fw
p-wl1ow
MOXIE GORE
3006-548
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p-wl1ow
Legend
CMP Ownership / Easement Extent
Project Centerline
Proposed Structures
Town Boundary
LUPC Zone
p-wl1; p-wl1ow; p-wl2; p-wl3
p-rr
p-fw
HDD Station LOD
New England Clean Energy Connect
Kennebec HDD
2,000
Feet
Figure 25-1
CENTRAL MAINE POWER
10/19/2018

Utility facilities such as the HVDC transmission line is an allowed use in each of these subdistricts, including those that require special exceptions for utility facilities, i.e., the P-RR and P-WL subdistricts. LUPC Ch. 10.23,I,3,d(8) and 10.23,N,3,d(9); *see also* LUPC Ch. 10.23,I,3,f and 10.23,N,3,f ("All uses not expressly allowed, with or without a permit or by special exception, shall be prohibited in P-RR subdistricts.").

The special exception criteria require the applicant to show that: a) there is no alternative site which is both suitable to the proposed use and reasonably available to the applicant; b) the use can be buffered from those other uses or resources within the subdistrict with which it is incompatible; and c) such other conditions are met that the Commission may reasonably impose in accordance with the policies of the Comprehensive Land Use Plan.

25.3.1 P-RR Subdistricts

P-RR subdistricts are those areas identified by the LUPC that provide or support unusually significant primitive recreation opportunities.

25.3.1.1 Upper Kennebec River

The Project corridor crosses the P-RR subdistrict associated with the Upper Kennebec River in West Forks Plt and Moxie Gore. The P-RR subdistrict extends 250 feet from the normal high-water mark on both sides of the river. The transmission line within an HDD crossing would be entirely underground as it passes below (and therefore not within) the P-RR subdistrict. The termination stations on either side of the river are located outside of the P-RR subdistrict. The purpose of the P-RR subdistrict is to provide protection from development and intensive recreational uses to those areas that currently support, or have opportunities for, unusually significant primitive recreation activities. The HDD installation and the development of the termination stations will not be visible from the P-RR subdistrict and therefore visual impacts to recreational users will be avoided. An underground crossing of the Upper Kennebec River would have no impact on the P-RR subdistrict or its intended purpose.

As discussed in CMP's September 27, 2017 application and as supplemented with this application amendment, there is no alternative site which is both suitable for the proposed (transmission line) use and reasonably available to the applicant. Further analysis of construction feasibility, operational and maintenance considerations, total project cost, and visual and recreational impact of the Underground Transmission Alternative described in the September 27, 2017 application have resulted in the conclusion that an HDD crossing beneath the Upper Kennebec River is both suitable and reasonably available to

CMP. Conversely, based on that analysis, the previous Preferred Alternative (an overhead transmission line), is no longer suitable for the crossing of the P-RR because it would have greater impacts than the HDD crossing. As described in the September 27, 2017 application, overhead conductors would be visible to rafters passing through or stopping in this portion of the river, and views of the transmission line structures would occur on the west side of the river with the overhead crossing. This will not occur with the HDD crossing.

Nor are the CMP Land Alternative or the Brookfield Alternative suitable or reasonably available, for the reasons stated in the September 27, 2017 application. Accordingly, no reasonable alternative to the HDD crossing exists which would have less adverse effect upon the natural and recreational features of this segment of the Kennebec River. 38 M.R.S. § 480-D(8).

In addition, the siting of the HDD installation and termination stations will result in maintained forest on both sides of the river and therefore will be buffered from those uses or resources within the subdistrict with which it is incompatible. The HDD crossing increases the forested buffers on both the east and west sides of the Upper Kennebec River beyond what was proposed for the overhead crossing, thereby avoiding visibility of the Project by recreational users on the river (see discussion in Section 6.0).

25.3.2 P-WL Subdistrict

P-WL subdistricts in the NECEC Project area are those areas contained within the normal high-water mark of flowing waters and bodies of standing water and freshwater wetlands. The purpose of the P-WL subdistrict is to conserve wetlands in essentially their natural state because of the indispensable biologic, hydrologic, and environmental functions they perform.

As discussed previously, the HDD installation will result in an underground crossing of the Upper Kennebec River. As a result, impacts to the P-WL subdistrict at the river will be avoided. There are no LUPC mapped P-WL subdistricts within the HDD installation work areas or the termination stations.

25.3.3 P-FW Subdistrict

Utility facilities are an allowed use in the P-FW subdistrict with a permit from the LUPC. Similar to the P-RR and P-WL subdistricts, the transmission line will pass beneath the P-FW subdistrict at the Upper Kennebec River crossing.

25.4 Applicable LUPC Land Use Standards

The LUPC established standards applicable to the Project, but not considered as part of MDEP's application review, include:

1. Land Division History, as required by the LUPC definition of subdivision, § 10.24,F
2. Dimensional Requirements, § 10.26
3. Vehicular Access, Circulation and Parking, § 10.24,B and § 10.25,D
4. Lighting, § 10.25,F
5. Activities in Flood Prone Areas, § 10.25,T
6. Vegetation Clearing, § 10.27,B
7. Signs, § 10.27,J

25.4.1 Land Division History

CMP has obtained title, right, or interest to all parcels required for the project in LUPC jurisdiction. The original application provided a 20-year land division history prepared by Curtis Thaxter, LLC, and associated maps demonstrating that none of the land divisions during that period created a subdivision.

25.4.2 Dimensional Requirements

The LUPC dimensional standards are contained in §10.26 of the Commission's Rules. Dimensional requirements for lot size (§10.26,A), shoreline frontage (§10.26,B), road frontage (§10.26,C), and lot coverage (§10.26,E) apply only to uses involving buildings. Infrastructure within the termination stations will include only electric components and overhead wires (see Attachment 1). There are no buildings or structures with floor area proposed within the termination stations, therefore the dimensional requirements for lot size, shoreline frontage, road frontage, and lot coverage do not apply to the development associated with HDD.

The dimensional requirements for minimum setbacks (§10.26,D) and maximum structure height (§10.26,F), applicable to the Project, are discussed below:

D. Minimum Setbacks: Section 10.26,D(2) states that the minimum setback for commercial or industrial development is 100 feet from minor flowing waters, P-WL1 wetlands, and waterbodies less than 10 acres. The setbacks from waterbodies greater than 10 acres and major flowing waters is 150 feet in all locations. Section 10.26,D(3) states that project components must be set back 75 feet from traveled portions of roads used by the public for access; and 25 feet from side and rear property boundary lines. The termination stations will be positioned outside of the setback requirements. In addition, an exception may be made to the shoreline, road, and/or property line setback requirements for structures where the

Commission finds that such structures must be located near to the shoreline, road, or property line due to the nature of their use. LUPC § 10.26,G(5).

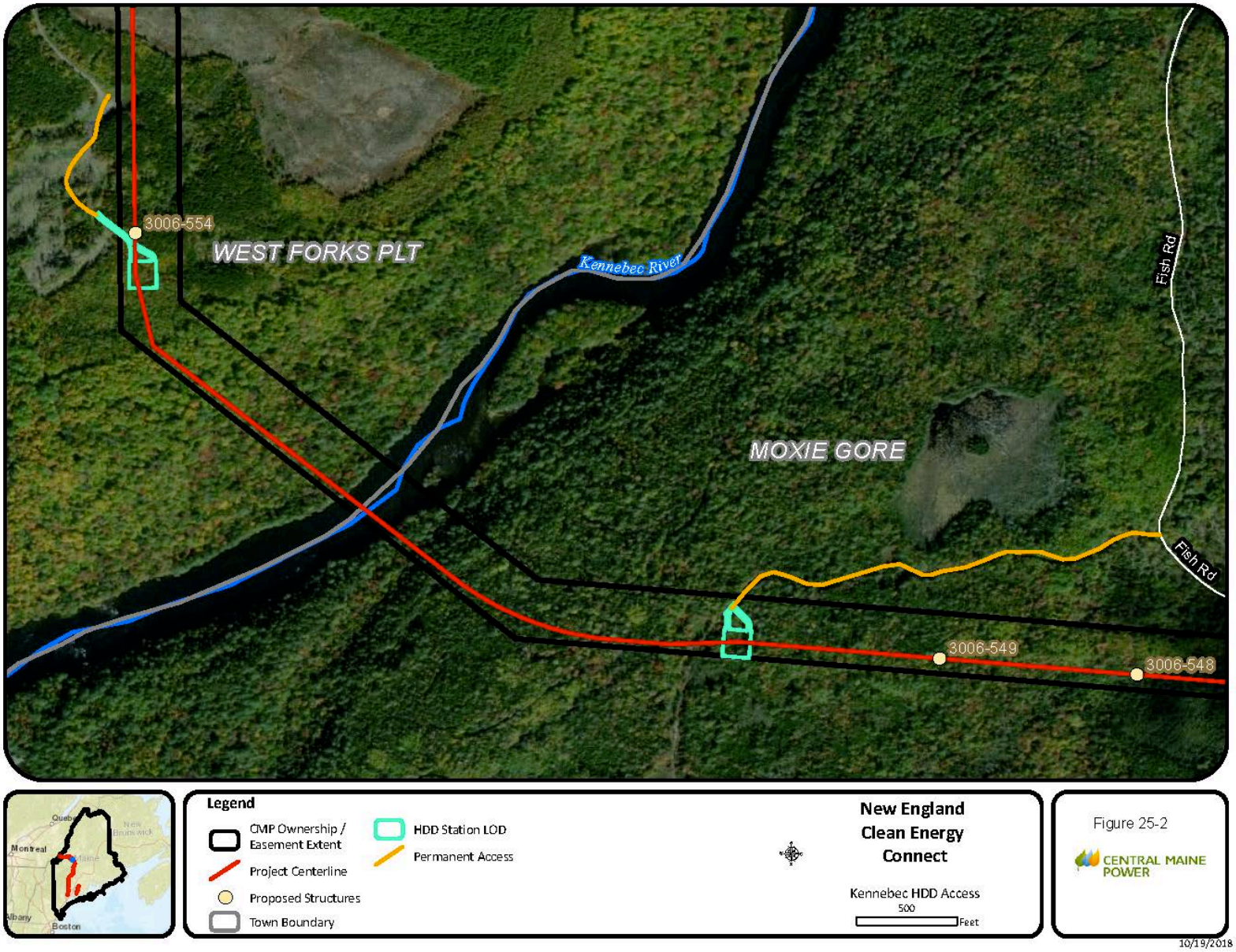
F. Maximum Structure Height: Section 10.26,F(2) states that the maximum structure height is 100 feet for commercial, industrial, and other non-residential uses involving one or more structures. Infrastructure within the termination stations will be no taller than 100 feet.

25.4.3 Vehicular Access, Circulation, and Parking

Section 10.24,B and Section 10.25,D pertain to the standards for vehicle access, parking, and general circulation. See also 12 M.R.S. § 685-B(4)(B).

Since the termination stations are unmanned, vehicular traffic would only be needed during construction (short-term) and maintenance (infrequent), and, as such, the operation of these facilities will not generate a significant amount of traffic. Existing land management roads (e.g., logging roads) will be upgraded and modified (e.g., widened) where needed and extended to the corridor. The existing land management road on the east and west sides of the river will need to be extended approximately 156 feet and 728 feet to gain access to the Moxie Gore and West Forks termination stations, respectively (see Figure 25-2).

Temporary access roads through sections of the new transmission line corridor will need to be established for the clearing and construction phases associated with the HDD and the construction of the termination stations. However, these access roads will be restored to pre-existing contours and revegetated once construction is complete and final restoration has been established. Project construction and maintenance related parking would primarily be in upland locations on the Project corridor or in existing developed areas. The termination stations are unmanned but will require operations visits on a bi-monthly inspection cycle, unless there is an emergency or if electrical switching is needed. Approximately 2-3 vehicles would be parked outside of the termination station during these visits. CMP will meet the vehicular circulation, access, and parking requirements of 10.25(D).


3006-554
WEST FORKS PLT
Kennebec River
Fish Rd
MOXIE GORE
Fish Rd
3006-549
3006-548
Legend
CMP Ownership / Easement Extent
Project Centerline
Proposed Structures
Town Boundary
HDD Station LOD
Permanent Access
New England Clean Energy Connect
Kennebec HDD Access
500
Feet
Figure 25-2
CENTRAL MAINE POWER
10/19/2018

25.4.4 Noise and Lighting

Section 10.25,F pertains to noise and lighting standards. Noise falls under MDEP jurisdiction, while lighting will be evaluated by LUPC.

There will be no station service or permanent lighting at the termination stations. Temporary nighttime lighting will be necessary throughout the HDD installation process. During operation and maintenance activities, work technicians will use portable lighting, as needed.

25.4.5 FEMA Standards

Section 10.25,T outlines the procedural requirements and development standards when conducting development activity in flood prone areas, including areas of special flood hazard, as identified by Flood Prone Protection (P-FP) subdistricts or Federal Emergency Management Agency ("FEMA") Flood Boundary and Floodway, Flood Hazard Boundary, or Flood Insurance Rate Maps ("FIRM").

Based on LUPC zoning maps, the HDD drilling and receiving platforms and termination stations on both the east and west sides of the river are located in the M-GN subdistrict. There are no P-FP subdistricts or FEMA identified flood hazards in the area. Therefore, the installation of transmission line structures will not impact or increase the risk of flooding along the proposed Project route.

25.4.6 Vegetation Clearing

Clearing widths within the 300-foot-wide corridor needed for the HDD installation of the underground conduit and termination stations vary; however, overall tree clearing as a result of the proposed modification will be reduced by approximately 7.16 acres. As a result, the vegetated buffers on the Upper Kennebec River will be expanded from 300 feet and 500 feet on the east and west sides to 1,450 feet and 1,160 feet, respectively.

Section 10.27,B pertains to the standards and requirements for vegetation clearing for any purpose other than road construction, wildlife management, forest management, agricultural management, and public trailered ramps or hand-carry launches. The MDEP applies clearing standards in NRPA resource areas and LUPC applies clearing standards in other areas.

Vegetation clearing activities not in conformance with the standards of Section 10.27,B may be allowed upon issuance of a permit from the Commission provided that such types of activities are allowed in the subdistrict involved. As stated previously, the Project is an allowed use in all subdistricts including those

allowed by special exception. Due to the nature of the Project, the buffer strips identified in LUPC Section 10.27,B will be retained but the Project cannot conform to the selective cutting requirements associated with the maintenance of vegetation (§10.27,B,2). The Project will maintain vegetative buffers in all scenarios but these buffers will not include capable vegetation that could grow to heights which would impede the conductor safety zone of the transmission line. Based on CMP's experience with its vegetation management plan, and based on the proposed compensation plan, vegetation clearing within the corridor will produce no undue adverse impact upon the resources and uses in the area.

25.4.7 Signs

Section 10.27, J pertains to the standards of any signs. Signage will be installed at the termination stations on the outside of the fence and gate panels in accordance with National Electric Safety Code requirements. The following signage will be required:

- A safety sign will be displayed at each entrance and on each side of the fenced enclosure.
- A standard "DANGER HIGH VOLTAGE" sign will be placed at each termination station main and secondary gate panel per gate location as well as within 10 feet from each side of each fence corner, and not more than 50 feet apart along the fence line.
- A standard "CAUTION ENERGIZED LINES OVERHEAD" sign will be placed at each termination station main and secondary gate panel.
- A standard "Substation Information" sign will be placed at each termination station main and secondary gate panel containing the Company's name, name of the termination station and emergency contact information.

This signage is consistent with the exemption for signs displayed for the direction, instruction, or convenience of the public, such as precautionary signs, and thus do not require a permit. Section 10.27,J(1)(e).

Traffic control signs and directional signs related to project construction will be limited and temporary; this signage does not require a permit from the LUPC, provided such signs are in conformance with the requirements of Section 10.27,J(1) and (2).

26.0 NOTICES

No public notices are required as a result of the submittal of application amendment materials. As required by DEP Ch. 3, Section 3(E), copies of this amendment application will be served on all parties and filed with the appropriate town or city clerks and with the county commissioners.

27.0 PROJECT PLANS

- Attachment 1- HDD and Termination Station Plans (attached)
- Attachment 2- Natural Resource Maps (Submitted with October 19, 2018 Supplemental Application Materials)
- Attachment 3- Aquifer Maps (no update necessary)
- Attachment 4- Floodplain and Soil Series Maps (no update necessary)
- Attachment 5- USGS Location Maps (no update necessary)
- Attachment 6- Significant Vernal Pool Location Maps (no update necessary)

REFERENCES

Clement, Christopher, Bertrand Pelletier, Jennifer Ort, and Jacob Freedman. 2018a. New England Clean Energy Connect Archaeological Reconnaissance Survey: Androscoggin, Cumberland, Franklin, Lincoln, Sagadahoc, Somerset, and Kennebec Counties, Maine. Report prepared for Central Maine Power Company, Augusta, ME.

Clement, Christopher, Robert Ingraham, Jacob Freedman, Jennifer Ort, Michael Hambacher, Bertrand Pelletier, Jessica Barnett, Kelly Hockersmith, and Meghan Mooney. 2018b. New England Clean Energy Connect Phase I Archaeological Survey: Androscoggin, Cumberland, Franklin, Lincoln, Sagadahoc, Somerset, and Kennebec Counties, Maine. Report prepared for Central Maine Power Company, Augusta, ME.

Dunham, Jenna, Maureen Bowman, Laurel Bartlett, Chad Blackwell, Liz Blackwell, Lauren Poche, Pamela Kendrick, Nick Linville, Tricia Peone, and Angelique Theriot. 2018. Revised Above Ground Historic Resources Identification Survey, NRHP Evaluation, and Finding of Effects Report New England Clean Energy Connect Androscoggin, Cumberland, Franklin, Lincoln, Sagadahoc, Somerset, and Kennebec Counties, Maine. Report prepared for Central Maine Power Company, Augusta, ME.

Freedman, Jacob A., Jenna Dunham, Jessica Fish, Tricia Peone, Robert Ingraham, Christopher Clement, and Jennifer Ort. 2017. New England Clean Energy Connect Cultural Resources Sensitivity Assessment and Scope of Work for Reconnaissance Surveys Androscoggin, Cumberland, Franklin, Lincoln, Sagadahoc, Somerset, and Kennebec Counties, Maine. Report prepared for Central Maine Power Company, Augusta, ME.

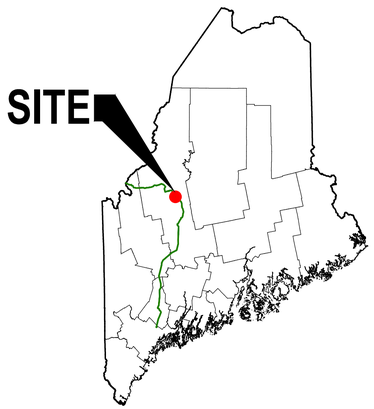
U.S. Fish & Wildlife Service (USFWS). Northern Long-eared Bat as Threatened Questions and Answers. Electronic document: https://www.fws.gov/midwest/endangered/mammals/nleb/FAQsFinalListNLEB.html. Accessed July 19, 2017.

ATTACHMENT 1: HDD and Termination Station Plans

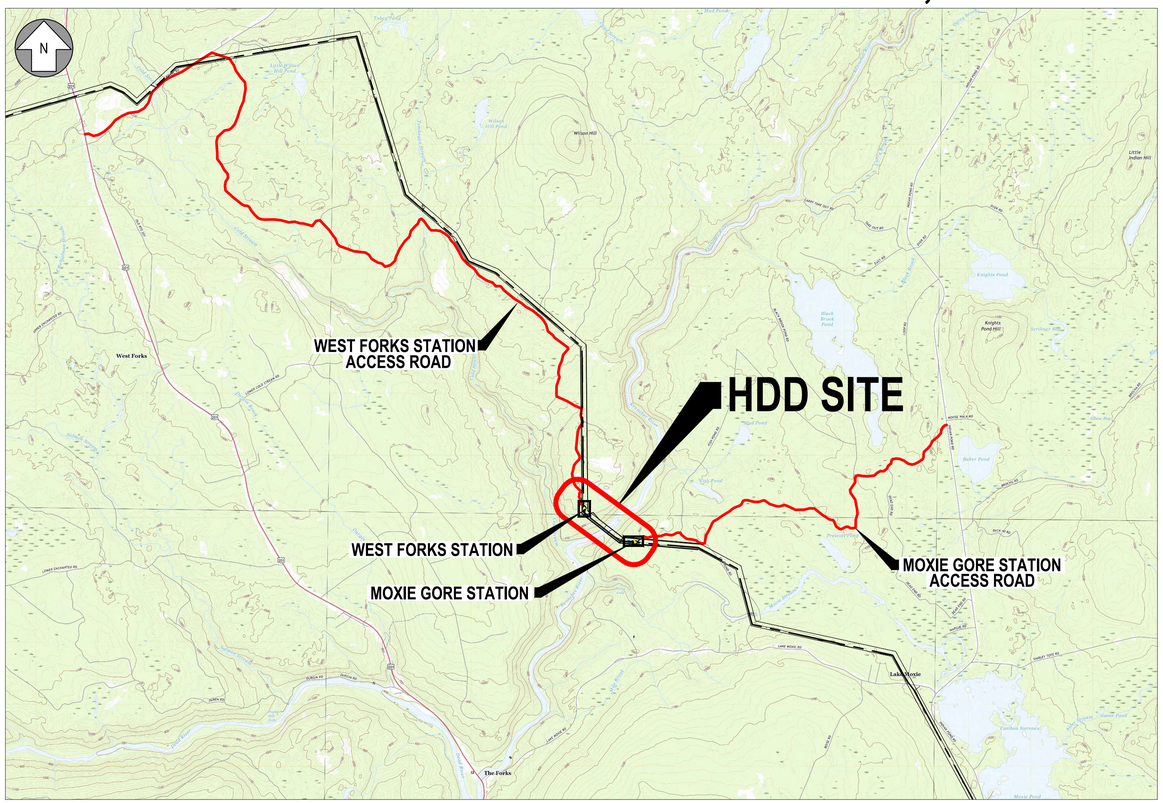
PERMITTING PLAN SET

NECEC KENNEBEC RIVER UNDERGROUND CABLE & HDD

SOMERSET COUNTY
WEST FORKS PLANTATION & MOXIE GORE, MAINE



STATE OF MAINE



LOCATION MAP
SCALE: 1"=4000'

DRAWING INDEX

G-1	COVER SHEET & DRAWING INDEX
G-2	GENERAL NOTES, LEGEND & VICINITY MAP
C-1	HDD CROSSING (STA 0+00 TO 20+50) PLAN & PROFILE
C-2	HDD CROSSING (STA 20+50 TO 36+00) PLAN & PROFILE
C-3	GRADING & RESTORATION PLAN – MOXIE GORE
C-4	GRADING & RESTORATION PLAN – WEST FORKS
C-5	CROSS SECTIONS AND HDD DETAILS 1
C-6	CROSS SECTIONS AND HDD DETAILS 2
C-7	EROSION CONTROL NOTES & DETAILS 1
C-8	EROSION CONTROL NOTES & DETAILS 2
SW-1	PRE-DEVELOPMENT WATERSHED PLAN - WEST FORKS
SW-2	POST-DEVELOPMENT WATERSHED PLAN - WEST FORKS
SW-3	PRE-DEVELOPMENT WATERSHED PLAN - MOXIE GORE
SW-4	POST-DEVELOPMENT WATERSHED PLAN - MOXIE GORE

PREPARED FOR:

AVANGRID

CENTRAL MAINE POWER CO.

83 EDISON DRIVE
AUGUSTA, ME 04336

PREPARED BY:

TRC

249 WESTERN AVENUE
AUGUSTA, ME 04330

811 DigSafe MA·ME·NH·RI·VT

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10/17/2018

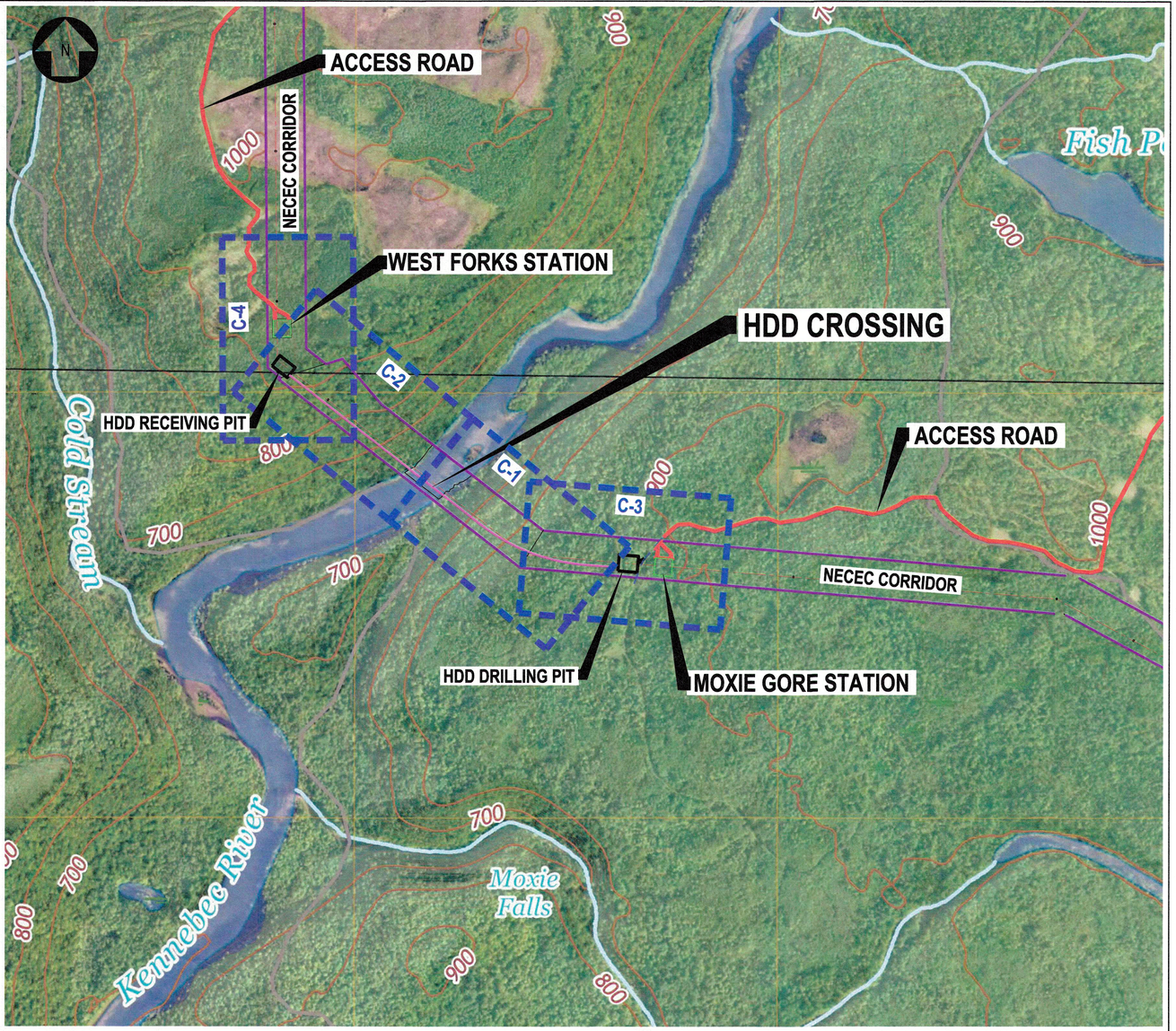
315641-G-1

GENERAL NOTES

1. SURVEY BOUNDARY DATA PROVIDED BY:
   SGC ENGINEERING, INC – "KENNEBEC RIVER GORGE" DATED 9-23-10
   DIRIGO PARTNERS, LTD – "WEYCO SURVEY" DATED 12-06-16
2. TOPOGRAPHIC LIDAR DATA PROVIDED BY CMP DATED SEPTEMBER 2018.
3. PROJECT PROJECTION: NAD83 UTM ZONE – 19 U.S FEET.
4. VERTICAL DATUM: NAVD 88 MEASURED IN U.S. FEET.
5. MEDIUM INTENSITY SOILS INFORMATION OBTAINED FROM WEB SOIL SURVEY OF SOMERSET COUNTY, ME.

LEGEND

EXISTING		PROPOSED
	PROPERTY/ROW LINE	
	SETBACK LINE	
	EASEMENT LINE	
	CENTERLINE	
	EDGE OF PAVEMENT	
	CURBING	
	EDGE OF GRAVEL	
	EDGE OF CONCRETE	
	SUBSTATION YARD	
	SUBSTATION BASELINE	
122	CONTOUR	122
	BUILDING	
	STONEWALL	
	TREELINE	
	CHAIN LINK FENCE	
	STOCKADE FENCE	
	BARB WIRE FENCE	
	RETAINING WALL	
	GUARDRAIL	
S	SEWER	S
FM	SEWER FORCE MAIN	FM
G	GAS	G
W	WATER	W
SD	STORM DRAIN	SD
UD	UNDERDRAIN	UD
12" CMP	CULVERT	12" CMP
UGE	UNDERGROUND ELECTRIC	UGE
	OVERHEAD TRANSMISSION	
○	IRON PIPE/REBAR	●
□	MONUMENT	■
△	SURVEY CONTROL POINT	
x124.6	SPOT ELEVATION	x122.50
Ⓢ	SEWER MANHOLE	●
Ⓓ	DRAINAGE MANHOLE	●
▥	CATCH BASIN	■
Ⓔ	ELECTRIC MANHOLE	●
⋈	SHUTOFF VALVE	⋈
⊹	HYDRANT	⊹
○	UTILITY POLE	●
☼	LIGHT POLE	✶
	MATCHLINE	
	LIMIT OF WORK	
	SILT FENCE	SF
	RIPRAP	
	EDGE OF WATER	
	STREAM	
	EDGE OF WETLANDS	
	WETLANDS	
	DRAINAGE FLOW	
	DRAINAGE SWALE	
	SIGN	
	SOIL BORING	



VICINITY MAP & SITE PLAN DRAWING INDEX
SCALE: 1"=500'

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INSTALL

REV	DESCRIPTION	DATE	BY	CK	APP
B	IFP - ISSUED FOR PERMITTING	10/17/2018	KAV	PGT	SGL
A	IFR - ISSUE FOR REVIEW	10/05/2018	KAV	PGT	SGL

PE STAMP: STATE OF MAINE, TICKY A. YOUNG, No. 15422, LICENSED PROFESSIONAL ENGINEER, October 19, 2018

AVANGRID ENGINEERING
CONFIDENTIAL, PROPRIETARY and TRADE SECRET INFORMATION
Property of AVANGRID

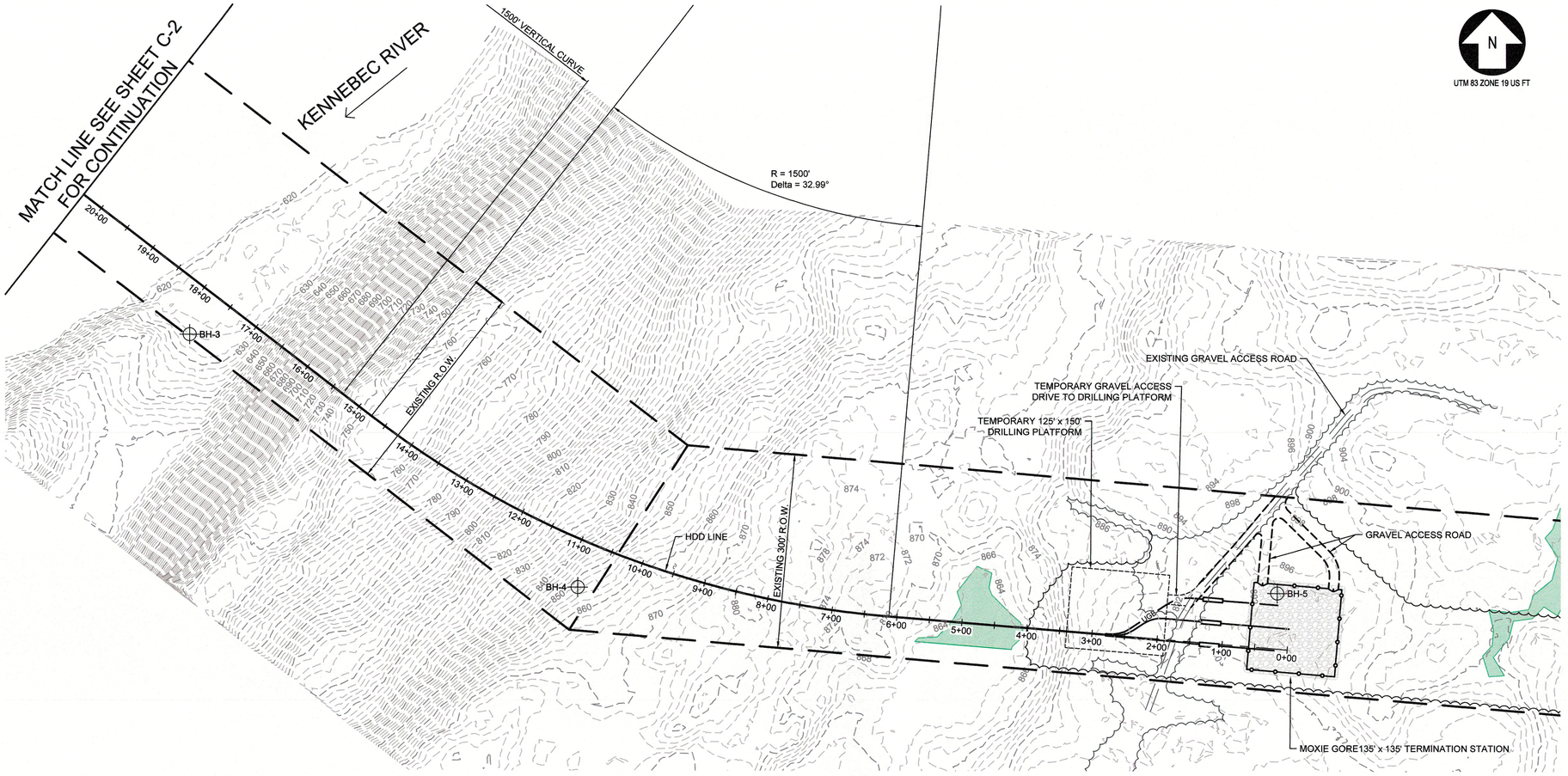
CMP AVANGRID

GENERAL NOTES, LEGEND & VICINITY MAP

NECEC HVDC LINE — MOXIE GORE & WEST FORKS, ME

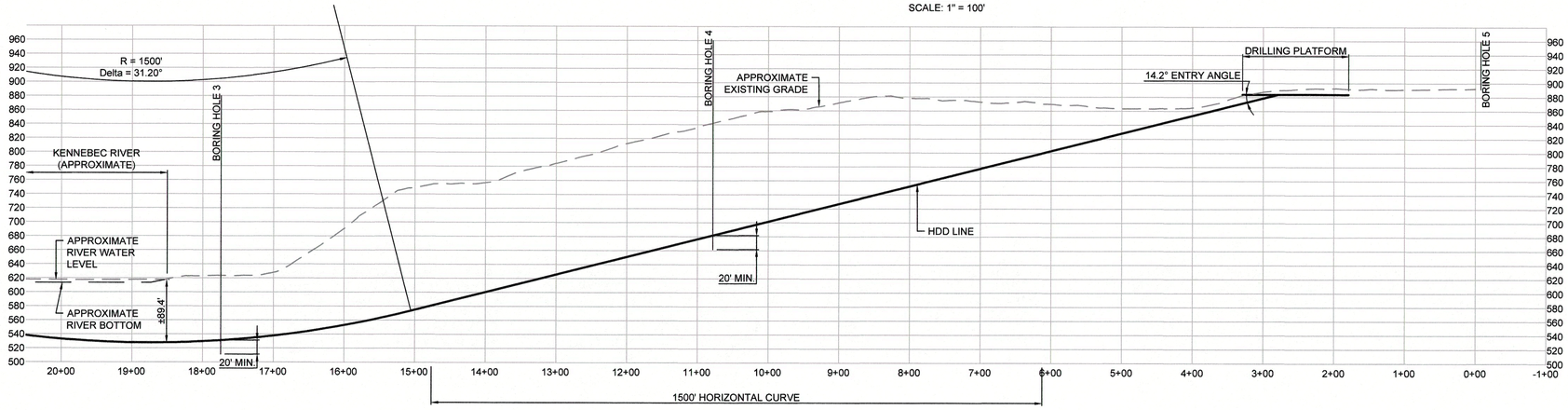
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APP	SGL/TRC	315641-G-2	0-0B
DATE	10/05/2018		

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INFO: TRC, 249 WESTERN AVENUE, AUGUSTA, MAINE, 207-621-7000
ANSI D 10/17/2018



PLAN

SCALE: 1" = 100'



PROFILE

SCALE: HORZ. 1" = 100'
VERT. 1" = 100'

100 0 100 200 FT

SCALE: 1" = 100'

UTM 83 ZONE 19 US FT

SYMBOL LEGEND

SYMBOL	DESCRIPTION
	HDD LINE
UGE	UNDERGROUND ELECTRIC LINE
	TERMINATION STATION FENCE
	ACCESS ROAD
	UNDERGROUND ELECTRIC VAULT
	TEMPORARY WORK PLATFORM
	TEMPORARY ACCESS ROAD
	EXISTING RIGHT OF WAY LINE
	WETLANDS
	STONE PAD
	EXISTING TREE LINE
	LIMIT OF CLEARING
BH-0	PROPOSED BORE HOLE LOCATION

REV	DESCRIPTION	DATE	BY	CK	APP
B.	IFP: ISSUED FOR PERMITTING	10/1/2018	DED	PGT	SGL
A.	IFR: ISSUE FOR REVIEW	10/5/2018	KAV	PGT	SGL

TRC
249 WESTERN AVENUE
AUGUSTA, MAINE 04330
207-621-8000
PROJECT NO:315641

LOCO INFO

ANSI D 10/19/2018

PE STAMP
STATE OF MAINE
RICKY A. YOUNG
No. 6422
LICENSED PROFESSIONAL ENGINEER
Oct. 19, 2018

AVANGRID ENGINEERING
CONFIDENTIAL, PROPRIETARY and TRADE SECRET INFORMATION
Property of AVANGRID

CMP AVANGRID

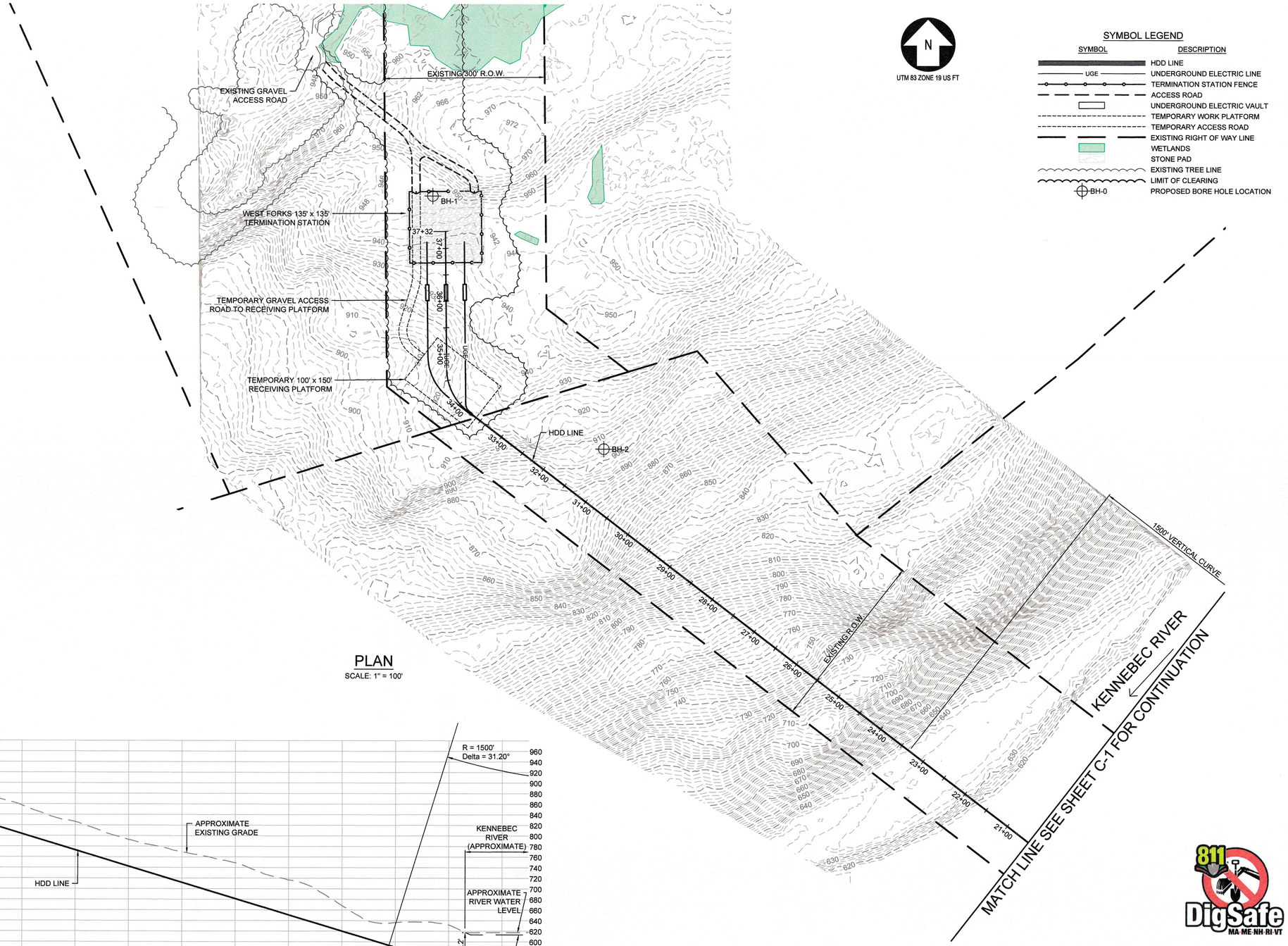
INSTALL
HDD CROSSING (STA 0+00 TO 20+50) PLAN & PROFILE

NECEC HVDC LINE — MOXIE GORE & WEST FORKS, ME

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DATE	10/05/2018		

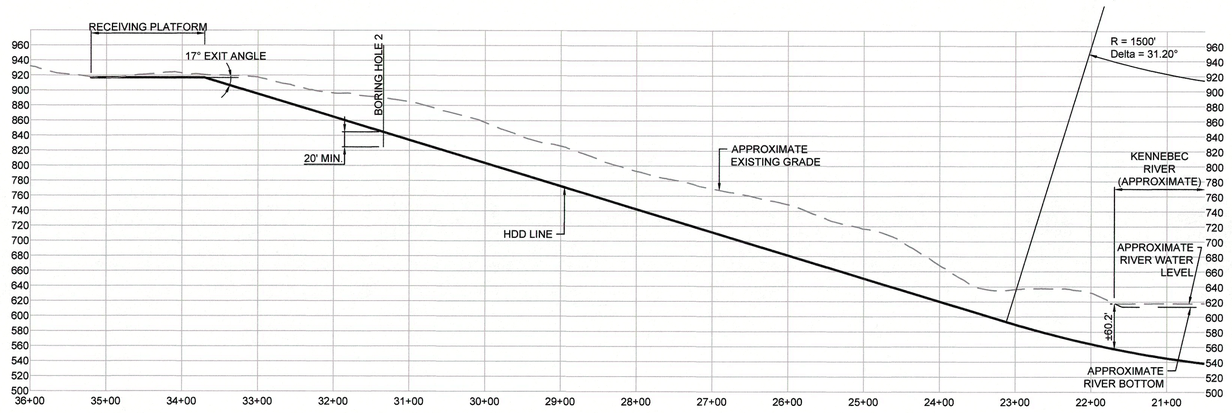
811 DigSafe MA·ME·NH·RI·VT

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NOT FOR CONSTRUCTION



PLAN

SCALE: 1" = 100'



PROFILE

SCALE: HORZ. 1" = 100'
VERT. 1" = 100'

100 0 100 200 FT

SCALE: 1" = 100'

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REV	DESCRIPTION	DATE	BY	CK	APP

INFO
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TRC
249 WESTERN AVENUE
AUGUSTA, ME 04330
207-621-7600
PROJECT NO.315441
ANSI D 10/19/2018

811 DigSafe MA ME NH RI VT

ISSUE FOR PERMITTING
NOT FOR CONSTRUCTION

INSTALL

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STATE OF MAINE
RICKY A. YOUNG
No. 6422
LICENSED PROFESSIONAL ENGINEER
OCT. 19, 2018

AVANGRID ENGINEERING
CONFIDENTIAL, PROPRIETARY and TRADE SECRET INFORMATION
Property of AVANGRID

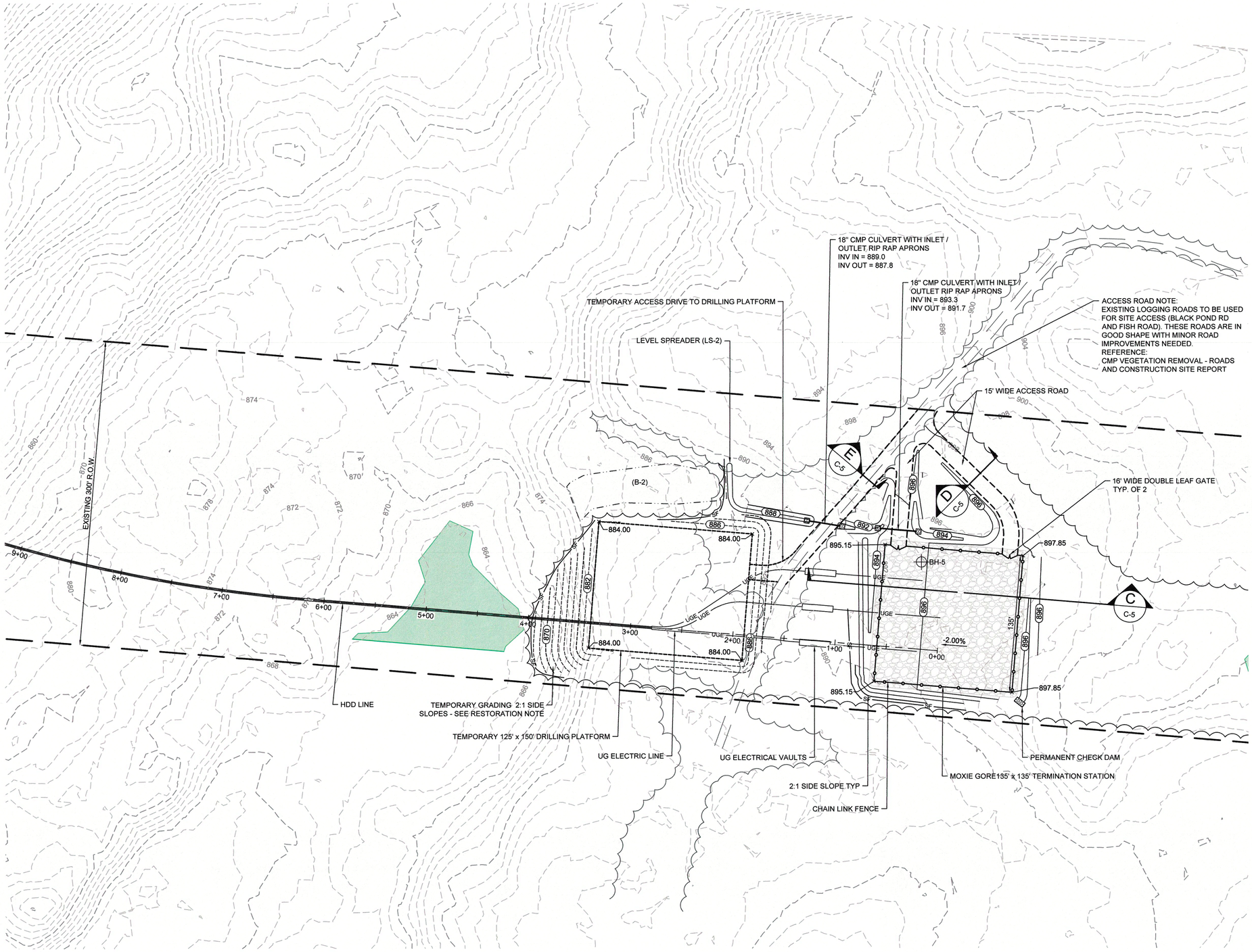
CMP AVANGRID

REV	DESCRIPTION	DATE	BY	CK	APP

HDD CROSSING (STA 20+50 TO 36+00)
PLAN & PROFILE

NECEC HVDC LINE — MOXIE GORE & WEST FORKS, ME

BY	DED/TRC	SCALE: AS NOTED	FILE: 315641 HDD Plan And Profile.dwg
CK	PGT/TRC	NO.	REV
APP	SGL/TRC	315641 C-2	0-OB
DATE	10/05/2018		



REV	DESCRIPTION	DATE	BY	CK	APP
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LOGO
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249 WESTERN AVENUE
AUGUSTA, ME 04330
207-621-7000
PROJECT NO.315941
INFO
ANSI D 10/19/2018

50 0 50 100 FT
SCALE: 1" = 50'

ISSUE FOR PERMITTING
NOT FOR CONSTRUCTION

INSTALL

PE STAMP
STATE OF MAINE
Patricia G. Crowley
No. 6422
LICENSED PROFESSIONAL ENGINEER
10/19/2018

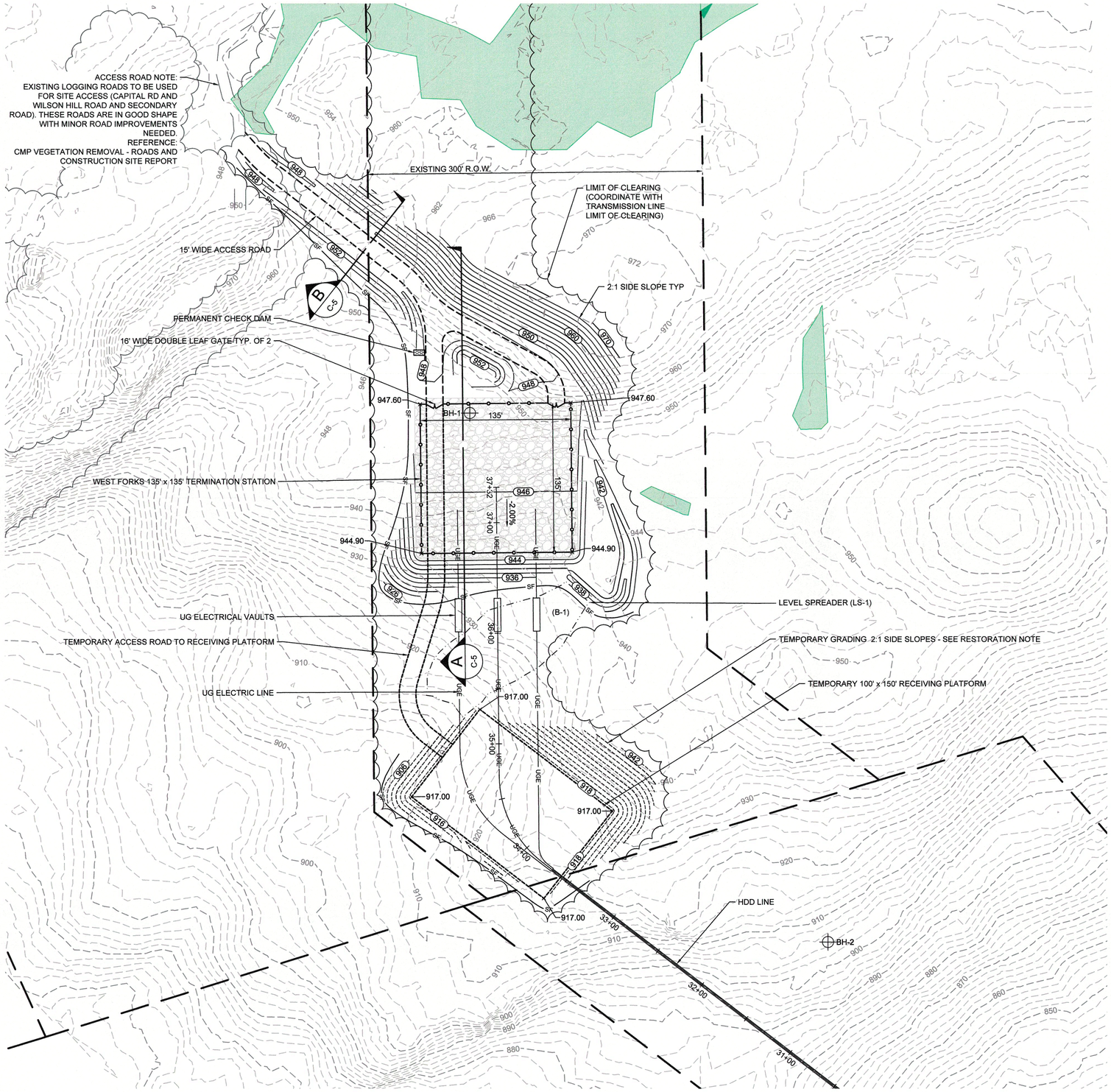
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GRADING & RESTORATION PLAN MOXIE GORE

NECEC HDVC LINE — MOXIE GORE & WEST FORKS, ME

BY	DED/TRC	SCALE: AS NOTED	FILE: 315641 Base.dwg
CK	PGT/TRC	NO.	REV
APP	SGL/TRC	315641 C-3	0-0B
DATE	10/05/2018		



N

UTM 83 ZONE 19 US FT

SYMBOL LEGEND

SYMBOL	DESCRIPTION
	HDD LINE
UGE	UNDERGROUND ELECTRIC LINE
	TERMINATION STATION FENCE
	ACCESS ROAD
	UNDERGROUND ELECTRIC VAULT
	TEMPORARY WORK PLATFORM
	TEMPORARY ACCESS ROAD
	RIGHT OF WAY LINE
	WETLANDS
	YARD SURFACING
	EXISTING TREE LINE
	LIMIT OF CLEARING
SF	SILT FENCE
850	EXISTING CONTOUR
850	PROPOSED CONTOUR
850	TEMPORARY CONTOUR (SEE RESTORATION NOTE)
BH-0	PROPOSED BORE HOLE LOCATION

RESTORATION NOTE:

PRIOR TO INITIAL SITE GRADING, TOPSOIL WILL BE REMOVED STOCKPILED AND STABILIZED FOR THE DURATION OF CONSTRUCTION. UPON COMPLETION OF CONSTRUCTION THE SITE WILL BE GRADED TO APPROXIMATE PRECONSTRUCTION CONTOURS AND TOPSOIL WILL BE REPLACED. A CONSERVATION SEED MIX (APRIL 16-OCTOBER 31) WILL BE APPLIED AT A RATE SPECIFIED BY THE MANUFACTURER. AN ANNUAL SEED MIXTURE WILL BE APPLIED BASED ON 3X THE MANUFACTURER'S SPECIFIED RATE (NOV 1-APRIL 15). ALL EXPOSED SOIL AND SEEDED AREAS WILL BE COVERED WITH HAY MULCH. MULCH WILL BE APPLIED AT A RATE OF 2 BALES (APRIL 16-OCTOBER 31) AND 5 BALES (NOV 1-APRIL 15) PER 1,000 SQUARE FEET.

REV	DESCRIPTION	DATE	BY	CK	APP
B	IFP - ISSUED FOR PERMITTING	10/17/2018	DED	PGT	SGL
A	IFR - ISSUE FOR REVIEW	10/05/2018	KVV	PGT	SGL

LOGO: TRC — PROJECT NO.315641
INFO: TRC, 249 WESTERN AVENUE, AUGUSTA, ME 04330, 207-621-7000
ANSI D 10/19/2018

811 DigSafe MA ME NH RI VT

ISSUE FOR PERMITTING
NOT FOR CONSTRUCTION

INSTALL

PE STAMP: STATE OF MAINE — RICKY A. YOUNG — LICENSED PROFESSIONAL ENGINEER — October 19, 2018

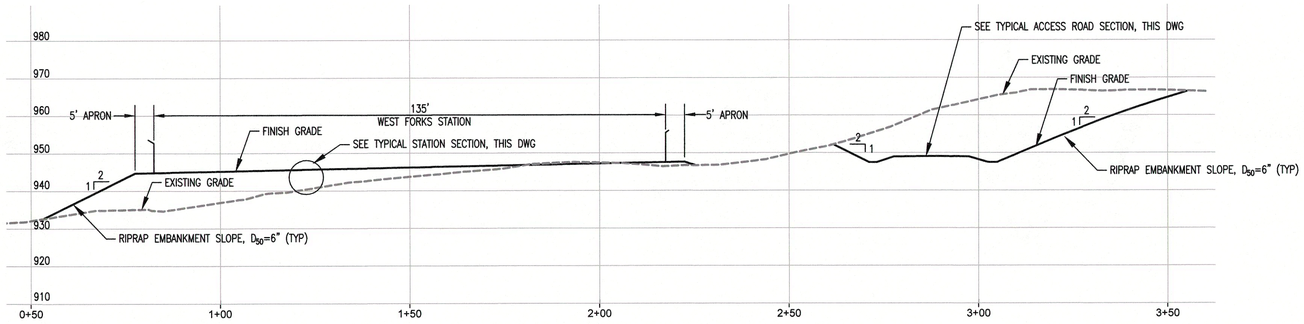
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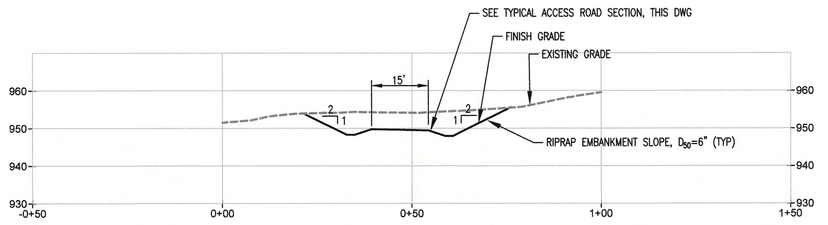
GRADING & RESTORATION PLAN WEST FORKS

NECEC HDVC LINE — MOXIE GORE & WEST FORKS, ME

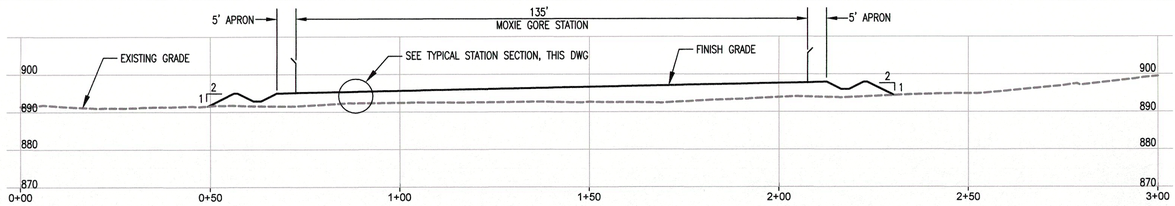
BY	DED/TRC	SCALE: AS NOTED	FILE: 315641 Base.dwg
CK	PGT/TRC	NO.	REV
APP	SGL/TRC	315641 C-4	0-0B
DATE	10/05/2018		



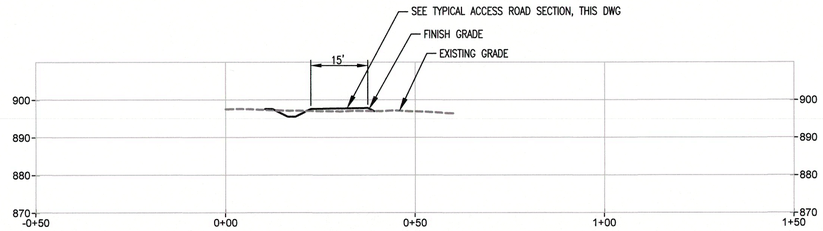
A C-4 WEST FORKS STATION CROSS-SECTION
NOT TO SCALE



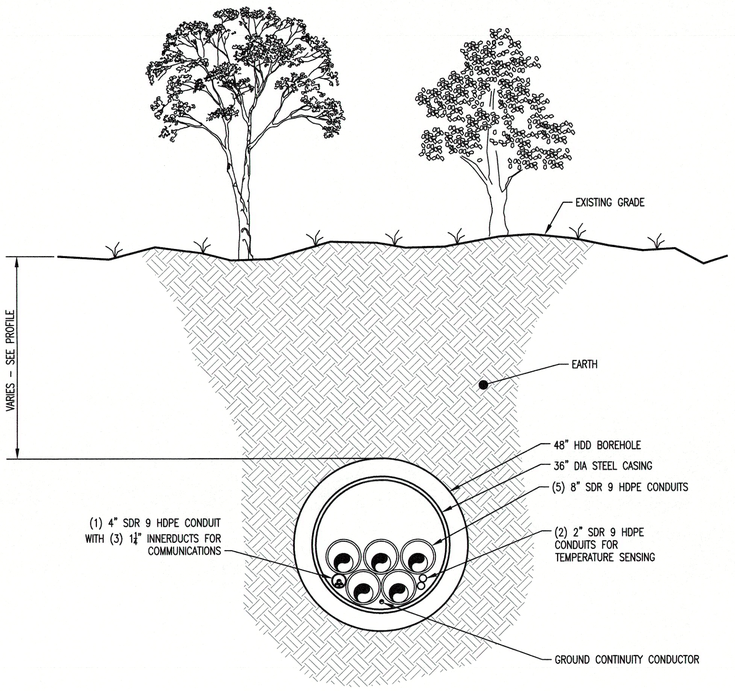
B C-4 WEST FORKS STATION CROSS-SECTION
NOT TO SCALE



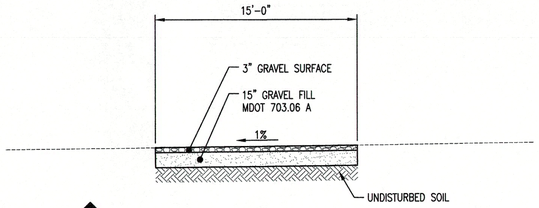
C C-3 MOXIE GORE STATION CROSS-SECTION
NOT TO SCALE



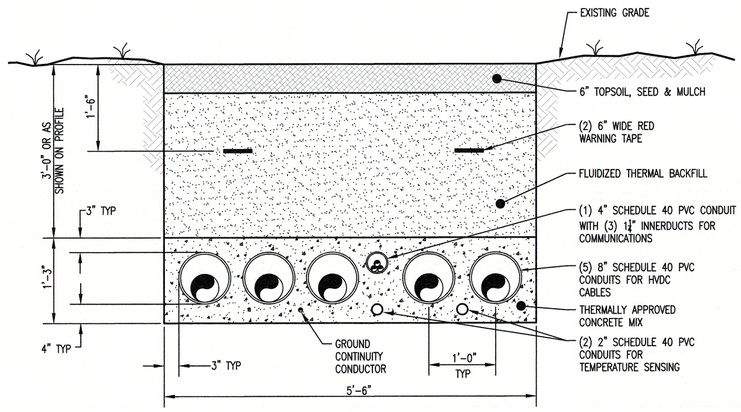
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NOT TO SCALE



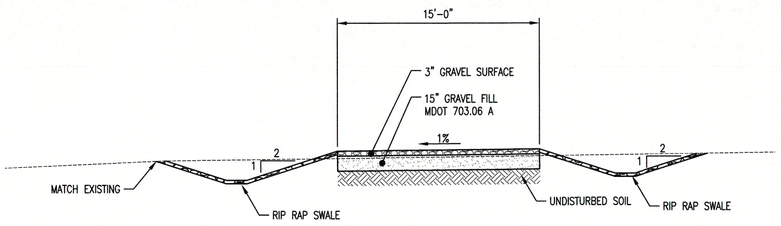
TYPICAL HVDC HDD BORE DETAIL
NOT TO SCALE



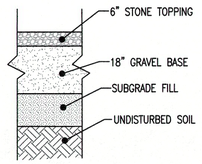
E C-3 TYPICAL ACCESS ROAD RESTORATION DETAIL
NOT TO SCALE



TYPICAL HVDC TRENCH DETAIL
NOT TO SCALE



TYPICAL ACCESS ROAD SECTION
NOT TO SCALE



TYPICAL STATION SECTION
NOT TO SCALE

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NOT FOR CONSTRUCTION

INSTALL

PE STAMP
STATE OF MAINE
RICKY A. YOUNG
No. 8422
LICENSED PROFESSIONAL ENGINEER
OCTOBER 19, 2018

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CROSS-SECTIONS & HDD DETAILS 1

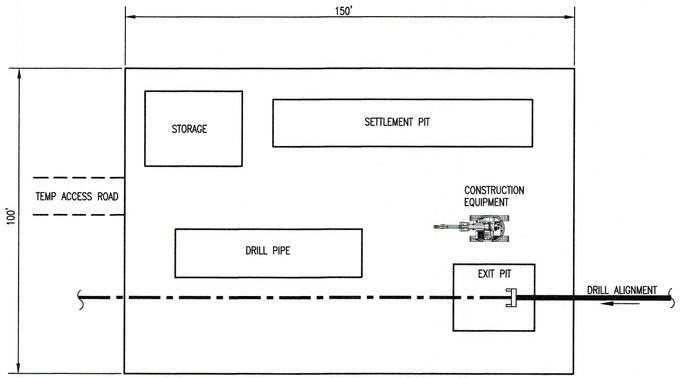
NECEC HVDC LINE — MOXIE GORE & WEST FORKS, ME

REV	DESCRIPTION	DATE	BY	CK	APP
B	IFP - ISSUED FOR PERMITTING	10/17/2018	KAV	PGT	SGL
A	IFR - ISSUE FOR REVIEW	10/05/2018	KAV	PGT	SGL

BY	KAV/TRC
CK	PGT/TRC
APP	SGL/TRC
DATE	10/5/2018
SCALE:	AS NOTED
FILE:	315641-C-5.dwg
NO.	315641-C-5
REV	0-0B

TRC
249 WESTERN AVENUE
AUGUSTA, ME 04330
207-621-7000
PROJECT NO.315641

LOGO
INFO
ANSI D 10/19/2018

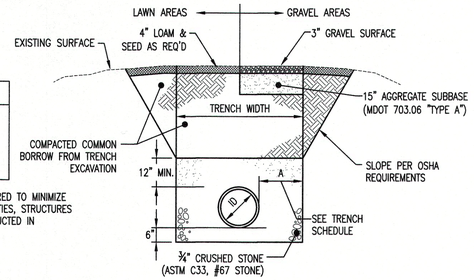


HDD RECEIVING SITE SETUP SCHEMATIC (WEST FORKS)

NOT TO SCALE

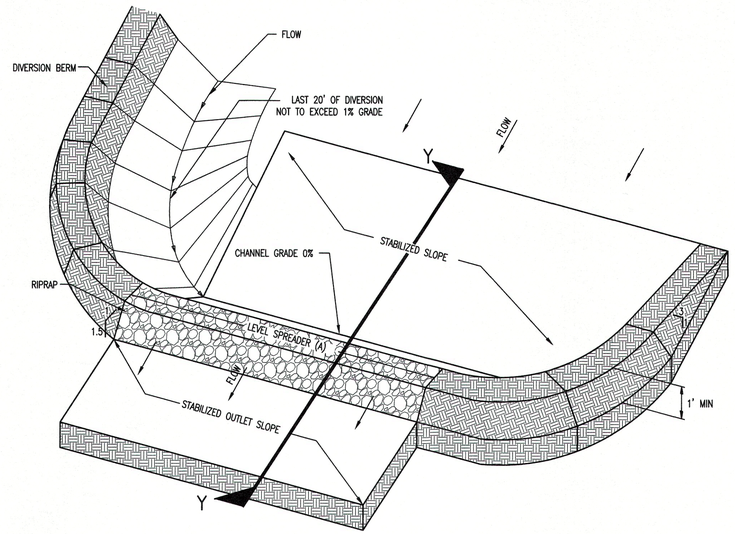
TRENCH SCHEDULE	
ID	A (MIN.)
4"–12"	0'–10"
15"	0'–10"
18"	0'–10"
24"	0'–6"
30"	0'–6"
36"	0'–6"

NOTE: SHORE TRENCH EXCAVATION AS REQUIRED TO MINIMIZE EXCAVATION AND IMPACTS TO ADJACENT UTILITIES, STRUCTURES OR PAVEMENT. TRENCHES SHALL BE CONSTRUCTED IN ACCORDANCE WITH OSHA REQUIREMENTS.

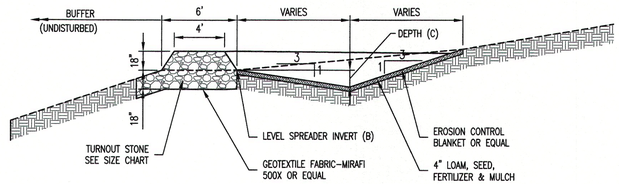


TYPICAL CULVERT TRENCH DETAIL

NOT TO SCALE



TURNOUT STONE SIZE	
SIEVE DESIGNATION	% PASSING BY WEIGHT
12 IN.	100
6 IN.	84–100
3 IN.	68–83
1 IN.	42–55
No. 4	8–12

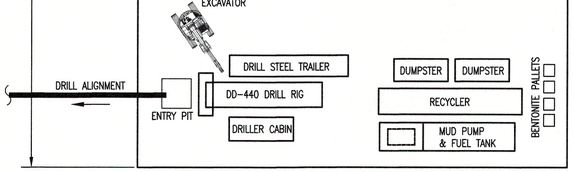


SECTION Y–Y

LEVEL SPREADER CHART				
SITE	ID	LENGTH (A)	INVERT (B)	DEPTH (C)
WEST FORKS	LS–1	30'	941.0	2.5'
MOXIE GORE	LS–2	30'	889.0	1.7'

LEVEL LIP SPREADER DETAIL

NOT TO SCALE



DRILL OPERATION SITE SETUP SCHEMATIC (MOXIE GORE)

NOT TO SCALE

REV	DESCRIPTION	DATE	BY	CK	APP
A	FR: ISSUE FOR REVIEW	10/05/2018	KAV	PGT	SGL
B	IFP: ISSUED FOR PERMITTING	10/17/2018	KAV	PGT	SGL

INFO
TRC
240 WESTERN AVENUE
AUGUSTA, ME 04330
207-621-1000

LOGO
TRC
PROJECT NO: 315641

ANSI D 10/17/2018

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INSTALL

PE STAMP
STATE OF MAINE
RICKY A YOUNG
No. 5402
LICENSED PROFESSIONAL ENGINEER
10/17/2018

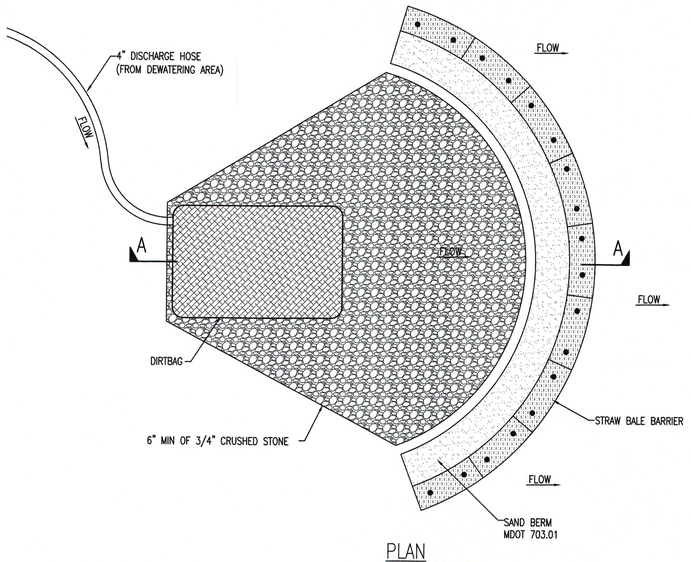
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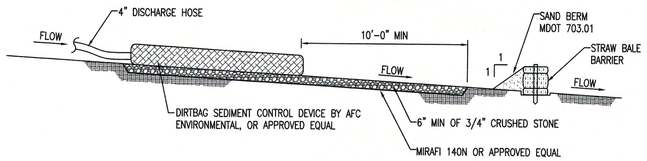
CROSS-SECTIONS & HDD DETAILS 2

NECEC HVDC LINE — MOXIE GORE & WEST FORKS, ME

BY	KAV/TRC	SCALE: AS NOTED	FILE: 315641-C-6.dwg
CK	PGT/TRC	NO.	REV
APP	SGL/TRC	315641-C-6	0-0B
DATE	10/05/2018		



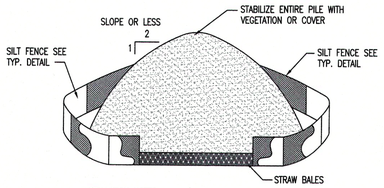
PLAN



SECTION A–A

DEWATERING SYSTEM DETAIL

NOT TO SCALE



INSTALLATION NOTES:

1. AREA CHOSEN FOR STOCKPILING OPERATIONS SHALL BE DRY AND STABLE. STOCKPILES SHALL NOT BE LOCATED:
   A. IN AREAS OF CONCENTRATED FLOW
   B. WITHIN 75' OF A WETLAND OR STREAM
   C. ON A SLOPE GREATER THAN 3%
2. MAXIMUM SLOPE OF STOCKPILE SHALL BE 2H:1V.
3. UPON COMPLETION OF SOIL STOCKPILING, EACH PILE SHALL BE SURROUNDED WITH EITHER SILT FENCING OR STRAW BALES, THEN STABILIZED WITH VEGETATION OR COVERED.

TYPICAL SOIL STOCKPILE

NOT TO SCALE

DEWATERING NOTES

1. THE CONTRACTOR SHALL INSTALL, MAINTAIN, AND OPERATE ALL CHANNELS, SUMPS, AND ALL OTHER TEMPORARY DIVERSION AND PROTECTIVE WORKS NEEDED TO DIVERT STREAM FLOW AND OTHER SURFACE WATER THROUGH OR AROUND THE CONSTRUCTION SITE. CONTROL OF SURFACE WATER SHALL BE CONTINUOUS DURING THE PERIOD THAT DAMAGE TO CONSTRUCTION WORK COULD OCCUR.

2. OPEN EXCAVATIONS SHALL BE DEWATERED AND KEPT FREE OF STANDING WATER AND MUDDY CONDITIONS AS NECESSARY FOR THE PROPER EXECUTION OF THE WORK. THE CONTRACTOR SHALL FURNISH, INSTALL, OPERATE, AND MAINTAIN ALL DRAINS, SUMPS AND ALL OTHER EQUIPMENT REQUIRED TO PROPERLY DEWATER THE SITE. DEWATERING SYSTEMS THAT CAUSE A LOSS OF SOIL FINES FROM THE FOUNDATION AREAS WILL NOT BE PERMITTED.

3. INSTALL DIVERSION DITCHES OR BERMS IF NECESSARY TO MINIMIZE THE AMOUNT OF CLEAN STORMWATER RUNOFF ALLOWED INTO THE EXCAVATED AREA.

4. REMOVAL OF WATER FROM THE CONSTRUCTION SITE SHALL BE ACCOMPLISHED SO THAT EROSION AND THE TRANSPORTING OF SEDIMENT AND OTHER POLLUTANTS ARE MINIMIZED.

5. DISCHARGE DEWATERING EFFLUENT TO AREAS AS INDICATED ON THE SITE GRADING PLAN. DISCHARGE SHALL BE IN SHEET FLOW.

6. DEWATERING IN PERIODS OF INTENSE, HEAVY RAIN, WHEN THE INFILTRATIVE CAPACITY OF THE SOIL IS EXCEEDED, SHALL BE AVOIDED.

7. FLOW TO THE SEDIMENT REMOVAL STRUCTURE MAY NOT EXCEED THE STRUCTURE'S CAPACITY TO SETTLE AND FILTER FLOW OR THE STRUCTURE'S VOLUME CAPACITY.

8. WHEN TEMPORARY WORKS ARE NO LONGER NEEDED, THE CONTRACTOR SHALL REMOVE AND RETURN THE AREA TO A CONDITION SIMILAR TO THAT WHICH EXISTED BEFORE CONSTRUCTION. AREAS WHERE TEMPORARY WORKS WERE LOCATED SHALL BE GRADED FOR SIGHTLY APPEARANCE WITH NO OBSTRUCTION TO NATURAL SURFACE WATER FLOWS OR THE PROPER FUNCTIONING AND ACCESS TO THE WORKS OF IMPROVEMENT INSTALLED. THE CONTRACTOR SHALL EXERCISE EXTREME CARE DURING THE REMOVAL STAGES TO MINIMIZE THE LOSS OF SOIL SEDIMENT AND DEBRIS THAT WAS TRAPPED DURING CONSTRUCTION.

DEWATERING DETAIL NOTES:

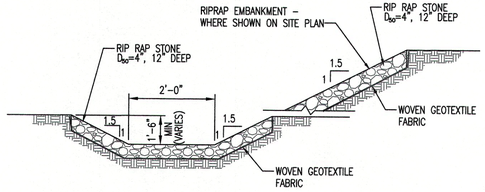
1. DIRT BAG MATERIAL BASED ON PARTICLE SIZE IN DIRTY WATER, I.E. FOR COARSE PARTICLES A WOVEN MATERIAL; FOR SILTS/CLAYS A NON-WOVEN MATERIAL.

2. DO NOT OVER PRESSURIZE DIRT BAG OR USE BEYOND CAPACITY.

3. LOCATE DISCHARGE SITE AS INDICATED ON SITE GRADING PLAN.

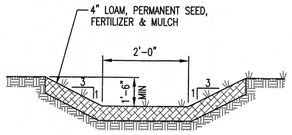
4. DOWNGRADIENT RECEIVING AREA MUST BE WELL VEGETATED OR OTHERWISE STABLE FROM EROSION, E.G. FOREST FLOOR OR COARSE GRAVEL/STONE.

5. DISCHARGE NOT PERMITTED WITHIN 100' OF A STREAM OR WETLAND.



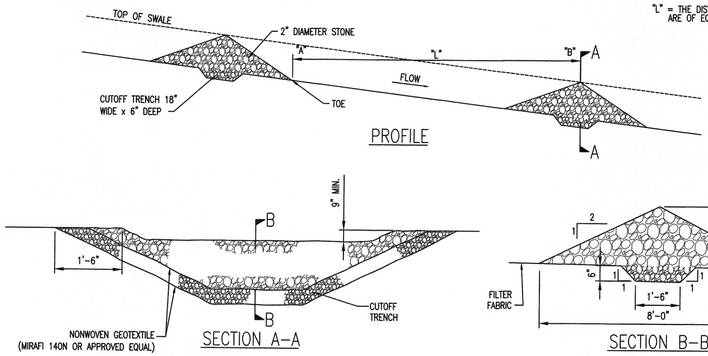
RIPRAP SWALE DETAIL (WEST FORKS STATION)

NOT TO SCALE



VEGETATED SWALE DETAIL (MOXIE GORE STATION)

NOT TO SCALE



"L" = THE DISTANCE SUCH THAT POINTS "A" AND "B" ARE OF EQUAL ELEVATION

SLOPE (FT/FT)	LENGTH (FT/FT)
0.020	100
0.030	66
0.040	50
0.050	40
0.080	25
0.100	20
0.120	17
0.150	13

NOTE: INSTALL WHERE INDICATED ON SITE GRADING PLAN AND AS NEEDED BY SPACING REQUIREMENTS.

CHECK DAM DETAILS

NOT TO SCALE

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LOGO: TRC
PROJECT NO:315641
INFO: TRC 249 WESTERN AVENUE AUGUSTA, ME 04330 207-621-7500
ANSI D 10/17/2018

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NOT FOR CONSTRUCTION

811 DigSafe MA ME NH RI VT

INSTALL

PE STAMP: STATE OF MAINE RICKY A. GOING No. 6422 PROFESSIONAL ENGINEER OCTOBER 5, 2018

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EROSION CONTROL NOTES & DETAILS 1

NECEC HVDC LINE — MOXIE GORE & WEST FORKS, ME

BY	KAV/TRC	SCALE: AS NOTED	FILE: 315641-C-7.dwg
CK	PGT/TRC	NO.	
APP	SGL/TRC		
DATE	10/05/2018		

315641-C-7 0-0B

CONSTRUCTION SEQUENCE

1. ESTABLISH CONSTRUCTION WORKSPACE LIMITS; IDENTIFY AND MARK SENSITIVE RESOURCES.

2. PERFORM ALL WORK IN ACCORDANCE WITH MAINE EROSION CONTROL AND SEDIMENT CONTROL HANDBOOK FOR CONSTRUCTION BEST MANAGEMENT PRACTICES (2003) AND MDEP WINTER CONSTRUCTION GUIDELINES (1999).

3. PRIOR TO USAGE, CONSTRUCT AND STABILIZE THE CONSTRUCTION ENTRANCE ON THE EXISTING PERMANENT ACCESS ROAD WITH A STONE PAD, MUD RACK, OR OTHER MATERIALS USED TO REDUCE THE TRACKING OR FLOWING OF SEDIMENT OFF THE SITE AND MAINTAIN UNTIL PAVING IS COMPLETED.

4. CLEAR TIMBER AND BRUSH; DO NOT GRUB UNTIL JUST PRIOR TO PRELIMINARY GRADING AND ESTABLISHMENT AND STABILIZATION OF TEMPORARY OR PERMANENT DRAINAGE COURSES.

5. INSTALL AND MAINTAIN SEDIMENT BARRIERS SUCH AS SILT FENCING AND/OR OTHER EROSION CONTROL BARRIERS ALONG THE DOWNHILL LIMIT OF WORK, AS SHOWN ON THE DRAWINGS. SEDIMENT BARRIER LOCATIONS MAY BE ADJUSTED IN THE FIELD BASED ON SITE CONDITIONS AS DETERMINED BY THE ENGINEERING INSPECTOR. WHERE SILT FENCE CANNOT BE TOED-IN PROPERLY DUE TO TREE ROOTS, ROCKS OR FROZEN GROUND, HAY BALES OR AN EROSION CONTROL MIX BERM MAY BE SUBSTITUTED. SILT FENCING WILL BE INSTALLED AFTER CLEARING BUT PRIOR TO GRUBBING AND GRADING ACTIVITIES. ANY EROSION ISSUES DEVELOPED DURING CLEARING WILL BE TEMPORARILY STABILIZED AS NECESSARY.

6. STABILIZE PERMANENT ACCESS ROAD SURFACE, PARKING AREAS AND EQUIPMENT STORAGE AND LAYDOWN AREAS WITH MATTING, CRUSHED STONE OR GRAVEL SUBBASE AS NECESSARY TO MINIMIZE RUTTING AND AVOID PONDING.

7. CONCURRENT WITH INITIATION OF SITE GRADING, CONSTRUCT AND STABILIZE TEMPORARY DRAINAGE SWALES, DIVERSION BERMS, CHECK DAMS, AND CULVERTS WITH TEMPORARY INLET AND OUTLET STRUCTURES TO MINIMIZE SEDIMENT IN SITE RUNOFF DURING THE CONSTRUCTION OF THE ROADWAY. DEWATER IN ACCORDANCE WITH DEWATERING NOTES BELOW.

8. INSTALL PROPERLY SPACED STONE CHECK DAMS IN ANY SECTION OF DITCH WITHIN 24 HOURS OF FORMING, SHAPING OR ROUGH GRADING THAT SECTION OF DITCH.

9. MINIMIZE THE AMOUNT OF DISTURBANCE AT ANY ONE TIME BY STAGING CONSTRUCTION AS MUCH AS PRACTICAL FOR EFFICIENT CONSTRUCTION OF THE FACILITY. NATURAL VEGETATIVE BUFFERS OR STRIPS SHOULD BE LEFT IN PLACE WHERE FEASIBLE TO AID IN SEDIMENT RETENTION AND REDUCE EROSION POTENTIAL.

10. STABILIZE ANY NEWLY GRADED SLOPE GREATER THAN EIGHT PERCENT AND ANY SECTION OF NEWLY CONSTRUCTED DITCH USING ANCHORED EROSION CONTROL BLANKETS OR OTHER APPROVED MULCHING TECHNIQUES WITHIN 24 HOURS. STABILIZE ANY SLOPE EXCEEDING EIGHT PERCENT AND BROUGHT TO FINAL GRADE WITHIN 24 HOURS USING THE APPROVED PERMANENT STABILIZATION MEASURES FOR SLOPES. STABILIZE ANY SECTION OF DITCH BROUGHT TO FINAL GRADE WITHIN 24 HOURS USING THE APPROVED PERMANENT STABILIZATION MEASURES FOR DITCHES.

11. DUST CONTROL METHODS WILL BE EMPLOYED AFTER GRADING AND PRIOR TO FINAL STABILIZATION TO PREVENT THE BLOWING AND MOVEMENT OF DUST THROUGH THE APPLICATION OF WATER AND/OR CALCIUM CHLORIDE TO REDUCE WIND EROSION. REPETITIVE TREATMENT WILL BE APPLIED AS NEEDED TO ACCOMPLISH CONTROL.

12. APPLY TEMPORARY SEED AND MULCH TO ANY EXPOSED AREAS WHERE ACTIVITY IS NOT ANTICIPATED FOR 30 DAYS OR MORE, OR WHERE ACTIVITY HAS NOT OCCURRED WITHIN 30 DAYS. TEMPORARILY MULCH ANY EXPOSED AREAS WITHIN 100 FEET OF A WETLAND WHERE ACTIVITY IS NOT ANTICIPATED OR HAS NOT OCCURRED IN 7 DAYS.

13. REMOVE EXCESS SPOILS FROM SITE THAT WILL NOT BE USED FOR THE FINAL DESIGN AND STABILIZATION. STOCKPILED SOILS THAT REMAIN IN PLACE FOR 48 HOURS OR MORE WILL BE CONTAINED WITH SEDIMENT BARRIERS SUCH AS SILT FENCE, HAY BALES OR EQUIVALENT. THE SEDIMENT BARRIERS SHALL BE ADEQUATELY LOCATED AND REINFORCED TO HANDLE A SIGNIFICANT RAIN EVENT AND THE POTENTIAL SLUMPING OF THE PILE. BETWEEN APRIL 15 AND OCTOBER 1, APPLY TEMPORARY SEED AND MULCH TO A STOCKPILE THAT IS NOT EXPECTED TO BE DISTURBED WITHIN 30 DAYS. APPLY ANCHORED MULCH DAILY, AS NEEDED, DURING WINTER CONSTRUCTION.

14. INSPECT AND REPAIR EROSION CONTROL MEASURES DAILY IN AREAS OF ACTIVE CONSTRUCTION; OTHERWISE WEEKLY AND AFTER RAINFALL OF ½ INCH OR GREATER WITHIN A 24-HOUR PERIOD. REMOVE ACCUMULATED SEDIMENT WHEN IT REACHES 1/3 THE HEIGHT OF THE BARRIER.

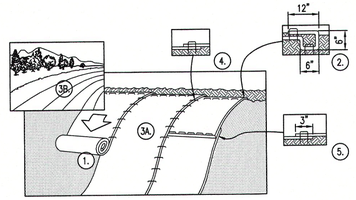
15. MONITOR PUBLIC ROADS FOR SIGNS OF TRACKING OR SPILLING OF SPOIL MATERIAL AND CLEANUP AS NEEDED.

16. COMPLETE FINAL GRADING AND STABILIZATION OF EARTHEN STRUCTURES SUCH AS DIVERSION BERMS, LEVEL SPREADERS AND SWALES THAT WILL CONTROL RUNOFF.

17. FINISH GRADE AND REPLACE TOPSOIL OR LOAM IN DISTURBED AREAS. SEED AND MULCH DISTURBED AREAS WITHIN 6 DAYS OF FINAL GRADING.

18. MAINTAIN ALL TEMPORARY EROSION CONTROLS AND SEDIMENT BARRIERS UNTIL VEGETATION HAS BEEN ESTABLISHED OVER 85-90% OF THE AREA TO BE REVEGETATED. RESEED SPARSELY VEGETATED AREAS.

19. REMOVE ALL TEMPORARY EROSION AND SEDIMENTATION CONTROL MEASURES ONCE THE SITE IS PERMANENTLY STABILIZED.



1. PREPARE SOIL BEFORE INSTALLING BLANKETS, INCLUDING ANY NECESSARY APPLICATION OF LIME, FERTILIZER, AND SEED. NOTE: WHEN USING CELL-O-SEED DO NOT SEED PREPARED AREA. CELL-O-SEED MUST BE INSTALLED WITH PAPER SIDE DOWN.

2. BEGIN AT THE TOP OF THE SLOPE BY ANCHORING THE BLANKET IN A 6" DEEP X 6" WIDE TRENCH WITH APPROXIMATELY 12" OF BLANKET EXTEDED BEYOND THE UP-SLOPE PORTION OF THE TRENCH. ANCHOR THE BLANKET WITH A ROW OF STAPLES/STAKES APPROXIMATELY 12" APART IN THE BOTTOM OF THE TRENCH. BACKFILL AND COMPACT THE TRENCH AFTER STAPLING. APPLY SEED TO COMPACTED SOIL AND FOLD REMAINING 12" PORTION OF BLANKET BACK OVER SEED AND COMPACTED SOIL. SECURE BLANKET OVER COMPACTED SOIL WITH A ROW OF STAPLES/STAKES SPACED APPROXIMATELY 12" APART ACROSS THE WIDTH OF THE BLANKET.

3. ROLL THE BLANKETS (A.) DOWN OR (B.) HORIZONTALLY ACROSS THE SLOPE. BLANKETS WILL UNROLL WITH APPROPRIATE SIDE AGAINST THE SOIL SURFACE. ALL BLANKETS MUST BE SECURELY FASTENED TO SOIL SURFACE BY PLACING STAPLES/STAKES IN APPROPRIATE LOCATIONS AS SHOWN IN THE STAPLE PATTERN GUIDE. WHEN USING OPTIONAL DOT SYSTEM, STAPLES/STAKES SHOULD BE PLACED THROUGH EACH OF THE COLORED DOTS CORRESPONDING TO THE APPROPRIATE STAPLE PATTERN.

4. THE EDGES OF PARALLEL BLANKETS MUST BE STAPLED WITH APPROXIMATELY 2"-5" OVERLAP DEPENDING ON BLANKET TYPE. TO ENSURE PROPER SEAM ALIGNMENT, PLACE THE EDGE OF THE OVERLAPPING BLANKET (BLANKET BEING INSTALLED ON TOP) EVEN WITH THE COLORED SEAM STITCH ON THE PREVIOUSLY INSTALLED BLANKET.

5. CONSECUTIVE BLANKETS SPLICED DOWN THE SLOPE MUST BE PLACED END OVER END (SHINGLE STYLE) WITH AN APPROXIMATE 3" OVERLAP. STAPLE THROUGH OVERLAPPED AREA, APPROXIMATELY 12" APART ACROSS ENTIRE BLANKET WIDTH.

NOTE:
*IN LOOSE SOIL CONDITIONS, THE USE OF STAPLE OR STAKE LENGTHS GREATER THAN 6" MAY BE NECESSARY TO PROPERLY SECURE THE BLANKETS.

EROSION CONTROL BLANKET INSTALLATION

NOT TO SCALE

MULCH AND SEEDING SPECIFICATIONS

SUMMARY OF TEMPORARY AND PERMANENT MULCH APPLICATION REQUIREMENTS

CONDITION	TIMING	MULCH TYPE[1,2]	APPLICATION RATES
TEMPORARY			
	IF NO ACTIVITY IN EXPOSED AREAS FOR 7 DAYS, OR PRIOR TO A STORM EVENT	STRAW MULCH OR WOOD FIBER MULCH	2 TONS/ACRES 2000 LB./ACRES
ALL DISTRIBUTED AREAS OF THE CONSTRUCTION WORKSPACE	APPLY MULCH TO ALL EXPOSED AREAS IF NO ACTIVITY OCCURS WITHIN 30 DAYS. APPLY MULCH AND TEMPORARY SEEDING SOONER WHEN IT CAN BE ANTICIPATED THAT ACTIVITY IS NOT GOING TO OCCUR WITHIN 30 DAYS.	STRAW MULCH OR WOOD FIBER MULCH	2 TONS/ACRES 2000 LB./ACRES [3]
ALL WORK AREAS EXPOSED ARE TO BE MULCHED DAILY EACH TIME SOIL IS DISTURBED	NOVEMBER 1 – APRIL 15	STRAW MULCH OR WOOD FIBER MULCH	3 TONS/ACRES 2000 LB./ACRES
PERMANENT			
ON ALL EXPOSED AREAS AFTER SEEDING TO STABILIZE THE SOIL SURFACE	PERMANENT GRASS AND/OR LEGUME SEEDING COVERED BY HAY OR STRAW MULCH ON ALL AREAS THAT HAVE BEEN RESTORED TO FINAL GRADE. THIS DOES NOT APPLY TO AREAS STABILIZED BY OTHER MEANS SUCH AS JUTE MATTING OR PERMANENT EROSION CONTROL MIX.	CRIMPED STRAW MULCH OR PAPER MULCH OR WOOD FIBER MULCH	2 TONS/ACRES 1500 LB./ACRES [4] 2000 LB./ACRES
WOOD CHIP APPLICATION AREAS	PERMANENT GRASS AND/OR LEGUME SEEDING COVERED BY HAY OR STRAW MULCH ON ALL AREAS THAT HAVE BEEN RESTORED TO FINAL GRADE. THIS DOES NOT APPLY TO AREAS STABILIZED BY OTHER MEANS SUCH AS JUTE MATTING OR PERMANENT EROSION CONTROL MIX.	CRIMPED STRAW MULCH OR PAPER MULCH OR WOOD FIBER MULCH	2 TONS/ACRES 1500 LB./ACRES [4] 2000 LB./ACRES

NOTES:
1. STRAW AND HAY MULCH MAY BE USED INTERCHANGEABLY, EXCEPT IN WETLAND AREAS WHERE STRAW MULCH WILL BE REQUIRED.
2. DOUBLE RATE OF WOOD FIBER MULCH WHEN USED IN CRITICAL AREAS.
3. STRAW, HAY, OR HYDROMULCH (WOOD FIBER OR PAPER MULCH AS APPROPRIATE) WILL PROVIDE 90 PERCENT GROUND COVERAGE
4. PAPER MULCH IS ACCEPTABLE FOR USE DURING THE GROWING SEASON. ON SLOPES >30 PERCENT AND IN AREAS WHERE VEGETATION HAS NOT ESTABLISHED WELL, ADDITIONAL HAY MULCH WILL BE ADDED AS A WINTERIZING MEASURE.

MULCH ANCHORING REQUIREMENTS

ON SLOPES GREATER THAN 3 PERCENT, HAY OR STRAW MULCH WILL BE FIRMLY ANCHORED INTO THE SOIL UTILIZING ONE OF THE FOLLOWING METHODS:
-CRIMPING WITH A STRAIGHT OR NOTCHED MULCH CRIMPING TOOL (FARM DISCS WILL NOT BE ALLOWED);
-TRACK WALKING WITH DEEP-CLEATED EQUIPMENT OPERATING UP AND DOWN THE SLOPE (MULCH CRIMPED PERPENDICULAR TO THE SLOPE) ON SLOPES <25 PERCENT;
-APPLICATION OF MULCH NETTING;
-APPLICATION OF 500 LB./ACRE OF WOOD FIBER MULCH OVER STRAW/HAY MULCH; AND
-COMMERCIALLY AVAILABLE TACKIFIERS (EXCEPT WITHIN 100 FEET OF WATERBODIES OR WETLANDS).

SEED MIX SPECIFICATIONS

SEED MIX NAME	SEED MIX COMPONENTS	LB./ACRE [1]
TEMPORARY SEED MIX	ANNUAL RYEGRASS	40
PERMANENT UPLAND SEED MIX	REDTOP CREEPING RED FESCUE TALL FESCUE BIRDSFOOT TREFOIL	4 40 40 16
WOODCHIP APPLICATION SEED MIX	CREEPING RED FESCUE REDTOP TALL FESCUE CROWNVETCH	20 4 30 30
WETLAND SEED MIX	ANNUAL RYEGRASS	40
SUPPLEMENTAL WINTER SEED MIX[2]	WINTER RYEGRASS	120

NOTES:
1. INCREASE SEEDING RATES 10% WHEN HYDROSEEDING
2. WINTER RYE WILL BE ADDED TO PERMANENT UPLAND MIX AT A RATE OF 120 LB./ACRE BETWEEN OCTOBER 1 AND APRIL 15

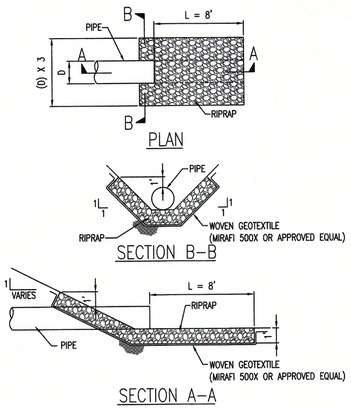
SUMMARY OF SEEDING REQUIREMENTS

CONDITION	TIMING[1,2]	SEED MIX
TEMPORARY SEEDING [3]	TEMPORARY SEED BETWEEN APRIL 15 AND OCTOBER 1 ONLY. DISTURBED AREAS OR SPOIL STOCKPILES WILL BE SEEDED IMMEDIATELY IF FURTHER DISTURBANCE IS NOT EXPECTED FOR 30 DAYS OR MORE.	ANNUAL RYEGRASS
PERMANENT SEEDING [3,4]		
UPLAND PORTIONS OF THE CONSTRUCTION AREA	DISTURBED AREA WILL BE SEEDED WITHIN 6 DAYS OF FINAL GRADING.	PERMANENT UPLAND MIX
SLOPES > 3:1	DISTURBED AREA WILL BE SEEDED IMMEDIATELY AFTER SEEDBED PREPARATION.	PERMANENT UPLAND MIX
WETLANDS	DISTURBED WETLANDS WILL BE SEEDED WITHIN 6 DAYS OF FINAL GRADING.	ANNUAL RYEGRASS
WOODCHIP APPLICATION AREAS	DISTURBED AREA WILL BE SEEDED WITHIN 6 DAYS OF FINAL GRADING.	WOODCHIP APPLICATION SEED MIX
WINTER DORMANT SEEDING	DORMANT SEED BETWEEN OCTOBER 1 AND APRIL 15 ONLY. NO SEEDING WILL OCCUR IF SNOW DEPTHS EXCEED 1 INCH.	PERMANENT UPLAND MIX PLUS WINTER RYEGRASS

NOTES:
1. WEATHER CONDITIONS PERMITTING.
2. AREAS THAT DO NOT SUCCESSFULLY REVEGETATE WITHIN APPROPRIATE PERIOD OF TIME WILL BE RESEEDED AS NECCESSARY.
3. LOOSEN COMPACTED SOIL TO A MINIMUM DEPTH OF 4 INCHES.
4. TOP DRESS WITH 6 INCHES LOAM, AS NEEDED.

FERTILIZER AND LIMESTONE REQUIREMENTS.

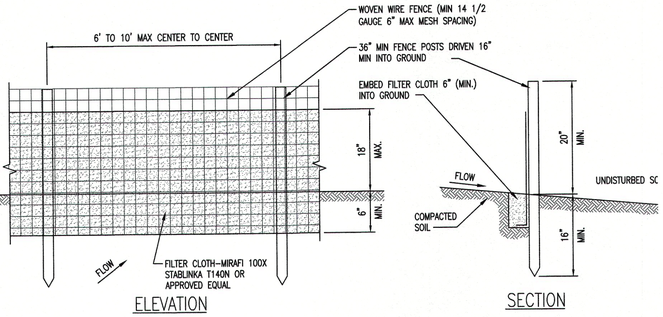
IN GENERAL, FERTILIZER AND LIME APPLICATION RATES WILL FOLLOW THE GUIDELINES IDENTIFIED BELOW UNLESS SITE SPECIFIC SOIL TESTS IDENTIFY THE NEED FOR ALTERNATIVE FERTILIZER/LIME APPLICATION RATES. FERTILIZER WILL BE APPLIED TO UPLAND AREAS PRIOR TO SEEDING AT A RATE OF 800 POUNDS PER ACRE USING 10-20-20 (N-P2O5-K2O) OR EQUIVALENT. GROUND LIMESTONE (EQUIVALENT TO 50 PERCENT CALCIUM PLUS MAGNESIUM OXIDE) WILL BE APPLIED AT A RATE OF 3 TONS PER ACRE. AN EQUIVALENT MIXTURE OF FERTILIZER AND LIME MAY BE APPLIED USING THE HYDROSEEDING METHOD. NO LIME OR FERTILIZER WILL BE APPLIED TO WETLANDS.



NOTES:
- D50=4", D100=6"
- THICKNESS=12"
- STONE FOR RIPRAP SHALL CONSIST OF SUB-ANGULAR FIELD STONE OR ROUGH UNHEWN QUARRY STONE OF APPROXIMATELY RECTANGULAR SHAPE. THE STONE SHALL BE HARD AND OF SUCH QUALITY THAT IT WILL NOT DISINTEGRATE ON EXPOSURE TO WATER OR WEATHERING, BE CHEMICALLY STABLE, AND IT SHALL BE SUITABLE IN ALL OTHER RESPECTS FOR THE PURPOSE INTENDED. THE BULK SPECIFIC GRAVITY (SATURATED SURFACE-DRY BASIS) OF THE INDIVIDUAL STONES SHALL BE AT LEAST 2.5.

CULVERT INLET/OUTLET PROTECTION

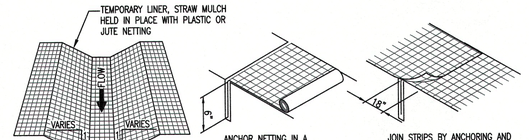
NOT TO SCALE



1. WOVEN WIRE FENCE TO BE FASTENED TO FENCE POSTS WITH WIRE TIES OR STAPLES.	POSTS: STEEL "T" OR "U" TYPE OR 2" HARDWOOD.
2. FILTER CLOTH TO BE FASTENED SECURELY TO WOVEN WIRE FENCE WITH TIES SPACED EVERY 24" AT TOP AND MIDSECTION.	FENCE: WOVEN WIRE. 14 1/2 GA 6" MAX MESH OPENING.
3. WHEN TWO SECTIONS OF FILTER CLOTH ADJOIN EACH OTHER THEY SHALL BE OVERLAPPED BY 6" AND FOLDED.	FILTER CLOTH: FILTER X, MIRAFI 100X. STABLINKA T140N OR APPROVED EQUAL.
4. MAINTENANCE SHALL BE PERFORMED AS NEEDED AND MATERIAL REMOVED WHEN BUILD-UP REACHES 1/3 THE HEIGHT OF THE FENCE.	PREFABRICATED UNIT: ENVIROFENCE OR APPROVED EQUAL

SILT FENCE DETAILS

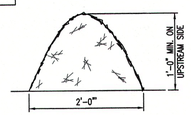
NOT TO SCALE



1. EXCAVATE THE CHANNEL AND SHAPE IT TO AN EVEN CROSS-SECTION AS SHOWN. WHEN STAKING INDICATE A 0.2' OVERCUT AROUND THE CHANNEL PERIMETER FOR SILTING AND BULKING.
2. GRADE SOIL AWAY FROM CHANNEL SO THAT SURFACE WATER MAY ENTER FREELY.
3. APPLY LIME, FERTILIZER AND SEED TO THE CHANNEL AND ADJOINING AREAS IN ACCORDANCE WITH THE EROSION CONTROL PLAN.
4. SPREAD HAY OR STRAW MULCH AT THE RATE OF 100LB/1000 SF.
5. HOLD MULCH IN PLACE IMMEDIATELY AFTER SPREADING WITH A PLASTIC NETTING INSTALLED AS SHOWN.
6. START LAYING THE NET FROM THE TOP OF THE UPSTREAM END OF THE CHANNEL AND UNROLL IT DOWN GRADE. DO NOT STRETCH THE NETTING.
7. BURY THE UP SLOPE END AND STAPLE THE NET EVERY 12" ACROSS THE TOP END, EVERY 3 FT AROUND THE EDGES AND ACROSS THE NET SO THAT THE STRAW IS HELD CLOSELY AGAINST THE SOIL. HOWEVER, DO NOT STRETCH THE NETTING WHEN STAPLING.
8. NETTING STRIPS SHOULD BE JOINED TOGETHER ALONG THE SIDES WITH A 3" OVERLAP AND STAPLED TOGETHER.
9. TO JOIN ENDS OF STRIPS, INSERT A NEW ROLL OF NET IN A TRENCH AS WITH THE UP SLOPE END AND OVERLAP IT 18" WITH THE PREVIOUSLY LAID UPPER ROLL. TURN UNDER 6" OF THE 18" OVERLAP AND STAPLE EVERY 12" ACROSS THE END.

GRASS LINED CHANNEL

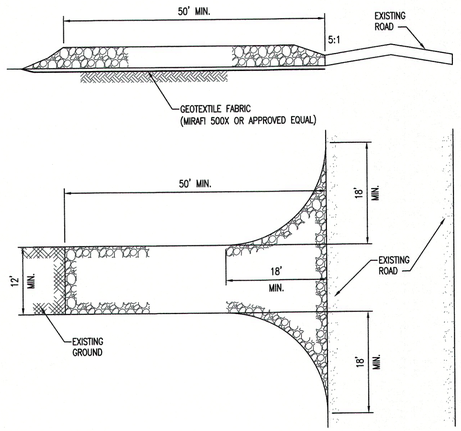
NOT TO SCALE



EROSION CONTROL SOIL/BARK MIX: SHALL CONSIST OF SHREDDED BARK, STUMP GRINDINGS, COMPOSTED BARK OR FLUME GRIT AND FRAGMENTED WOOD GENERATED FROM WATER-FLUME LOG HANDLING SYSTEMS. THE MIX SHALL CONFORM TO THE FOLLOWING:
1. pH – 5.0 TO 8.0.
2. SCREEN SIZE: 6" – 100% PASSING
   3/4" – 70% TO 85% PASSING
   MIX SHALL NOT CONTAIN LARGE PORTIONS OF SILTS, CLAYS OR FINE SANDS
3. ORGANIC MATERIAL 20% – 100% (DRY WEIGHT BASIS)
   ORGANIC PORTION MUST BE FIBROUS AND ELONGATED
4. SOLUBLE SALTS SHALL BE < 4.0 mmhos/cm

EROSION CONTROL BERM

NOT TO SCALE



1. STONE SIZE – USE 2" STONE.
2. LENGTH – NOT LESS THAN 50 FEET.
3. THICKNESS – NOT LESS THAN SIX (6) INCHES.
4. WIDTH – TWELVE (12) FOOT MIN. BUT NOT LESS THAN THE FULL WIDTH AT POINTS WHERE INGRESS OR EGRESS OCCURS. TWENTY-FOUR (24) FOOT IF SINGLE ENTRANCE TO SITE.
5. GEOTEXTILE FABRIC – WILL BE PLACED OVER THE ENTIRE AREA PRIOR TO PLACING THE STONE.
6. SURFACE WATER – ALL SURFACE WATER FLOWING OR DIVERTED TOWARD CONSTRUCTION ENTRANCES SHALL BE PIPED ACROSS THE ENTRANCE. IF PIPING IS IMPRACTICAL, A MOUNTABLE BERM WITH 5:1 SLOPES WILL BE PERMITTED.
7. MAINTENANCE – THE ENTRANCE SHALL BE MAINTAINED IN A CONDITION WHICH WILL PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO PUBLIC RIGHTS-OF-WAY. ALL SEDIMENT SPILLED, DROPPED, WASHED OR TRACKED ONTO PUBLIC RIGHTS-OF-WAY MUST BE REMOVED IMMEDIATELY.
8. WHEN WASHING IS REQUIRED, IT SHALL BE DONE ON AN AREA STABILIZED WITH STONE THAT DRAINS INTO AN APPROVED SEDIMENT TRAPPING DEVICE.

STABILIZED CONSTRUCTION ENTRANCE

NOT TO SCALE

811 DigSafe MA ME NH RI VT

ISSUED FOR PERMITTING
NOT FOR CONSTRUCTION

INSTALL

REV	DESCRIPTION	DATE	BY	CK	APP
A	IFR - ISSUE FOR REVIEW	10/05/2018	KAV	PGT	SGL
B	IFP - ISSUED FOR PERMITTING	10/17/2018	KAV	PGT	SGL

PE STAMP
STATE OF MAINE
RICKY A. YOUNG
No. 6424
LICENSED
PROFESSIONAL ENGINEER
10/17/2018

AVANGRID ENGINEERING
CONFIDENTIAL, PROPRIETARY and TRADE SECRET INFORMATION
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CMP AVANGRID

EROSION CONTROL NOTES & DETAILS 2

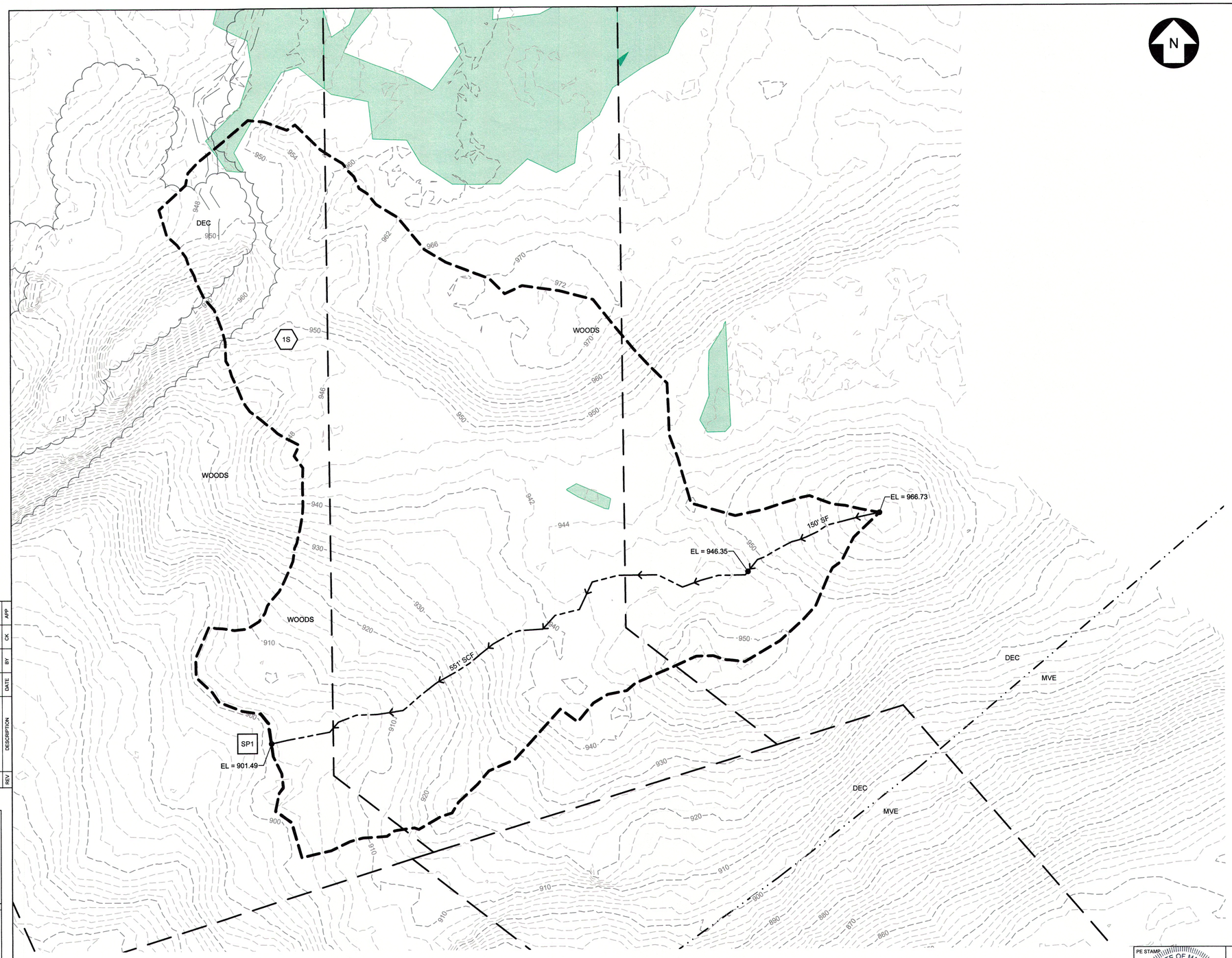
NECEC HVDC LINE — MOXIE GORE & WEST FORKS, ME

BY	KAV/TRC	SCALE: AS NOTED	FILE: 315641-C-8.dwg
CK	PGT/TRC	NO.	REV
APP	SGL/TRC	315641-C-8	0-0B
DATE	10/05/2018		

INFO: TRC, 249 WESTERN AVENUE AUGUSTA, MAINE 04330, 207-621-7000

LOGO: TRC PROJECT NO.315641

ANSI D 10/17/2018



SOILS LEGEND		
MAP UNIT SYMBOL	MAP UNIT NAME	HSG RATING
DEC	DANFORTH-ELLIOTTSVILLE ASSOCIATION, 3 TO 15 PERCENT SLOPES	B
MOB	MONARDA-BURNHAM COMPLEX, 0 TO 3 PERCENT SLOPES, VERY STONY	D
MTB	MONARDA-TELOS COMPLEX, 0 TO 8 PERCENT SLOPES, VERY STONY	D
MVE	MONSON-ELLIOTTSVILLE-KNOB LOCK COMPLEX, 30 TO 60 PERCENT SLOPES, VERY ROCKY	D

WEST FORKS PRE-DEVELOPMENT LAND COVER COMPARISON SUMMARY (ACRES)		
COVER TYPE	CN	1S
ROOFS & FOUNDATIONS	98	0.00
STONE YARD SURFACE	55	0.00
GRAVEL ROAD, HSG B	96	0.00
BRUSH, HSG B	67	0.14
WOODS, HSG B	66	5.89
TOTAL AREA		6.03

LEGEND

- SUBCATCHMENTBOUNDARY
- TIME OF CONCENTRATION FLOW LINE
- REACH
- 100' SF — SHEET FLOW
- 100' SCF — SHALLOW CONCENTRATED FLOW
- 100' CF — CHANNEL FLOW
- EL. 520.0± — SPOT ELEVATION
- 1R — REACH ID
- 1S — SUBCATCHMENT ID
- 1P — POND ID
- SP1 — STUDY POINT ID
- RIGHT OF WAY
- SOILS
- 100 — CONTOUR
- TREELINE
- WETLAND

811 DigSafe MA·ME·NH·RI·VT

ISSUE FOR PERMITTING
NOT FOR CONSTRUCTION

INSTALL

REV	DESCRIPTION	DATE	BY	CK	APP
B	IFP - ISSUED FOR PERMITTING	10/17/2018	CMW	PGT	SGL
A	IFR - ISSUE FOR REVIEW	10/05/2018	KAV	PGT	SGL

INFO
TRC
249 WESTERN AVENUE
AUGUSTA, ME 04330
207-621-7000

LOGO
TRC
PROJECT NO.315641

ANSI D 10/17/2018

PE STAMP
STATE OF MAINE
RICKY A. GAGNON
LICENSED
PROFESSIONAL ENGINEER
OCT 19, 2018

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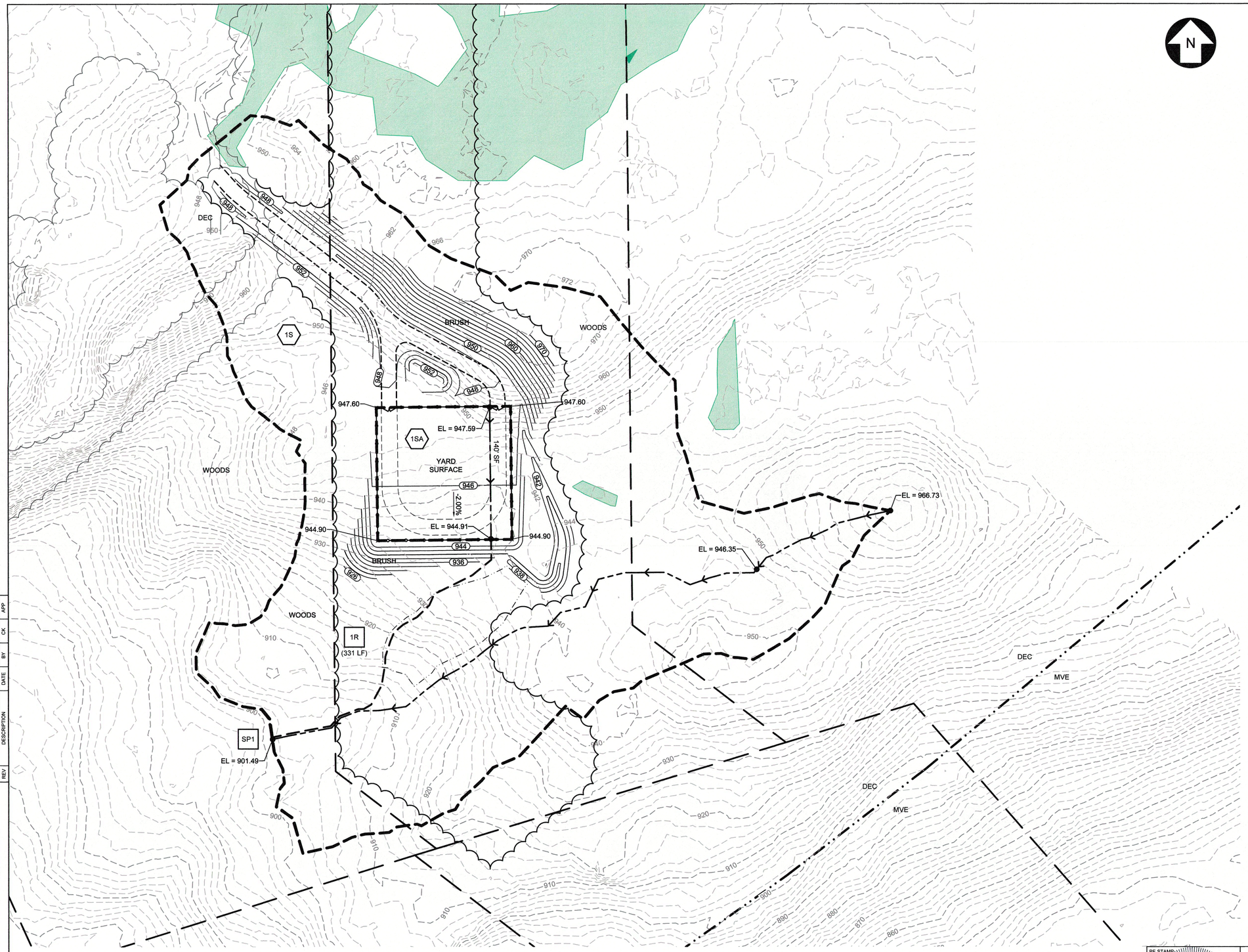
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PRE-DEVELOPMENT WATERSHED PLAN

WEST FORKS STATION

NECEC HVDC LINE — MOXIE GORE & WEST FORKS, ME

BY	PGT/TRC	SCALE: AS NOTED	FILE: 315641 Watershed.dwg
CK	PGT/TRC	NO.	REV
APP	SGL/TRC	315641 SW-1	0-0B
DATE	10/05/2018		



SOILS LEGEND		
MAP UNIT SYMBOL	MAP UNIT NAME	HSG RATING
DEC	DANFORTH-ELLIOTTSVILLE ASSOCIATION, 3 TO 15 PERCENT SLOPES	B
MOB	MONARDA-BURNHAM COMPLEX, 0 TO 3 PERCENT SLOPES, VERY STONY	D
MTB	MONARDA-TELOS COMPLEX, 0 TO 8 PERCENT SLOPES, VERY STONY	D
MVE	MONSON-ELLIOTTSVILLE-KNOB LOCK COMPLEX, 30 TO 60 PERCENT SLOPES, VERY ROCKY	D

WEST FORKS POST-DEVELOPMENT LAND COVER COMPARISON SUMMARY (ACRES)			
COVER TYPE	CN	1S	1SA
ROOFS & FOUNDATIONS	98	0.00	0.01
STONE YARD SURFACE	55	0.00	0.47
GRAVEL ROAD, HSG B	96	0.15	0.00
BRUSH, HSG B	67	0.48	0.00
WOODS, HSG B	66	4.92	0.00
TOTAL AREA		5.55	0.48

LEGEND

- SUBCATCHMENTBOUNDARY
- TIME OF CONCENTRATION FLOW LINE
- REACH
- 100' SF — SHEET FLOW
- 100' SCF — SHALLOW CONCENTRATED FLOW
- 100' CF — CHANNEL FLOW
- EL. 520.0± — SPOT ELEVATION
- 1R — REACH ID
- 1S — SUBCATCHMENT ID
- 1P — POND ID
- SP1 — STUDY POINT ID
- RIGHT OF WAY
- SOILS
- 100 — EXISTING CONTOUR
- 100 — PROPOSED CONTOUR
- TREELINE
- WETLAND

811 DigSafe MA ME NH RI VT

ISSUE FOR PERMITTING
NOT FOR CONSTRUCTION

INSTALL

50 0 50 100 FT
SCALE: 1" = 50'

REV	DESCRIPTION	DATE	BY	CK	APP
B	IFP - ISSUED FOR PERMITTING	10/11/2018	CMW	PGT	SGL
A	IFR - ISSUE FOR REVIEW	10/05/2018	KAV	PGT	CK
					BY
					APP

LOGO: TRC
INFO: TRC, 249 WESTERN AVENUE AUGUSTA, MAINE 04330, 207-621-7000
PROJECT NO:315641
ANSI D 10/19/2018

PE STAMP: STATE OF MAINE, RICKY A. YOUNG, 12082, LICENSED PROFESSIONAL ENGINEER, Oct. 19, 2018

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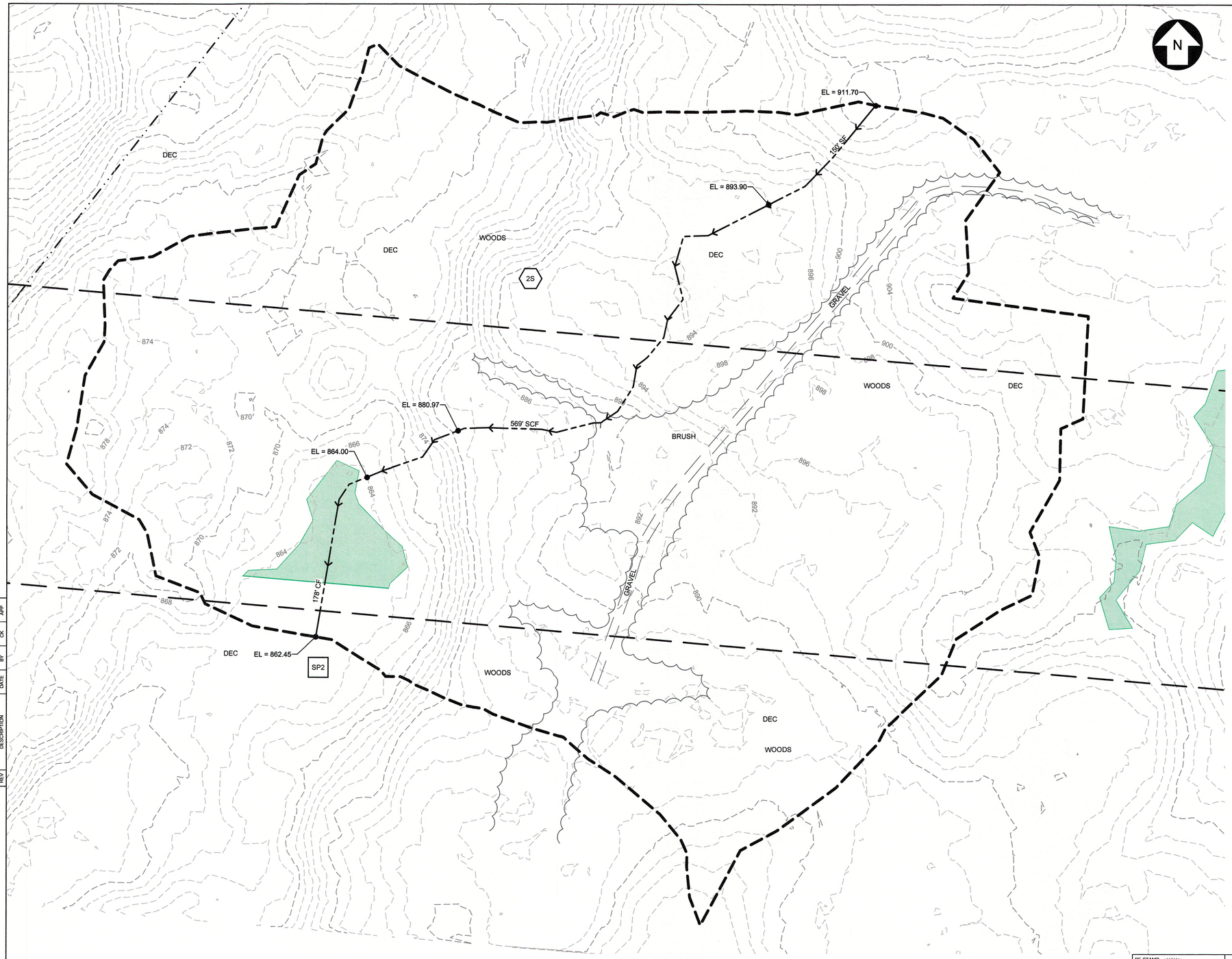
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POST-DEVELOPMENT WATERSHED PLAN

WEST FORKS STATION

NECEC HVDC LINE — MOXIE GORE & WEST FORKS, ME

BY	PGT/TRC	SCALE: AS NOTED	FILE: 315641 Watershed.dwg
CK	PGT/TRC	NO.	REV
APP	SGL/TRC	315641 SW-2	0-0B
DATE	10/05/2018		



SOILS LEGEND		
MAP UNIT SYMBOL	MAP UNIT NAME	HSG RATING
DEC	DANFORTH-ELLIOTTSVILLE ASSOCIATION, 3 TO 15 PERCENT SLOPES	B
MOB	MONARDA-BURNHAM COMPLEX, 0 TO 3 PERCENT SLOPES, VERY STONY	D
MTB	MONARDA-TELOS COMPLEX, 0 TO 8 PERCENT SLOPES, VERY STONY	D
MVE	MONSON-ELLIOTTSVILLE-KNOB LOCK COMPLEX, 30 TO 60 PERCENT SLOPES, VERY ROCKY	D

MOXIE GORE PRE-DEVELOPMENT LAND COVER COMPARISON SUMMARY (ACRES)		
COVER TYPE	HSG	2S
ROOFS & FOUNDATIONS	98	0.00
STONE YARD SURFACE	55	0.00
GRAVEL ROAD, HSG B	96	0.25
BRUSH, HSG B	67	0.58
WOODS, HSG B	66	11.57
TOTAL AREA		12.40

LEGEND

- SUBCATCHMENTBOUNDARY
- TIME OF CONCENTRATION FLOW LINE
- REACH
- 100' SF — SHEET FLOW
- 100' SCF — SHALLOW CONCENTRATED FLOW
- 100' CF — CHANNEL FLOW
- EL. 520.0± — SPOT ELEVATION
- 1R — REACH ID
- 1S — SUBCATCHMENT ID
- 1P — POND ID
- SP1 — STUDY POINT ID
- RIGHT OF WAY
- SOILS
- 100 — CONTOUR
- TREELINE
- WETLAND

REV	DESCRIPTION	DATE	BY	CK	APP
B	IFP - ISSUED FOR PERMITTING	10/17/2018	CMW	PGT	SGL
A	IFR - ISSUE FOR REVIEW	10/05/2018	KVJ	PGT	SGL

50 0 50 100 FT
SCALE: 1" = 50'

ANSI D 10/18/2018

LOGO TRC PROJECT NO: 315641

INFO TRC 249 WESTERN AVENUE AUGUSTA, MAINE 207-621-7000

ISSUE FOR PERMITTING
NOT FOR CONSTRUCTION

INSTALL

PE STAMP: STATE OF MAINE — RICKY A YOUNG No. 6422 — LICENSED PROFESSIONAL ENGINEER — OCT. 19 2018

AVANGRID ENGINEERING
CONFIDENTIAL, PROPRIETARY and TRADE SECRET INFORMATION
Property of AVANGRID

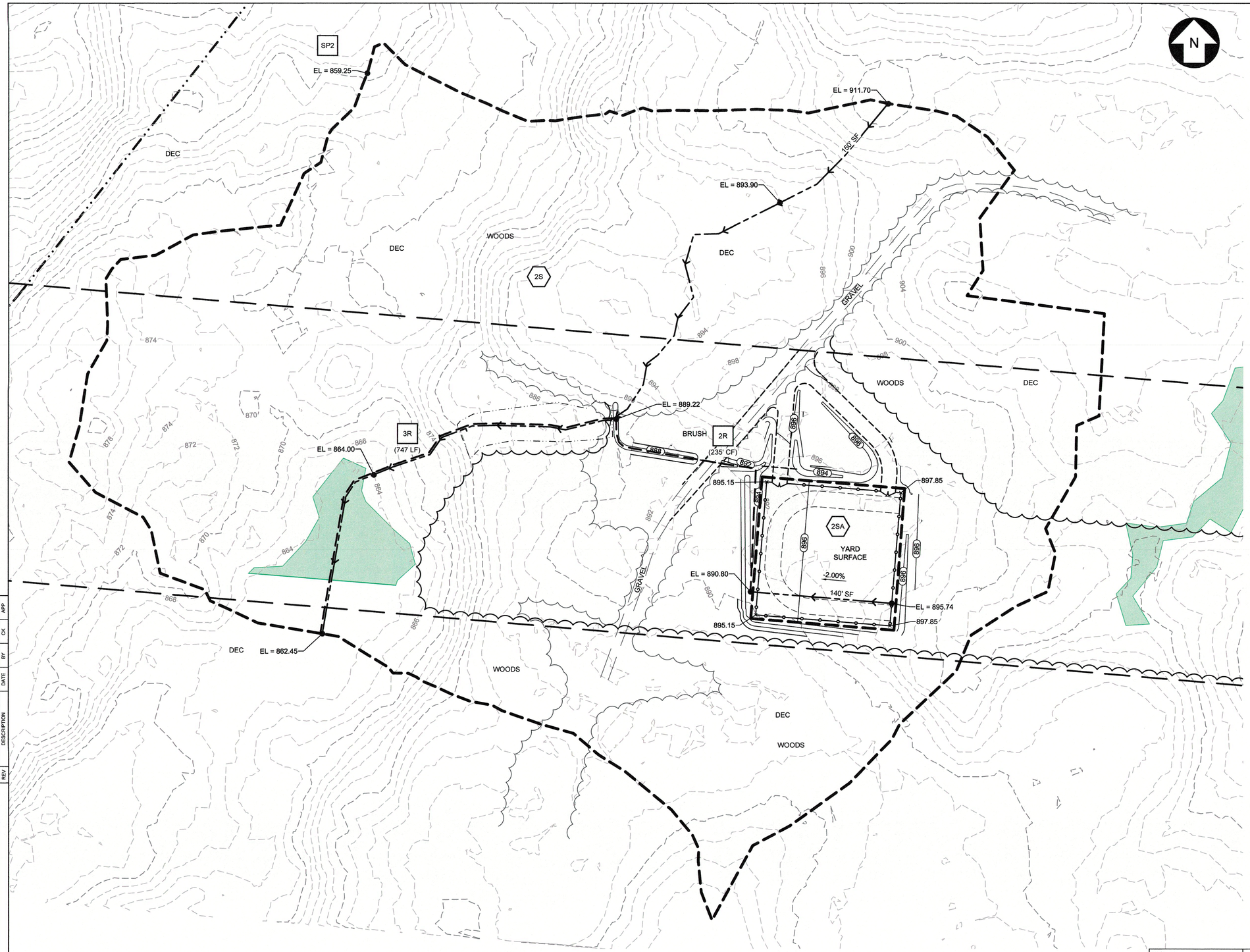
CMP AVANGRID

PRE-DEVELOPMENT WATERSHED PLAN

MOXIE GORE STATION

NECEC HVDC LINE — MOXIE GORE & WEST FORKS, ME

BY	PGT/TRC	SCALE: AS NOTED	FILE: 315641 Watershed.dwg
CK	PGT/TRC	NO.	REV
APP	SGL/TRC	315641 SW-3	0-0B
DATE	10/05/2018		



SOILS LEGEND		
MAP UNIT SYMBOL	MAP UNIT NAME	HSG RATING
DEC	DANFORTH-ELLIOTTSVILLE ASSOCIATION, 3 TO 15 PERCENT SLOPES	B
MOB	MONARDA-BURNHAM COMPLEX, 0 TO 3 PERCENT SLOPES, VERY STONY	D
MTB	MONARDA-TELOS COMPLEX, 0 TO 8 PERCENT SLOPES, VERY STONY	D
MVE	MONSON-ELLIOTTSVILLE-KNOB LOCK COMPLEX, 30 TO 60 PERCENT SLOPES, VERY ROCKY	D

MOXIE GORE POST-DEVELOPMENT LAND COVER COMPARISON SUMMARY (ACRES)			
COVER TYPE	HSG	2S	2SA
ROOFS & FOUNDATIONS	98	0.00	0.01
STONE YARD SURFACE	55	0.00	0.47
GRAVEL ROAD, HSG B	96	0.38	0.00
BRUSH, HSG B	67	0.83	0.00
WOODS, HSG B	66	10.71	0.00
TOTAL AREA		11.92	0.48

LEGEND

- SUBCATCHMENTBOUNDARY
- TIME OF CONCENTRATION FLOW LINE
- REACH
- 100' SF — SHEET FLOW
- 100' SCF — SHALLOW CONCENTRATED FLOW
- 100' CF — CHANNEL FLOW
- EL. 520.0± — SPOT ELEVATION
- 1R — REACH ID
- 1S — SUBCATCHMENT ID
- 1P — POND ID
- SP1 — STUDY POINT ID
- RIGHT OF WAY
- SOILS
- 100 — EXISTING CONTOUR
- 100 — PROPOSED CONTOUR
- TREELINE
- WETLAND

REV	DESCRIPTION	DATE	BY	CK	APP
B	IFP - ISSUE FOR PERMITTING	10/17/2018	CMW	PGT	SGL
A	IFR - ISSUE FOR REVIEW	10/05/2018	AAV	PGT	SGL

INFO
TRC
249 WESTERN AVENUE
AUGUSTA, ME 04330
207-621-7000

LOGO
TRC
PROJECT NO.315641

ANSI D 10/19/2018

50 0 50 100 FT
SCALE: 1" = 50'

PE STAMP
STATE OF MAINE
RICKY A. CYR
No. 14422
LICENSED PROFESSIONAL ENGINEER
10/19/2018

AVANGRID ENGINEERING
CONFIDENTIAL, PROPRIETARY and TRADE SECRET INFORMATION
Property of AVANGRID

CMP AVANGRID

ISSUE FOR PERMITTING
NOT FOR CONSTRUCTION

INSTALL

POST-DEVELOPMENT WATERSHED PLAN

MOXIE GORE STATION

NECEC HVDC LINE — MOXIE GORE & WEST FORKS, ME

BY	PGT/TRC	SCALE: AS NOTED	FILE: 315641 Watershed.dwg
CK	PGT/TRC	NO.	REV
APP	SGL/TRC	315641 SW-4	0-0B
DATE	10/05/2018		

Exhibit 16-1: Groundwater Quality Analysis Memorandum from Megan Desrosiers, Maine Geologist #588

Memorandum

BURNS McDONNELL

Date: January 30, 2024

To: Mr. Gerry J. Mirabile, Director Permitting & Compliance – NECEC Transmission LLC

From: Megan Desrosiers, Maine Geologist #588

Subject: NECEC Kennebec River Horizontal Directional Drilling (HDD) Water Supply Groundwater Quantity and Quality Analysis

This memo summarizes the hydrogeologic data that have been assembled to satisfy the requirements of Section 16: Water Supply of the Maine Site Location of Development Act (38 M.R.S.A. §§ 481-490) permit application minor revision, which is being submitted by NECEC Transmission LLC ("NECEC LLC") in support of a horizontal directional drilling (HDD) boring construction under the Kennebec River. Two temporary bedrock wells are proposed as part of this project to provide process (non-potable) water supply for the drilling operation. One well is proposed for each side of the Kennebec River (to the northwest in West Forks Plantation and to the southeast in Moxie Gore). The wells will be installed within the temporary workspaces and within the limits of disturbance, water will be used only for construction, and wells will be properly abandoned in accordance with the Maine Well Drillers and Pump Installers Rules when construction is complete. The locations of the proposed temporary wells and associated termination stations are shown on the attached figure.

Both temporary wells are expected to be in use for at least six months. The target water usage per temporary well is approximately 8,000 to 12,000 gallons per day, with a combined water usage of approximately 16,000-24,000 gallons per day. The project will require approximately 1,000,000 gallons of water.

The Maine Geological Survey (MGS) has published a variety of resources, which were reviewed to conclude that a sufficient and healthful (although water will be used exclusively for HDD operations and will not be consumed) groundwater supply may be available to support the requirements of the individual water supply wells to be installed at the proposed workspaces. Further discussion of the information used to support this conclusion is included below.

Surficial deposits at the proposed termination stations in Moxie Gore and West Forks Plantation are mapped as till (t) (MGS Open-File Report No. SGMM, 1985). Till is a heterogeneous mixture of sand, silt, clay and stones. The till may include many boulders, but in many places contains beds and lenses of variably washed and stratified sediments. The surficial geology mapping is consistent with the Danforth-Elliottsville association mapped beneath the proposed temporary well locations by the United States Department of Agriculture Soil Conservation Science (USDA-SCS, 2009). The Danforth-Elliottsville association is characterized by loamy and coarse-loamy supraglacial meltout till derived from slate.

Water supply wells are commonly drilled into underlying unconsolidated sand and gravel aquifers, where available. The closest significant sand and gravel aquifer is mapped approximately 0.45 mile southwest of the proposed Moxie Gore termination station and workspace and approximately 0.52 mile south of the West Forks Plantation termination station and workspace (MGS Open-File Report No. 08-13, 2008). The location of the proposed Moxie Gore workspace is within the same groundwater drainage basin as the closest significant sand and gravel aquifer. The location of the proposed West Forks Plantation workspace is within the adjacent groundwater drainage basin.

In areas where unconsolidated materials are not capable of providing a sufficient water supply, bedrock water supply wells are typically constructed. Structural features of the bedrock unit, such as porosity, fracture zones, and joints, can store reservoirs capable of supplying bedrock water supply wells. Bedrock beneath the proposed termination station and workspace in Moxie Gore is mapped as a Devonian pelite of the Carrabassett Formation, which is a marine sandstone and slate (MGS Open-File Report No. BGMM, 1985). Bedrock beneath the proposed termination station and workspace in West Forks Plantation is mapped as a Silurian limy marine shale of The Forks Formation (MGS Open-File Report No. BGMM, 1985).

MGS has compiled Bedrock Groundwater Resources Maps that provide the yield, depth and estimated overburden (i.e., depth to bedrock) thickness for approximately 663 to 669 bedrock wells mapped on the 30 x 60-minute Dover-Foxcroft Quadrangle. There are no mapped bedrock wells within one mile of either proposed temporary well location. One bedrock well is approximately 2 to 2.5 miles from the proposed temporary well locations, and the next three closest bedrock wells are approximately 2.7 to 3 miles from the proposed temporary well. Six additional bedrock wells have been mapped since the 2010 publications and information for these wells is available in the online MGS Well Database Digital Map Viewer (MGS, 2024). These bedrock wells are mapped approximately 1.3 to 1.5 miles, 1.3 to 1.8 miles, 1.7 to 2.3 miles, 2.5 to 2.6 miles, 2.6 to 2.7 miles, and 2.7 to 3 miles from each of the respective proposed temporary well locations.

Depths of the wells are provided on the Bedrock Depth map (MGS Open-File Report No. 10-40, 2010) and on the online MGS Well Database Digital Map Viewer. The depths of the three closest wells (i.e., less than 2.5 miles) are 185 to 500 feet. The depths of the six wells 2.5 to 3 miles from the proposed temporary well locations are 205 to 400 feet. Overburden thickness is estimated at 0 to 70 feet at the bedrock wells located within three miles of the proposed temporary well locations (MGS Open-File Report No. 10-41, 2010 and MGS Well Database Digital Map Viewer, 2024).

Yield for the 10 bedrock wells located within three miles of the proposed temporary well locations is provided on the Bedrock Yield map (MGS Open-File Report No. 10-42, 2010 and the MGS Well Database Digital Map Viewer, 2024). The three closest bedrock wells (located 1.3 to 2 miles from the proposed temporary well locations) have yields of between 1 and 20 gallons per minute (gpm). The three bedrock wells located approximately 2.5 to 3 miles from the proposed temporary well locations have yields of between 1 and 15 gpm, with one bedrock having a yield between 25 and 50 gpm.

According to the Maine Department of Health and Human Services, Division of Environmental and Community Health Drinking Water Program, the most common source of drinking water for homes in Maine is a drilled bedrock well, and the typical bedrock well is six inches in diameter, 100 to 500 or more feet deep, and has a yield of less than 10 gpm. A deeper well typically has a greater storage capacity than a shallower well, which would affect the well's ability to recover and yield water. The Maine Well Drillers and Pump Installers Rules (10 CMR 232 Table 407.1) recommends minimum bedrock well recovery rates ranging from one-half gpm for a 420-foot deep well to 5 gpm for a 75-foot deep well. The construction for the two proposed bedrock wells is eight inches in diameter and approximately 300 feet deep. The bedrock yield data for bedrock wells in the vicinity of the two proposed termination stations and workspaces is highly variable, ranging from 1 to 50 gpm. Based on this data the construction of the two temporary bedrock wells may meet the above yield rate recommendations to provide a sufficient and healthful supply of groundwater for HDD operations.

There are currently no buildings present near either proposed temporary well location sites. As a best management practice, the wells should be installed greater than 300 feet from the nearest likely site of an existing, non-public water supply well to minimize the risk of pumping interference between wells. Through review of aerial imagery, there are no visible buildings or cleared areas on adjacent properties. Therefore, the temporary wells would be located more than 300 feet from the nearest likely site of an existing, non-public water supply well (proximal to a building and within cleared areas). If the proposed water supply wells operate at more than 2,000 gallons per day, it appears that the distance between the proposed workspaces and the nearest likely bedrock water supply well is sufficient to minimize the risk of pumping interference between wells, as indicated in the Maine Subsurface Waste Disposal Rules (10 CMR 241 Table 7B).

References Cited

Maine Department of Health and Human Services, Division of Environmental Health Drinking Water Program, 2005. CMR Chapter 232 – Well Drillers and Pump Installers Rules.

Maine Department of Health and Human Services, Division of Environmental Health Subsurface Wastewater Program, 2014. CMR Chapter 241 – Subsurface Wastewater Disposal Rules.

Maine Geological Survey Open-File Report No. 10-40, 2010. Bedrock Well Depth in the Dover-Foxcroft 30 x 60-Minute Quadrangle.

Maine Geological Survey Open-File Report No. 10-41, 2010. Overburden Thickness in the Dover-Foxcroft 30 x 60-Minute Quadrangle.

Maine Geological Survey Open-File Report No. 10-42, 2010. Bedrock Well Yield in the Dover-Foxcroft 30 x 60-Minute Quadrangle.

Maine Geological Survey Open-File Report No. 08-13, 2008. Significant Sand and Gravel Aquifers of The Forks Quadrangle, Maine.

Maine Geological Survey Open-File Report No. SGMM, 1985. Surficial Geologic Map of Maine.

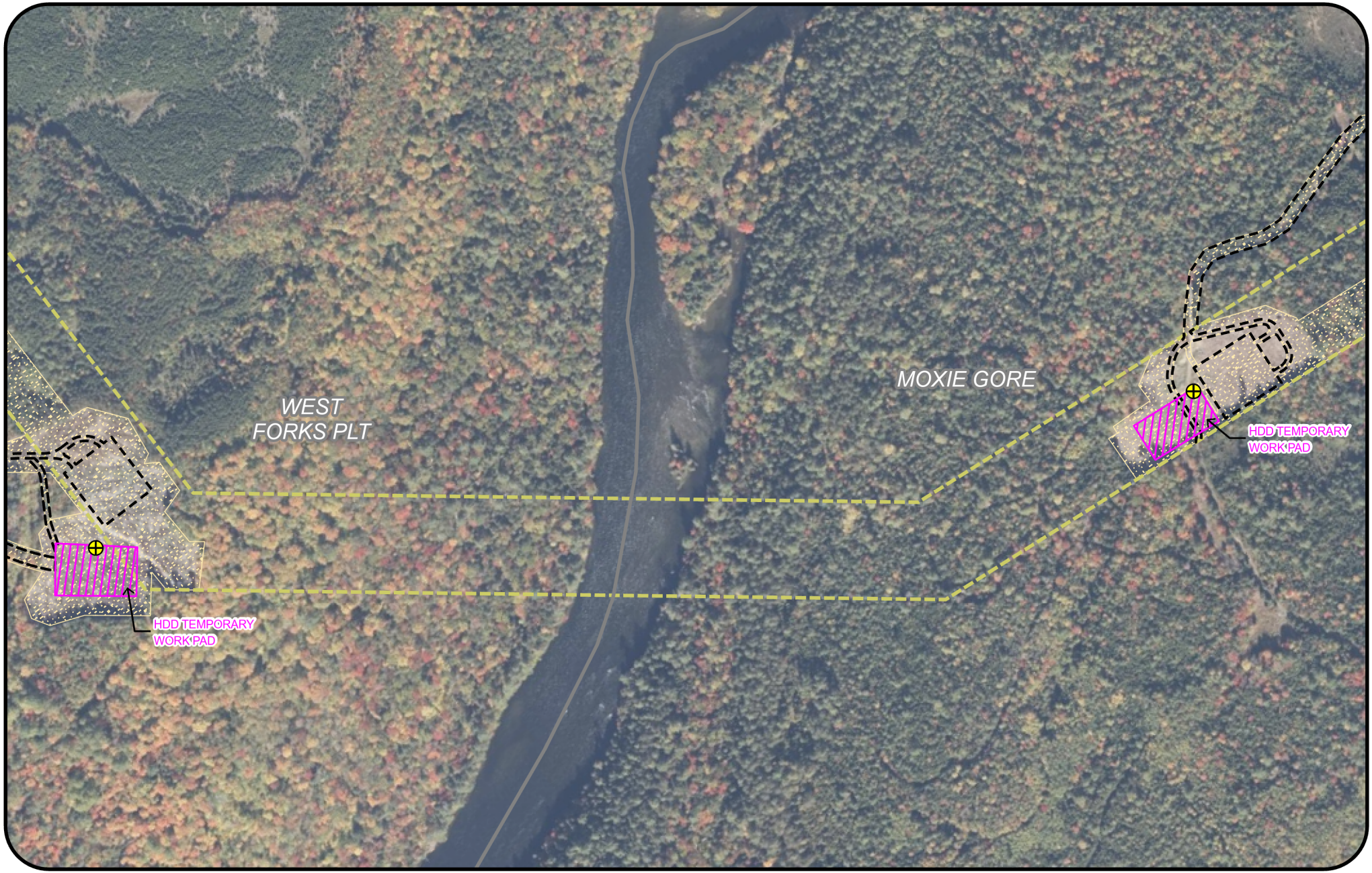
Maine Geological Survey Open-File Report No. 95-55, 1998. Surficial Materials of The Forks Quadrangle, Maine.

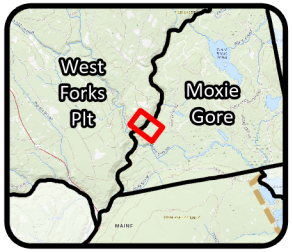
Maine Geological Survey Open-File Report No. BGMM, 1985. Bedrock Geologic Map of Maine.

Maine Geological Survey Well Database Digital Map Viewer. Accessed at https://www.maine.gov/dacf/mgs/pubs/digital/well.htm Viewed on January 9, 2024.

United States Department of Agriculture, Natural Resources Conservation Services, 2009, Soil Survey of Somerset County Area and Parts of Franklin and Oxford Counties, Maine.

FIGURE 1 - HDD TEMPORARY WELL LOCATION MAP





Legend

- Approximate Location of Temporary Well
- HDD Temporary Work Pad
- Termination Station Limit of Disturbance
- Clearing Limits
- NECEC Transmission Line Corridor
- Town Boundary

New England Clean Energy Connect

HDD Temporary Wells

400 Feet

NEW ENGLAND CLEAN ENERGY CONNECT

1/30/2024

Exhibit 17-1: HDD Waste Disposal Facilities Letters

Date: 01/23/2024

Mr. Adam Copeland
The HDD Company
3117 N Cessna Avenue
Casa Grande, Arizona 85122

Re: New England Clean Energy Connect (NECEC) Underground Cable Project, Waste Disposal Request.

Dear Mr. Copeland:

As discussed, NECEC is required to demonstrate to the Maine Department of Environmental Protection (MDEP) that the solid waste management facilities receiving the waste generated during this project construction are appropriately licensed by MDEP, have adequate capacity and are willing to accept solid waste generated by the project.

Please accept this letter of Intent that WM can accept Drilling Mud Solids at the Waste Management Disposal Services of Maine – Norridgewock, Maine -Crossroads Landfill (DEP license # S-010735). Anticipated solids for disposal will be between 1,900 to 4,000 cubic yards. The Crossroads Landfill has the capacity to manage this and will accept these volumes.

Lastly, the intent assumes that the spoils generated from the bores are non-contaminated/non-hazardous material and that analytics will show that the material falls within the limits of the above-listed permit for disposal.

If you have any questions, please contact me at 603-833-1559

Sincerely, Mark Thompson 1/23/2024
Mark Thompson
Account Executive – Industrial Solutions - Special Waste
WM of Maine and New Hampshire

WM of NH & ME

Date: 01/23/2024

Mr. Adam Copeland
The HDD Company
3117 N Cessna Avenue
Casa Grande, Arizona 85122

Re: New England Clean Energy Connect (NECEC)
Horizontal Directional Drilling Wastes Disposal Letter of Intent

Dear Mr. Copeland:

As discussed, NECEC is required to demonstrate to the Maine Department of Environmental Protection (MDEP) that the solid and liquid wastes generated as a result of horizontal directional drilling (HDD) activities will be disposed of at appropriately licensed solid waste management facilities having adequate capacity, and whose owners or operators are willing to accept these wastes for disposal.

Based on our discussions, NECEC HDD operations will generate 110,000-130,000 gallons of bentonite-based drilling fluids. The liquids will be stored in 21,000-gallon bins onsite and will be transported in 5,000-gallon tanker trucks by the appropriate liquid handlers to the disposal facility after the boring hole is completed.

Casella Waste Systems, Inc will provide solidification and disposal of this waste at our Hyland Landfill at 6653 Herdman Road in Angelica, NY. The NY DEC Permit # is 9-0232-003. The transporter will be required to have the NY 364 permit with Hyland Landfill listed on their permit for solidification. Please accept this letter of intent that Casella Waste Systems, Inc. is permitted, has the capacity, and is willing to accept this waste, based on this material being nonhazardous as profiled and approved by our Special Waste Department.

Additionally, Casella Waste Systems, Inc will accept for disposal, drilling mud solids (cuttings) at the Juniper Ridge landfill in Old Town, ME (DEP license #S-020700-WD-BC-A Condition 10). Anticipated volume of this material is between 1,900 and 3,000 cubic yards. Please accept this letter of intent that Casella Waste Systems, Inc. is permitted, has the capacity, and is willing to accept this waste. This intent assumes that these cuttings are non-contaminated/non-hazardous and that analyses confirm that these cuttings meet the Juniper Ridge Landfill MDEP permit's waste constituents limits.

If you have any questions, please contact me at 603-235-3597.

Sincerely,
Scott Sampson

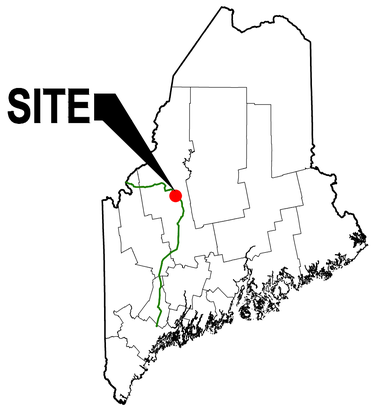
Landfill Account Manager
Casella Waste Systems, Inc

Exhibit 27-1: Permitting Plan Set for NECEC Kennebec River Underground Cable & HDD

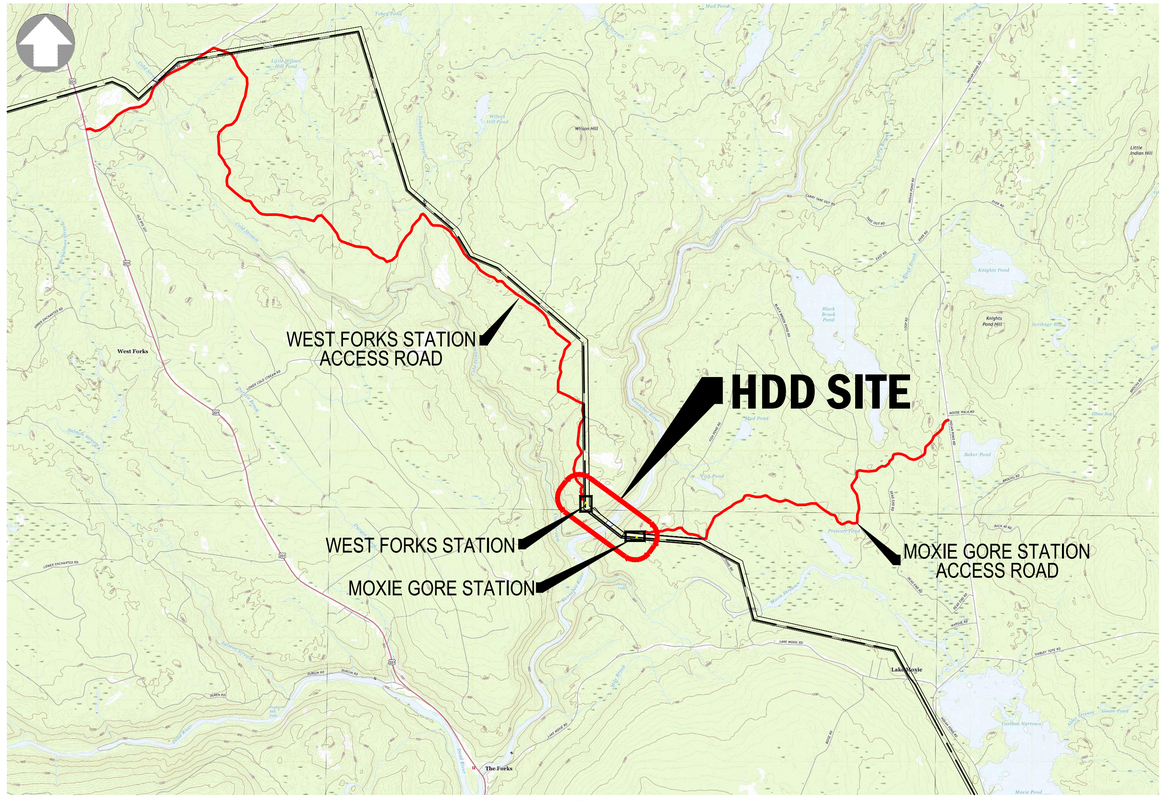
PERMITTING PLAN SET

NECEC KENNEBEC RIVER UNDERGROUND CABLE & HDD

SOMERSET COUNTY
WEST FORKS PLANTATION & MOXIE GORE, MAINE



STATE OF MAINE



LOCATION MAP
SCALE: 1"=4000'

DRAWING INDEX

	COVER SHEET
315641-G-2	VICINITY MAP
1081-0003-001 SH 003	HDD PLAN & PROFILE STA. 0+00 TO 10+00
1081-0003-001 SH 004	HDD PLAN & PROFILE STA. 10+00 TO 25+50
1081-0003-001 SH 005	HDD PLAN & PROFILE STA. 25+50 TO 37+50
1081-0003-001 SH 006	HDD PIPE LAYDOWN & CLEARING PLAN
1081-0003-004 SH 001	MOXIE GORE GRADING PLAN & SECTIONS
1081-0003-004 SH 002	MOXIE GORE TEMPORARY GRADING PLAN
1081-0003-005 SH 001	MOXIE GORE EROSION & SEDIMENT CONTROL PLAN
1081-0003-005 SH 002	EROSION CONTROL GENERAL NOTES
1081-0003-005 SH 003	EROSION CONTROL DETAILS
1081-0003-005 SH 004	EROSION CONTROL DETAILS
1081-0003-005 SH 005	EROSION CONTROL DETAILS
1082-0003-001 SH 001	WEST FORKS ACCESS ROAD PLAN
1082-0003-004 SH 001	WEST FORKS GRADING PLAN & SECTIONS - PHASE 1
1082-0003-004 SH 002	WEST FORKS GRADING PLAN & SECTIONS - PHASE 2
1082-0003-005 SH 001	WEST FORKS EROSION & SEDIMENT CONTROL PLAN

PROJECT GENERAL NOTES

1. CALL BEFORE YOU DIG. PRIOR TO ANY DIGGING OR EARTHWORK ACTIVITIES CALL MAINE DIG SAFE AT 811 OR 1-888-344-7233 AT LEAST 3 BUSINESS DAYS IN ADVANCE OF PLANNED WORK.
2. SURVEY DATA PERFORMED BY OTHERS. FISHER ASSOCIATES, MAKES NO GUARANTEE TO THE ACCURACY OF THE EXISTING SURFACE INFORMATION, PROPERTY LINES OR OTHER LINEWORK.
3. FISHER ASSOCIATES DOES NOT MAKE ANY REPRESENTATION, WARRANTY, ASSURANCE OR GUARANTEE THAT THE INFORMATION RECEIVED PURSUANT TO SAID REQUEST AND AS REFLECTED ON THESE DRAWINGS IS CORRECT OR ACCURATE.

PREPARED FOR:

AVANGRID

CENTRAL MAINE POWER CO.
83 EDISON DRIVE
AUGUSTA, ME 04336

PREPARED BY:

FISHER ASSOCIATES

FISHER ASSOCIATES
180 CHARLOTTE STREET
ROCHESTER, NY 14607

811 DigSafe MA·ME·NH·RI·VT

ISSUED FOR PERMITTING
NOT FOR CONSTRUCTION

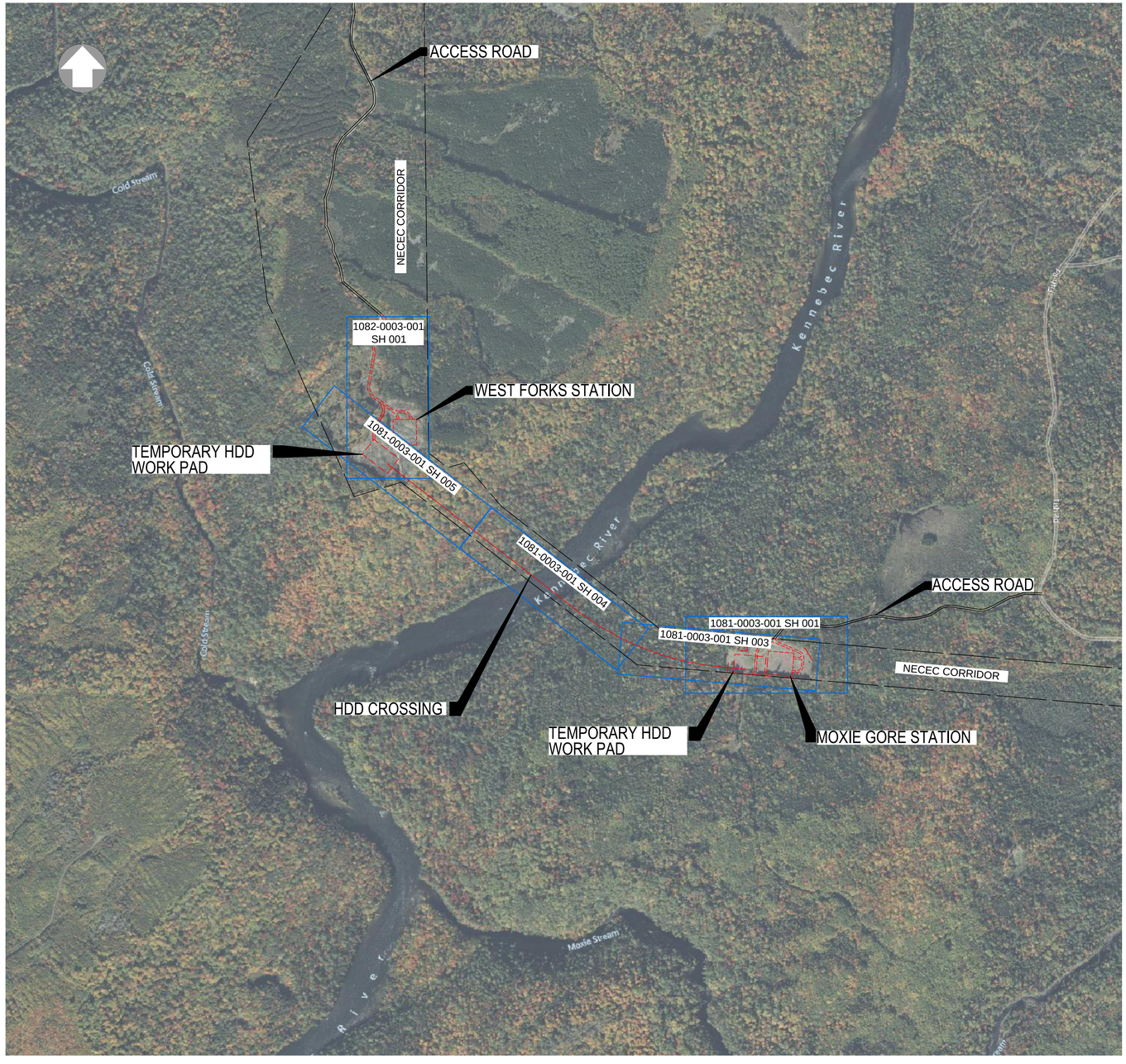
JANUARY 2024

GENERAL NOTES

1. SURVEY BOUNDARY DATA PROVIDED BY:
   SGC ENGINEERING, INC - "KENNEBEC RIVER GORGE" DATED 9-23-10
   DIRIGO PARTNERS, LTD - "WEYCO SURVEY" DATED 12-06-16
2. TOPOGRAPHIC LIDAR DATA PROVIDED BY CMP DATED SEPTEMBER 2018, UNLESS NOTED OTHERWISE.
3. PROJECT PROJECTION: NAD83 UTM ZONE - 19 U.S. FEET.
4. VERTICAL DATUM: NAVD 88 MEASURED IN U.S. FEET.
5. MEDIUM INTENSITY SOILS INFORMATION OBTAINED FROM WEB SOIL SURVEY OF SOMERSET COUNTY, ME.

LEGEND

EXISTING		PROPOSED
	PROPERTY/ROW LINE	
	SETBACK LINE	
	EASEMENT LINE	
	CENTERLINE	
	EDGE OF PAVEMENT	
	CURBING	
	EDGE OF GRAVEL	
	SUBSTATION YARD	
122	CONTOUR	122
	BUILDING	
	STONEWALL	
	TREELINE	
	CHAIN LINK FENCE	
	STOCKADE FENCE	
	BARB WIRE FENCE	
	RETAINING WALL	
	GUARDRAIL	
S	SEWER	S
FM	SEWER FORCE MAIN	FM
G	GAS	G
W	WATER	W
SD	STORM DRAIN	SD
UD	UNDERDRAIN	UD
12" CMP	CULVERT	12" CMP
UGE	UNDERGROUND ELECTRIC	UGE
	OVERHEAD TRANSMISSION	
	IRON PIPE/REBAR	
	MONUMENT	
	SURVEY CONTROL POINT	
X124.6	SPOT ELEVATION	
12" CMP	SEWER MANHOLE	12" CMP
Ⓢ	DRAINAGE MANHOLE	
Ⓓ	CATCH BASIN	
	ELECTRIC MANHOLE	
Ⓔ	SHUTOFF VALVE	
	HYDRANT	
	UTILITY POLE	
	LIGHT POLE	
	MATTCHLINE	
	LIMIT OF DISTURBANCE	
	SILT FENCE	
	FILTER SOCK	
	RIPRAP	
	EDGE OF WATER	
	STREAM	
	WETLANDS	
	DRAINAGE FLOW	
	DRAINAGE SWALE	
	SIGN	
	SOIL BORING	
	TRENCH	



VICINITY MAP & SITE PLAN DRAWING INDEX
SCALE: 1"=500'

ISSUED FOR PERMITTING
NOT FOR CONSTRUCTION

INSTALL

811 DigSafe MA ME NH RI VT

REV	DESCRIPTION	DATE	BY	CK	APP
0-1	ISSUED FOR PERMITTING	12/7/2023	DJFSA	RWFSA	RWFSA
0-0	ISSUED FOR PERMITTING	11/3/2023	DJFSA	RWFSA	RWFSA
1-0	ISSUED FOR CONSTRUCTION	08/31/2022	DJFSA	RWFSA	RWFSA
0-A	ISSUED FOR REVIEW	04/22/2021	JEC	SSS	SSS

PE STAMP
STATE OF MAINE
ROSEMARY WIGHTMAN
No. 16457
REGISTERED PROFESSIONAL ENGINEER

AVANGRID ENGINEERING
CONFIDENTIAL, PROPRIETARY and TRADE SECRET INFORMATION
Property of AVANGRID

NECEC AVANGRID

GENERAL NOTES, LEGEND & VICINITY MAP

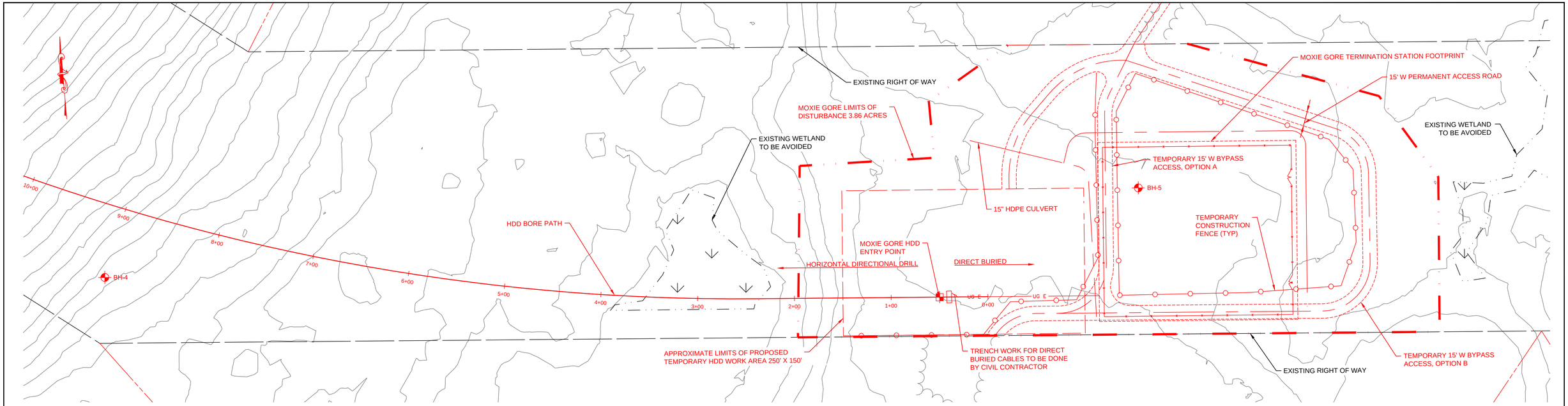
NECEC HVDC LINE — MOXIE GORE & WEST FORKS, ME

BY	DJFSA	SCALE: AS NOTED	FILE: 315641-G-2.dwg
CK	RWFSA	NO.	
APP	RWFSA		
DATE	01/23/2024		

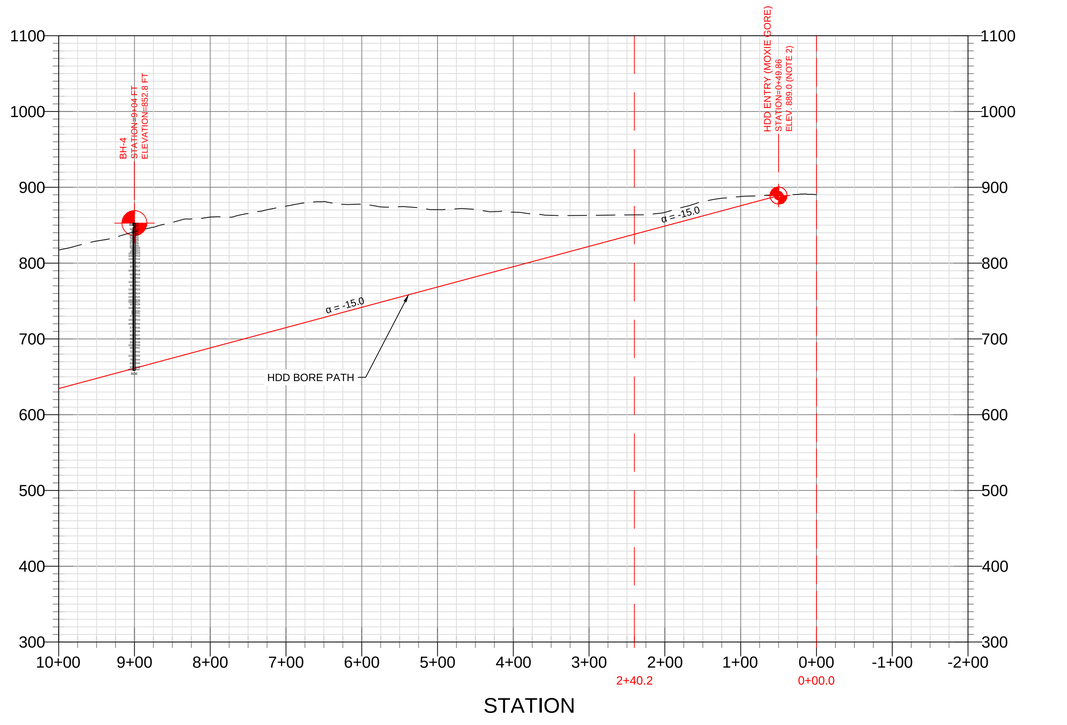
315641-G-2 | REV 0-1

Realtime Utility Engineers, Inc.
284 Huntington Ave, Suite 100
Fitchburg, MA 01379
(800) 287-4078

INFO
LOGO
ANSI D 1/23/2024



HDD Plan View (STA. 0+00 TO 10+00)
1"=50'



HDD Profile View (STA. 0+00 TO 10+00)
HORZ: 1"=50'
VERT: 1"=50'

0 50 100 150
SCALE: 1"=50'

GENERAL BORING NOTES

1. PROPOSED HDD ALIGNMENT IS APPROXIMATE. PILOT HOLE BORE PATH SHALL BE INSTALLED WITH THE FOLLOWING TOLERANCES:
   - 1.1. ENTRY AND EXIT LOCATION WILL BE WITHIN 25 FEET OF PROPOSED LOCATIONS.
   - 1.2. PLAN VIEW HORIZONTAL ALIGNMENT WITHIN +/– 10 FEET OF PROPOSED ALIGNMENT.
   - 1.3. BORE PATH ELEVATIONS WILL MAINTAIN MINIMUM 75 FEET OF CLEARANCE BENEATH THE BOTTOM OF THE KENNEBEC RIVER.
   - 1.4. DRILL PATH COORDINATES IN PROFILE VIEW REFER TO THE CENTERLINE OF THE PILOT HOLE AND NOT TO THE TOP OF THE BORE.
2. DESIGN ELEVATION OF TEMPORARY HDD WORK AREA. ACTUAL ELEVATIONS MAY VARY (+/– 2.5FT) AS NEEDED.

REV	DESCRIPTION	DATE	BY	CK	APP
0-1	ISSUED FOR PERMITTING	12/19/2023	DJFSA	RWFSA	RWFSA
0-0	ISSUED FOR PERMITTING	11/3/2023	DJFSA	RWFSA	SSSFSA
0-A	ISSUED FOR REVIEW	04/22/2021	JECFSA	SSSFSA	APP

LOGO
REALTIME Utility Engineers
INFO
Realtime Utility Engineers, Inc.
284 Huntington Avenue, Suite 100
Fairbury, NE 68319
(800) 551-1478

ANSI D 1/22/2024

ISSUED FOR PERMITTING
NOT FOR CONSTRUCTION

INSTALL

PE STAMP
STATE OF MAINE
ROMEO SHIPLEE
No. 16932
LICENSED PROFESSIONAL ENGINEER

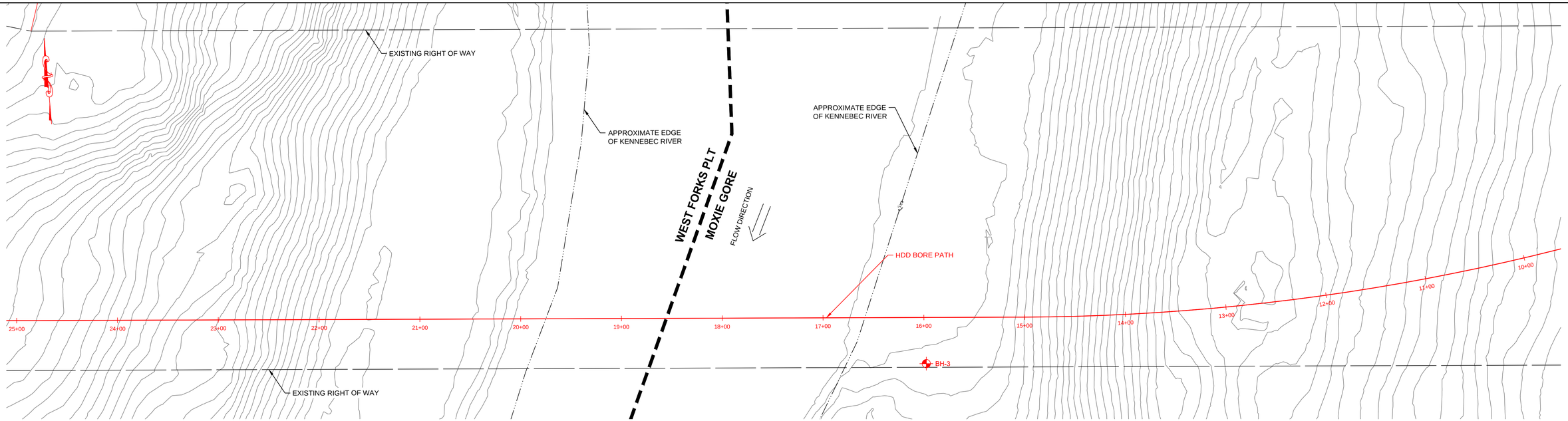
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CONFIDENTIAL, PROPRIETARY and TRADE SECRET INFORMATION
Property of AVANGRID

NECEC AVANGRID

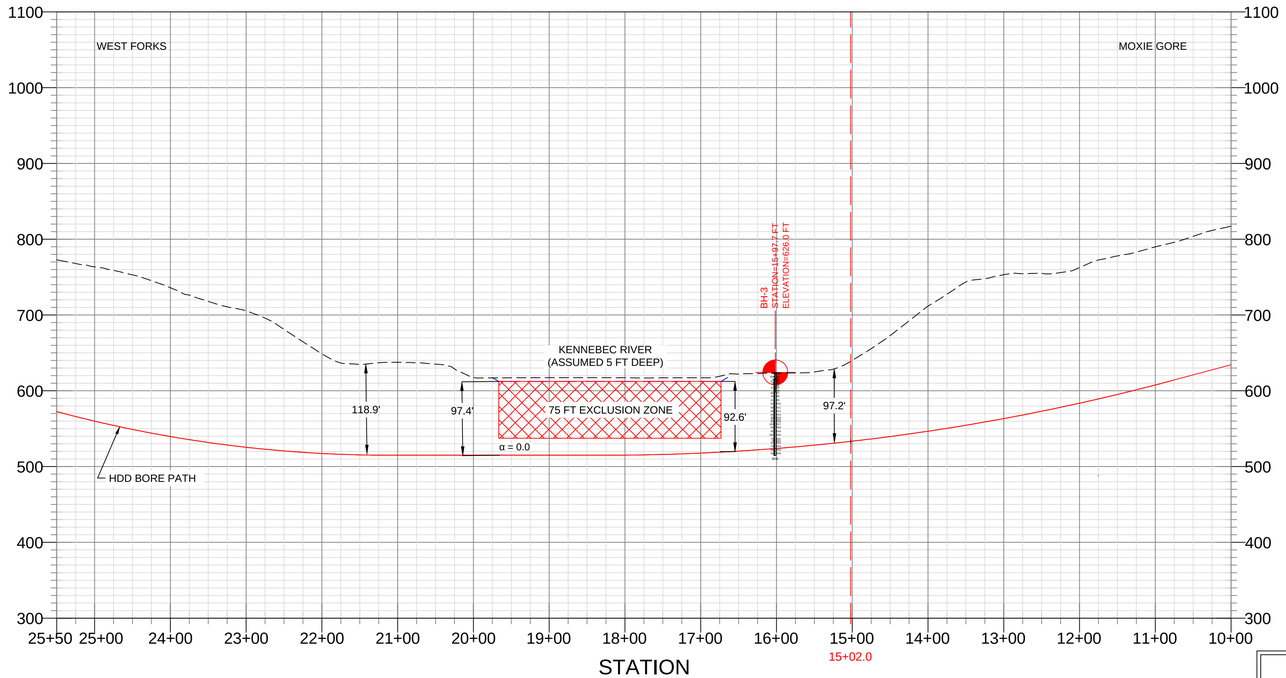
HDD PLAN & PROFILE STA. 0+00 TO 10+00

NECEC HVDC LINE MOXIE GORE & WEST FORKS, ME

BY	DJFSA	SCALE: AS NOTED	FILE: 1081-0003-001 SH 004.dwg
CK	RWFSA	NO.	REV
APP	RWFSA	1081-0003-001 SH 003	0-1
DATE	01/23/2024		



HDD Plan View (STA. 10+00 TO 25+50)
1"=50'



HDD Profile View (STA. 10+00 TO 25+50)
HORZ: 1"=50'
VERT: 1"=50'

0 50 100 150
SCALE: 1"=50'

ISSUED FOR PERMITTING
NOT FOR CONSTRUCTION

INSTALL

GENERAL BORING NOTES

1. PROPOSED HDD ALIGNMENT IS APPROXIMATE. PILOT HOLE BORE PATH SHALL BE INSTALLED WITH THE FOLLOWING TOLERANCES:
   - 1.1. ENTRY AND EXIT LOCATION WILL BE WITHIN 25 FEET OF PROPOSED LOCATIONS.
   - 1.2. PLAN VIEW HORIZONTAL ALIGNMENT WITHIN +/– 10 FEET OF PROPOSED ALIGNMENT.
   - 1.3. BORE PATH ELEVATIONS WILL MAINTAIN MINIMUM 75 FEET OF CLEARANCE BENEATH THE BOTTOM OF THE KENNEBEC RIVER.
   - 1.4. DRILL PATH COORDINATES IN PROFILE VIEW REFER TO THE CENTERLINE OF THE PILOT HOLE AND NOT TO THE TOP OF THE BORE.
2. DESIGN ELEVATION OF TEMPORARY HDD WORK AREA. ACTUAL ELEVATIONS MAY VARY (+/– 2.5FT) AS NEEDED.

REV	DESCRIPTION	DATE	BY	CK	APP
0-1	ISSUED FOR PERMITTING	12/7/2023	DJFSA	RWFSA	RWFSA
0-0	ISSUED FOR PERMITTING	11/3/2023	DJFSA	RWFSA	SSSFSA
00A	ISSUED FOR REVIEW	04/22/2021	JEJFSA	SSSFSA	SSSFSA

INFO
Realtime Utility Engineers, Inc.
200 Millennium Way, Ste 101
Pittsford, NY 14519
(585) 250-1470

LOGO
REALTIME Utility Engineers

ANSI D 1/22/2024

PE STAMP
STATE OF MAINE
ROMEO SHIPCSE
No. 16932
LICENSED PROFESSIONAL ENGINEER

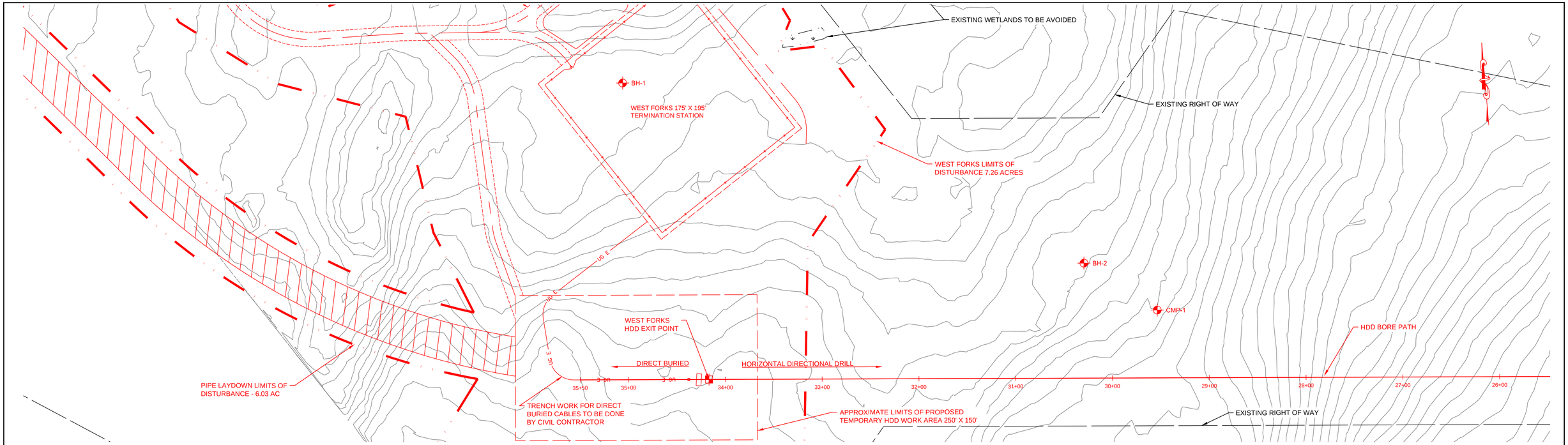
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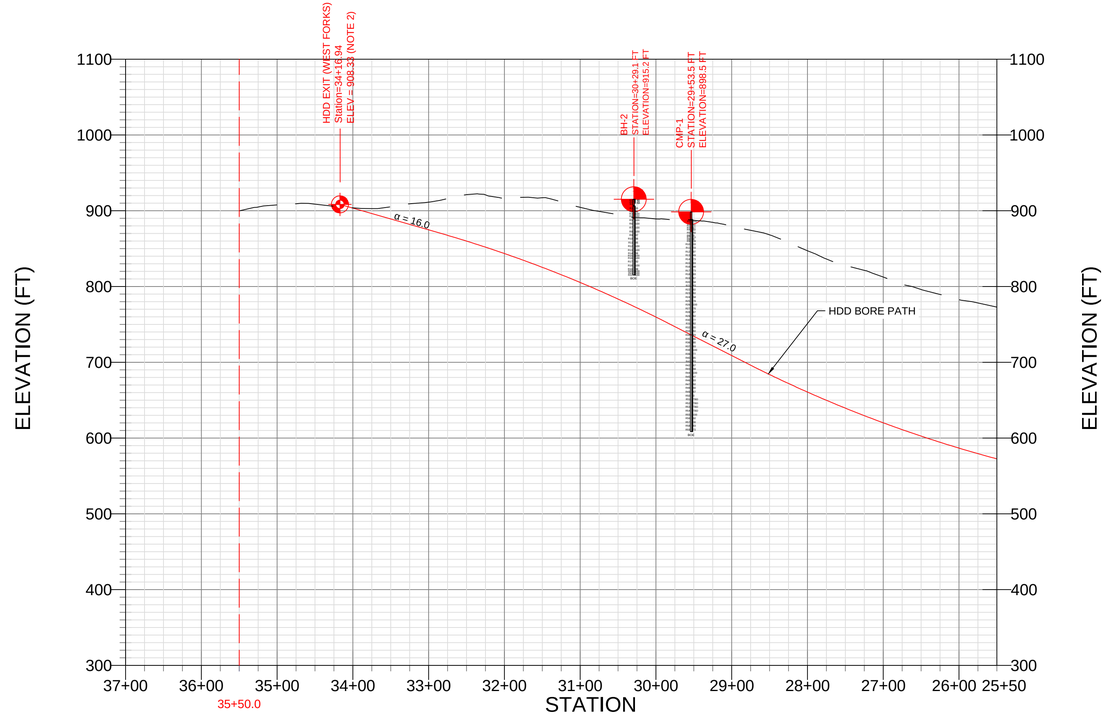
HDD PLAN & PROFILE STA. 10+00 TO 25+50

NECEC HVDC LINE — MOXIE GORE & WEST FORKS, ME

BY	DJFSA	SCALE: AS NOTED	FILE: 1081-0003-001 SH 004.dwg
CK	RWFSA	NO.	REV
APP	RWFSA	1081-0003-001 SH 004	0-1
DATE	01/23/2024		



HDD Plan View (STA. 25+50 TO 37+00)
1"=50'



HDD Profile View (STA. 25+50 TO 37+00)
HORZ: 1"=50'
VERT: 1"=50'

0 50 100 150
SCALE: 1"=50'

GENERAL BORING NOTES

1. PROPOSED HDD ALIGNMENT IS APPROXIMATE. PILOT HOLE BORE PATH SHALL BE INSTALLED WITH THE FOLLOWING TOLERANCES:
   - 1.1. ENTRY AND EXIT LOCATION WILL BE WITHIN 25 FEET OF PROPOSED LOCATIONS.
   - 1.2. PLAN VIEW HORIZONTAL ALIGNMENT WITHIN +/- 10 FEET OF PROPOSED ALIGNMENT.
   - 1.3. BORE PATH ELEVATIONS WILL MAINTAIN MINIMUM 75 FEET OF CLEARANCE BENEATH THE BOTTOM OF THE KENNEBEC RIVER.
   - 1.4. DRILL PATH COORDINATES IN PROFILE VIEW REFER TO THE CENTERLINE OF THE PILOT HOLE AND NOT TO THE TOP OF THE BORE.
2. DESIGN ELEVATION OF TEMPORARY HDD WORK AREA. ACTUAL ELEVATIONS MAY VARY (+/- 2.5FT) AS NEEDED.

REV	DESCRIPTION	DATE	BY	CK	APP
0.1	ISSUED FOR PERMITTING	12/19/2023	DJFSA	RWFSA	RWFSA
0.0	ISSUED FOR PERMITTING	11/3/2023	DJFSA	RWFSA	RWFSA
0.0A	ISSUED FOR REVIEW	04/22/2021	JEVFSA	SSGFSA	SSGFSA

INFO
Realtime Utility Engineers, Inc.
2500 Wharton Way, Suite 200
Folsom, WI 53319
(800) 432-1416

LOGO
REALTIME Utility Engineers

ANSI D 1/22/2024

ISSUED FOR PERMITTING
NOT FOR CONSTRUCTION

INSTALL

PE STAMP
STATE OF MAINE
ROMEO SHIPLEE
No. 12932
LICENSED
PROFESSIONAL ENGINEER

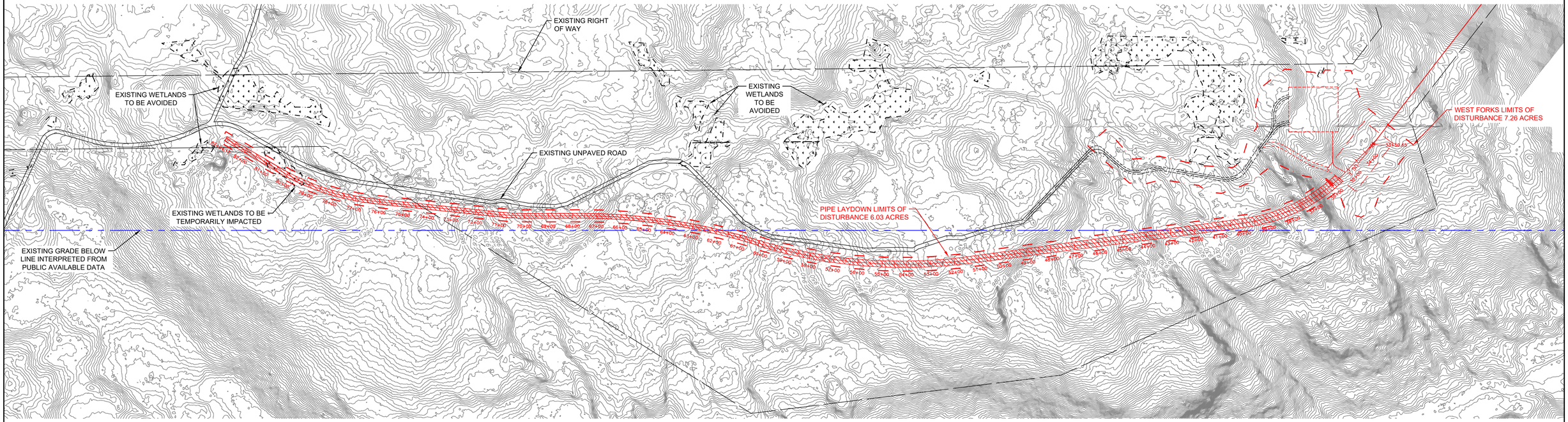
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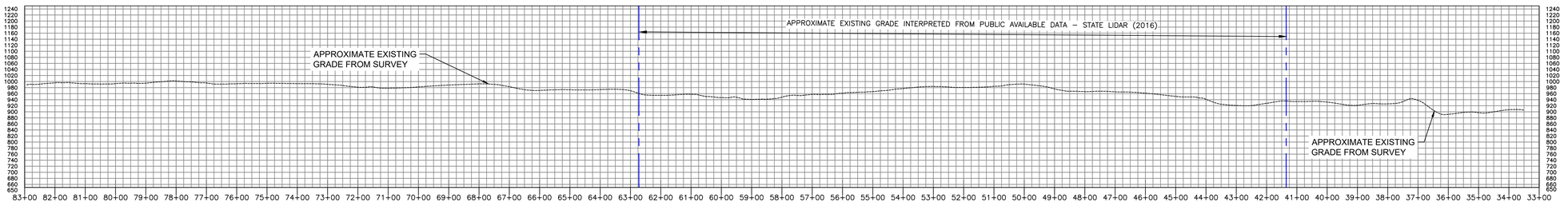
HDD PLAN & PROFILE STA. 25+50 TO 37+00

NECEC HVDC LINE MOXIE GORE & WEST FORKS, ME

BY	DJFSA	SCALE: AS NOTED	FILE: 1081-0003-001 SH 005.dwg
CK	RWFSA	NO.	REV
APP	RWFSA	1081-0003-001 SH 005	0-1
DATE	01/23/2024		



HDD Pipe Laydown Plan View (STA. 37+50 TO 83+00)
1"=200'



HDD Profile View (STA. 37+50 TO 83+00)
HORZ: 1"=200'
VERT: 1"=200'

NOTES:

1. CONTRACTOR TO ASSEMBLE PIPE ALONG WEST SIDE OF SITE ACCESS ROAD IN PIPE LAYDOWN ZONE.
2. PIPE LAYDOWN CORRIDOR SHALL INCLUDE TREE/BRUSH CLEARING AND GRUBBING AS NEEDED. GROUND FOR THE PIPE ASSEMBLY ACTIVITIES SHALL BE CLEARED OF PROTRUDING OBSTRUCTIONS/ROCKS AND/OR LEVELED WHERE REQUIRED.

200 FEET 0 200 400 600
SCALE:1"=200'

ISSUED FOR PERMITTING
NOT FOR CONSTRUCTION

INSTALL

REV	DESCRIPTION	DATE	BY	CK	APP
0-1	ISSUED FOR PERMITTING	12/19/2023	DJP/SA	RWF/SA	SSS/FSA
0-0A	ISSUED FOR REVIEW	04/22/2021	JEC/FSA	SSS/FSA	SSS/FSA

PE STAMP
STATE OF MAINE
ROMEO SHIPLEE No. 16932
LICENSED PROFESSIONAL ENGINEER

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Property of AVANGRID

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HDD PIPE LAYDOWN & CLEARING PLAN

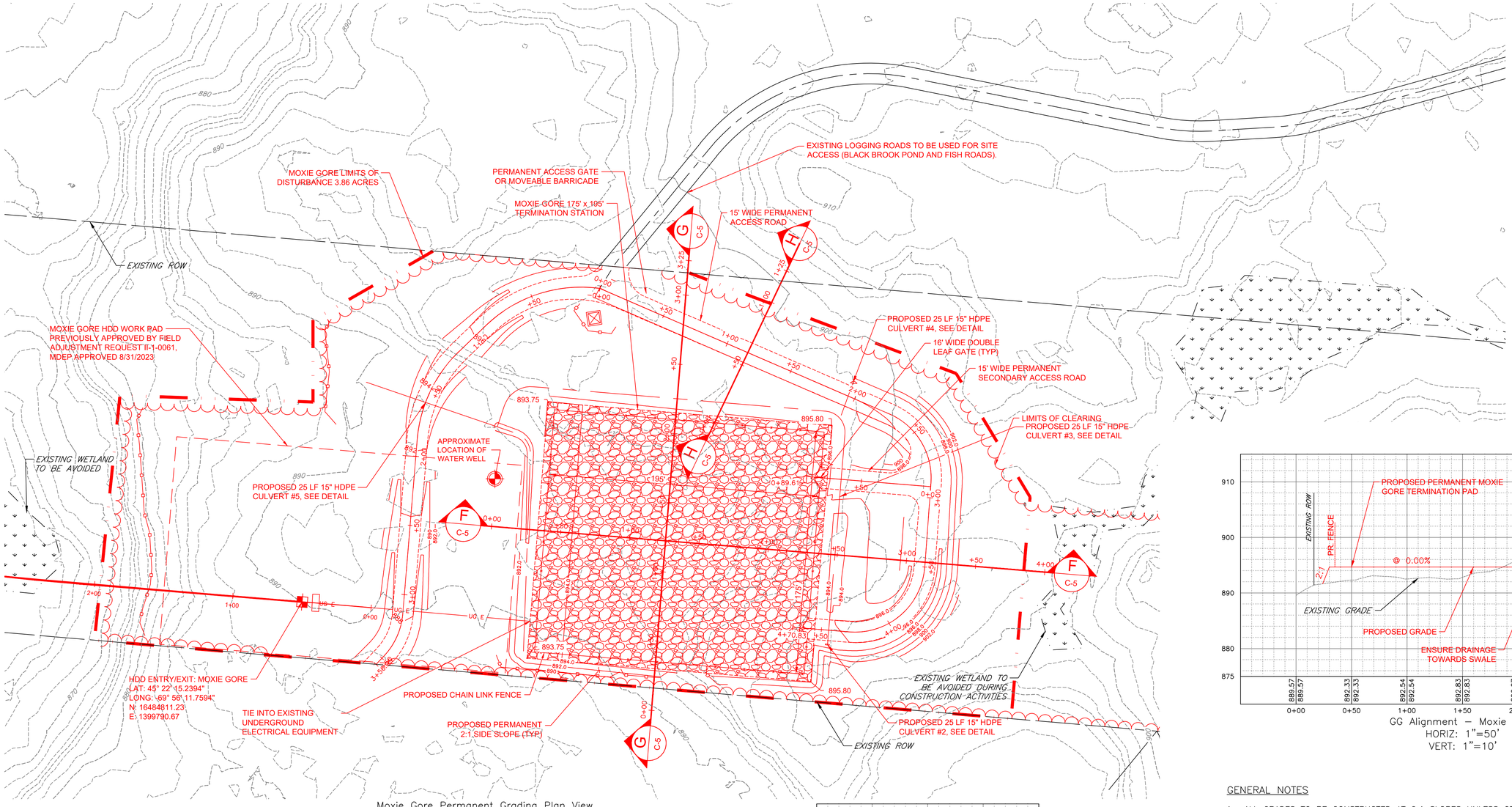
NECEC HVDC LINE MOXIE GORE & WEST FORKS, ME

BY	JEC/FSA	SCALE: AS NOTED	FILE: 1081-0003-001 SH 006.dwg
CK	SSS/FSA	NO.	REV
APP	SSS/FSA	1081-0003-001 SH 006	0-1
DATE	01/23/2024		

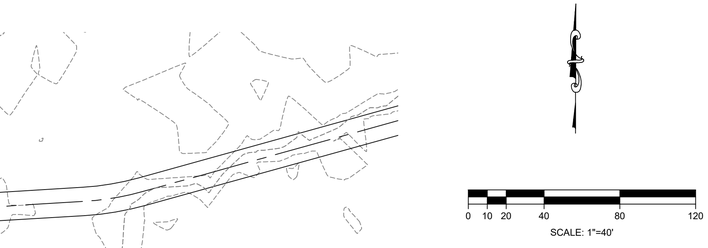
INFO
Realtime Utility Engineers, Inc.
284 Washington Ave. Ste 100
Fitchburg, MA 01420
(800) 291-1478

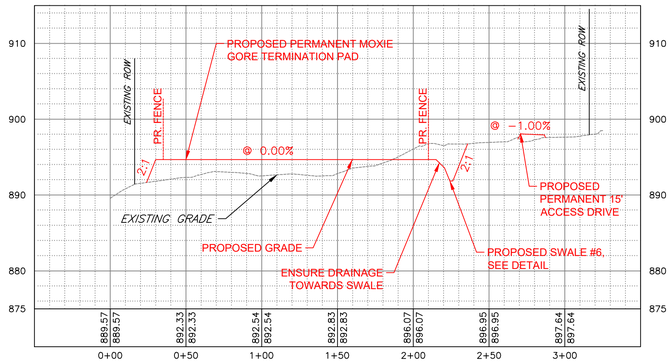
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REALTIME Utility Engineers

ANSI D 1/22/2024

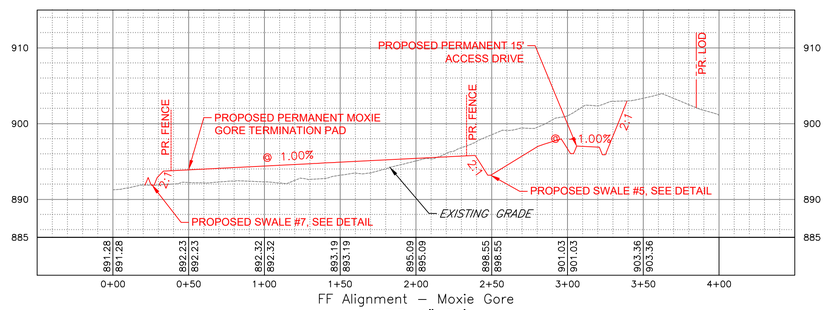


Moxie Gore Permanent Grading Plan View
1"=40'

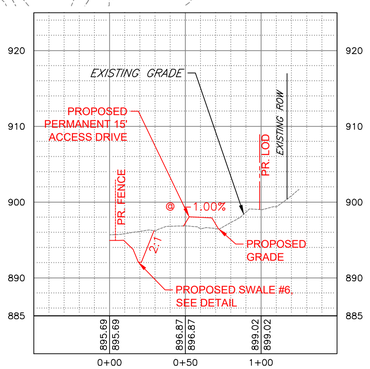




GG Alignment – Moxie Gore
HORIZ: 1"=50'
VERT: 1"=10'



FF Alignment – Moxie Gore
HORIZ: 1"=50'
VERT: 1"=10'



HH Alignment – Moxie Gore
HORIZ: 1"=50'
VERT: 1"=10'

GENERAL NOTES

1. ALL GRADES TO BE CONSTRUCTED AT 2:1 SLOPES UNLESS OTHERWISE SPECIFIED.
2. FINAL FILL SLOPES SHALL BE DESIGNED BY A GEOTECHNICAL ENGINEER, AND IF NECESSARY FILL SLOPES SHOULD BE CONSTRUCTED WITH A TOE KEY.
3. TEMPORARY EROSION & SEDIMENT CONTROL MEASURES SHOULD BE ADJUSTED PRIOR TO FINAL GRADING; SEE E&S SHEETS.

ISSUED FOR PERMITTING
NOT FOR CONSTRUCTION

INSTALL

811 DigSafe ME NH RI VT

REV	DESCRIPTION	DATE	BY	CK	APP
0-1	ISSUED FOR PERMITTING	12/18/2023	DJFSA	RWFSA	RWFSA
0-0	ISSUED FOR PERMITTING	11/3/2023	DJFSA	RWFSA	RWFSA
0-0	ISSUED FOR CONSTRUCTION	08/01/2023	DJFSA	RWFSA	RWFSA
0-0A	ISSUED FOR REVIEW	04/22/2021	JEC/FSA	SSF/FSA	SSS/FSA

PE STAMP
STATE OF MAINE
ROSEMARY WIGHTMAN
No. 16457
REGISTERED PROFESSIONAL ENGINEER

AVANGRID ENGINEERING
CONFIDENTIAL, PROPRIETARY and TRADE SECRET INFORMATION
Property of AVANGRID

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MOXIE GORE GRADING PLAN & SECTIONS

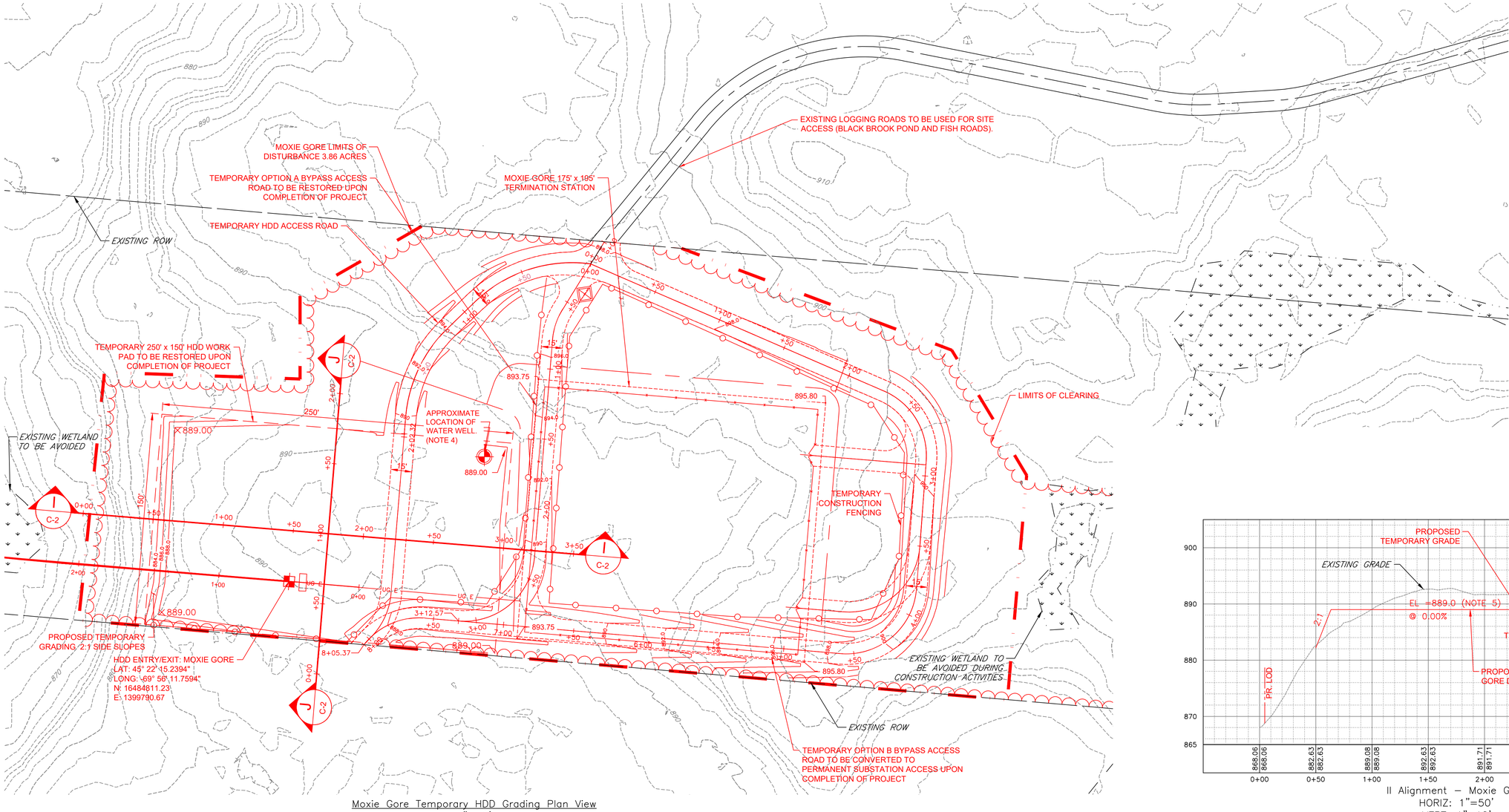
NECEC HVDC LINE | MOXIE GORE & WEST FORKS, ME

BY	DJFSA	SCALE: AS NOTED	FILE: 1081-0003-004 SH 001.dwg
CK	RWFSA	NO.	REV
APP	RWFSA	1081-0003-004 SH 001	0-1
DATE	01/23/2024		

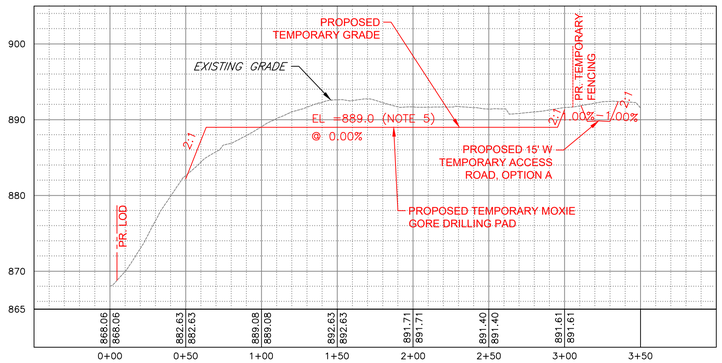
INFO
Realtime Utility Engineers, Inc.
2500 Wilsonville Rd, Suite 150
Altoona, WI 53119
(920) 230-1408

LOGO
REALTIME Utility Engineers

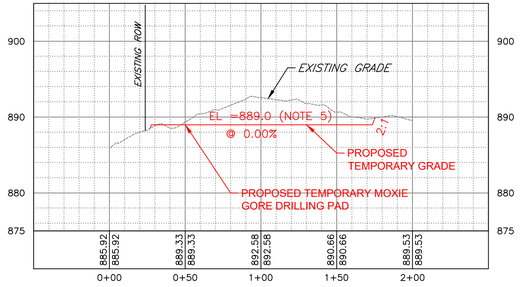
ANSI D 1/23/2024



Moxie Gore Temporary HDD Grading Plan View
1"=40'



II Alignment – Moxie Gore
HORIZ: 1"=50'
VERT: 1"=10'



JJ Alignment – Moxie Gore
HORIZ: 1"=50'
VERT: 1"=10'

GENERAL NOTES

1. ALL GRADES TO BE CONSTRUCTED AT 2:1 SLOPES UNLESS OTHERWISE SPECIFIED.
2. TEMPORARY FILL SLOPES SHALL BE DESIGNED BY A GEOTECHNICAL ENGINEER, AND IF NECESSARY FILL SLOPES SHOULD BE CONSTRUCTED WITH A TOE KEY.
3. HDD CONTRACTOR IS RESPONSIBLE FOR THE INSTALLATION AND MAINTENANCE OF ALL TEMPORARY E&S CONTROLS, AND DRAINAGE MEASURES.
4. APPROXIMATE LOCATION OF PROPOSED WATER WELL FOR TEMPORARY WATER SUPPLY. WELL MAY BE RELOCATED TO ANOTHER LOCATION WITHIN THE TEMPORARY HDD WORK PAD BASED ON FUTURE CONSTRUCTION CONSIDERATIONS, AND/OR SUBSURFACE CONDITIONS ENCOUNTERED DURING WELL DRILLING.
5. DESIGN ELEVATION OF TEMPORARY HDD WORK AREA. ACTUAL ELEVATIONS MAY VARY (±2.5 FT) AS NEEDED.

0 10 20 40 80 120
SCALE: 1"=40'

ISSUED FOR PERMITTING
NOT FOR CONSTRUCTION

INSTALL

REV	DESCRIPTION	DATE	BY	CK	APP
0-1	ISSUED FOR PERMITTING	12/19/2023	DJFSA	RWFSA	RWFSA
0-0	ISSUED FOR PERMITTING	11/3/2023	DJFSA	RWFSA	RWFSA
0-0	ISSUED FOR CONSTRUCTION	08/31/2023	DJFSA	RWFSA	SSSFSA
0-0A	ISSUED FOR REVIEW	04/22/2021	JEOFSA	SSSFSA	SSSFSA

INFO
Realtime Utility Engineers, Inc.
209 Main Street, Suite 201
Fitchburg, WI 53319
(920) 287-4183

LOGO
REALTIME Utility Engineers

ANSI D 1/22/2024

PE STAMP
STATE OF MAINE
ROSEMARY WIGHTMAN
No. 16457
REGISTERED PROFESSIONAL ENGINEER

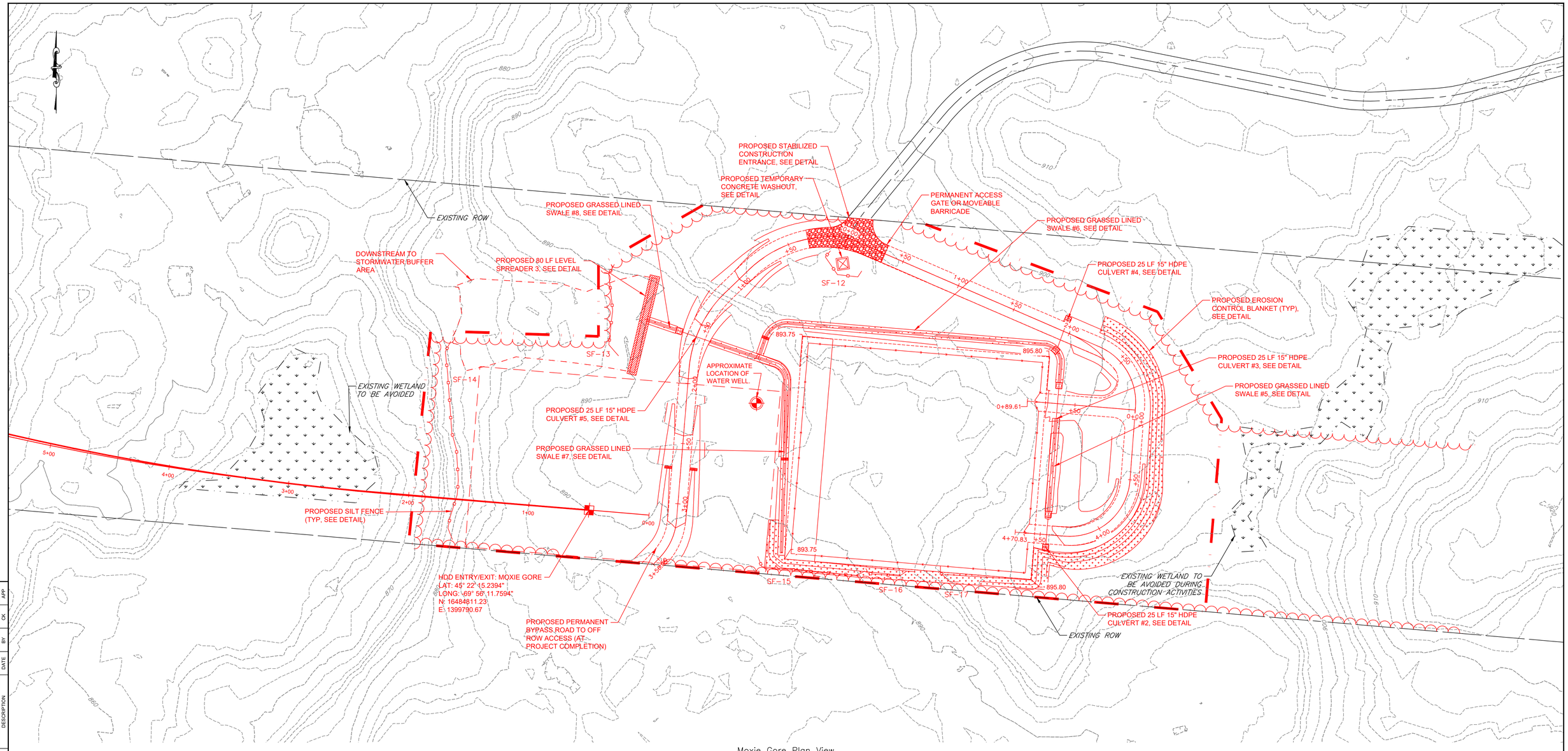
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MOXIE GORE TEMPORARY GRADING PLAN

NECEC HVDC LINE MOXIE GORE & WEST FORKS, ME

BY	DJFSA	SCALE: AS NOTED	FILE: 1081-0003-004 SH 002.dwg
CK	RWFSA	NO.	REV
APP	RWFSA	1081-0003-004 SH 002	0-1
DATE	01/23/2024		



Moxie Gore Plan View
1"=40'

REV	DESCRIPTION	DATE	BY	CK	APP
0-1	ISSUED FOR PERMITTING	12/19/2023	DJFSA	RWFSA	RWFSA
0-0	ISSUED FOR PERMITTING	11/3/2023	DJFSA	RWFSA	RWFSA
0-0	ISSUED FOR CONSTRUCTION	08/31/2023	DJFSA	RWFSA	SSSFSA
0-0A	ISSUED FOR REVIEW	04/22/2021	JECFSA	SSSFSA	SSSFSA

MOXIE GORE SILT FENCE TABLE

NUMBER	ESTIMATED LENGTH (ft)
SF-12	47
SF-13	78
SF-14	168
SF-15	96
SF-16	37
SF-17	24

MOXIE GORE GRASSED SWALE TABLE

NUMBER	ESTIMATED LENGTH (ft)	INLET INVERT	OUTLET INVERT	SLOPE
5	82	893.65	893.40	1.0%
6	300	892.75	891.00	0.6%
7	175	892.75	891.00	1.0%
8	35	890.35	890.00	1.0%

TOTAL EROSION & SEDIMENT CONTROL QUANTITIES

BMP	ESTIMATED QUANTITY	UNIT
STABILIZED CONSTRUCTION ENTRANCE	1	EA
SILT FENCE	450	LF
GRASSED SWALES	592	LF
CONCRETE WASHOUTS	1	EA
EROSION CONTROL BLANKET	6641	SF
15" HDPE DRAINAGE CULVERT	100	LF
80 LF LEVEL SPREADER	1	EA

0 10 20 40 80 120
SCALE: 1"=40'

ISSUED FOR PERMITTING
NOT FOR CONSTRUCTION

INSTALL

811 DigSafe ME NH RI VT

Realtime Utility Engineers, Inc.
2500 Wilson Street, Suite 100
Fairburn, GA 30213
(800) 237-1406

REALTIME Utility Engineers

INFO

LOGO

ANSI D 1/22/2024

PE STAMP
STATE OF MAINE
ROSEMARY WIGHTMAN
No. 16457
LICENSED
PROFESSIONAL ENGINEER

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MOXIE GORE EROSION & SEDIMENT CONTROL PLAN

NECEC HVDC LINE MOXIE GORE & WEST FORKS, ME

BY	DJFSA	SCALE: AS NOTED	FILE: 1081-0003-005 SH 001.dwg
CK	RWFSA	NO.	REV
APP	RWFSA		
DATE	01/23/2024	1081-0003-005 SH 001	0-1

CONSTRUCTION SEQUENCE

1. ESTABLISH CONSTRUCTION WORKSPACE LIMITS; IDENTIFY AND MARK SENSITIVE RESOURCES, INCLUDING WETLANDS.
2. PERFORM ALL WORK IN ACCORDANCE WITH MAINE EROSION AND SEDIMENT CONTROL BEST MANAGEMENT PRACTICES (BMPs) (OCT., 2016) AND MDEP EROSION AND SEDIMENT CONTROL PRACTICES FIELD GUIDE FOR CONTRACTORS (2014).
3. PRIOR TO USAGE, CONSTRUCT AND STABILIZE THE CONSTRUCTION ENTRANCES ON THE EXISTING PERMANENT AGGREGATE ACCESS ROADS WITH A STONE PAD, MUD RACK, OR OTHER MATERIALS USED TO REDUCE THE TRACKING OR FLOWING OF SEDIMENT OFF THE SITE AND MAINTAIN UNTIL SITE STABILIZATION IS COMPLETED.
4. CLEAR TIMBER AND BRUSH; DO NOT GRUB UNTIL JUST PRIOR TO PRELIMINARY GRADING AND ESTABLISHMENT AND STABILIZATION OF TEMPORARY & PERMANENT DRAINAGE COURSES.
5. INSTALL AND MAINTAIN SEDIMENT BARRIERS SUCH AS SILT FENCING AND/OR OTHER EROSION CONTROL BARRIERS ALONG THE DOWNHILL LIMIT OF WORK, AS SHOWN ON THE DRAWINGS. SEDIMENT BARRIER LOCATIONS MAY BE ADJUSTED IN THE FIELD BASED ON SITE CONDITIONS AS DETERMINED BY THE ENGINEERING INSPECTOR. WHERE SILT FENCE CANNOT BE TOED-IN PROPERLY DUE TO TREE ROOTS, ROCKS OR FROZEN GROUND, HAY BALES OR AN EROSION CONTROL MIX BERM MAY BE SUBSTITUTED. SILT FENCING WILL BE INSTALLED AFTER CLEARING BUT PRIOR TO GRUBBING AND GRADING ACTIVITIES. ANY EROSION ISSUES DEVELOPED DURING CLEARING WILL BE TEMPORARILY STABILIZED AS NECESSARY.
6. STABILIZE PERMANENT ACCESS ROAD SURFACE, PARKING AREAS AND EQUIPMENT STORAGE AND LAYDOWN AREAS WITH MATTING, CRUSHED STONE OR GRAVEL SUBBASE AS NECESSARY TO MINIMIZE RUTTING AND AVOID PONDING.
7. CONCURRENT WITH THE INITIATION OF SITE GRADING, CONSTRUCT AND STABILIZE TEMPORARY DRAINAGE SWALES, DIVERSION BERMS, CHECK DAMS, AND CULVERTS WITH TEMPORARY INLET AND OUTLET STRUCTURES TO MINIMIZE SEDIMENT IN SITE RUNOFF DURING THE CONSTRUCTION OF THE ROADWAY. DEWATER IN ACCORDANCE WITH DEWATERING NOTES BELOW AND USING STATE APPROVED MEASURES.
8. INSTALL PROPERLY SPACED STONE CHECK DAMS IN ANY SECTION OF DITCH WITHIN 24 HOURS OF FORMING, SHAPING OR ROUGH GRADING THAT SECTION OF DITCH.
9. MINIMIZE THE AMOUNT OF DISTURBANCE AT ANY ONE TIME BY STAGING CONSTRICTION AS MUCH AS PRACTICAL FOR EFFICIENT CONSTRUCTION OF THE FACILITY. NATURAL VEGETATIVE BUFFERS OR STRIPS SHOULD BE LEFT IN PALCE WHERE FEASIBLE TO AID IN SEDIMENT RETENTION AND REDUCE EROSION POTENTIAL.
10. STABILIZE ANY NEWLY GRADED SLOPE GREATER THAN 8 PERCENT AND ANY SECTION OF NEWLY CONSTRUCTED DITCH USING ANCHORED EROSION CONTROL BLANKETS OR OTHER APPROVED MULCHING TECHNIQUES WITHIN 24 HOURS. STABILIZE ANY SLOPES EXCEEDING 8 PERCENT AND BROUGHT TO FINAL GRADE WITHIN 24 HOURS USING THE APPROVED PERMANENT STABILIZATION MEASURE FOR SLOPES. STABILIZE ANY SECTION OF DITCH BROUGHT TO FINAL GRADE WITHIN 24 HOURS USING THE APPROVED PERMANENT STABILIZATION MEASURES FOR DITCHES.
11. DUST CONTROL METHODS WILL BE EMPLOYED AFTER GRADING AND PRIOR TO FINAL STABILIZATION TO PREVENT THE BLOWING AND MOVEMENT OF DUST THROUGH THE APPLICATION OF WATER AND/OR CALCIUM CHLORIDE TO REDUCE WIND EROSION. REPETITIVE TREATMENT WILL BE APPLIED AS NEEDED TO ACCOMPLISH CONTROL.
12. APPLY TEMPORARY SEED AND MULCH TO ANY EXPOSED AREAS WHERE ACTIVITY IS NOT ANTICIPATED FOR 30 DAYS OR MORE, OR WHERE ACTIVITY HAS NOT OCCURRED WITHIN 30 DAYS. TEMPORARILY MULCH ANY EXPOSED AREAS WITHIN 100 FEET OF A WETLAND WHERE ACTIVITY IS NOT ANTICIPATED OR HAS NOT OCCURRED IN 7 DAYS.
13. REMOVE EXCESS SPOILS FROM SITE THAT WILL NOT BE USED FOR THE FINAL DESIGN AND STABILIZATION. STOCKPILED SOILS THAT REMAIN IN PLACE FOR 48 HOURS OR MORE WILL BE CONTAINED WITH SEDIMENT BARRIERS SUCH AS SILT FENCE, HAY BALES OR EQUIVALENT. THE SEDIMENT BARRIERS SHALL BE ADEQUATELY LOCATED AND REINFORCED TO HANDLE A SIGNIFICANT RAIN EVENT AND THE POTENTIAL SLUMPING OF THE PILE. BETWEEN APRIL 15 AND OCTOBER 1, APPLY TEMPORARY SEED AND MULCH TO A STOCKPILE THAT IS NOT EXPECTED TO BE DISTURBED WITHIN 30 DAYS. APPLY ANCHORED MULCH DAILY, AS NEEDED, DURING WINTER CONSTRUCTION.
14. INSPECT AND REPAIR EROSION CONTROL MEASURES DAILY IN AREAS OF ACTIVE CONSTRUCTION; OTHERWISE WEEKLY AND AFTER RAINFALL OF ½ INCH OR GREATER WITHIN A 24-HOUR PERIOD. REMOVE ACCUMULATED SEDIMENT WHEN IT REACHES ½ THE HEIGHT OF THE BARRIER.
15. MONITOR PUBLIC ROADS FOR SIGNS OF TRACKING OR SPILLING OF SPOIL MATERIAL AND CLEANUP AS NEEDED.
16. COMPLETE FINAL GRADING AND STABILIZATION OF EARTHEN STRUCTURES SUCH AS DIVERSION BERMS, LEVEL SPREADERS AND SWALES THAT WILL CONTROL RUNOFF.
17. FINISH GRADE AND REPLACE TOPSOIL OR LOAM IN DISTURBED AREAS. SEED AND MULCH DISTURBED AREAS WITHIN 6 DAYS OF FINAL GRADING.
18. MAINTAIN ALL TEMPORARY EROSION CONTROLS AND SEDIMENT BARRIERS UNTIL VEGETATION HAS BEEN ESTABLISHED OVER 85-90% OF THE AREA TO BE REVEGETATED. RESEED SPARSELY VEGETATED AREAS.
19. REMOVE ALL TEMPORARY EROSION AND SEDIMENTATION CONTROL MEASURES ONCE THE SITE IS PERMANENTLY STABILIZED.

DEWATERING NOTES

1. CONTRACTOR SHALL INSTALL, MAINTAIN, AND OPERATE ALL CHANNELS, SUMPS, AND ALL OTHER TEMPORARY DIVERSION AND PROTECTIVE WORKS NEEDED TO DIVERT STREAM FLOW AND OTHER SURFACE WATER THROUGH OR AROUND THE CONSTRUCTION SITE. CONTROL OF SURFACE WATER SHALL BE CONTINUOUS DURING THE PERIOD THAT DAMAGE TO CONSTRUCTION WORK COULD OCCUR.
2. OPEN EXCAVATIONS SHALL BE DEWATERED AND KEPT FREE OF STANDING WATER AND MUDDY CONDITIONS AS NECESSARY FOR THE PROPER EXECUTION OF THE WORK. THE CONTRACTOR SHALL FURNISH, INSTALL, OPERATE AND MAINTAIN ALL DRAINS, SUMPS AND ALL OTHER EQUIPMENT REQUIRED TO PROPERLY DEWATER THE SITE. DEWATERING SYSTEMS THAT CAUSE A LOSS OF SOIL FINES FROM THE FOUNDATION AREAS WILL NOT BE PERMITTED.
3. INSTALL DIVERSION DITCHES OR BERMS IF NECESSARY TO MINIMIZE THE AMOUNT OF CLEAN STORMWATER RUNOFF ALLOWED INTO THE EXCAVATED AREA.
4. REMOVAL OF WATER FROM THE CONSTRUCTION SITE SHALL BE ACCOMPLISHED SO THAT EROSION AND THE TRANSPORTING OF SEDIMENT AND OTHER POLLUTANTS ARE MINIMIZED.
5. DISHCHARGE DEWATERING EFFLUENT TO AREAS AS INDICATED ON THE SITE GRADING PLAN. DISCHARGE SHALL BE IN SHEET FLOW.
6. DEWATERING IN PERIODS OF INTENSE, HEAVY RAIN, WHEN THE INFILTRATIVE CAPACITY OF THE SOIL IS EXCEEDED, SHALL BE AVOIDED.
7. FLOW TO THE SEDIMENT REMOVAL STRUCTURE MAY NOT EXCEED THE STRUCTURES CAPACITY TO SETTLE AND FILTER FLOW OR THE STRUCTURE'S VOLUME CAPACITY.
8. WHEN THE TEMPORARY WORKS ARE NO LONGER NEEDED, THE CONTRACTOR SHALL REMOVE AND RETURN THE AREA TO A CONDITION SIMILAR TO THAT WHICH EXISTED BEFORE CONSTRUCTION. AREAS WHERE TEMPORARY WORKS WERE LOCATED SHALL BE GRADED FOR SIGHTLY APPEARANCE WITH NO OBSTRUCTION TO NATURAL SURFACE WATER FLOWS OR THE PROPER FUNCTIONING AND ACCESS TO THE WORKS OF IMPROVEMENT INSTALLED. THE CONTRACTOR SHALL EXERCISE EXTREME CARE DURING THE REMOVAL STAGES TO MINIMIZE THE LOSS OF SOIL SEDIMENT AND DEBRIS THAT WAS TRAPPED DURING CONSTRUCTION.

FERTILIZER AND LIMESTONE REQUIREMENT

IN GENERAL, FERTILIZER AND LIME APPLICATION RATES WILL FOLLOW THE GUIDELINES IDENTIFIED BELOW UNLESS SITE SPECIFIC SOIL TESTS IDENTIFY THE NEED FOR ALTERNATE FERTILIZER/LIME APPLICATION RATES.

- FERTILIZER WILL BE APPLIED TO UPLAND AREAS PRIOR TO SEEDING AT A RATE OF 800 POUNDS PER ACRE USING 10-20-20 (N-P205-K20) OR EQUIVALENT.
- GROUND LIMESTONE (EQUIVALENT TO 50 PERCENT CALCIUM PLUS MAGNESIUM OXIDE) WILL BE APPLIED AT A RATE OF 3 TONS PER ACRE.
- AN EQUIVALENT MIXTURE OF FERTILIZER AND LIME MAY BE APPLIED USING THE HYDROSEEDING METHOD.
- NO LIME OR FERTILIZER WILL BE APPLIED TO WETLANDS.

MULCH & SEEDING SPECIFICATIONS

SUMMARY OF TEMPORARY AND PERMANENT MULCH APPLICATION REQUIREMENTS

CONDITION	TIMING	MULCH TYPE	APPLICATION RATES
TEMPORARY			
	IF NO ACTIVITY IN EXPOSED AREAS FOR 7 DAYS, OR PRIOR TO A STORM EVENT	STRAW MULCH OR WOOD FIBER MULCH	2 TONS/ACRES 2000 LB./ACRES
ALL DISTRIBUTED AREAS OF THE CONSTRUCTION WORKSPACE	APPLY MULCH TO ALL EXPOSED AREAS IF NO ACTIVITY OCCURS WITHIN 30 DAYS. APPLY MULCH AND TEMPORARY SEEDING SOONER WHEN IT CAN BE ANITICIPATED THAT ACTIVITY IS NOT GOING TO OCCUR WITHIN 30 DAYS.	STRAW MULCH OR WOOD FIBER MULCH	2 TONS/ACRES 2000 LB./ACRES[3]
ALL WORK AREAS EXPOSED ARE TO BE MULCHED DAILY EACH TIME SOIL IS DISTURBED	NOVEMBER 1 – APRIL 15	STRAW MULCH OR WOOD FIBER MULCH	3 TONS/ACRES 2000 LB./ACRES
PERMANENT			
ON ALL EXPOSED AREAS AFTER SEEDING TO STABILIZE THE SOIL SURFACE	PERMANENT GRASS AND/OR LEGUME SEEDING COVERED BY HAY OR STRAY MULCH ON ALL AREAS THAT HAVE BEEN RESTORED TO FINAL GRADE. THIS DOES NOT APPLY TO AREAS STABILIZED BY OTHER MEANS SUCH AS JUTE MATTING OR PERMANENT EROSION CONTROL MIX.	CRIMPED STRAW MULCH OR PAPER MULCH OR WOOD FIBER MULCH	2 TONS/ACRES 1500 LB./ACRES[4] 2000 LB./ACRES
WOOD CHIP APPLICATION AREAS	PERMANENT GRASS AND/OR LEGUME SEEDING COVERED BY HAY OR STRAY MULCH ON ALL AREAS THAT HAVE BEEN RESTORED TO FINAL GRADE. THIS DOES NOT APPLY TO AREAS STABILIZED BY OTHER MEANS SUCH AS JUTE MATTING OR PERMANENT EROSION CONTROL MIX.	CRIMPED STRAW MULCH OR PAPER MULCH OR WOOD FIBER MULCH	2 TONS/ACRES 1500 LB./ACRES[4] 2000 LB./ACRES

NOTES:
1. STRAW AND HAY MULCH MAY BE USED INTERCHANGEABLY, EXCEPT IN WETLAND AREAS WHERE STRAW MULCH WILL BE REQUIRE.
2. DOUBLE RATE OF WOOD FIBER MULCH WHEN USED IN CRITICAL AREAS
3. STRAW, HAY, OR HYDROMULCH (WOOD FIBER OR PAPER MULCH AS APPROPRIATE) WILL PROVIDE 90 PERCENT GROUND COVERAGE.
4. PAPER MULCH IS ACCEPTABLE FOR USE DURING THE GROWING SEASON. ON SLOPES >30 PERCENT AND IN AREAS WHERE VEGETATION HAS NOT ESTABLISHED WELL, ADDITIONAL HAY MULCH WILL BE ADDED AS A WINTERIZING MEASURE.

MULCH ANCHORING REQUIREMENTS

ON SLOPES GREATER THAN 3 PERCENT, HAY OR STRAW MULCH WILL BE FIRMLY ANCHORED INTO THE SOIL UTILIZING ONE OF THE FOLLOWING METHODS:

- CRIMPING WITH A STRAIGHT OR NOTCHED MULCH CRIMPING TOOL (FARM DISCS WILL NOT BE ALLOWED);
- TRACK WALKING WITH DEEP-CLEATED EQUIPMENT OPERATING UP AND DOWN THE SLOPE (MULCH CRIMPED PERPENDICULAR TO THE SLOPE) ON SLOPES < 25 PERCENT;
- APPLICATION OF MULCH NETTING;
- APPLICATION OF 500 LB/ACRE OF WOOD FIBER MULCH OVER STRAW/HAY MULCH; AND
- COMMERCIALLY ANAILABLE TACKIFIERS (EXCEPT WITH 100 FEET OF WATERBODIES OR WETLANDS).

SEED MIX SPECIFICATIONS

SEED MIX NAME	SEED MIX COMPONENTS	LB./ACRE[1]
TEMPORARY SEED MIX	ANNUAL RYEGRASS	40
PERMANENT UPLAND SEED MIX	REDTOP CREEPING RED FESCUE TALL FESCUE BIRDSFOOT TREFOIL	4 40 40 16
WOODCHIP APPLICATION SEED MIX	CREEPING RED FESCUE REDTOP TALL FESCUE CROWNVETCH	20 4 30 30
WETLAND SEED MIX	ANNUAL RYEGRASS	40
SUPPLEMENTAL WINTER SEED MIX[2]	WINTER RYEGRASS	120

NOTES:
1. INCREASE SEEDING RATES 10% WHEN HYDROSEEDING
2. WINTER RYE BE ADDED TO PERMANENT UPLAND MIX AT A RATE OF 120 LB./ACRE BETWEEN OCTOBER 1 AND APRIL 15

SEED MIX SPECIFICATIONS

SEED MIX NAME	TIMING[1,2]	SEED MIX
TEMPORARY SEED MIX [3]	TEMPORARY SEED BETWEEN APRIL 15 AND OCTOBER 1 ONLY. DISTURBED AREAS OR SPOIL STOCKPILES WILL BE SEEDED IMMEDIATELY IF FURTHER DISTURBANCE IS NOT EXPECTED FOR 30 DAYS OR MORE	ANNUAL RYEGRASS
PERMANENT SEEDING [3,4]		
UPLAND PORTIONS OF THE CONSTRUCTION AREA	DISTURBED AREA WLL BE SEEDED WITHIN 6 DAYS OF FINAL GRADING.	PERMANENT UPLAND MIX
SLOPES > 3:1	DISTURBED AREA WLL BE SEEDED IMMEDIATELY AFTER SEED BED PREPERATION,	PERMANENT UPLAND MIX
WETLANDS	DISTURBED AREA WLL BE SEEDED WITHIN 6 DAYS OF FINAL GRADING.	ANNUAL RYEGRASS
WOODCHIPS APPLICATION AREAS	DISTURBED AREA WLL BE SEEDED WITHIN 6 DAYS OF FINAL GRADING.	WOODCHIP APPLICATION MIX
WINTER DORMANT SEEDING	DORMANT SEED BETWEEN OCTOBER 1 AND APRIL15 ONLY. NO SEEDING WILL OCCUR IF SNOW DEPTH EXCEED 1 INCH.	PERMANENT UPLAND MIX PLUS WINTER RYEGRASS

NOTES:
1. WEATHER CONDITIONS PERMITTING.
2. AREAS THAT DO NOT SUCCESSFULLY REVEGETATE WITHIN APPROPRIATE PERIOD OF TIME WILL BE RESEEDED AS NECCESSARY.
3. LOOSEN COMPACTED SOIL TO A MINIMUM DEPTH OF 4 INCHES.
4. TOP DRESS WITH 6 INCHES LOAN, AS NEEDED.

WETLAND STABILIZATION/RESTORATION

WETLAND STABILIZATION/RESTORATION SHALL BE COMPLETED AS FOLLOWS:

1. RETURN SUBSOIL TO THE EXCAVATION.
2. REPLACE TOPSOIL AND VEGETATIVE ROOT MASS TO AS NEAR THE ORIGINAL POSITION AND CONTOUR AS POSSIBLE.
3. APPLY SMALL GRAIN STRAW AT 2 TONS/ACRE. DO NOT ANCHOR WITH NETTING OR TACTIFIER.
4. REMOVE ACCESS SPOIL MATERIAL AWAY FROM ALL WETLANDS AND/OR WATER BODIES AND STABILIZE.

LEGEND

EXISTING

- MINOR CONTOUR
- MAJOR CONTOUR (950)
- CENTER OF ROAD
- EDGE OF GRAVEL
- TREE LINE
- CMP RIGHT OF WAY
- GIS PROPERTY LINE
- EDGE OF RIVER
- WETLANDS

PROPOSED

- MINOR CONTOUR
- MAJOR CONTOUR (950)
- CENTER OF ROAD
- EDGE OF GRAVEL
- LIMITS OF CLEARING
- FENCE LINE
- TEMPORARY CONSTRUCTION FENCE
- CONSTRUCTION BARRIER
- STORM WATER CULVERT
- LIMITS OF DISTURBANCE
- DRAINAGE SWALE
- UNDERGROUND ELECTRIC (UG E)
- HDD CENTERLINE
- PLANNED HDD ROUTE
- GRAVEL PAD
- PLANNED HDD ENTRY/EXIT POINT
- GATE
- DRILLED WATER WELL

PROPOSED EROSION SEDIMENT CONTROL

- SILT FENCE
- GRASSED LINED SWALE
- LEVEL SPREADER
- STORMWATER BUFFER AREA
- CONCRETE WASHOUT
- RIPRAP INLET/OUTLET PROTECTION
- EROSION CONTROL BLANKETS
- STABILIZED CONSTRUCTION ENTRANCE

ISSUED FOR PERMITTING
NOT FOR CONSTRUCTION

INSTALL

811 DigSafe ME NH VT

PE STAMP
STATE OF MAINE
ROSEMARY WIGHTMAN
No. 16457
LICENSED PROFESSIONAL ENGINEER

AVANGRID ENGINEERING
CONFIDENTIAL, PROPRIETARY and TRADE SECRET INFORMATION
Property of AVANGRID

NECEC AVANGRID

REV	DESCRIPTION	DATE	BY	CK	APP
0-1	ISSUED FOR PERMITTING	12/7/2023	DJFSA	RWFSA	RWFSA
0-0	ISSUED FOR PERMITTING	11/3/2023	DJFSA	RWFSA	RWFSA
0-0	ISSUED FOR CONSTRUCTION	06/21/2023	DJFSA	RWFSA	SSSFSA
0-0A	ISSUED FOR REVIEW	04/22/2021	JEOFSA	SSSFSA	SSSFSA

EROSION CONTROL GENERAL NOTES

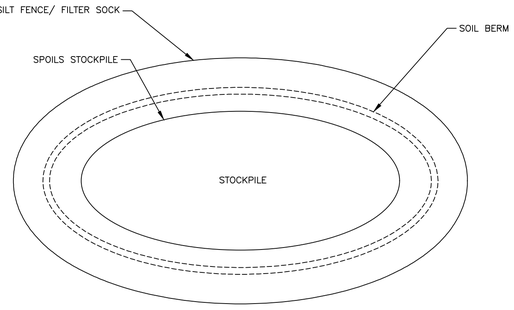
NECEC HVDC LINE MOXIE GORE & WEST FORKS, ME

BY	DJFSA	SCALE: AS NOTED	FILE: 1081-0003-005 SH 002.dwg	
CK	RWFSA	NO.		REV
APP	RWFSA		1081-0003-005 SH 002	0-1
DATE	01/23/2024			

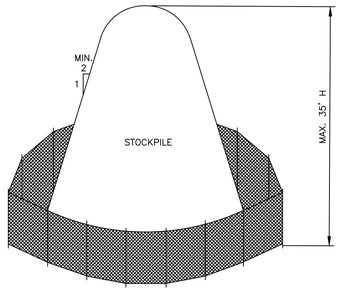
LOGO
REALTIME Utility Engineers

INFO
Realtime Utility Engineers, Inc.
29 Main Street, Suite 202
Fryeburg, ME 03909
(603) 297-1418

ANSI D 1/22/2024



PLAN VIEW

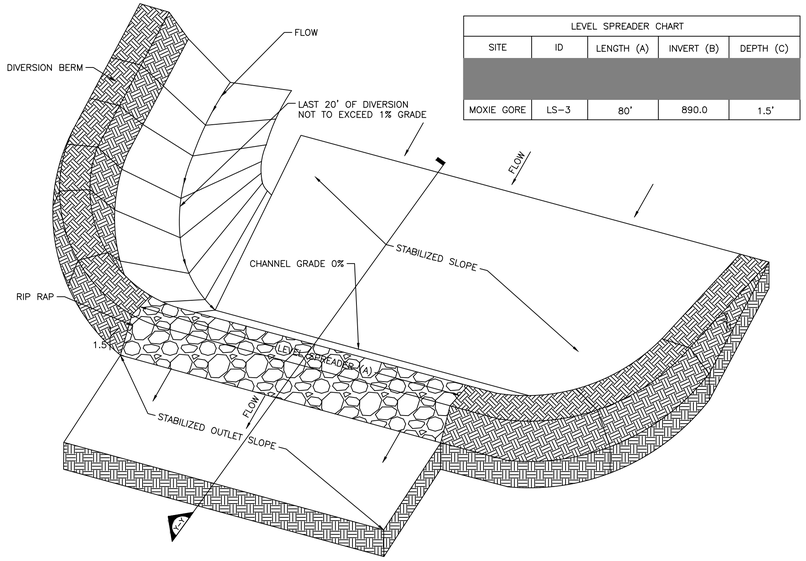


ISOMETRIC

NOTES:

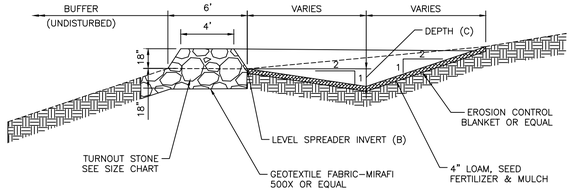
1. AREA CHOSEN FOR STOCKPILING OPERATIONS SHALL BE DRY AND STABLE. STOCKPILES SHALL NOT BE LOCATED:
   A. IN AREAS OF CONCENTRATED FLOW
   B. WITHIN 75' OF A WETLAND OR STREAM
   C. ON A SLOPE GREATER THAN 5%
2. SILT FENCE MUST BE PLACED DOWNSLOPE OF ALL STOCKPILES (AS SHOWN ON PLAN). IMMEDIATELY APPLY TEMPORARY SEEDING TO ALL STOCKPILES WHICH WILL REMAIN IN PLACE 14 DAYS OR MORE.
3. TOPSOIL AND SPOIL STOCKPILES SHOULD BE KEPT SEPARATE FOR BACKFILL, GRADING AND RESTORATION PURPOSES.
4. STOCKPILES TO BE KEPT AT SAFE DISTANCE FROM ALL OVERHEAD WIRES.

ON SITE STOCKPILES
NOT TO SCALE



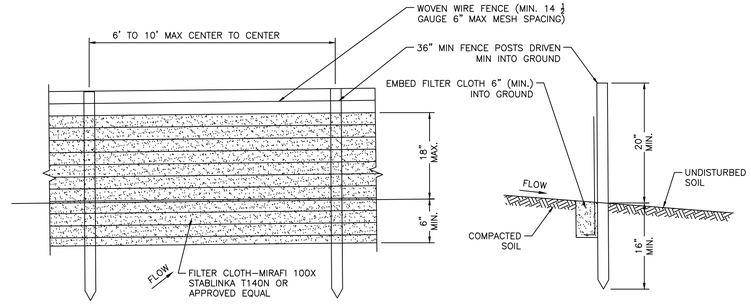
LEVEL SPREADER CHART				
SITE	ID	LENGTH (A)	INVERT (B)	DEPTH (C)
MOXIE GORE	LS-3	80'	890.0	1.5'

TURNOUT STONE SIZE	
SIEVE DESIGNATION	% PASSING BY WEIGHT
12 IN.	100
6 IN.	84-100
3 IN.	68-83
1 IN.	42-55
NO. 4	8-12



SECTION Y-Y

LEVEL LIP SPREADER DETAIL
NOT TO SCALE



ELEVATION SECTION

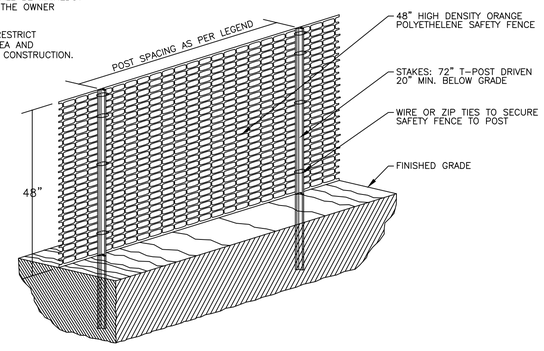
1. WOVEN WIRE FENCE TO BE FASTENED TO FENCE POSTS WITH WIRE TIES OR STAPLES.
2. FILTER CLOTH TO BE FASTENED SECURELY TO WOVEN WIRE FENCE WITH TIES SPACED EVERY 24" AT TOP AND MIDSECTION.
3. WHEN TWO SECTIONS OF FILTER CLOTH ADJOIN EACH OTHER THEY SHALL BE OVERLAPPED BY 6" AND FOLDED.
4. MAINTENANCE SHALL BE PERFORMED AS NEEDED AND MATERIAL REMOVED WHEN BUILD-UP REACHES 1/3 THE HEIGHT OF THE FENCE.

POSTS:	STEEL "T" OR "U" TYPE OR 2" HARDWOOD.
FENCE:	WOVEN WIRE 14 1/2 GA. 6" MAX MESH OPENING.
FILTER CLOTH:	FILTER X, MIRAFI 100X. STABLINKA T140N OR APPROVED EQUAL.
PREFABRICATED UNIT:	ENVIROFENCE OR APPROVED EQUAL

SILT FENCE DETAILS
NOT TO SCALE

BARRIER NOTES:

1. TEMPORARY OR PERMANENT BARRIERS SHALL BE MAINEDOT APPROVED AND SHALL BE APPROVED BY THE OWNER PRIOR TO INSTALLATION.
2. THE PURPOSE OF THE BARRIERS IS TO RESTRICT UNAUTHORIZED ACCESS TO THE WORK AREA AND TERMINATION STATION DURING AND AFTER CONSTRUCTION.



48" SAFETY FENCE, 72" T-POSTS

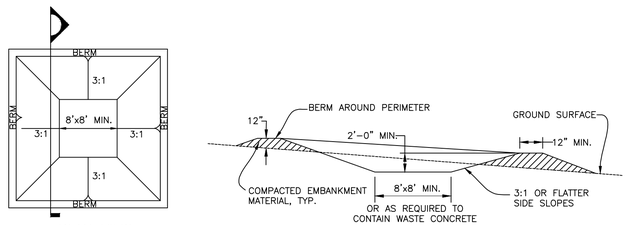
LEGEND

SAF12	48" ORANGE FENCE, 12 FEET O.C.
SAF11	48" ORANGE FENCE, 11 FEET O.C.
SAF10	48" ORANGE FENCE, 10 FEET O.C.
SAF9	48" ORANGE FENCE, 9 FEET O.C.
SAF8	48" ORANGE FENCE, 8 FEET O.C..
SAF7	48" ORANGE FENCE, 7 FEET O.C.
SAF6	48" ORANGE FENCE, 6 FEET O.C.

NOTES:

1. ALL SENSITIVE OR WETLAND AREAS SHALL BE PROTECTED AS NECESSARY OR STATED BY THE OWNER.
2. ALL TREES IN THE CONSTRUCTION AREA NOT SPECIFICALLY DESIGNATED FOR REMOVAL SHALL BE PRESERVED AND PROTECTED WITH HIGH VISIBILITY FENCE.
3. WHEN PRACTICABLE, INSTALL HIGH VISIBILITY 3 FEET OUTSIDE OF THE DRIP LINE OF THE TREE.
4. SAFETY FENCE SHOULD BE FASTENED SECURELY TO THE T-POSTS.
5. THE FENCING MUST REMAIN IN PLACE DURING ALL PHASES OF CONSTRUCTION; ANY CHANGE OF THE PROTECTIVE FENCING MUST BE APPROVED.

TEMPORARY CONSTRUCTION SAFETY FENCE
NOT TO SCALE



PLAN VIEW

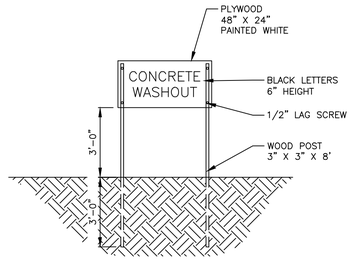
SECTION A

CONCRETE WASHOUT AREA INSTALLATION NOTES:

1. CONTRACTOR TO DETERMINE FINAL LOCATION OF CONCRETE WASHOUT AREA.
2. THE CONCRETE WASHOUT AREA SHALL BE INSTALLED PRIOR TO ANY CONCRETE PLACEMENT ON THE SITE.
3. VEHICLE TRACKING CONTROL IS REQUIRED AT THE ACCESS POINT.
4. SIGNS SHALL BE PLACED AT THE CONSTRUCTION ENTRANCE, AT THE WASHOUT AREA, AND ELSEWHERE AS NECESSARY TO CLEARLY INDICATE THE LOCATION OF THE CONCRETE WASHOUT AREA TO OPERATORS OF CONCRETE TRUCKS AND PUMP RIGS.
5. EXCAVATED MATERIAL SHALL BE UTILIZED IN PERIMETER BERM CONSTRUCTION.

CONCRETE WASHOUT AREA MAINTENANCE NOTES:

1. THE CONCRETE WASHOUT AREA SHALL BE REPAIRED AND ENLARGED OR CLEANED OUT AS NECESSARY TO MAINTAIN CAPACITY FOR WASTED CONCRETE.
2. AT THE END OF CONSTRUCTION, ALL CONCRETE SHALL BE REMOVED FROM THE SITE AND DISPOSED AT AN APPROVED WASTE SITE.
3. WHEN THE CONCRETE WASHOUT AREA IS REMOVED, COVER THE DISTURBED AREA WITH TOP SOIL, SEED AND MULCH OR OTHERWISE STABILIZE IN ACCORDANCE WITH THE SWPPP PREPARED FOR THE PROJECT.
4. INSPECT WEEKLY OR OTHERWISE INDICATED IN THE SWPPP.



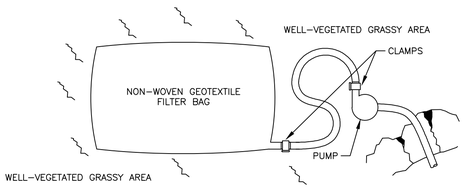
CONCRETE WASHOUT SIGN DETAIL
(OR EQUIVALENT)

NOTES:

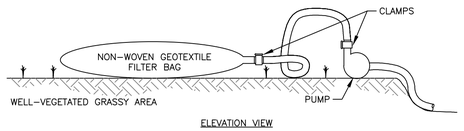
1. SUMPS TO BE LOCATED IN YARD BUT SHOULD BE KEPT AS FAR FROM DRAINAGE CHANNELS AND WETLAND AREAS AS PRACTICAL.
2. SUMPS TO BE CLEANED AND WASTE CONCRETE REMOVED AND PROPERLY DISPOSED OF UPON COMPLETION OF WORK.
3. METAL STAKES AND/OR #4 REBAR MUST BE LONG ENOUGH TO PENETRATE 6" OF GRAVEL AND ANCHOR INTO UNDERLYING ASPHALT.

CONCRETE WASHOUT (BERM TYPE)
NOT TO SCALE

FILTER BAGS FOR REMOVING SEDIMENT FROM PUMPED WATER



PLAN VIEW



ELEVATION VIEW

1. FILTER BAGS SHALL BE MADE FROM NON-WOVEN GEOTEXTILE MATERIAL SEWN WITH HIGH STRENGTH, DOUBLE STITCHED "J" TYPE SEAMS. THEY SHALL BE CAPABLE OF TRAPPING PARTICLES LARGER THAN 150 MICRONS.
2. A SUITABLE MEANS OF ACCESSING THE BAG WITH MACHINERY REQUIRED FOR DISPOSAL PURPOSES MUST BE PROVIDED. FILTER BAGS SHALL BE REPLACED WHEN THEY BECOME 1/2 FULL. SPARE BAGS SHALL BE KEPT AVAILABLE FOR REPLACEMENT OF THOSE THAT HAVE FAILED OR ARE 1/2 FILLED WITH SEDIMENT.
3. BAGS SHALL BE LOCATED IN WELL-VEGETATED (GRASSY) AREA AND DISCHARGE ONTO STABLE, EROSION RESISTANT AREAS. WHERE THIS IS NOT POSSIBLE, A GEOTEXTILE FLOW PATH SHALL BE PROVIDED. BAGS SHALL NOT BE PLACED ON SLOPES GREATER THAN 5%.
4. THE PUMP DISCHARGE HOSE SHALL BE INSERTED INTO THE BAGS IN THE MANNER SPECIFIED BY THE MANUFACTURER AND SECURELY CLAMPED.
5. THE PUMPING RATE SHALL BE NO GREATER THAN 750 GPM OR 1/2 THE MAXIMUM SPECIFIED BY THE MANUFACTURER, WHICHEVER IS LESS. PUMP INTAKES SHOULD BE FLOATING AND SCREENED.
6. ALL FILTER BAGS AND TRAPPED SEDIMENT SHALL BE REMOVED TO A SUITABLE WASTE AREA WHEN ACCUMULATED SEDIMENTS REACH 1/2 TOTAL BAG CAPACITY.

DEWATERING FILTER BAG
NOT TO SCALE

ISSUED FOR PERMITTING
NOT FOR CONSTRUCTION

INSTALL

811 DigSafe MA ME NH RI VT

PE STAMP
STATE OF MAINE
ROSEMARY WIGHTMAN
No. 16457
LICENSED PROFESSIONAL ENGINEER

AVANGRID ENGINEERING
CONFIDENTIAL, PROPRIETARY and **TRADE SECRET INFORMATION**
Property of AVANGRID

NECEC AVANGRID

EROSION CONTROL DETAILS

NECEC HVDC LINE MOXIE GORE & WEST FORKS, ME

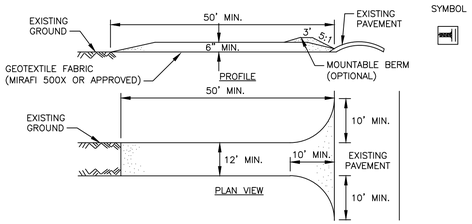
BY	DJFSA	SCALE: AS NOTED	FILE: 1081-0003-005 SH 003.dwg
CK	RWFSA	NO.	REV
APP	RWFSA	1081-0003-005 SH 003	0-1
DATE	01/23/2024		

REV	DESCRIPTION	DATE	BY	CK	APP
0-1	ISSUED FOR PERMITTING	12/19/2023	DJFSA	RWFSA	RWFSA
0-0	ISSUED FOR PERMITTING	11/3/2023	DJFSA	RWFSA	RWFSA
0-0	ISSUED FOR CONSTRUCTION	08/31/2023	DJFSA	RWFSA	RWFSA
0-0A	ISSUED FOR REVIEW	04/22/2021	JEC/FSA	SSS/FSA	SSS/FSA

INFO
Realtime Utility Engineers, Inc.
2363 Technology Drive, Suite 500
Fitchburg, WI 53719
(608) 535-1490

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ANSI D 1/22/2024



CONSTRUCTION SPECIFICATIONS

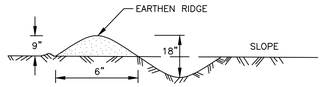
1. STONE SIZE – USE 2" STONE.
2. LENGTH – NOT LESS THAN 50 FEET (EXCEPT ON A SINGLE RESIDENCE LOT WHERE A 30 FOOT MINIMUM LENGTH WOULD APPLY).
3. THICKNESS – NOT LESS THAN SIX (6) INCHES.
4. WIDTH – TWELVE (12) FOOT MINIMUM, BUT NOT LESS THAN THE FULL WIDTH AT POINTS WHERE INGRESS OR EGRESS OCCURS. TWENTY–FOUR (24) FOOT IF SINGLE ENTRANCE TO SITE.
5. GEOTEXTILE FABRIC – WILL BE PLACED OVER THE ENTIRE AREA PRIOR TO PLACING OF STONE.
6. SURFACE WATER – ALL SURFACE WATER FLOWING OR DIVERTED TOWARD CONSTRUCTION ENTRANCES SHALL BE PIPED ACROSS THE ENTRANCE. IF PIPING IS IMPRACTICAL, A MOUNTABLE BERM WITH 5:1 SLOPES WILL BE PERMITTED.
7. MAINTENANCE – THE ENTRANCE SHALL BE MAINTAINED IN A CONDITION WHICH WILL PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO PUBLIC RIGHTS–OF–WAY. ALL SEDIMENT SPILLED, DROPPED, WASHED OR TRACKED ONTO PUBLIC RIGHTS–OF–WAY MUST BE REMOVED IMMEDIATELY.
8. WHEN WASHING IS REQUIRED, IT SHALL BE DONE ON AN AREA STABILIZED WITH STONE, AND WHICH DRAINS INTO AN APPROVED SEDIMENT TRAPPING DEVICE.
9. PERIODIC INSPECTION AND NEEDED MAINTENANCE SHALL BE PROVIDED AFTER EACH RAIN.

STABILIZED CONSTRUCTION ENTRANCE

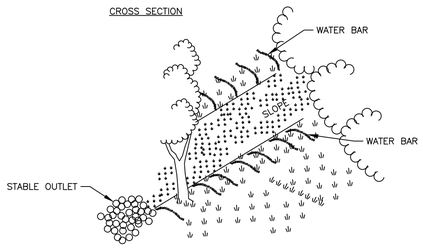
NOT TO SCALE

CONSTRUCTION SPECIFICATIONS

1. INSTALL THE WATER BAR AS SOON AS THE RIGHT OF WAY IS CLEARED AND GRADED.
2. DISK OR STRIP THE SOD FROM THE BASE FOR THE CONSTRUCTED RIDGE BEFORE PLACING FILL.
3. TRACK THE RIDGE TO COMPACT IT TO THE DESIGN CROSS SECTION.
4. THE OUTLET SHALL BE LOCATED ON AN UNDISTURBED AREA. FIELD SPACING WILL BE ADJUSTED TO USE THE MOST STABLE OUTLET AREAS. OUTLET PROTECTION WILL BE PROVIDED WHEN NATURAL AREAS ARE NOT ADEQUATE.
5. VEHICLE CROSSING SHALL BE STABILIZED WITH GRAVEL. EXPOSED AREAS SHALL BE IMMEDIATELY SEEDED AND MULCHED.
6. PERIODICALLY INSPECT WATER BARS FOR EROSION DAMAGE AND SEDIMENT. CHECK OUTLET AREAS AND MAKE REPAIRS AS NEEDED TO RESTORE OPERATION.

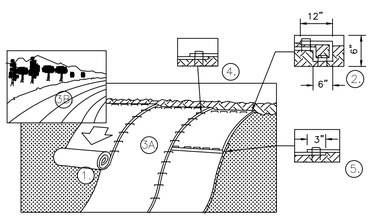


CROSS SECTION



WATER BARS

NOT TO SCALE



1. PREPARE SOIL BEFORE INSTALLING BLANKETS, INCLUDING ANY NECESSARY APPLICATION OF LIME, FERTILIZER, AND SEED. NOTE: WHEN USING CELL–O–SEE DO NOT SEED PREPARED AREA. CELL–O–SEED MUST BE INSTALLED WITH PAPER SIDE DOWN.
2. BEGIN AT THE TOP OF THE SLOPE BY ANCHORING THE BLANKET IN A 6" DEEP X 6" WIDE TRENCH WITH APPROXIMATELY 12" OF BLANKET EXTENDED BEYOND THE UP–SLOPE PORTION OF THE TRENCH. ANCHOR THE BLANKET WITH A ROW OF STAPLES/STAKES APPROXIMATELY 12" APART IN THE BOTTOM OF THE TRENCH. BACKFILL AND COMPACT THE TRENCH AFTER STAPLING. APPLY SEED TO COMPACTED SOIL AND FOLD REMAINING 12" PORTION OF BLANKET BACK OVER SEED AND COMPACTED SOIL SECURE BLANKET OVER COMPACTED SOIL WITH A ROW OF STAPLES/STAKES SPACED APPROXIMATELY 12" APART ACROSS THE WIDTH OF THE BLANKET.
3. ROLL THE BLANKETS (A.) DOWN OR (B.) HORIZONTALLY ACROSS THE SLOPE BLANKETS WILL UNROLL WITH APPROPRIATE SIDE AGAINST THE SOIL SURFACE. ALL BLANKETS MUST BE SECURELY FASTENED TO SOIL SURFACE BY PLACING STAPLES/STAKES IN APPROPRIATE LOCATIONS AS SHOWN IN THE STAPLE PATTERN GUIDE. WHEN USING OPTIONAL DOT SYSTEM, STAPLES/STAKES SHOULD BE PLACED THROUGH EACH OF THE COLORED DOTS CORRESPONDING TO THE APPROPRIATE STAPLE PATTERN.
4. THE EDGES OF PARALLEL BLANKETS MUST BE STAPLED WITH APPROXIMATELY 2"–5" OVERLAP DEPENDING ON BLANKET TYPE. TO ENSURE PROPER SEAM ALIGNMENT, PLACE THE EDGE OF THE OVERLAPPING BLANKET (BLANKET BEING INSTALLED ON TOP) EVEN WITH THE COLORED SEAM STITCH ON THE PREVIOUSLY INSTALLED BLANKET.
5. CONSECUTIVE BLANKETS SPLICED DOWN THE SLOPE MUST BE PLACED END OVER END (SHINGLE STYLE) WITH AN APPROXIMATE 3" OVERLAP. STAPLE THROUGH OVERLAPPED AREA, APPROXIMATELY 12" APART ACROSS ENTIRE BLANKET WIDTH.

NOTE:
* IN LOOSE SOIL CONDITIONS, THE USE OF STAPLE OR STAKE LENGTHS GREATER THAN 6" MAY BE NECESSARY TO PROPERLY SECURE THE BLANKETS.

EROSION CONTROL BLANKET INSTALLATION

NOT TO SCALE

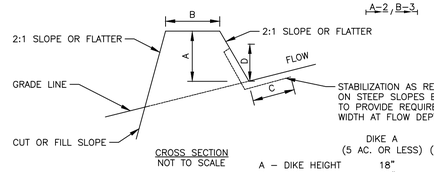
REV	DESCRIPTION	DATE	BY	CK	APP
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0-0	ISSUED FOR PERMITTING	11/3/2023	DJFSA	RWFSA	RWFSA
0-0	ISSUED FOR CONSTRUCTION	8/31/2023	DJFSA	RWFSA	RWFSA
0-A	ISSUED FOR REVIEW	04/22/2021	JECFSA	SSSFSA	SSSFSA

INFO
Realtime Utility Engineers, Inc.
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(855) 221-1476

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REALTIME Utility Engineers

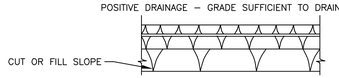
ANSI D 1/22/2024

SYMBOL



CROSS SECTION
NOT TO SCALE

	DIKE A (5 AC. OR LESS)	DIKE B (5–10 AC.)
A – DIKE HEIGHT	18"	36"
B – DIKE WIDTH	24"	36"
C – FLOW WIDTH	48"	60"
D – FLOW DEPTH	8"	15"

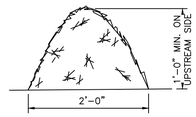


CONSTRUCTION SPECIFICATIONS

1. ALL DIKES SHALL BE COMPACTED BY EARTH–MOVING EQUIPMENT.
2. ALL DIKES SHALL HAVE POSITIVE DRAINAGE TO AN OUTLET.
3. TOP WIDTH MAY BE WIDER AND SIDE SLOPES BE FLATTER IF DESIRED TO FACILITATE CROSSING BY CONSTRUCTION TRAFFIC.
4. FIELD LOCATION SHOULD BE ADJUSTED AS NEEDED TO UTILIZE A STABILIZED SAFE OUTLET.
5. EARTH DIKES SHALL HAVE AN OUTLET THAT FUNCTIONS WITH A MINIMUM OF EROSION. RUNOFF SHALL BE CONVEYED TO A SEDIMENT TRAPPING DEVICE SUCH AS A SEDIMENT TRAP OR SEDIMENT BASIN WHERE EITHER THE DIKE CHANNEL OR THE DRAINAGE AREA ABOVE THE DIKE ARE NOT ADEQUATELY STABILIZED.
6. STABILIZATION SHALL BE: (A) IN ACCORDANCE WITH STANDARD SPECIFICATIONS FOR SEED AND STRAW MULCH IF NOT IN SEEDING SEASON, (B) FLOW CHANNEL AS PER THE CHART ON THE PREVIOUS PAGE.

EARTH DIKE

NOT TO SCALE

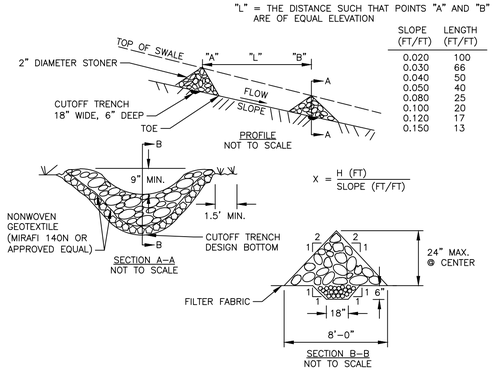


EROSION CONTROL SOIL/BARK MIX: SHALL CONSIST OF SHREDDED BARK, STUMP GRINDINGS, COMPOSTED BARK OR FLUME GRIT AND FRAGMENTED WOOD GENERATED FROM WATER–FLUME LOG HANDLING SYSTEMS. THE MIX SHALL CONFORM TO THE FOLLOWING:

1. pH – 5.0 TO 8.0.
2. SCREEN SIZE: 6" – 100% PASSING
   ¾" – 70% TO 85% PASSING
   MIX SHALL NOT CONTAIN LARGE PORTIONS OF SILTS, CLAYS OR FINE SANDS
3. ORGANIC MATERIAL 20% – 100% (DRY WEIGHT BASIS)
   ORGANIC PORTION MUST BE FIBROUS AND ELONGATED
4. SOLUBLE SALTS SHALL BE < 4.0 mmhos/cm

NATURAL EROSION CONTROL BERM

NOT TO SCALE



SLOPE (FT/FT)	LENGTH (FT/FT)
0.020	100
0.030	66
0.040	50
0.050	40
0.080	25
0.100	20
0.120	17
0.150	13

CONSTRUCTION SPECIFICATIONS

1. STONE WILL BE PLACED ON A FILTER FABRIC FOUNDATION TO THE LINES, GRADES AND LOCATIONS SHOWN IN THE PLAN.
2. SET SPACING OF CHECK DAMS TO ASSUME THAT THE ELEVATIONS OF THE CREST OF THE DOWNSTREAM DAM IS AT THE SAME ELEVATION OF THE TOE OF THE UPSTREAM DAM.
3. EXTEND THE STONE A MINIMUM OF 1.5 FEET BEYOND THE DITCH BANKS TO PREVENT CUTTING AROUND THE DAM.
4. PROTECT THE CHANNEL DOWNSTREAM OF THE LOWEST CHECK DAM FROM SCOUR AND EROSION WITH STONE OR LINER AS APPROPRIATE.
5. ENSURE THAT CHANNEL APPURTENANCES SUCH AS CULVERT ENTRANCES BELOW CHECK DAMS ARE NOT SUBJECT TO DAMAGE OR BLOCKAGE FROM DISPLACED STONE.

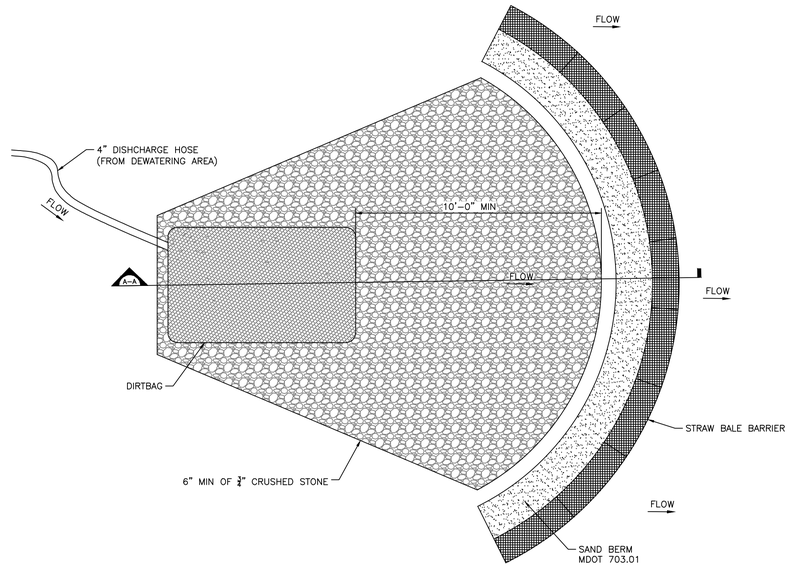
MAXIMUM DRAINAGE AREA 2 ACRES

CHECK DAM

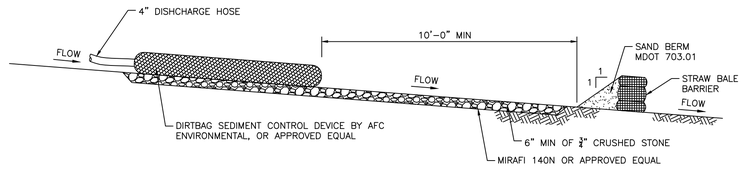
NOT TO SCALE

DEWATERING DETAIL NOTES

1. DIRT BAG MATERIAL BASED ON PARTICLE SIZE IN DIRTY WATER, I.E. FOR COARSE PARTICLES A WOVEN MATERIAL; FOR SILTS/CLAYS A NON–WOVEN MATERIAL.
2. DO NOT OVER PRESSURIZE DIRT BAG OR USE BEYOND CAPACITY.
3. LOCATE DISCHARGE SITE AS INDICATED ON SITE GRADING PLAN.
4. DOWNGRADIENT RECEIVING AREA MUST BE WELL VEGETATED OR OTHERWISE STABLE FROM EROSION, E.G. FOREST FLOOR OR COARSE GRAVEL/STONE.
5. DISCHARGE NOT PERMITTED WITHIN 100' OF A STREAM OR WETLAND.



PLAN



SECTION A–A

DEWATERING SYSTEM DETAIL

NOT TO SCALE

ISSUED FOR PERMITTING
NOT FOR CONSTRUCTION

INSTALL

811 DigSafe MA ME NH RI VT

PE STAMP
STATE OF MAINE
ROSEMARY WIGHTMAN
No. 16457
LICENSED
PROFESSIONAL ENGINEER

AVANGRID ENGINEERING
CONFIDENTIAL, PROPRIETARY and TRADE SECRET INFORMATION
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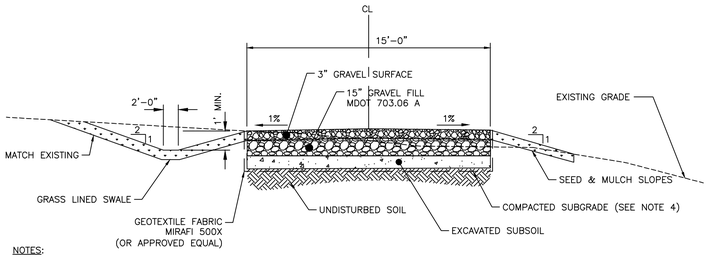
NECEC AVANGRID

REV	DESCRIPTION	DATE	BY	CK	APP

EROSION CONTROL DETAILS

NECEC HVDC LINE MOXIE GORE & WEST FORKS, ME

BY	DJFSA	SCALE: AS NOTED	FILE: 1081-0003-005 SH 004.dwg
CK	RWFSA	NO.	REV
APP	RWFSA	1081-0003-005 SH 004	0-1
DATE	01/23/2024		



NOTES:

1. ROAD SHOULD BE CROWNED OR SLOPED AT 1% TO THE UPHILL SIDE.
2. ALL MATERIALS SHALL BE MAINEDOT APPROVED AND SHALL MEET MAINEDOT SPECIFICATIONS FOR MATERIAL REQUIREMENTS AND CONSTRUCTION DETAILS.
3. ALL SPOIL MATERIALS TO REMAIN ON SITE; SEE STOCKPILES AREAS SHOWN ON C SHEETS.
4. ANY SUBGRADE FILL REQUIRED SHOULD BE MDOT 703.06 TYPE D THAT MEETS 25–70% PASSING THE 1/4" SIEVE. STRIP & STOCKPILE ANY EXISTING TOPSOIL AND/OR SOIL MATERIAL TO ACHIEVE REQUIRED STONE DEPTH. PROOFROLL SUBGRADE PRIOR TO GEOTEXTILE PLACEMENT.
5. ALL CUT & FILL SLOPES TO BE GRADED AT 2:1 SLOPES, UNLESS OTHERWISE NOTED ON THE PLANS.
6. PROPOSED GRADES TO MATCH EXISTING GRADES, UNLESS OTHERWISE NOTED ON THE DESIGN SHEETS.
7. ALL TEMPORARY ROADS SHOULD BE RESTORED UPON COMPLETION OF NECESSARY CONSTRUCTION ACTIVITIES. GRAVEL SHOULD BE REMOVED, BACKFILLED, COMPACTED AND DRESSED WITH 4" MINIMUM TOPSOIL FOR RESEEDING AND REVEGETATION.

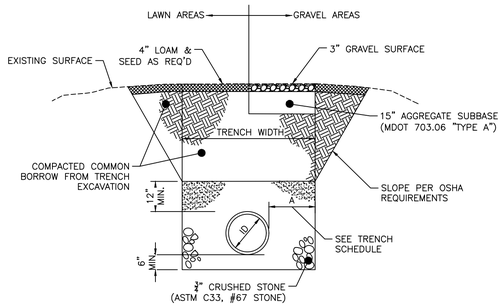
TYPICAL ACCESS ROAD SECTION

NOT TO SCALE

TRENCH SCHEDULE

ID	A (MIN.)
4"–12"	0'–10"
15"	0'–10"
18"	0'–10"
24"	0'–6"
30"	0'–6"
36"	0'–6"

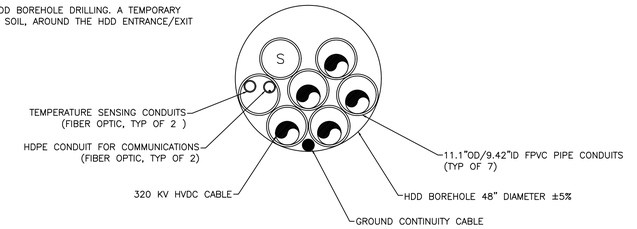
NOTE: SHORE TRENCH EXCAVATION AS REQUIRED TO MINIMIZE EXCAVATION AND IMPACTS TO ADJACENT UTILITIES, STRUCTURES OR PAVEMENT. TRENCHES SHALL BE CONSTRUCTED IN ACCORDANCE WITH OSHA REQUIREMENTS.



TYPICAL CULVERT TRENCH DETAIL

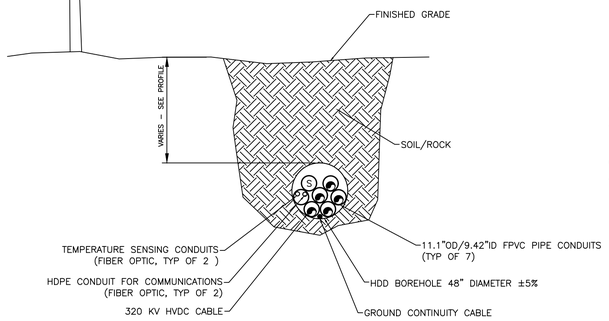
NOTES:

1. DETAILS FOR DIRECT CONDUIT BUNDLE AND DIRECT–BURY CABLE TRENCH ARE PRELIMINARY AND SUBJECT TO CHANGE AFTER FINAL DESIGN AND ENGINEERING OF THE 320 KV HVDC CABLES.
2. CONDUIT IDENTIFICATION IS PRELIMINARY. CONDUITS MAY SHIFT DURING PULLBACK.
3. "S" IDENTIFICATION IS SPARE CONDUIT.
4. HDD BOREHOLE DIAMETER IS 48" WITH A ±5% TOLERANCE. TO FACILITATE HDD BOREHOLE DRILLING. A TEMPORARY 60" DIAMETER SURFACE CASING TO BE INSTALLED IN SHALLOW OVERBURDEN SOIL, AROUND THE HDD ENTRANCE/EXIT LOCATIONS AS NEEDED TO FACILITATE DRILLING OF THE HDD BOREHOLE.



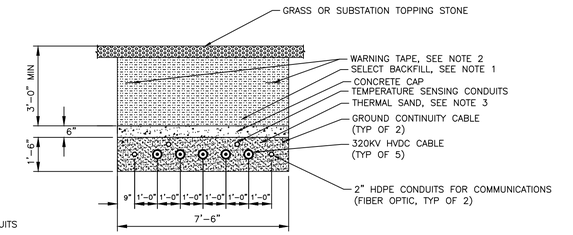
CONDUIT BUNDLE INSTALLATION DETAIL

NOT TO SCALE



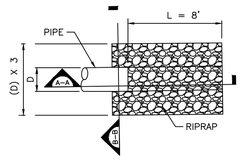
DIRECT BURY CABLE TRENCH DIAGRAM

NOT TO SCALE

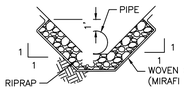


NOTES:

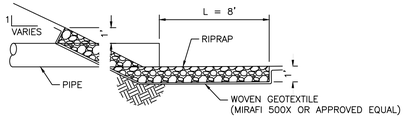
1. BACKFILL FOR DIRECT BURIED CABLES SHALL BE THERMALLY ACCEPTABLE. FLOWABLE THERMAL BACKFILL (FTB) AND THERMAL GRANULAR ARE POSSIBLE BACKFILL MATERIALS. ALL BACKFILL MATERIALS SHALL BE APPROVED BEFORE INSTALLATION. ALL BACKFILL SHALL BE INSTALLED IN ACCORDANCE WITH THE SPECIFICATIONS.
2. CONTRACTOR TO INSTALL TWO (2) WARNING MARKING TAPES ABOVE THE CONCRETE CAP K 18" BELOW GRADE.
3. CLEAN THERMAL SAND SHALL BE USED FOR DIRECT BURIED CABLES. ALL BACKFILL MATERIALS SHALL BE INSTALLED IN ACCORDANCE WITH THE SPECIFICATIONS.



PLAN



SECTION B–B



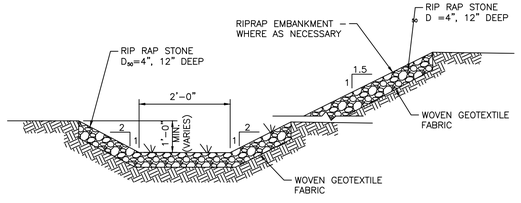
SECTION A–A

NOTES:

- D_{50}=4", D_{MAX}=6"
- THICKNESS = 12"
- STONE FOR RIPRAP SHALL CONSIST OF SUB ANGULAR FIELD STONE FOR ROUGH UNHEWN QUARRY STONE OF APPROXIMATELY RECTANGULAR SHAPE. THE STONE SHALL BE HARD AND OF SUCH QUALITY THAT IT WILL NOT DISINIGRATE ON EXPOSURE TO WATER OR WEATHERING, BE CHEMICALLY STABLE, AND IT SHALL BE SUITABLE IN ALL OTHER RESPECTS FOR THE PURPOSE INTENDED. THE BULK SPECIFIC GRAVITY (SATURATED SURFACE–DRY BASIS) OF THE INDIVIDUAL STONES SHALL BE AT LEAST 2.5.

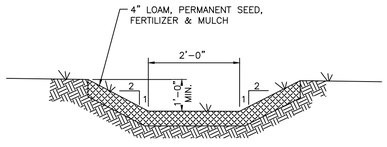
CULVERT INLET/OUTLET PROTECTION

NOT TO SCALE



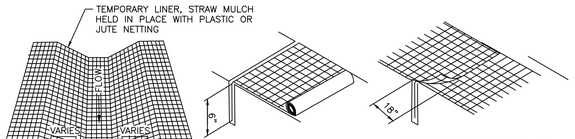
RIPRAP SWALE DETAIL

NOT TO SCALE



VEGETATED SWALE DETAIL

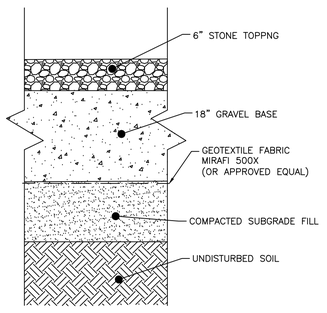
NOT TO SCALE



1. EXCAVTE THE CHANNEL SHAPE TO AN EVEN CROSS–SECTION AS SHOWN. WHEN STAKING INDICATE A 0.2' OVERCUT AROUND THE CHANNEL PERIMETER FOR SILTING AND BULKING.
2. GRADE SOIL AWAY FROM CHANNEL SO THAT SURFACE WATER MAY ENTER FREELY.
3. APPLY LIME, FERTILIZER AND SEED TO THE CHANNEL AND ADJOINING AREAS IN ACCORDANCE WITH THE EROSION CONTROL PLAN.
4. SPREAD HAY OR STRAW MULCH AT THE RATE OF 110LB/1000 SF.
5. HOLD MULCH IN PLACE IMMEDIATELY AFTER SPREADING WITH A PLASTIC NETTING INSTALLED AS SHOWN.
6. STATE LAYING THE NET FROM THE TOP OF THE UPSTREAM END OF THE CHANNEL AND UNROLL IT DOWN GRADE. DO NOT STRETCH THE NETTING.
7. BURY THE UP SLOPE END AND STAPLE THE NET EVERY 12" ACROSS THE TOP END, EVERY 3 FT AROUND THE EDGES AND ACROSS THE NET SO THAT THE STRAW IS HELD CLOSELY AGAINST THE SOIL. HOWEVER, DO NOT STRETCH THE NETTING WHEN STAPLING.
8. NETTING STRIPS SHOULD BE JOINED TOGETHER ALONG THE SIDE WITH A 3" OVERLAP AND STAPLED TOGETHER.
9. TO JOIN ENDS OF STRIPS, INSERT A NEW ROLL OF NET IN A TRENCH AS WITH THE UP SLOPE END AND OVERLAP IT 18" WITH THE PREVIOUSLY LAID UPPER ROLL. TURN UNDER 6" OF THE 18" OVERLAP AND STAPLE EVERY 12" ACROSS THE END.

GRASS LINED CHANNEL

NOT TO SCALE



TYPICAL STATION SECTION

NOT TO SCALE

ISSUED FOR PERMITTING
NOT FOR CONSTRUCTION

INSTALL

811 DigSafe MA ME NH RI VT

REV	DESCRIPTION	DATE	BY	CK	APP
0-1	ISSUED FOR PERMITTING	12/15/2023	DJFSA	RWFSA	RWFSA
0-0	ISSUED FOR PERMITTING	11/3/2023	DJFSA	RWFSA	RWFSA
0-0	ISSUED FOR CONSTRUCTION	08/31/2022	DJFSA	RWFSA	RWFSA
0-0A	ISSUED FOR REVIEW	04/22/2021	JECFSA	SSSFSA	SSSFSA

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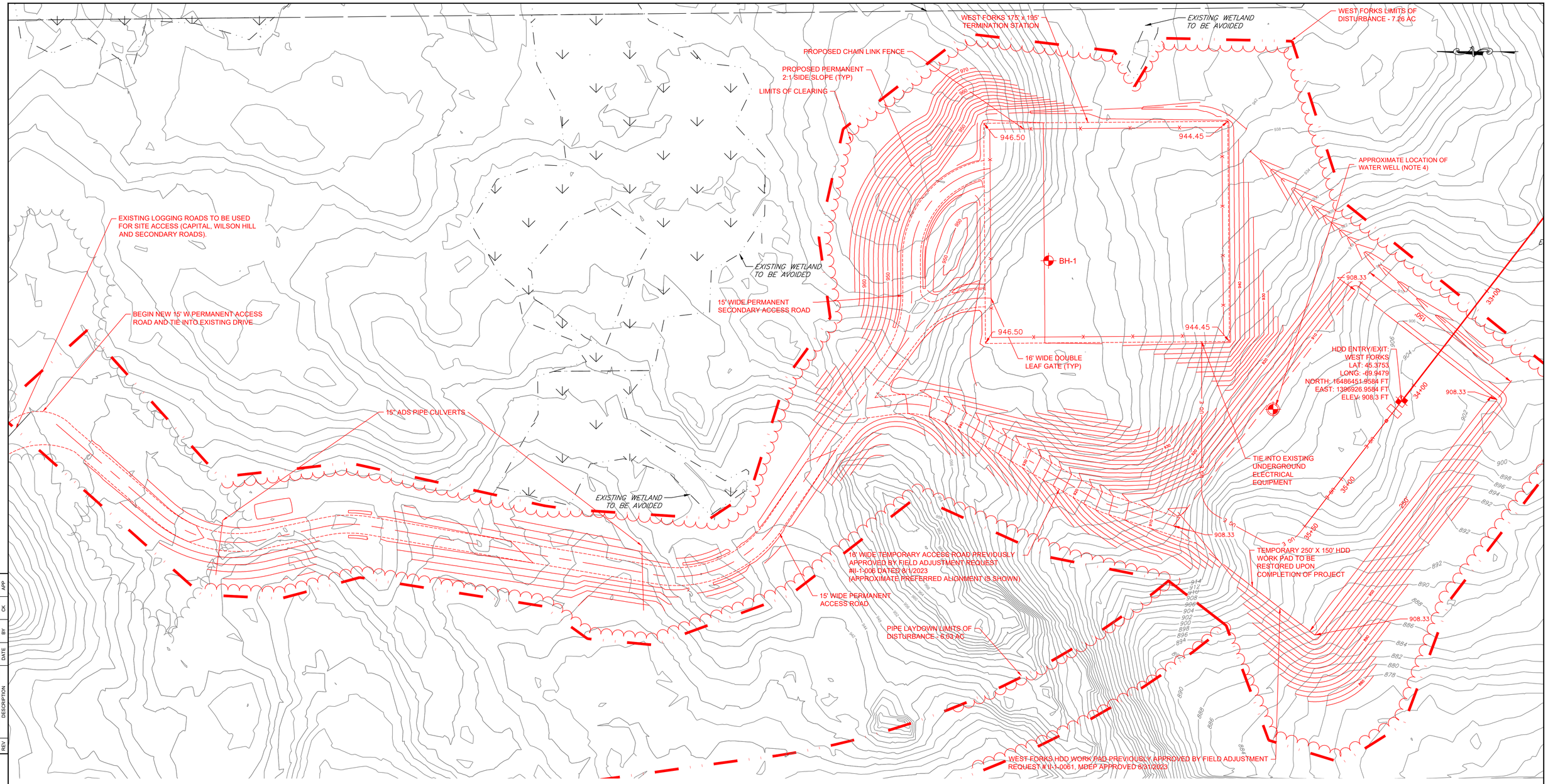
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APP	RWFSA	1081-0003-005 SH 005	0-1
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West Forks Access Drive Plan View
1"=40'

0 10 20 40 80 120
SCALE: 1"=40'

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WEST FORKS ACCESS ROAD PLAN

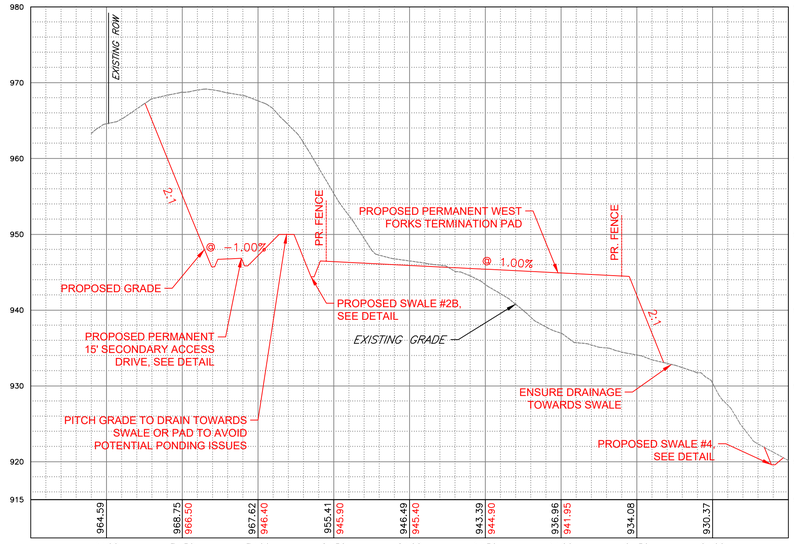
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APP	RWFSA	1082-0003-001 SH 001	0-1
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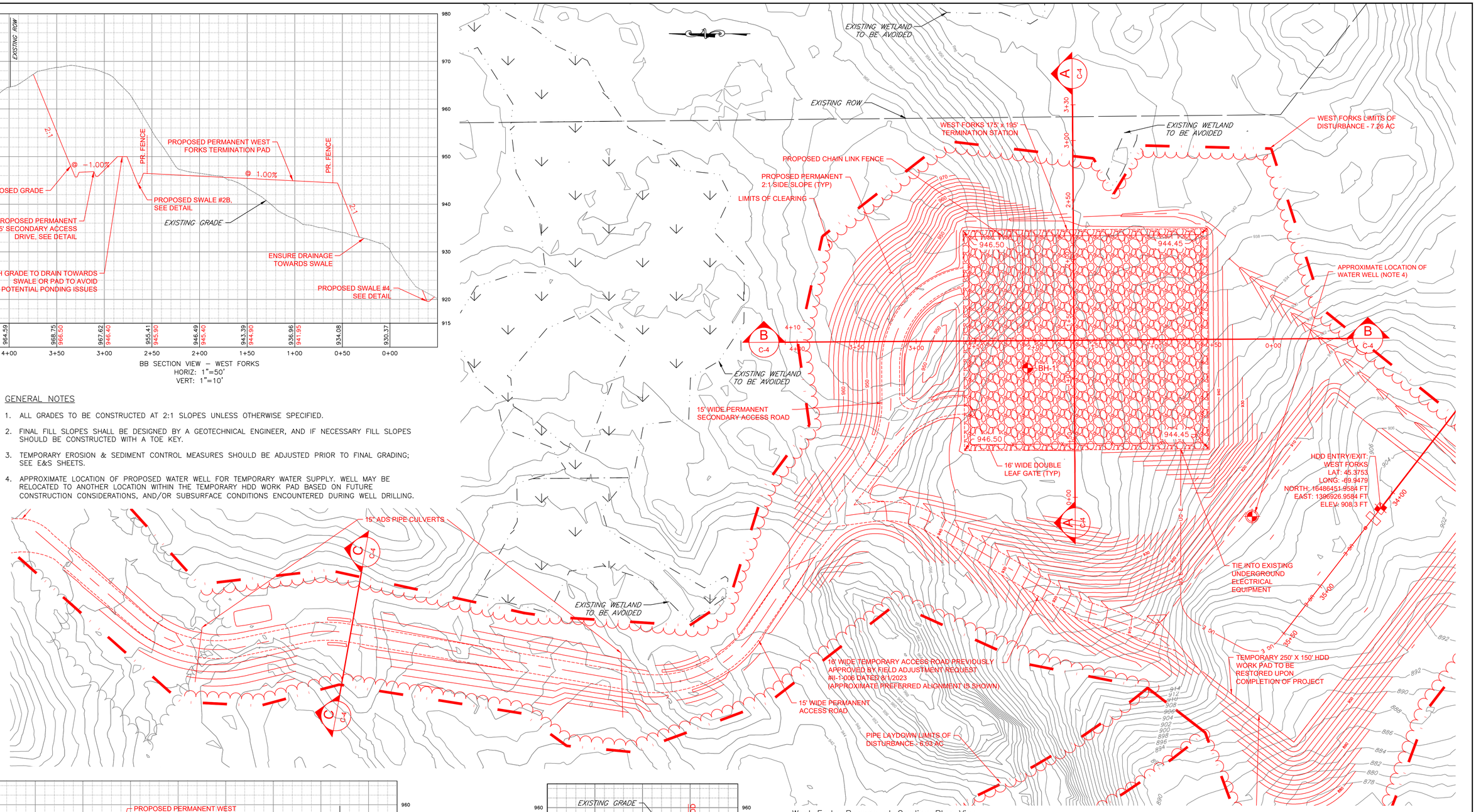
ANSI D 1/22/2024



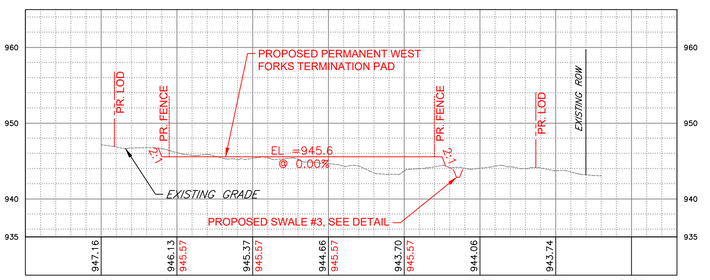
BB SECTION VIEW – WEST FORKS
HORIZ: 1"=50'
VERT: 1"=10'

GENERAL NOTES

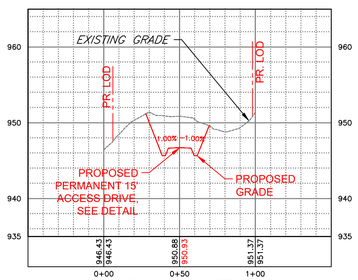
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2. FINAL FILL SLOPES SHALL BE DESIGNED BY A GEOTECHNICAL ENGINEER, AND IF NECESSARY FILL SLOPES SHOULD BE CONSTRUCTED WITH A TOE KEY.
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4. APPROXIMATE LOCATION OF PROPOSED WATER WELL FOR TEMPORARY WATER SUPPLY. WELL MAY BE RELOCATED TO ANOTHER LOCATION WITHIN THE TEMPORARY HDD WORK PAD BASED ON FUTURE CONSTRUCTION CONSIDERATIONS, AND/OR SUBSURFACE CONDITIONS ENCOUNTERED DURING WELL DRILLING.



West Forks Permanent Grading Plan View
1"=40'



AA SECTION VIEW – WEST FORKS
HORIZ: 1"=50'
VERT: 1"=10'



CC SECTION VIEW – WEST FORKS
HORIZ: 1"=50'
VERT: 1"=10'

0 10 20 40 80 120
SCALE: 1"=40'

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0-0B	ISSUED FOR REVIEW	08/08/2023	DJFSA	CMLFSA	CMLFSA
0-0A	ISSUED FOR REVIEW	04/22/2021	JEC/FSA	SSS/FSA	SSS/FSA

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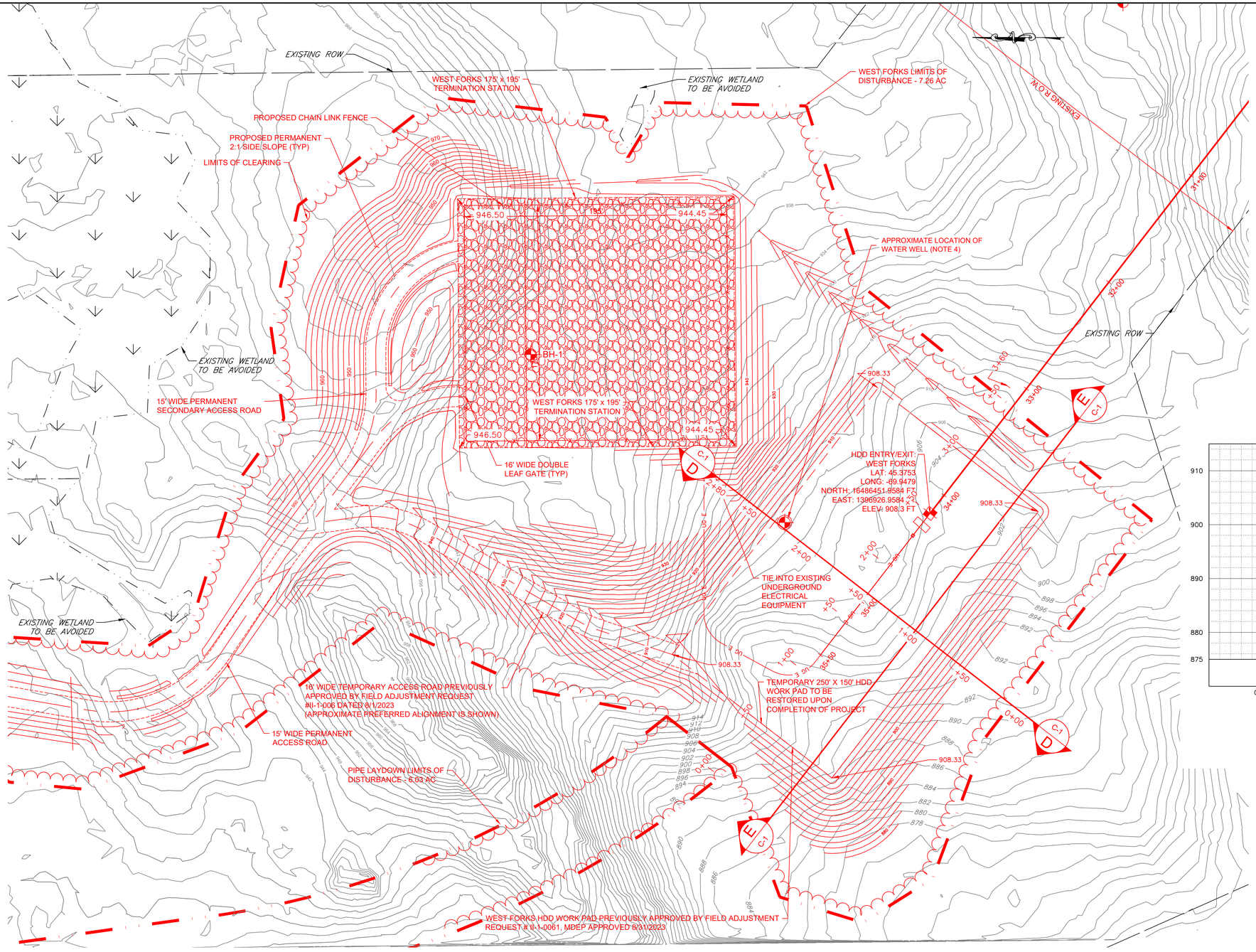
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WEST FORKS GRADING PLAN & SECTIONS

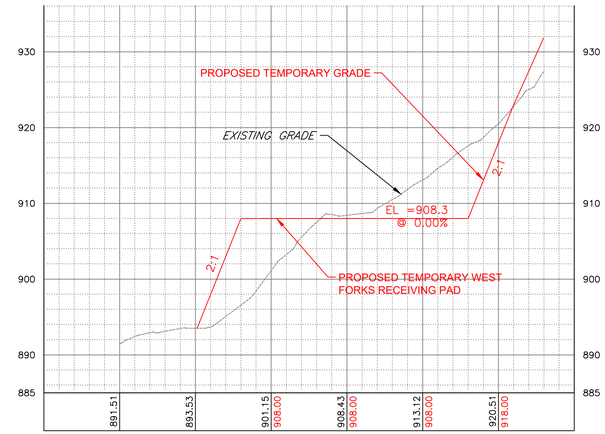
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NECEC HVDC LINE MOXIE GORE & WEST FORKS, ME

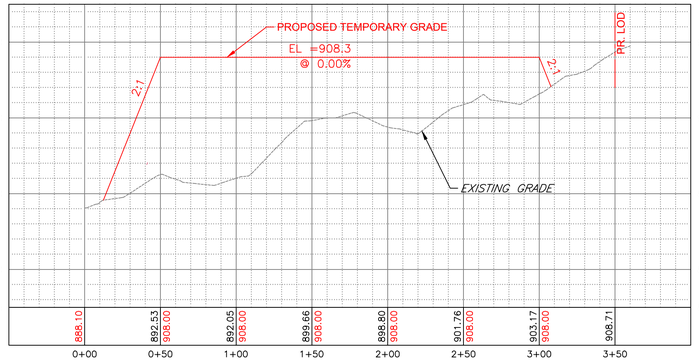
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CK	RWFSA	NO.	REV
APP	RWFSA	1082-0003-004 SH 001	0-1
DATE	01/23/2024		



West Forks Permanent Grading Plan View
1"=40'



DD SECTION VIEW – WEST FORKS
HORIZ: 1"=50'
VERT: 1"=10'



EE SECTION VIEW – WEST FORKS
HORIZ: 1"=50'
VERT: 1"=10'

SCALE: 1"=40'

GENERAL NOTES

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0-0B	ISSUED FOR REVIEW	08/08/2023	DJFSA	CMLFSA	SSSFSA
0-0A	ISSUED FOR REVIEW	04/22/2021	JECFSA	SSSFSA	CK

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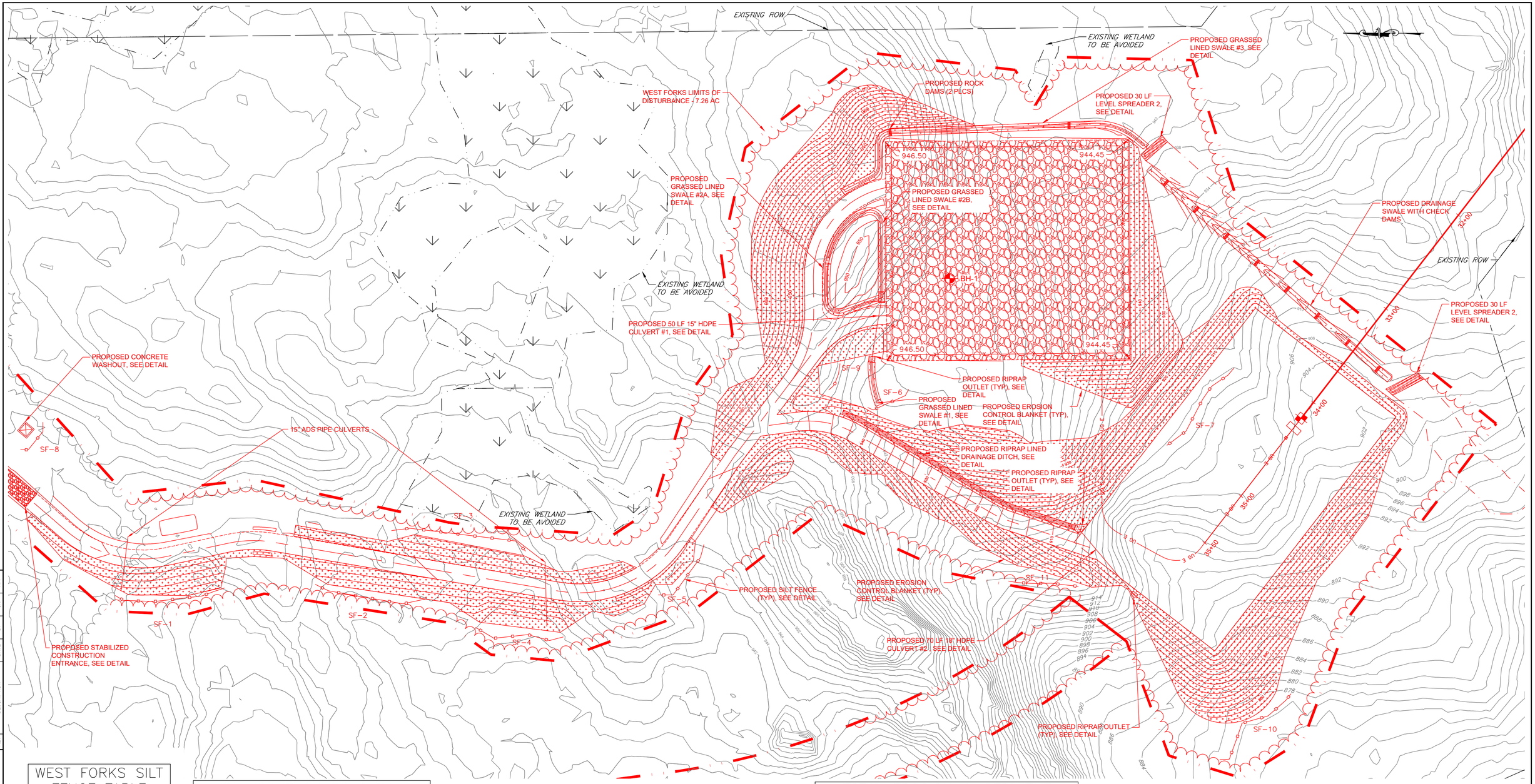
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WEST FORKS GRADING PLAN & SECTIONS
PHASE 2

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West Forks Plan View
1"=40'

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SCALE: 1"=40'

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0-0B	ISSUED FOR REVIEW	08/08/2023	DJFSA	CMLFSA	CMLFSA
0-0A	ISSUED FOR REVIEW	04/22/2021	JEOFSA	SSSFSA	SSSFSA

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WEST FORKS SILT FENCE TABLE

NUMBER	ESTIMATED LENGTH (ft)
SF-1	95
SF-2	95
SF-3	118
SF-4	78
SF-5	62
SF-6	46
SF-7	100
SF-8	34
SF-9	25
SF-10	90
SF-11	60

WEST FORKS GRASSED SWALE TABLE

NUMBER	ESTIMATED LENGTH (ft)	INLET INVERT	OUTLET INVERT	SLOPE
1	50	943.50	943.00	1.0%
2A	85	945.35	944.00	1.6%
2B	135	945.35	944.00	2.0%
3	275	945.00	940.00	1.8%
4	266	938.00	906.40	-12.8%

TOTAL EROSION & SEDIMENT CONTROL QUANTITIES

BMP	ESTIMATED QUANTITY	UNIT
STABILIZED CONSTRUCTION ENTRANCE	1	EA
SILT FENCE	784	LF
GRASSED SWALES	811	LF
CONCRETE WASHOUTS	1	EA
EROSION CONTROL BLANKET	78350	SF
15" HDPE DRAINAGE CULVERT	50	LF
18" HDPE DRAINAGE CULVERT	70	LF
15" ADS CULVERT	100	LF
ROCK CHECK DAM	2	EA
SEEDING & MULCHING	3	AC
30 LF LEVEL SPREADER	2	EA

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WEST FORKS EROSION & SEDIMENT CONTROL PLAN

NECEC HVDC LINE MOXIE GORE & WEST FORKS, ME

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APP	RWFSA	1082-0003-005 SH 001	0-1
DATE	01/23/2024		

Table 2 - Summary of Supplemental Information Associated with the NECEC NRPA Application		
NRPA Chapter & Title	*Affects Pending Application? (Yes/No)*	*Supplemental Information Provided Below*
Chapter 1 - Project Description	**Yes**	**See Site Law Section 1.0**
Chapter 2 - Alternative Analysis	No	
Chapter 3 - USGS Map	No	
Chapter 4 - Photographs	No	
Chapter 5 - Project Plans	**Yes**	**See Site Law Section 27.0, Exhibit 27-1.**
Chapter 6 - Additional Plans	No	
Chapter 7 - Construction Plan	**Yes**	**See 7.0, Exhibit 7-1.**
Chapter 8 - Erosion Control Plan	No	
Chapter 9 - Site Conditions	No	
Chapter 10 - Public Notice	No	
Chapter 11 - Maine Historic Preservation Commission and Outreach to Indian Tribes	No	
Chapter 12 - Wetland Functions and Values Assessment	No	
Chapter 13 - Compensatory Mitigation	No	

7.0 CONSTRUCTION PLAN

Exhibit 7-1 includes the HDD Company's work execution plan, which describes the construction methodology of the HDD beneath the Upper Kennebec River.

Exhibit 7-1: HDD Work Execution Plan

HDD EXECUTION PLAN

Owner: Central Maine Power

Project: New England Clean Energy Connect

Table of Contents

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1.1 Project Description 3
1.2 Equipment 3
1.3 Construction Methodology 4
1.3.1 Geotechnical Data Review 4
1.3.2 Drilling Prognosis 5
1.3.3 Drilling Fluid Management 5
1.3.4 Surface Casing 5
1.3.5 Intersect Operations 6
1.3.6 Pilot Hole Navigation 6
1.3.7 Reaming 7
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1.3.10 Handling and Disposal of Mud and Spoils 7
1.3.12 Demobilization 8

Appendix A – Drawings & Layout

Appendix B – Execution Details

Appendix C – Equipment

Appendix D – Steering Equipment

Appendix E – In Hole Tooling

Appendix F –- Sample Reports & Logs

Appendix G – Contingency Plans

Appendix H – Inadvertent Drilling Fluid Return Contingency Plan

Appendix I – Drilling Fluid Additives, Safety Data Sheets

Appendix J – Key Personnel

Appendix K – Drilling Mud Plan

NECEC Note 02.09.2024:
Appendix G, H, I are superseded and replaced in entirety with an updated version of The HDD Company's "Inadvertent Fluid Release Contingency Plan" and associated updated documents. Appendix K is enclosed per HDD's updated January 2024 transmittal.

HDD EXECUTION PLAN

1.0 KENNEBEC RIVER

1.1 PROJECT DESCRIPTION

Central Maine Power is proposing to construct a pipeline crossing of the Kennebec River, using the Horizontal Directional Drilling (HDD) method. The project involves the installation of a single HDD crossing, 3,481-feet in length, with seven (7) 10-inch DR 14 FPVC pipelines under the Kennebec River. The HDD construction period is expected to be 111 days and is expected to start on April 22, 2024. (Please refer to the attached technical details and schedule in Appendix B for more information). During construction, daily progress reports will be provided to Avangrid by The HDD Company (HDD).

1.2 EQUIPMENT

For the east side operations, HDD proposes to provide drilling Spread 7. Spread 7 has HDD Company's Rig 7, a Vermeer D750 x 900 with 768,000 pounds of thrust/pullback capabilities, and 99,400-foot pounds of rotary torque. To compliment Rig 7, HDD will use an American Augers MCD-1000, a 1000 gallons per minute (gpm) recycling system, with a 9,300-gallon cleaning/mixing capacity. This unit comes equipped with two (2) scalping shale shakers, two (2) 10-inch de-sanding cyclones with a mud cleaner shaker underlying the cyclones, and (20) 4-inch de-silting cyclones with a mud cleaner shaker underlying the de-silting cyclones. Additionally, two (2) Vermeer SA-400 high pressure mud pumping units will be used as primary drilling support for Rig 7. Each mud pumping unit will have a maximum output of 550 gallons per minute (gpm), delivering fluid pressures up to 1,000 psi, if configured with the appropriate pistons and liners and these pressures become required.

Rig 7 will be supported with an assortment of in-hole tools (e.g., tri-cone bits, hole-openers, misc. subs) and will use Range 2, 5 ½-inch or 6 5/8-inch full-hole (FH), Grade S-135 drill pipe, 24.70 and 27.70 pound per foot (ppf) respectively, for pilot hole and reaming operations.

Rig 7 will also have hired equipment as additional drilling support (e.g., excavators, forklifts, gen-sets) and have fully equipped tool vans with all the necessary spare parts and appurtenances to support all drilling operations during the project. (Please see the Equipment Inventory Drawings and Execution Plan Technical Details in Appendix B, as well as the manufacturers' specifications in Appendix C for additional information).

For the west side operations, HDD proposes to use Spread 8. Spread 8 has HDD Company's Rig 8, an American Augers DD-140B with 140,000 pounds of thrust/pullback capabilities and 25,000 foot-pounds of rotary torque. To compliment Rig 8, HDD will use a Vermeer R9 x 12T recycling system, with an 8,560-gallon cleaning/mixing capacity. This unit comes equipped with two (2) scalping shale shakers, two (3) 10-inch de-sanding cyclones with a mud cleaner shaker underlying the 10-inch cyclones, and (16) 5-inch de-silting cyclones with a mud cleaner shaker underlying the de-silting cyclones. To support the drilling operations of Spread 8, HDD will plan on using two (2) Vermeer SA 400 mud pumping units (or equivalent), with a maximum output of 550 gallons per minute (gpm), delivering fluid pressures up to 1,000 psi, if configured with the appropriate pistons and liners and these pressures become required.

Rig 8 will be supported with an assortment of in-hole tools (e.g., tri-cone bits, hole-openers, misc. subs) and will use Range 2, 5-inch X-hole, 19.5 (ppf), Grade S-135 drill pipe for the pilot hole.

Rig 8 will also have hired equipment as additional drilling support (e.g., excavators, forklifts, gen-sets) and have fully equipped tool vans with all the necessary spare parts and appurtenances to support all

drilling operations during the project. (Please see the Equipment Inventory Drawings and Execution Plan Technical Details in Appendix B, as well as the manufacturers' specifications in Appendix C for additional information).

1.3 CONSTRUCTION METHODOLOGY

1.3.1 Geotechnical Data Review[1]

BH-4 (approximately 813' west of entry point)

Depth from Surface (ft)	Approximate Elevation (ft)	SPT (N) Value	Classification	Other Notes
0 - 1	856 - 855	0 - 20/0"	-	-Forest duff
1 - 4	855 - 852	9 - 50/4"	Silty sand	-Medium dense, reddish-brown, some gravel with numerous cobbles
4 - 6	852 - 850	-	Bedrock	-
4 - 193.4	852 - 662.6	-	Bedrock	-Slate w/ quartz zones, siltstone lenses -Mohs Hardness ranging from 4-6 -RQD ranging from 0-100 -UCS ranging from 5811 psi - 14,526 psi -Water encountered at 22' BGS

BH-3 (approximate sta. 17+81, offset -59')

Depth from Surface (ft)	Approximate Elevation (ft)	SPT (N) Value	Classification	Other Notes
0 - 0.4	626 - 625.6	5 - 17	-	-Forest duff
0.4 - 8.4	625.6 - 617.6	50/4"	Gravelly silty sand	-Medium dense to dense, brown, occasional cobbles -Glacial till -Water encountered at 4' BGS
8.4 - 111.5	617.6 - 514.5	-	Bedrock	-Slate w/ quartz zones, phyllite lenses, pyrite crystals -Mohs Hardness ranging from 3 - 6 -RQD ranging from 0 - 100 -UCS ranging from 8529 psi - 18,526 psi

BH-2 (approximate sta. 32+12, offset 107')

Depth from Surface (ft)	Approximate Elevation (ft)	SPT (N) Value	Classification	Other Notes
0 - 0.4	915 - 914.6	10 - 32	-	-Forest duff
0.4 - 8.2	914.6 - 906.8	9 - 50/2"	Gravelly silty sand	-Medium dense to dense, brown, occasional cobbles -Glacial till
8.2 - 100	906.8 - 815	-	Bedrock	-Calcareous siltstone -Slightly to moderately weathered -Mohs Hardness = 5 -RQD ranging from 55 - 100 -UCS ranging from 3536 psi - 5288 psi

[1]Explorations and Geotechnical Engineering Services, S.W. Cole Engineering, Inc., Report 18-0345 S

1.3.2 Drilling Prognosis

0 ft to 3,367 ft Measured Depth (relative to entry point)

The geotechnical investigation indicates that most of the bore path will be contained in slate and siltstone bedrock. The ground formation in Cole Engineering's geotechnical report is described as slightly to moderately weathered, with unconfined compressive strengths (UCS) ranging from 3,536 psi to 18,526 psi.

1.3.3 Drilling Fluid Management

Drilling fluid is used throughout HDD operations to lubricate and cool tooling, power the mud motor, support the borehole against collapse and fluid loss, and carry cuttings from the borehole. Drilling fluid properties and performance will be monitored throughout the HDD operations using standard methods: measurement of marsh funnel viscosity, mud weight, and sand content. The additive mix may be adjusted during the project at the discretion of the drill rig operator and mud technician.

The drilling fluid will be recycled and cleaned using shale shakers, de-sander and de-silter cyclones with mud cleaner shakers underlying. This equipment is intended to remove the cuttings while preserving the desired drilling fluid properties. However, over time micro-fines, too small to be removed by the mechanical cleaning equipment, may accumulate within the drilling fluid. These micro-fines will increase the fluid weight (density) leading to increased fluid pressures, increased wear on tooling and equipment, and decreased drilling fluid performance. Freshly mixed drilling fluid is expected to have a density of 8.5 - 9 lbs/gal. and fluid performance is generally acceptable up to a density of about 10 lbs/gal. If the drilling fluid density exceeds about 10 lbs/gal it may be necessary to dispose of some volume of drilling fluid and replace it with fresh, lighter, fluid.

Drilling fluid flow rates will be managed based on drilling conditions throughout the bore path. During pilot hole operations, flow rates will depend on mud motor power requirements, annular pressure, hole cleaning, return circulation, and soil strength. Typical flow rates for both Rig 7 and Rig 8's planned pilot hole, using a 12 1/4-inch drill bit, and an 8-inch mud motor combination, are expected to be from 290 - 900 gal/min. During reaming operations flow rates will depend on tooling performance, hole cleaning, and pumping pressures and are expected to be 350-750 gals/min.

The slightly softer siltstone is nearest to the exit point of the drill. Higher levels of fracturing and weathering may be prone to losses of circulation due to cracks in the rock. To mitigate the risk of circulation loss, mud returns will be monitored throughout drilling operations and adjusted based on the downhole characteristics of the ground. (See HDD's Inadvertent Drilling Fluid Release and Contingency Plan in Appendix H)

1.3.4 Surface Casing

To install the 60-inch surface casing on the east side HDD will utilize the following strategy. The lead piece of casing will have a drive shoe welded to it prior to set-up and will be dug in and set at the appropriate angle. A TT Technologies Taurus Grundoram pneumatic hammer will be used to drive the casing into the ground by repeated percussive blows. The pipe will be installed open ended, which allows the soil to enter the pipe. Once a length of casing pipe has been driven down, the hammer will be removed, and another length of casing will be welded in place. Upon completion of welding, the next pipe will be driven down and the process repeated until the casing has reached the desired length or to refusal. Periodic cleaning of the casing segments may be required during the casing installation. The need for cleaning will be determined in the field. Cleaning of the casing will be completed using tapered augers or

reamers, in conjunction with the HDD rig. Surface casing on the west side will be installed with the same methodology.

Following the surface casing installation, HDD will install a 16-inch centralizer casing within the 60" surface casing. The centralizer casing pipe will be installed to ensure that the drill string is in the center of the casing and not laying at the bottom during pilot hole operations. The centralizer casing will be inspected and replaced as necessary during pilot hole operation and removed upon starting the reaming operations.

1.3.5 Intersect Operations

An intersect method has been chosen to complete the pilot hole for these crossings. Rig 7 and Rig 8 will drill toward each other along intersecting drill paths. The proposed intersect zone is the bottom tangent under the Kennebec River, and between STA 18+27 to STA 21+11, or as the lead guidance technician chooses, based on how the pilot holes drill. At the intersect zone, the two pilot holes will be connected.

To achieve the intersect, the steering technicians will calculate their pilot hole positions using the same magnetic surface coil and gyro data. This will provide both technicians the exact locations of each other's pilot BHAs. From this data an intersect course will be determined and drilled. Once the intersect is achieved, the east rig (Rig 7) will trip ahead while the west rig (Rig 8) withdraws its drill string.

Utilizing the method noted above, HDD has completed many crossings of varying lengths and depths with intersects over the last 10 years. Please refer to Figure 1 below for a summary of some of our team's most technically complex intersects in the past seven (7) years.

Figure 1. Intersect Crossings

Area	Total Length of Crossing	Depth from Surface at Intersect Location	Measured Depth of Intersect (from Entry)	Year
San Rafael, CA	4338'	60'	3880'	2020
Great Falls, MT	3532'	119'	2569'	2019
Millbrae, CA	3355'	67'	2652'	2018
Fremont, CA	4432'	76'	2040'	2018
Barstow, CA	4150'	55'	2557'	2018
Meredosia, IL	6511'	69'	3577'	2016

1.3.6 Pilot Hole Navigation

Rig 7 will drill a 12 ¼-inch pilot hole with an eight (8)-inch mud motor along the bore path trajectory, and as shown on drawing Kennebec River HDD Design 2023-10-11, sheet HDD-2, and up to the pre-planned intersect point. Rig 8 will also drill along the same path, in the opposite direction from the west side to the intersect point, using a 12 ¼-inch pilot hole with an eight (8)-inch mud motor. Both pilot hole's bottom hole assemblies (BHAs) will house a ParaTrack 2, high resolution steering tool with ParaTrack 2's Gyro module.

The steering tools (wireline and gyro steering systems) will be used to determine the position of the drilling assemblies at the bottom of each length of drill pipe (approximately every 30 feet). The wire line system includes a surface-mounted electromagnetic coil to determine the position of the drilling assembly, relative to the project's bore path, while the gyro steering system requires no coil wire.

To form the electromagnetic coil, the crew will run 6-gauge insulated wire to form a closed loop. Depending on access and width of the crossing, more than one coil may be used with gaps in between, to provide tracking for as much of the crossing length as possible. The primary side of the coil will run

on the right-of-way over top of the bore path's alignment, while the return side of the coil will be up to 100 feet from the primary side. The Gyro may also be used in areas where it is not possible to set-up a coil for the ParaTrack 2's wire line steering tool. (Please see Appendix A for additional information.)

1.3.7 Reaming

Following completion of the pilot hole, a 30-inch tungsten-carbide insert (TCI) rock hole opener will be added in the drill string at Rig 7 on the east side, while Rig 8 connects to Rig 7's drill string at the west side. The hole opener will be pulled from the east side to the west side. As the reamer is pulled to the west, (toward Rig 8), 5 ½-inch or 6 5/8-inch drill pipe will be added on at Rig 7. As the reaming operation proceeds (from east to the west), 5 ½-inch or 6 5/8-inch drill pipe or "tail string" is removed on the west side as reaming progresses.

Rig 8 will be used to apply tension to the drill string and make-up and break-out drill pipe, while Rig 7 will be the primary source for the rotary power used for reaming the hole. Drilling fluid will be recycled from Rig 7's MCD-1000 recycler and pumped down hole with the two Vermeer SA 400 mud pumping units.

Following the 30-inch ream pass, a 42-inch ream pass will occur with the same procedure as above. The final reaming pass will be sized to 48-inch (+/-5%) and will complete the reaming operations, per drawing Kennebec River HDD Design 2023-10-11, sheet HDD-1. A swab/cleaning pass using a 42-inch reamer will follow reaming operations to ensure borehole integrity. (See Appendix E for additional information.)

1.3.8 Pipe Pull

Following completion of the cleaning pass, HDD will meet with Avangrid to evaluate the cleaning pass before proceeding with pullback operations. Rig 8 and its support equipment will be moved from this location. Moving Rig 8 allows the FPVC pipe bundle/drag section to be moved into position for the pipe pull back on the west side of the crossing. The FPVC pipe bundle and pulling head will be attached to the pipe pulling BHA.

The pipe pulling BHA (looking up hole) is comprised of the drilling string which is connected to the 42-inch reamer. The barrel reamer is then connected to the pull swivel. After the drill string, reamer, and pipe swivel are connected, the pull swivel and pipe bundle's pulling head are connected using a large shackle.

1.3.9 Pipe Handling

HDD will fuse the 10-inch FPVC conduits on the west side while the pilot hole and reaming operations are occurring. (Please refer to Appendix H for additional information). During pullback operations, HDD will also handle the pipe on the west side. Large excavators outfitted with appropriately sized Roli® cradles will support the pipelines through the overbend and any curves. Sufficient pipeline rollers will be spaced at approximately 50-60 feet apart for the length of the FPVC pipe bundle or drag section, which is approximately 3,421'. The FPVC pipe's tail-end will be supported with equipment to prevent it from touching the ground as it leaves each roller during pullback.

1.3.10 Handling and Disposal of Mud and Spoils

Throughout drilling operations, solids will be separated from the drilling fluids using the solids control/recycling units onsite. The drilled solids will fall off the recycling units (i.e., shale shakers and cyclone mud cleaners) into bins, then will be dried and transferred to dump trucks periodically for transfer to the final disposal site.

The excess drilling fluid during pipe pull will be sucked up by vacuum trucks for transfer. If there will not be enough vacuum trucks to haul off all the fluids during pullback, the remaining amount will be pumped into frac tanks for temporary storage. See Appendix B for approximate volumes of solids and fluids for disposal.

1.3.12 Demobilization

Following completion of the crossing HDD will demobilize Rig 7, Rig 8, and associated materials, support equipment, and debris from both ends of the crossings. HDD will leave the work areas to a state as clean or cleaner than when the HDD equipment arrived onsite.

Appendix A - Drawings & Layout

Contents

Kennebeck River HDD Design Drawings
& Geotechnical Information



SITE LOCATION
Not to Scale

HORIZONTAL DIRECTIONAL DRILL DRAWINGS
KENNEBEC RIVER CROSSING
NEW ENGLAND CLEAN ENERGY PROJECT
SOMERSET COUNTY
WEST FORKS PLANTATION AND MOXIE GORE, MAINE



PLAN VIEW
SCALE: 1" = 4000'

BASIS OF INFORMATION

1. AERIAL IMAGERY OBTAINED FROM AUTOCAD ONLINE MAP AND IS FOR REFERENCE ONLY AND IS NOT NECESSARILY AN ACCURATE REPRESENTATION OF EXISTING CONDITIONS.
2. TOPOGRAPHIC CONTROURS AND EXISTING SITE CONDITIONS OBTAINED FROM AUTOCAD FILES PROVIDED BY NECEC.
3. DRAWING DATUM
   - 3.1. US SURVEY FEET
   - 3.2. HORIZONTAL: UTM WITH NAD83 DATUM ZONE 19
   - 3.3. VERTICAL: NAVD88

PROJECT CONTACT INFORMATION

OWNER
NEW ENGLAND CLEAN ENERGY CONNECT
NICK ACHORN
DC LINES MANAGER
ONE CITY CENTER
PORTLAND, MAINE, 04105
207-816-0124

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CAMPOS EPC
ROMEO SHIPLEE, PE
PRINCIPAL ENGINEER
1401 BLAKE STREET
DENVER, COLORADO 80202
559-708-9731

CONTRACTOR
THE HDD COMPANY
PHILLIP PERRON
PROJECT MANAGER
3117 N CESNA AVENUE
CASA GRANDE, ARIZONA 85122
530-676-5705

DRAWING INDEX

SHEET NO.	SHEET DESCRIPTION
C-1	COVER SHEET
O-1	SITE OVERVIEW
HDD-1	HDD CONSTRUCTION NOTES
HDD-2	PLAN AND PROFILE
HDD-3	ENTRY/EXIT WORKSPACES
HDD-4	HDD CALCULATIONS
GEO-1	GEOTECHNICAL PROFILE
GEO-2	GEOTECHNICAL BORING LOGS (1 OF 5)
GEO-3	GEOTECHNICAL BORING LOGS (2 OF 5)
GEO-4	GEOTECHNICAL BORING LOGS (3 OF 5)
GEO-5	GEOTECHNICAL BORING LOGS (4 OF 5)
GEO-6	GEOTECHNICAL BORING LOGS (5 OF 5)

LEGEND

- PROPERTY LINES
- RIGHT-OF-WAY (EXISTING)
- RIGHT-OF-WAY (PROPOSED)
- TEMPORARY WORKSPACE
- PROPOSED ALIGNMENT
- MAJOR CONTOUR (EXISTING)
- MINOR CONTOUR (EXISTING)
- GEOTECHNICAL BORING LOCATION
- PROPOSED HDD ENTRY / EXIT LOCATIONS

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REVISIONS

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DESIGN BY	ESB	9/5/23
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CASA GRANDE, ARIZONA 85122

SITE NAME
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NEW ENGLAND CLEAN ENERGY PROJECT
SOMERSET COUNTY
WEST FORKS AND MOXIE GORE, MAINE

DRAWING STAGE
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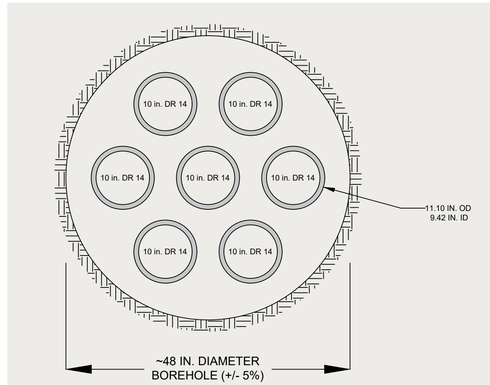
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COVER

DRAWING NO.
C-1

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GENERAL NOTES

1. NOTIFY THE PUBLIC UTILITY LOCATING SYSTEM (MAINE 811) AND OBTAIN A CLEARED, APPROVED TICKET PRIOR TO BEGINNING WORK.
2. PRIOR TO THE START OF CONSTRUCTION ALL COORDINATES AND DIMENSIONS SHALL BE FIELD VERIFIED. IF DISCREPANCIES ARE OBSERVED, THE ENGINEER SHALL BE NOTIFIED.
3. DESIGNATIONS OF ENTRY AND EXIT LOCATION DO NOT SPECIFY WHERE DRILLING WILL OCCUR FROM. DRILLING MAY BE PERFORMED FROM EITHER THE ENTRY OR EXIT SIDE, OR BOTH.
4. THE DRILL PATH STATIONING IS IN FEET BY HORIZONTAL MEASUREMENT AND IS INDEPENDENT OF THE REST OF THE PROJECT ALIGNMENT.
5. DRILL PATH COORDINATES REFER TO THE CENTERLINE OF THE PILOT HOLE AND NOT TO THE TOP OF INSTALLED PIPE.
6. TREE CLEARING AND GRUBBING AND ACCESS ROAD CONSTRUCTION TO BE COMPLETED PRIOR TO THE START OF CONSTRUCTION BY NECEC.
7. PRIOR TO START OF WORK THE FOLLOWING SHALL BE STAKED IN THE FIELD BY NECEC:
   - 7.1. WETLANDS AND OTHER SENSITIVE AREAS
   - 7.2. LIMITS OF DISTURBANCE



1 **TYPICAL BORE CROSS-SECTION**
NOT TO SCALE

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SITE NAME

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NEW ENGLAND CLEAN ENERGY PROJECT

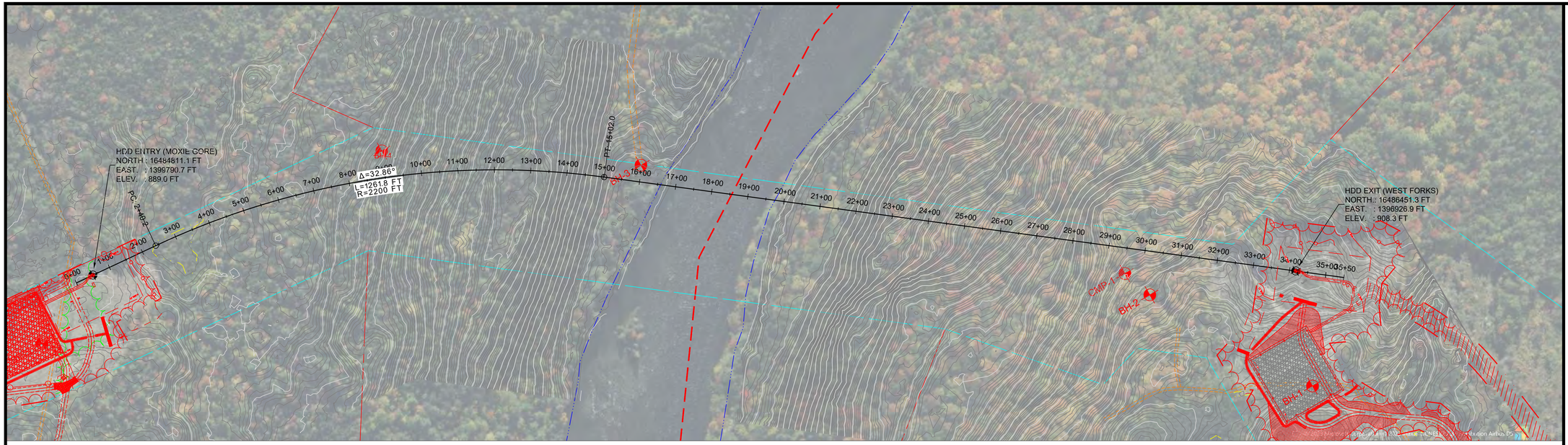
SOMERSET COUNTY
WEST FORKS AND MOXIE GORE, MAINE

DRAWING STAGE
ISSUE FOR APPROVAL

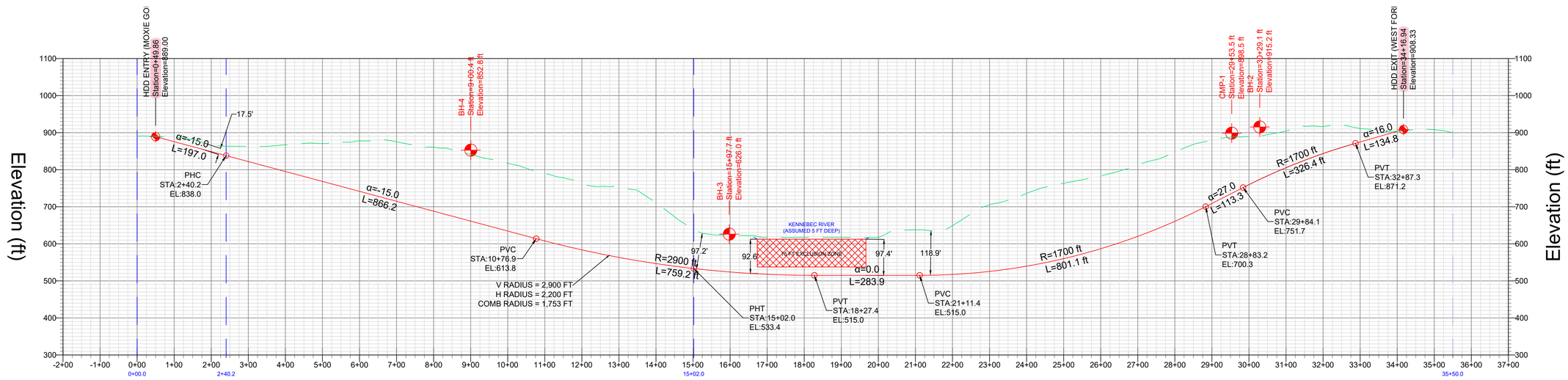
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HDD CONSTRUCTION NOTES

DRAWING NO.
HDD-1

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PLAN VIEW
SCALE: 1" = 150'



PROFILE VIEW
HORIZONTAL SCALE: 1" = 150'

NOTES
1. DESIGNATIONS OF ENTRY AND EXIT DO NOT SPECIFY WHERE DRILLING WILL OCCUR FROM. DRILLING MAY BE PERFORMED FROM EITHER THE ENTRY SIDE, EXIT SIDE, OR BOTH.
2. THE DRILL PATH STATIONING IS IN FEET BY HORIZONTAL MEASUREMENT AND IS INDEPENDENT OF THE REST OF THE PROJECT ALIGNMENT.
3. DRILL PATH COORDINATES REFER TO THE CENTERLINE OF THE PILOT HOLE AND NOT TO THE TOP OF INSTALLED PIPE.

PILOT HOLE BORE PATH INSTALLATION TOLERANCES
- ENTRY LOCATION: +10/-25 FT ALONG ALIGNMENT
- EXIT LOCATION: +25 / -10 FT ALONG ALIGNMENT
- HORIZONTAL ALIGNMENT: +/- 10 FEET OF ALIGNMENT
- MINIMUM COMBINED RADIUS: 1,000 FT OVER 100 FT
- VERTICAL ELEVATION: MIN. 75 FT BELOW KENNEBEC RIVER
- BOREHOLE DIAMETER: +/- 5%

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SCALE: 1" = 150' SCALE IN FEET
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	NAME	DATE
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SITE NAME

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NEW ENGLAND CLEAN ENERGY PROJECT

SOMERSET COUNTY
WEST FORKS AND MOXIE GORE, MAINE

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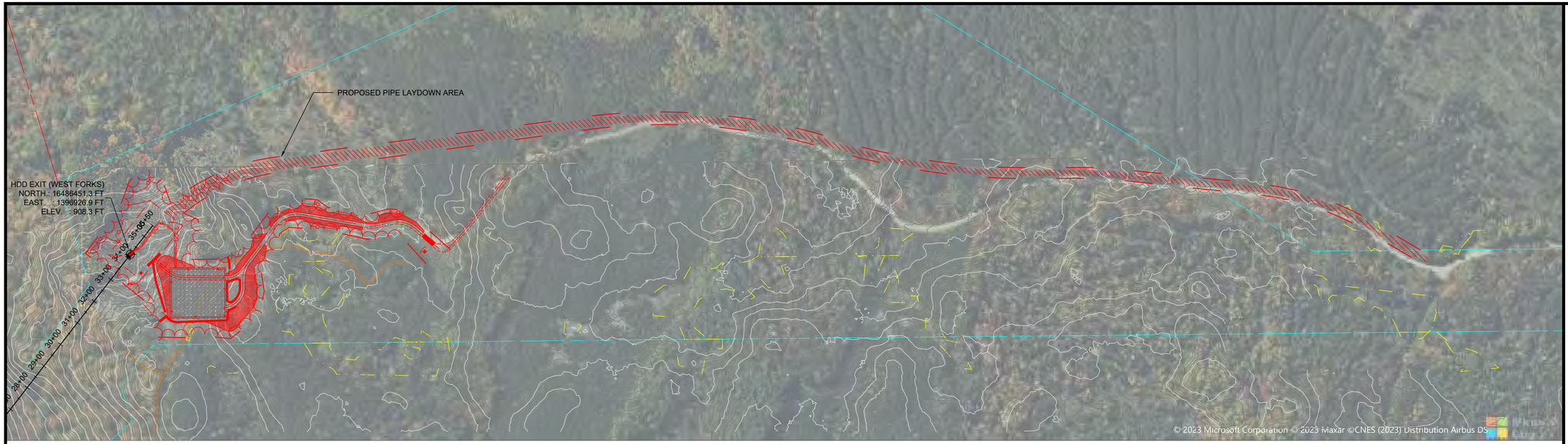
PLAN AND PROFILE

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HDD-2

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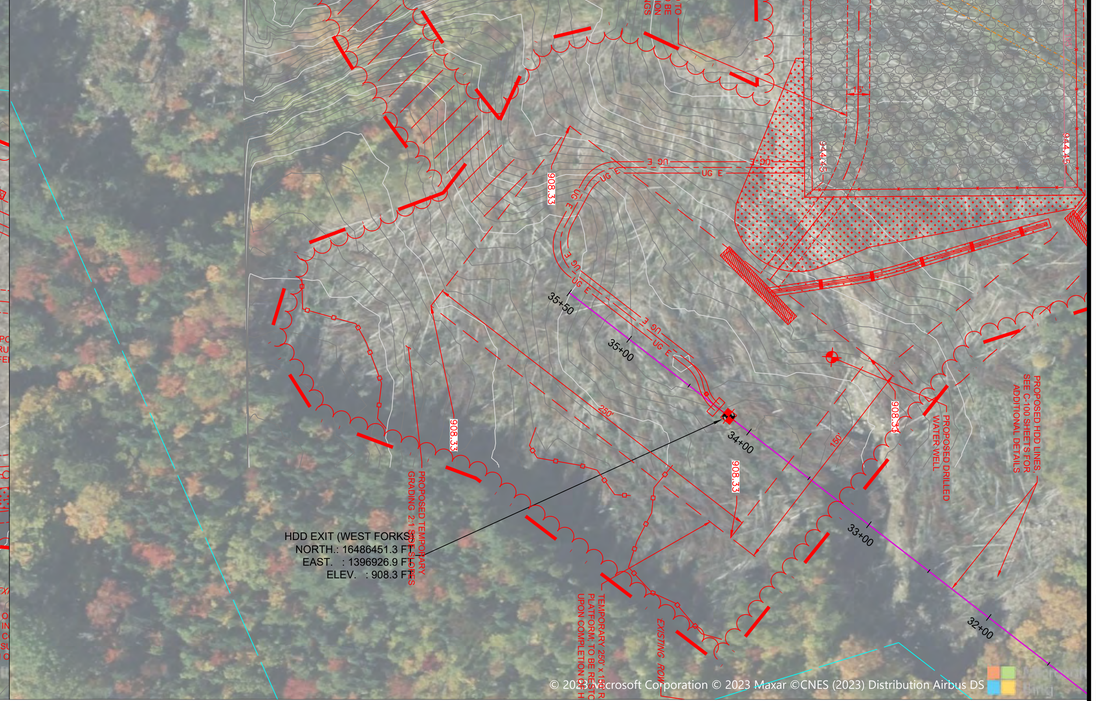
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PIPE LAYDOWN AREA
SCALE: 1" = 200'



ENTRY WORKSPACE (MOXIE GORE)
SCALE: 1" = 50'



EXIT WORKSPACE (WEST FORKS)
SCALE: 1" = 50'

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0" 1" 2" 3"
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SOMERSET COUNTY
WEST FORKS AND MOXIE GORE, MAINE

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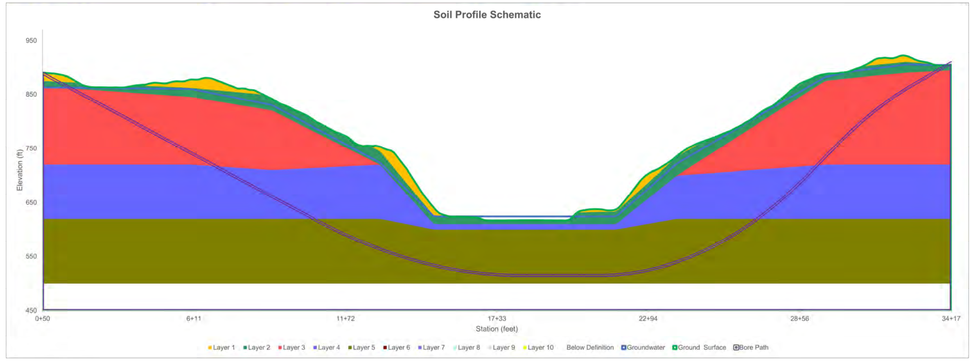
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PROPOSED WORKSPACE

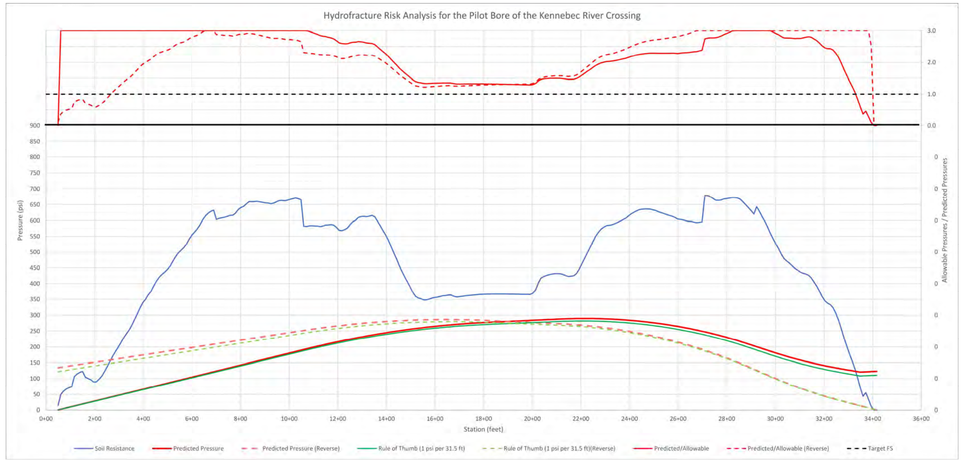
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HDD-3

Layer No.	Description	N-Value	Total Unit Weight (pcf)	Friction Angle (deg)	Cohesion (psf)	Shear Modulus (ksf)
1	Silty Clay (CL-ML)	20	113	5	2000	47
2	Silty Sand (SM)	25	123	33	750	78
3	Weathered Rock (Sandy)	45	150	20	100	1300
4	Weathered Rock (Sandy)	40	145	20	100	1200
5	Weathered Rock (Sandy)	25	140	20	100	800
6						
7						
8						
9						
10						



Note:



DRILL PATH DEFINITION

Entry Angle	15.0 deg
Exit Angle	16.0 deg
Total Drill Length	3,481.8 ft
Min. Design Combined Radius	1700 ft
Assumed Bore Diameter	16 in

PIPE PROPERTIES

Pipe Outside Diameter	11.1 in
Pipe Thickness	0.793 in
Dimension Ratio (DR)	14
Pipe Type	Fusible PVC
MAOP	0 psi
Pull Duration	12 hr
Short Term Elastic Modulus	400,000 psi
Long Term Elastic Modulus	400,000 psi
Ballasted	Yes

INSTALLATION CALCULATION RESULTS

Estimated Pull Force	62,821 lb
Allowable Tensile Load	71,885 lb
Check Pull Force < Allowable	Good
Check 2 x Pull Force < Allowable	**CDR=1.14**
Min. Recommended Rig Capacity (2 x Estimate)	125,642 lb
Maximum Axial Stress	2,447 psi
Safe Pull Stress	2,800 psi
Check Pull Stress < Allowable	Good
Factor of Safety for Pull Stress	1.1

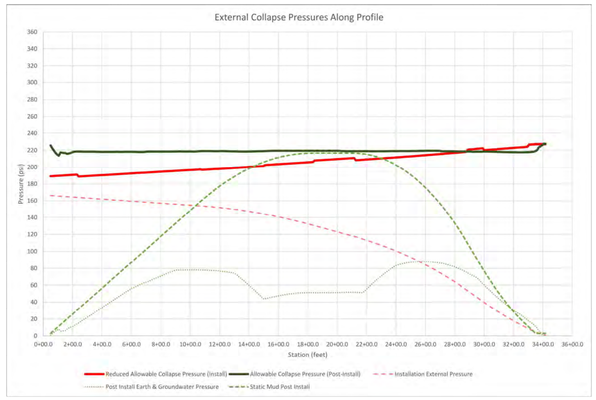
HYDROFRACTURE RISK ANALYSIS ASSUMPTIONS

Basis of Assumptions	Preliminary Assumptions
Drill Rig Properties	
Rod Diameter	5.5 in
Collar Diameter	6 in
Pilot Hole Diameter	12.25 in
Mud Pump Output	530 gpm
Average Uphole Velocity	108 ft/min
Mud Properties	
Unit Weight	11.0 lb/gal
Yield Point	46 lb/100 ft^2
Plastic Viscosity	24 cP

Notes

Segment	Type	Length	Average Inclination	Vertical Radius	Horizontal Radius	Combined Radius
9	Tangent	134.8	16.0	0	0	
8	Vertical Curve	326.4	21.5	1700	0	1700
7	Tangent	113.3	27.0	0	0	
6	Vertical Curve	801.1	13.5	1700	0	1700
5	Tangent	283.9	0.0	0	0	
4	Vertical Curve	326.1	-3.2	2900	0	2900
3	Compound Curve (Right)	433.2	-10.7	2900	2200	1753
2	Horizontal Curve	866.1	-15.0	0	2200	2200
1	Tangent	197.0	-15.0	0	0	

	Percent Ovality (%)	Maximum External Pressure (psi)	Allowable Collapse Pressure (psi)	Check Collapse Pressure
During Pullback	0.03	166.2	189.1	Good
Post Installation	0.65	88.1	219.3	Good



REFERENCES:

American Society of Civil Engineers. (2014). "ASCE Manuals and Reports on Engineering Practice No. 108 - Pipeline Design for Installation by Horizontal Directional Drilling", ASCE, Alexandria, VA.
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Willoughby, David A. (2005). "Horizontal Directional Drilling Utility and Pipeline Applications.", New York, NY.

Calculation By:	DHK	Client	The HDD Company		
Checked By	ESB	Project Number	00066.0000.0001	Print Date:	10/12/2023
Calculation Date	10/2/2023	Project Name	NECEC	User:	Eric Backlund
Program Version	Beta 1.5 (Rev. 10/12/23)	Project Address	, West Forks, Maine		
File Location:	X:\01 Project Folders\HDD Company\00066.0000.001 NECEC Kennebec River HDD\Calcs\[HDD Calculation Sheet_Beta 1.5_working.xlsm]OUTPUT (Plastic)				

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NEW ENGLAND CLEAN ENERGY PROJECT

SOMERSET COUNTY
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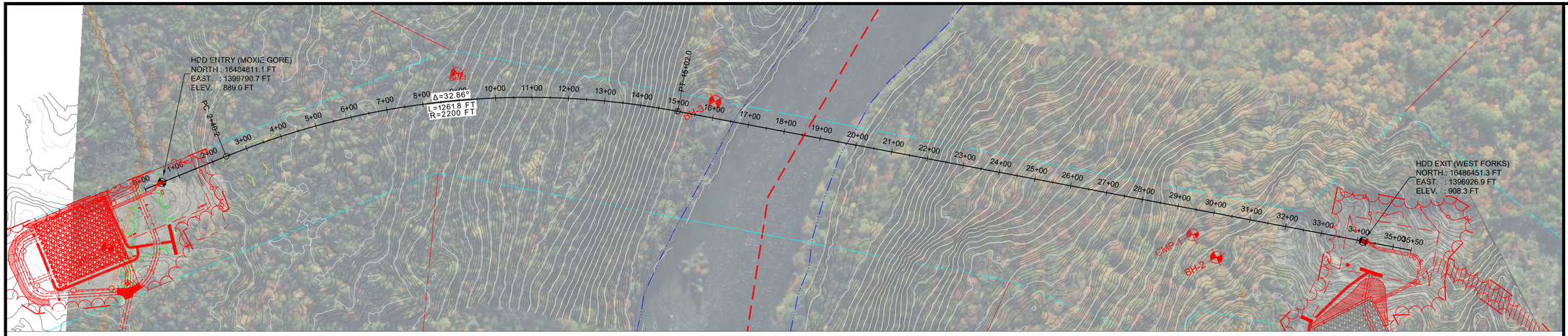
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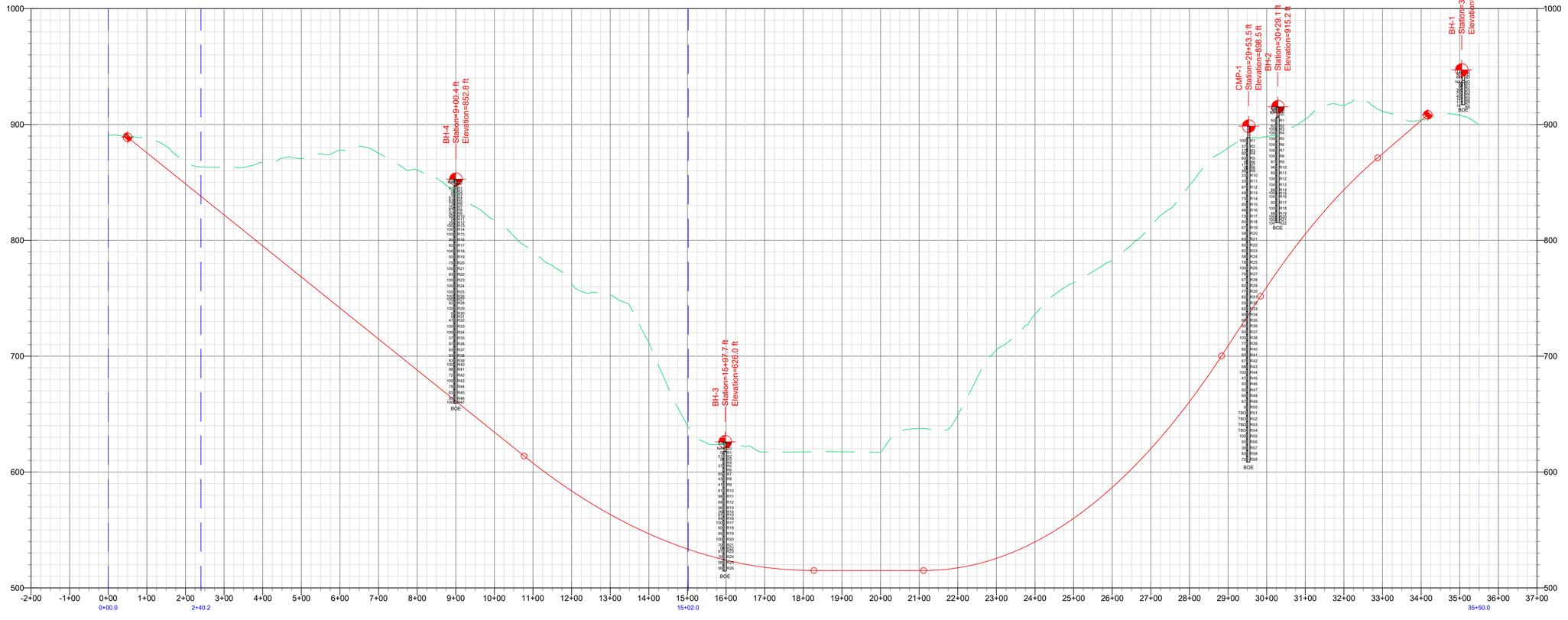
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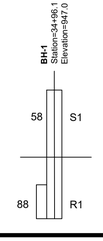


PLAN VIEW

SCALE: 1" = 150'



TEST BORING LEGEND:



BORING DESIGNATION
APPROXIMATE STATION
APPROXIMATE ELEVATION

STANDARD PENETRATION TEST "N" VALUE — SOIL SAMPLE NUMBER

TOP OF BEDROCK INTERFACE

ROCK CORE RUN. NUMBER INDICATES ROCK QUALITY DESIGNATION, "RQD" — ROCK CORE NUMBER

PROFILE VIEW

HORIZONTAL SCALE: 1" = 150'
VERTICAL SCALE: 1" = 25'

NOTE: Stratification lines and subsurface material descriptions shown on this drawing have been simplified for presentation purposes. Refer to the project getoechnical boring logs and report for more detailed subsurface information.

Soil boring logs shown on the HDD profile drawing represent approximate subusrface stratification. Copies of the soil boring logs from the borings shown on this profile are included in Drawing Numbers 7 to 11.

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WEST FORKS AND MOXIE GORE, MAINE

DRAWING STAGE

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DRAWING TITLE

GEOTECHNICAL PROFILE

DRAWING NO.

GEO-1

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REPORT

18-0345 S

April 19, 2019

Explorations and Geotechnical Engineering Services

Proposed NECEC Kennebec River
Underground Cable & HDD
Somerset County
West Forks Plantation & Moxie Gore, Maine

Prepared For:
Central Maine Power Company
Attention: Adam Desrosiers – Program Manager - NECEC
83 Edison Drive
Augusta, Maine 04336

Prepared By:
S. W. Cole Engineering, Inc.
286 Portland Road
Gray, Maine 04039
T: 207-657-2866

S.W.COLE ENGINEERING, INC.

- *Geotechnical Engineering*
- *Construction Materials Testing and Special Inspections*
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2.0 EXPLORATION AND TESTING 3
2.1 Explorations 3
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2.3 Laboratory Testing 4
2.3.1 Geotechnical Laboratory Testing 4
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18-0345 S

April 19, 2019

Central Maine Power Company
Attention: Adam Desrosiers – Program Manager - NECEC
83 Edison Drive
Augusta, Maine 04336

Subject: Explorations and Geotechnical Engineering Services
Proposed NECEC Kennebec River
Underground Cable & HDD
Somerset County
West Forks Plantation and Moxie Gore, Maine

Dear Adam:

In accordance with our revised Proposal, dated September 24, 2018, we have performed subsurface explorations for the subject project. This report summarizes our findings and geotechnical recommendations and its contents are subject to the limitations set forth in Appendix A.

1.0 INTRODUCTION

1.1 Scope and Purpose

The purpose of our services was to obtain subsurface information at the site in order to develop geotechnical recommendations relative to foundations and earthwork associated with the proposed termination stations, provide field soil resistivity testing data and provide subsurface information at certain locations along the proposed Horizontal Directional Drilling (HDD) line. Our scope of services included test boring explorations, soils and rock laboratory testing, field testing, a limited geotechnical analysis of the subsurface findings and preparation of this report. A report summarizing our field soil resistivity services has been submitted under separate cover.

1.2 Site and Proposed Construction

We understand Central Maine Power (CMP) Company is considering an underground electric transmission line crossing below the Kennebec River as part of the New England Clean Energy Connect (NECEC) Project. We understand the underground line will be installed using HDD methods. Based on the provided site plans, we understand a 320kv overhead HVDC transmission line will enter the HDD site on the east side of the Kennebec River at about Project Station 0+00 (Moxie Gore Termination Station) and continue below ground and beneath the Kennebec River to about Station 37+00 (West Forks Termination Station) before exiting the HDD site as an overhead line. We understand the termination station yards will be about 135 feet by 135 feet in plan dimensions. The existing ground surface at the Moxie Gore station varies from about elevation 894 to 890 feet, east to west and the proposed station pad elevation is 896 feet, requiring minor fills. The existing ground surface at the West Forks station varies from about elevation 960 to 932 feet, northeast to southwest and the proposed station pad is 946, requiring tapered cuts of about 14 feet and tapered fills approaching 14 feet. We understand the yard areas will be constructed with 2H:1V side slopes and surfaced with 6 inches of crushed aggregate topping overlying 18 inches of gravel base material overlying compacted subgrade fill (as needed) overlying native, undisturbed non-organic soils. Drainage swales are planned around the station yards. Access roads are proposed on the northerly side of each station yard with sections consisting of 3 inches of gravel surface overlying 15 inches of MaineDOT Type A gravel base.

Based on limited information available at this time, we anticipate the termination stations will include new equipment structures (transformers, dead-end, switchgear and steel pole structures) and possibly a control building. We understand spread footings, surficial concrete pads, mat foundations with rock anchors and drilled shafts are being considered for equipment foundation and tower support. Since the stations are still in concept design, details regarding the proposed equipment and structures, including sizing, locations and structural loading, are unknown at this time.

We understand the proposed HVDC line will be placed in a 48 inch diameter HDD borehole that will be about 3700 linear feet in plan view. We understand the HDD borehole will be drilled at depths varying from about 30 to 80 feet below the existing ground surface and about 80 to 90 feet below the river bottom.

The current site conditions on each side of the river consist of moderate to thickly wooded forest with ground elevations sloping down to the river from approximately elevation 890 feet on the east side and 950 feet on the west side down to about elevation 620 feet at the river's edge. Slopes become progressively steeper approaching the river with the lower elevations being about 2H:1V or steeper.

Proposed station and HDD locations as well as existing and proposed grades are shown on the "Exploration Location Plans" attached in Appendix B.

2.0 EXPLORATION AND TESTING

2.1 Explorations

Five test borings (BH-1 through BH-5) and were made at the site during the period of October 30 through November 30, 2018 by S. W. Cole Explorations, LLC. The exploration locations were selected by CMP and TRC (project engineer) and established in the field by CMP, Comprehensive Land Technology (CLT) and S. W. Cole Engineering, Inc. (S.W.COLE) with mapping grade GPS equipment using coordinates provided by others. Cutting, clearing and erosion control, where needed, was provided by CLT under subcontract to CMP. The approximate exploration locations are shown on the "Exploration Location Plans" attached in Appendix B. Logs of the explorations and a key to the notes and symbols used on the logs are attached in Appendix C. The elevations shown on the logs were estimated based on topographic information shown on the "Exploration Location Plans". Photos of recovered rock core are also attached in Appendix C.

Three inch diameter PVC casing was installed at borings BH-1 and BH-5 from the bedrock surface up to about 3 feet above the ground surface to maintain an open borehole for later use by CMP.

2.2 Field Testing

The test borings were drilled using cased wash-boring and NQ rock coring techniques. The soils were sampled at 2 to 5 foot intervals using a split-spoon sampler and Standard Penetration Testing (SPT) methods. SPT blow count results are shown on the logs. Rock coring was performed at each boring using a NQ2 core bit. At several borings, a roller bit was used to penetrate the surface of the bedrock prior to coring.

Bulk soil samples were obtained at borings BH-1 through BH-5 for geotechnical and analytical laboratory soil testing.

2.3 Laboratory Testing

2.3.1 Geotechnical Laboratory Testing

Soil samples obtained from the explorations were returned to our laboratory for further classification and testing. Moisture content test results are noted on the exploration logs. Laboratory soil gradation and moisture-density test results are attached in Appendix D. Rock core physical properties, including rock type, RQD (Rock Quality Designation), fractures, foliation, Mohs hardness and degree of weathering are also noted on the logs. Eleven rock core samples were provided to GeoTesting Express for laboratory rock core compression (ASTM D-7012C) and unit weight testing under subcontract to S.W.COLE. These rock core samples were selected by S.W.COLE in collaboration with CMP and TRC as well as estimated depths to the HDD line. The test results are attached in Appendix D.

2.3.2 Laboratory Soil Chemistry, Soil and Rock Thermal Conductivity Testing

Soil Chemistry: Five soil samples; one from each exploration location, were submitted to Alpha Analytical Services for determination of pH (EPA SW846-9045), water soluble chloride content (EPA SW846-9251) and water soluble sulfate content (EPA SW846-9038) testing. Results of the pH and water soluble chloride and sulfate testing as well as sulfate exposure classifications in accordance with ACI 318 Table 4.3.1 are included in Appendix D and summarized in the following table:

Exploration/ sample interval	pH Testing	Chloride Testing (ppm)	Sulfate Testing (ppm)	Sulfate Exposure Classification (ACI 318 Table 4.3.1)
BH-1 / 2'-4''	6.0	< PQL	< PQL	Negligible
BH-2 / 0.4'-2''	7.5	< PQL	< PQL	Negligible
BH-3 / 2'-5'	5.3	22	< PQL	Negligible
BH-4 / 1'-2.5'	7.0	< PQL	< PQL	Negligible
BH-5 / 5'-7'	6.4	< PQL	< PQL	Negligible

Notes
ppm = parts per million
PQL – Procedure Quantification Limit
PQL for chloride testing is 20 ppm
PQL for sulfate testing is 10 ppm

Soil Thermal Conductivity: Five bulk soil samples, one from each boring location, were collected and shipped to Geotherm USA by S.W,COLE for thermal conductivity testing The soil thermal conductivity testing was performed under contract to TRC and specific

sample locations/depths were selected by Geotherm USA. Results of this testing have been provided by TRC under separate cover.

Rock Thermal Conductivity: Fourteen rock core samples were collected and shipped to Geotherm USA by S.W.COLE for laboratory thermal conductivity testing. The rock thermal conductivity testing was performed under contract to TRC and specific sample locations/depths were selected by Geotherm USA. Results of this testing have been provided by TRC under separate cover.

2.3.3 Additional Laboratory Rock Testing

As requested, additional samples of rock core were shipped to GeoTesting Express for laboratory testing. The additional testing included Bulk Density and Compressive Strength (ASTM D7012C), unit weight (ASTM D4543), Abrasiveness (ASTM D7625), Slake Durability (ASTM D4644) and Rock Drillability (NTNU/SINTEF 13A-98). The results are attached in Appendix D.

3.0 SUBSURFACE CONDITIONS

3.1 Soil and Bedrock

In general, the explorations encountered a soils profile consisting of forest duff and topsoil with roots overlying medium dense silty sand with varying amounts of gravel (borings BH-1 and BH-4) overlying either bedrock or medium dense to dense brown sand and silt with varying amounts of gravel and cobbles with some boulders (glacial till) overlying bedrock. The forest duff, topsoil and soils with roots varies from about 2 to 3 feet in thickness at the explorations. Where encountered, the silty sand extends to depths of about 2 to 4 feet and the glacial till varies in thickness from about 0 to 8 feet. Highly weathered/decomposed bedrock (saprolite) was encountered at borings BH-1 and BH-5 below the glacial till and prior to encountering more competent bedrock. A 2 foot thick zone of saprolite was encountered at a depth of about 9 feet at boring BH-1 and a 4.5 foot thick zone was encountered at a depth of about 19.5 feet below the existing ground surface at boring BH-5. Approximate depths and corresponding elevations of apparent competent bedrock are summarized below.

APPARENT DEPTH/ELEVATION TO BEDROCK AND DEPTH/ELEVATION OF BOTTOM BORING			
Exploration	**Approximate Ground Surface Elevation (ft)**	**Approximate Depth (Elevation) to Bedrock (ft)**	**Approximate Depth (Elevation) to Bottom of Boring (ft)**
BH-1	947	11 (936)	30 (917)
BH-2	915	8.2 (906)	100 (815)
BH-3	626	8.4 (617.6)	111.5 (514.5)
BH-4	856	4 (852)	193.4 (662.6)
BH-5	894	24 (870)	30 (864)

Note: Depths to bedrock do not include the saprolite layers encountered at BH-1 and BH-5 (depths in table are to apparent competent bedrock). Photos of the recovered bedrock core are attached in Appendix C.

Not all the strata were encountered at each exploration; refer to the attached logs in Appendix C for more detailed subsurface information.

3.2 Groundwater

The soils encountered at the test borings were moist to wet from the ground surface. Saturated soils were encountered at depths varying from about 3 to 10 feet. Depths to groundwater in the open boreholes after drilling were measured at about 7.6, 45, 4, 21.8 and 3.7 feet below the existing ground surface at BH-1 through BH-5, respectively. Long term groundwater information is not available. It should be anticipated that groundwater levels will fluctuate seasonally, particularly in response to the water level of the Kennebec River, periods of snowmelt and precipitation, as well as changes in site use.

3.3 Geological Conditions

The Maine Geological Survey (MGS) *Surficial Geologic Map of Maine* (Thompson and Borns, 1985) depicts surficial sediments in the project area to consist mostly of glacial till (mixture of sand, silt, clay and stones), with zones of glacial outwash (sand and gravel) and eskers (gravel and sand) immediately adjacent to the Kennebec River. The soil samples collected at the boring locations are generally consistent with the MGS surficial sediment mapping.

The MGS *Preliminary Bedrock Geology of The Forks Quadrangle* map (Burroughs and Marvinney, 1991) depicts several different bedrock formations in the project area, including: Dead River Formation (slate and phyllite); Hurricane Mountain Formation (slate and meta-siltstone); Hildreth's Formation (calcareous sulfidic slate); The Forks Formation (dolostone, limestone and calcareous siltstone); and Carrabassett Formation (slate). The bedrock core collected at the five boring locations is generally consistent with the MGS mapping. In general, the core from BH-1 consists of phyllite; the core

from BH-2 consists of calcareous siltstone; the core from BH-3 consists of slate and phyllite; the core from BH-4 consists of slate, calcareous slate and calcareous siltstone with zones of phyllite; and the core from BH-5 consists of slate.

3.4 Seismic – Faulting Data

Seismic activity from two sources can impact a site: ground rupture directly beneath a site, and shaking produced at the site from nearby seismic activity. There are no recorded cases of ground rupture that can be definitely attributed to seismic activity in New England since the glaciers receded more than 10,000 years ago.

The MGS *Earthquakes in Maine* map and narrative (Berry and Marvinney, 2003) indicates that an ancient bedrock fault oriented southwest to northeast exists in the general project area. However, none of the ancient bedrock faults in Maine have been correlated with modern earthquake activity.

3.5 Seismic and Frost Conditions

According to IBC 2015/ASCE 7-16, we interpret the following Seismic Site Classes at the termination stations using the N-Value method for soil (borings BH-1 and BH-5):

- Seismic Site Class B (for foundations on sound bedrock)
- Seismic Site Class D (for foundations on compacted fill or native soil)

We recommend consideration of the following seismic design parameters for the 2,500-year design earthquake:

RECOMMENDED SEISMIC DESIGN PARAMETERS (2,500-year Design Earthquake)		
Peak Ground Acceleration (PGA)	0.2-second Spectral Acceleration (S_s)	1-second Spectral Acceleration (S_1)
0.157	0.23g	0.079

NOTE: Seismic design parameters from USGS accessed December 14, 2018. (https://earthquake.usgs.gov/designmaps/us/application.php)

Liquefiable soils typically consist of loose, fine sands and non-plastic silts below the groundwater table. Based on the subsurface findings, it is our opinion the soils at the termination station sites are not susceptible to liquefaction during a seismic event and therefore the risk of lateral spread and seismic induced settlement are negligible.

The 100-year Air Freezing Index for the West Forks, Maine area is about 2,450 Fahrenheit degree days, which corresponds to a frost penetration depth on the order of 6.0 feet. We recommend foundations exposed to freezing be covered with at least 6.0 feet of soil and unheated slabs be insulated or underlain with 6 feet of non-frost susceptible soil for frost protection.

4.0 EVALUATION AND RECOMMENDATIONS

4.1 General Findings

Based on the subsurface findings and limited project information at this time, the proposed termination station(s) construction appears feasible from a geotechnical standpoint. The principle geotechnical considerations include:

- Bedrock Excavations: Based on the subsurface conditions encountered and the proposed grading information, bedrock excavation is not anticipated at the Moxie Gore station, but should be expected at the West Forks station, particularly in the northeast corner where the most significant cut is planned. Removal will require blasting to achieve the necessary grades.

- Termination Station Pads: Topsoil and organics, soils with roots and disturbed or soft yielding soil must be completely removed from beneath the proposed terminal station pads and embankment areas. We recommend bedrock removal extend to at least 6 feet below finish termination pad grade to allow for a 6 foot thick zone of material including the pad surface (designed by others) to allow for excavations for shallow foundations and subgrade utilities.

- Building Structures: Spread footing foundations and a slab-on-grade floors bearing on properly prepared subgrades appear suitable for the proposed control building. Building footings should bear on at least 12-inches of compacted Structural Fill overlying properly prepared subgrades. On-grade floor slabs for unheated structures should bear on at least 6 feet of compacted Gravel Borrow or Structural Fill overlying properly prepared subgrades.

- Equipment and Structure Foundations: We recommend all lightweight equipment foundations bear on at least 6 feet of compacted Gravel Borrow or Structural Fill overlying properly prepared subgrades. Foundations for heavier,

moment carrying structures such as dead end structures are anticipated to be supported by large reinforced concrete mat foundations bearing on compacted Structural Fill overlying properly prepared subgrades, directly on sound, intact bedrock with rock anchors, or on caissons drilled into the bedrock to resist overturning.

- Groundwater: The depth to groundwater upon completion of the borings BH-1 and BH-5 was about 7.5 and 3.5 feet below the existing ground surface, respectively. Excavations below groundwater will require dewatering to help control water levels below excavation grades. Drainage swales will be needed surrounding the yard areas to help provide long-term drainage. Foundation drains are recommended for the control building.

- Reuse of Native Soils: In our opinion, the native, non-organic granular (silty sand and glacial till) soils can likely be reused as Common Borrow for mass embankment fills provided they are at a compactable moisture content at the time of construction. The silty sand and glacial till soils are moisture sensitive and may be difficult to compact when above the optimum moisture content. Therefore, we do not recommend reuse of the native soils during wet and freezing conditions.

- Reuse of Blasted Bedrock: Blasted bedrock can be crushed and processed on-site to create Gravel Borrow, Structural Fill and Crushed Stone needed for construction.

4.2 Site and Subgrade Preparation

We recommend site preparation begin with the construction of an erosion control system to protect adjacent drainage ways and areas outside the construction limits. Surficial organics, topsoil and soils with roots should be completely removed from areas of proposed fill and construction. As much vegetation as possible should remain outside the construction areas to lessen the potential for erosion and site disturbance.

Based on the subsurface findings, the thickness of forest duff, topsoil and soils with roots vary across the sites. The contractor should anticipate areas where roots and soils containing organics will extend several feet into the underlying soil. The methods used by the contractor for removal and the moisture condition of the site will affect the

volume of material removal required. Topsoil and organics can likely be stockpiled and screened for reuse as a topsoil layer in landscape areas. Suitability of the topsoil re-use from a nutrient and fertility standpoint should be evaluated by soil testing prior to its use.

4.3 Excavation and Dewatering

Excavations for the termination stations will generally encounter forest duff, topsoil, soils with roots, silty sand with gravel and cobbles, glacial till with varying amounts of gravel and cobbles and boulders, and shallow bedrock in some areas. Care must be exercised during construction to reduce potential for disturbance of subgrades. Construction traffic on wet soil subgrades should be avoided when practical. Should subgrades become disturbed, the subgrade should be over-excavated to expose suitable soil and replaced with compacted Structural Fill, Gravel Borrow, Crushed Stone or moisture conditioned glacial till.

Based on the proposed grading and subsurface findings at the boring locations, bedrock removal to achieve the required subgrade elevations should be anticipated, particularly in the cut areas of the West Forks station. Bedrock removal will require drilling and blasting. We recommend a licensed blasting contractor be engaged for bedrock removal. Vibrations due to blasting should be monitored during construction. In addition, we recommend the blasting subcontractor submit a detailed drilling and blasting plan with qualifications and references prior to blasting.

Temporary, unsupported soil excavations should be sloped back to 1.5H:1V or flatter. In all cases, excavations must be properly shored and/or sloped according to OSHA regulations to prevent sloughing and caving of the sidewalls during construction.

Sumping and pumping and the use of temporary diversion ditching dewatering techniques should be adequate to control water inflow into excavations above the groundwater table. When working at the bottom of slopes, temporary dewatering may require construction of uphill cut-off swales and/or diversion berms to direct up gradient runoff water away from the work areas.

4.4 Embankment Construction

The proposed topographic information shown on the site grading plan indicates fill and cut soil slopes for the station yards and access roads will be constructed with slopes of

2H:1V or flatter. All forest duff, topsoil, soils with roots and stumps will need to be removed from beneath the proposed yard areas, access roads and fill embankments.

4.4.1 General

Fill slopes should be constructed as level benches, which are overbuilt to facilitate compaction. The final slope face should be constructed by cutting back into the compacted core prior to placing slope surface materials. Fill slopes constructed on existing terrain steeper than 3H:1V should be keyed into the existing ground surface with continuous level benches. Fill slopes constructed on existing slopes flatter than 3H:1V do not need continuous benching. We recommend a 10 foot wide bench be cut into the native soil beneath the toe of fill slopes for installation of a 1-foot thick drainage blanket consisting of Gravel Borrow prior to placing fill soils. The drainage blanket should be day-lighted for gravity drainage.

4.4.2 Fill Slopes 2H:1V or Flatter

Fill materials needed to construct fill slopes at inclinations of 2H:1V or flatter should consist of compacted Common Borrow, Gravel Borrow or Structural Fill. Exposed soil slopes will be susceptible to surface erosion, slumping and sloughing, particularly during heavy rain and freeze/thaw events. Exposed slopes should be surfaced with an erosion control blanket and loam and seed, as soon as practicable, to create a vegetated mat. In areas of concentrated surface water, we recommend 8-inch minus rip-rap overlying a non-woven geotextile fabric such as Mirafi 160N be used in lieu of the erosion blanket and loam and seed. We recommend cross-slope stone lined drainage channels underlain with geotextile fabric be construct into the slope face when the height of the embankment exceeds 25 feet.

4.4.3 Fill Slopes Steeper than 2H:1V

Although not anticipated, if proposed fill slopes are to be constructed steeper than 2H:1V, we recommend these slopes be constructed with compacted Gravel Borrow and the slopes be covered with at least 2 feet of compacted rip-rap. Further, lateral edges where the riprap terminates along the face of the embankment should be keyed into the ground surface. We recommend slopes be constructed no steeper than 1.5H:1V.

4.4.4 Cut Slopes

We recommend proposed soil cut slopes less than 15 feet in height consider slope inclinations of 2H:1V or flatter since the depth to bedrock is unknown between and outside the exploration locations. The final slope inclination will be dependent on the

subsurface conditions (soil or bedrock) encountered during construction. Cut slopes in bedrock should be sloped back to a stable condition, which will depend on rock fracturing, as well as bedrock formation strike and dip in relation to slope orientation. We recommend a representative from S.W.COLE observe the bedrock slopes during construction.

We recommend a rock fall catchment zone be provided at the toe of rock cut slopes following FHWA Publication No. HI-99-007 *Rock Slopes Reference Manual.*

In addition, we recommend a minimum 5-foot wide bench be constructed at the interface of the overburden soil and bedrock to reduce potential erosion that could cause soils, cobbles and boulders to wash down the rock slopes potentially clogging drainage swales and causing blocking hazards.

In areas of concentrated surface water or locations of groundwater seeps, rip-rap should be used in lieu of the erosion blanket and loam/seed. We recommend cross-slope stone lined drainage channels underlain with geotextile fabric be constructed into the slope when the height of the slope exceeds 25 feet.

4.4.5 Slope Surface Erosion Control

Unprotected and un-established slopes, regardless of inclination, will be susceptible to surface erosion, slumping, and sloughing especially during precipitations and freeze/thaw events. Topsoil and seed should be installed, as soon as practicable, to create a vegetated mat over the entire surface of the slope. We recommend the use of UV resistant synthetic erosion control mesh to reinforce the surface soils until the vegetated mat is established, particularly if constructed during the winter or spring seasons.

Groundwater seepage and up gradient runoff water can make establishment of soil slopes difficult. In areas where surface water may be concentrated and discharged over the slope or where groundwater seepage is encountered, we recommend locally covering the slope with a small diameter rip-rap placed over a layer of crushed gravel and a woven filter fabric.

4.5 Foundations

4.5.1 Building and Equipment Foundations

We recommend the proposed building foundations be supported on spread footings founded on at least 12-inches of compacted Structural Fill overlying properly prepared subgrades. Unheated building slabs should be underlain with at least 12 inches of compacted Structural fill overlying at least 5 feet of additional Structural Fill or Gravel Borrow. Non-moment-carrying equipment foundations and lightweight equipment pads should also be founded on at least 12-inches of compacted Structural Fill overlying at least 5 feet of compacted Structural Fill or Gravel Borrow. For foundations bearing on properly prepared subgrades, we recommend the following geotechnical parameters for design consideration:

GEOTECHNICAL PARAMETERS	
Net Allowable Soil Bearing Pressure	4.0 ksf or less
Net Allowable Bedrock Bearing Pressure	12.0 ksf (Clean, sound, intact bedrock)
Design Frost Depth for Footings on Soil	6.0 ft
Recommended Minimum Depth for Footings Pinned to Sound, Intact Bedrock	2.5 ft
Base Friction Factor	0.35 (Mass concrete to structural fill)
Base Friction Factor	0.45 (Mass concrete to bedrock)
Passive Lateral Earth Pressure Coeff. (K_p)	3.0 (compacted Structural Fill)
Equivalent Fluid Pressure (Passive)	390 psf/ft (compacted Structural Fill)
Active Lateral Earth Pressure Coeff. (K_a)	0.3 (compacted Structural Fill)
Equivalent Fluid Pressure (Active)	40 psf/ft (compacted Structural Fill)
At-Rest Lateral Earth Pressure Coeff. (K_o)	0.5 (compacted Structural Fill)
Equivalent Fluid Pressure (At-Rest)	60 psf/ft (compacted Structural Fill)
Total Unit Weight of Backfill (γ_t)	125 pcf (compacted Structural Fill)
Internal Friction Angle (Φ)	32 degrees (compacted Structural Fill)

Spread footings should be at least 24 inches in width regardless of the bearing pressure. We understand all foundations and concrete structures and slabs will be designed by others.

4.5.2 Rock Anchors

Based on the subsurface conditions and guidance from the Post-Tensioning Institute's manual entitled *Recommendations for Prestressed Rock and Soil Anchors* (PTI, 2014), we recommend the use of prestressed, Class I corrosion protected, grouted rock anchors be considered by the foundation designer where rock anchors are being

considered. We recommend the following geotechnical parameters for preliminary rock anchor design consideration:

GEOTECHNICAL PARAMETERS FOR ROCK ANCHORS	
RQD of Sound Rock Core (see boring logs)	0 to 75 %
Average Dry Unit Weight of Bedrock Samples	169 pcf
Rock Cone Pull-Out Angle (from vertical)	45 degrees (from vertical)
Average Ultimate Grout to Bedrock Bond Strength	120 psi

Note: the above values do not include saprollite (decomposed rock) as found at borings BH-1 and BH-5. Saprolite should be treated as dense soil.

Based on guidance from the *Recommendations for Prestressed Rock and Soil Anchors* (PTI, 2004) we recommend a minimum unbonded length (free-stressing length) of 15 feet for strand tendons and 10 feet for bar tendons be considered for preliminary rock anchor design. The bonded length in sound bedrock will depend upon the uplift load and the diameter of the drill hole. Rock anchor spacing should be at least 1.2 times the free-stressing length; closer spacing will reduce allowable anchor loads. Rock anchors installed in groups should be designed with consideration of pullout resistance from overlapping failure surfaces extending from the midpoint of the anchor bond zone to the bedrock surface.

The drill-hole for each rock anchor should be cleaned of any drilling fines and tightness tested to determine the need for pre-grouting. Rock anchors should be installed, tested and locked-off according to the design engineer's recommendations.

4.5.3 Dead End Structure Foundations

We anticipate dead end structures will be constructed within the proposed station yards. Structural loads and locations are not known at this time. Based on the findings at the explorations, depths to apparent sound bedrock are about 11 and 24 feet below the existing ground surface at borings BH-1 and BH-5, respectively.

Depending upon anticipated structural loads, we anticipate dead end foundations may need to derive support from the underlying bedrock. Depending upon the location and actual subsurface conditions, the foundation could consist of a mat foundation bearing on and anchored to bedrock, or if rock is deep, drilled shafts extending through the pad fills and glacial till and socketed into bedrock. L-pile parameters for use in drilled shaft design are shown on the logs for borings BH-1 and BH-5. Large mat foundation bearing

on Structural Fill and properly prepared subgrades are also feasible, depending upon loading conditions. An allowable bearing contact pressure of 12.0 ksf or less should be considered for sound, intact bedrock and 4 ksf or less for compacted Structural Fill. Soft, weathered bedrock, if encountered, should be removed. Where bedrock is encountered, a concrete leveling mat may be placed on the prepared bedrock surface prior to placing reinforced concrete foundations. The leveling mat should extend beyond the footing edges or piers by at least 24 inches. Foundations should be pinned to the bedrock if the rock is sloping steeper than 3H:1V and/or if structural loads dictate. Rock anchors extending into bedrock may be needed to provide uplift capacity for dead end structures founded on mat foundations bearing on bedrock. We understand the dead end structure(s) foundation type and design will be by the project structural engineer.

4.6 Foundation Drainage

We recommend an underdrain system be installed on the outside edge of the perimeter footings for the control buildings. The underdrain pipe should consist of 4-inch diameter, perforated SDR-35 foundation drain pipe bedded in Crushed Stone and covered with non-woven geotextile fabric. The underdrain pipe must have a positive gravity outlet protected from freezing, clogging and backflow. Surface grades should be sloped away from the building and other structures for positive surface water drainage.

4.7 Slab-On-Grade

On-grade floor slabs may be designed using a subgrade reaction modulus of 100 pci (pounds per cubic inch) provided the slab is underlain by at least 12-inches of compacted Structural Fill placed over properly prepared subgrades. The structural engineer or concrete consultant must design steel reinforcing and joint spacing appropriate to slab thickness and function.

We recommend a sub-slab vapor retarder particularly in areas of the building where the concrete slab will be covered with an impermeable surface treatment or floor covering that may be sensitive to moisture vapors, if applicable. The vapor retarder must have a permeance that is less than the floor cover or surface treatment that is applied to the slab. The vapor retarder must have sufficient durability to withstand direct contact with the sub-slab base material and construction activity. The vapor retarder material should be placed according to the manufacturer's recommended method, including the taping and lapping of all joints and wall connections. The architect and/or flooring consultant

should select the vapor retarder products compatible with flooring and adhesive materials.

The floor slab should be appropriately cured using moisture retention methods after casting. Typical floor slab curing methods should be used for at least 7 days. The architect or flooring consultant should assign curing methods consistent with current applicable American Concrete Institute (ACI) procedures with consideration of curing method compatibility to proposed surface treatments, flooring and adhesive materials.

4.8 Backfill and Compaction

Although a wide range of soil materials can be used successfully, it has been our experience that granular soils with good drainage characteristics provide significant advantages, particularly in wet conditions and during cold weather construction. We have made recommendations for materials that are suitable for support of the proposed construction from a geotechnical standpoint. However, the electrical designer must provide parameters for fill to achieve proper compatibility between the fill soils and the electrical grounding system. In general, we recommend the following materials for consideration:

Common Borrow: Embankment fill to raise grades in station pad areas below frost depth. We anticipate the native glacial till can be used as Common Borrow provided boulders are removed and at a moisture content at the time of use that will facilitate the required compaction.

Gravel Borrow: Fill to raise grades in the station pad areas should be sand or silty sand meeting the requirements of 2014 MaineDOT Standard Specification 703.20 Gravel Borrow. Gravel Borrow can likely be made from on-site crushing of blasted bedrock.

Structural Fill: Fill to raise grades in the station pad areas and as backfill below footings, equipment pads, adjacent to foundations and material below floor slabs should be clean, non-frost susceptible sand and gravel meeting the gradation requirements for Structural Fill as given below:

Structural Fill	
Sieve Size	**Percent Finer by Weight**
4 inch	100
3 inch	90 to 100
¼ inch	25 to 90
#40	0 to 30
#200	0 to 6

Structural Fill can likely be made from on-site crushing of blasted bedrock.

Crushed Stone: Crushed Stone, used for underdrain aggregate should be washed ¾-inch crushed stone meeting the requirements of 2014 MaineDOT Standard Specification 703.22 Underdrain Backfill Material Type C.

Reuse of Site Soils: The non-organic on-site glacial till appears suitable as Common Borrow and to blend and process with crushed blasted bedrock to create Gravel Borrow, provided they are at a compactable moisture content at the time of blending and reuse. The glacial till borrow, if used for subgrade fill, should be screened of rock over 12 inches.

Placement and Compaction: Fill should be placed in horizontal lifts and compacted such that the desired density is achieved throughout the lift thickness with 3 to 5 passes of the compaction equipment. Loose lift thicknesses for grading, fill and backfill activities should not exceed 12 inches. We recommend that fill and backfill in building areas be compacted to at least 95 percent of its maximum dry density as determined by ASTM D-1557. Crushed Stone should be compacted with 3 to 5 passes of a vibratory plate compactor having a static weight of at least 500 pounds.

4.9 Weather Considerations

Construction activity should be limited during wet and freezing weather and the site soils may require drying or thawing before construction activities may continue. The contractor should anticipate the need for water to temper fills in order to facilitate compaction during dry weather. If construction takes place during cold weather, subgrades, foundations and floor slabs must be protected during freezing conditions. Concrete and fill must not be placed on frozen soil; and once placed, the concrete and soil beneath the structure must be protected from freezing.

4.10 Design Review and Construction Testing

S.W.COLE should be retained to review the construction documents prior to bidding to determine that our earthwork and foundation recommendations have been properly interpreted and implemented.

A soils and concrete testing program should be implemented during construction to observe compliance with the design concepts, plans, and specifications. S.W.COLE is available to observe earthwork activities, the preparation of foundation bearing surfaces and installation of rock anchors and caiisons, as well as to provide testing and IBC Special Inspection services for soils, concrete, steel and structural masonry construction materials.

4.11 Recommendations for Additional Study

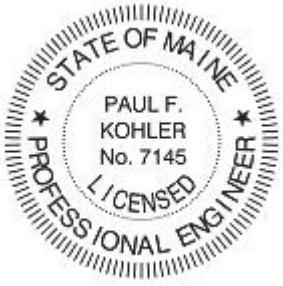
We understand design of the terminal station pads, building and equipment is still in development. We understand additional explorations, laboratory soils and rock testing and evaluation may be needed as design of the terminal stations progresses.

5.0 CLOSURE

It has been a pleasure to be of assistance to you with this phase of your project. We look forward to working with you during the design and construction phase of the project.

Sincerely,

S. W. Cole Engineering, Inc.



Paul F. Kohler, P.E.
Senior Geotechnical Engineer

PFK:nas/tjb/ajh

APPENDIX A

Limitations

This report has been prepared for the exclusive use of Central Maine Power Company for specific application to the proposed Terminal Stations in West Forks Plantation and Moxie Gore, Maine. S. W. Cole Engineering, Inc. (S.W.COLE) has endeavored to conduct our services in accordance with generally accepted soil and foundation engineering practices. No warranty, expressed or implied, is made.

The soil profiles described in the report are intended to convey general trends in subsurface conditions. The boundaries between strata are approximate and are based upon interpretation of exploration data and samples.

The analyses performed during this investigation and recommendations presented in this report are based in part upon the data obtained from subsurface explorations made at the site. Variations in subsurface conditions may occur between explorations and may not become evident until construction. If variations in subsurface conditions become evident after submission of this report, it will be necessary to evaluate their nature and to review the recommendations of this report.

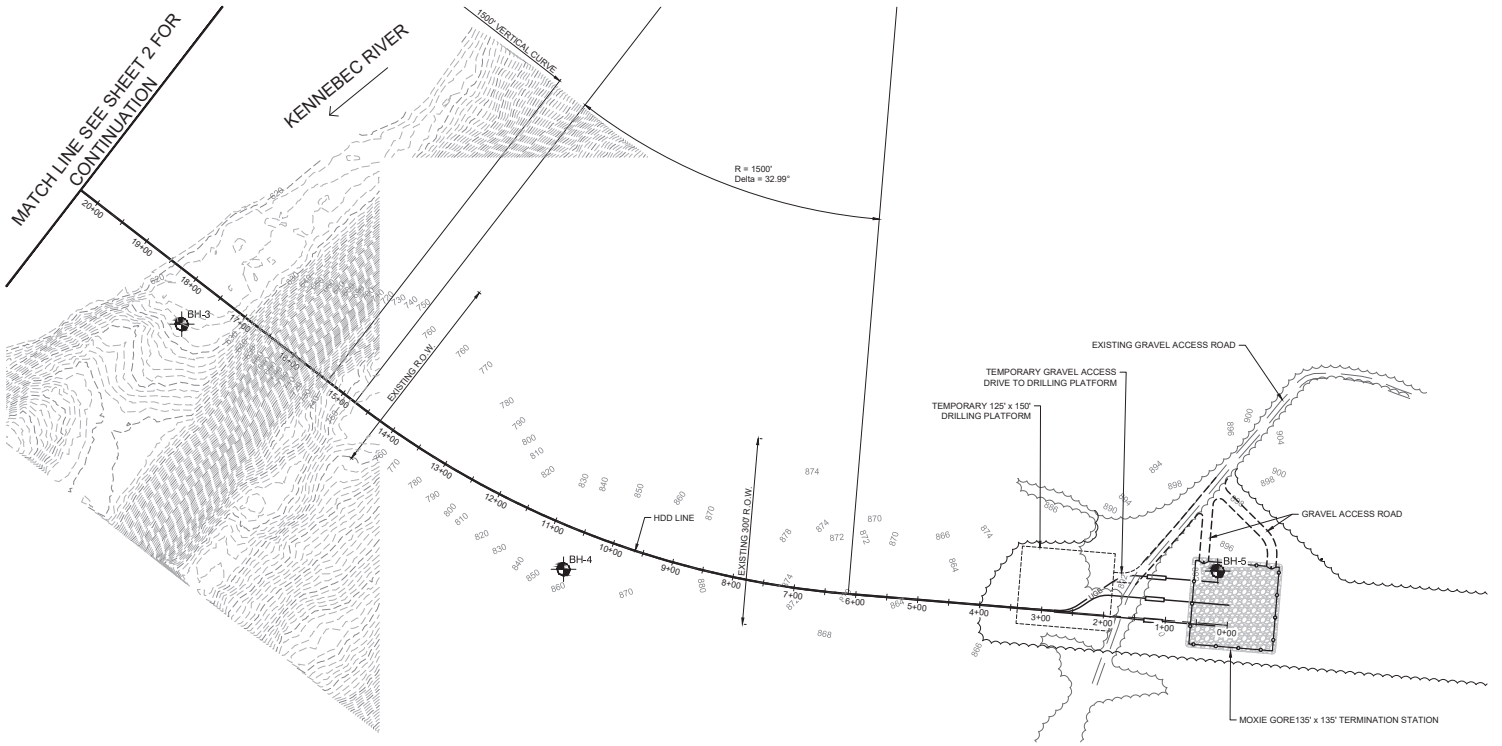
Observations have been made during exploration work to assess site groundwater levels. Fluctuations in water levels will occur due to variations in rainfall, temperature, and other factors.

S.W.COLE's scope of services has not included the investigation, detection, or prevention of any Biological Pollutants at the project site or in any existing or proposed structure at the site. The term "Biological Pollutants" includes, but is not limited to, molds, fungi, spores, bacteria, and viruses, and the byproducts of any such biological organisms.

Recommendations contained in this report are based substantially upon information provided by others regarding the proposed project. In the event that any changes are made in the design, nature, or location of the proposed project, S.W.COLE should review such changes as they relate to analyses associated with this report. Recommendations contained in this report shall not be considered valid unless the changes are reviewed by S.W.COLE.

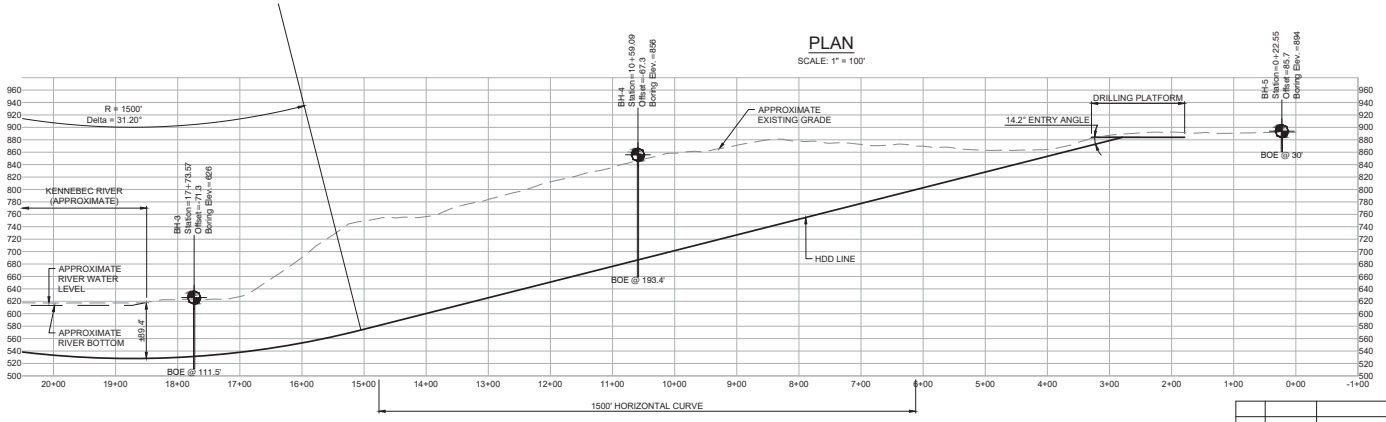
APPENDIX B

Figures



PLAN

SCALE: 1" = 100'



PROFILE

SCALE: HORZ. 1" = 100'
VERT. 1" = 100'

LEGEND:

APPROXIMATE BORING LOCATION

NOTES:

1. EXPLORATION LOCATION PLAN WAS PREPARED FROM A 1"=100' SCALE PLAN OF THE SITE ENTITLED "HDD CROSSING (STA 0+00 TO 20+50) PLAN AND PROFILE," PREPARED BY TRC COMPANIES, INC. (TRC), DATED 10/05/2018 AND PROVIDED IN AUTOCAD DWG FORMAT.
2. THE BORING LOCATIONS WERE SELECTED BY TRC AND WERE LOCATED IN THE FIELD BY SURVEY BY COMPREHENSIVE LAND TECHNOLOGIES, INC. (CLT). THE LOCATIONS OF BORINGS BH-2 AND BH-4 WERE ADJUSTED IN THE FIELD AT THE TIME OF LAYOUT BY CLT AND CENTRAL MAINE POWER. THE LOCATION OF BH-4 WAS FURTHER ADJUSTED AT THE TIME OF DRILLING BY S.W.COLE.
3. THIS PLAN SHOULD BE USED IN CONJUNCTION WITH THE ASSOCIATED S. W. COLE ENGINEERING, INC. GEOTECHNICAL REPORT.
4. THE PURPOSE OF THIS PLAN IS ONLY TO DEPICT THE LOCATION OF THE EXPLORATIONS IN RELATION TO THE EXISTING CONDITIONS AND PROPOSED CONSTRUCTION AND IS NOT TO BE USED FOR CONSTRUCTION.

100 0 100 200 FT

SCALE: 1" = 100'

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S.W.COLE ENGINEERING, INC

CENTRAL MAINE POWER COMPANY

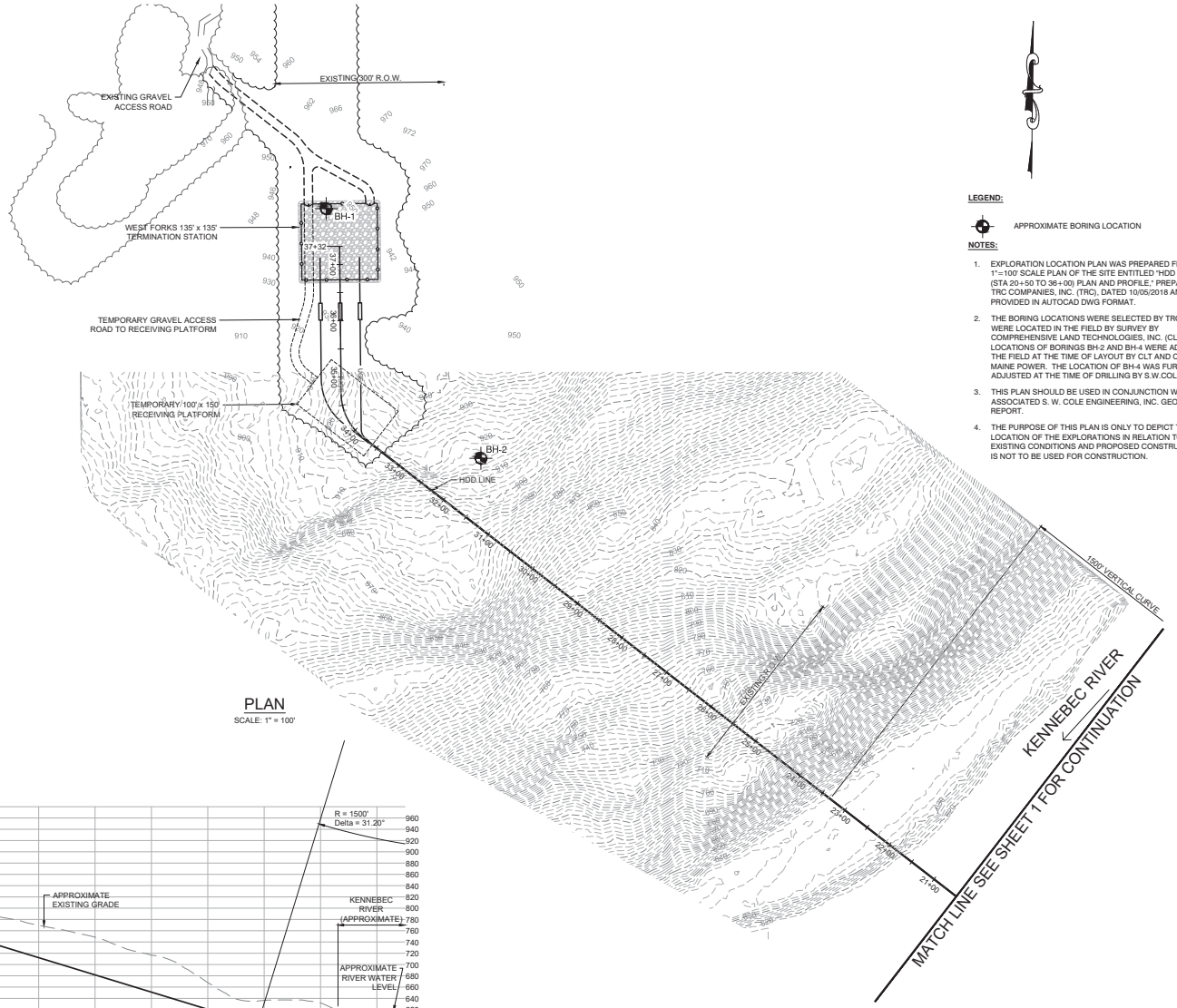
EXPLORATION LOCATION PLAN

PROPOSED KENNEBEC RIVER UNDERGROUND CROSSING
NEW ENGLAND CLEAN ENERGY CONNECT PROJECT
THE FORKS, MAINE

Job No.: 18-0345 Scale: As Noted
Date: 12/18/2018 Sheet: 1 OF 4

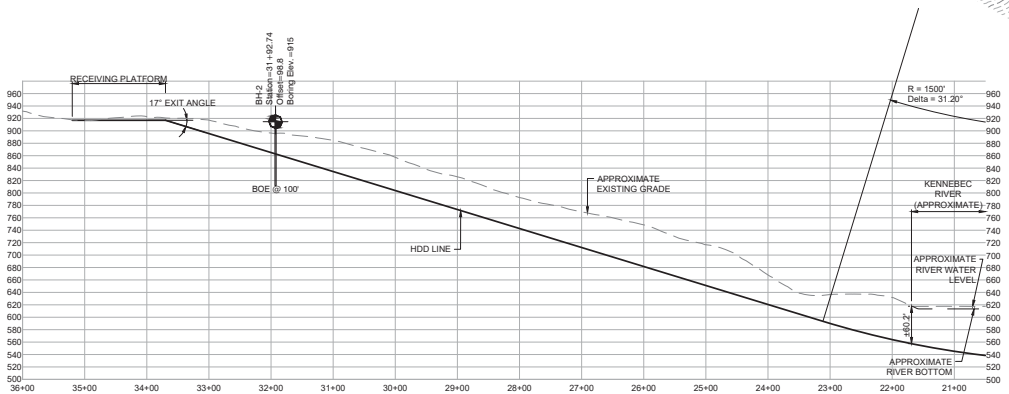
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Checked By: NDS
Approved By: PFK



PLAN

SCALE: 1" = 100'



PROFILE

SCALE: HORZ. 1" = 100'
VERT. 1" = 100'

100 0 100 200 FT

SCALE: 1" = 100'

LEGEND:

APPROXIMATE BORING LOCATION

NOTES:

1. EXPLORATION LOCATION PLAN WAS PREPARED FROM A 1"=100' SCALE PLAN OF THE SITE ENTITLED "HDD CROSSING (STA 20+50 TO 36+00) PLAN AND PROFILE," PREPARED BY TRC COMPANIES, INC. (TRC), DATED 10/05/2018 AND PROVIDED IN AUTOCAD DWG FORMAT.
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S.W.COLE ENGINEERING, INC.

CENTRAL MAINE POWER COMPANY

EXPLORATION LOCATION PLAN

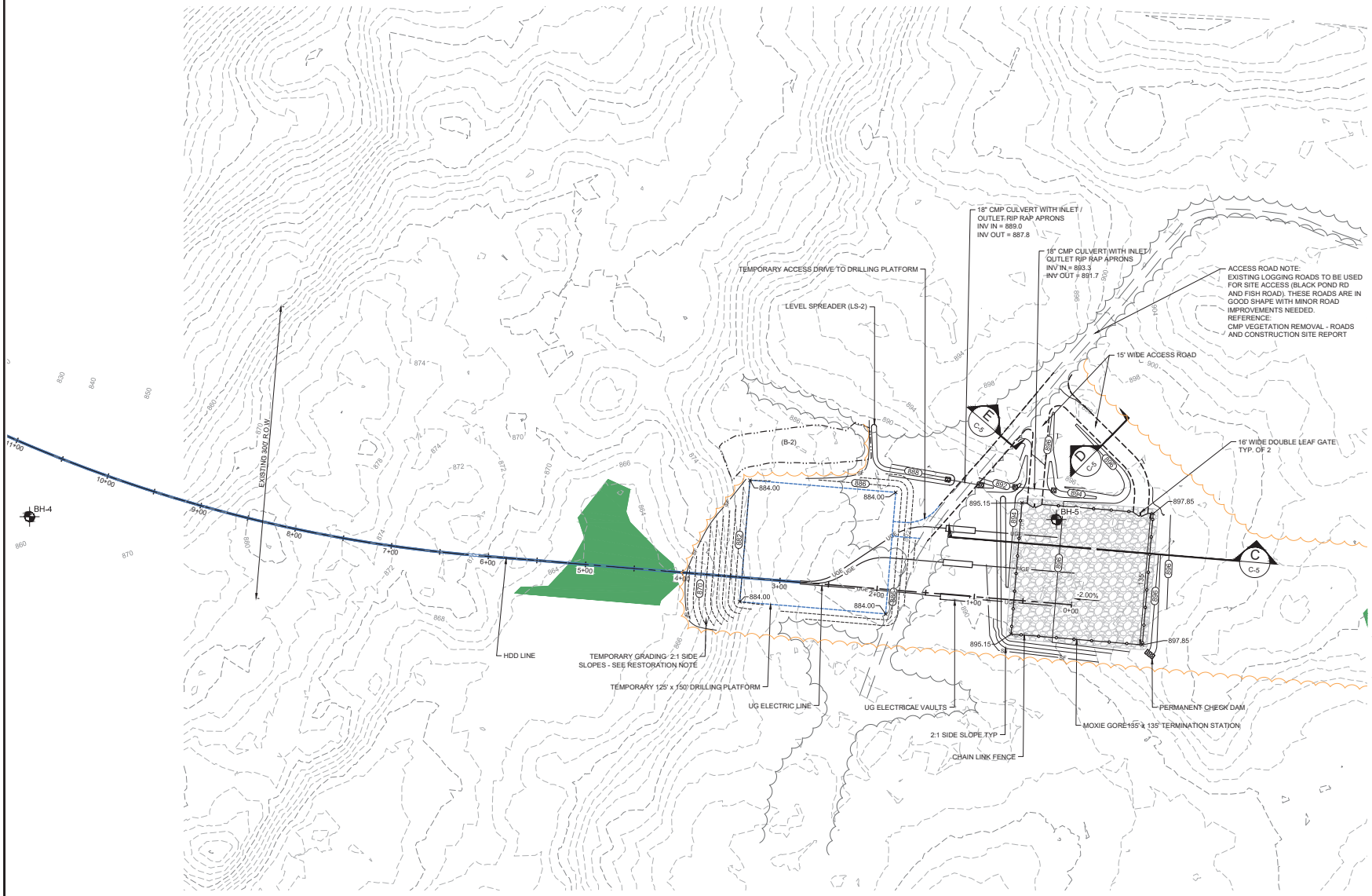
PROPOSED KENNEBEC RIVER UNDERGROUND CROSSING
NEW ENGLAND CLEAN ENERGY CONNECT PROJECT
THE FORKS, MAINE

Job No.: 18-0345 Scale: As Noted
Date : 12/18/2018 Sheet: 2 OF 4

Sheet No.: 2

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Checked By: NDS
Approved By: PFK

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LEGEND:

APPROXIMATE BORING LOCATION

NOTES:

1. EXPLORATION LOCATION PLAN WAS PREPARED FROM A 1"=50' SCALE PLAN OF THE SITE ENTITLED "GRADING & RESTORATION PLAN MOXIE GORE " PREPARED BY TRC COMPANIES, INC. (TRC), DATED 10/05/2018 AND PROVIDED IN AUTOCAD DWG FORMAT.
2. THE BORING LOCATIONS WERE SELECTED BY TRC AND WERE LOCATED IN THE FIELD BY SURVEY BY COMPREHENSIVE LAND TECHNOLOGIES, INC. (CLT). THE LOCATIONS OF BORINGS BH-2 AND BH-4 WERE ADJUSTED IN THE FIELD AT THE TIME OF LAYOUT BY CLT AND CENTRAL MAINE POWER. THE LOCATION OF BH-4 WAS FURTHER ADJUSTED AT THE TIME OF DRILLING BY S.W.COLE.
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S.W. COLE ENGINEERING, INC.

CENTRAL MAINE POWER COMPANY

EXPLORATION LOCATION PLAN

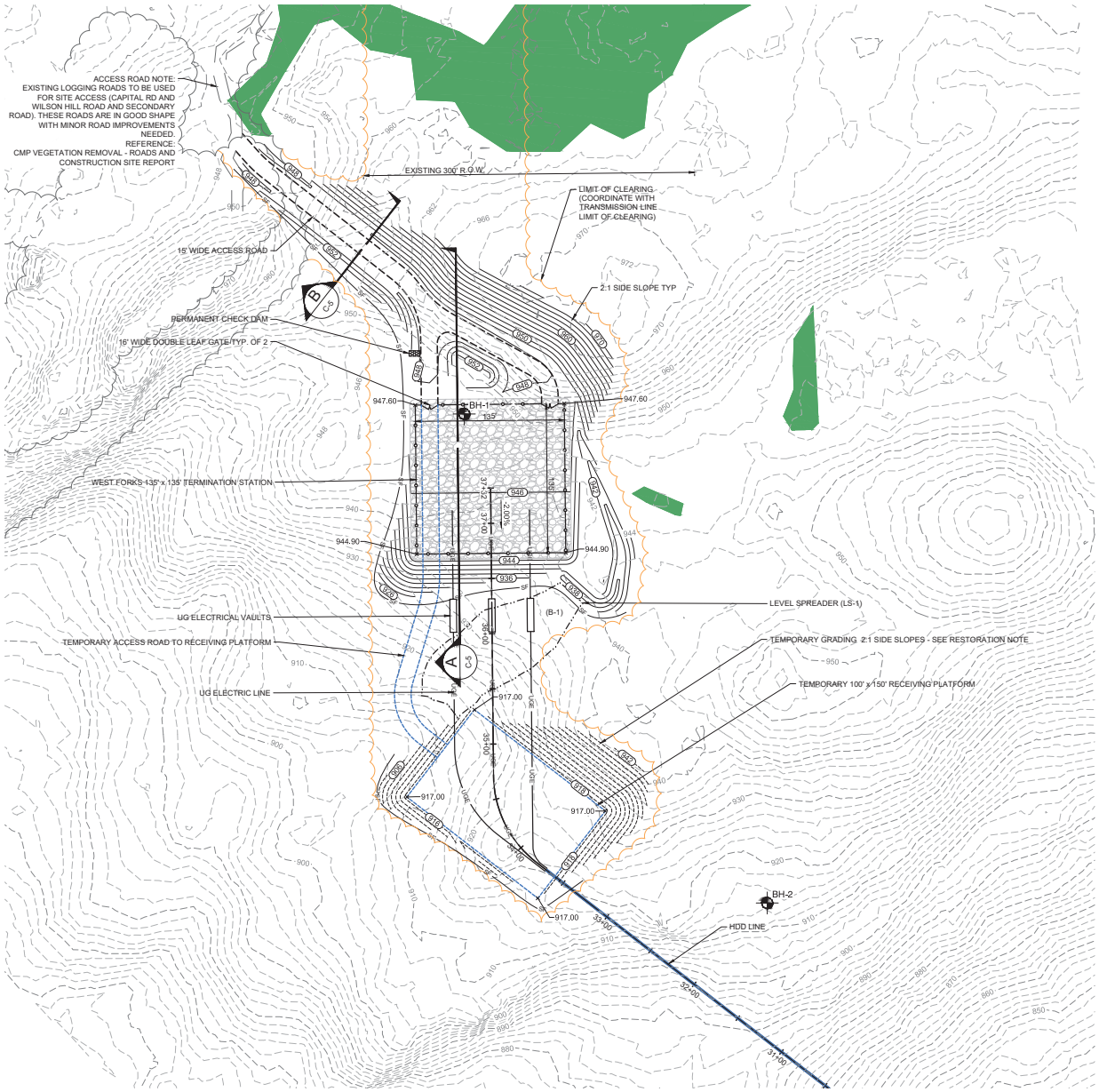
PROPOSED KENNEBEC RIVER UNDERGROUND CROSSING
NEW ENGLAND CLEAN ENERGY CONNECT PROJECT
THE FORKS, MAINE

Job No.: 18-0345 Scale: As Noted
Date : 12/18/2018 Sheet: 3 OF 4

Sheet No.: 3

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Checked By: NDS
Approved By: PFK

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50 0 50 100 FT

SCALE: 1" = 50'

LEGEND:

APPROXIMATE BORING LOCATION

NOTES:

1. EXPLORATION LOCATION PLAN WAS PREPARED FROM A 1"=50' SCALE PLAN OF THE SITE ENTITLED "GRADING & RESTORATION PLAN WEST FORKS," PREPARED BY TRC COMPANIES, INC. (TRC), DATED 10/05/2018 AND PROVIDED IN AUTOCAD DWG FORMAT.
2. THE BORING LOCATIONS WERE SELECTED BY TRC AND WERE LOCATED IN THE FIELD BY SURVEY BY COMPREHENSIVE LAND TECHNOLOGIES, INC. (CLT). THE LOCATIONS OF BORINGS BH-2 AND BH-4 WERE ADJUSTED IN THE FIELD AT THE TIME OF LAYOUT BY CLT AND CENTRAL MAINE POWER. THE LOCATION OF BH-4 WAS FURTHER ADJUSTED AT THE TIME OF DRILLING BY S.W.COLE.
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S.W.COLE ENGINEERING, INC.

CENTRAL MAINE POWER COMPANY

EXPLORATION LOCATION PLAN

PROPOSED KENNEBEC RIVER UNDERGROUND CROSSING
NEW ENGLAND CLEAN ENERGY CONNECT PROJECT
THE FORKS, MAINE

Job No.: 18-0345 Scale: As Noted
Date : 12/18/2018 Sheet: 4 OF 4

Sheet No.: 4

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Approved By: PFK

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APPENDIX C

Exploration Logs and Key and Rock Core Photos

BORING LOG

CLIENT: Central Maine Power Company
PROJECT: Proposed Kennebec River Underground Crossing
LOCATION: NECEC, The Forks Plantation & Moxie Gore, Maine

BORING NO.: BH-1
SHEET: 1 of 2
PROJECT NO. 18-0345
DATE START: 10/30/2018
DATE FINISH: 10/30/2018

Drilling Information

LOCATION: See Exploration Location Plan | **ELEVATION (FT):** 947' Estimated | **TOTAL DEPTH (FT):** 30.0 | **LOGGED BY:** Nate Strout
DRILLING CO.: S. W. Cole Explorations, LLC | **DRILLER:** Kevin Hanscom | **DRILLING METHOD:** Cased Boring
RIG TYPE: Track Mounted Diedrich D-50 | **AUGER ID/OD:** N/A / N/A | **SAMPLER:** Standard Split-Spoon
HAMMER TYPE: Automatic / Automatic | **HAMMER WEIGHT (lbs):** 140 / 140 | **CASING ID/OD:** 4 in / 4 1/2 in | **CORE BARREL:** NQ2 / 2
HAMMER EFFICIENCY FACTOR: 0.92 | **HAMMER DROP (inch):** 30 / 30
WATER LEVEL DEPTHS (ft): ▼ 7.6 ft 10/31/2018 Free water at 7.6'
GENERAL NOTES: Following completion of the boring, 3 inch PVC casing installed from 3 feet above existing grade to top of bedrock

KEY TO NOTES AND SYMBOLS: Water Level: ▽ At time of Drilling; ▼ At Completion of Drilling; ▼ After Drilling
D = Split Spoon Sample; U = Thin Walled Tube Sample; R = Rock Core Sample; V = Field Vane Shear
Pen. = Penetration Length; Rec. = Recovery Length; bpf = Blows per Foot; mpf = Minute per Foot
WOR = Weight of Rods; WOH = Weight of Hammer; RQD = Rock Quality Designation; PID = Photoionization Detector
S_v = Field Vane Shear Strength, kips/sq.ft.; q_u = Unconfined Compressive Strength, kips/sq.ft.; Ø = Friction Angle (Estimated); N/A = Not Applicable

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION: Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD	Field / Lab Test Data	Graphic Log	Sample Description & Classification	H_2O Depth	Remarks	LPile® Input Parameters (Rec)
			1D		0-2	24/10	2-6-7-6	w =26.9 %		0.5 Forest Duff Medium dense, brown Silty SAND, trace gravel			Sand (Reese) γ =115 pcf ϕ =30 ° *k* =90 pci
945			2D		2-4	24/24	13-20-25-22	w =7.8 %		2.0 Dense, brown Silty SAND and GRAVEL with occasional cobbles (Glacial Till)			Sand (Reese) γ =125 pcf ϕ =34 ° *k* =150 pci
	5		3D		5-7	24/20	37-32-32-32	w =5.6 %			▼		
940										9.0 Highly weathered / saprolite (decomposed) Bedrock			Sand (Reese) γ =63 pcf ϕ =34 ° *k* =110 pci
	10		4D	⊠	10-10.3	3/3	50/3"						Weak Rock (Reese) γ =145 pcf
			R1		11-12.6	19/19	0			11.0 Bedrock; **R1:** Dark Gray Phyllite; soft; Moderately to highly weathered…severe iron oxide staining on core and fracture surfaces; Tightly folded, thin laminated bedding planes at 65-80 degrees from horizontal; Very intensely fractured, pieces 3" and less			Strong Rock (Vuggy Limestone)
935			R2		12.6-13.5	11/11	0			**R2:** Same rock description and properties as R1 above			
			R3		13.5-16.5	36/36	39			**R3:** Same rock description as R1 above; Moderately weathered; Tightly folded, thin laminated bedding planes at 65-80 degrees from horizontal; Very intensely fractured becoming intensely fractured, fractures in pieces 4" and greater at 50-70 degrees from horizontal			
	15												
930			R4		16.5-18.5	24/24	75			**R4:** Same rock description as R1 above; Moderately weathered; Tightly folded, thin laminated bedding planes at 65-80 degrees from horizontal; Slightly to moderately fractured, fractures in pieces 4" and greater at 30-60 degrees from horizontal			
			R5		18.5-21.8	40/40	40			**R5:** Same rock description as R1 above; Moderately weathered; Tightly folded, thin laminated bedding planes at 65-80 degrees from horizontal; Moderately fractured becoming very intensely fractured, fractures in pieces 4" and greater at 60-80 degrees from horizontal. * Compressive strength sample R5, 19.1'-20.5'			
	20												
925			R6		21.8-24.1	28/28	14			**R6:** Same rock description as R1 above; very soft; Highly weathered; Tightly folded, thin laminated bedding planes at 65-80 degrees from horizontal; Intensely fractured, most pieces 2" and less			
			R7		24.1-27.3	38/37	11			**R7:** Same rock description as R1 above; soft; Moderately to highly weathered; Tightly folded, thin			

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

(Continued Next Page)

BORING / WELL 18-0345.GPJ SWCE TEMPLATE.GDT 12/20/18

BORING LOG

CLIENT: Central Maine Power Company
PROJECT: Proposed Kennebec River Underground Crossing
LOCATION: NECEC, The Forks Plantation & Moxie Gore, Maine

BORING NO.: BH-1
SHEET: 2 of 2
PROJECT NO. 18-0345
DATE START: 10/30/2018
DATE FINISH: 10/30/2018

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION: Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD	Field / Lab Test Data	Graphic Log	Sample Description & Classification	H_20 Depth	Remarks	LPile® Input Parameters (Rec)
920			R8		27.3-30	32/20	16			laminated bedding planes at 65-80 degrees from horizontal; Intensely fractured becoming moderately fractured, fractures at 35-85 degrees from horizontal **R8:** Same rock description as R1 above (pyrite crystals abundant 28.0'-28.2'); soft; Moderately to highly weathered; Tightly folded, thin laminated bedding planes at 65-80 degrees from horizontal; Intensely fractured, fractures at 25-85 degrees from horizontal			
	30									Bottom of Exploration at 30.0 feet			

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

BORING / WELL 18-0345.GPJ SWCE TEMPLATE.GDT 12/20/18

BORING LOG

CLIENT:	Central Maine Power Company
PROJECT:	Proposed Kennebec River Underground Crossing
LOCATION:	NECEC, The Forks Plantation & Moxie Gore, Maine

BORING NO.:	**BH-2**
SHEET:	1 of 4
PROJECT NO.	18-0345
DATE START:	10/30/2018
DATE FINISH:	11/2/2018

Drilling Information

LOCATION: See Exploration Location Plan | **ELEVATION (FT):** 915' Estimated | **TOTAL DEPTH (FT):** 100.0 | **LOGGED BY:** Nate Strout

DRILLING CO.: S. W. Cole Explorations, LLC | **DRILLER:** Kevin Hanscom | **DRILLING METHOD:** Cased Boring

RIG TYPE: Track Mounted Diedrich D-50 | **AUGER ID/OD:** N/A / N/A | **SAMPLER:** Standard Split-Spoon

HAMMER TYPE: Automatic / Automatic | **HAMMER WEIGHT (lbs):** 140 / 140 | **CASING ID/OD:** 4 in / 4 1/2 in | **CORE BARREL:** NQ2 / 2

HAMMER EFFICIENCY FACTOR: 0.92 | **HAMMER DROP (inch):** 30 / 30

WATER LEVEL DEPTHS (ft): 11/2/2018 Free water observed at 14.4' after coring to 45.0'

GENERAL NOTES: No water return below 74'

KEY TO NOTES AND SYMBOLS:
Water Level: ▽ At time of Drilling; ▼ At Completion of Drilling; ▼ After Drilling
D = Split Spoon Sample; U = Thin Walled Tube Sample; R = Rock Core Sample; V = Field Vane Shear
Pen. = Penetration Length; Rec. = Recovery Length; bpf = Blows per Foot; mpf = Minute per Foot
WOR = Weight of Rods; WOH = Weight of Hammer; RQD = Rock Quality Designation; PID = Photoionization Detector
S_v = Field Vane Shear Strength, kips/sq.ft.; q_u = Unconfined Compressive Strength, kips/sq.ft.; Ø = Friction Angle (Estimated); N/A = Not Applicable

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION: Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD	Field / Lab Test Data	Graphic Log	Sample Description & Classification	H_20 Depth	Remarks
			1D		0-2	24/17	10-32-14-10	w =15.4 %		0.4 Forest Duff Medium dense to dense, brown Gravelly Silty SAND with occasional cobbles (Glacial Till)		
			2D		2-4	24/20	9-18-20-27	w =6.1 %				
910	5		3D		5-5.2	2/2	50/2"					
										8.2 Bedrock (advanced by rollercone to 9.3')		
			R1		9.3-14.3	60/58	55			9.3 **R1:** Light Gray Calcareous Siltstone; moderately hard (MOHS = 5); Moderately weathered…iron oxide staining on core and fracture surfaces; Fine-grained texture; Intensely to moderately fractured, fractures at 40-50 and 70 degrees from horizontal		
905	10											
			R2		14.3-18.6	52/52	62			**R2:** Same rock description as R1 above; Moderately weathered…iron oxide staining on core and fracture surfaces (severely weathered 14.9' to 15.4'); Intensely to moderately fractured, fractures at 10, 30-50 and 70 degrees from horizontal		
900	15											
			R3		18.6-20	17/17	100			**R3:** Same rock description as R1 above; Slightly weathered; Moderately fractured, fractures at 40 and 50 degrees from horizontal		
895	20		R4		20-25	60/60	100			**R4:** Same rock description as R1 above; Slightly weathered; Moderately fractured, fractures at 40-55 degrees from horizontal. * Thermal properties sample R4, 22.4'-23.3'		

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

(Continued Next Page)

BORING / WELL 18-0345.GPJ SWCE TEMPLATE.GDT 12/20/18

BORING LOG

CLIENT: Central Maine Power Company
PROJECT: Proposed Kennebec River Underground Crossing
LOCATION: NECEC, The Forks Plantation & Moxie Gore, Maine

BORING NO.: BH-2
SHEET: 2 of 4
PROJECT NO. 18-0345
DATE START: 10/30/2018
DATE FINISH: 11/2/2018

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION: Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD	Field / Lab Test Data	Graphic Log	Sample Description & Classification	H_20 Depth	Remarks
			R5		25-30	60/60	100			**R5:** Light Gray Calcareous Siltstone; moderately hard (MOHS = 5); Moderately weathered…iron oxide staining on core and fracture surfaces; Fine-grained texture; Slightly fractured (1 mechanical drilling break), fractures at 50 degrees and 80 degrees from horizontal		
885	30		R6		30-35	60/60	100			**R6:** Same rock description as R5 above; Slightly fractured (some mechanical drilling breaks), fractures at 35-55 degrees from horizontal		
880	35		R7		35-40	60/60	100			**R7:** Same rock description as R5 above; Slightly weathered; Slightly fractured (mechanical drilling breaks), fractures at 40-50 degrees from horizontal. * Compressive strength sample R9, 46.1' -47.4'		
875	40		R8		40-45	60/60	100			**R8:** Same rock description as R5 above; Slightly weathered; Slightly fractured (mechanical drilling breaks), fractures at 30-45 degrees from horizontal		
870	45		R9		45-50	60/60	87			**R9:** Light Gray Calcareous Siltstone; moderately hard (MOHS = 5); Slightly to moderately weathered…slight pitting on core surface; Fine grained texture; Moderately fractured, fractures at 10 degrees, 30-65 degrees from horizontal. * Compressive strength sample R11, 54.5' -55.9'		
865	50		R10		50-54.5	54/54	96			**R10:** Same rock description as R9 above; Fractures at 5 degrees, 30-40 degrees, and 65 degrees from horizontal		
860	55		R11		54.5-59.5	60/60	85			**R11:** Same rock description as R9 above; Moderately to intensely fractured, fractures at 5-10 degrees, 30-55 degrees from horizontal		

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

(Continued Next Page)

BORING / WELL 18-0345.GPJ SWCE TEMPLATE.GDT 12/20/18

BORING LOG

CLIENT: Central Maine Power Company
PROJECT: Proposed Kennebec River Underground Crossing
LOCATION: NECEC, The Forks Plantation & Moxie Gore, Maine

BORING NO.: BH-2
SHEET: 3 of 4
PROJECT NO. 18-0345
DATE START: 10/30/2018
DATE FINISH: 11/2/2018

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION: Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD	Field / Lab Test Data	Graphic Log	Sample Description & Classification	H_20 Depth	Remarks
855	60		R12		59.5-64.7	62/62	100			**R12:** Same rock description as R9 above; Slightly to moderately fractured, fractures at 20-30 degrees, 30-55 degrees from horizontal		
850	65		R13		64.7-69.9	62/62	100			**R13:** Light Gray Calcareous Siltstone; moderately hard (MOHS = 5); Slightly weathered…slight pitting on core surface and slight staining on some fracture surfaces; Fine grained texture; Slightly fractured, fractures at 15-30 degrees and 70 degrees from horizontal.		
845	70		R14		69.9-73.3	41/36	88			**R14:** Same rock description as R13 above; Slightly to moderately fractured, fractures at 15 degrees and 50-60 degrees from horizontal; * Compressive strength sample R14, 69.9' -70.8'		
			R15		73.3-75.5	26/26	100			**R15:** Same rock description as R13 above; Slightly to moderately fractured, fractures at 5 degrees and 20-30 degrees from horizontal		
840	75		R16		75-80	60/60	100			**R16:** Same rock description as R13 above; Slightly to moderately weathered… moderate pitting on core surface and slight staining on fracture surfaces; Slightly to moderately fractured, fractures at 40-50 degrees and 80 degrees from horizontal		
835	80		R17		80-85	60/60	92			**R17:** Light Gray Calcareous Siltstone; moderately hard (MOHS = 5); Slightly to moderately weathered…slight pitting on core surface and slight staining on some fracture surfaces; Fine grained texture; Slightly to moderately fractured (some mechanical drilling breaks), fractures at 30 degrees and 50-70 degrees from horizontal		
830	85		R18		85-90	60/60	100			**R18:** Same rock description as R17 above; Slightly weathered; Slightly to moderately fractured (mechanical drilling breaks), fractures at 30-40 degrees and 60-70 degrees from horizontal		

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

(Continued Next Page)

BORING / WELL 18-0345.GPJ SWCE TEMPLATE.GDT 12/20/18

BORING LOG

CLIENT: Central Maine Power Company
PROJECT: Proposed Kennebec River Underground Crossing
LOCATION: NECEC, The Forks Plantation & Moxie Gore, Maine

BORING NO.: BH-2
SHEET: 4 of 4
PROJECT NO. 18-0345
DATE START: 10/30/2018
DATE FINISH: 11/2/2018

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION: Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD	Field / Lab Test Data	Graphic Log	Sample Description & Classification	H_20 Depth	Remarks
825	90		R19		90-94.2	50/50	88			**R19:** Same rock description as R17 above; Slightly to moderately fractured (some mechanical drilling breaks), fractures at 40-50 degrees from horizontal		
			R20		94.2-95	10/10	100			**R20:** Same rock description as R17 above; Slightly weathered; Unfractured		
820	95		R21		95-96.5	18/18	100			**R21:** Same rock description as R17 above; Slightly to moderately fractured (some mechanical drilling breaks), fractures at 55-60 degrees from horizontal		
			R22		96.5-100	42/42	100			**R22:** Same rock description as R17 above; Moderately weathered; Slightly to moderately fractured (some mechanical drilling breaks), fractures at 40-65 degrees from horizontal		
815	100									Bottom of Exploration at 100.0 feet		

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

BORING / WELL 18-0345.GPJ SWCE TEMPLATE.GDT 12/20/18

BORING LOG

CLIENT: Central Maine Power Company
PROJECT: Proposed Kennebec River Underground Crossing
LOCATION: NECEC, The Forks Plantation & Moxie Gore, Maine

BORING NO.: BH-3
SHEET: 1 of 4
PROJECT NO. 18-0345
DATE START: 11/26/2018
DATE FINISH: 11/28/2018

Drilling Information

LOCATION: See Exploration Location Plan | **ELEVATION (FT):** 626' Estimated | **TOTAL DEPTH (FT):** 111.5 | **LOGGED BY:** Paul Kohler
DRILLING CO.: S. W. Cole Explorations, LLC | **DRILLER:** Kevin Hanscom | **DRILLING METHOD:** Cased Boring
RIG TYPE: Track Mounted Diedrich D-50 | **AUGER ID/OD:** N/A / N/A | **SAMPLER:** Standard Split-Spoon
HAMMER TYPE: Automatic / Automatic | **HAMMER WEIGHT (lbs):** 140 / 140 | **CASING ID/OD:** 4 in / 4 1/2 in | **CORE BARREL:** NQ2 / 2
HAMMER EFFICIENCY FACTOR: 0.92 | **HAMMER DROP (inch):** 30 / 30
WATER LEVEL DEPTHS (ft): ▼ 4 ft 11/28/2018 Free water at 4'
GENERAL NOTES:

KEY TO NOTES AND SYMBOLS:
Water Level: ▽ At time of Drilling; ▼ At Completion of Drilling; ▼ After Drilling
D = Split Spoon Sample; U = Thin Walled Tube Sample; R = Rock Core Sample; V = Field Vane Shear
Pen. = Penetration Length; Rec. = Recovery Length; bpf = Blows per Foot; mpf = Minute per Foot
WOR = Weight of Rods; WOH = Weight of Hammer; RQD = Rock Quality Designation; PID = Photoionization Detector
S_v = Field Vane Shear Strength, kips/sq.ft.; q_u = Unconfined Compressive Strength, kips/sq.ft.; Ø = Friction Angle (Estimated); N/A = Not Applicable

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD	Field / Lab Test Data	Graphic Log	Sample Description & Classification	H_20 Depth	Remarks
625			1D		0-2	24/12	5-5-17-11			0.4 Forest Duff Medium dense to dense, brown Gravelly Silty SAND with occasional cobbles (Glacial Till)	▼	
	5		2D		5-5.3	4/4	50/4"					
620			R-1		8.4-10.3	23/23	0			8.4 Bedrock; **R1:** Gray Slate; soft to moderately soft (MOHS = 3-4); Highly weathered…iron oxide staining on core and fracture surfaces; Faint, thin laminated bedding planes at 75-85 degrees from horizontal; Intensely, most fractures parallel to bedding planes		
	10		R-2		10.3-14.5	50/50	51			**R2:** Same rock description as R1 above; moderately soft to moderately hard (MOHS = 4-5); Moderately weathered to highly weathered… iron oxide staining on core and fracture surfaces; Slightly fractured to intensely fractured, fractures at 60-85 degrees from horizontal		
615			R-3		14.5-15.4	11/10	0			**R3:** Same rock description as R1 above; moderately soft (MOHS = 4); Highly weathered…iron oxide staining on core and fracture surfaces; Intensely fractured; fractures mostly parallel to bedding planes at 85 degrees from horizontal		
	15		R-4		15.4-19	43/43				**R4:** Gray Slate; moderately soft to moderately hard (MOHS = 4-5); Highly weathered; iron oxide staining on core and fracture surfaces; Moderately to intensely fractured, fractures at 30, 50 and 80 degrees from horizontal		
610			R-5		19-22.6	43/35	37			**R5:** Same rock description as R1 above; moderately hard (MOHS = 5); Moderately to highly weathered… iron oxide staining on core and fracture surfaces; Moderately to intensely fractured, fractures at 5 and 75-85 degrees from horizontal		
	20											
605			R-6		22.6-25.9	39/39				**R6:** Same rock description as R1 above; moderately soft to moderately hard (MOHS = 4-5); Highly weathered… iron oxide staining on core and fracture surfaces; Intensely fractured (some mechanical drilling breaks), fractures at 75-95 degrees from horizontal		

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(Continued Next Page)

BORING LOG

CLIENT: Central Maine Power Company
PROJECT: Proposed Kennebec River Underground Crossing
LOCATION: NECEC, The Forks Plantation & Moxie Gore, Maine

BORING NO.: BH-3
SHEET: 2 of 4
PROJECT NO. 18-0345
DATE START: 11/26/2018
DATE FINISH: 11/28/2018

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION: Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD	Field / Lab Test Data	Graphic Log	Sample Description & Classification	H_20 Depth	Remarks
600			R-7		25.8-29.6	45/45	85			**R7:** Gray Slate with thin (0.5" or less) Quartz seams; moderately hard to hard (MOHS = 5-6); Slightly to moderately weathered…iron oxide staining on some fracture surfaces; Faint, thin laminated bedding planes at 75-85 degrees from horizontal; Slightly fractured (mechanical drilling breaks), fractures at 45 and 75 degrees from horizontal		
	30		R-8		29.5-34.5	60/47	43			**R8:** Same rock description as R7 above; Slightly weathered; Slightly fractured (mechanical drilling breaks), fractures at 25 and 75-85 degrees		
595												
	35		R-9		34.5-39.5	60/60	41			**R9:** Gray Slate with zones of Phylitte; moderately hard (MOHS = 5); Slightly weathered; Slightly to moderately fractured (some mechanical drilling breaks), fractures at 10-30 and 80-90 degrees from horizontal		
590												
	40		R-10		39.5-44.5	60/60	81			**R10:** Gray Slate; moderately hard (MOHS = 5); Fresh to slightly weathered; Faint, thin laminated bedding planes at 70-80 degrees from horizontal; Slightly to moderately fractured (some mechanical drilling breaks), fractures at 20 and 70 degrees from horizontal		
585												
	45		R-11		44.5-49.5	60/60	98			**R11:** Gray Slate; moderately hard to hard (MOHS = 5-6); Fresh to slightly weathered; Very faint, thin laminated bedding planes at 80-85 degrees from horizontal; Very slightly fractured (mechanical drilling breaks), fractures at 5-10 and 20-25 degrees from horizontal		
580												
	50		R-12		49.5-54.5	60/60	68			**R12:** Gray Slate with thin (0.5" or less) Quartz seams; moderately hard to hard (MOHS = 5-6); Slightly weathered; Slightly to moderately fractured (some mechanical drilling breaks), fractures at 10 and 30-45 degrees from horizontal		
575												
	55		R-13		54.5-59.5	60/60	56			**R13:** Gray Slate with thin (0.25" or less) Quartz seams; moderately hard to hard (MOHS = 5-6); Slightly to moderately weathered (slight iron oxide staining on some fracture surfaces; Slightly to moderately fractured (some mechanical drilling breaks), fractures at 5-10, 40 and 85 degrees from horizontal		
570												

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BORING / WELL 18-0345.GPJ SWCE TEMPLATE.GDT 12/20/18

BORING LOG

S.W.COLE ENGINEERING, INC.

CLIENT: Central Maine Power Company
PROJECT: Proposed Kennebec River Underground Crossing
LOCATION: NECEC, The Forks Plantation & Moxie Gore, Maine

BORING NO.: BH-3
SHEET: 3 of 4
PROJECT NO. 18-0345
DATE START: 11/26/2018
DATE FINISH: 11/28/2018

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION: Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD	Field / Lab Test Data	Graphic Log	Sample Description & Classification	H_20 Depth	Remarks
	60		R-14		59.5-61.1	19/18	26			**R14:** Gray Slate; moderately hard (MOHS = 5); Slightly weathered; Moderately fractured (mechanical drilling breaks), fractures at 45 and 85 degrees from horizontal		
565			R15		61.1-64.5	41/40	97			**R15:** Same rock description as R14 above; Fresh to slightly weathered; Very slightly fractured (mechanical drilling breaks), fractures at 5 degrees from horizontal		
	65		R16		64.5-67.7	38/37	94			**R16:** Gray Slate transitioning to Phyllite; moderately hard (MOHS = 5); Slightly weathered; Thin, slightly folded, laminated bedding planes at 75-80 degrees from horizontal; Very slightly fractured (mechanical drilling break), fracture at 10 degrees from horizontal		
560			R17		67.7-71.5	46/46	100			**R17:** Gray Phyllite; moderately hard (MOHS = 5); Slightly weathered; Very slightly fractured (mechanical drilling breaks), fracture at 75 degrees from horizontal		
	70											
555			R18		71.5-76.5	60/60	60			**R18:** Gray Phyllite transitioning to Slate; moderately hard (MOHS = 5); Fresh to slightly weathered; Moderately fractured (some mechanical drilling breaks), fractures at 30-40 and 60-70 degrees from horizontal		
	75											
550			R-19		76.5-81.5	60/60	95			**R19:** Gray Slate; moderately hard (MOHS = 5); A few Pyrite crystals on core surface; Fresh to slightly weathered; Slightly to moderately fractured (mechanical drilling breaks), fractures at 30 and 70-75 degrees from horizontal. * Compressive strength sample 79.2'-81.0'		
	80											
545			R20		81.5-86.5	60/60	100			**R20:** Gray Slate; moderately hard (MOHS = 5); Fresh to slightly weathered; Very faint, thin laminated bedding planes at 70-80 degrees from horizontal; Slightly to moderately fractured (mechanical drilling breaks), fractures at 5, 40 and 70 degrees from horizontal. * Compressive strength sample: 90.3' - 91.2'		
	85											
540			R-21		86.5-91.5	60/60	70			**R21:** Gray Slate with thin (0.5" or less) Quartz seams; moderately hard to hard (MOHS = 5-6); Fresh to slightly weathered; Moderately fractured (some mechanical drilling breaks), fractures at 35 and 75 degrees from horizontal		

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

(Continued Next Page)

BORING / WELL 18-0345.GPJ SWCE TEMPLATE.GDT 12/20/18

BORING LOG

CLIENT: Central Maine Power Company
PROJECT: Proposed Kennebec River Underground Crossing
LOCATION: NECEC, The Forks Plantation & Moxie Gore, Maine

BORING NO.: BH-3
SHEET: 4 of 4
PROJECT NO. 18-0345
DATE START: 11/26/2018
DATE FINISH: 11/28/2018

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION: Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD	Field / Lab Test Data	Graphic Log	Sample Description & Classification	H_20 Depth	Remarks
	90											
535			R-22		91.5-92.1	7/7	0			**R22:** Gray Slate; moderately hard (MOHS = 5); Slightly weathered; Highly fractured (some mechanical drilling breaks), fractures at 35 and 85 degrees from horizontal **R23:** Gray Slate; moderately hard (MOHS = 5); Slightly weathered; Slightly to moderately fractured (some mechanical drilling breaks), fractures at 50 and 70-80 degrees from horizontal		
			R-23		92.1-96.5	53/53	81					
	95											
530			R-24		96.5-101.5	60/60	70			**R24:** Gray Slate; moderately hard (MOHS = 5); Fresh to slightly weathered; Slightly to moderately fractured (some mechanical drilling breaks), fractures at 10 and 40-80 degrees from horizontal. * Compressive strength sample: 100.0' - 101.1'		
	100											
525			R-25		101.5-106.5	60/60	56			**R25:** Gray Slate with Quartz inclusions; moderately hard to hard (MOHS = 5-6); Slightly weathered; Very faint, thin laminated bedding planes at 75-80 degrees from horizontal; Moderately fractured (some mechanical drilling breaks), fractures at 50 and 65-70 degrees from horizontal		
	105											
520			R-26		106.5-111.5	60/32	56			**R26:** Gray Slate with Quartz inclusions; moderately hard to hard (MOHS = 5-6); Fresh to slightly weathered; Slightly fractured (some mechanical drilling breaks), fractures at 65 and 80 degrees from horizontal. * Compressive strength sample: 110.0'-111.3'		
	110											
515												

Bottom of Exploration at 111.5 feet

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BORING NO.: BH-3

BORING LOG

CLIENT: Central Maine Power Company
PROJECT: Proposed Kennebec River Underground Crossing
LOCATION: NECEC, The Forks Plantation & Moxie Gore, Maine

BORING NO.: BH-4
SHEET: 1 of 7
PROJECT NO. 18-0345
DATE START: 11/5/2018
DATE FINISH: 11/9/2018

Drilling Information

LOCATION: See Exploration Location Plan | **ELEVATION (FT):** 856' Estimated | **TOTAL DEPTH (FT):** 193.4 | **LOGGED BY:** Nate Strout
DRILLING CO.: S. W. Cole Explorations, LLC | **DRILLER:** Kevin Hanscom | **DRILLING METHOD:** Cased Boring
RIG TYPE: Track Mounted Diedrich D-50 | **AUGER ID/OD:** N/A / N/A | **SAMPLER:** Standard Split-Spoon
HAMMER TYPE: Automatic / Automatic | **HAMMER WEIGHT (lbs):** 140 / 140 | **CASING ID/OD:** 4 in / 4 1/2 in | **CORE BARREL:** NQ2 / 2
HAMMER EFFICIENCY FACTOR: 0.92 | **HAMMER DROP (inch):** 30 / 30
WATER LEVEL DEPTHS (ft): ▼ 21.8 ft Free water at 21.8' on 11/9/18 after coring to 193.4' on 11/8/18
GENERAL NOTES:

KEY TO NOTES AND SYMBOLS:
Water Level: ▽ At time of Drilling; ▼ At Completion of Drilling; ▼ After Drilling
D = Split Spoon Sample; U = Thin Walled Tube Sample; R = Rock Core Sample; V = Field Vane Shear
Pen. = Penetration Length; Rec. = Recovery Length; bpf = Blows per Foot; mpf = Minute per Foot
WOR = Weight of Rods; WOH = Weight of Hammer; RQD = Rock Quality Designation; PID = Photoionization Detector
S_v = Field Vane Shear Strength, kips/sq.ft.; q_u = Unconfined Compressive Strength, kips/sq.ft.; Ø = Friction Angle (Estimated); N/A = Not Applicable

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD	Field / Lab Test Data	Graphic Log	Sample Description & Classification	H_20 Depth	Remarks
			1D		0-1.5	18/10	2-2-19-25/0/0"			Forest Duff		
855								w =15.3 %		1.0 Medium dense, reddish-brown Silty SAND, some gravel with numerous cobbles		
			2D		2-3.3	16/14	9-25-50/4"	w =20.1 %				
	5									4.0 Bedrock (advanced by rollercone to 6')		
850			R1		6-9.6	43/39	91			6.0 **R1:** Gray Slate with very thin (1/8" or less) Quartz zones; moderately hard (MOHS = 5); Moderately weathered….some slight pitting and iron oxide staining on core surface; Very thin laminated bedding planes at 55 to 65 degrees from horizontal; Moderately tight fractures varying between 10 degrees and 85 degrees from horizontal * Thermal Properties Sample R1, 6.9'-8.4'		
	10		R2		9.6-11	17/5	0			**R2:** Gray Slate with very thin (1/8" or less) Quartz zones; Moderately hard (MOHS = 5); Moderately weathered….some slight pitting and iron oxide staining on core surface; Very thin laminated bedding planes at 55 to 65 degrees from horizontal; Moderately tight fractures varying between 10 degrees and 85 degrees from horizontal		
845			R3		11-11.4	5/5	0			**R3:** Gray Slate; Soft (crumbled by hand pressure); highly weathered and very intensely fractured; Bedding planes and fracture orientation difficult to discern due to degree of fracturing		
			R4		11.4-14.6	38/38	61			**R4:** Gray to rusty gray Slate with Quartz zones ¼" to 1" in thickness; Soft becoming hard (MOHS = 4-6); Highly weathered becoming moderately weathered….pitting up to ¼" deep on core surface; Intensely fractured becoming moderately fractured; Faint thin bedding planes at 50 to 65 degrees from horizontal; Fractures at 5 degrees to 60 degrees from horizontal		
	15		R5		14.6-17.8	38/38	63			**R5:** Gray Slate with very thin (1/8" or less) Quartz zones; moderately hard (MOHS = 5); Moderately weathered becoming slightly weathered….some slight pitting and iron oxide staining on core surface; Thin laminated bedding planes at 60 degrees to 70 degrees from horizontal; Slightly to moderately fractured with fracture angles mostly parallel to bedding planes * Thermal Properties Sample R5, 14.6'-16.5'		
840			R6		17.8-19.6	22/22	73			**R6:** Gray Slate; Moderately hard (MOHS = 5); Slightly weathered; Thin laminated bedding planes at 60 degrees to 75 degrees from horizontal; Slightly to moderately fractured with fracture angles mostly parallel to bedding planes * Thermal Properties Sample R6, 17.8'-19.3'		
	20		R7		19.6-21.6	24/24	25			**R7:** Gray Slate; Moderately hard (MOHS = 5); Moderately weathered…slight iron oxide staining on fracture surfaces; Thin laminated bedding planes at 65 degrees to 75 degrees from horizontal; Moderately to intensely fractured with most fracture angles parallel to bedding planes		
835			R8		21.6-24.6	36/35	67			**R8:** Gray Slate; hard (MOHS = 5-6); Moderately weathered; Faint, thin laminated bedding planes at 70-80 degrees from horizontal; Moderately to intensely fractured, fractures at 5, 35 and 80 degrees from horizontal	▼	

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

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BORING LOG

CLIENT: Central Maine Power Company
PROJECT: Proposed Kennebec River Underground Crossing
LOCATION: NECEC, The Forks Plantation & Moxie Gore, Maine

BORING NO.: BH-4
SHEET: 2 of 7
PROJECT NO. 18-0345
DATE START: 11/5/2018
DATE FINISH: 11/9/2018

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION: Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD	Field / Lab Test Data	Graphic Log	Sample Description & Classification	H_20 Depth	Remarks
830			R9		24.6-28.8	50/49	92			**R9:** Same rock description as R8 above; Slightly weathered; Fractures at 5, 35-40 and 70 degrees from horizontal		
			R10		28.8-31.5	32/32	50			**R10:** Same rock description as R8 above; moderately hard (MOHS = 5); Slightly to moderately weathered (iron oxide staining on fracture surfaces); Fractures at 20, 45, and 70-80 degrees from horizontal		
	30											
825			R11		31.5-34.7	38/38	0			**R11:** Same rock description as R8 above (MOHS = 5); Moderately weathered; Intensely fractured, fractures at 45-50 and 85-90 degrees from horizontal		
	35		R12		34.7-38.7	48/48	29			**R12:** Same rock description as R8 above (MOHS = 5); Moderately weathered (some iron oxide staining on fracture surfaces); Moderately to intensely fractured, fractures at 65-85 degrees from horizontal		
820			R13		38.7-41.6	35/35	100			**R13:** Gray Slate; hard (MOHS = 5-6); Slightly to moderately weathered; Faint, thin laminated bedding planes at 75-80 degrees from horizontal; Slightly to moderately fractured, fractures at 35-45 degrees from horizontal		
	40											
815			R14		41.6-45.1	42/42	100			**R14:** Same rock description as R13 above; Slightly weathered; Very slightly fractured, the one fracture at 30 degrees from horizontal		
	45		R15		45.1-49.6	54/54	100			**R15:** Same rock description as R13 above; Slightly weathered; Very slightly fractured, the one fracture (mechanical drilling break) at 25 degrees from horizontal		
810												
	50		R16		49.6-54.6	60/60	90			**R16:** Same rock description as R13 above; Slightly weathered; Slightly fractured, fractures (some mechanical breaks) at 20 and 70 degrees from horizontal		
805												
	55		R17		54.6-59.6	60/60	82			**R17:** Same rock description as R13 above; Fresh to slightly weathered; Slightly fractured, fractures (some mechanical breaks) at 15-20 and 70-75 degrees from horizontal		
800												

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

(Continued Next Page)

BORING LOG

S.W.COLE ENGINEERING, INC.

CLIENT: Central Maine Power Company
PROJECT: Proposed Kennebec River Underground Crossing
LOCATION: NECEC, The Forks Plantation & Moxie Gore, Maine

BORING NO.: BH-4
SHEET: 3 of 7
PROJECT NO. 18-0345
DATE START: 11/5/2018
DATE FINISH: 11/9/2018

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION: Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD	Field / Lab Test Data	Graphic Log	Sample Description & Classification	H_20 Depth	Remarks
795	60		R18		59.6-64.6	60/60	100			**R18:** Gray Slate; moderately hard (MOHS = 5); Moderately weathered…iron oxide staining on fracture surfaces; Fine grained texture; Faint, very thin laminated bedding planes at 80-85 degrees from horizontal; Slightly fractured, fractures at 0, 30 and 65-85 degrees from horizontal		
790	65		R19		64.6-69.6	60/60	50			**R19:** Gray Slate becoming Calcareous Slate-some Pyrite crystals on core and fracture surfaces; Slightly to moderately fractured, fractures at 5, 25 and 85-90 degrees from horizontal		
785	70		R20		69.6-74.6	60/57	75			**R20:** Same rock description as R18 above (no Pyrite); Slightly weathered; Slightly to moderately fractured, fractures at 25-40 and 85 degrees from horizontal		
780	75		R21		74.6-79.6	60/60	100			**R21:** Gray Calcareous Slate transitioning to Calcareous Siltstone; moderately hard (MOHS =5); Slightly weathered; Very fine grained texture; Slightly fractured, fractures at 25, 45, and 85 degrees from horizontal		
775	80		R22		79.6-84.6	60/60	93			**R22:** Gray Calcareous Siltstone; moderately hard (MOHS = 5); Slightly weathered; Very fine grained texture; Slightly fractured, fractures at 5 and 20-25 degrees from horizontal		
770	85		R23		84.6-89.6	60/60	100			**R23:** Same rock description as R22 above; Slightly fractured (mechanical drilling breaks), fractures at 5-10 and 55 degrees from horizontal		

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

(Continued Next Page)

BORING / WELL 18-0345.GPJ SWCE TEMPLATE.GDT 12/20/18

BORING LOG

CLIENT: Central Maine Power Company
PROJECT: Proposed Kennebec River Underground Crossing
LOCATION: NECEC, The Forks Plantation & Moxie Gore, Maine

BORING NO.: BH-4
SHEET: 4 of 7
PROJECT NO. 18-0345
DATE START: 11/5/2018
DATE FINISH: 11/9/2018

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION: Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD	Field / Lab Test Data	Graphic Log	Sample Description & Classification	H_20 Depth	Remarks
	90		R24		89.6-94.6	60/60	100			**R24:** Same rock description as R22 above; Slightly fractured (mechanical drilling breaks), fractures at 5 and 50 degrees from horizontal		
765												
	95		R25		94.6-99.6	60/60	100			**R25:** Same rock description as R22 above; Slightly fractured (mechanical drilling breaks), fractures at 15, 50 and 75 degrees from horizontal		
760												
	100		R26		99.6-102.5	35/35	100			**R26:** Gray Calcareous Siltstone; moderately hard to hard (MOHS = 5-6); Slightly weathered; Fine grained texture; Unfractured		
755												
			R27		102.5-104.6	25/25	100			**R27:** Same rock description as R26 above; Slightly weathered; Slightly fractured (some mechanical drilling breaks), fractures at 70-85 degrees from horizontal		
	105		R28		104.6-108.9	52/51	92			**R28:** Same rock description as R26 above; Slightly weathered; Slightly fractured (some mechanical drilling breaks), fractures at 5, 25 and 70 degrees from horizontal		
750												
			R29		108.9-114	61/61	100			**R29:** Same rock description as R26 above; Moderately weathered…iron oxide staining on some fracture surfaces; Slightly fractured (some mechanical drilling breaks); fractures at 60 and 75-85 degrees from horizontal		
	110											
745												
			R30		114-117.5	42/42	0			**R30:** Gray Calcareous Siltstone transitioning to Calcareous Slate (Siltstone moderately hard, Slate soft); Moderately (Siltstone) to highly (Slate) weathered, Moderately (Siltstone) to intensely (Slate) fractured; Siltstone fine grained texture; Slate has very faint laminated bedding planes at 85 degrees from horizontal; most fractures parallel to Slate bedding planes		
	115											
740												
			R31		117.5-119	18/18	0			**R31:** Gray Calcareous Slate; soft and highly weathered; Intensely fractured with most fractures parallel to 85 degree bedding planes		
			R32		119-124.2	62/62	47			**R32:** Gray Calcareous Slate; moderately hard (MOHS = 5); Moderately weathered; Very faint thin laminated bedding planes at 80-85 degrees from horizontal; Slightly to intensely fractured, fractures at 5, 20-40 and 65-85 degrees from horizontal		
	120											
735												

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(Continued Next Page)

BORING LOG

CLIENT: Central Maine Power Company
PROJECT: Proposed Kennebec River Underground Crossing
LOCATION: NECEC, The Forks Plantation & Moxie Gore, Maine

BORING NO.: BH-4
SHEET: 5 of 7
PROJECT NO. 18-0345
DATE START: 11/5/2018
DATE FINISH: 11/9/2018

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION: Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD	Field / Lab Test Data	Graphic Log	Sample Description & Classification	H_20 Depth	Remarks
730	125		R33		124.2-129.4	62/62	100			**R33:** Gray Calcareous Slate (Phyllite zone 128.5'-129.4'); Moderately hard (MOHS = 5); Slightly to moderately weathered; Very faint thin laminated bedding planes at 80-85 degrees from horizontal; Slightly to moderately fractured (mechanical drilling breaks), fractures at 10, 50 and 80 degrees from horizontal		
725	130		R34		129.4-134.6	62/62	100			**R34:** Same rock description as R32 above; Slightly to moderately fractured (mechanical drilling breaks), fractures at 5-10 and 55 degrees from horizontal		
720	135		R35		134.6-139.6	60/60	57			**R35:** Same rock description as R32 above; Slightly fractured (mechanical drilling breaks), fractures at 35, 65 -70, and 85-90 degrees from horizontal		
715	140		R36		139.6-144.6	60/60	97			**R36:** Gray Calcareous Slate; moderately hard (MOHS = 5); Slightly weathered; Very faint thin laminated bedding planes at 75-85 degrees from horizontal; Moderately fractured (some mechanical drilling breaks), fractures at 40 and 65-85 degrees from horizontal		
710	145		R37		144.6-149.6	60/60	83			**R37:** Same rock description as R36 above; Moderately hard (MOHS = 5); Slightly weathered to fresh; Moderately fractured (some mechanical drilling breaks), fractures at 35-45 and 75-85 degrees from horizontal * Compressive strength sample: 146.8' - 148.5'		
705	150		R38		149.6-154.6	60/60	93			**R38:** Gray calcareous Slate transitioning to calcareous Siltstone; Moderately hard (MOHS = 5); Siltstone has fine-grained texture; Moderately fractured (some mechanical drilling breaks), fractures at 15-35, 45, and 85 degrees from horizontal		

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(Continued Next Page)

BORING / WELL 18-0345.GPJ SWCE TEMPLATE.GDT 12/20/18

BORING LOG

S.W.COLE ENGINEERING, INC.

CLIENT: Central Maine Power Company
PROJECT: Proposed Kennebec River Underground Crossing
LOCATION: NECEC, The Forks Plantation & Moxie Gore, Maine

BORING NO.: BH-4
SHEET: 6 of 7
PROJECT NO. 18-0345
DATE START: 11/5/2018
DATE FINISH: 11/9/2018

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION: Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD	Field / Lab Test Data	Graphic Log	Sample Description & Classification	H_20 Depth	Remarks
	155		R39		154.6-158.5	47/47	83			**R39:** Gray calcareous Siltstone transitioning to calcareous slate; moderately hard (MOHS = 5); Slightly weathered to fresh; Slate has very faint, thin laminated bedding planes at 70-80 degrees from horizontal; Slightly fractured (mechanical drilling breaks), fractures at 5, 35-45, and 70 degrees from horizontal		
700												
			R40		158.5-161.6	37/37	100			**R40:** Gray calcareous Slate transitioning to calcareous phyllite; moderately hard (MOHS = 5); Slightly weathered; Very faint thin laminated bedding planes at 70-80 degrees from horizontal; Slightly fractured (mechanical drilling breaks), fractures at 75 degrees from horizontal		
	160											
695												
			R41		161.6-166.6	60/60	98			**R41:** Same rock description as R40 above; Slightly to moderately fractured (some mechanical drilling breaks); fractures at 30-50 degrees from horizontal		
	165											
690												
			R42		166.6-171.6	60/60	72			**R42:** Same rock description as R40 above; Slightly weathered to fresh; Slightly fractured (some mechanical drilling breaks); fractures at 5-10 and 35 degrees from horizontal		
	170											
685												
			R43		171.6-176.6	60/60	100			**R43:** Same rock description as R40 above; Slightly fractured (mechanical drilling breaks); fractures at 25-35 and 75 degrees from horizontal * Compressive strength sample: 174.9' - 175.7'		
	175											
680												
			R44		176.6-181.6	60/60	78			**R44:** Gray calcareous Phyllite with quartz inclusions; moderately hard to hard (MOHS = 5-6); Fresh to slightly weathered; Very faint thin laminated bedding planes at 80-85 degrees from horizontal; Slightly to moderately fractured, fractures at 5 and 80-85 degrees from horizontal		
	180											
675												
			R45		181.6-186.6	60/60	63			**R45:** Same rock description as R44 above; Moderately fractured; fractures at 10-20 and 85 degrees from horizontal		
	185											
670												

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(Continued Next Page)

BORING LOG

CLIENT: Central Maine Power Company
PROJECT: Proposed Kennebec River Underground Crossing
LOCATION: NECEC, The Forks Plantation & Moxie Gore, Maine

BORING NO.: BH-4
SHEET: 7 of 7
PROJECT NO. 18-0345
DATE START: 11/5/2018
DATE FINISH: 11/9/2018

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION: Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD	Field / Lab Test Data	Graphic Log	Sample Description & Classification	H_20 Depth	Remarks
			R46		186.6-191.6	60/60	93			**R46:** Gray calcareous Phyllite; moderately hard (MOHS = 5); Slightly weathered; Very faint thin laminated bedding planes at 75-85 degrees from horizontal; Slightly to moderately fractured (some mechanical drilling breaks); fractures at 5-10 and 80 degrees from horizontal		
	190											
665												
			R47		191.6-193.4	22/22	100			**R47:** Same rock description as R46 above; Slightly to moderately fractured (mechanical drilling breaks); Fractures at 5-10 degrees from horizontal		

Bottom of Exploration at 193.4 feet

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

BORING / WELL 18-0345.GPJ SWCE TEMPLATE.GDT 12/20/18

BORING LOG

CLIENT: Central Maine Power Company
PROJECT: Proposed Kennebec River Underground Crossing
LOCATION: NECEC, The Forks Plantation & Moxie Gore, Maine

BORING NO.: BH-5
SHEET: 1 of 2
PROJECT NO. 18-0345
DATE START: 11/2/2018
DATE FINISH: 11/5/2018

Drilling Information

LOCATION: See Exploration Location Plan
ELEVATION (FT): 894' Estimated
TOTAL DEPTH (FT): 30.0
LOGGED BY: Nate Strout
DRILLING CO.: S. W. Cole Explorations, LLC
DRILLER: Kevin Hanscom
DRILLING METHOD: Cased Boring
RIG TYPE: Track Mounted Diedrich D-50
AUGER ID/OD: N/A / N/A
SAMPLER: Standard Split-Spoon
HAMMER TYPE: Automatic / Automatic
HAMMER WEIGHT (lbs): 140 / 140
CASING ID/OD: 4 in / 4 1/2 in
CORE BARREL: NQ2 / 2
HAMMER EFFICIENCY FACTOR: 0.92
HAMMER DROP (inch): 30 / 30
WATER LEVEL DEPTHS (ft): ▼ 3.7 ft 11/6/2018 Free water at 3.7' on 11/6/2018
GENERAL NOTES: Following completion of the boring, 3 inch PVC casing installed from 3 feet above existing grade to top of bedrock

KEY TO NOTES AND SYMBOLS:
Water Level: ▽ At time of Drilling; ▼ At Completion of Drilling; ▼ After Drilling
D = Split Spoon Sample; U = Thin Walled Tube Sample; R = Rock Core Sample; V = Field Vane Shear
Pen. = Penetration Length; Rec. = Recovery Length; bpf = Blows per Foot; mpf = Minute per Foot
WOR = Weight of Rods; WOH = Weight of Hammer; RQD = Rock Quality Designation; PID = Photoionization Detector
S_v = Field Vane Shear Strength, kips/sq.ft.; q_u = Unconfined Compressive Strength, kips/sq.ft.; Ø = Friction Angle (Estimated); N/A = Not Applicable

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD	Field / Lab Test Data	Graphic Log	Sample Description & Classification	H_2O Depth	Remarks	LPile® Input Parameters (Rec)
			1D		0-2	24/9	1-5-7-8	w =16.3 %		0.5 Forest Duff Medium dense, brown Gravelly SILT and SAND (Glacial Till)			Sand (Reese) γ =115 pcf ϕ =30 ° *k* =90 pci
			2D		2-4	24/10	16-24-35-37	w =4.4 %			▼		
890													Sand (Reese) γ =58 pcf ϕ =30 ° *k* =60 pci
	5		3D		5-7	24/17	11-8-6-9	w =10.9 %		5.0 Medium dense, brown SILT and SAND, some gravel with occasional cobbles (Glacial Till)			Sand (Reese) γ =58 pcf ϕ =32 ° *k* =80 pci
885													
	10		4D		10-12	24/20	13-16-15-26	w =13.2 %					
880													
	15		5D		15-17	24/21	19-22-26-35	w =13.5 %		15.0 Dense, gray Sandy SILT, some gravel, some clay (Glacial Till)			Sand (Reese) γ =63 pcf ϕ =32 ° *k* =90 pci
875													
	20									19.5 Saprolite (decomposed) Bedrock			Weak Rock (Reese) γ =145 pcf
			6D		21.5-21.8	4/4	50/4"						
870			R1		24-27.6	43/26	16			24.0 Bedrock; **R1:** Gray Slate; soft to moderately hard (MOHS = 3-5);			Strong Rock (Vuggy

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

(Continued Next Page)

BORING LOG

CLIENT: Central Maine Power Company
PROJECT: Proposed Kennebec River Underground Crossing
LOCATION: NECEC, The Forks Plantation & Moxie Gore, Maine

BORING NO.: BH-5
SHEET: 2 of 2
PROJECT NO. 18-0345
DATE START: 11/2/2018
DATE FINISH: 11/5/2018

Elev. (ft)	Depth (ft)	Casing Pen. (bpf)	SAMPLE INFORMATION: Sample No.	Type	Depth (ft)	Pen./ Rec. (in)	Blow Count or RQD	Field / Lab Test Data	Graphic Log	Sample Description & Classification	H_20 Depth	Remarks	LPile® Input Parameters (Rec)
										Highly weathered becoming moderately weathered; Very thin laminated bedding planes at 60 degrees from horizontal; Very tight fractures paralleling bedding planes			Limestone)
865	30		R2		27.6-30	29/29	38			**R2:** Gray Slate with thin (1/4" or less) Quartz zones; moderately hard (MOHS = 5); Moderately weathered….iron oxide staining on some fracture surfaces; Very thin laminated bedding planes at 45 to 65 degrees from horizontal; Very tight fractures mostly paralleling bedding planes			

Bottom of Exploration at 30.0 feet

Stratification lines represent approximate boundary between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the time measurements were made.

BORING / WELL 18-0345.GPJ SWCE TEMPLATE.GDT 12/20/18

S.W.COLE ENGINEERING, INC. • Geotechnical Engineering • Field & Lab Testing • Scientific & Environmental Consulting

KEY TO NOTES & SYMBOLS
Test Boring and Test Pit Explorations

All stratification lines represent the approximate boundary between soil types and the transition may be gradual.

Key to Symbols Used:

w	-	water content, percent (dry weight basis)
q_u	-	unconfined compressive strength, kips/sq. ft. - laboratory test
S_v	-	field vane shear strength, kips/sq. ft.
L_v	-	lab vane shear strength, kips/sq. ft.
q_p	-	unconfined compressive strength, kips/sq. ft. – pocket penetrometer test
O	-	organic content, percent (dry weight basis)
W_L	-	liquid limit - Atterberg test
W_P	-	plastic limit - Atterberg test
WOH	-	advance by weight of hammer
WOM	-	advance by weight of man
WOR	-	advance by weight of rods
HYD	-	advance by force of hydraulic piston on drill
RQD	-	Rock Quality Designator - an index of the quality of a rock mass.
γ_T	-	total soil weight
γ_B	-	buoyant soil weight

Description of Proportions:

Trace:	0 to 5%
Some:	5 to 12%
"Y"	12 to 35%
And	35+%
With	Undifferentiated

Description of Stratified Soils

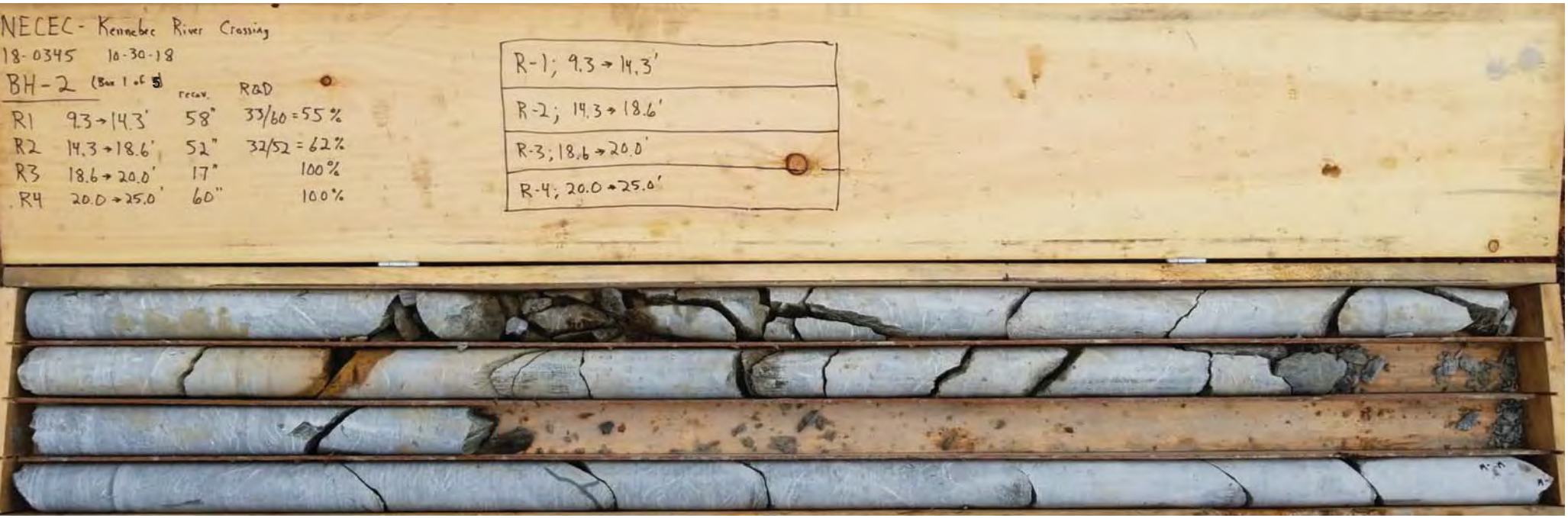
Parting:	0 to 1/16" thickness
Seam:	1/16" to 1/2" thickness
Layer:	½" to 12" thickness
Varved:	Alternating seams or layers
Occasional:	one or less per foot of thickness
Frequent:	more than one per foot of thickness

REFUSAL: **Test Boring Explorations** - Refusal depth indicates that depth at which, in the drill foreman's opinion, sufficient resistance to the advance of the casing, auger, probe rod or sampler was encountered to render further advance impossible or impracticable by the procedures and equipment being used.

REFUSAL: **Test Pit Explorations** - Refusal depth indicates that depth at which sufficient resistance to the advance of the backhoe bucket was encountered to render further advance impossible or impracticable by the procedures and equipment being used.

Although refusal may indicate the encountering of the bedrock surface, it may indicate the striking of large cobbles, boulders, very dense or cemented soil, or other buried natural or man-made objects or it may indicate the encountering of a harder zone after penetrating a considerable depth through a weathered or disintegrated zone of the bedrock.


NECEC - Kennebec River Crossing
18-0345 10-30-18
BH-1 recov. RQD
R1 11→12.6' 19" 0
R2 12.6→13.5' 11" 0
R3 13.5→16.5' 36" 14/36=39%
R4 16.5→18.5' 24" 18/24=75%
R5 18.5→21.8' 40" 16/40=40%
R6 21.8→24.1' 28" 4/28=14%
R7 24.1→27.3' 37" 4/38=11%
R8 27.3→30.0' 25" 5/32=16%
R1; 11.0→12.6'
R2; 12.6→13.5'
R3; 13.5→15.8'
R3; 15.8→16.5'
R4; 16.5→18.5'
R5; 18.5→20.5'
R5; 20.5→21.8'
R6; 21.8→24.1'
R7; 24.1→25.1'
R7; 25.1→27.3'
R8; 27.3→30.0'


NECEC - Kennebec River Crossing
18-0345 10-30-18
BH-2 (Box 1 of 5)
recov. RQD
R1 9.3→14.3' 58" 33/60 = 55%
R2 14.3→18.6' 52" 32/52 = 62%
R3 18.6→20.0' 17" 100%
R4 20.0→25.0' 60" 100%
R-1; 9.3→14.3'
R-2; 14.3→18.6'
R-3; 18.6→20.0'
R-4; 20.0→25.0'


NECEC- Kennebec River Crossing
18-0345 10-31-18
BH-2 (Box 2 of 5)
rcvr. RQD
R5 25.0 → 30.0' 60" 100%
R6 30.0 → 35.0' 60" 100%
R7 35.0 → 40.0' 60 100%
R8 40.0 → 45.0' 60 100%
R5; 25.0 → 30.0'
R6; 30.0 → 35.0'
R7; 35.0 → 40.0'
R8; 40.0 → 45.0'

NECEC - Kennebec River Crossing

18-0345 11-1-18

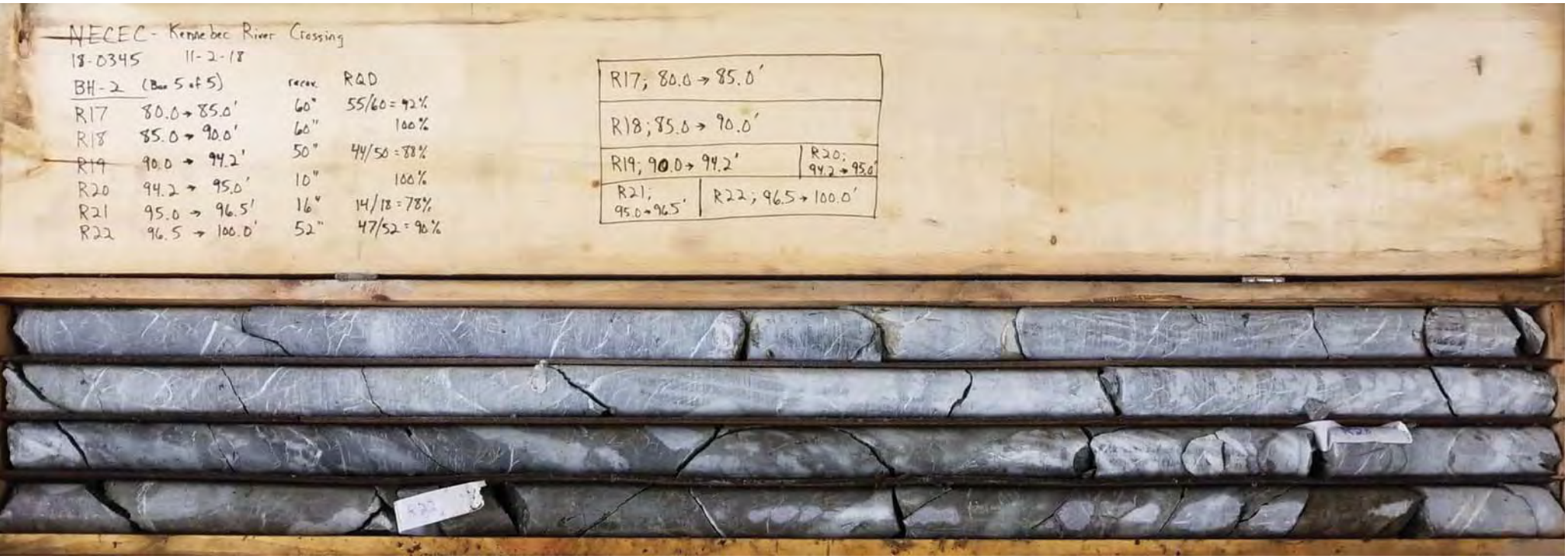
BH-2 (Box 3 of 5)

		recov.	RQD
R9	45.0 → 50.0'	60"	52/60 = 87%
R10	50.0 → 54.5'	54"	52/54 = 96%
R11	54.5 → 59.5'	60"	51/60 = 85%
R12	59.5 → 64.7'	62"	100%

R9; 45.0 → 50.0'	
R10; 50.0 → 54.5'	R11 54.5 → 59.5'
R11; 54.9 → 59.5'	R12 59.5 → 64.7'
R12; 59.7 → 64.7'	

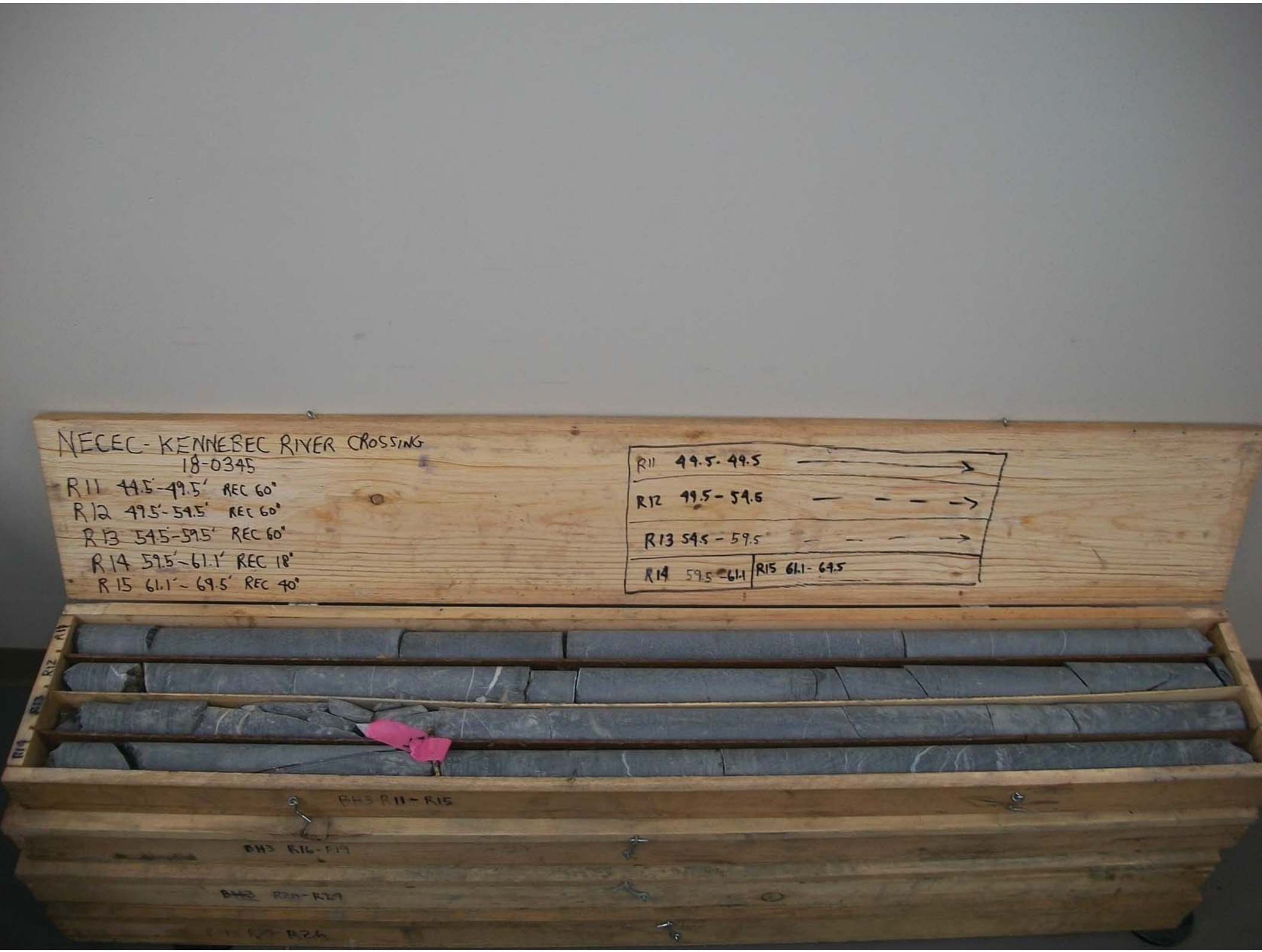



NECEC - Kennebec River Crossing
18-0345 11-1-18
BH-2 (Box 4 of 5)
recov. RQD
R13 64.7 → 69.9' 62" 100%
R14 69.9 → 73.3' 36" 36/41 =
R15 73.3 → 75.0' 26" 100%
R16 75.0 → 80.0' 60" 100%
R13; 64.7 → 69.5'
R13; 69.5 → 69.9'
R14; 69.9 → 73.3'
R15 73.3 → 74.1'
R15 74.1 → 75.0'
R16; 75.0 → 78.6'
R16; 78.6 → 80.0'
1R
2R →
4
R16


NECEC - Kennebec River Crossing
18-0345 11-2-18
BH-2 (Box 5 of 5)
recov. RQD
R17 80.0 → 85.0' 60" 55/60 = 92%
R18 85.0 → 90.0' 60" 100%
R19 90.0 → 94.2' 50" 44/50 = 88%
R20 94.2 → 95.0' 10" 100%
R21 95.0 → 96.5' 16" 14/18 = 78%
R22 96.5 → 100.0' 52" 47/52 = 90%
R17; 80.0 → 85.0'
R18; 85.0 → 90.0'
R19; 90.0 → 94.2'
R20; 94.2 → 95.0'
R21; 95.0 → 96.5'
R22; 96.5 → 100.0'


NECEC KRC 18-0345
BH-3
REC RQD
R-1 8.9'-10.3' 23"/1.9' 0/13 = 0
R-2 10.3-19.5 27/90 27/91 = 53
R-3 19.5-15.9 10" 0/11 = 0
R-4 15.4-19 48" 9/43 = 9
R-5 19-22.6 35" 12/43 = 30
R-6 22.6-25.9 39" 7/39 = 18
BH-3 R-1 8.9-10.3
BH-3 R-2 10.3-19.5
R2
RH3 19.5-15.4
R3
BH-3
R4 15.4-19
R4
R5 19-22.6
R5
R6 26.2-25.8
BH3 R1-R6


NECEC KENNEBEC RIVER CROSSING
18-0345 11-26-2018 BH-3
R7 25.8→29.6 REC 45°
R8 29.5→34.5 REC 47°
R9 34.5→39.5 REC 60°
R10 39.5→49.5 REC 60°
R7 25.8-29.5
R8 29.5-34.5
R9 34.5-39.5
R10 39.5-49.5
R8
R9
R10
BH3 R7-R10


NECEC - KENNEBEC RIVER CROSSING
18-0345
R11 49.5-49.5' REC 60°
R12 49.5'-59.5' REC 60°
R13 59.5'-59.5' REC 60°
R14 59.5'-61.1' REC 18°
R15 61.1'-69.5' REC 40°
R11 49.5-49.5
R12 49.5-59.5
R13 59.5-59.5
R14 59.5-61.1
R15 61.1-69.5
BH3 R11-R15
BH3 R16-R19
BH2 R20-R24
R25-R26


NECEC - KENNEBEC RIVER CROSSING
18-0375
R16 69.5-67.7 REC 37"
R17 67.7-71.5' REC 46"
R18 71.5'-76.5' REC 60"
R19 76.5'-81.5' REC 60"
R16 69.5-67.7
R17
R18
R19
71.5-76.5
76.5-81.5
BH3 R16-R19
BH2 R16-R24


NECEC KENNEBEC RIVER CROSSING
10-0315
R20 81.5 → 86.5 REC = 60"
R21 86.5 → 91.5 REC = 60"
R22 91.5 → 92.1 REC = 7"
R23 92.1 → 96.5 REC = 53"
R24 96.5 → 101.5 REC = 60"
BH-3
R20 81.5 - 86.5
R21 86.5 - 91.5
R22 91.5 - 92.1
R23
92.1 - 96.5
R23
R24
96.5 - 101.5
CONT
Next Box
BH3 R20-R24


NECEC KENNEBEC RIVER XING
BH-3
(Cont.)
R24 100→101.5 R=18"
R25 101.5→106.5 R=60"
R26 106.5→111.5 R=32"
R24 cont 96.5-101.5
R25 101.5-106.5
R25
R26 106.5-111.5


NECEC - Kennebec River Crossing
18-0345 11-5-18
BH-5
R1 24.0→27.6' recov 26" RQD 7/43 = 16%
R2 27.6→30.0' 29" 11/29 = 38%
BH-4 (Box 1 of 10)
R1 6.0→9.6' 39" 39/45 = 91%
R2 9.6→11.0' 5"
R3 11.0→11.4' 5"
R4 11.4→14.6' 38" 23/38 = 61%
BH-5; R1, 24.0→27.6'
BH-5; R2, 27.6→30.0'
BH-4; R1, 6.0→9.6'
BH-4; R2 9.6→11.0'
BH-4; R3 11.0→11.4'
BH-4; R4 11.4→12'
BH-4; R4, 12→14.6'
BH-4; R5, 14.6→17'
BH-4; R5 17→17.8'
BH-4 R6 17.8→19.6'
BH-4; R7, 19.6→21.6'
BH-4
R5 14.6→17.8' recov 38" RQD 24/38 = 63%
R6 17.8→19.6' 22" 16/22 = 73%
R7 19.6→21.6' 24" 6/24 = 25%
R2
R4
R5
R6
R7


NECEC - Kennebec River Crossing
18-0345 11-6-18
BH-4 (Box 2 of 10)
Recov. RQD
R8 21.6→24.6' 35" 24/36 = 67%
R9 24.6→28.8' 49" 46/50 = 92%
R10 28.8→31.5' 32" 16/32 = 50%
R11 31.5→34.7' 38" 0
R12 34.7→38.7' 48" 14/48 = 29%
R13 38.7→41.6' 35" 100%
R8; 21.6→24.6'
R9; 24.6→26.6'
R9; 26.6→28.8'
R10; 28.8→31.5'
R11; 31.5→34.7'
R12; 34.7→36.1'
R12; 36.1→38.7'
R13; 38.7→40.9'
R9
R10
R13


NECEC - Kennebec River Crossing
18-0345 11-6-18
BH-4 (Box 3 of 10)
Recov. RQD (38.7→40.9' in box 2)
R13 38.7→41.6' 35" 100%
R14 41.6→45.1' 42" 100%
R15 45.1→49.6' 54" 100%
R16 49.6→54.6' 60" 54/60=90%
R17 54.6→59.6' 60" 49/60=82%
R13; 40.9→41.6'
R14; 41.6→45.1'
R15; 45.1→49.6'
R16; 49.6→54.6'
R17; 54.6→59.6'


NECEC- Kennebec River Crossing
18-0345 11-6-18
BH-4 (Box 4 of 10)
RUN RQD
R18 59.6→64.6' 60" 100%
R19 64.6→69.6' 60" 30/60=50%
R20 69.6→74.6' 57" 45/60=75%
R21 74.6→79.6' 60" 100%
R18; 59.6→64.6'
R19; 64.6→69.6'
R20; 69.6→74.6'
R21; 74.6→79.6'


NECEC - Kennebec River Crossing
18-0345 11-7-18
BH-H (Box 5 of 10)
rcvr. RQD
R22; 79.6→84.6' 60" 56/60 = 93%
R23; 84.6→89.6' 60" 100%
R24; 89.6→94.6' 60" 100%
R25; 94.6→99.6' 60" 100%
R22; 79.6→84.6'
R23; 84.6→89.6'
R24; 89.6→94.6'
R25; 94.6→99.6'


NECEC - Kennebec River Crossing
18-0345 11-7-18
BH-4 (Box 6 of 10)
recov. RQD
R26; 99.6→102.5' 35" 100%
R27; 102.5→104.6' 25" 100%
R28 104.6→108.9' 51" 48/52=92%
R29 108.9→114.0' 61" 100%
R30 114.0→117.5' 42" 0%
R31 117.5→119.0' 18" 0
R26; 99.6→102.5'
R27; 102.5→104.6'
R28; 104.6→108.9'
R29; 108.9→109.6'
R29; 109.6→114.0'
R30; 114.0→114.6'
R30; 114.6→117.5'
R31; 117.5→119.0'
R27
R29
R30
R31


NECEC - Kennebec River Crossing
18-0345 11-7-18
BH-4 (Box 7 of 10)
recov. RQD
R32 119.0 → 124.2 62" 29/62 = 47%
R33 124.2 → 129.4' 62" 100%
R34 129.4 → 134.6' 62" 100%
R35 134.6 → 139.6' 60" 34/60 = 57%
(↳ 138.5 → 139.6 in box 8)
R32; 119.0 → 123.5'
R32; 123.5 → 124.2'
R33; 124.2 → 128.5'
R33; 128.5 → 129.4'
R34; 129.4 → 133.5'
R34 133.5 → 134.6'
R35; 134.6 → 138.5'
R33
R34
R35


NECEC - Kennebec River Crossing
18-0345 11-8-18
BH-4 (Box 8 of 10)
Recov. RQD
R35 134.6 → 139.6' 60" 34/60 = 57% (134.6 → 138.5' in box 7)
R36 139.6 → 144.6' 60" 58/60 = 97%
R37 144.6 → 149.6' 60" 50/60 = 83%
R38 149.6 → 154.6' 60" 56/60 = 93%
R39 154.6 → 158.5' 47" 39/47 = 83%
↳ (157.2 → 158.5' in box 9)
R35; 138.5 → 139.6'
R36; 139.6 → 143.5'
R36; 143.5 → 144.6'
R37; 144.6 → 148.5'
R37; 148.5 → 149.6'
R38; 149.6 → 153.4'
R38; 153.4 → 154.6'
R39; 154.6 → 157.2
R37
R38


NECEC- Kennebec River Crossing
18-0345 11-8-18
BH-4 (Box 9 of 10)
recov. RQD
(154.6→157.2 in box 8)
R39 154.6→158.5' 47" 39/47 = 83%
R40 158.5→161.6' 37" 100%
R41 161.6→166.6' 60" 59/60 = 98%
R42 166.6→171.6' 60" 43/60 = 72%
R43 171.6→176.6' 60" 100%
R39; 157.2→158.5' | R40; 158.5→161.6'
R41: 161.6→166.6'
R42; 166.6→171.6'
R43; 171.6'→176.6'
R40


NECEC - Kennebec River Crossing
18-0345 11-8-18
BH-4 (Box 10 of 10)
recov. RQD
R44 176.6→181.6' 60" 47/60=78%
R45 181.6→186.6' 60" 38/60=63%
R46 186.6→191.6' 60" 56/60=93%
R47 191.6→193.4' 22" 100%
R44; 176.6→181.6'
R45; 181.6→186.6'
R46; 186.6→191.6'
R47; 191.6'→193.4'


NECEC - Kennebec River Crossing
18-0345 11-5-18
BH-5
recov RQD
R1 24.0→27.6' 26" 7/43 = 16%
R2 27.6→30.0' 29" 11/29 = 38%
BH-5; R1, 24.0→27.6'
BH-5; R2, 27.6→30.0'
R2

APPENDIX D

Laboratory Geotechnical and Analytical Test Results

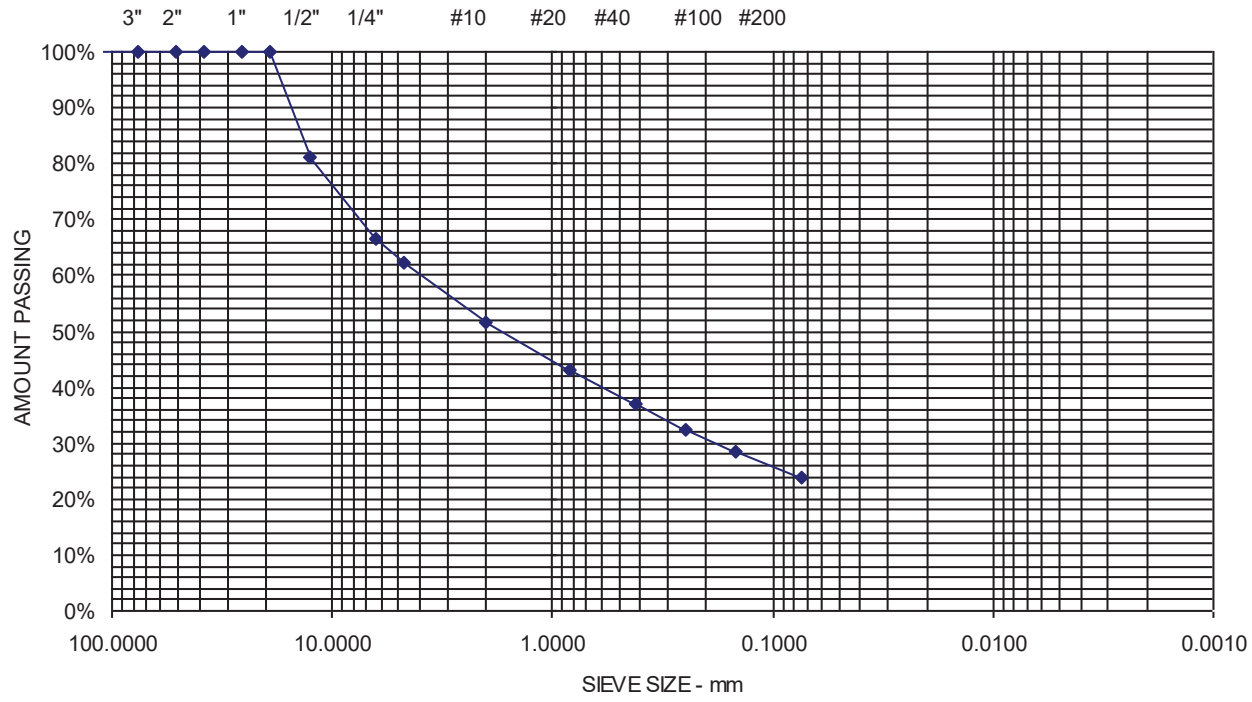
S.W.COLE ENGINEERING, INC.

Report of Gradation

ASTM C-117 & C-136

Project Name	THE FORKS ME - NEW ENGLAND CLEAN ENERGY PROJECT - KENNEBEC RIVER CROSSING - GEOTECHNICAL ENGINEERING	Project Number	18-0345
Client	CENTRAL MAINE POWER COMPANY	Lab ID	22228B
Exploration	**3D**	Date Received	11/3/2018
Material Source	**BH-1, 5-7'**	Date Completed	11/6/2018
		Tested By	THOMAS HIGGINS

STANDARD DESIGNATION (mm/µm)	SIEVE SIZE	AMOUNT PASSING (%)	
150	**6"**	**100**	
125	**5"**	**100**	
100	**4"**	**100**	
75	**3"**	**100**	
50	**2"**	**100**	
38.1	**1-1/2"**	**100**	
25.0	**1"**	**100**	
19.0	**3/4"**	**100**	
12.5	**1/2"**	**81**	
6.3	**1/4"**	**67**	
4.75	**No. 4**	**62**	37.8% Gravel
2.00	**No. 10**	**52**	
850	**No. 20**	**43**	
425	**No. 40**	**37**	38.4% Sand
250	**No. 60**	**32**	
150	**No. 100**	**29**	
75	**No. 200**	**23.8**	23.8% Fines



Comments:

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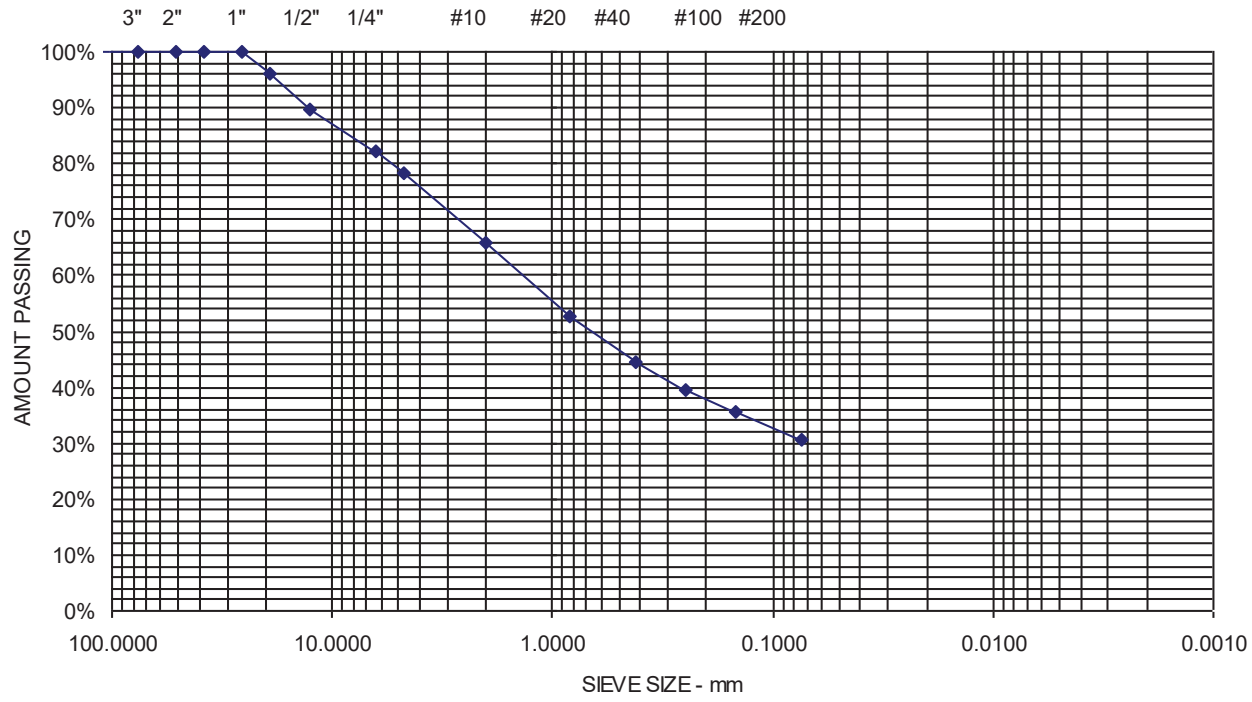
S.W.COLE ENGINEERING, INC.

Report of Gradation

ASTM C-117 & C-136

Project Name	THE FORKS ME - NEW ENGLAND CLEAN ENERGY PROJECT - KENNEBEC RIVER CROSSING - GEOTECHNICAL ENGINEERING	Project Number	18-0345
Client	CENTRAL MAINE POWER COMPANY	Lab ID	22229B
Exploration	**2D**	Date Received	11/3/2018
Material Source	**BH-2, 2-4'**	Date Completed	11/6/2018
		Tested By	THOMAS HIGGINS

STANDARD DESIGNATION (mm/µm)	SIEVE SIZE	AMOUNT PASSING (%)	
150	**6"**	**100**	
125	**5"**	**100**	
100	**4"**	**100**	
75	**3"**	**100**	
50	**2"**	**100**	
38.1	**1-1/2"**	**100**	
25.0	**1"**	**100**	
19.0	**3/4"**	**96**	
12.5	**1/2"**	**90**	
6.3	**1/4"**	**82**	
4.75	**No. 4**	**78**	21.5% Gravel
2.00	**No. 10**	**66**	
850	**No. 20**	**53**	
425	**No. 40**	**45**	47.7% Sand
250	**No. 60**	**39**	
150	**No. 100**	**35**	
75	**No. 200**	**30.7**	30.7% Fines



Comments:

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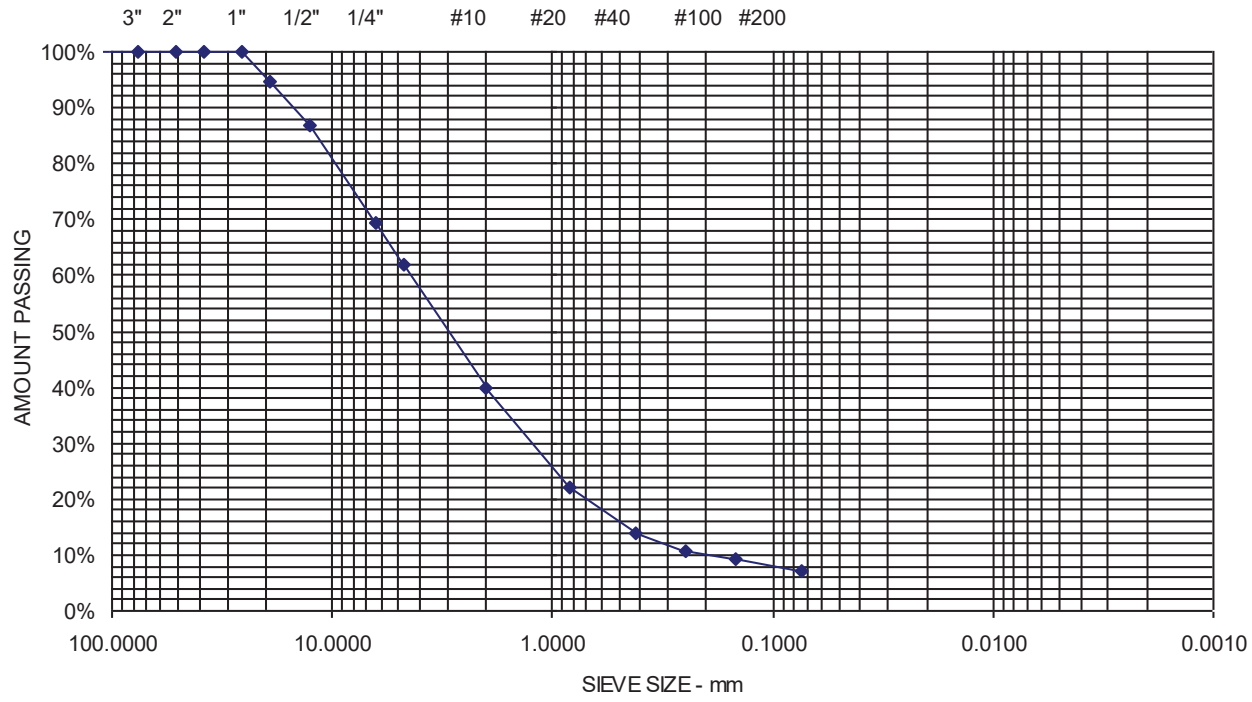
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Report of Gradation

ASTM C-117 & C-136

Project Name	THE FORKS ME - NEW ENGLAND CLEAN ENERGY PROJECT - KENNEBEC RIVER CROSSING - GEOTECHNICAL ENGINEERING	Project Number	18-0345
Client	CENTRAL MAINE POWER COMPANY	Lab ID	22272B
Exploration	**S-1**	Date Received	11/30/2018
Material Source	**BH-3, 2-5'**	Date Completed	12/3/2018
		Tested By	THOMAS HIGGINS

STANDARD DESIGNATION (mm/µm)	SIEVE SIZE	AMOUNT PASSING (%)	
150	**6"**	**100**	
125	**5"**	**100**	
100	**4"**	**100**	
75	**3"**	**100**	
50	**2"**	**100**	
38.1	**1-1/2"**	**100**	
25.0	**1"**	**100**	
19.0	**3/4"**	**95**	
12.5	**1/2"**	**87**	
6.3	**1/4"**	**69**	
4.75	**No. 4**	**62**	38.2% Gravel
2.00	**No. 10**	**40**	
850	**No. 20**	**22**	
425	**No. 40**	**14**	54.6% Sand
250	**No. 60**	**11**	
150	**No. 100**	**9**	
75	**No. 200**	**7.2**	7.2% Fines



Comments:

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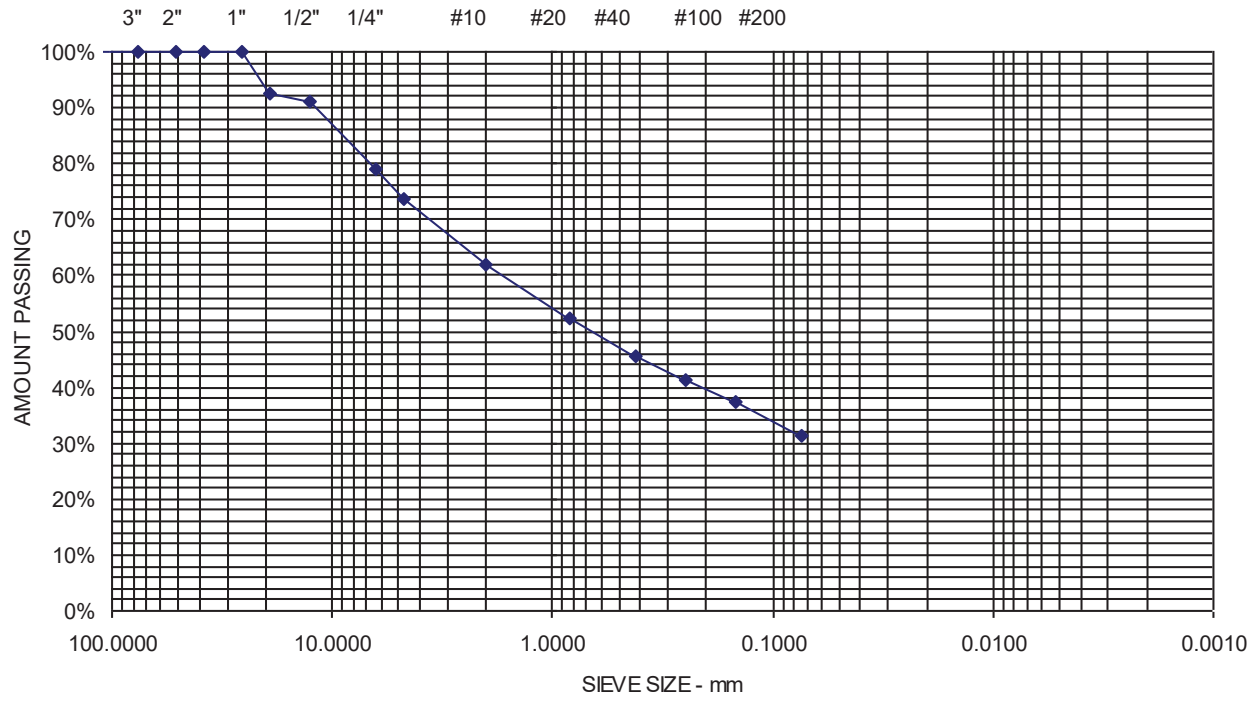
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Report of Gradation

ASTM C-117 & C-136

Project Name	THE FORKS ME - NEW ENGLAND CLEAN ENERGY PROJECT - KENNEBEC RIVER CROSSING - GEOTECHNICAL ENGINEERING	Project Number	18-0345
Client	CENTRAL MAINE POWER COMPANY	Lab ID	22236B
Exploration	**2D**	Date Received	11/10/2018
Material Source	**BH-4, 2-3.3'**	Date Completed	11/14/2018
		Tested By	SEAN GIROUX

STANDARD DESIGNATION (mm/µm)	SIEVE SIZE	AMOUNT PASSING (%)	
150	**6"**	**100**	
125	**5"**	**100**	
100	**4"**	**100**	
75	**3"**	**100**	
50	**2"**	**100**	
38.1	**1-1/2"**	**100**	
25.0	**1"**	**100**	
19.0	**3/4"**	**93**	
12.5	**1/2"**	**91**	
6.3	**1/4"**	**79**	
4.75	**No. 4**	**74**	26.4% Gravel
2.00	**No. 10**	**62**	
850	**No. 20**	**52**	
425	**No. 40**	**46**	42.1% Sand
250	**No. 60**	**41**	
150	**No. 100**	**37**	
75	**No. 200**	**31.4**	31.4% Fines



Comments:

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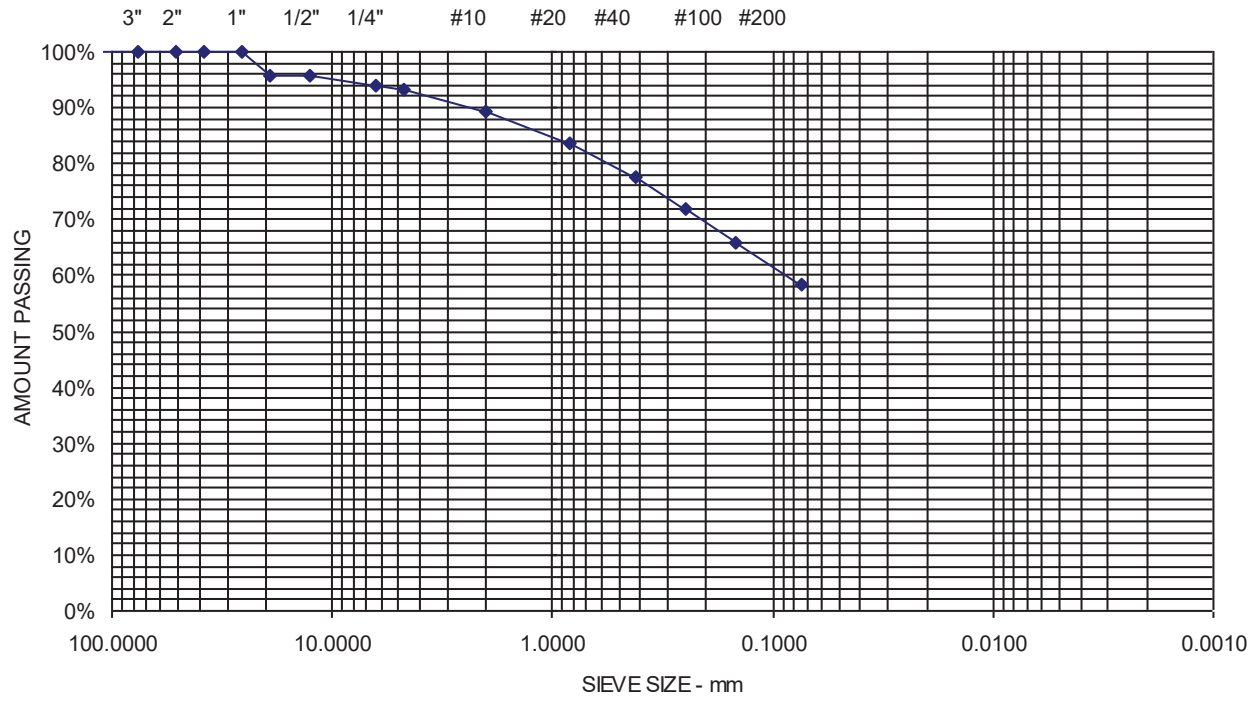
S.W.COLE ENGINEERING, INC.

Report of Gradation

ASTM C-117 & C-136

Project Name	THE FORKS ME - NEW ENGLAND CLEAN ENERGY PROJECT - KENNEBEC RIVER CROSSING - GEOTECHNICAL ENGINEERING	Project Number	18-0345
Client	CENTRAL MAINE POWER COMPANY	Lab ID	22230B
Exploration	**4D**	Date Received	11/3/2018
Material Source	**BH-5, 10-12'**	Date Completed	11/6/2018
		Tested By	SEAN GIROUX

STANDARD DESIGNATION (mm/µm)	SIEVE SIZE	AMOUNT PASSING (%)	
150	**6"**	**100**	
125	**5"**	**100**	
100	**4"**	**100**	
75	**3"**	**100**	
50	**2"**	**100**	
38.1	**1-1/2"**	**100**	
25.0	**1"**	**100**	
19.0	**3/4"**	**96**	
12.5	**1/2"**	**96**	
6.3	**1/4"**	**94**	
4.75	**No. 4**	**93**	6.9% Gravel
2.00	**No. 10**	**89**	
850	**No. 20**	**84**	
425	**No. 40**	**77**	34.9% Sand
250	**No. 60**	**72**	
150	**No. 100**	**66**	
75	**No. 200**	**58.2**	58.2% Fines



Comments:

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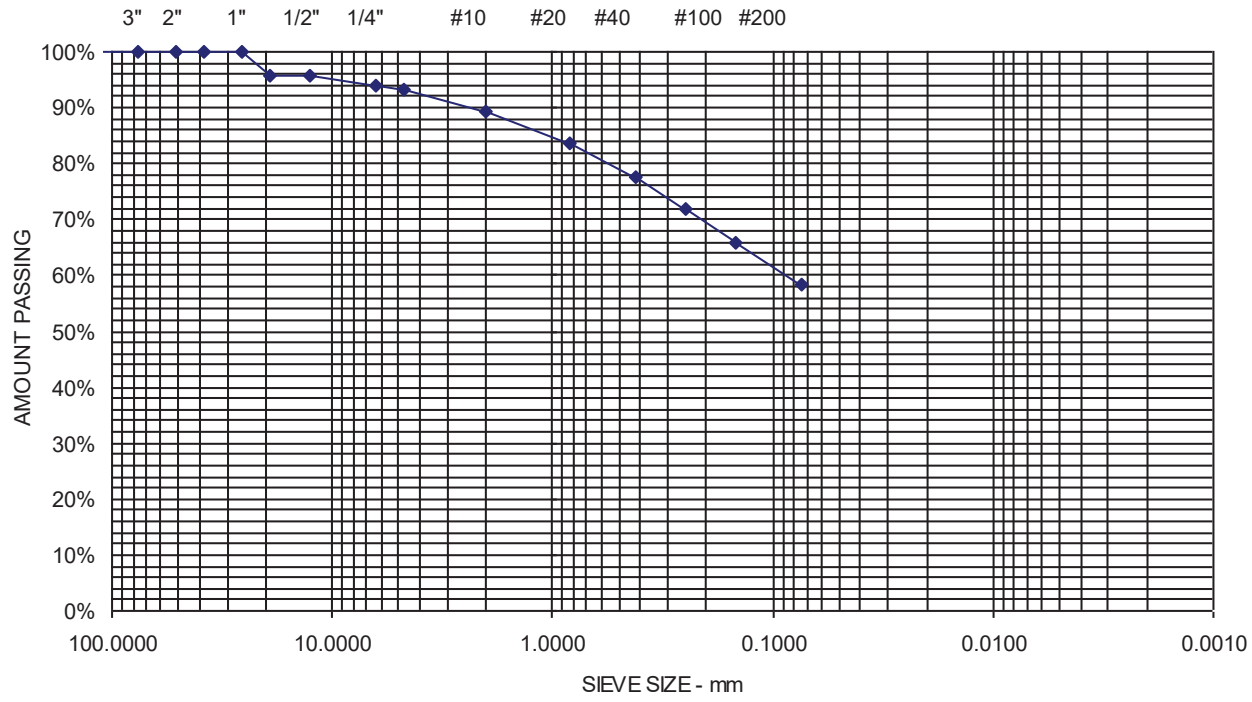
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Report of Gradation

ASTM C-117 & C-136

Project Name	THE FORKS ME - NEW ENGLAND CLEAN ENERGY PROJECT - KENNEBEC RIVER CROSSING - GEOTECHNICAL ENGINEERING	Project Number	18-0345
Client	CENTRAL MAINE POWER COMPANY	Lab ID	22230B
Exploration	**4D**	Date Received	11/3/2018
Material Source	**BH-5, 10-12'**	Date Completed	11/6/2018
		Tested By	SEAN GIROUX

STANDARD DESIGNATION (mm/µm)	SIEVE SIZE	AMOUNT PASSING (%)	
150	**6"**	**100**	
125	**5"**	**100**	
100	**4"**	**100**	
75	**3"**	**100**	
50	**2"**	**100**	
38.1	**1-1/2"**	**100**	
25.0	**1"**	**100**	
19.0	**3/4"**	**96**	
12.5	**1/2"**	**96**	
6.3	**1/4"**	**94**	
4.75	**No. 4**	**93**	6.9% Gravel
2.00	**No. 10**	**89**	
850	**No. 20**	**84**	
425	**No. 40**	**77**	34.9% Sand
250	**No. 60**	**72**	
150	**No. 100**	**66**	
75	**No. 200**	**58.2**	58.2% Fines



Comments:

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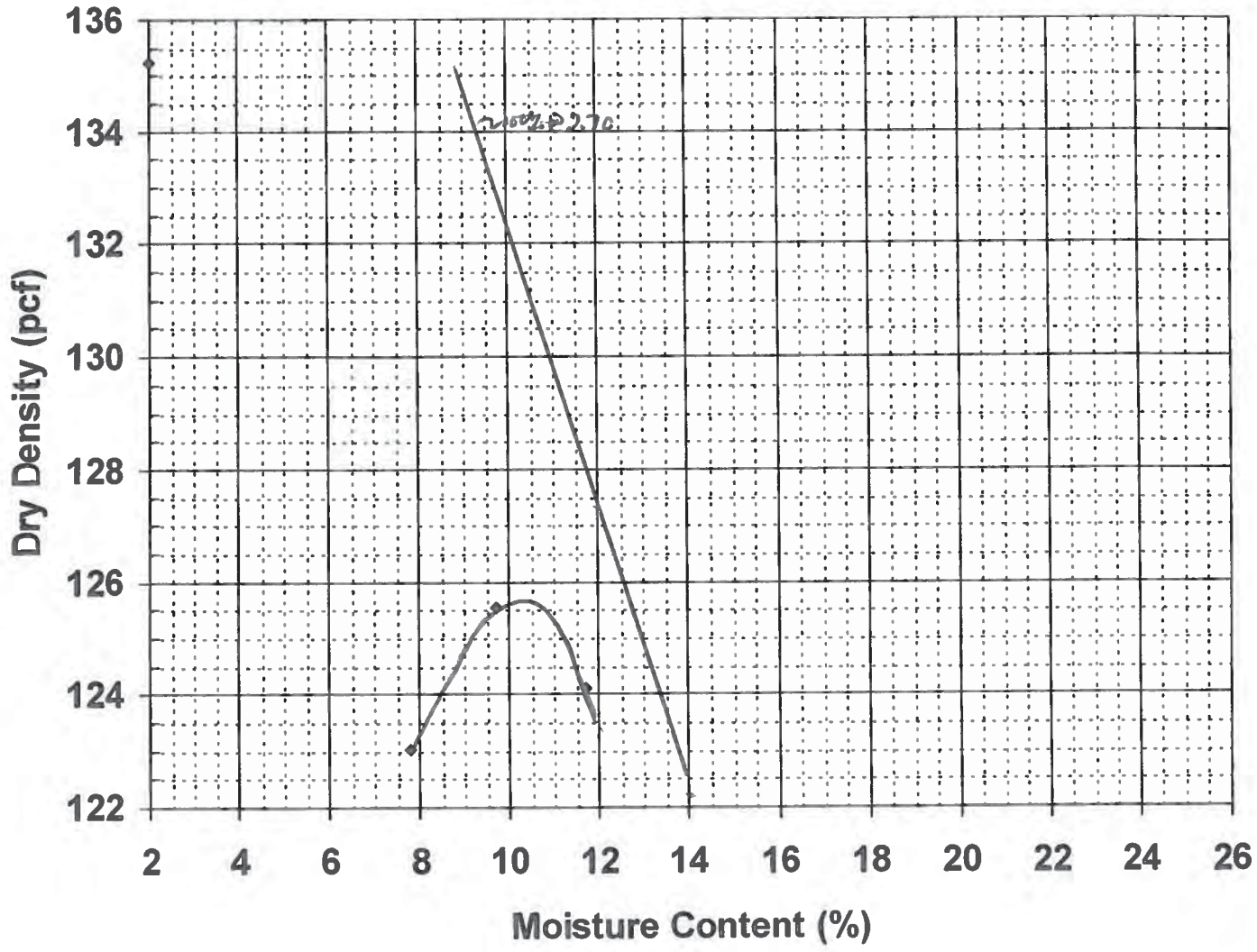
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Report of Moisture-Density

Method ASTM D-698 STANDARD Procedure A

Project Name	THE FORKS ME - NEW ENGLAND CLEAN ENERGY PROJECT - KENNEBEC RIVER CROSSING - GEOTECHNICAL	Project Number	18-0345
		Lab ID	22221B
Client	CENTRAL MAINE POWER COMPANY	Date Received	11/1/2018
Material Type	GLACIAL TILL	Date Completed	11/2/2018
Material Source	BH-2, 1 - 8'	Tested By	CHRISTOPHER RAYMOND

Moisture-Density Relationship Curve



Maximum Dry Density (pcf)	125.6
Optimum Moisture Content (%)	10.4
Percent Oversized	13.1%

Corrected Dry Density (pcf)	**129**
Corrected Moisture Content (%)	**9.3**

Comments

Thomas J. Higgins

37 Liberty Drive, Bangor, ME 04401-5874 • Tel (207) 848-6029 • Fax (207) 848-2403 • www.swcole.com

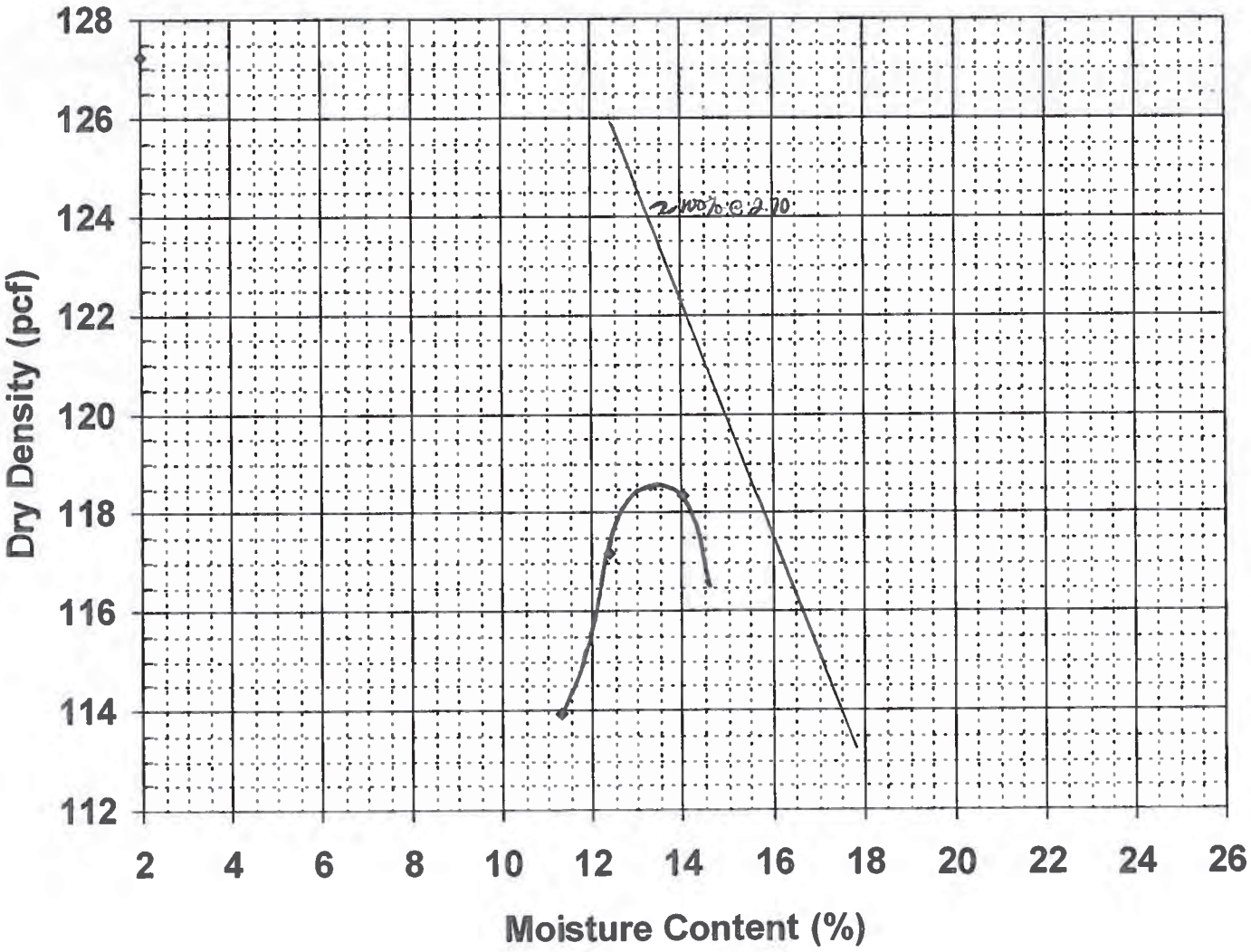
S.W.COLE ENGINEERING, INC.

Report of Moisture-Density

Method ASTM D-698 STANDARD Procedure C

Project Name	THE FORKS ME - NEW ENGLAND CLEAN ENERGY PROJECT - KENNEBEC RIVER CROSSING - GEOTECHNICAL	Project Number	18-0345
Client	CENTRAL MAINE POWER COMPANY	Lab ID	22237B
Material Type	GLACIAL TILL	Date Received	11/10/2018
Material Source	BH-4, 1-2.5'	Date Completed	11/14/2018
		Tested By	STEPHEN PHILBROOK

Moisture-Density Relationship Curve



Maximum Dry Density (pcf)	118.6
Optimum Moisture Content (%)	13.4
Percent Oversized	9.2%

Corrected Dry Density (pcf)	**121.3**
Corrected Moisture Content (%)	**12.4**

Comments

Thomas J. Higgins

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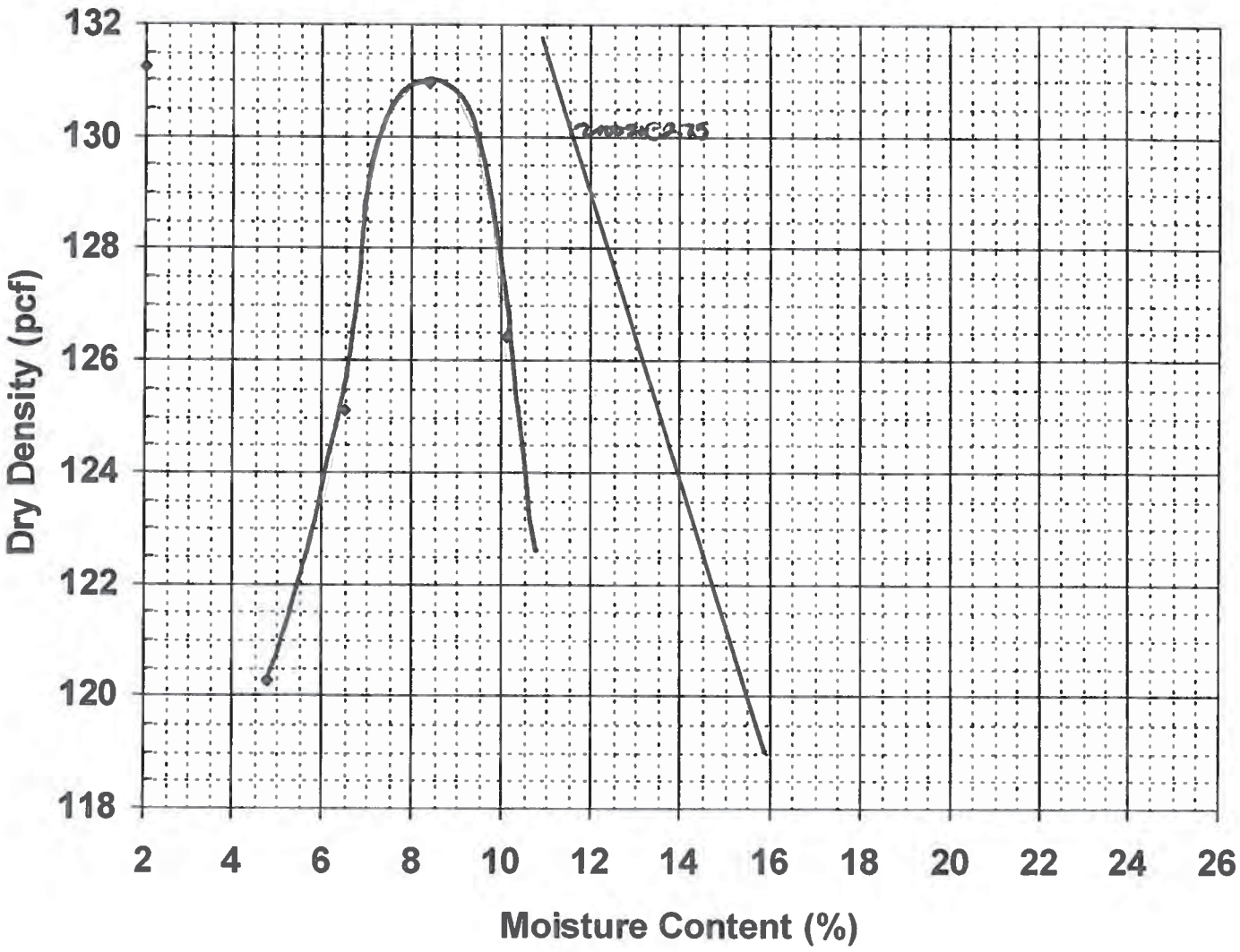
S.W.COLE ENGINEERING, INC.

Report of Moisture-Density

Method ASTM D-698 STANDARD Procedure A

Project Name	THE FORKS ME - NEW ENGLAND CLEAN ENERGY PROJECT - KENNEBEC RIVER CROSSING - GEOTECHNICAL	Project Number	18-0345
Client	CENTRAL MAINE POWER COMPANY	Lab ID	22231B
Material Type	GLACIAL TILL	Date Received	11/3/2018
Material Source	BH-5, 5 - 10'	Date Completed	11/6/2018
		Tested By	CHRISTOPHER RAYMOND

Moisture-Density Relationship Curve



Maximum Dry Density (pcf)	131
Optimum Moisture Content (%)	8.5
Percent Oversized	11.5%

Corrected Dry Density (pcf)	**133.6**
Corrected Moisture Content (%)	**7.8**

Comments

Thomas J. Higgins

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Transmittal

TO:

Paul Kohler

S.W. Cole Engineering, Inc.

286 Portland Road

Gray, ME 04039-9586

DATE: 12/26/2018	GTX NO: 309265
RE: NECEC/KRC	

COPIES	DATE	DESCRIPTION
	12/26/2018	**December 2018 Laboratory Test Report**

REMARKS:

SIGNED:

CC:

Jonathan Campbell, Assistant Laboratory Manager

APPROVED BY:

Mark Dobday, P.G., Laboratory Manager

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December 26, 2018

Paul Kohler
S.W. Cole Engineering, Inc.
286 Portland Road
Gray, ME 04039-9586

RE: NECEC/KRC, Maine (GTX-309265)

Dear Paul:

Enclosed are the test results you requested for the above referenced project. GeoTesting Express, Inc. (GTX) received 11 samples from you on 12/7/2018. These samples were labeled as follows:

Boring Number	Sample Number	Depth
R5	BH-1	19.1-20.5 ft
R9	BH-2	46.1-47.4 ft
R11	BH-2	54.5-55.8 ft
R14	BH-2	69.9-70.8 ft
R19	BH-3	79.2-81 ft
R21	BH-3	90.3-91.2 ft
R24	BH-3	100-101.1 ft
R26	BH-3	110-111.3 ft
R37	BH-4	46.8-48.5 ft
R40	BH-4	160.3-161.6 ft
R43	BH-4	174.9-175.7 ft

GTX performed the following tests on these samples:

10 ASTM D7012 Method C- Uniaxial Compressive Strength of Rock

Sample BH-2, R14, 69.9-70.8 ft fell apart during preparation. The assigned compression test could not be performed.

A copy of your test request is attached.

The results presented in this report apply only to the items tested. This report shall not be reproduced except in full, without written approval from GeoTesting Express. The remainder of these samples will be retained for a period of sixty (60) days and will then be discarded unless otherwise notified by you. Please call me if you have any questions or require additional information. Thank you for allowing GeoTesting Express the opportunity of providing you with testing services. We look forward to working with you again in the future.

Respectfully yours,



Jonathan Campbell
Assistant Laboratory Manager

GeoTesting EXPRESS

Technologies to manage risk for infrastructure

Boston
Atlanta
Chicago
Los Angeles
New York

www.geotesting.com

Geotechnical Test Report **12/26/2018**

GTX-309265

NECEC/KRC

Maine

Client Project No.: 18-0345

Prepared for:

S.W. Cole Engineering, Inc.

Client:	S.W. Cole Engineering, Inc.				
Project:	NECEC/KRC				
Location:	Maine			Project No:	GTX-309265
Boring ID:	---	Sample Type:	---	Tested By:	smd
Sample ID:	---	Test Date:	12/26/18	Checked By:	jsc
Depth :	---	Test Id:	484987		

Bulk Density and Compressive Strength of Rock Core Specimens by ASTM D7012 Method C

Boring ID	Sample Number	Depth	Bulk Density, pcf	Compressive strength, psi	Failure Type	Meets ASTM D4543	Note(s)
R5	BH-1	19.1-20.5	171	4376	2	Yes	---
R9	BH-2	46.21-46.60	170	5288	3	Yes	---
R11	BH-2	54.71-55.11	172	8494	3	Yes	---
R19	BH-3	79.67-80.09	170	17872	3	Yes	---
R21	BH-3	90.33-90.71	169	8376	3	Yes	---
R24	BH-3	100.36-100.78	168	8529	3	No	2,*
R43	BH-4	174.99-175.38	169	7514	3	Yes	---

Notes: Density determined on core samples by measuring dimensions and weight and then calculating.

All specimens tested at the approximate as-received moisture content and at standard laboratory temperature.

The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.

Failure Type: 1 = Intact Material Failure; 2 = Discontinuity Failure; 3 = Intact Material and Discontinuity Failure (See attached photographs)

1: Best effort end preparation. See Tolerance report for details.
2: The as-received core did not meet the ASTM side straightness tolerance due to irregularities in the sample as cored.
3: Specimen L/D < 2.
4: The as-received core did not meet the ASTM minimum diameter tolerance of 1.875 inches.
5: Specimen diameter is less than 10 times maximum particle size.
6: Specimen diameter is less than 6 times maximum particle size.

*Because the indicated tested specimens did not meet the ASTM D4543 standard tolerances, the results reported here may differ from those for a test specimen within tolerances.

Client:	S.W. Cole Engineering, Inc.				
Project:	NECEC/KRC				
Location:	Maine			Project No:	GTX-309265
Boring ID:	---	Sample Type:	---	Tested By:	smd
Sample ID:	---	Test Date:	12/26/18	Checked By:	jsc
Depth :	---	Test Id:	484986		

Bulk Density and Compressive Strength of Rock Core Specimens by ASTM D7012 Method C

Boring ID	Sample Number	Depth	Bulk Density, pcf	Compressive strength, psi	Failure Type	Meets ASTM D4543	Note(s)
R26	BH-3	110.25-110.65	169	12949	3	Yes	---
R37	BH-4	46.92-47.33	174	14526	3	Yes	---
R40	BH-4	160.66-161.06	168	12715	3	Yes	---

Notes: Density determined on core samples by measuring dimensions and weight and then calculating.

All specimens tested at the approximate as-received moisture content and at standard laboratory temperature.

The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.

Failure Type: 1 = Intact Material Failure; 2 = Discontinuity Failure; 3 = Intact Material and Discontinuity Failure (See attached photographs)

Client:	S.W. Cole Engineering, Inc.	Test Date:	12/17/2018
Project Name:	NECEC/KRC	Tested By:	cmh
Project Location:	Maine	Checked By:	jsc
GTX #:	309265		
Boring ID:	R5		
Sample ID:	BH-1		
Depth:	19.1-20.5 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.54	4.54	4.54
Specimen Diameter, in:	2.00	2.00	2.00
Specimen Mass, g:	641.6		
Bulk Density, lb/ft^3	171	**Minimum Diameter Tolerence Met?**	YES
Length to Diameter Ratio:	2.3	**Length to Diameter Ratio Tolerance Met?**	YES

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? YES

END FLATNESS AND PARALLELISM (Procedure FP1)

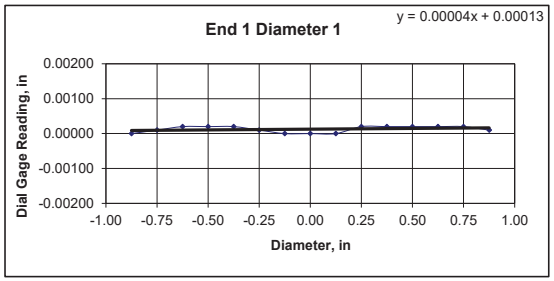
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00000	0.00010	0.00020	0.00020	0.00020	0.00010	0.00000	0.00000	0.00000	0.00020	0.00020	0.00020	0.00020	0.00020	0.00010
Diameter 2, in (rotated 90°)	0.00010	0.00010	0.00030	0.00010	0.00020	0.00020	0.00020	0.00000	0.00000	0.00020	0.00020	0.00010	0.00010	0.00030	0.00000

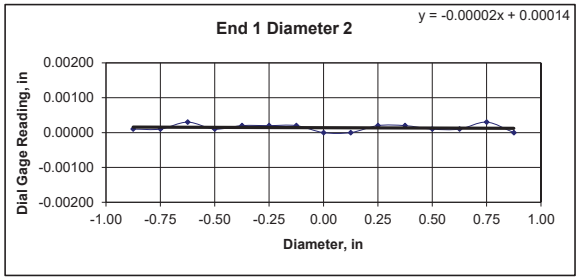
Difference between max and min readings, in:
0° = 0.00020 90° = 0.00030

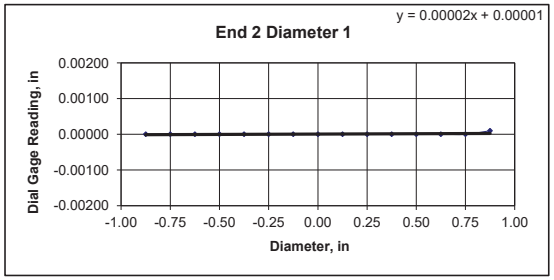
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00010
Diameter 2, in (rotated 90°)	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	0.00000	-0.00010	-0.00010	-0.00010	-0.00010

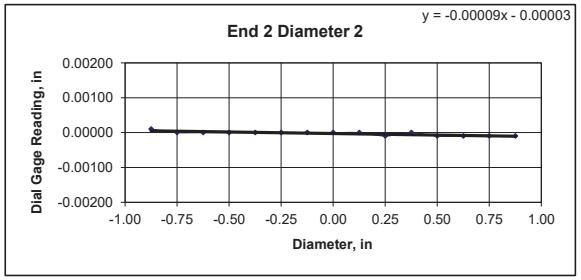
Difference between max and min readings, in:
0° = 0.0001 90° = 0.0002

Maximum difference must be < 0.0020 in. Difference = ± 0.00015
Flatness Tolerance Met? YES









DIAMETER 1

End 1:
Slope of Best Fit Line 0.00004
Angle of Best Fit Line: 0.00246

End 2:
Slope of Best Fit Line 0.00002
Angle of Best Fit Line: 0.00115

Maximum Angular Difference: 0.00131

Parallelism Tolerance Met? YES
Spherically Seated

DIAMETER 2

End 1:
Slope of Best Fit Line 0.00002
Angle of Best Fit Line: 0.00115

End 2:
Slope of Best Fit Line 0.00009
Angle of Best Fit Line: 0.00507

Maximum Angular Difference: 0.00393

Parallelism Tolerance Met? YES
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00020	2.000	0.00010	0.006	YES
Diameter 2, in (rotated 90°)	0.00030	2.000	0.00015	0.009	YES
END 2					
Diameter 1, in	0.00010	2.000	0.00005	0.003	YES
Diameter 2, in (rotated 90°)	0.00020	2.000	0.00010	0.006	YES

Maximum angle of departure must be ≤ 0.25°
Perpendicularity Tolerance Met? YES

Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Test Date:	12/24/2018
Tested By:	cmh
Checked By:	jsc
Boring ID:	R5
Sample ID:	BH-1
Depth, ft:	19.1-20.5



After cutting and grinding



After break

Client:	S.W. Cole Engineering, Inc.	Test Date:	12/17/2018
Project Name:	NECEC/KRC	Tested By:	cmh
Project Location:	Maine	Checked By:	jsc
GTX #:	309265		
Boring ID:	R9		
Sample ID:	BH-2		
Depth:	46.21-46.60 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.48	4.48	4.48
Specimen Diameter, in:	2.00	2.00	2.00
Specimen Mass, g:	627.37		
Bulk Density, lb/ft^3	170	**Minimum Diameter Tolerence Met?**	YES
Length to Diameter Ratio:	2.2	**Length to Diameter Ratio Tolerance Met?**	YES

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? YES

END FLATNESS AND PARALLELISM (Procedure FP1)

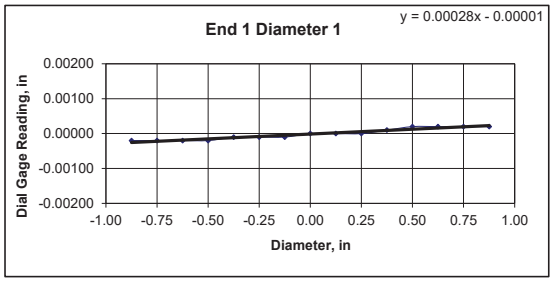
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00020	-0.00020	-0.00020	-0.00020	-0.00010	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00010	0.00020	0.00020	0.00020	0.00020
Diameter 2, in (rotated 90°)	0.00020	0.00010	0.00010	0.00010	0.00020	0.00020	0.00020	0.00000	0.00010	0.00010	0.00010	0.00010	0.00010	0.00000	0.00000

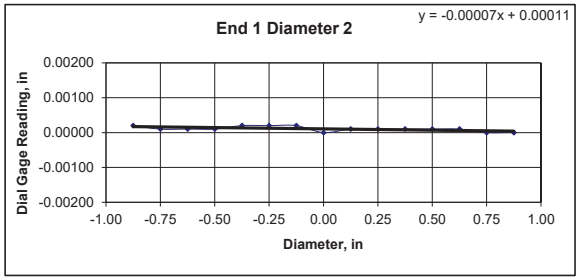
Difference between max and min readings, in:
0° = 0.00040 90° = 0.00020

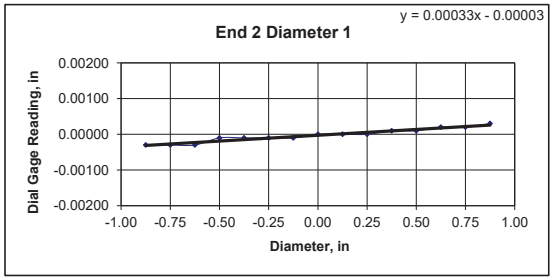
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00030	-0.00030	-0.00030	-0.00010	-0.00010	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00010	0.00010	0.00020	0.00020	0.00030
Diameter 2, in (rotated 90°)	-0.00010	0.00010	0.00010	0.00000	-0.00010	0.00000	0.00000	0.00000	0.00000	-0.00010	0.00000	0.00000	0.00000	-0.00010	-0.00020

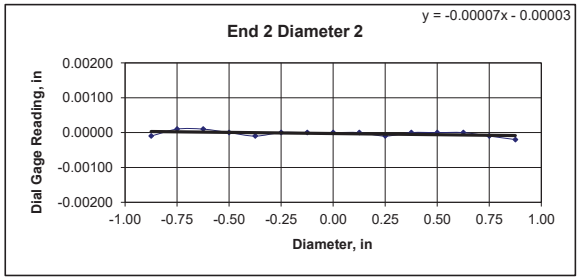
Difference between max and min readings, in:
0° = 0.0006 90° = 0.0003

Maximum difference must be < 0.0020 in. Difference = ± 0.00030
Flatness Tolerance Met? YES









DIAMETER 1

End 1:
Slope of Best Fit Line 0.00028
Angle of Best Fit Line: 0.01588

End 2:
Slope of Best Fit Line 0.00033
Angle of Best Fit Line: 0.01866

Maximum Angular Difference: 0.00278

Parallelism Tolerance Met? YES
Spherically Seated

DIAMETER 2

End 1:
Slope of Best Fit Line 0.00007
Angle of Best Fit Line: 0.00426

End 2:
Slope of Best Fit Line 0.00007
Angle of Best Fit Line: 0.00377

Maximum Angular Difference: 0.00049

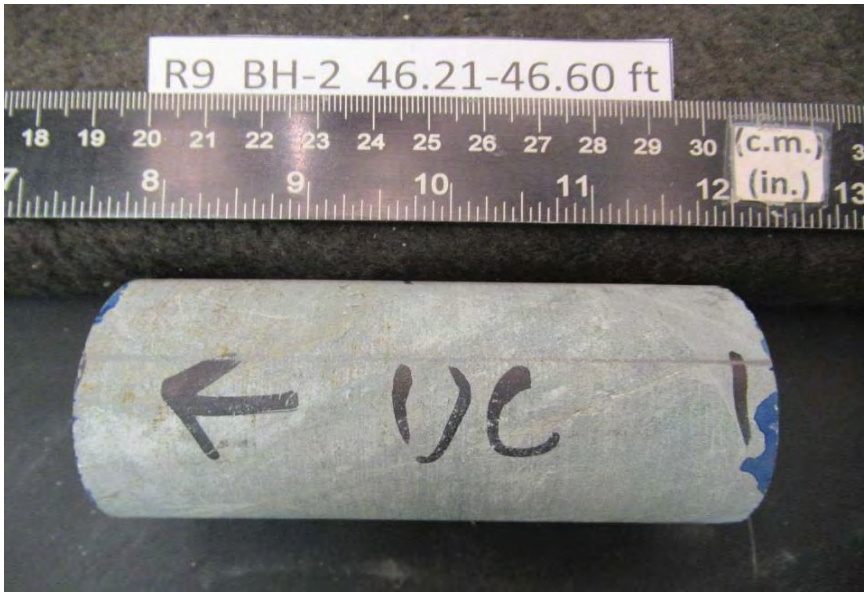
Parallelism Tolerance Met? YES
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00040	2.000	0.00020	0.011	YES
Diameter 2, in (rotated 90°)	0.00020	2.000	0.00010	0.006	YES
END 2					
Diameter 1, in	0.00060	2.000	0.00030	0.017	YES
Diameter 2, in (rotated 90°)	0.00030	2.000	0.00015	0.009	YES

Maximum angle of departure must be ≤ 0.25°
Perpendicularity Tolerance Met? YES

Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Test Date:	12/24/2018
Tested By:	cmh
Checked By:	jsc
Boring ID:	R9
Sample ID:	BH-2
Depth, ft:	46.21-46.60



After cutting and grinding



After break

Client:	S.W. Cole Engineering, Inc.	Test Date:	12/17/2018
Project Name:	NECEC/KRC	Tested By:	cmh
Project Location:	Maine	Checked By:	jsc
GTX #:	309265		
Boring ID:	R11		
Sample ID:	BH-2		
Depth:	54.71-55.11 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.52	4.52	4.52
Specimen Diameter, in:	2.00	2.00	2.00
Specimen Mass, g:	641.27		
Bulk Density, lb/ft^3	172	**Minimum Diameter Tolerence Met?**	YES
Length to Diameter Ratio:	2.3	**Length to Diameter Ratio Tolerance Met?**	YES

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? YES

END FLATNESS AND PARALLELISM (Procedure FP1)

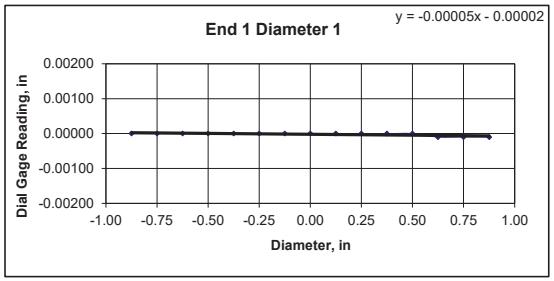
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00010
Diameter 2, in (rotated 90°)	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010

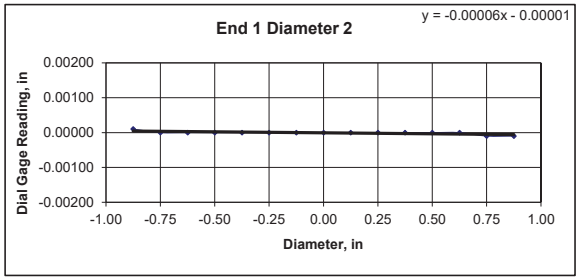
Difference between max and min readings, in:
0° = 0.00010 90° = 0.00020

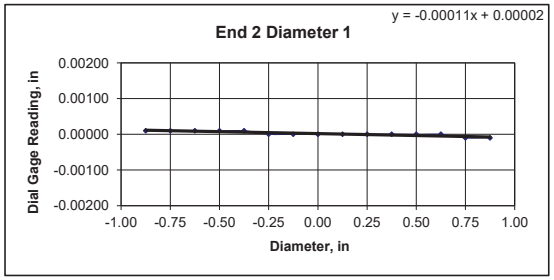
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00010	0.00010	0.00010	0.00010	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010
Diameter 2, in (rotated 90°)	0.00010	0.00010	0.00010	0.00010	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00020

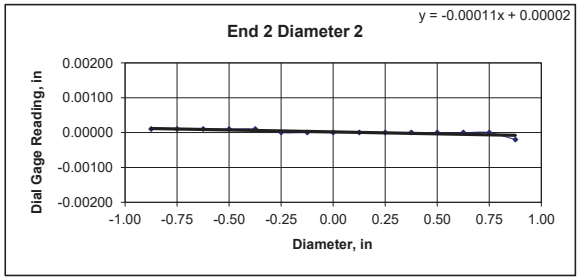
Difference between max and min readings, in:
0° = 0.0002 90° = 0.0003

Maximum difference must be < 0.0020 in. Difference = ± 0.00015
Flatness Tolerance Met? YES









DIAMETER 1

End 1:
Slope of Best Fit Line 0.00005
Angle of Best Fit Line: 0.00295

End 2:
Slope of Best Fit Line 0.00011
Angle of Best Fit Line: 0.00622

Maximum Angular Difference: 0.00327

Parallelism Tolerance Met? YES
Spherically Seated

DIAMETER 2

End 1:
Slope of Best Fit Line 0.00006
Angle of Best Fit Line: 0.00327

End 2:
Slope of Best Fit Line 0.00011
Angle of Best Fit Line: 0.00638

Maximum Angular Difference: 0.00311

Parallelism Tolerance Met? YES
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00010	2.000	0.00005	0.003	YES
Diameter 2, in (rotated 90°)	0.00020	2.000	0.00010	0.006	YES
END 2					
Diameter 1, in	0.00020	2.000	0.00010	0.006	YES
Diameter 2, in (rotated 90°)	0.00030	2.000	0.00015	0.009	YES

Maximum angle of departure must be ≤ 0.25°
Perpendicularity Tolerance Met? YES

Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Test Date:	12/24/2018
Tested By:	cmh
Checked By:	jsc
Boring ID:	R11
Sample ID:	BH-2
Depth, ft:	54.71-55.11



After cutting and grinding



After break

Client:	S.W. Cole Engineering, Inc.	Test Date:	12/17/2018
Project Name:	NECEC/KRC	Tested By:	cmh
Project Location:	Maine	Checked By:	jsc
GTX #:	309265		
Boring ID:	R19		
Sample ID:	BH-3		
Depth:	79.67-80.09 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.63	4.63	4.63
Specimen Diameter, in:	1.99	1.99	1.99
Specimen Mass, g:	640.85		
Bulk Density, lb/ft^3	170	**Minimum Diameter Tolerence Met?**	YES
Length to Diameter Ratio:	2.3	**Length to Diameter Ratio Tolerance Met?**	YES

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? YES

END FLATNESS AND PARALLELISM (Procedure FP1)

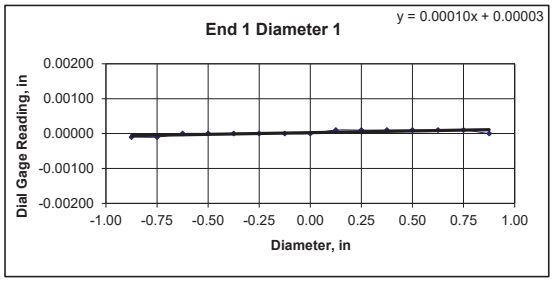
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00000
Diameter 2, in (rotated 90°)	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010

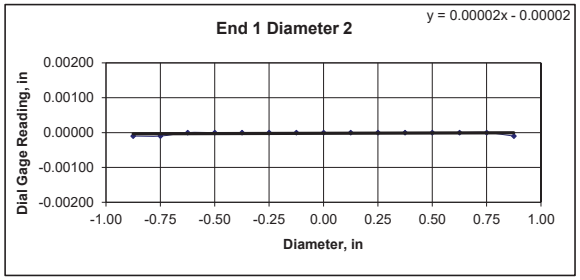
Difference between max and min readings, in:
0° = 0.00020 90° = 0.00010

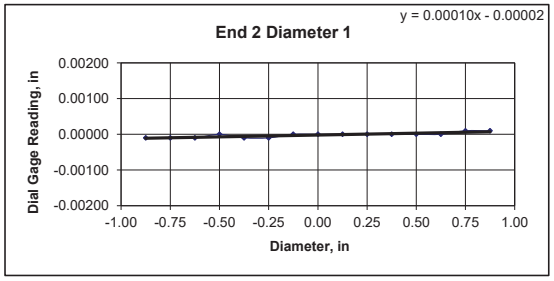
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00010	-0.00010	-0.00010	0.00000	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00010	0.00010
Diameter 2, in (rotated 90°)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

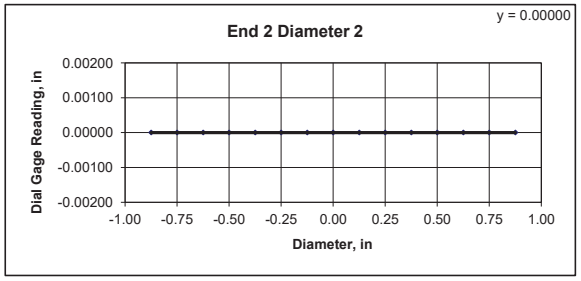
Difference between max and min readings, in:
0° = 0.0002 90° = 0

Maximum difference must be < 0.0020 in. Difference = ± 0.00010
Flatness Tolerance Met? YES









DIAMETER 1

End 1:
Slope of Best Fit Line 0.00010
Angle of Best Fit Line: 0.00557

End 2:
Slope of Best Fit Line 0.00010
Angle of Best Fit Line: 0.00589

Maximum Angular Difference: 0.00033

Parallelism Tolerance Met? YES
Spherically Seated

DIAMETER 2

End 1:
Slope of Best Fit Line 0.00002
Angle of Best Fit Line: 0.00098

End 2:
Slope of Best Fit Line 0.00000
Angle of Best Fit Line: 0.00000

Maximum Angular Difference: 0.00098

Parallelism Tolerance Met? YES
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00020	1.990	0.00010	0.006	YES
Diameter 2, in (rotated 90°)	0.00010	1.990	0.00005	0.003	YES
END 2					
Diameter 1, in	0.00020	1.990	0.00010	0.006	YES
Diameter 2, in (rotated 90°)	0.00000	1.990	0.00000	0.000	YES

Maximum angle of departure must be ≤ 0.25°
Perpendicularity Tolerance Met? YES

Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Test Date:	12/24/2018
Tested By:	cmh
Checked By:	jsc
Boring ID:	R19
Sample ID:	BH-3
Depth, ft:	79.67-80.09



After cutting and grinding



After break

Client:	S.W. Cole Engineering, Inc.	Test Date:	12/17/2018
Project Name:	NECEC/KRC	Tested By:	cmh
Project Location:	Maine	Checked By:	jsc
GTX #:	309265		
Boring ID:	R21		
Sample ID:	BH-3		
Depth:	90.33-90.71 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.47	4.47	4.47
Specimen Diameter, in:	1.99	1.99	1.99
Specimen Mass, g:	617.77		
Bulk Density, lb/ft^3	169	**Minimum Diameter Tolerence Met?**	YES
Length to Diameter Ratio:	2.2	**Length to Diameter Ratio Tolerance Met?**	YES

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? YES

END FLATNESS AND PARALLELISM (Procedure FP1)

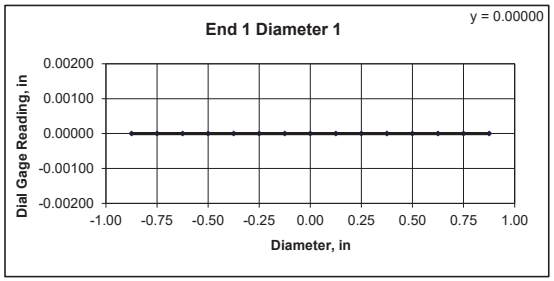
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Diameter 2, in (rotated 90°)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00010	-0.00010	-0.00010

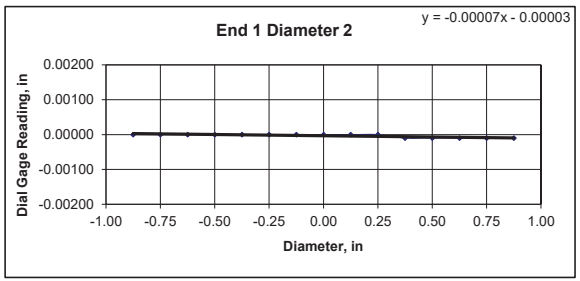
Difference between max and min readings, in:
0° = 0.00000 90° = 0.00010

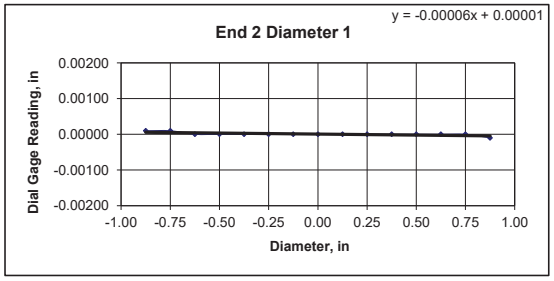
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00010	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010
Diameter 2, in (rotated 90°)	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00010

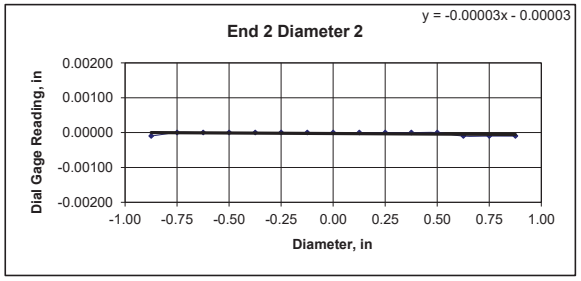
Difference between max and min readings, in:
0° = 0.0002 90° = 0.0001

Maximum difference must be < 0.0020 in. Difference = ± 0.00010
Flatness Tolerance Met? YES









DIAMETER 1

End 1:
Slope of Best Fit Line 0.00000
Angle of Best Fit Line: 0.00000

End 2:
Slope of Best Fit Line 0.00006
Angle of Best Fit Line: 0.00327

Maximum Angular Difference: 0.00327

Parallelism Tolerance Met? YES
Spherically Seated

DIAMETER 2

End 1:
Slope of Best Fit Line 0.00007
Angle of Best Fit Line: 0.00409

End 2:
Slope of Best Fit Line 0.00003
Angle of Best Fit Line: 0.00180

Maximum Angular Difference: 0.00229

Parallelism Tolerance Met? YES
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00000	1.990	0.00000	0.000	YES
Diameter 2, in (rotated 90°)	0.00010	1.990	0.00005	0.003	YES
END 2					
Diameter 1, in	0.00020	1.990	0.00010	0.006	YES
Diameter 2, in (rotated 90°)	0.00010	1.990	0.00005	0.003	YES

Maximum angle of departure must be ≤ 0.25°
Perpendicularity Tolerance Met? YES

Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Test Date:	12/24/2018
Tested By:	cmh
Checked By:	jsc
Boring ID:	R21
Sample ID:	BH-3
Depth, ft:	90.33-90.71



After cutting and grinding



After break

Client:	S.W. Cole Engineering, Inc.	Test Date:	12/24/2018
Project Name:	NECEC/KRC	Tested By:	cmh
Project Location:	Maine	Checked By:	jsc
GTX #:	309265		
Boring ID:	R24		
Sample ID:	BH-3		
Depth:	100.36-100.78 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.60	4.60	4.60
Specimen Diameter, in:	1.99	1.99	1.99
Specimen Mass, g:	629.88		
Bulk Density, lb/ft^3	168	**Minimum Diameter Tolerence Met?**	YES
Length to Diameter Ratio:	2.3	**Length to Diameter Ratio Tolerance Met?**	YES

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? NO

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? NO

END FLATNESS AND PARALLELISM (Procedure FP1)

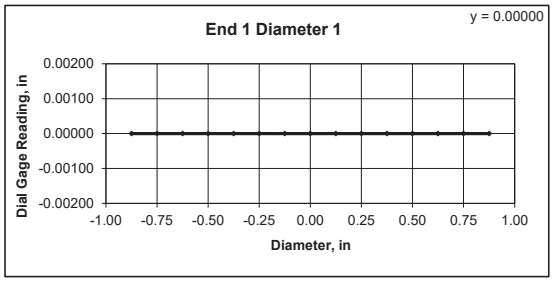
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Diameter 2, in (rotated 90°)	-0.00010	-0.00010	0.00000	0.00010	0.00000	0.00010	0.00010	0.00000	0.00000	0.00010	0.00010	0.00000	0.00000	-0.00010	-0.00010

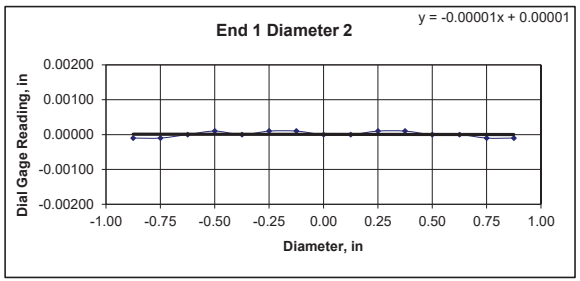
Difference between max and min readings, in:
0° = 0.00000 90° = 0.00020

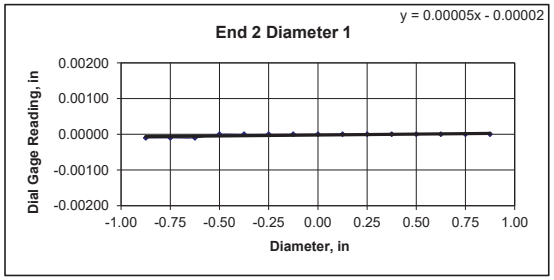
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00010	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Diameter 2, in (rotated 90°)	-0.00010	-0.00020	-0.00020	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00010	-0.00010	-0.00010	-0.00010

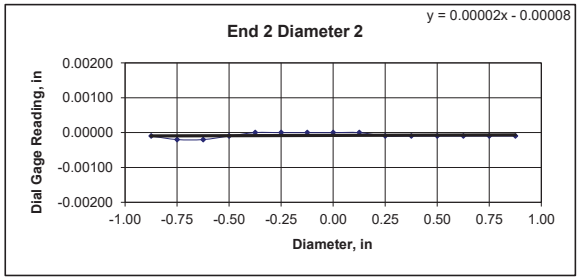
Difference between max and min readings, in:
0° = 0.0001 90° = 0.0002

Maximum difference must be < 0.0020 in. Difference = ± 0.00010
Flatness Tolerance Met? YES









DIAMETER 1

End 1:
Slope of Best Fit Line 0.00000
Angle of Best Fit Line: 0.00000

End 2:
Slope of Best Fit Line 0.00005
Angle of Best Fit Line: 0.00295

Maximum Angular Difference: 0.00295

Parallelism Tolerance Met? YES
Spherically Seated

DIAMETER 2

End 1:
Slope of Best Fit Line 0.00001
Angle of Best Fit Line: 0.00033

End 2:
Slope of Best Fit Line 0.00002
Angle of Best Fit Line: 0.00098

Maximum Angular Difference: 0.00065

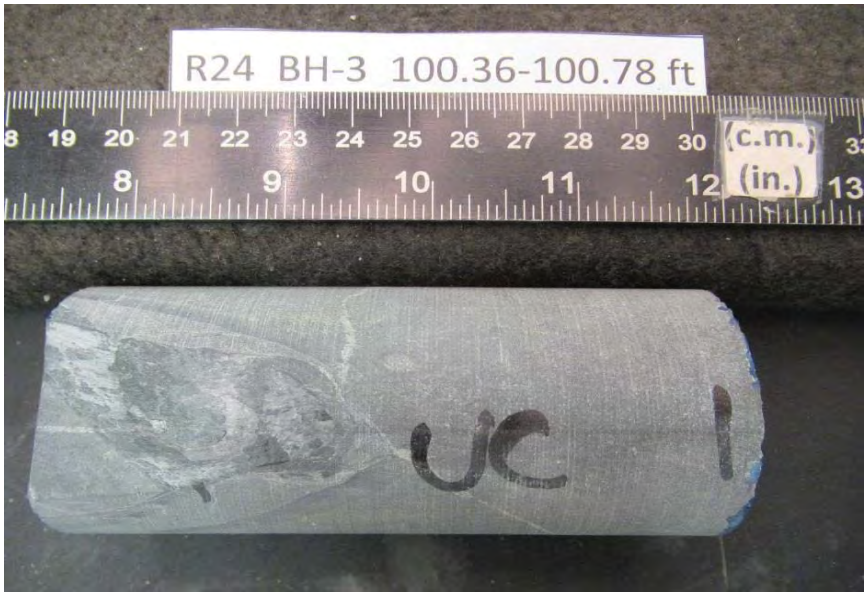
Parallelism Tolerance Met? YES
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00000	1.990	0.00000	0.000	YES
Diameter 2, in (rotated 90°)	0.00020	1.990	0.00010	0.006	YES
END 2					
Diameter 1, in	0.00010	1.990	0.00005	0.003	YES
Diameter 2, in (rotated 90°)	0.00020	1.990	0.00010	0.006	YES

Maximum angle of departure must be ≤ 0.25°
Perpendicularity Tolerance Met? YES

Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Test Date:	12/24/2018
Tested By:	cmh
Checked By:	jsc
Boring ID:	R24
Sample ID:	BH-3
Depth, ft:	100.36-100.78



After cutting and grinding



After break

Client:	S.W. Cole Engineering, Inc.	Test Date:	12/24/2018
Project Name:	NECEC/KRC	Tested By:	cmh
Project Location:	Maine	Checked By:	jsc
GTX #:	309265		
Boring ID:	R26		
Sample ID:	BH-3		
Depth:	110.25-110.65 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.49	4.49	4.49
Specimen Diameter, in:	1.98	1.98	1.98
Specimen Mass, g:	614.3		
Bulk Density, lb/ft^3	169	**Minimum Diameter Tolerence Met?**	YES
Length to Diameter Ratio:	2.3	**Length to Diameter Ratio Tolerance Met?**	YES

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? YES

END FLATNESS AND PARALLELISM (Procedure FP1)

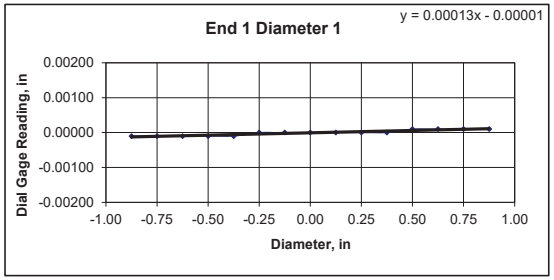
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00010	-0.00010	-0.00010	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00010	0.00010	0.00010	0.00010
Diameter 2, in (rotated 90°)	-0.00020	-0.00020	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010

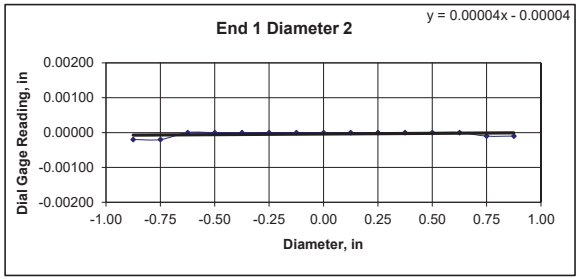
Difference between max and min readings, in:
0° = 0.00020 90° = 0.00020

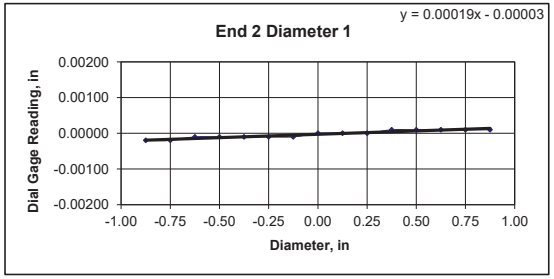
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00020	-0.00020	-0.00010	-0.00010	-0.00010	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00010	0.00010	0.00010	0.00010	0.00010
Diameter 2, in (rotated 90°)	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

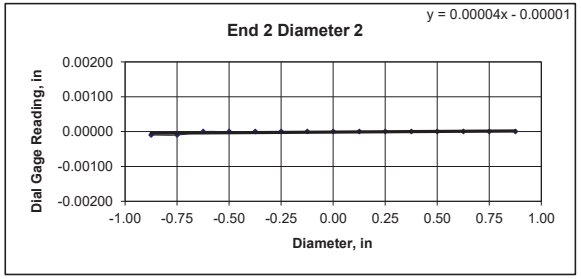
Difference between max and min readings, in:
0° = 0.0003 90° = 0.0001

Maximum difference must be < 0.0020 in. Difference = ± 0.00015
Flatness Tolerance Met? YES









DIAMETER 1

End 1:
Slope of Best Fit Line 0.00013
Angle of Best Fit Line: 0.00769

End 2:
Slope of Best Fit Line 0.00019
Angle of Best Fit Line: 0.01080

Maximum Angular Difference: 0.00311

Parallelism Tolerance Met? YES
Spherically Seated

DIAMETER 2

End 1:
Slope of Best Fit Line 0.00004
Angle of Best Fit Line: 0.00213

End 2:
Slope of Best Fit Line 0.00004
Angle of Best Fit Line: 0.00213

Maximum Angular Difference: 0.00000

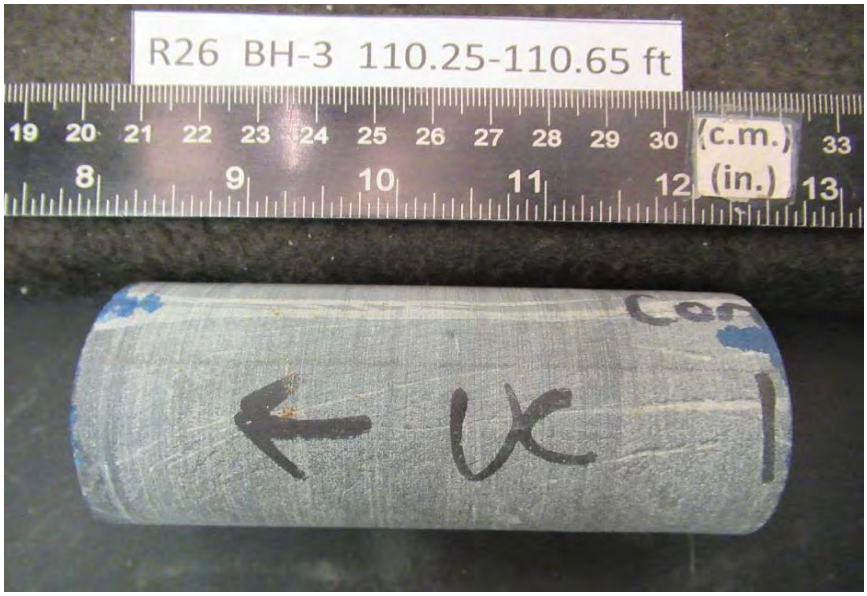
Parallelism Tolerance Met? YES
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00020	1.980	0.00010	0.006	YES
Diameter 2, in (rotated 90°)	0.00020	1.980	0.00010	0.006	YES
END 2					
Diameter 1, in	0.00030	1.980	0.00015	0.009	YES
Diameter 2, in (rotated 90°)	0.00010	1.980	0.00005	0.003	YES

Maximum angle of departure must be ≤ 0.25°
Perpendicularity Tolerance Met? YES

Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Test Date:	12/24/2018
Tested By:	cmh
Checked By:	jsc
Boring ID:	R26
Sample ID:	BH-3
Depth, ft:	110.25-110.65



After cutting and grinding



After break

Client:	S.W. Cole Engineering, Inc.	Test Date:	12/24/2018
Project Name:	NECEC/KRC	Tested By:	cmh
Project Location:	Maine	Checked By:	jsc
GTX #:	309265		
Boring ID:	R37		
Sample ID:	BH-4		
Depth:	46.92-47.33 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.57	4.57	4.57
Specimen Diameter, in:	1.99	1.99	1.99
Specimen Mass, g:	647.19		
Bulk Density, lb/ft^3	174	**Minimum Diameter Tolerence Met?**	YES
Length to Diameter Ratio:	2.3	**Length to Diameter Ratio Tolerance Met?**	YES

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? YES

END FLATNESS AND PARALLELISM (Procedure FP1)

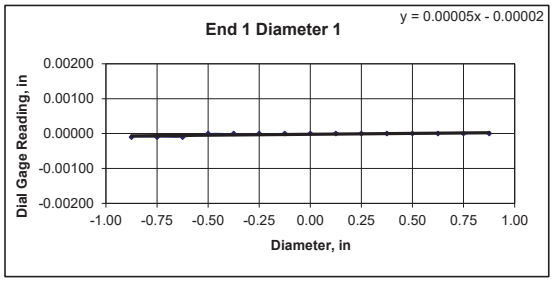
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00010	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Diameter 2, in (rotated 90°)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

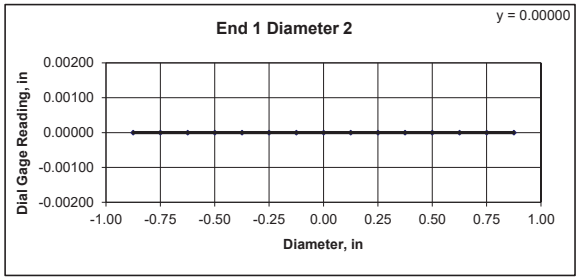
Difference between max and min readings, in:
0° = 0.00010 90° = 0.00000

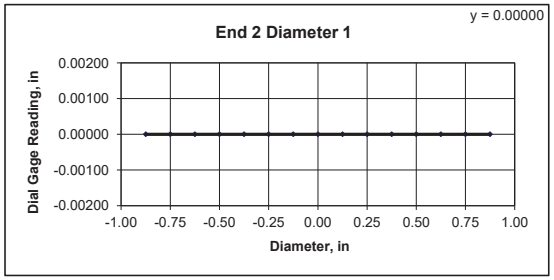
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Diameter 2, in (rotated 90°)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

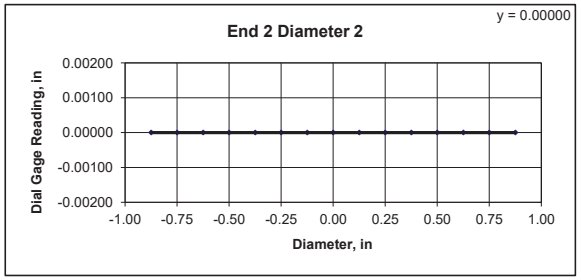
Difference between max and min readings, in:
0° = 0 90° = 0

Maximum difference must be < 0.0020 in. Difference = ± 0.00005
Flatness Tolerance Met? YES









DIAMETER 1

End 1:
Slope of Best Fit Line 0.00005
Angle of Best Fit Line: 0.00295

End 2:
Slope of Best Fit Line 0.00000
Angle of Best Fit Line: 0.00000

Maximum Angular Difference: 0.00295

Parallelism Tolerance Met? YES
Spherically Seated

DIAMETER 2

End 1:
Slope of Best Fit Line 0.00000
Angle of Best Fit Line: 0.00000

End 2:
Slope of Best Fit Line 0.00000
Angle of Best Fit Line: 0.00000

Maximum Angular Difference: 0.00000

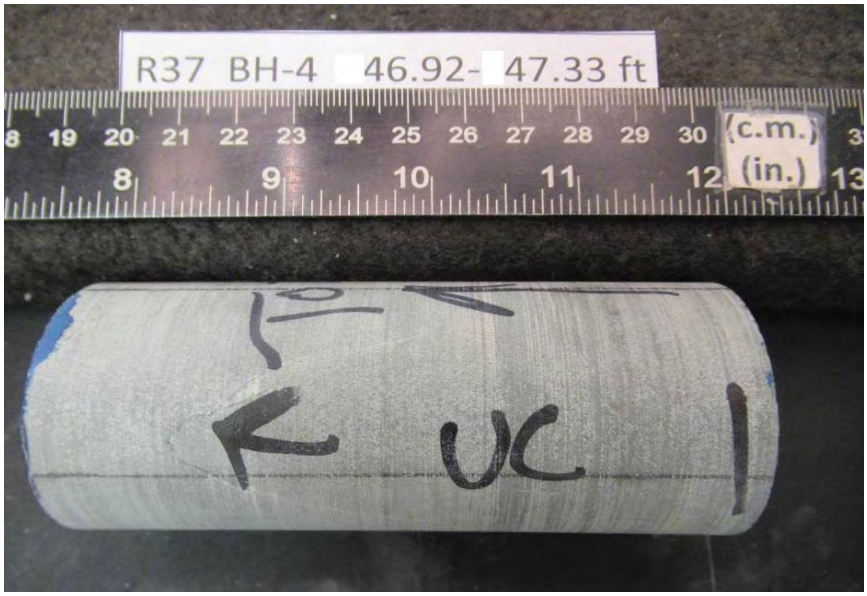
Parallelism Tolerance Met? YES
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00010	1.990	0.00005	0.003	YES
Diameter 2, in (rotated 90°)	0.00000	1.990	0.00000	0.000	YES
END 2					
Diameter 1, in	0.00000	1.990	0.00000	0.000	YES
Diameter 2, in (rotated 90°)	0.00000	1.990	0.00000	0.000	YES

Maximum angle of departure must be ≤ 0.25°
Perpendicularity Tolerance Met? YES

Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Test Date:	12/24/2018
Tested By:	cmh
Checked By:	jsc
Boring ID:	R37
Sample ID:	BH-4
Depth, ft:	46.92-47.33



After cutting and grinding



After break

Client:	S.W. Cole Engineering, Inc.	Test Date:	12/24/2018
Project Name:	NECEC/KRC	Tested By:	cmh
Project Location:	Maine	Checked By:	jsc
GTX #:	309265		
Boring ID:	R40		
Sample ID:	BH-4		
Depth:	160.66-161.06 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.49	4.49	4.49
Specimen Diameter, in:	1.99	1.99	1.99
Specimen Mass, g:	617.49		
Bulk Density, lb/ft^3	168	**Minimum Diameter Tolerence Met?**	YES
Length to Diameter Ratio:	2.3	**Length to Diameter Ratio Tolerance Met?**	YES

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? YES

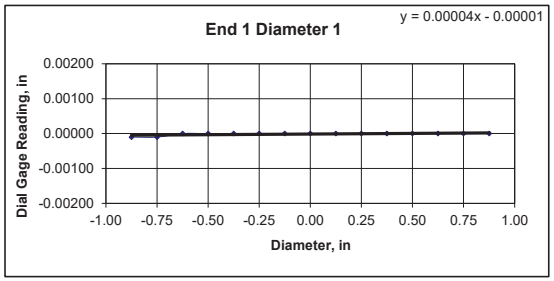
END FLATNESS AND PARALLELISM (Procedure FP1)

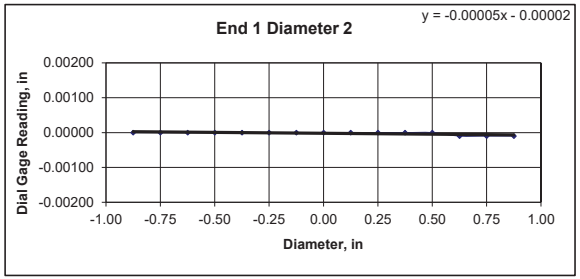
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Diameter 2, in (rotated 90°)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00010

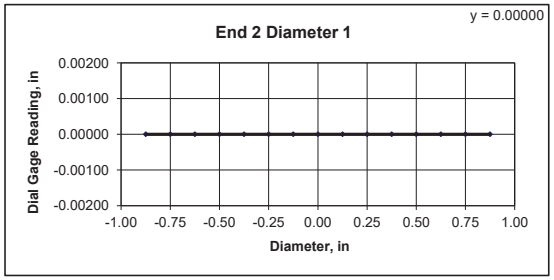
Difference between max and min readings, in:
0° = 0.00010 90° = 0.00010

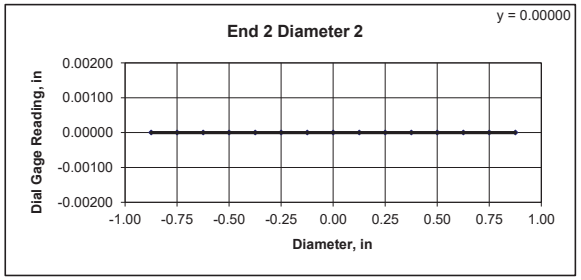
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Diameter 2, in (rotated 90°)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Difference between max and min readings, in:
0° = 0 90° = 0
Maximum difference must be < 0.0020 in. Difference = ± 0.00005
Flatness Tolerance Met? YES









DIAMETER 1

End 1:
Slope of Best Fit Line 0.00004
Angle of Best Fit Line: 0.00213

End 2:
Slope of Best Fit Line 0.00000
Angle of Best Fit Line: 0.00000

Maximum Angular Difference: 0.00213

Parallelism Tolerance Met? YES
Spherically Seated

DIAMETER 2

End 1:
Slope of Best Fit Line 0.00005
Angle of Best Fit Line: 0.00295

End 2:
Slope of Best Fit Line 0.00000
Angle of Best Fit Line: 0.00000

Maximum Angular Difference: 0.00295

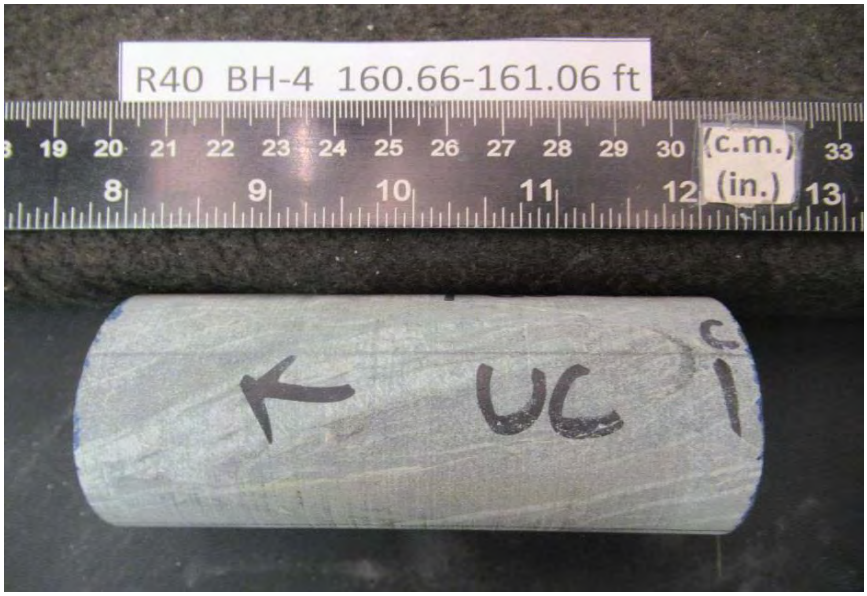
Parallelism Tolerance Met? YES
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

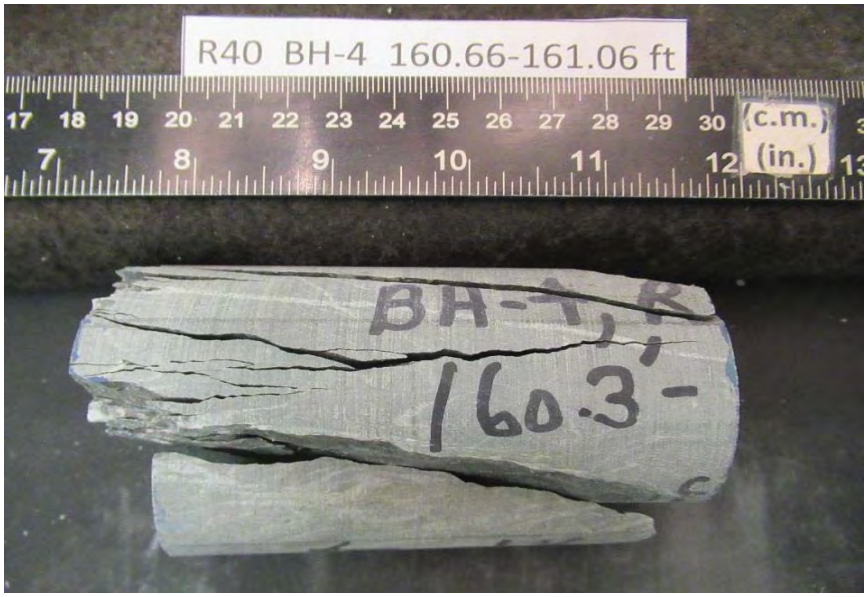
END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00010	1.990	0.00005	0.003	YES
Diameter 2, in (rotated 90°)	0.00010	1.990	0.00005	0.003	YES
END 2					
Diameter 1, in	0.00000	1.990	0.00000	0.000	YES
Diameter 2, in (rotated 90°)	0.00000	1.990	0.00000	0.000	YES

Maximum angle of departure must be ≤ 0.25°
Perpendicularity Tolerance Met? YES

Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Test Date:	12/24/2018
Tested By:	cmh
Checked By:	jsc
Boring ID:	R40
Sample ID:	BH-4
Depth, ft:	160.66-161.06



After cutting and grinding



After break

Client:	S.W. Cole Engineering, Inc.	Test Date:	12/24/2018
Project Name:	NECEC/KRC	Tested By:	cmh
Project Location:	Maine	Checked By:	jsc
GTX #:	309265		
Boring ID:	R43		
Sample ID:	BH-4		
Depth:	174.99-175.38 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.40	4.40	4.40
Specimen Diameter, in:	1.99	1.99	1.99
Specimen Mass, g:	609.4		
Bulk Density, lb/ft^3	169	**Minimum Diameter Tolerence Met?**	YES
Length to Diameter Ratio:	2.2	**Length to Diameter Ratio Tolerance Met?**	YES

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? YES

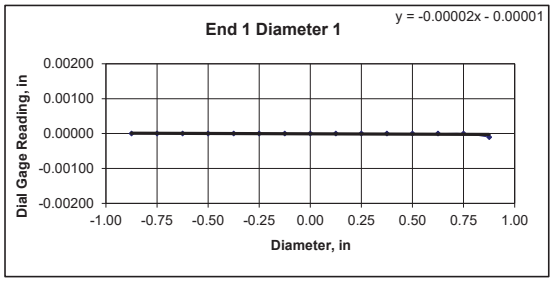
END FLATNESS AND PARALLELISM (Procedure FP1)

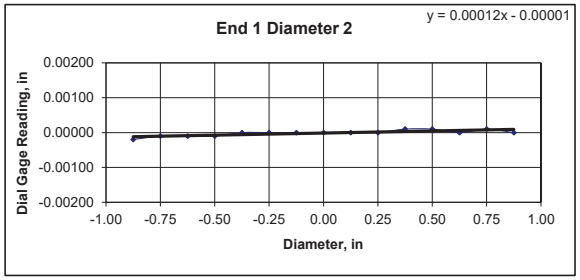
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010
Diameter 2, in (rotated 90°)	-0.00020	-0.00010	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00010	0.00010	0.00000	0.00010	0.00000

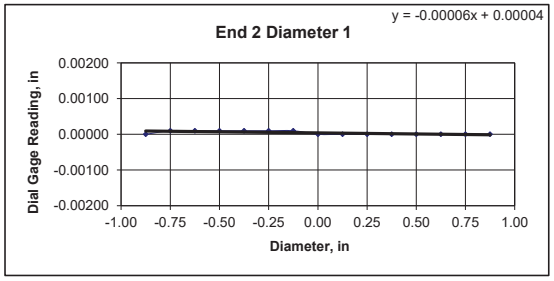
Difference between max and min readings, in:
0° = 0.00010 90° = 0.00030

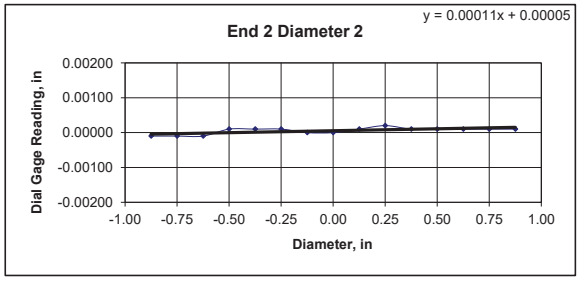
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00000	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Diameter 2, in (rotated 90°)	-0.00010	-0.00010	-0.00010	0.00010	0.00010	0.00010	0.00000	0.00000	0.00010	0.00020	0.00010	0.00010	0.00010	0.00010	0.00010

Difference between max and min readings, in:
0° = 0.0001 90° = 0.0003
Maximum difference must be < 0.0020 in. Difference = ± 0.00015
Flatness Tolerance Met? YES









DIAMETER 1

End 1:
Slope of Best Fit Line 0.00002
Angle of Best Fit Line: 0.00115

End 2:
Slope of Best Fit Line 0.00006
Angle of Best Fit Line: 0.00344

Maximum Angular Difference: 0.00229

Parallelism Tolerance Met? YES
Spherically Seated

DIAMETER 2

End 1:
Slope of Best Fit Line 0.00012
Angle of Best Fit Line: 0.00688

End 2:
Slope of Best Fit Line 0.00011
Angle of Best Fit Line: 0.00638

Maximum Angular Difference: 0.00049

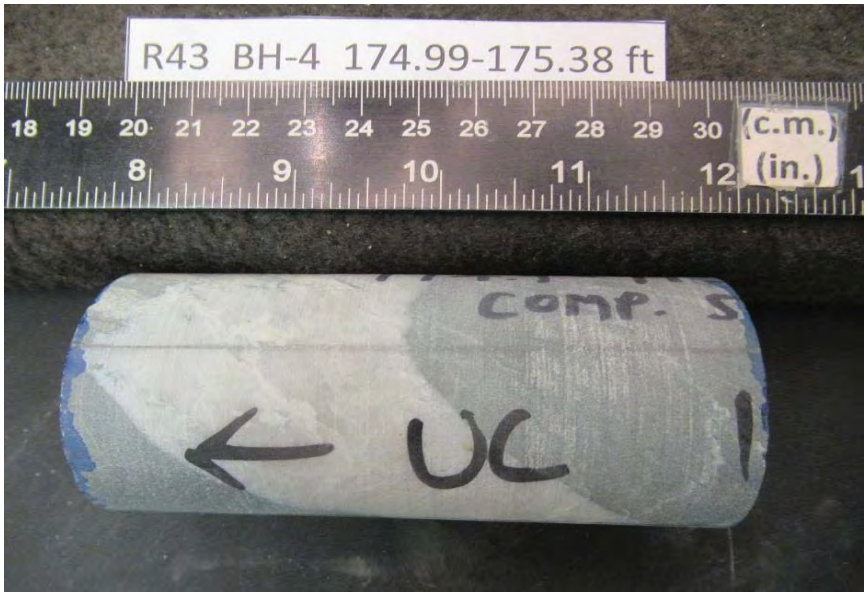
Parallelism Tolerance Met? YES
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00010	1.990	0.00005	0.003	YES
Diameter 2, in (rotated 90°)	0.00030	1.990	0.00015	0.009	YES
END 2					
Diameter 1, in	0.00010	1.990	0.00005	0.003	YES
Diameter 2, in (rotated 90°)	0.00030	1.990	0.00015	0.009	YES

Maximum angle of departure must be ≤ 0.25°
Perpendicularity Tolerance Met? YES

Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Test Date:	12/24/2018
Tested By:	cmh
Checked By:	jsc
Boring ID:	R43
Sample ID:	BH-4
Depth, ft:	174.99-175.38



After cutting and grinding



After break

GeoTesting EXPRESS

ROCK CHAIN OF CUSTODY & TEST REQUEST

Attn: John Campbell

GeoTesting Express, Inc.
125 Nagog Park
Acton, MA 01720
800 434 1062 Toll Free
978 635 0266 Fax

2358 Perimeter Park Drive, Suite 320
Atlanta, GA 30341
770 645 6575 Tel
770 645 6570 Fax

www.geotesting.com

CLIENT		INVOICE (complete if different from Client)	
Company: S W Cole Engineering, Inc		Company:	
Address: 286 Portland Rd		Address:	
City, State, Zip: Gray Me 04039		City, State, Zip:	
Contact: PAUL KOHLER	Phone: 207-517-4867	Contact:	Phone:
E-mail: pkohler@swcole.com	Cell: 207-615-2760	E-mail:	Cell:

PROJECT		
Project Name: NECEC / KRC	Client Project #: 18-0345	Purchase Order#:
Project Location: MAINE	GTX Sales Order #:	Requested Turnaround:
On-site Contact: PAUL KOHLER	E-mail: pkohler@swcole.com	Phone: 207-517-4867

ROCK

Core Run #	Sample ID	Depth (ft)	CERCHAR Abrasivity (ASTM D 7625) * 55HRC/40HRC	Direct Shear (ASTM D5607)*	Direct Tensile Strength (ASTM D 2936)	Elastic Moduli in Triaxial Compression (ASTM D 7012B)	Elastic Moduli in Unlaxial Compression (ASTM D 7012D)	Unit Weight (ISRM)	Petrographic Analysis (ISRM)	Point Load Index (ASTM D 5731)* Diametral, Axial, Lump/Block	Punch Penetration (Handewith)	Slake Durability (ASTM D 4644)	Splitting (Brazillan) Tensile Strength (ASTM D 3967)	Schmidt Hammer (ASTM D 5873)	Total Hardness (Schmidt Hammer and Taber Abrasion)	Triaxial Compression (ASTM D 7012A)	Unconfined Compression (ASTM D 7012C) $230	Other:	Other:
R5	BH-1	19.1-20.5						✓									✓		
R9	BH-2	46.1-47.4						✓									✓		
R11	BH-2	54.5-55.8						✓									✓		
R14	BH-2	69.9-70.8						✓									✓		
R19	BH-3	79.2-81.0						✓									✓		
R21	BH-3	90.3-91.2						✓									✓		
R24	BH-3	100-101.1						✓									✓		
R26	BH-3	110-111.3						✓									✓		
R37	BH-4	46.8-48.5						✓									✓		
R40	BH-4	160.3-161.6						✓									✓		
R43	BH-4	174.9-175.7						✓									✓		

*Specify Test Conditions (Undisturbed or Remolded, Density and Moisture, Test Normal Loads, Test Confining Stresses, etc.):

AUTHORIZE BY SIGNING AND DATING:

SIGNATURE: Paul F Kohler PRINT NAME: PAUL F. KOHLER DATE: 12/5/18

For GTX Use Only
Incoming Sample Inspection Performed ☐
Adverse conditions:

Relinquished By: PAUL KOHLER	DATE: 12-6-18 TIME: 10:09am	Received By: Shawn Pond	DATE: 12/7/18 TIME:
Relinquished By:	DATE: TIME:	Received By:	DATE: TIME:

GeoTesting EXPRESS

WARRANTY and LIABILITY

GeoTesting Express (GTX) warrants that all tests it performs are run in general accordance with the specified test procedures and accepted industry practice. GTX will correct or repeat any test that does not comply with this warranty. GTX has no specific knowledge as to conditioning, origin, sampling procedure or intended use of the material.

GTX may report engineering parameters that require us to interpret the test data. Such parameters are determined using accepted engineering procedures. However, GTX does not warrant that these parameters accurately reflect the true engineering properties of the *in situ* material. Responsibility for interpretation and use of the test data and these parameters for engineering and/or construction purposes rests solely with the user and not with GTX or any of its employees.

GTX's liability will be limited to correcting or repeating a test which fails our warranty. GTX's liability for damages to the Purchaser of testing services for any cause whatsoever shall be limited to the amount GTX received for the testing services. GTX will not be liable for any damages, or for any lost benefits or other consequential damages resulting from the use of these test results, even if GTX has been advised of the possibility of such damages. GTX will not be responsible for any liability of the Purchaser to any third party.

Commonly Used Symbols

A	pore pressure parameter for $\Delta\sigma_1 - \Delta\sigma_3$
B	pore pressure parameter for $\Delta\sigma_3$
CAI	CERCHAR Abrasiveness Index
CIU	isotropically consolidated undrained triaxial shear test
CR	compression ratio for one dimensional consolidation
CSR	cyclic stress ratio
C_c	coefficient of curvature, $(D_{30})^2 / (D_{10} \times D_{60})$
C_u	coefficient of uniformity, D_{60}/D_{10}
C_c	compression index for one dimensional consolidation
C_α	coefficient of secondary compression
c_v	coefficient of consolidation
c	cohesion intercept for total stresses
c'	cohesion intercept for effective stresses
D	diameter of specimen
D	damping ratio
D_{10}	diameter at which 10% of soil is finer
D_{15}	diameter at which 15% of soil is finer
D_{30}	diameter at which 30% of soil is finer
D_{50}	diameter at which 50% of soil is finer
D_{60}	diameter at which 60% of soil is finer
D_{85}	diameter at which 85% of soil is finer
d_{50}	displacement for 50% consolidation
d_{90}	displacement for 90% consolidation
d_{100}	displacement for 100% consolidation
E	Young's modulus
e	void ratio
e_c	void ratio after consolidation
e_o	initial void ratio
G	shear modulus
G_s	specific gravity of soil particles
H	height of specimen
H_R	Rebound Hardness number
i	gradient
I_S	Uncorrected point load strength
$I_{S(50)}$	Size corrected point load strength index
H_A	Modified Taber Abrasion
H_T	Total hardness
K_o	lateral stress ratio for one dimensional strain
k	permeability
LI	Liquidity Index
m_v	coefficient of volume change
n	porosity
PI	plasticity index
P_c	preconsolidation pressure
p	$(\sigma_1 + \sigma_3) / 2$, $(\sigma_v + \sigma_h) / 2$
p'	$(\sigma'_1 + \sigma'_3) / 2$, $(\sigma'_v + \sigma'_h) / 2$
p'_c	p' at consolidation
Q	quantity of flow
q	$(\sigma_1 - \sigma_3) / 2$
q_f	q at failure
q_o, q_i	initial q
q_c	q at consolidation
S_r	Post cyclic undrained shear strength
T	temperature
t	time
U, UC	unconfined compression test
UU, Q	unconsolidated undrained triaxial test
u_a	pore gas pressure
u_e	excess pore water pressure
u, u_w	pore water pressure
V	total volume
V_g	volume of gas
V_s	volume of solids
V_s	shear wave velocity
V_v	volume of voids
V_w	volume of water
V_o	initial volume
v	velocity
W	total weight
W_s	weight of solids
W_w	weight of water
w	water content
w_c	water content at consolidation
w_f	final water content
w_l	liquid limit
w_n	natural water content
w_p	plastic limit
w_s	shrinkage limit
w_o, w_i	initial water content
α	slope of q_f versus p_f
α'	slope of q_f versus p_f'
γ_t	total unit weight
γ_d	dry unit weight
γ_s	unit weight of solids
γ_w	unit weight of water
ε	strain
ε_{vol}	volume strain
ε_h, ε_v	horizontal strain, vertical strain
μ	Poisson's ratio, also viscosity
σ	normal stress
σ'	effective normal stress
σ_c, σ'_c	consolidation stress in isotropic stress system
σ_h, σ'_h	horizontal normal stress
σ_v, σ'_v	vertical normal stress
σ'_{vc}	Effective vertical consolidation stress
σ_1	major principal stress
σ_2	intermediate principal stress
σ_3	minor principal stress
τ	shear stress
φ	friction angle based on total stresses
φ'	friction angle based on effective stresses
φ'_r	residual friction angle
φ_{ult}	φ for ultimate strength

GeoTesting EXPRESS

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Transmittal

TO:

Paul Kohler

S.W. Cole Engineering, Inc.

286 Portland Road

Gray, ME 04039-9586

DATE: 3/21/2019	GTX NO: 309265
RE: NECEC/KRC	

COPIES	DATE	DESCRIPTION
	3/21/2019	**March 2019 Laboratory Test Report**

REMARKS:

SIGNED:

Jonathan Campbell, Assistant Laboratory Manager

CC:

APPROVED BY:

Mark Dobday, P.G., Laboratory Manager

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March 21, 2019

Paul Kohler
S.W. Cole Engineering, Inc.
286 Portland Road
Gray, ME 04039-9586

RE: NECEC/KRC, Maine (GTX-309265)

Dear Paul:

Enclosed are the test results you requested for the above referenced project. GeoTesting Express, Inc. (GTX) received nine samples from you on 2/12/2019. These samples were labeled as follows:

Boring Number	Sample Number	Depth
BH-2	R16	75-80 ft
BH-2	R18	85-90 ft
BH-3	R17	67.7-71.5 ft
BH-3	R23 / R24	92.1-100.0 ft
BH-3	R25	101.5-106.5 ft
BH-4	R21	74.6-79.6 ft
BH-4	R40 / R41	160-166.6 ft
BH-4	R42	167-177.5 ft
BH-4	R44	176.6-181.6 ft

GTX performed the following tests on these samples:

4 ASTM D4644 - Slake Durability
7 ASTM D7012 Method C- Uniaxial Compressive Strength of Rock
7 ASTM D7625 -CERCHAR Abrasivity Index (CAI)
2 NTNU 13A-98 - Drillability Test Suite

GTX also subcontracted with Spectrum Petrographics of Vancouver, WA to perform a Petrographic Analysis (thin section) on seven of your samples. We will forward you the results of these analyses as soon as the Spectrum reports are received.

A copy of your test request is attached.

The results presented in this report apply only to the items tested. This report shall not be reproduced except in full, without written approval from GeoTesting Express. The remainder of these samples will be retained for a period of sixty (60) days and will then be discarded unless otherwise notified by you. Please call me if you have any questions or require additional information. Thank you for allowing GeoTesting Express the opportunity of providing you with testing services. We look forward to working with you again in the future.

Respectfully yours,



Jonathan Campbell
Assistant Laboratory Manager

GeoTesting EXPRESS

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Geotechnical Test Report **3/21/2019**

GTX-309265

NECEC/KRC

Maine

Client Project No.: 18-0345

Prepared for:

S.W. Cole Engineering, Inc.

Client:	S.W. Cole Engineering, Inc.				
Project:	NECEC/KRC				
Location:	Maine			Project No:	GTX-309265
Boring ID:	---	Sample Type:	---	Tested By:	smd
Sample ID:	---	Test Date:	02/22/19	Checked By:	jsc
Depth :	---	Test Id:	495067		

Bulk Density and Compressive Strength of Rock Core Specimens by ASTM D7012 Method C

Boring ID	Sample Number	Depth	Bulk Density, pcf	Compressive strength, psi	Failure Type	Meets ASTM D4543	Note(s)
BH-2	R16	75 - 80 ft	169	3536	1	Yes	---
BH-2	R18	85 - 90 ft	170	4755	1	Yes	---
BH-3	R17	67.7 - 71.5 ft	167	18526	1	Yes	---
BH-3	R24	96.5 - 98.5 ft	169	16264	1	Yes	---
BH-4	R21	74.6 - 79.6 ft	177	5811	1	Yes	---
BH-4	R42	167 - 177.5 ft	168	8267	1	Yes	---
BH-4	R44	176.6 - 181.6 ft	168	5951	1	Yes	---

Notes: Density determined on core samples by measuring dimensions and weight and then calculating.

All specimens tested at the approximate as-received moisture content and at standard laboratory temperature.

The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.

Failure Type: 1 = Intact Material Failure; 2 = Discontinuity Failure; 3 = Intact Material and Discontinuity Failure (See attached photographs)

Client:	S.W. Cole Engineering, Inc.	Test Date:	2/22/2019
Project Name:	NECEC/KRC	Tested By:	cmh
Project Location:	Maine	Checked By:	jsc
GTX #:	309265		
Boring ID:	BH-2		
Sample ID:	R16		
Depth:	75-80 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.16	4.16	4.16
Specimen Diameter, in:	2.00	1.99	2.00
Specimen Mass, g:	578.59		
Bulk Density, lb/ft^3	169	**Minimum Diameter Tolerence Met?**	**YES**
Length to Diameter Ratio:	2.1	**Length to Diameter Ratio Tolerance Met?**	**YES**

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? **YES**

END FLATNESS AND PARALLELISM (Procedure FP1)

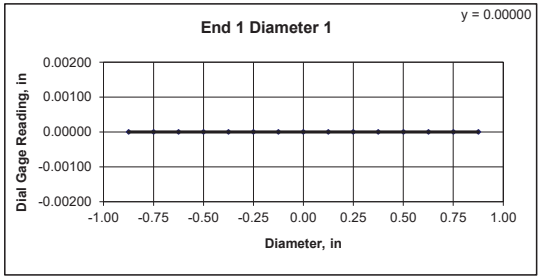
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Diameter 2, in (rotated 90°)	-0.00060	-0.00060	-0.00050	-0.00040	-0.00040	-0.00040	-0.00020	0.00000	0.00010	0.00010	0.00020	0.00040	0.00050	0.00060	0.00060

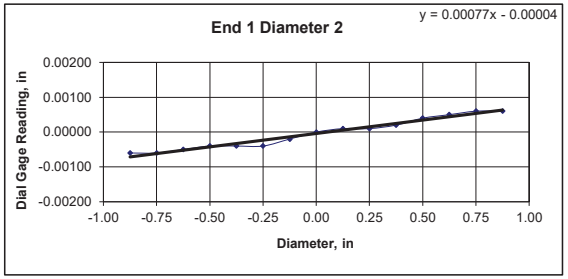
Difference between max and min readings, in:
0° = 0.00000 90° = 0.00120

END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00010	-0.00010	-0.00010
Diameter 2, in (rotated 90°)	-0.00090	-0.00090	-0.00080	-0.00070	-0.00050	-0.00040	-0.00040	0.00000	0.00010	0.00020	0.00020	0.00020	0.00020	0.00030	0.00050

Difference between max and min readings, in:
0° = 0.0001 90° = 0.0014

Maximum difference must be < 0.0020 in. Difference = ± 0.00070
Flatness Tolerance Met? **YES**





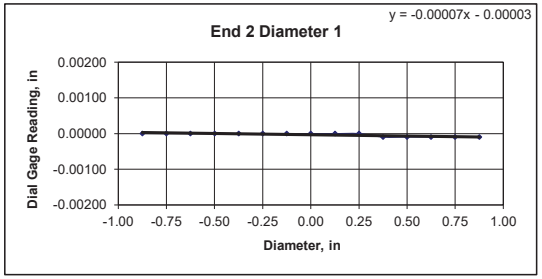
DIAMETER 1

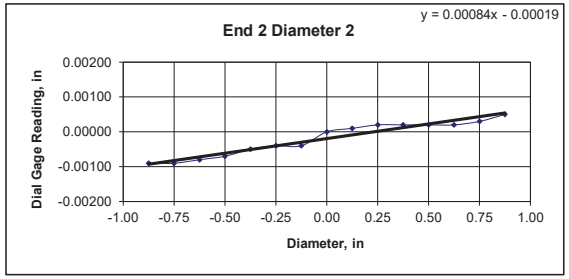
End 1:
Slope of Best Fit Line 0.00000
Angle of Best Fit Line: 0.00000

End 2:
Slope of Best Fit Line 0.00007
Angle of Best Fit Line: 0.00409

Maximum Angular Difference: 0.00409

Parallelism Tolerance Met? **YES**
Spherically Seated





DIAMETER 2

End 1:
Slope of Best Fit Line 0.00077
Angle of Best Fit Line: 0.04404

End 2:
Slope of Best Fit Line 0.00084
Angle of Best Fit Line: 0.04813

Maximum Angular Difference: 0.00409

Parallelism Tolerance Met? **YES**
Spherically Seated

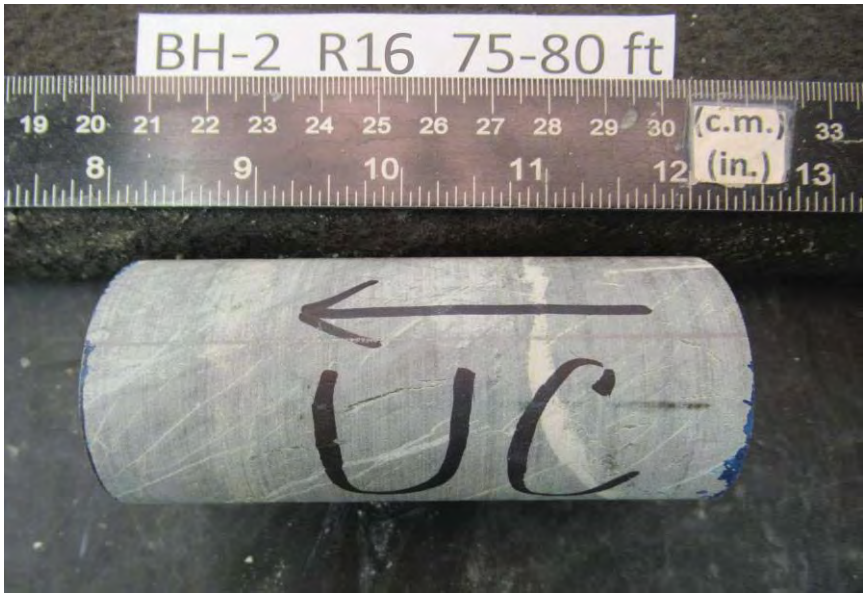
PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00000	1.995	0.00000	0.000	YES
Diameter 2, in (rotated 90°)	0.00120	1.995	0.00060	0.034	YES
END 2					
Diameter 1, in	0.00010	1.995	0.00005	0.003	YES
Diameter 2, in (rotated 90°)	0.00140	1.995	0.00070	0.040	YES

Maximum angle of departure must be ≤ 0.25°

Perpendicularity Tolerance Met? **YES**

Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Test Date:	2/22/2019
Tested By:	cmh
Checked By:	jsc
Boring ID:	BH-2
Sample ID:	R16
Depth, ft:	75-80



After cutting and grinding



After break

Client:	S.W. Cole Engineering, Inc.	Test Date:	2/22/2019
Project Name:	NECEC/KRC	Tested By:	cmh
Project Location:	Maine	Checked By:	jsc
GTX #:	309265		
Boring ID:	BH-2		
Sample ID:	R18		
Depth:	85-90 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.40	4.40	4.40
Specimen Diameter, in:	1.99	1.99	1.99
Specimen Mass, g:	613.59		
Bulk Density, lb/ft^3	170	**Minimum Diameter Tolerence Met?**	**YES**
Length to Diameter Ratio:	2.2	**Length to Diameter Ratio Tolerance Met?**	**YES**

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? **YES**

END FLATNESS AND PARALLELISM (Procedure FP1)

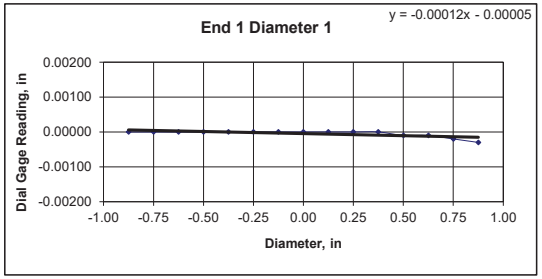
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00020	-0.00030
Diameter 2, in (rotated 90°)	-0.00050	-0.00050	-0.00030	-0.00020	-0.00010	-0.00010	0.00000	0.00000	0.00020	0.00030	0.00040	0.00050	0.00050	0.00050	0.00060

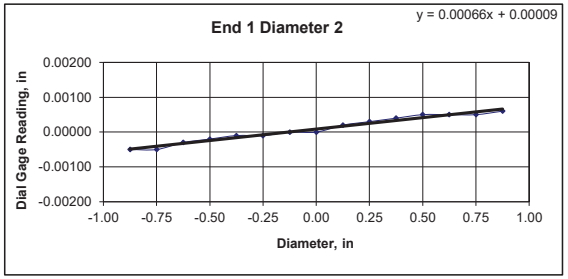
Difference between max and min readings, in:
0° = 0.00030 90° = 0.00110

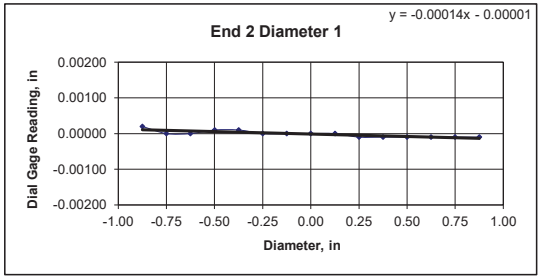
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00020	0.00000	0.00000	0.00010	0.00010	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00010	-0.00010	-0.00010	-0.00010
Diameter 2, in (rotated 90°)	-0.00070	-0.00070	-0.00070	-0.00070	-0.00060	-0.00040	-0.00040	0.00000	0.00000	0.00000	0.00000	0.00000	0.00020	0.00040	0.00050

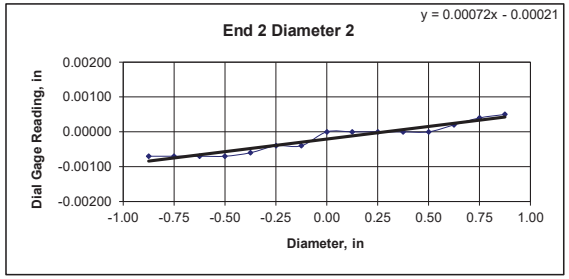
Difference between max and min readings, in:
0° = 0.0003 90° = 0.0012

Maximum difference must be < 0.0020 in. Difference = ± 0.00060
Flatness Tolerance Met? **YES**









DIAMETER 1

End 1:
Slope of Best Fit Line 0.00012
Angle of Best Fit Line: 0.00688

End 2:
Slope of Best Fit Line 0.00014
Angle of Best Fit Line: 0.00786

Maximum Angular Difference: 0.00098

Parallelism Tolerance Met? **YES**
Spherically Seated

DIAMETER 2

End 1:
Slope of Best Fit Line 0.00066
Angle of Best Fit Line: 0.03765

End 2:
Slope of Best Fit Line 0.00072
Angle of Best Fit Line: 0.04142

Maximum Angular Difference: 0.00377

Parallelism Tolerance Met? **YES**
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00030	1.990	0.00015	0.009	YES
Diameter 2, in (rotated 90°)	0.00110	1.990	0.00055	0.032	YES
END 2					
Diameter 1, in	0.00030	1.990	0.00015	0.009	YES
Diameter 2, in (rotated 90°)	0.00120	1.990	0.00060	0.035	YES

Maximum angle of departure must be ≤ 0.25°

Perpendicularity Tolerance Met? **YES**

Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Test Date:	2/22/2019
Tested By:	cmh
Checked By:	jsc
Boring ID:	BH-2
Sample ID:	R18
Depth, ft:	85-90



After cutting and grinding



After break

Client:	S.W. Cole Engineering, Inc.	Test Date:	2/22/2019
Project Name:	NECEC/KRC	Tested By:	cmh
Project Location:	Maine	Checked By:	jsc
GTX #:	309265		
Boring ID:	BH-3		
Sample ID:	R17		
Depth:	67.7-71.5 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.49	4.48	4.49
Specimen Diameter, in:	1.99	2.00	2.00
Specimen Mass, g:	616.76		
Bulk Density, lb/ft^3	167	**Minimum Diameter Tolerence Met?**	YES
Length to Diameter Ratio:	2.2	**Length to Diameter Ratio Tolerance Met?**	YES

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? YES

END FLATNESS AND PARALLELISM (Procedure FP1)

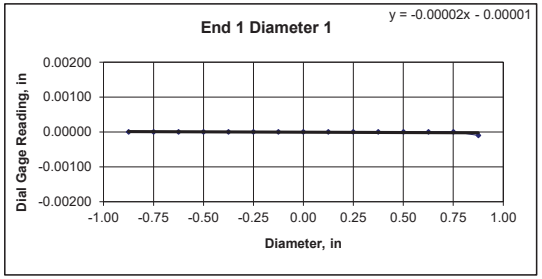
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010
Diameter 2, in (rotated 90°)	0.00050	0.00050	0.00040	0.00040	0.00040	0.00030	0.00020	0.00000	0.00000	0.00000	-0.00010	-0.00020	-0.00050	-0.00060	-0.00060

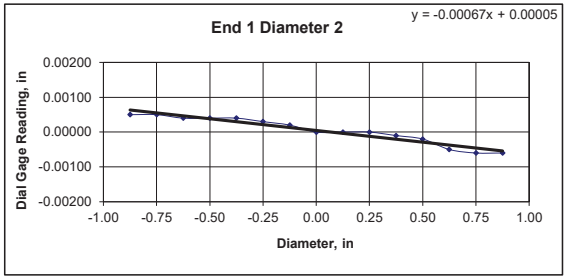
Difference between max and min readings, in:
0° = 0.00010 90° = 0.00110

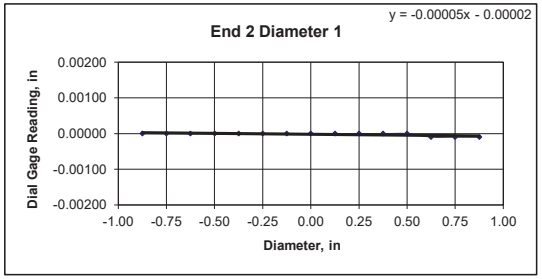
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00010
Diameter 2, in (rotated 90°)	0.00060	0.00050	0.00030	0.00020	0.00010	0.00010	0.00010	0.00000	-0.00010	-0.00010	-0.00020	-0.00030	-0.00040	-0.00050	-0.00070

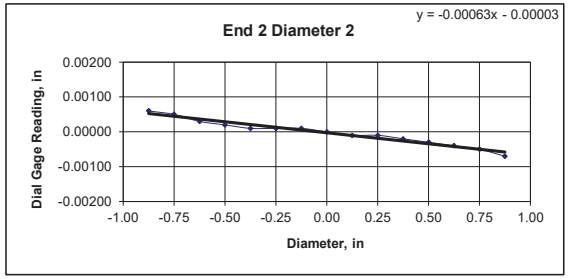
Difference between max and min readings, in:
0° = 0.0001 90° = 0.0013

Maximum difference must be < 0.0020 in. Difference = ± 0.00065
Flatness Tolerance Met? YES









DIAMETER 1

End 1:
Slope of Best Fit Line 0.00002
Angle of Best Fit Line: 0.00115

End 2:
Slope of Best Fit Line 0.00005
Angle of Best Fit Line: 0.00295

Maximum Angular Difference: 0.00180

Parallelism Tolerance Met? YES
Spherically Seated

DIAMETER 2

End 1:
Slope of Best Fit Line 0.00067
Angle of Best Fit Line: 0.03847

End 2:
Slope of Best Fit Line 0.00063
Angle of Best Fit Line: 0.03618

Maximum Angular Difference: 0.00229

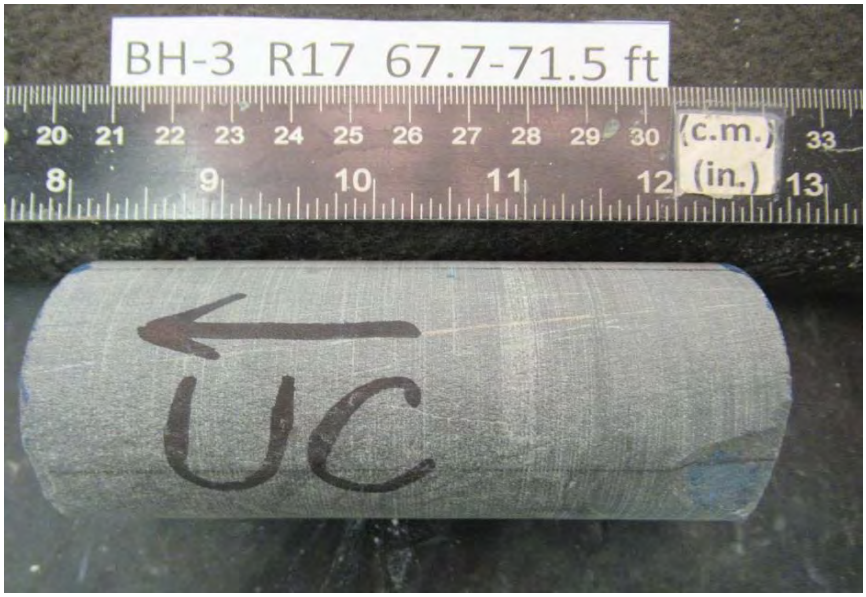
Parallelism Tolerance Met? YES
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00010	1.995	0.00005	0.003	YES
Diameter 2, in (rotated 90°)	0.00110	1.995	0.00055	0.032	YES
END 2					
Diameter 1, in	0.00010	1.995	0.00005	0.003	YES
Diameter 2, in (rotated 90°)	0.00130	1.995	0.00065	0.037	YES

Maximum angle of departure must be ≤ 0.25°
Perpendicularity Tolerance Met? YES

Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Test Date:	2/22/2019
Tested By:	cmh
Checked By:	jsc
Boring ID:	BH-3
Sample ID:	R17
Depth, ft:	67.7-71.5



After cutting and grinding



After break

Client:	S.W. Cole Engineering, Inc.	Test Date:	2/22/2019
Project Name:	NECEC/KRC	Tested By:	cmh
Project Location:	Maine	Checked By:	jsc
GTX #:	309265		
Boring ID:	BH-3		
Sample ID:	R24		
Depth:	96.5-98.5 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.51	4.51	4.51
Specimen Diameter, in:	1.99	1.99	1.99
Specimen Mass, g:	624.08		
Bulk Density, lb/ft^3	169	**Minimum Diameter Tolerence Met?**	**YES**
Length to Diameter Ratio:	2.3	**Length to Diameter Ratio Tolerance Met?**	**YES**

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? **YES**

END FLATNESS AND PARALLELISM (Procedure FP1)

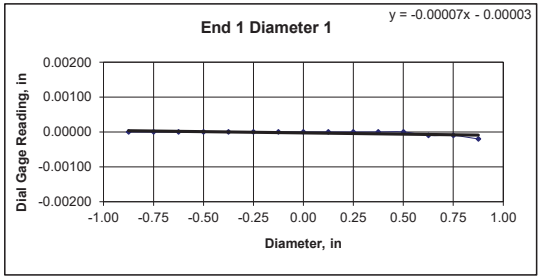
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00020
Diameter 2, in (rotated 90°)	0.00020	0.00020	0.00020	0.00020	0.00020	0.00020	0.00010	0.00000	-0.00010	-0.00010	-0.00020	-0.00030	-0.00040	-0.00040	-0.00050

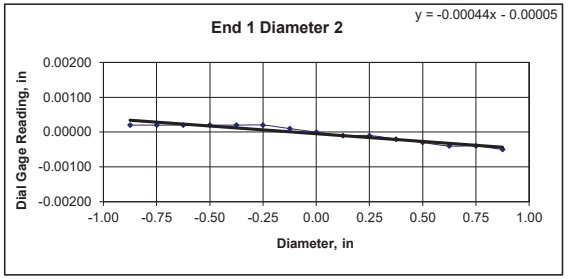
Difference between max and min readings, in:
0° = 0.00020 90° = 0.00070

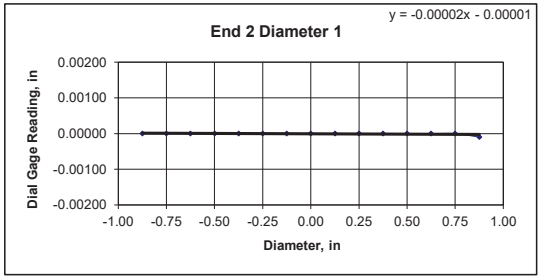
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010
Diameter 2, in (rotated 90°)	0.00020	0.00020	0.00020	0.00020	0.00020	0.00020	0.00020	0.00000	0.00000	-0.00020	-0.00030	-0.00040	-0.00040	-0.00050	-0.00060

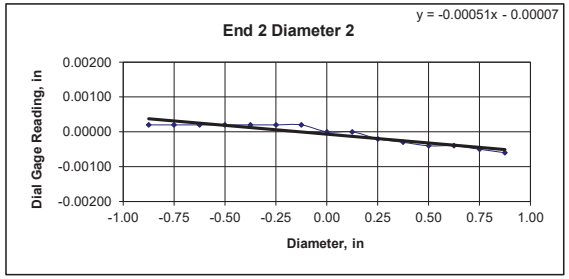
Difference between max and min readings, in:
0° = 0.0001 90° = 0.0008

Maximum difference must be < 0.0020 in. Difference = ± 0.00040
Flatness Tolerance Met? **YES**









DIAMETER 1

End 1:
Slope of Best Fit Line 0.00007
Angle of Best Fit Line: 0.00409

End 2:
Slope of Best Fit Line 0.00002
Angle of Best Fit Line: 0.00115

Maximum Angular Difference: 0.00295

Parallelism Tolerance Met? **YES**
Spherically Seated

DIAMETER 2

End 1:
Slope of Best Fit Line 0.00044
Angle of Best Fit Line: 0.02537

End 2:
Slope of Best Fit Line 0.00051
Angle of Best Fit Line: 0.02898

Maximum Angular Difference: 0.00360

Parallelism Tolerance Met? **YES**
Spherically Seated

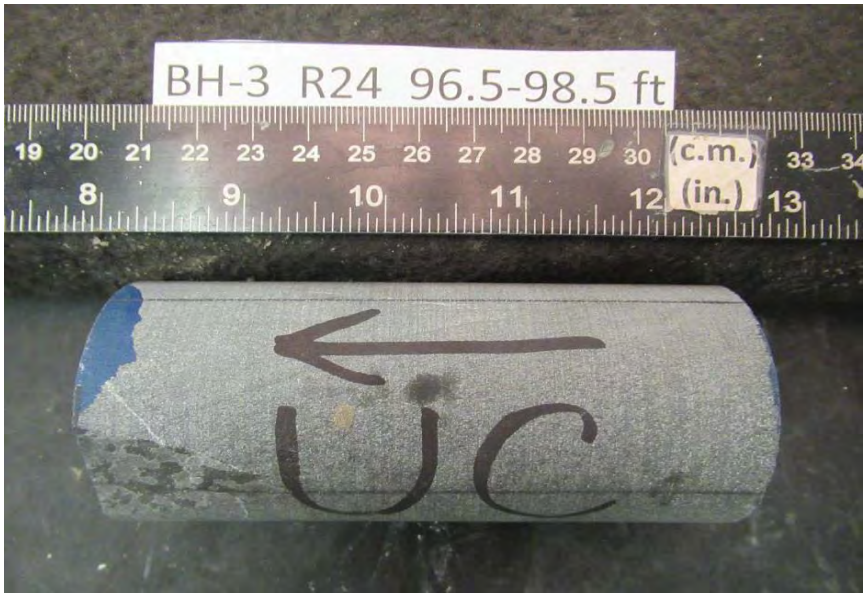
PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00020	1.990	0.00010	0.006	YES
Diameter 2, in (rotated 90°)	0.00070	1.990	0.00035	0.020	YES
END 2					
Diameter 1, in	0.00010	1.990	0.00005	0.003	YES
Diameter 2, in (rotated 90°)	0.00080	1.990	0.00040	0.023	YES

Maximum angle of departure must be ≤ 0.25°

Perpendicularity Tolerance Met? **YES**

Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Test Date:	2/22/2019
Tested By:	cmh
Checked By:	jsc
Boring ID:	BH-3
Sample ID:	R24
Depth, ft:	96.5-98.5



After cutting and grinding



After break

GeoTesting EXPRESS

Client:	S.W. Cole Engineering, Inc.	Test Date:	2/22/2019
Project Name:	NECEC/KRC	Tested By:	cmh
Project Location:	Maine	Checked By:	jsc
GTX #:	309265		
Boring ID:	BH-4		
Sample ID:	R21		
Depth:	74.6-79.6 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.44	4.44	4.44
Specimen Diameter, in:	1.99	1.99	1.99
Specimen Mass, g:	643.57		
Bulk Density, lb/ft^3	177	**Minimum Diameter Tolerence Met?**	**YES**
Length to Diameter Ratio:	2.2	**Length to Diameter Ratio Tolerance Met?**	**YES**

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? **YES**

END FLATNESS AND PARALLELISM (Procedure FP1)

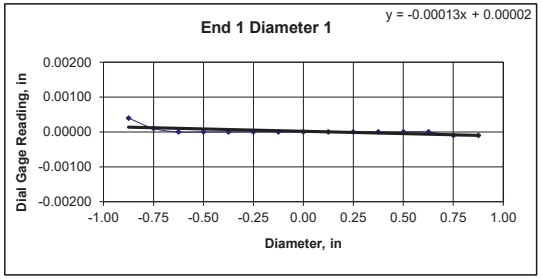
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00040	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010
Diameter 2, in (rotated 90°)	-0.00040	-0.00040	-0.00040	-0.00030	-0.00020	-0.00010	-0.00010	0.00000	0.00010	0.00010	0.00020	0.00030	0.00040	0.00040	0.00040

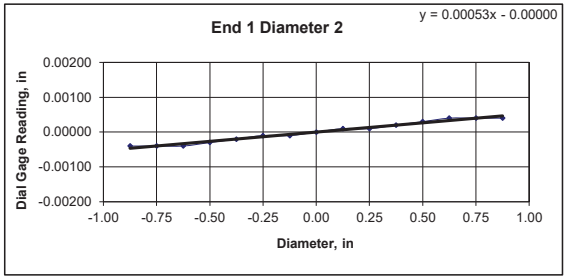
Difference between max and min readings, in:
0° = 0.00050 90° = 0.00080

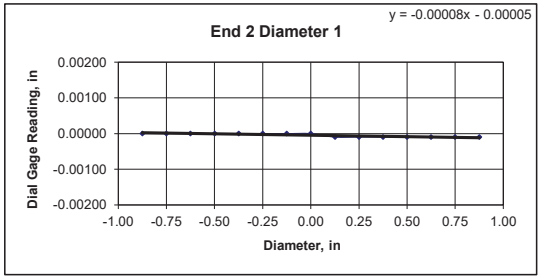
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00010	-0.00010	-0.00010	-0.00010	-0.00010
Diameter 2, in (rotated 90°)	-0.00050	-0.00040	-0.00010	0.00000	0.00010	0.00020	0.00000	0.00000	0.00000	0.00000	0.00010	0.00020	0.00040	0.00040	0.00070

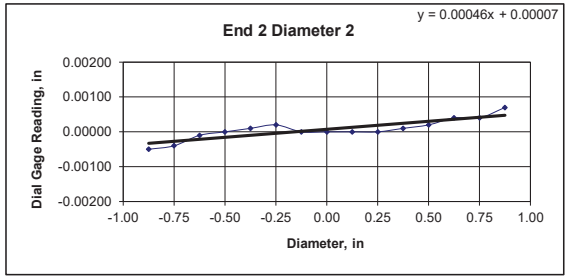
Difference between max and min readings, in:
0° = 0.0001 90° = 0.0012

Maximum difference must be < 0.0020 in. Difference = ± 0.00060
Flatness Tolerance Met? **YES**









DIAMETER 1

End 1:
Slope of Best Fit Line 0.00013
Angle of Best Fit Line: 0.00769

End 2:
Slope of Best Fit Line 0.00008
Angle of Best Fit Line: 0.00458

Maximum Angular Difference: 0.00311

Parallelism Tolerance Met? **YES**
Spherically Seated

DIAMETER 2

End 1:
Slope of Best Fit Line 0.00053
Angle of Best Fit Line: 0.03045

End 2:
Slope of Best Fit Line 0.00046
Angle of Best Fit Line: 0.02636

Maximum Angular Difference: 0.00409

Parallelism Tolerance Met? **YES**
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00050	1.990	0.00025	0.014	YES
Diameter 2, in (rotated 90°)	0.00080	1.990	0.00040	0.023	YES
END 2					
Diameter 1, in	0.00010	1.990	0.00005	0.003	YES
Diameter 2, in (rotated 90°)	0.00120	1.990	0.00060	0.035	YES

Maximum angle of departure must be ≤ 0.25°

Perpendicularity Tolerance Met? **YES**

Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Test Date:	2/22/2019
Tested By:	cmh
Checked By:	jsc
Boring ID:	BH-4
Sample ID:	R21
Depth, ft:	74.6-79.6



After cutting and grinding



After break

Client:	S.W. Cole Engineering, Inc.	Test Date:	2/22/2019
Project Name:	NECEC/KRC	Tested By:	cmh
Project Location:	Maine	Checked By:	jsc
GTX #:	309265		
Boring ID:	BH-4		
Sample ID:	R42		
Depth:	167-177.5 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.56	4.56	4.56
Specimen Diameter, in:	1.98	1.99	1.99
Specimen Mass, g:	625.25		
Bulk Density, lb/ft^3	168	**Minimum Diameter Tolerence Met?**	**YES**
Length to Diameter Ratio:	2.3	**Length to Diameter Ratio Tolerance Met?**	**YES**

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? **YES**

END FLATNESS AND PARALLELISM (Procedure FP1)

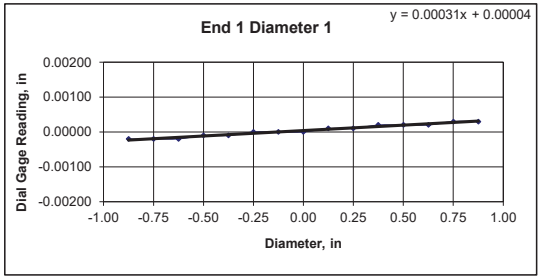
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00020	-0.00020	-0.00020	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00010	0.00010	0.00020	0.00020	0.00020	0.00030	0.00030
Diameter 2, in (rotated 90°)	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00000	0.00000	-0.00010	-0.00010	-0.00040	-0.00040	-0.00040	-0.00040	-0.00050

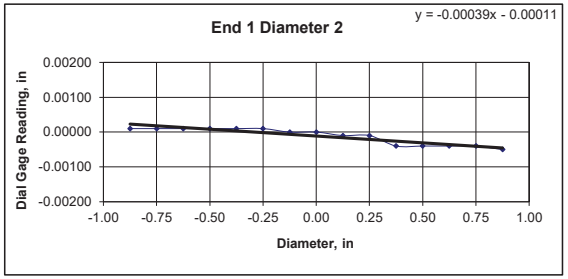
Difference between max and min readings, in:
0° = 0.00050 90° = 0.00060

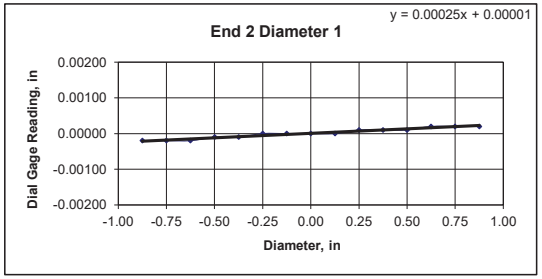
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00020	-0.00020	-0.00020	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00010	0.00010	0.00010	0.00020	0.00020	0.00020
Diameter 2, in (rotated 90°)	0.00040	0.00040	0.00030	0.00020	0.00020	0.00020	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00020	-0.00020	-0.00020	-0.00050

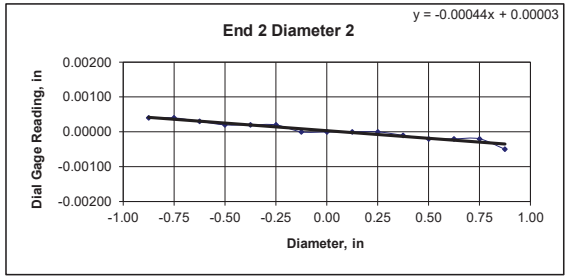
Difference between max and min readings, in:
0° = 0.0004 90° = 0.0009

Maximum difference must be < 0.0020 in. Difference = ± 0.00045
Flatness Tolerance Met? **YES**









DIAMETER 1

End 1:
Slope of Best Fit Line 0.00031
Angle of Best Fit Line: 0.01784

End 2:
Slope of Best Fit Line 0.00025
Angle of Best Fit Line: 0.01441

Maximum Angular Difference: 0.00344

Parallelism Tolerance Met? **YES**
Spherically Seated

DIAMETER 2

End 1:
Slope of Best Fit Line 0.00039
Angle of Best Fit Line: 0.02243

End 2:
Slope of Best Fit Line 0.00044
Angle of Best Fit Line: 0.02505

Maximum Angular Difference: 0.00262

Parallelism Tolerance Met? **YES**
Spherically Seated

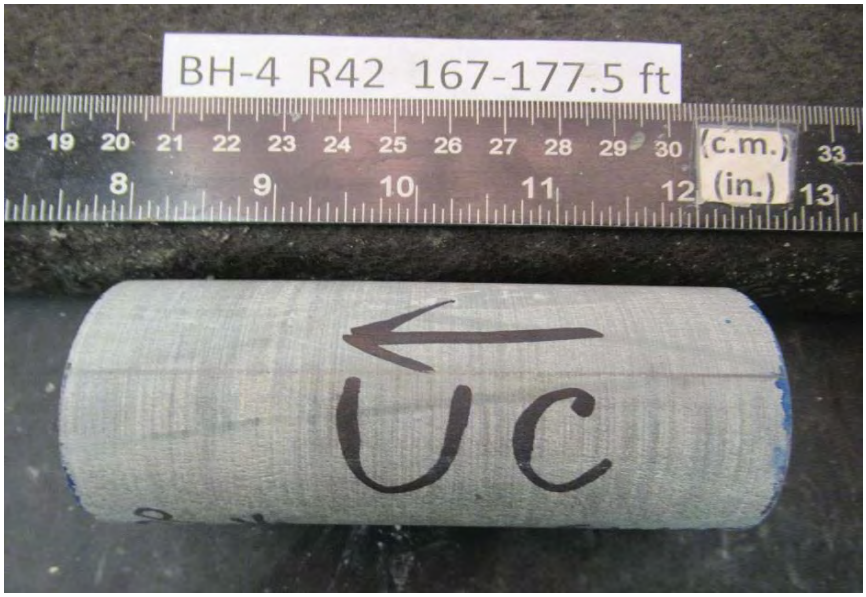
PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00050	1.985	0.00025	0.014	YES
Diameter 2, in (rotated 90°)	0.00060	1.985	0.00030	0.017	YES
END 2					
Diameter 1, in	0.00040	1.985	0.00020	0.012	YES
Diameter 2, in (rotated 90°)	0.00090	1.985	0.00045	0.026	YES

Maximum angle of departure must be ≤ 0.25°

Perpendicularity Tolerance Met? **YES**

Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Test Date:	2/22/2019
Tested By:	cmh
Checked By:	jsc
Boring ID:	BH-4
Sample ID:	R42
Depth, ft:	167-177.5



After cutting and grinding



After break

Client:	S.W. Cole Engineering, Inc.	Test Date:	2/22/2019
Project Name:	NECEC/KRC	Tested By:	cmh
Project Location:	Maine	Checked By:	jsc
GTX #:	309265		
Boring ID:	BH-4		
Sample ID:	R44		
Depth:	176.6-181.6 ft		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.49	4.50	4.50
Specimen Diameter, in:	1.99	1.99	1.99
Specimen Mass, g:	615.89		
Bulk Density, lb/ft^3	168	**Minimum Diameter Tolerence Met?**	YES
Length to Diameter Ratio:	2.3	**Length to Diameter Ratio Tolerance Met?**	YES

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? YES

END FLATNESS AND PARALLELISM (Procedure FP1)

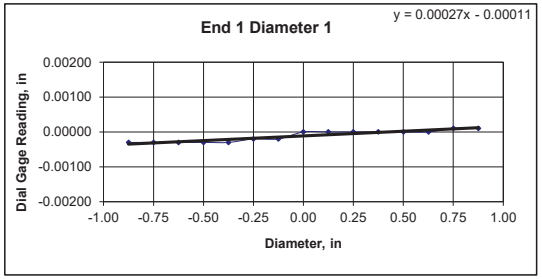
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00030	-0.00030	-0.00030	-0.00030	-0.00030	-0.00020	-0.00020	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00010	0.00010
Diameter 2, in (rotated 90°)	0.00020	0.00020	0.00010	0.00010	0.00010	0.00010	0.00010	0.00000	-0.00010	-0.00030	-0.00040	-0.00040	-0.00040	-0.00050	-0.00080

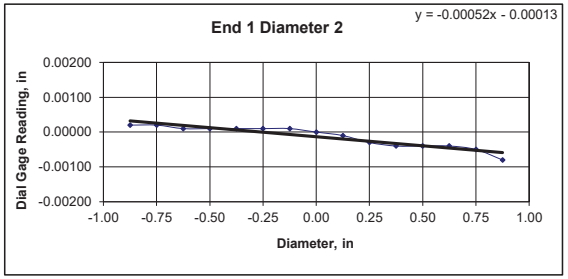
Difference between max and min readings, in:
0° = 0.00040 90° = 0.00100

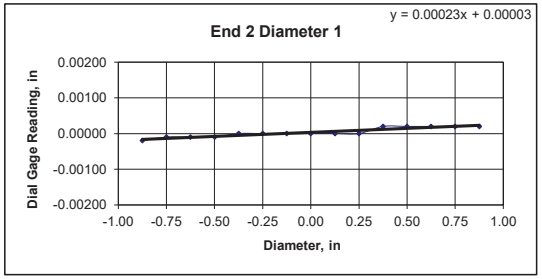
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00020	-0.00010	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00020	0.00020	0.00020	0.00020	0.00020
Diameter 2, in (rotated 90°)	0.00020	0.00020	0.00010	0.00010	0.00020	0.00020	0.00000	0.00000	0.00000	-0.00010	-0.00020	-0.00040	-0.00050	-0.00050	-0.00050

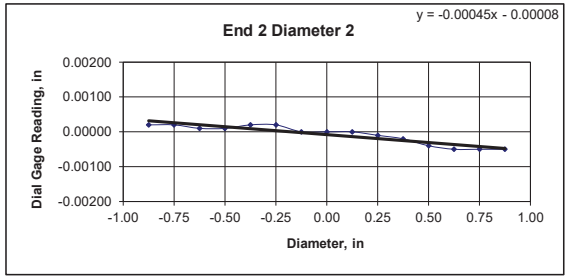
Difference between max and min readings, in:
0° = 0.0004 90° = 0.0007

Maximum difference must be < 0.0020 in. Difference = ± 0.00050
Flatness Tolerance Met? YES









DIAMETER 1

End 1:
Slope of Best Fit Line 0.00027
Angle of Best Fit Line: 0.01539

End 2:
Slope of Best Fit Line 0.00023
Angle of Best Fit Line: 0.01293

Maximum Angular Difference: 0.00246

Parallelism Tolerance Met? YES
Spherically Seated

DIAMETER 2

End 1:
Slope of Best Fit Line 0.00052
Angle of Best Fit Line: 0.02979

End 2:
Slope of Best Fit Line 0.00045
Angle of Best Fit Line: 0.02603

Maximum Angular Difference: 0.00377

Parallelism Tolerance Met? YES
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00040	1.990	0.00020	0.012	YES
Diameter 2, in (rotated 90°)	0.00100	1.990	0.00050	0.029	YES
END 2					
Diameter 1, in	0.00040	1.990	0.00020	0.012	YES
Diameter 2, in (rotated 90°)	0.00070	1.990	0.00035	0.020	YES

Maximum angle of departure must be ≤ 0.25°
Perpendicularity Tolerance Met? YES

Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Test Date:	2/22/2019
Tested By:	cmh
Checked By:	jsc
Boring ID:	BH-4
Sample ID:	R44
Depth, ft:	176.6-181.6



After cutting and grinding



After break

Client:	S.W. Cole Engineering, Inc.		
Project:	NECEC/KRC		
Location:	Maine		Project No: GTX-309265
Boring ID:	BH-2	Sample Type: cylinder	Tested By: smd
Sample ID:	R16	Test Date: 02/25/19	Checked By: jsc
Depth :	75-80 ft	Test Id: 495043	
Test Comment:	---		
Visual Description:	---		
Sample Comment:	---		

Abrasiveness of Rock Using the Cerchar Method by ASTM D7625

Boring ID	Sample ID	Depth	Stylus No	Reading 1	Reading 2	Average	Comments
BH-2	R16	75-80	1	0.5	0.4	0.45	
			2	1.3	0.5	0.90	
			3	0.4	0.6	0.50	
			4	1.0	0.6	0.80	
			5	0.8	0.7	0.75	
			Average CAIs			0.68	
			Average CAI *			1.15	
					CERCHAR Abrasiveness Index Classification	**Medium abrasiveness**	

Notes

Test Surface: Saw Cut
Moisture Condition: As Received
Apparatus Type: Original CERCHAR
Stylus Hardness: Rockwell Hardess 54/56 HRC
Stylus Displacement Relative to Rock Fabric:
Styli 1-3: Normal; Styli 4-5: Parallel
* CAI = (0.99 * CAIs) + 0.48
CAIs = CERCHAR index for smooth (saw cut) surface
CAI = CERCHAR index for natural surface
Comments:



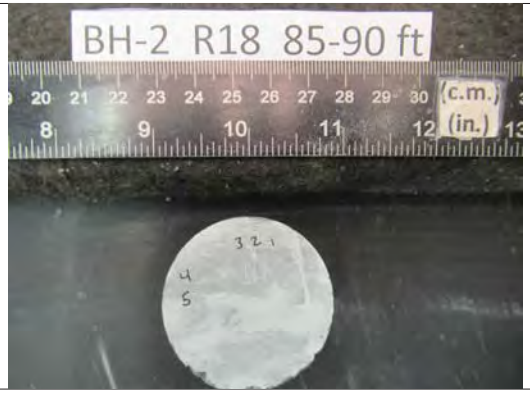
Client:	S.W. Cole Engineering, Inc.				
Project:	NECEC/KRC				
Location:	Maine			Project No:	GTX-309265
Boring ID:	BH-2	Sample Type:	cylinder	Tested By:	smd
Sample ID:	R18	Test Date:	02/25/19	Checked By:	jsc
Depth :	85-90 ft	Test Id:	495047		
Test Comment:	---				
Visual Description:	---				
Sample Comment:	---				

Abrasiveness of Rock Using the Cerchar Method by ASTM D7625

Boring ID	Sample ID	Depth	Stylus No	Reading 1	Reading 2	Average	Comments
BH-2	R18	85-90	1	1.0	0.6	0.80	
			2	1.0	0.9	0.95	
			3	0.1	0.5	0.30	
			4	0.1	0.4	0.25	
			5	0.6	0.3	0.45	
			Average CAIs			0.55	
			Average CAI *			1.02	
				CERCHAR Abrasiveness Index Classification		**Medium abrasiveness**	

Notes

Test Surface: Saw Cut
Moisture Condition: As Received
Apparatus Type: Original CERCHAR
Stylus Hardness: Rockwell Hardess 54/56 HRC
Stylus Displacement Relative to Rock Fabric:
Styli 1-3: Normal; Styli 4-5: Parallel
* CAI = (0.99 * CAIs) + 0.48
CAIs = CERCHAR index for smooth (saw cut) surface
CAI = CERCHAR index for natural surface
Comments:



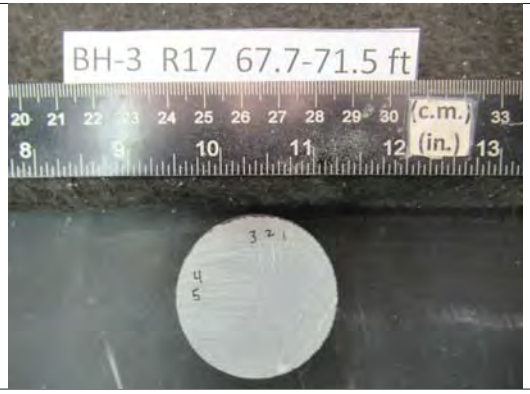
Client:	S.W. Cole Engineering, Inc.				
Project:	NECEC/KRC				
Location:	Maine			Project No:	GTX-309265
Boring ID:	BH-3	Sample Type:	cylinder	Tested By:	smd
Sample ID:	R17	Test Date:	02/25/19	Checked By:	jsc
Depth :	67.7-71.5 ft	Test Id:	495052		
Test Comment:	---				
Visual Description:	---				
Sample Comment:	---				

Abrasiveness of Rock Using the Cerchar Method by ASTM D7625

Boring ID	Sample ID	Depth	Stylus No	Reading 1	Reading 2	Average	Comments
BH-3	R17	67.7-71.5	1	0.5	0.8	0.65	
			2	1.7	1.1	1.40	
			3	0.1	0.3	0.20	
			4	0.4	0.3	0.35	
			5	0.7	0.3	0.50	
			Average CAIs			0.62	
			Average CAI *			1.09	
				CERCHAR Abrasiveness Index Classification		**Medium abrasiveness**	

Notes

Test Surface: Saw Cut
Moisture Condition: As Received
Apparatus Type: Original CERCHAR
Stylus Hardness: Rockwell Hardess 54/56 HRC
Stylus Displacement Relative to Rock Fabric:
Styli 1-3: Normal; Styli 4-5: Parallel
* CAI = (0.99 * CAIs) + 0.48
CAIs = CERCHAR index for smooth (saw cut) surface
CAI = CERCHAR index for natural surface
Comments:



Client:	S.W. Cole Engineering, Inc.				
Project:	NECEC/KRC				
Location:	Maine			Project No:	GTX-309265
Boring ID:	BH-3	Sample Type:	cylinder	Tested By:	smd
Sample ID:	R25	Test Date:	02/25/19	Checked By:	jsc
Depth :	101.5-106.5 ft	Test Id:	495054		
Test Comment:	---				
Visual Description:	---				
Sample Comment:	---				

Abrasiveness of Rock Using the Cerchar Method by ASTM D7625

Boring ID	Sample ID	Depth	Stylus No	Reading 1	Reading 2	Average	Comments
BH-3	R25	101.5-106.5	1	0.1	0.1	0.10	
			2	0.1	0.1	0.10	
			3	0.1	0.1	0.10	
			4	0.1	0.1	0.10	
			5	0.3	0.1	0.20	
			Average CAIs			0.12	
			Average CAI *			0.60	
				CERCHAR Abrasiveness Index Classification		**Low abrasiveness**	

Notes

Test Surface: Saw Cut
Moisture Condition: As Received
Apparatus Type: Original CERCHAR
Stylus Hardness: Rockwell Hardess 54/56 HRC
Stylus Displacement Relative to Rock Fabric:
Styli 1-3: Normal; Styli 4-5: Parallel
* CAI = (0.99 * CAIs) + 0.48
CAIs = CERCHAR index for smooth (saw cut) surface
CAI = CERCHAR index for natural surface
Comments:



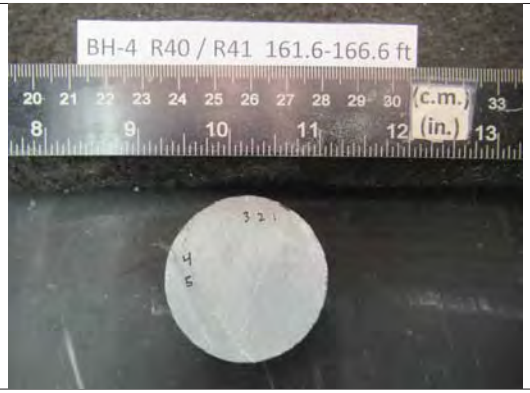
Client:	S.W. Cole Engineering, Inc.				
Project:	NECEC/KRC				
Location:	Maine			Project No:	GTX-309265
Boring ID:	BH-4	Sample Type:	cylinder	Tested By:	smd
Sample ID:	R40 / R41	Test Date:	02/25/19	Checked By:	jsc
Depth :	160-166.6 ft	Test Id:	495062		
Test Comment:	---				
Visual Description:	---				
Sample Comment:	---				

Abrasiveness of Rock Using the Cerchar Method by ASTM D7625

Boring ID	Sample ID	Depth	Stylus No	Reading 1	Reading 2	Average	Comments
BH-4	R40 / R41	161.6-166.6	1	1.2	0.7	0.95	
			2	1.4	1.2	1.30	
			3	0.2	0.1	0.15	
			4	0.4	0.3	0.35	
			5	0.7	0.3	0.50	
			Average CAIs			0.65	
			Average CAI *			1.12	
				CERCHAR Abrasiveness Index Classification		**Medium abrasiveness**	

Notes

Test Surface: Saw Cut
Moisture Condition: As Received
Apparatus Type: Original CERCHAR
Stylus Hardness: Rockwell Hardess 54/56 HRC
Stylus Displacement Relative to Rock Fabric:
Styli 1-3: Normal; Styli 4-5: Parallel
* CAI = (0.99 * CAIs) + 0.48
CAIs = CERCHAR index for smooth (saw cut) surface
CAI = CERCHAR index for natural surface
Comments:



Client:	S.W. Cole Engineering, Inc.				
Project:	NECEC/KRC				
Location:	Maine			Project No:	GTX-309265
Boring ID:	BH-4	Sample Type:	cylinder	Tested By:	smd
Sample ID:	R21	Test Date:	02/25/19	Checked By:	jsc
Depth :	74.6-79.6 ft	Test Id:	495059		
Test Comment:	---				
Visual Description:	---				
Sample Comment:	---				

Abrasiveness of Rock Using the Cerchar Method by ASTM D7625

Boring ID	Sample ID	Depth	Stylus No	Reading 1	Reading 2	Average	Comments
BH-4	R21	74.6-79.6	1	0.2	0.8	0.50	
			2	0.4	0.5	0.45	
			3	1.2	0.9	1.05	
			4	0.3	0.2	0.25	
			5	0.7	0.8	0.75	
			Average CAIs			0.6	
			Average CAI *			1.07	
				CERCHAR Abrasiveness Index Classification		**Medium abrasiveness**	

Notes

Test Surface: Saw Cut
Moisture Condition: As Received
Apparatus Type: Original CERCHAR
Stylus Hardness: Rockwell Hardess 54/56 HRC
Stylus Displacement Relative to Rock Fabric:
Styli 1-3: Normal; Styli 4-5: Parallel
* CAI = (0.99 * CAIs) + 0.48
CAIs = CERCHAR index for smooth (saw cut) surface
CAI = CERCHAR index for natural surface
Comments:



Client:	S.W. Cole Engineering, Inc.				
Project:	NECEC/KRC				
Location:	Maine			Project No:	GTX-309265
Boring ID:	BH-4	Sample Type:	cylinder	Tested By:	smd
Sample ID:	R44	Test Date:	02/25/19	Checked By:	jsc
Depth :	176.6-181.6 ft	Test Id:	495068		
Test Comment:	---				
Visual Description:	---				
Sample Comment:	---				

Abrasiveness of Rock Using the Cerchar Method by ASTM D7625

Boring ID	Sample ID	Depth	Stylus No	Reading 1	Reading 2	Average	Comments
BH-4	R44	176.6-181.6	1	2.2	2.3	2.25	
			2	2.8	2.5	2.65	
			3	2.7	2.4	2.55	
			4	2.7	3.0	2.85	
			5	2.8	6.0	4.40	
			Average CAIs			2.94	
			Average CAI *			3.39	
					CERCHAR Abrasiveness Index Classification	**High abrasiveness**	

Notes

Test Surface: Saw Cut
Moisture Condition: As Received
Apparatus Type: Original CERCHAR
Stylus Hardness: Rockwell Hardess 54/56 HRC
Stylus Displacement Relative to Rock Fabric:
Styli 1-3: Normal; Styli 4-5: Parallel
* CAI = (0.99 * CAIs) + 0.48
CAIs = CERCHAR index for smooth (saw cut) surface
CAI = CERCHAR index for natural surface
Comments:



Client:	S.W. Cole Engineering, Inc.				
Project:	NECEC/KRC				
Location:	Maine			Project No:	GTX-309265
Boring ID:	BH-2	Sample Type:	cylinder	Tested By:	smd
Sample ID:	R16	Test Date:	03/01/19	Checked By:	jsc
Depth :	75-80 ft	Test Id:	495044		
Test Comment:	---				
Visual Description:	See photograph(s)				
Sample Comment:	---				

Slake Durability of Shales and Similar Weak Rocks by ASTM D4644

Boring ID	Sample ID	Depth	Visual Description	Slake Durability Index %	Average water temperature, degrees C	As-Received Water Content %	Description of Fragments
BH-2	R16	75-80	See photograph(s)	99.5	20	0.1	Type I

Comments: Description of the appearance of the fragments retained in the drum:

Type I - Retained pieces remain virtually unchanged

Type II - Retained materials consist of large and small fragments

Type III - Retained material is exclusively small fragments

Before Test:



After Test:



Client:	S.W. Cole Engineering, Inc.				
Project:	NECEC/KRC				
Location:	Maine			Project No:	GTX-309265
Boring ID:	BH-3	Sample Type:	cylinder	Tested By:	smd
Sample ID:	R25	Test Date:	03/01/19	Checked By:	jsc
Depth :	101.5-106.5 ft	Test Id:	495056		
Test Comment:	---				
Visual Description:	See photograph(s)				
Sample Comment:	---				

Slake Durability of Shales and Similar Weak Rocks by ASTM D4644

Boring ID	Sample ID	Depth	Visual Description	Slake Durability Index %	Average water temperature, degrees C	As-Received Water Content %	Description of Fragments
BH-3	R25	101.5-106.5	See photograph(s)	99.4	20	0.1	Type I

Comments: Description of the appearance of the fragments retained in the drum:

Type I - Retained pieces remain virtually unchanged

Type II - Retained materials consist of large and small fragments

Type III - Retained material is exclusively small fragments

Before Test:



After Test:



Client:	S.W. Cole Engineering, Inc.				
Project:	NECEC/KRC				
Location:	Maine			Project No:	GTX-309265
Boring ID:	BH-4	Sample Type:	cylinder	Tested By:	smd
Sample ID:	R21	Test Date:	03/01/19	Checked By:	jsc
Depth :	74.6-79.6 ft	Test Id:	495060		
Test Comment:	---				
Visual Description:	See photograph(s)				
Sample Comment:	---				

Slake Durability of Shales and Similar Weak Rocks by ASTM D4644

Boring ID	Sample ID	Depth	Visual Description	Slake Durability Index %	Average water temperature, degrees C	As-Received Water Content %	Description of Fragments
BH-4	R21	74.6-79.6	See photograph(s)	99.4	20	0.1	Type I

Comments: Description of the appearance of the fragments retained in the drum:

Type I - Retained pieces remain virtually unchanged

Type II - Retained materials consist of large and small fragments

Type III - Retained material is exclusively small fragments

Before Test:



After Test:



Client:	S.W. Cole Engineering, Inc.				
Project:	NECEC/KRC				
Location:	Maine			Project No:	GTX-309265
Boring ID:	BH-4	Sample Type:	cylinder	Tested By:	smd
Sample ID:	R42	Test Date:	03/01/19	Checked By:	jsc
Depth :	167-177.5 ft	Test Id:	495066		
Test Comment:	---				
Visual Description:	See photograph(s)				
Sample Comment:	---				

Slake Durability of Shales and Similar Weak Rocks by ASTM D4644

Boring ID	Sample ID	Depth	Visual Description	Slake Durability Index %	Average water temperature, degrees C	As-Received Water Content %	Description of Fragments
BH-4	R42	167-177.5	See photograph(s)	99.4	20	0.0	Type I

Comments: Description of the appearance of the fragments retained in the drum:

Type I - Retained pieces remain virtually unchanged

Type II - Retained materials consist of large and small fragments

Type III - Retained material is exclusively small fragments

Before Test:



After Test:



Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Test Date:	3/12/2019
Tested By:	tlm
Checked By:	jsc
Boring ID:	BH-3
Sample ID:	R23/R24
Depth, ft:	92.1-100.0

Rock Drillability Tests (1) (2)

Test Results:

Brittleness Value S_{20}, (%)	Flakiness, (f)	Compaction Index	Density, (g/cm^3)	Sievers J-Value, (0.1 mm)	Abrasion Value, (mg)	Abrasion Value Steel Cutters, (mg)
46.57	1.49	1	2.74	3.09	1.40	1.75
Medium	---	---	---	**Very High**	**Very Low**	**Very Low**

Calculated Indices:

	Drilling Rate Index	Bit Wear Index	Cutter Life Index
Assessed value	41	24	17.2
Classification Category	**Low**	**Low**	**High**

NTNU/SINTEF Rock Drillability Tests Classifications:

Classification of Indices according to "13A-98 Drillability Test Methods," Dept. of Civil and Transport Engineering, NTNU.

Category	Drilling Rate Index	Bit Wear Index	Cutter Life Index
Extremely Low Very Low	$\leq$ 25 26 - 32	$\leq$ 10 11-20	$\leq$ 5 5.0-5.9
Low	33 - 42	21 - 30	6.0 - 7.9
Medium	43 - 57	31 - 44	8.0 - 14.9
High	58 - 69	45 - 55	15 - 34
Very High Extremely High	70 - 82 $\geq$ 83	56 - 69 $\geq$ 70	35 - 74 $\geq$ 75

Notes:

1. GeoTesting Express's Rock Drillability testing suite is based on NTNU/SINTEF's 13A-98 Drillability Test Methods, Dept. of Civil and Transportation Engineering and performed in accordance with Dahl, Filip, 2003, The Suggested DRI, BWI, CLI Standard.
2. The trademarked acronyms and terms DRI™, BWI™, CLI™ BWI™, SAT™, Bit Wear Index™, Cutter Life Index™ and Soil Abrasion Test™ are unique for test results and calculated indices originating from NTNU/SINTEF and can only be obtained by testing samples at their reference laboratory in Trondheim, Norway.
3. Samples were delivered to GTX by client.
4. Testing was done on best representative rock specimens from samples provided.
5. Samples were stored at $20^{o} \pm 5^{o}$ C for a minimum of 48 hrs before testing.
6. Assessed values were measured by NTNU/SINTEF's Hard Rock Tunnel Boring Drillability Test Methods figures.

Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Test Date:	43536
Tested By:	tlm
Checked By:	jsc
Boring ID:	BH-3
Sample ID:	R23/R24
Depth, ft:	92.1-100.0

Rock Drillability Tests

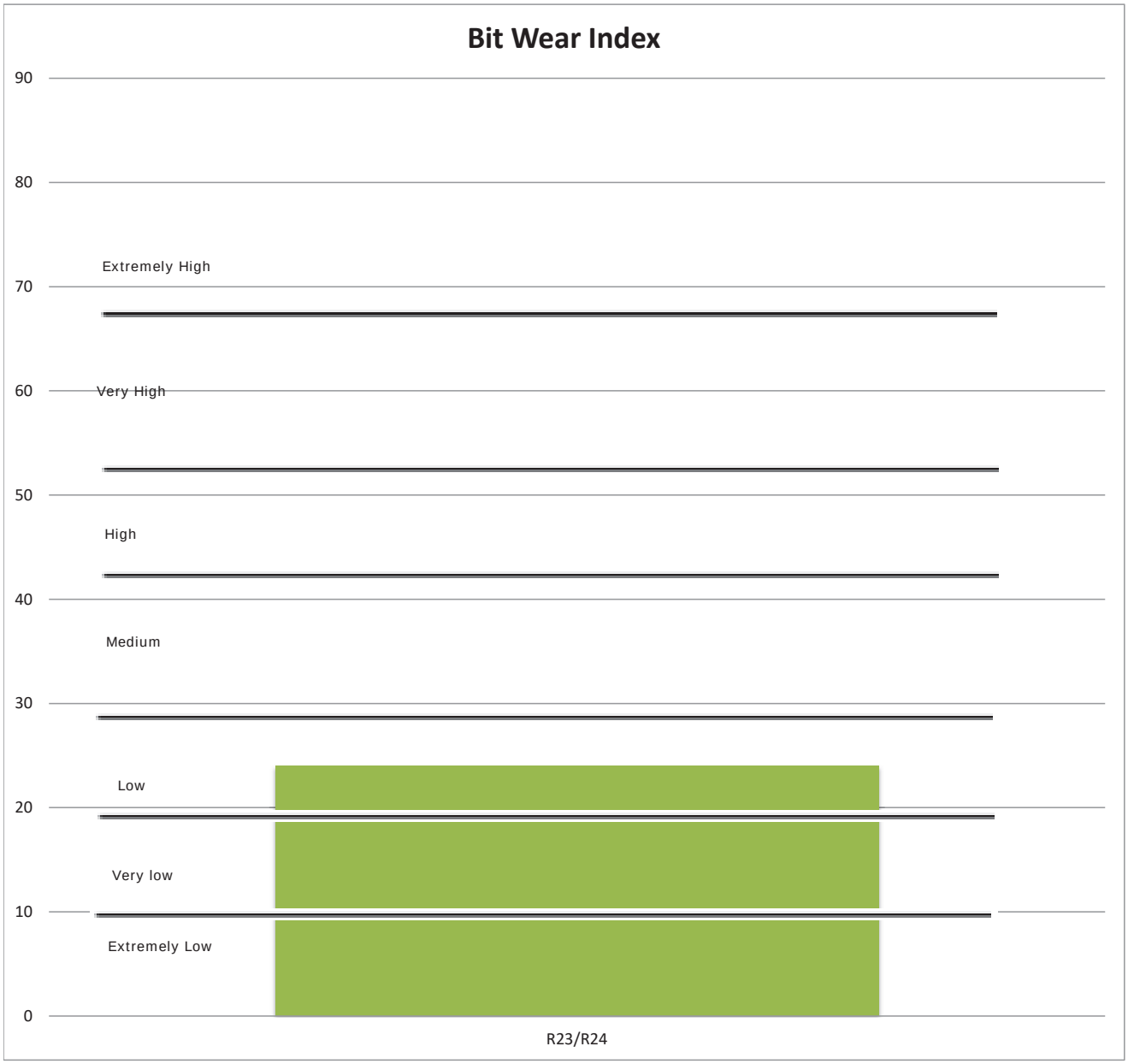


Notes:

1. GeoTesting Express's Rock Drillability testing suite is based on NTNU/SINTEF's 13A-98 Drillability Test Methods, Dept. of Civil and Transportation Engineering and performed in accordance with Dahl, Filip, 2003, The Suggested DRI, BWI, CLI Standard.
2. The trademarked acronyms and terms DRI™, BWI™, CLI™ BWI™, SAT™, Bit Wear Index™, Cutter Life Index™ and Soil Abrasion Test™ are unique for test results and calculated indices originating from NTNU/SINTEF and can only be obtained by testing samples at their reference laboratory in Trondheim, Norway.

Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Test Date:	43536
Tested By:	tlm
Checked By:	jsc
Boring ID:	BH-3
Sample ID:	R23/R24
Depth, ft:	92.1-100.0

Rock Drillability Tests



Notes:

1. GeoTesting Express's Rock Drillability testing suite is based on NTNU/SINTEF's 13A-98 Drillability Test Methods, Dept. of Civil and Transportation Engineering and performed in accordance with Dahl, Filip, 2003, The Suggested DRI, BWI, CLI Standard.
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Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Test Date:	43536
Tested By:	tlm
Checked By:	jsc
Boring ID:	BH-3
Sample ID:	R23/R24
Depth, ft:	92.1-100.0

Rock Drillability Tests



Notes:

1. GeoTesting Express's Rock Drillability testing suite is based on NTNU/SINTEF's 13A-98 Drillability Test Methods, Dept. of Civil and Transportation Engineering and performed in accordance with Dahl, Filip, 2003, The Suggested DRI, BWI, CLI Standard.
2. The trademarked acronyms and terms DRI™, BWI™, CLI™ BWI™, SAT™, Bit Wear Index™, Cutter Life Index™ and Soil Abrasion Test™ are unique for test results and calculated indices originating from NTNU/SINTEF and can only be obtained by testing samples at their reference laboratory in Trondheim, Norway.

Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Boring ID:	BH-3
Sample ID:	R23/R24
Depth, ft:	92.1-100.0

Rock Drillability - Sample As-Received



(* indicates location of Sievers' J-Value sampling)

Notes:

1. GeoTesting Express's Rock Drillability testing suite is based on NTNU/SINTEF's 13A-98 Drillability Test Methods, Dept. of Civil and Transportation Engineering and performed in accordance with Dahl, Filip, 2003, The Suggested DRI, BWI, CLI Standard.
2. The trademarked acronyms and terms DRI™, BWI™, CLI™ BWI™, SAT™, Bit Wear Index™, Cutter Life Index™ and Soil Abrasion Test™ are unique for test results and calculated indices originating from NTNU/SINTEF and can only be obtained by testing samples at their reference laboratory in Trondheim, Norway.

Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Test Date:	3/12/2019
Tested By:	tlm
Checked By:	jsc
Boring ID:	BH-3
Sample ID:	R23/R24
Depth, ft:	92.1-100.0

Rock Drillability - Brittleness Value

Individual Test Results

Test Number	Brittleness Value, S_{20} (%)
1	27.4
2	51.0
3	61.3
Average	46.6

Sample classification: Medium

Brittleness Value Reference Classification Chart

Category	Brittleness Value, S_{20} (%)
Extremely Low	≤ 29.0
Very Low	29.1 - 34.9
Low	35.0 - 40.9
Medium	41.0 - 50.9
High	51.0 - 59.9
Very High	60.0 - 65.9
Extremely High	≥ 66.0

Notes:

1. GeoTesting Express's Rock Drillability testing suite is based on NTNU/SINTEF's 13A-98 Drillability Test Methods, Dept. of Civil and Transportation Engineering and performed in accordance with Dahl, Filip, 2003, The Suggested DRI, BWI, CLI Standard.
2. The trademarked acronyms and terms DRI™, BWI™, CLI™ BWI™, SAT™, Bit Wear Index™, Cutter Life Index™ and Soil Abrasion Test™ are unique for test results and calculated indices originating from NTNU/SINTEF and can only be obtained by testing samples at their reference laboratory in Trondheim, Norway.
3. The Brittleness Value test is performed on three extractions from one representative and homogenized sample of crushed and sieved rock material. When there is not enough material provided to perform the three tests, one or two tests may be performed.

Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Test Date:	3/5/2019
Tested By:	tlm
Checked By:	jsc
Boring ID:	BH-3
Sample ID:	R23/R24
Depth, ft:	92.1-100.0

Rock Drillability - Sievers' J-Value

Individual Test Results

Test Number	Sievers' J-Value SJ (1/10 mm)
1	2.15
2	5.25
3	1.33
4	4.00
5	2.70
Average	3.09

Sample Classification: Very High

Sievers' J-Value Reference Classification Chart

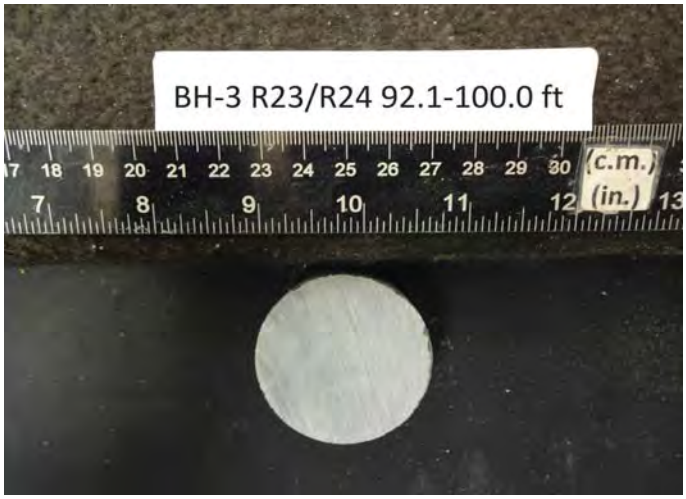
Category	SJ-Value (1/10 mm)
Extremely High	≤ 2.0
Very High	2.1 - 3.9
High	4.0 - 6.9
Medium	7.0 - 18.9
Low	19.0 - 55.9
Very Low	56.0 - 85.9
Extremely Low	≥ 86.0

Notes:

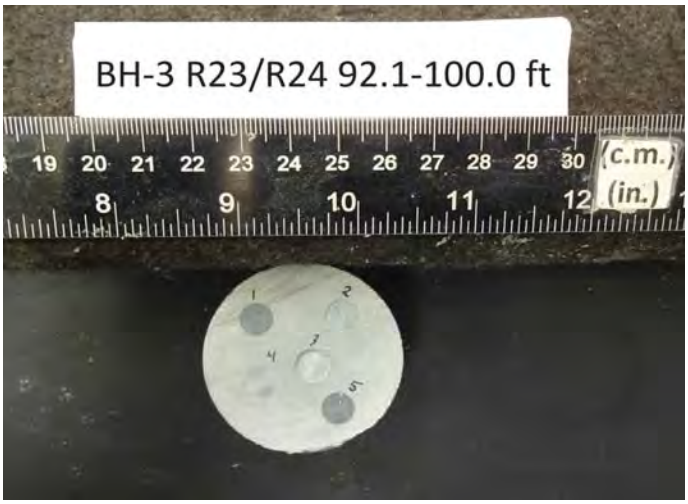
1. GeoTesting Express's Rock Drillability testing suite is based on NTNU/SINTEF's 13A-98 Drillability Test Methods, Dept. of Civil and Transportation Engineering and performed in accordance with Dahl, Filip, 2003, The Suggested DRI, BWI, CLI Standard.
2. The trademarked acronyms and terms DRI™, BWI™, CLI™ BWI™, SAT™, Bit Wear Index™, Cutter Life Index™ and Soil Abrasion Test™ are unique for test results and calculated indices originating from NTNU/SINTEF and can only be obtained by testing samples at their reference laboratory in Trondheim, Norway.
3. The standard number of Sievers' J drillings performed on each sample is 4 to 8, depending on the variation in the texture of the sample. Drilling locations were selected to be tested on 60% hard and 40% softer layers found in the sample. Soft/hard combinations at drill locations are avoided as best as possible to try to give a more accurate representation of the rock. This is however impossible in samples which have alternating soft and hard layered mineral composition. The average Sievers' J value is regarded as representative for the tested rock.
4. Test was performed at 197 RPM.

Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Test Date:	3/5/2019
Tested By:	tlm
Checked By:	jsc
Boring ID:	BH-3
Sample ID:	R23/R24
Depth, ft:	92.1-100.0

Rock Drillability - Sievers' J-Value Sample



Sample before testing



After testing showing drill locations

Notes:

1. GeoTesting Express's Rock Drillability testing suite is based on NTNU/SINTEF's 13A-98 Drillability Test Methods, Dept. of Civil and Transportation Engineering and performed in accordance with Dahl, Filip, 2003, The Suggested DRI, BWI, CLI Standard.
2. The trademarked acronyms and terms DRI™, BWI™, CLI™ BWI™, SAT™, Bit Wear Index™, Cutter Life Index™ and Soil Abrasion Test™ are unique for test results and calculated indices originating from NTNU/SINTEF and can only be obtained by testing samples at their reference laboratory in Trondheim, Norwav.

Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Test Date:	3/12/2019
Tested By:	tlm
Checked By:	jsc
Boring ID:	BH-3
Sample ID:	R23/R24
Depth, ft:	92.1-100.0

Rock Drillability - Abrasion Value (AV)

Individual Test Results

Test Number	Abrasion Value AV (mg)
1	1.70
2	1.10
Average	1.40

Sample Classification: Very Low

Abrasion Value Reference Classification Chart

Category	AV (mg)
Extremely Low	≤ 1.0
Very Low	1.1 - 3.9
Low	4.0 - 10.9
Medium	11.0 - 27.9
High	28.0 - 41.9
Very High	42.0 - 57.9
Extremely High	≥ 58.0

Notes:

1. GeoTesting Express's Rock Drillability testing suite is based on NTNU/SINTEF's 13A-98 Drillability Test Methods, Dept. of Civil and Transportation Engineering and performed in accordance with Dahl, Filip, 2003, The Suggested DRI, BWI, CLI Standard.
2. The trademarked acronyms and terms DRI™, BWI™, CLI™ BWI™, SAT™, Bit Wear Index™, Cutter Life Index™ and Soil Abrasion Test™ are unique for test results and calculated indices originating from NTNU/SINTEF and can only be obtained by testing samples at their reference laboratory in Trondheim, Norway.
3. Abrasion test material was taken from the extractions used for the Brittleness Value test. The AV test pieces are comprised of tungsten carbide. Grain size, shape and binding are some factors that are believed to have substantial influence on the abrasiveness of the rock.
4. Test was performed at 20 RPM for 5 mins for a total of 100 revolutions

Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Test Date:	3/12/2019
Tested By:	tlm
Checked By:	jsc
Boring ID:	BH-3
Sample ID:	R23/R24
Depth, ft:	92.1-100.0

Rock Drillability - Abrasion Value Cutter Steel (AVS)

Individual Test Results

Test Number	Abrasion Value Cutter Steel AVS (mg)
1	1.60
2	1.90
Average	1.75

Sample Classification: Very Low

Abrasion Value Cutter Steel Reference Classification Chart

Category	AVS (mg)
Extremely Low	≤ 1.0
Very Low	1.1 - 3.9
Low	4.0 - 12.9
Medium	13.0 - 25.9
High	26.0 - 35.9
Very High	36.0 - 43.9
Extremely High	≥ 44.0

Notes:

1. GeoTesting Express's Rock Drillability testing suite is based on NTNU/SINTEF's 13A-98 Drillability Test Methods, Dept. of Civil and Transportation Engineering and performed in accordance with Dahl, Filip, 2003, The Suggested DRI, BWI, CLI Standard.
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3. Abrasion test material was taken from the extractions used for the Brittleness Value test. The AVS test pieces are comprised of cutter ring steel. Grain size, shape and binding are some factors that are believed to have substantial influence on the abrasiveness of the rock.
4. Test was performed at 20 RPM for 1 minute for a total of 20 revolutions.

Rock Drillability Test Equipment



Brittleness test equipment



An example sample prior to impacts



An example sample after 20 impacts

Notes:

1. GeoTesting Express's Rock Drillability testing suite is based on NTNU/SINTEF's 13A-98 Drillability Test Methods, Dept. of Civil and Transportation Engineering and performed in accordance with Dahl, Filip, 2003, The Suggested DRI, BWI, CLI Standard.
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Rock Drillability Test Equipment



Sievers' J-Value Apparatus



Closeup of Sievers J-Value Apparatus with sample



Sievers' J-Value untested drillbits

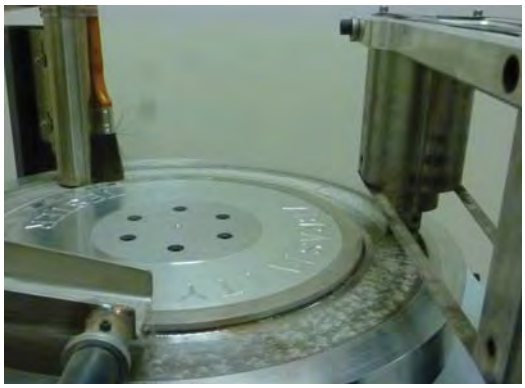
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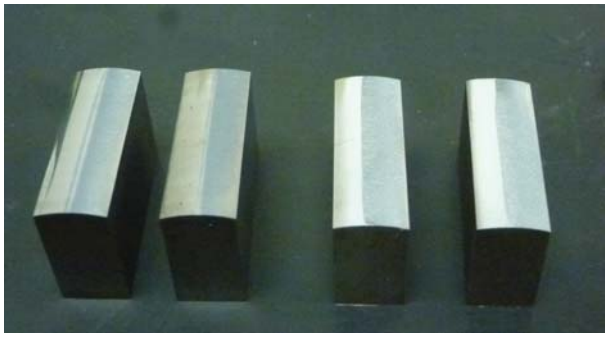
Rock Drillability Test Equipment



Abrasivity machine



Closeup of Abrasivity machine with sample



AV (left) & AVS (right) bits showing wear from testing

Notes:

1. GeoTesting Express's Rock Drillability testing suite is based on NTNU/SINTEF's 13A-98 Drillability Test Methods, Dept. of Civil and Transportation Engineering and performed in accordance with Dahl, Filip, 2003, The Suggested DRI, BWI, CLI Standard.
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Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Test Date:	3/12/2019
Tested By:	tlm
Checked By:	jsc
Boring ID:	BH-4
Sample ID:	R40/R41
Depth, ft:	160-166.6

Rock Drillability Tests (1) (2)

Test Results:

Brittleness Value S_{20}, (%)	Flakiness, (f)	Compaction Index	Density, (g/cm^3)	Sievers J-Value, (0.1 mm)	Abrasion Value, (mg)	Abrasion Value Steel Cutters, (mg)
45.75	1.4	1	2.73	5.64	1.85	2.75
Medium	---	---	---	**High**	**Very Low**	**Very Low**

Calculated Indices:

	Drilling Rate Index	Bit Wear Index	Cutter Life Index
Assessed value	44	23	18.2
Classification Category	**Medium**	**Low**	**High**

NTNU/SINTEF Rock Drillability Tests Classifications:

Classification of Indices according to "13A-98 Drillability Test Methods," Dept. of Civil and Transport Engineering, NTNU.

Category	Drilling Rate Index	Bit Wear Index	Cutter Life Index
Extremely Low Very Low	$\leq$ 25 26 - 32	$\leq$ 10 11-20	$\leq$ 5 5.0-5.9
Low	33 - 42	21 - 30	6.0 - 7.9
Medium	43 - 57	31 - 44	8.0 - 14.9
High	58 - 69	45 - 55	15 - 34
Very High Extremely High	70 - 82 $\geq$ 83	56 - 69 $\geq$ 70	35 - 74 $\geq$ 75

Notes:

1. GeoTesting Express's Rock Drillability testing suite is based on NTNU/SINTEF's 13A-98 Drillability Test Methods, Dept. of Civil and Transportation Engineering and performed in accordance with Dahl, Filip, 2003, The Suggested DRI, BWI, CLI Standard.
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3. Samples were delivered to GTX by client.
4. Testing was done on best representative rock specimens from samples provided.
5. Samples were stored at $20^{o} \pm 5^{o}$ C for a minimum of 48 hrs before testing.
6. Assessed values were measured by NTNU/SINTEF's Hard Rock Tunnel Boring Drillability Test Methods figures.

Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Test Date:	43536
Tested By:	tlm
Checked By:	jsc
Boring ID:	BH-4
Sample ID:	R40/R41
Depth, ft:	160-166.6

Rock Drillability Tests

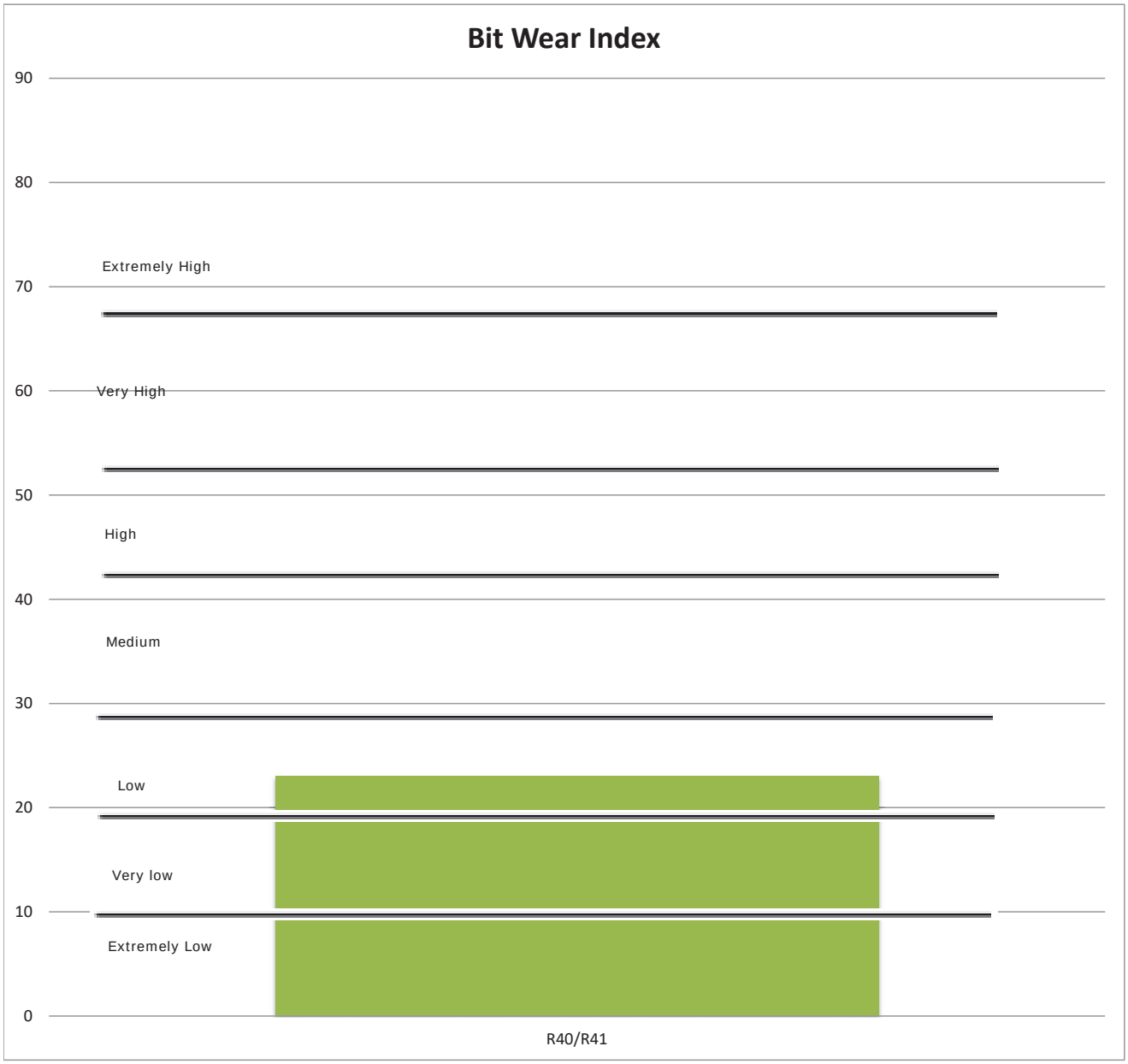


Notes:

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Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Test Date:	43536
Tested By:	tlm
Checked By:	jsc
Boring ID:	BH-4
Sample ID:	R40/R41
Depth, ft:	160-166.6

Rock Drillability Tests



Notes:

1. GeoTesting Express's Rock Drillability testing suite is based on NTNU/SINTEF's 13A-98 Drillability Test Methods, Dept. of Civil and Transportation Engineering and performed in accordance with Dahl, Filip, 2003, The Suggested DRI, BWI, CLI Standard.
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Boring ID:	BH-4
Sample ID:	R40/R41
Depth, ft:	160-166.6

Rock Drillability Tests



Notes:

1. GeoTesting Express's Rock Drillability testing suite is based on NTNU/SINTEF's 13A-98 Drillability Test Methods, Dept. of Civil and Transportation Engineering and performed in accordance with Dahl, Filip, 2003, The Suggested DRI, BWI, CLI Standard.
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Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Boring ID:	BH-4
Sample ID:	R40/R41
Depth, ft:	160-166.6

Rock Drillability - Sample As-Received



(* indicates location of Sievers' J-Value sampling)

Notes:

1. GeoTesting Express's Rock Drillability testing suite is based on NTNU/SINTEF's 13A-98 Drillability Test Methods, Dept. of Civil and Transportation Engineering and performed in accordance with Dahl, Filip, 2003, The Suggested DRI, BWI, CLI Standard.
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Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Test Date:	3/12/2019
Tested By:	tlm
Checked By:	jsc
Boring ID:	BH-4
Sample ID:	R40/R41
Depth, ft:	160-166.6

Rock Drillability - Brittleness Value

Individual Test Results

Test Number	Brittleness Value, S_{20} (%)
1	28.95
2	49.48
3	58.83
Average	45.75

Sample classification: Medium

Brittleness Value Reference Classification Chart

Category	Brittleness Value, S_{20} (%)
Extremely Low	≤ 29.0
Very Low	29.1 - 34.9
Low	35.0 - 40.9
Medium	41.0 - 50.9
High	51.0 - 59.9
Very High	60.0 - 65.9
Extremely High	≥ 66.0

Notes:

1. GeoTesting Express's Rock Drillability testing suite is based on NTNU/SINTEF's 13A-98 Drillability Test Methods, Dept. of Civil and Transportation Engineering and performed in accordance with Dahl, Filip, 2003, The Suggested DRI, BWI, CLI Standard.
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3. The Brittleness Value test is performed on three extractions from one representative and homogenized sample of crushed and sieved rock material. When there is not enough material provided to perform the three tests, one or two tests may be performed.

Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Test Date:	3/5/2019
Tested By:	tlm
Checked By:	jsc
Boring ID:	BH-4
Sample ID:	R40/R41
Depth, ft:	160.50-160.40

Rock Drillability - Sievers' J-Value

Individual Test Results

Test Number	Sievers' J-Value SJ (1/10 mm)
1	1.60
2	1.60
3	0.75
4	22.00
5	2.25
Average	5.64

Sample Classification: High

Sievers' J-Value Reference Classification Chart

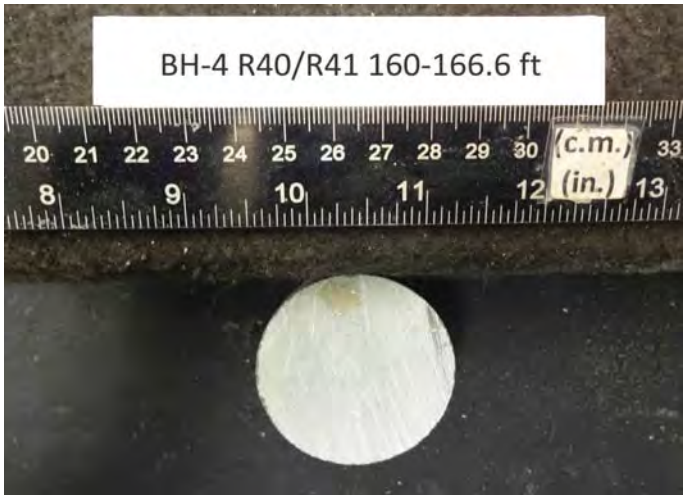
Category	SJ-Value (1/10 mm)
Extremely High	≤ 2.0
Very High	2.1 - 3.9
High	4.0 - 6.9
Medium	7.0 - 18.9
Low	19.0 - 55.9
Very Low	56.0 - 85.9
Extremely Low	≥ 86.0

Notes:

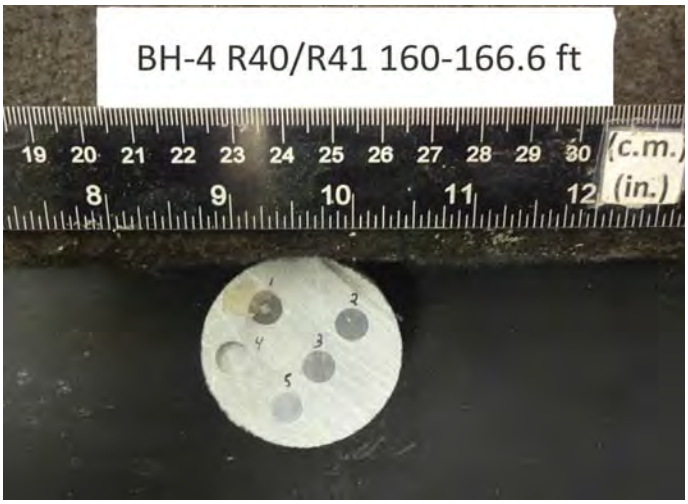
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3. The standard number of Sievers' J drillings performed on each sample is 4 to 8, depending on the variation in the texture of the sample. Drilling locations were selected to be tested on 60% hard and 40% softer layers found in the sample. Soft/hard combinations at drill locations are avoided as best as possible to try to give a more accurate representation of the rock. This is however impossible in samples which have alternating soft and hard layered mineral composition. The average Sievers' J value is regarded as representative for the tested rock.
4. Test was performed at 197 RPM.

Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Test Date:	3/5/2019
Tested By:	jsc
Checked By:	mpd
Boring ID:	BH-4
Sample ID:	R40/R41
Depth, in:	160.50-160.40

Rock Drillability - Sievers' J-Value Sample



Sample before testing



After testing showing drill locations

Notes:

1. GeoTesting Express's Rock Drillability testing suite is based on NTNU/SINTEF's 13A-98 Drillability Test Methods, Dept. of Civil and Transportation Engineering and performed in accordance with Dahl, Filip, 2003, The Suggested DRI, BWI, CLI Standard.
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Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Test Date:	3/12/2019
Tested By:	tlm
Checked By:	jsc
Boring ID:	BH-4
Sample ID:	R40/R41
Depth, ft:	160-166.6

Rock Drillability - Abrasion Value (AV)

Individual Test Results

Test Number	Abrasion Value AV (mg)
1	2.20
2	1.50
Average	1.85

Sample Classification: Very Low

Abrasion Value Reference Classification Chart

Category	AV (mg)
Extremely Low	≤ 1.0
Very Low	1.1 - 3.9
Low	4.0 - 10.9
Medium	11.0 - 27.9
High	28.0 - 41.9
Very High	42.0 - 57.9
Extremely High	≥ 58.0

Notes:

1. GeoTesting Express's Rock Drillability testing suite is based on NTNU/SINTEF's 13A-98 Drillability Test Methods, Dept. of Civil and Transportation Engineering and performed in accordance with Dahl, Filip, 2003, The Suggested DRI, BWI, CLI Standard.
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3. Abrasion test material was taken from the extractions used for the Brittleness Value test. The AV test pieces are comprised of tungsten carbide. Grain size, shape and binding are some factors that are believed to have substantial influence on the abrasiveness of the rock.
4. Test was performed at 20 RPM for 5 mins for a total of 100 revolutions

Client:	S.W. Cole Engineering, Inc.
Project Name:	NECEC/KRC
Project Location:	Maine
GTX #:	309265
Test Date:	3/12/2019
Tested By:	tlm
Checked By:	jsc
Boring ID:	BH-4
Sample ID:	R40/R41
Depth, ft:	160-166.6

Rock Drillability - Abrasion Value Cutter Steel (AVS)

Individual Test Results

Test Number	Abrasion Value Cutter Steel AVS (mg)
1	2.90
2	2.60
Average	2.75

Sample Classification: Very Low

Abrasion Value Cutter Steel Reference Classification Chart

Category	AVS (mg)
Extremely Low	≤ 1.0
Very Low	1.1 - 3.9
Low	4.0 - 12.9
Medium	13.0 - 25.9
High	26.0 - 35.9
Very High	36.0 - 43.9
Extremely High	≥ 44.0

Notes:

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3. Abrasion test material was taken from the extractions used for the Brittleness Value test. The AVS test pieces are comprised of cutter ring steel. Grain size, shape and binding are some factors that are believed to have substantial influence on the abrasiveness of the rock.
4. Test was performed at 20 RPM for 1 minute for a total of 20 revolutions.

Rock Drillability Test Equipment



Brittleness test equipment



An example sample prior to impacts



An example sample after 20 impacts

Notes:

1. GeoTesting Express's Rock Drillability testing suite is based on NTNU/SINTEF's 13A-98 Drillability Test Methods, Dept. of Civil and Transportation Engineering and performed in accordance with Dahl, Filip, 2003, The Suggested DRI, BWI, CLI Standard.
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Rock Drillability Test Equipment



Sievers' J-Value Apparatus



Closeup of Sievers J-Value Apparatus with sample



Sievers' J-Value untested drillbits

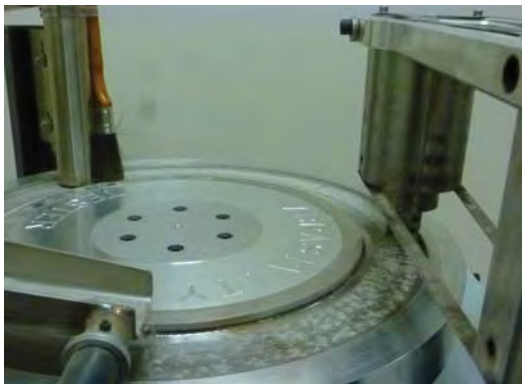
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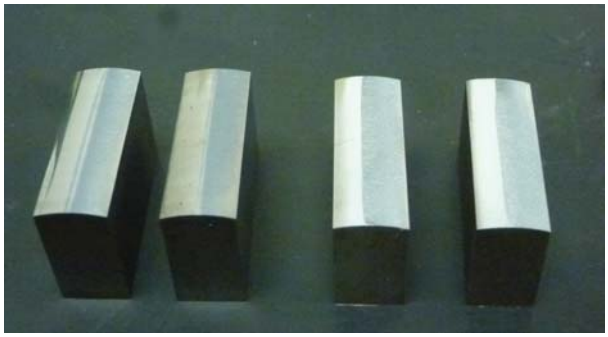
Rock Drillability Test Equipment



Abrasivity machine



Closeup of Abrasivity machine with sample



AV (left) & AVS (right) bits showing wear from testing

Notes:

1. GeoTesting Express's Rock Drillability testing suite is based on NTNU/SINTEF's 13A-98 Drillability Test Methods, Dept. of Civil and Transportation Engineering and performed in accordance with Dahl, Filip, 2003, The Suggested DRI, BWI, CLI Standard.
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2/12/19

BLACK & VEATCH

LABORATORY TEST ASSIGNMENTS

Client	Central Maine Power	Prepared By	T. Bonnie
Plant	NECEC - Keneebec River HDD	Revision	0
Project No.	400319	Date Requested	February 7, 2019
Lab Contractor	SW Cole	Completion Due Date	
Lab Supervisor			

Boring No.	Sample No.	Depth	Sample Type	Logged Soil Type	% or Length Recovery	Moisture Content	Density	Liquid Limit	Plastic Limit	Percent < #200	Sieve Analysis	Hydrometer Analysis	Unconfined Compression	Triaxial UU	Confining Pressures (ksf)	CERCHAR Abrasivity Index	Slake	petrographic	Drill-ability	Comments
BH-2	R16	75 -80	RC	Siltstone	100%								X			x	X	X		
BH-2	R18	85-90	RC	Siltstone	100%								x			x				
BH-3	Composite of R23 (92.1 to 96.5 ft) + R24 (96.5 to 100.0 ft)	See depths under Sample No.	RC	Slate	100%								X Run UCS test on R24 somewhere between 96.5 and 98.5 ft prior to running Drillability testing. After UCS test, combine failed UCS specimen with R23/24 composite sample and run Drillability testing.			X	X	X (see Comment)	X	Obtain petrographic sample somewhere between 96.5 to 98.5 ft.
BH-3	R24	100-101.5	RC	Slate	100%											x	X			
BH-3	R17	67.7-71.5	RC	Phyllite	100%								x			x		X		
BH-3	R25	101.5-106.5	RC	Slate	100%											x	X	X		
BH-4	R21	74.6 - 79.6	RC	slate	100%								x			x	X	X		
BH-4	Composite of R40 (160 to 161.6 ft) + R41 (161.6 to 166.6 ft)	See depths under Sample No.	RC	Siltstone	100%											X		X	X	
BH-4	R42	167-177.5	RC	Siltstone	100%								X				X			
BH-4	R44	176.6-181.6	RC	Phyllite	100%								x			x		X		

NOTE - Sample No. based on elevation of HDD vertical alignment shown on Plan & Profile Dwg. Rev B by TRC dated 10/17/18 and corresponding elevation on test boring logs in Geotechnical Data report by S.W. Cole dated December 20, 2018. Depth noted is from S.W. Cole report.

GEOTESTING EXPRESS
ATTN: JOHN CAMBELL
125 NAGOG PARK
ACTON, MA 01720

JOHN- THIS IS THE SPEAD SHEET PROVIDED TO SW COLE BY BLACK & VEATCH. THE ROCK CORE IS ALL LABELED. SOME MAY SAY BH-(19)-4 BUT THIS IS THE SAME AS BH-4 ON THIS SHEET. PLEASE REPORT USING BH-2, BH-3 and BH-4 NOTATION. REPORTS AND INVOICE SHOULD GO TO S.W. COLE ENG, INC. ATTN: PAUL KOHLER
pkohler@swcole.com
SWCE PROJECT NO: 18-0345
FOR: CMP/KRC

THANKS
PAUL
207-517-4867 (DESK)
207-615-2760 (CELL)

GeoTesting EXPRESS

WARRANTY and LIABILITY

GeoTesting Express (GTX) warrants that all tests it performs are run in general accordance with the specified test procedures and accepted industry practice. GTX will correct or repeat any test that does not comply with this warranty. GTX has no specific knowledge as to conditioning, origin, sampling procedure or intended use of the material.

GTX may report engineering parameters that require us to interpret the test data. Such parameters are determined using accepted engineering procedures. However, GTX does not warrant that these parameters accurately reflect the true engineering properties of the *in situ* material. Responsibility for interpretation and use of the test data and these parameters for engineering and/or construction purposes rests solely with the user and not with GTX or any of its employees.

GTX's liability will be limited to correcting or repeating a test which fails our warranty. GTX's liability for damages to the Purchaser of testing services for any cause whatsoever shall be limited to the amount GTX received for the testing services. GTX will not be liable for any damages, or for any lost benefits or other consequential damages resulting from the use of these test results, even if GTX has been advised of the possibility of such damages. GTX will not be responsible for any liability of the Purchaser to any third party.

Commonly Used Symbols

A	pore pressure parameter for $\Delta\sigma_1 - \Delta\sigma_3$
B	pore pressure parameter for $\Delta\sigma_3$
CAI	CERCHAR Abrasiveness Index
CIU	isotropically consolidated undrained triaxial shear test
CR	compression ratio for one dimensional consolidation
CSR	cyclic stress ratio
C_c	coefficient of curvature, $(D_{30})^2 / (D_{10} \times D_{60})$
C_u	coefficient of uniformity, D_{60}/D_{10}
C_c	compression index for one dimensional consolidation
C_α	coefficient of secondary compression
c_v	coefficient of consolidation
c	cohesion intercept for total stresses
c'	cohesion intercept for effective stresses
D	diameter of specimen
D	damping ratio
D_{10}	diameter at which 10% of soil is finer
D_{15}	diameter at which 15% of soil is finer
D_{30}	diameter at which 30% of soil is finer
D_{50}	diameter at which 50% of soil is finer
D_{60}	diameter at which 60% of soil is finer
D_{85}	diameter at which 85% of soil is finer
d_{50}	displacement for 50% consolidation
d_{90}	displacement for 90% consolidation
d_{100}	displacement for 100% consolidation
E	Young's modulus
e	void ratio
e_c	void ratio after consolidation
e_o	initial void ratio
G	shear modulus
G_s	specific gravity of soil particles
H	height of specimen
H_R	Rebound Hardness number
i	gradient
I_S	Uncorrected point load strength
$I_{S(50)}$	Size corrected point load strength index
H_A	Modified Taber Abrasion
H_T	Total hardness
K_o	lateral stress ratio for one dimensional strain
k	permeability
LI	Liquidity Index
m_v	coefficient of volume change
n	porosity
PI	plasticity index
P_c	preconsolidation pressure
p	$(\sigma_1 + \sigma_3) / 2$, $(\sigma_v + \sigma_h) / 2$
p'	$(\sigma'_1 + \sigma'_3) / 2$, $(\sigma'_v + \sigma'_h) / 2$
p'_c	p' at consolidation
Q	quantity of flow
q	$(\sigma_1 - \sigma_3) / 2$
q_f	q at failure
q_o, q_i	initial q
q_c	q at consolidation
S_r	Post cyclic undrained shear strength
T	temperature
t	time
U, UC	unconfined compression test
UU, Q	unconsolidated undrained triaxial test
u_a	pore gas pressure
u_e	excess pore water pressure
u, u_w	pore water pressure
V	total volume
V_g	volume of gas
V_s	volume of solids
V_s	shear wave velocity
V_v	volume of voids
V_w	volume of water
V_o	initial volume
v	velocity
W	total weight
W_s	weight of solids
W_w	weight of water
w	water content
w_c	water content at consolidation
w_f	final water content
w_l	liquid limit
w_n	natural water content
w_p	plastic limit
w_s	shrinkage limit
w_o, w_i	initial water content
α	slope of q_f versus p_f
α'	slope of q_f versus p_f'
γ_t	total unit weight
γ_d	dry unit weight
γ_s	unit weight of solids
γ_w	unit weight of water
ε	strain
ε_{vol}	volume strain
ε_h, ε_v	horizontal strain, vertical strain
μ	Poisson's ratio, also viscosity
σ	normal stress
σ'	effective normal stress
σ_c, σ'_c	consolidation stress in isotropic stress system
σ_h, σ'_h	horizontal normal stress
σ_v, σ'_v	vertical normal stress
σ'_{vc}	Effective vertical consolidation stress
σ_1	major principal stress
σ_2	intermediate principal stress
σ_3	minor principal stress
τ	shear stress
φ	friction angle based on total stresses
φ'	friction angle based on effective stresses
φ'_r	residual friction angle
φ_{ult}	φ for ultimate strength

ANALYTICAL REPORT

Lab Number:	L1845199
Client:	S. W. Cole Engineering, Inc. 37 Liberty Drive Bangor, ME 04401-5784
ATTN:	Nate Strout
Phone:	(207) 657-2866
Project Name:	NECEC, KRC
Project Number:	18-0345
Report Date:	11/14/18

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Certifications & Approvals: MA (M-MA086), NH NELAP (2064), CT (PH-0574), IL (200077), ME (MA00086), MD (348), NJ (MA935), NY (11148), NC (25700/666), PA (68-03671), RI (LAO00065), TX (T104704476), VT (VT-0935), VA (460195), USDA (Permit #P330-17-00196).

Eight Walkup Drive, Westborough, MA 01581-1019
508-898-9220 (Fax) 508-898-9193 800-624-9220 - www.alphalab.com

Project Name: NECEC, KRC
Project Number: 18-0345

Lab Number: L1845199
Report Date: 11/14/18

Alpha Sample ID	Client ID	Matrix	Sample Location	Collection Date/Time	Receive Date
L1845199-01	BH-1, 2D, 2-4'	SOIL	WEST FORKS PLANTATION, ME	10/30/18 10:00	11/05/18
L1845199-02	BH-2, 1D, 0.4-2'	SOIL	WEST FORKS PLANTATION, ME	10/30/18 14:45	11/05/18
L1845199-03	BH-5, 3D, 5-7'	SOIL	WEST FORKS PLANTATION, ME	11/02/18 15:15	11/05/18

Project Name: NECEC, KRC
Project Number: 18-0345

Lab Number: L1845199
Report Date: 11/14/18

Case Narrative

The samples were received in accordance with the Chain of Custody and no significant deviations were encountered during the preparation or analysis unless otherwise noted. Sample Receipt, Container Information, and the Chain of Custody are located at the back of the report.

Results contained within this report relate only to the samples submitted under this Alpha Lab Number and meet NELAP requirements for all NELAP accredited parameters unless otherwise noted in the following narrative. The data presented in this report is organized by parameter (i.e. VOC, SVOC, etc.). Sample specific Quality Control data (i.e. Surrogate Spike Recovery) is reported at the end of the target analyte list for each individual sample, followed by the Laboratory Batch Quality Control at the end of each parameter. Tentatively Identified Compounds (TICs), if requested, are reported for compounds identified to be present and are not part of the method/program Target Compound List, even if only a subset of the TCL are being reported. If a sample was re-analyzed or re-extracted due to a required quality control corrective action and if both sets of data are reported, the Laboratory ID of the re-analysis or re-extraction is designated with an "R" or "RE", respectively. When multiple Batch Quality Control elements are reported (e.g. more than one LCS), the associated samples for each element are noted in the grey shaded header line of each data table. Any Laboratory Batch, Sample Specific % recovery or RPD value that is outside the listed Acceptance Criteria is bolded in the report. All specific QC information is also incorporated in the Data Usability format of our Data Merger tool where it can be reviewed along with any associated usability implications. Soil/sediments, solids and tissues are reported on a dry weight basis unless otherwise noted. Definitions of all data qualifiers and acronyms used in this report are provided in the Glossary located at the back of the report.

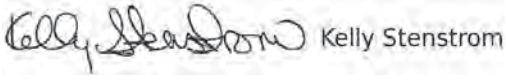
In reference to questions H (CAM) or 4 (RCP) when "NO" is checked, the performance criteria for CAM and RCP methods allow for some quality control failures to occur and still be within method compliance. In these instances the specific failure is not narrated but noted in the associated QC table. The information is also incorporated in the Data Usability format of our Data Merger tool where it can be reviewed along with any associated usability implications.

Please see the associated ADEx data file for a comparison of laboratory reporting limits that were achieved with the regulatory Numerical Standards requested on the Chain of Custody.

HOLD POLICY
For samples submitted on hold, Alpha's policy is to hold samples (with the exception of Air canisters) free of charge for 21 calendar days from the date the project is completed. After 21 calendar days, we will dispose of all samples submitted including those put on hold unless you have contacted your Client Service Representative and made arrangements for Alpha to continue to hold the samples. Air canisters will be disposed after 3 business days from the date the project is completed.

Please contact Client Services at 800-624-9220 with any questions.

I, the undersigned, attest under the pains and penalties of perjury that, to the best of my knowledge and belief and based upon my personal inquiry of those responsible for providing the information contained in this analytical report, such information is accurate and complete. This certificate of analysis is not complete unless this page accompanies any and all pages of this report.

Authorized Signature:  Kelly Stenstrom

Title: Technical Director/Representative Date: 11/14/18

INORGANICS
&
MISCELLANEOUS

Project Name: NECEC, KRC
Project Number: 18-0345

Lab Number: L1845199
Report Date: 11/14/18

SAMPLE RESULTS

Lab ID: L1845199-01
Client ID: BH-1, 2D, 2-4'
Sample Location: WEST FORKS PLANTATION, ME

Date Collected: 10/30/18 10:00
Date Received: 11/05/18
Field Prep: Not Specified

Sample Depth:
Matrix: Soil

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Solids, Total	92.2		%	0.100	NA	1	-	11/06/18 10:03	121,2540G	RI
Chloride	ND		mg/kg	11	--	1	-	11/12/18 20:12	1,9251	ML
pH (H)	6.0		SU	-	NA	1	-	11/06/18 15:00	1,9045D	LH
Sulfate	ND		mg/kg	110	--	1	-	11/07/18 13:02	1,9038	BR
Moisture	7.80		%	0.100	NA	1	-	11/06/18 10:03	121,2540G	RI

Project Name: NECEC, KRC
Project Number: 18-0345

Lab Number: L1845199
Report Date: 11/14/18

SAMPLE RESULTS

Lab ID: L1845199-02
Client ID: BH-2, 1D, 0.4-2'
Sample Location: WEST FORKS PLANTATION, ME

Date Collected: 10/30/18 14:45
Date Received: 11/05/18
Field Prep: Not Specified

Sample Depth:
Matrix: Soil

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Solids, Total	84.6		%	0.100	NA	1	-	11/06/18 10:03	121,2540G	RI
Chloride	ND		mg/kg	11	--	1	-	11/12/18 20:14	1,9251	ML
pH (H)	7.5		SU	-	NA	1	-	11/06/18 15:00	1,9045D	LH
Sulfate	ND		mg/kg	120	--	1	-	11/07/18 13:02	1,9038	BR
Moisture	15.4		%	0.100	NA	1	-	11/06/18 10:03	121,2540G	RI

Project Name: NECEC, KRC
Project Number: 18-0345

Lab Number: L1845199
Report Date: 11/14/18

SAMPLE RESULTS

Lab ID: L1845199-03
Client ID: BH-5, 3D, 5-7'
Sample Location: WEST FORKS PLANTATION, ME

Date Collected: 11/02/18 15:15
Date Received: 11/05/18
Field Prep: Not Specified

Sample Depth:
Matrix: Soil

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Solids, Total	89.1		%	0.100	NA	1	-	11/06/18 10:03	121,2540G	RI
Chloride	ND		mg/kg	9.5	--	1	-	11/12/18 20:15	1,9251	ML
pH (H)	6.4		SU	-	NA	1	-	11/06/18 15:00	1,9045D	LH
Sulfate	ND		mg/kg	110	--	1	-	11/07/18 13:02	1,9038	BR
Moisture	10.9		%	0.100	NA	1	-	11/06/18 10:03	121,2540G	RI

Project Name: NECEC, KRC
Project Number: 18-0345
Lab Number: L1845199
Report Date: 11/14/18

Method Blank Analysis
Batch Quality Control

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab for sample(s): 01-03 Batch: WG1176859-1										
Sulfate	ND		mg/kg	100	--	1	-	11/07/18 13:02	1,9038	BR
General Chemistry - Westborough Lab for sample(s): 01-03 Batch: WG1178627-1										
Chloride	ND		mg/kg	10	--	1	-	11/12/18 19:47	1,9251	ML

Lab Control Sample Analysis

Batch Quality Control

Project Name: NECEC, KRC
Project Number: 18-0345

Lab Number: L1845199
Report Date: 11/14/18

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
General Chemistry - Westborough Lab Associated sample(s): 01-03 Batch: WG1176501-1								
pH	100		-		99-101	-		
General Chemistry - Westborough Lab Associated sample(s): 01-03 Batch: WG1176859-2								
Sulfate	105		-		80-121	-		12
General Chemistry - Westborough Lab Associated sample(s): 01-03 Batch: WG1178627-2								
Chloride	105		-		89-109	-		35

Matrix Spike Analysis
Batch Quality Control

Project Name: NECEC, KRC
Project Number: 18-0345

Lab Number: L1845199
Report Date: 11/14/18

Parameter	Native Sample	MS Added	MS Found	MS %Recovery	Qual	MSD Found	MSD %Recovery	Qual	Recovery Limits	RPD	Qual	RPD Limits
General Chemistry - Westborough Lab Associated sample(s): 01-03 QC Batch ID: WG1176859-4 QC Sample: L1845199-01 Client ID: BH-1, 2D, 2-4'												
Sulfate	ND	216	230	110		-	-		22-183	-		12
General Chemistry - Westborough Lab Associated sample(s): 01-03 QC Batch ID: WG1178627-4 QC Sample: L1845199-01 Client ID: BH-1, 2D, 2-4'												
Chloride	ND	430	460	106		-	-		62-129	-		35

Lab Duplicate Analysis

Batch Quality Control

Project Name: NECEC, KRC
Project Number: 18-0345

Lab Number: L1845199
Report Date: 11/14/18

Parameter	Native Sample	Duplicate Sample	Units	RPD	Qual	RPD Limits
General Chemistry - Westborough Lab Associated sample(s): 01-03 QC Batch ID: WG1176408-1 QC Sample: L1845199-01 Client ID: BH-1, 2D, 2-4'						
Solids, Total	92.2	92.4	%	0		20
Moisture	7.8	7.60	%	3		20
General Chemistry - Westborough Lab Associated sample(s): 01-03 QC Batch ID: WG1176501-2 QC Sample: L1845199-01 Client ID: BH-1, 2D, 2-4'						
pH (H)	6.0	6.0	SU	0		5
General Chemistry - Westborough Lab Associated sample(s): 01-03 QC Batch ID: WG1178627-3 QC Sample: L1845199-01 Client ID: BH-1, 2D, 2-4'						
Chloride	ND	ND	mg/kg	NC		35

Project Name: NECEC, KRC
Project Number: 18-0345

Lab Number: L1845199
Report Date: 11/14/18

Sample Receipt and Container Information

Were project specific reporting limits specified? YES

Cooler Information

Cooler	Custody Seal
A	Present/Intact

Container Information

Container ID	Container Type	Cooler	Initial pH	Final pH	Temp deg C	Pres	Seal	Frozen Date/Time	Analysis(*)
L1845199-01A	Glass 250ml/8oz unpreserved	A	NA		2.9	Y	Present/Intact		CL-9251(28),SO4-9038(28),PH-9045(1),ME-TS-2540(7),MOISTURE(7)
L1845199-02A	Glass 250ml/8oz unpreserved	A	NA		2.9	Y	Present/Intact		CL-9251(28),SO4-9038(28),PH-9045(1),ME-TS-2540(7),MOISTURE(7)
L1845199-03A	Glass 250ml/8oz unpreserved	A	NA		2.9	Y	Present/Intact		CL-9251(28),SO4-9038(28),PH-9045(1),ME-TS-2540(7),MOISTURE(7)

*Values in parentheses indicate holding time in days

Project Name:	NECEC, KRC	**Lab Number:**	L1845199
Project Number:	18-0345	**Report Date:**	11/14/18

GLOSSARY

Acronyms

EDL	- Estimated Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the reporting limit (RL). The EDL includes any adjustments from dilutions, concentrations or moisture content, where applicable. The use of EDLs is specific to the analysis of PAHs using Solid-Phase Microextraction (SPME).
EMPC	- Estimated Maximum Possible Concentration: The concentration that results from the signal present at the retention time of an analyte when the ions meet all of the identification criteria except the ion abundance ratio criteria. An EMPC is a worst-case estimate of the concentration.
EPA	- Environmental Protection Agency.
LCS	- Laboratory Control Sample: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.
LCSD	- Laboratory Control Sample Duplicate: Refer to LCS.
LFB	- Laboratory Fortified Blank: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.
MDL	- Method Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the reporting limit (RL). The MDL includes any adjustments from dilutions, concentrations or moisture content, where applicable.
MS	- Matrix Spike Sample: A sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available.
MSD	- Matrix Spike Sample Duplicate: Refer to MS.
NA	- Not Applicable.
NC	- Not Calculated: Term is utilized when one or more of the results utilized in the calculation are non-detect at the parameter's reporting unit.
NDPA/DPA	- N-Nitrosodiphenylamine/Diphenylamine.
NI	- Not Ignitable.
NP	- Non-Plastic: Term is utilized for the analysis of Atterberg Limits in soil.
RL	- Reporting Limit: The value at which an instrument can accurately measure an analyte at a specific concentration. The RL includes any adjustments from dilutions, concentrations or moisture content, where applicable.
RPD	- Relative Percent Difference: The results from matrix and/or matrix spike duplicates are primarily designed to assess the precision of analytical results in a given matrix and are expressed as relative percent difference (RPD). Values which are less than five times the reporting limit for any individual parameter are evaluated by utilizing the absolute difference between the values; although the RPD value will be provided in the report.
SRM	- Standard Reference Material: A reference sample of a known or certified value that is of the same or similar matrix as the associated field samples.
STLP	- Semi-dynamic Tank Leaching Procedure per EPA Method 1315.
TEF	- Toxic Equivalency Factors: The values assigned to each dioxin and furan to evaluate their toxicity relative to 2,3,7,8-TCDD.
TEQ	- Toxic Equivalent: The measure of a sample¿s toxicity derived by multiplying each dioxin and furan by its corresponding TEF and then summing the resulting values.
TIC	- Tentatively Identified Compound: A compound that has been identified to be present and is not part of the target compound list (TCL) for the method and/or program. All TICs are qualitatively identified and reported as estimated concentrations.

Footnotes

1	- The reference for this analyte should be considered modified since this analyte is absent from the target analyte list of the original method.

Terms

Analytical Method: Both the document from which the method originates and the analytical reference method. (Example: EPA 8260B is shown as 1,8260B.) The codes for the reference method documents are provided in the References section of the Addendum.

Final pH: As it pertains to Sample Receipt & Container Information section of the report, Final pH reflects pH of container determined after adjustment at the laboratory, if applicable. If no adjustment required, value reflects Initial pH.

Frozen Date/Time: With respect to Volatile Organics in soil, Frozen Date/Time reflects the date/time at which associated Reagent Water-preserved vials were initially frozen. Note: If frozen date/time is beyond 48 hours from sample collection, value will be reflected in 'bold'.

Initial pH: As it pertains to Sample Receipt & Container Information section of the report, Initial pH reflects pH of container determined upon receipt, if applicable.

Total: With respect to Organic analyses, a 'Total' result is defined as the summation of results for individual isomers or Aroclors. If a 'Total' result is requested, the results of its individual components will also be reported. This is applicable to 'Total' results for methods 8260, 8081 and 8082.

Report Format: Data Usability Report

Project Name:	NECEC, KRC	**Lab Number:**	L1845199
Project Number:	18-0345	**Report Date:**	11/14/18

Data Qualifiers

A - Spectra identified as "Aldol Condensation Product".

B - The analyte was detected above the reporting limit in the associated method blank. Flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank. For MCP-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank. For DOD-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank AND the analyte was detected above one-half the reporting limit (or above the reporting limit for common lab contaminants) in the associated method blank. For NJ-Air-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte above the reporting limit. For NJ-related projects (excluding Air), flag only applies to associated field samples that have detectable concentrations of the analyte, which was detected above the reporting limit in the associated method blank or above five times the reporting limit for common lab contaminants (Phthalates, Acetone, Methylene Chloride, 2-Butanone).

C - Co-elution: The target analyte co-elutes with a known lab standard (i.e. surrogate, internal standards, etc.) for co-extracted analyses.

D - Concentration of analyte was quantified from diluted analysis. Flag only applies to field samples that have detectable concentrations of the analyte.

E - Concentration of analyte exceeds the range of the calibration curve and/or linear range of the instrument.

G - The concentration may be biased high due to matrix interferences (i.e, co-elution) with non-target compound(s). The result should be considered estimated.

H - The analysis of pH was performed beyond the regulatory-required holding time of 15 minutes from the time of sample collection.

I - The lower value for the two columns has been reported due to obvious interference.

M - Reporting Limit (RL) exceeds the MCP CAM Reporting Limit for this analyte.

NJ - Presumptive evidence of compound. This represents an estimated concentration for Tentatively Identified Compounds (TICs), where the identification is based on a mass spectral library search.

P - The RPD between the results for the two columns exceeds the method-specified criteria.

Q - The quality control sample exceeds the associated acceptance criteria. For DOD-related projects, LCS and/or Continuing Calibration Standard exceedences are also qualified on all associated sample results. Note: This flag is not applicable for matrix spike recoveries when the sample concentration is greater than 4x the spike added or for batch duplicate RPD when the sample concentrations are less than 5x the RL. (Metals only.)

R - Analytical results are from sample re-analysis.

RE - Analytical results are from sample re-extraction.

S - Analytical results are from modified screening analysis.

J - Estimated value. This represents an estimated concentration for Tentatively Identified Compounds (TICs).

ND - Not detected at the reporting limit (RL) for the sample.

Report Format: Data Usability Report

Project Name:	NECEC, KRC	**Lab Number:**	L1845199
Project Number:	18-0345	**Report Date:**	11/14/18

REFERENCES

1 Test Methods for Evaluating Solid Waste: Physical/Chemical Methods. EPA SW-846. Third Edition. Updates I - IV, 2007.

121 Standard Methods for the Examination of Water and Wastewater. APHA-AWWA-WEF. Standard Methods Online.

LIMITATION OF LIABILITIES

Alpha Analytical performs services with reasonable care and diligence normal to the analytical testing laboratory industry. In the event of an error, the sole and exclusive responsibility of Alpha Analytical shall be to re-perform the work at it's own expense. In no event shall Alpha Analytical be held liable for any incidental, consequential or special damages, including but not limited to, damages in any way connected with the use of, interpretation of, information or analysis provided by Alpha Analytical.

We strongly urge our clients to comply with EPA protocol regarding sample volume, preservation, cooling, containers, sampling procedures, holding time and splitting of samples in the field.

Certification Information

The following analytes are not included in our Primary NELAP Scope of Accreditation:

Westborough Facility
EPA 624/624.1: m/p-xylene, o-xylene
EPA 8260C: NPW: 1,2,4,5-Tetramethylbenzene; 4-Ethyltoluene, Azobenzene; SCM: Iodomethane (methyl iodide), Methyl methacrylate, 1,2,4,5-Tetramethylbenzene; 4-Ethyltoluene.
EPA 8270D: NPW: Dimethylnaphthalene,1,4-Diphenylhydrazine; SCM: Dimethylnaphthalene,1,4-Diphenylhydrazine.

EPA 6860: SCM: Perchlorate

SM4500: NPW: Amenable Cyanide; SCM: Total Phosphorus, TKN, NO2, NO3.

Mansfield Facility
SM 2540D: TSS
EPA 8082A: NPW: PCB: 1, 5, 31, 87,101, 110, 141, 151, 153, 180, 183, 187.
EPA TO-15: Halothane, 2,4,4-Trimethyl-2-pentene, 2,4,4-Trimethyl-1-pentene, Thiophene, 2-Methylthiophene, 3-Methylthiophene, 2-Ethylthiophene, 1,2,3-Trimethylbenzene, Indan, Indene, 1,2,4,5-Tetramethylbenzene, Benzothiophene, 1-Methylnaphthalene.
Biological Tissue Matrix: EPA 3050B

The following analytes are included in our Massachusetts DEP Scope of Accreditation

Westborough Facility:

Drinking Water
EPA 300.0: Chloride, Nitrate-N, Fluoride, Sulfate; **EPA 353.2**: Nitrate-N, Nitrite-N; **SM4500NO3-F**: Nitrate-N, Nitrite-N; **SM4500F-C, SM4500CN-CE, EPA 180.1, SM2130B, SM4500Cl-D, SM2320B, SM2540C, SM4500H-B**
EPA 332: Perchlorate; **EPA 524.2:** THMs and VOCs; **EPA 504.1:** EDB, DBCP.
Microbiology: **SM9215B; SM9223-P/A, SM9223B-Colilert-QT,SM9222D**.

Non-Potable Water
SM4500H,B, EPA 120.1, SM2510B, SM2540C, SM2320B, SM4500CL-E, SM4500F-BC, SM4500NH3-BH: Ammonia-N and Kjeldahl-N, **EPA 350.1**: Ammonia-N, **LACHAT 10-107-06-1-B**: Ammonia-N, **EPA 351.1, SM4500NO3-F, EPA 353.2**: Nitrate-N**, SM4500P-E, SM4500P-B, E, SM4500SO4-E, SM5220D, EPA 410.4, SM5210B, SM5310C, SM4500CL-D, EPA 1664, EPA 420.1, SM4500-CN-CE, SM2540D, EPA 300: Chloride, Sulfate, Nitrate.**
EPA 624.1: Volatile Halocarbons & Aromatics,
EPA 608.3: Chlordane, Toxaphene, Aldrin, alpha-BHC, beta-BHC, gamma-BHC, delta-BHC, Dieldrin, DDD, DDE, DDT, Endosulfan I, Endosulfan II, Endosulfan sulfate, Endrin, Endrin Aldehyde, Heptachlor, Heptachlor Epoxide, PCBs
EPA 625.1: SVOC (Acid/Base/Neutral Extractables), **EPA 600/4-81-045**: PCB-Oil.
Microbiology: **SM9223B-Colilert-QT; Enterolert-QT, SM9221E, EPA 1600, EPA 1603.**

Mansfield Facility:

Drinking Water
EPA 200.7: Al, Ba, Cd, Cr, Cu, Fe, Mn, Ni, Na, Ag, Ca, Zn. **EPA 200.8:** Al, Sb, As, Ba, Be, Cd, Cr, Cu, Pb, Mn, Ni, Se, Ag, TL, Zn. **EPA 245.1** Hg.
EPA 522.

Non-Potable Water
EPA 200.7: Al, Sb, As, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Ag, Na, Sr, TL, Ti, V, Zn.
EPA 200.8: Al, Sb, As, Be, Cd, Cr, Cu, Fe, Pb, Mn, Ni, K, Se, Ag, Na, TL, Zn.
EPA 245.1 Hg.
SM2340B

For a complete listing of analytes and methods, please contact your Alpha Project Manager.

CHAIN OF CUSTODY

PAGE 1 OF 1

Date Rec'd in Lab: 11/05/18

ALPHA Job #: L1845199

ALPHA ANALYTICAL
8 Walkup Drive, Westboro, MA 01581, Tel: 508-898-9220
320 Forbes Blvd, Mansfield, MA 02048, Tel: 508-822-9300

Client Information

Client: S.W. Cole Engineering, Inc.
Address: 37 Liberty Drive, Hermon, ME
Phone: 207-848-5714
Email: Nate.Strout@swcole.com

Project Information

Project Name: NECEC, KRC
Project Location: West Forks Plantation, ME
Project #: 18-0345
Project Manager: Paul Kohler
ALPHA Quote #: to PKohler@swcole.com

Turn-Around Time

☑ Standard ☐ RUSH (only confirmed if pre-approved)
Date Due:

Additional Project Information:

Report Information - Data Deliverables

☐ ADEx ☑ EMAIL

Billing Information

☑ Same as Client info PO #:

Regulatory Requirements & Project Information Requirements

☐ Yes ☐ No MA MCP Analytical Methods ☐ Yes ☐ No CT RCP Analytical Methods
☐ Yes ☐ No Matrix Spike Required on this SDG? (Required for MCP Inorganics)
☐ Yes ☐ No GW1 Standards (Info Required for Metals & EPH with Targets)
☐ Yes ☐ No NPDES RGP
☐ Other State /Fed Program _____ Criteria _____

ALPHA Lab ID (Lab Use Only)	Sample ID	Collection Date	Collection Time	Sample Matrix	Sampler Initials	VOC: ☐ 8260 ☐ 624 ☐ 524.2	SVOC: ☐ ABN ☐ PAH	METALS: ☐ MCP 13	METALS: ☐ MCP 14 ☐ RCP 15	EPH: ☐ RCRA5 ☐ RCRA8 ☐ PP13	VPH: ☐ Ranges & Targets ☐ Ranges Only	☐ PCB ☐ PEST	TPH: ☐ Quant Only ☐ Fingerprint	Sulfate - 9038	Chloride - 9251	pH - 9045 moisture as-found			Sample Comments	TOTAL # BOTTLES
45199-01	BH-1, 2D, 2-4'	10-30-18	16:00	soil	NDS									✓	✓	✓	✓			
02	BH-2, 1D, 0.4-2'	10-30-18	14:45	soil	NDS									✓	✓	✓	✓			
03	BH-5, 3D, 5-7'	11-2-18	15:15	soil	NDS									✓	✓	✓	✓			
Container Type														6	6	6				
Preservative														A	A	A				

Container Type
P= Plastic
A= Amber glass
V= Vial
G= Glass
B= Bacteria cup
C= Cube
O= Other
E= Encore
D= BOD Bottle

Preservative
A= None
B= HCl
C= HNO_3
D= H_2SO_4
E= NaOH
F= MeOH
G= $NaHSO_4$
H = $Na_2S_2O_3$
I= Ascorbic Acid
J = NH_4Cl
K= Zn Acetate
O= Other

Relinquished By:	Date/Time	Received By:	Date/Time
Tierney Waldwell	15:22 11/5/18		11/5/18 15:22
			11/5/18 23:23

All samples submitted are subject to Alpha's Terms and Conditions. See reverse side.

FORM NO: 01-01 (rev. 12-Mar-2012)

UNISHIP
COURIER SERVICES LLC

10 Iron Road
Hermon, Maine 04401

Bill Shipping Charge to

Shipper ☐ ☐ Next Day
Recipient ☐ ☐ Same Day

Special _____

052018

Phone 207•848•7546 ■ Toll-Free 800•427•7547 ■ Fax 207•561•2467

390 US Route One, #3
Falmouth, Maine 04105

FROM: Shipper	TO: Recipient
Street	Street
Origin Brewer, ME Zip Code	Destination Westbrook, ME Zip Code
Phone #	Phone #

No. Pieces	Weight Each	Description of Items	Total Weight (Subject to Correction)	Oversize Charge	Shipping Charges
1		1 cooler SW crate			
	◀ TOTAL PIECES	WEIGHT GRAND TOTAL ▶		TOTAL CHARGES ▶	

Shipper authorizes Uniship to deliver this shipment without obtaining a delivery signature.

Shipper's Signature _____

Please use complete ship to address.
Uniship can not deliver to P.O. Boxes.

RECEIVED, subject to the classifications and tariffs in effect on the date of the issue of this Bill of Lading, the property described above in apparent good order, except as noted (contents and condition of contents of packages unknown), marked, consigned, and destined as indicated above which said carrier (the word carrier being understood throughout this contract as meaning any person or corporation in possession of the property, under the contract) agrees to carry to its usual place of delivery at said destination, if on its route, otherwise to deliver to another carrier on the route to said destination. It is mutually agreed as to each carrier of all or any of said property overall or any portion of said route to destination and as to each party at any time interested in all or any of said property, that every service to be performed hereunder shall be subject to all the bill of lading terms and conditions in the governing classification on the date of shipment.

Shipper hereby certifies that he is familiar with all the bill of lading terms and conditions in the governing classification and the said terms and conditions are hereby agreed to by the shipper and accepted for himself and his assigns.

SHIPPER	PICK-UP TIME 8:10	RECIPIENT	DELIVERY TIME
COURIER SIGNATURE	DATE 11-5-2016	COURIER SIGNATURE	DATE

RECIPIENT COPY

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Committed to Quality Since 1963
PRECLEANED CONTAINERS

ANALYTICAL REPORT

Lab Number:	L1849289
Client:	S. W. Cole Engineering, Inc. 37 Liberty Drive Bangor, ME 04401-5784
ATTN:	Nate Strout
Phone:	(207) 657-2866
Project Name:	NECEC, KRC
Project Number:	18-0345
Report Date:	12/10/18

The original project report/data package is held by Alpha Analytical. This report/data package is paginated and should be reproduced only in its entirety. Alpha Analytical holds no responsibility for results and/or data that are not consistent with the original.

Certifications & Approvals: MA (M-MA086), NH NELAP (2064), CT (PH-0574), IL (200077), ME (MA00086), MD (348), NJ (MA935), NY (11148), NC (25700/666), PA (68-03671), RI (LAO00065), TX (T104704476), VT (VT-0935), VA (460195), USDA (Permit #P330-17-00196).

Eight Walkup Drive, Westborough, MA 01581-1019
508-898-9220 (Fax) 508-898-9193 800-624-9220 - www.alphalab.com

Project Name: NECEC, KRC
Project Number: 18-0345

Lab Number: L1849289
Report Date: 12/10/18

Alpha Sample ID	Client ID	Matrix	Sample Location	Collection Date/Time	Receive Date
L1849289-01	BH-3, S-1, 2-5'	SOIL	MOXIE GORE, ME	11/26/18 12:30	12/03/18

Project Name: NECEC, KRC
Project Number: 18-0345

Lab Number: L1849289
Report Date: 12/10/18

Case Narrative

The samples were received in accordance with the Chain of Custody and no significant deviations were encountered during the preparation or analysis unless otherwise noted. Sample Receipt, Container Information, and the Chain of Custody are located at the back of the report.

Results contained within this report relate only to the samples submitted under this Alpha Lab Number and meet NELAP requirements for all NELAP accredited parameters unless otherwise noted in the following narrative. The data presented in this report is organized by parameter (i.e. VOC, SVOC, etc.). Sample specific Quality Control data (i.e. Surrogate Spike Recovery) is reported at the end of the target analyte list for each individual sample, followed by the Laboratory Batch Quality Control at the end of each parameter. Tentatively Identified Compounds (TICs), if requested, are reported for compounds identified to be present and are not part of the method/program Target Compound List, even if only a subset of the TCL are being reported. If a sample was re-analyzed or re-extracted due to a required quality control corrective action and if both sets of data are reported, the Laboratory ID of the re-analysis or re-extraction is designated with an "R" or "RE", respectively. When multiple Batch Quality Control elements are reported (e.g. more than one LCS), the associated samples for each element are noted in the grey shaded header line of each data table. Any Laboratory Batch, Sample Specific % recovery or RPD value that is outside the listed Acceptance Criteria is bolded in the report. All specific QC information is also incorporated in the Data Usability format of our Data Merger tool where it can be reviewed along with any associated usability implications. Soil/sediments, solids and tissues are reported on a dry weight basis unless otherwise noted. Definitions of all data qualifiers and acronyms used in this report are provided in the Glossary located at the back of the report.

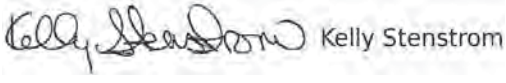
In reference to questions H (CAM) or 4 (RCP) when "NO" is checked, the performance criteria for CAM and RCP methods allow for some quality control failures to occur and still be within method compliance. In these instances the specific failure is not narrated but noted in the associated QC table. The information is also incorporated in the Data Usability format of our Data Merger tool where it can be reviewed along with any associated usability implications.

Please see the associated ADEx data file for a comparison of laboratory reporting limits that were achieved with the regulatory Numerical Standards requested on the Chain of Custody.

HOLD POLICY
For samples submitted on hold, Alpha's policy is to hold samples (with the exception of Air canisters) free of charge for 21 calendar days from the date the project is completed. After 21 calendar days, we will dispose of all samples submitted including those put on hold unless you have contacted your Client Service Representative and made arrangements for Alpha to continue to hold the samples. Air canisters will be disposed after 3 business days from the date the project is completed.

Please contact Client Services at 800-624-9220 with any questions.

I, the undersigned, attest under the pains and penalties of perjury that, to the best of my knowledge and belief and based upon my personal inquiry of those responsible for providing the information contained in this analytical report, such information is accurate and complete. This certificate of analysis is not complete unless this page accompanies any and all pages of this report.

Authorized Signature:  Kelly Stenstrom

Title: Technical Director/Representative Date: 12/10/18

INORGANICS
&
MISCELLANEOUS

Project Name: NECEC, KRC
Project Number: 18-0345

Lab Number: L1849289
Report Date: 12/10/18

SAMPLE RESULTS

Lab ID: L1849289-01
Client ID: BH-3, S-1, 2-5'
Sample Location: MOXIE GORE, ME

Date Collected: 11/26/18 12:30
Date Received: 12/03/18
Field Prep: Not Specified

Sample Depth:
Matrix: Soil

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Solids, Total	87.7		%	0.100	NA	1	-	12/06/18 10:54	121,2540G	RI
Chloride	22		mg/kg	11	--	1	-	12/05/18 23:19	1,9251	TL
pH (H)	5.3		SU	-	NA	1	-	12/04/18 18:32	1,9045D	AS
Sulfate	ND		mg/kg	110	--	1	-	12/04/18 22:10	1,9038	BR

Project Name: NECEC, KRC
Project Number: 18-0345
Lab Number: L1849289
Report Date: 12/10/18

Method Blank Analysis
Batch Quality Control

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab for sample(s): 01 Batch: WG1185515-1										
Sulfate	ND		mg/kg	100	--	1	-	12/04/18 22:10	1,9038	BR
General Chemistry - Westborough Lab for sample(s): 01 Batch: WG1186007-1										
Chloride	ND		mg/kg	10	--	1	-	12/05/18 21:48	1,9251	TL

Lab Control Sample Analysis
Batch Quality Control

Project Name: NECEC, KRC
Project Number: 18-0345

Lab Number: L1849289
Report Date: 12/10/18

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
General Chemistry - Westborough Lab Associated sample(s): 01 Batch: WG1185515-2								
Sulfate	95		-		80-121	-		12
General Chemistry - Westborough Lab Associated sample(s): 01 Batch: WG1185563-1								
pH	100		-		99-101	-		
General Chemistry - Westborough Lab Associated sample(s): 01 Batch: WG1186007-2								
Chloride	101		-		89-109	-		35

Project Name: NECEC, KRC
Project Number: 18-0345

Lab Number: L1849289
Report Date: 12/10/18

Sample Receipt and Container Information

Were project specific reporting limits specified? YES

Cooler Information

Cooler	Custody Seal
B	Present/Intact

Container Information

Container ID	Container Type	Cooler	Initial pH	Final pH	Temp deg C	Pres	Seal	Frozen Date/Time	Analysis(*)
L1849289-01A	Glass 250ml/8oz unpreserved	B	NA		4.7	Y	Present/Intact		CL-9251(28),SO4-9038(28),PH-9045(1),ME-TS-2540(7)

*Values in parentheses indicate holding time in days

Project Name:	NECEC, KRC	**Lab Number:**	L1849289
Project Number:	18-0345	**Report Date:**	12/10/18

GLOSSARY

Acronyms

EDL	- Estimated Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the reporting limit (RL). The EDL includes any adjustments from dilutions, concentrations or moisture content, where applicable. The use of EDLs is specific to the analysis of PAHs using Solid-Phase Microextraction (SPME).
EMPC	- Estimated Maximum Possible Concentration: The concentration that results from the signal present at the retention time of an analyte when the ions meet all of the identification criteria except the ion abundance ratio criteria. An EMPC is a worst-case estimate of the concentration.
EPA	- Environmental Protection Agency.
LCS	- Laboratory Control Sample: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.
LCSD	- Laboratory Control Sample Duplicate: Refer to LCS.
LFB	- Laboratory Fortified Blank: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.
MDL	- Method Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the reporting limit (RL). The MDL includes any adjustments from dilutions, concentrations or moisture content, where applicable.
MS	- Matrix Spike Sample: A sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available.
MSD	- Matrix Spike Sample Duplicate: Refer to MS.
NA	- Not Applicable.
NC	- Not Calculated: Term is utilized when one or more of the results utilized in the calculation are non-detect at the parameter's reporting unit.
NDPA/DPA	- N-Nitrosodiphenylamine/Diphenylamine.
NI	- Not Ignitable.
NP	- Non-Plastic: Term is utilized for the analysis of Atterberg Limits in soil.
RL	- Reporting Limit: The value at which an instrument can accurately measure an analyte at a specific concentration. The RL includes any adjustments from dilutions, concentrations or moisture content, where applicable.
RPD	- Relative Percent Difference: The results from matrix and/or matrix spike duplicates are primarily designed to assess the precision of analytical results in a given matrix and are expressed as relative percent difference (RPD). Values which are less than five times the reporting limit for any individual parameter are evaluated by utilizing the absolute difference between the values; although the RPD value will be provided in the report.
SRM	- Standard Reference Material: A reference sample of a known or certified value that is of the same or similar matrix as the associated field samples.
STLP	- Semi-dynamic Tank Leaching Procedure per EPA Method 1315.
TEF	- Toxic Equivalency Factors: The values assigned to each dioxin and furan to evaluate their toxicity relative to 2,3,7,8-TCDD.
TEQ	- Toxic Equivalent: The measure of a sample¿s toxicity derived by multiplying each dioxin and furan by its corresponding TEF and then summing the resulting values.
TIC	- Tentatively Identified Compound: A compound that has been identified to be present and is not part of the target compound list (TCL) for the method and/or program. All TICs are qualitatively identified and reported as estimated concentrations.

Footnotes

1	- The reference for this analyte should be considered modified since this analyte is absent from the target analyte list of the original method.

Terms

Analytical Method: Both the document from which the method originates and the analytical reference method. (Example: EPA 8260B is shown as 1,8260B.) The codes for the reference method documents are provided in the References section of the Addendum.

Final pH: As it pertains to Sample Receipt & Container Information section of the report, Final pH reflects pH of container determined after adjustment at the laboratory, if applicable. If no adjustment required, value reflects Initial pH.

Frozen Date/Time: With respect to Volatile Organics in soil, Frozen Date/Time reflects the date/time at which associated Reagent Water-preserved vials were initially frozen. Note: If frozen date/time is beyond 48 hours from sample collection, value will be reflected in 'bold'.

Initial pH: As it pertains to Sample Receipt & Container Information section of the report, Initial pH reflects pH of container determined upon receipt, if applicable.

Total: With respect to Organic analyses, a 'Total' result is defined as the summation of results for individual isomers or Aroclors. If a 'Total' result is requested, the results of its individual components will also be reported. This is applicable to 'Total' results for methods 8260, 8081 and 8082.

Report Format: Data Usability Report

Project Name:	NECEC, KRC	**Lab Number:**	L1849289
Project Number:	18-0345	**Report Date:**	12/10/18

Data Qualifiers

A - Spectra identified as "Aldol Condensation Product".

B - The analyte was detected above the reporting limit in the associated method blank. Flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank. For MCP-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank. For DOD-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank AND the analyte was detected above one-half the reporting limit (or above the reporting limit for common lab contaminants) in the associated method blank. For NJ-Air-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte above the reporting limit. For NJ-related projects (excluding Air), flag only applies to associated field samples that have detectable concentrations of the analyte, which was detected above the reporting limit in the associated method blank or above five times the reporting limit for common lab contaminants (Phthalates, Acetone, Methylene Chloride, 2-Butanone).

C - Co-elution: The target analyte co-elutes with a known lab standard (i.e. surrogate, internal standards, etc.) for co-extracted analyses.

D - Concentration of analyte was quantified from diluted analysis. Flag only applies to field samples that have detectable concentrations of the analyte.

E - Concentration of analyte exceeds the range of the calibration curve and/or linear range of the instrument.

G - The concentration may be biased high due to matrix interferences (i.e, co-elution) with non-target compound(s). The result should be considered estimated.

H - The analysis of pH was performed beyond the regulatory-required holding time of 15 minutes from the time of sample collection.

I - The lower value for the two columns has been reported due to obvious interference.

M - Reporting Limit (RL) exceeds the MCP CAM Reporting Limit for this analyte.

NJ - Presumptive evidence of compound. This represents an estimated concentration for Tentatively Identified Compounds (TICs), where the identification is based on a mass spectral library search.

P - The RPD between the results for the two columns exceeds the method-specified criteria.

Q - The quality control sample exceeds the associated acceptance criteria. For DOD-related projects, LCS and/or Continuing Calibration Standard exceedences are also qualified on all associated sample results. Note: This flag is not applicable for matrix spike recoveries when the sample concentration is greater than 4x the spike added or for batch duplicate RPD when the sample concentrations are less than 5x the RL. (Metals only.)

R - Analytical results are from sample re-analysis.

RE - Analytical results are from sample re-extraction.

S - Analytical results are from modified screening analysis.

J - Estimated value. This represents an estimated concentration for Tentatively Identified Compounds (TICs).

ND - Not detected at the reporting limit (RL) for the sample.

Report Format: Data Usability Report

Project Name:	NECEC, KRC	**Lab Number:**	L1849289
Project Number:	18-0345	**Report Date:**	12/10/18

REFERENCES

1 Test Methods for Evaluating Solid Waste: Physical/Chemical Methods. EPA SW-846. Third Edition. Updates I - IV, 2007.

121 Standard Methods for the Examination of Water and Wastewater. APHA-AWWA-WEF. Standard Methods Online.

LIMITATION OF LIABILITIES

Alpha Analytical performs services with reasonable care and diligence normal to the analytical testing laboratory industry. In the event of an error, the sole and exclusive responsibility of Alpha Analytical shall be to re-perform the work at it's own expense. In no event shall Alpha Analytical be held liable for any incidental, consequential or special damages, including but not limited to, damages in any way connected with the use of, interpretation of, information or analysis provided by Alpha Analytical.

We strongly urge our clients to comply with EPA protocol regarding sample volume, preservation, cooling, containers, sampling procedures, holding time and splitting of samples in the field.

Certification Information

The following analytes are not included in our Primary NELAP Scope of Accreditation:

Westborough Facility
EPA 624/624.1: m/p-xylene, o-xylene
EPA 8260C: NPW: 1,2,4,5-Tetramethylbenzene; 4-Ethyltoluene, Azobenzene; SCM: Iodomethane (methyl iodide), Methyl methacrylate, 1,2,4,5-Tetramethylbenzene; 4-Ethyltoluene.
EPA 8270D: NPW: Dimethylnaphthalene,1,4-Diphenylhydrazine; SCM: Dimethylnaphthalene,1,4-Diphenylhydrazine.

EPA 6860: SCM: Perchlorate

SM4500: NPW: Amenable Cyanide; SCM: Total Phosphorus, TKN, NO2, NO3.

Mansfield Facility
SM 2540D: TSS
EPA 8082A: NPW: PCB: 1, 5, 31, 87,101, 110, 141, 151, 153, 180, 183, 187.
EPA TO-15: Halothane, 2,4,4-Trimethyl-2-pentene, 2,4,4-Trimethyl-1-pentene, Thiophene, 2-Methylthiophene, 3-Methylthiophene, 2-Ethylthiophene, 1,2,3-Trimethylbenzene, Indan, Indene, 1,2,4,5-Tetramethylbenzene, Benzothiophene, 1-Methylnaphthalene.
Biological Tissue Matrix: EPA 3050B

The following analytes are included in our Massachusetts DEP Scope of Accreditation

Westborough Facility:

Drinking Water
EPA 300.0: Chloride, Nitrate-N, Fluoride, Sulfate; **EPA 353.2**: Nitrate-N, Nitrite-N; **SM4500NO3-F**: Nitrate-N, Nitrite-N; **SM4500F-C, SM4500CN-CE, EPA 180.1, SM2130B, SM4500Cl-D, SM2320B, SM2540C, SM4500H-B**
EPA 332: Perchlorate; **EPA 524.2:** THMs and VOCs; **EPA 504.1:** EDB, DBCP.
Microbiology: **SM9215B; SM9223-P/A, SM9223B-Colilert-QT,SM9222D**.

Non-Potable Water
SM4500H,B, EPA 120.1, SM2510B, SM2540C, SM2320B, SM4500CL-E, SM4500F-BC, SM4500NH3-BH: Ammonia-N and Kjeldahl-N, **EPA 350.1**: Ammonia-N, **LACHAT 10-107-06-1-B**: Ammonia-N, **EPA 351.1, SM4500NO3-F, EPA 353.2**: Nitrate-N**, SM4500P-E, SM4500P-B, E, SM4500SO4-E, SM5220D, EPA 410.4, SM5210B, SM5310C, SM4500CL-D, EPA 1664, EPA 420.1, SM4500-CN-CE, SM2540D, EPA 300: Chloride, Sulfate, Nitrate.**
EPA 624.1: Volatile Halocarbons & Aromatics,
EPA 608.3: Chlordane, Toxaphene, Aldrin, alpha-BHC, beta-BHC, gamma-BHC, delta-BHC, Dieldrin, DDD, DDE, DDT, Endosulfan I, Endosulfan II, Endosulfan sulfate, Endrin, Endrin Aldehyde, Heptachlor, Heptachlor Epoxide, PCBs
EPA 625.1: SVOC (Acid/Base/Neutral Extractables), **EPA 600/4-81-045**: PCB-Oil.
Microbiology: **SM9223B-Colilert-QT; Enterolert-QT, SM9221E, EPA 1600, EPA 1603.**

Mansfield Facility:

Drinking Water
EPA 200.7: Al, Ba, Cd, Cr, Cu, Fe, Mn, Ni, Na, Ag, Ca, Zn. **EPA 200.8:** Al, Sb, As, Ba, Be, Cd, Cr, Cu, Pb, Mn, Ni, Se, Ag, TL, Zn. **EPA 245.1** Hg.
EPA 522.

Non-Potable Water
EPA 200.7: Al, Sb, As, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Ag, Na, Sr, TL, Ti, V, Zn.
EPA 200.8: Al, Sb, As, Be, Cd, Cr, Cu, Fe, Pb, Mn, Ni, K, Se, Ag, Na, TL, Zn.
EPA 245.1 Hg.
SM2340B

For a complete listing of analytes and methods, please contact your Alpha Project Manager.

CHAIN OF CUSTODY

PAGE 1 OF 1

Date Rec'd in Lab: 12/3/18

ALPHA Job #: L1849289

ALPHA ANALYTICAL

8 Walkup Drive
Westboro, MA 01581
Tel: 508-898-9220

320 Forbes Blvd
Mansfield, MA 02048
Tel: 508-822-9300

Client Information

Client: S.W. Cole Engineering, Inc.

Address: 37 Liberty Dr, Hermon, ME

Phone: 207-848-5714

Email: Nate Stout@swcole.com

Additional Project Information:

Project Information

Project Name: NECEC, KRC

Project Location: Maine Gore, ME

Project #: 18-0345

Project Manager: Paul Kahler

ALPHA Quote #: PKahler@swcole.com

Turn-Around Time

☑ Standard ☐ RUSH (only confirmed if pre-approved!)

Date Due:

Report Information - Data Deliverables

☐ ADEx ☑ EMAIL

Billing Information

☑ Same as Client info PO #:

Regulatory Requirements & Project Information Requirements

☐ Yes ☐ No MA MCP Analytical Methods ☐ Yes ☐ No CT RCP Analytical Methods

☐ Yes ☐ No Matrix Spike Required on this SDG? (Required for MCP Inorganics)

☐ Yes ☐ No GW1 Standards (Info Required for Metals & EPH with Targets)

☐ Yes ☐ No NPDES RGP

☐ Other State /Fed Program _____ Criteria _____

ANALYSIS

VOC: ☐ 8260 ☐ 624 ☐ 524.2

SVOC: ☐ ABN ☐ PAH

METALS: ☐ MCP 13 ☐ MCP 14 ☐ RCP 15

METALS: ☐ RCRA5 ☐ RCRA8

EPH: ☐ Ranges & Targets ☐ PP13 ☐ Ranges Only

VPH: ☐ Ranges & Targets ☐ Ranges Only

☐ PCB ☐ PEST

TPH: ☐ Quant Only ☐ Fingerprint

Sulfate - 9038

Chloride - 9251

pH - 9045

SAMPLE INFO

Filtration
☐ Field
☐ Lab to do

Preservation
☐ Lab to do

Sample Comments

TOTAL # BOTTLES

ALPHA Lab ID (Lab Use Only)	Sample ID	Collection Date	Collection Time	Sample Matrix	Sampler Initials	TOTAL # BOTTLES
49289-01	BH-3, S-1, 2-5'	11-26-18	12:30	Soil	KH	3

Container Type	6	6	6
Preservative	A	A	A

Container Type
P= Plastic
A= Amber glass
V= Vial
G= Glass
B= Bacteria cup
C= Cube
O= Other
E= Encore
D= BOD Bottle

Preservative
A= None
B= HCl
C= HNO_3
D= H_2SO_4
E= NaOH
F= MeOH
G= $NaHSO_4$
H = $Na_2S_2O_3$
I= Ascorbic Acid
J = NH_4Cl
K= Zn Acetate
O= Other

Relinquished By:	Date/Time	Received By:	Date/Time
	12-3-18/15:30		12-3-18/15:30
	12-3-18/1530		12/3/18 15:30
			12/3/18 23:20

All samples submitted are subject to Alpha's Terms and Conditions. See reverse side.

FORM NO: 01-01 (rev. 12-Mar-2012)

UNISHIP
COURIER SERVICES LLC

10 Iron Road
Hermon, Maine 04401

Phone 207•848•7546 ■ Toll-Free 800•427•7547 ■ Fax 207•561•2467

Bill Shipping Charge to

Shipper ☐ ☐ Next Day
Recipient ☐ ☐ Same Day
Special

043251

390 US Route One, #3
Falmouth, Maine 04105

FROM:
Shipper Alpha
Street 22 Center St
Origin Brewer Zip Code
Phone #

TO:
Recipient Alpha
Street Cumberland Ave
Destination Portland ME Zip Code
Phone #

No. Pieces	Weight Each	Description of Items	Total Weight (Subject to Correction)	Oversize Charge	Shipping Charges
4		1 waiter			
		2 sw rack			
		1 TES			

◀ TOTAL PIECES | WEIGHT GRAND TOTAL ▶ | TOTAL CHARGES ▶

Shipper authorizes Uniship to deliver this shipment without obtaining a delivery signature.
Shipper's Signature Danny Pelle

Please use complete ship to address.
Uniship can not deliver to P.O. Boxes.

RECEIVED, subject to the classifications and tariffs in effect on the date of the issue of this Bill of Lading, the property described above in apparent good order, except as noted (contents and condition of contents of packages unknown), marked, consigned, and destined as indicated above which said carrier (the word carrier being understood throughout this contract as meaning any person or corporation in possession of the property, under the contract) agrees to carry to its usual place of delivery at said destination, if on its route, otherwise to deliver to another carrier on the route to said destination. It is mutually agreed as to each carrier of all or any of said property overall or any portion of said route to destination and as to each party at any time interested in all or any of said property, that every service to be performed hereunder shall be subject to all the bill of lading terms and conditions in the governing classification on the date of shipment.

Shipper hereby certifies that he is familiar with all the bill of lading terms and conditions in the governing classification and the said terms and conditions are hereby agreed to by the shipper and accepted for himself and his assigns.

SHIPPER		PICK-UP TIME	17:14	RECIPIENT	DELIVERY TIME 23:25
COURIER SIGNATURE	CW	DATE	12-7-18	COURIER SIGNATURE	DATE 12-7-18

RECIPIENT COPY


SCI SPEC
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Committed to Quality Since 1963
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SIGNATURE
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PRECLEANED CONTAINERS
Committed to Quality Since 1963

Cooler B

ANALYTICAL REPORT

Lab Number:	L1846610
Client:	S. W. Cole Engineering, Inc. 37 Liberty Drive Bangor, ME 04401-5784
ATTN:	Nate Strout
Phone:	(207) 657-2866
Project Name:	NECEC-KRC
Project Number:	18-0345
Report Date:	11/21/18

The original project report/data package is held by Alpha Analytical. This report/data package is paginated and should be reproduced only in its entirety. Alpha Analytical holds no responsibility for results and/or data that are not consistent with the original.

Certifications & Approvals: MA (M-MA086), NH NELAP (2064), CT (PH-0574), IL (200077), ME (MA00086), MD (348), NJ (MA935), NY (11148), NC (25700/666), PA (68-03671), RI (LAO00065), TX (T104704476), VT (VT-0935), VA (460195), USDA (Permit #P330-17-00196).

Eight Walkup Drive, Westborough, MA 01581-1019
508-898-9220 (Fax) 508-898-9193 800-624-9220 - www.alphalab.com

Project Name: NECEC-KRC
Project Number: 18-0345

Lab Number: L1846610
Report Date: 11/21/18

Alpha Sample ID	Client ID	Matrix	Sample Location	Collection Date/Time	Receive Date
L1846610-01	BH-4, S-1, 1.0-2.5'	SOIL	MOXIE GORE, ME	11/08/18 11:00	11/14/18

Project Name: NECEC-KRC
Project Number: 18-0345

Lab Number: L1846610
Report Date: 11/21/18

Case Narrative

The samples were received in accordance with the Chain of Custody and no significant deviations were encountered during the preparation or analysis unless otherwise noted. Sample Receipt, Container Information, and the Chain of Custody are located at the back of the report.

Results contained within this report relate only to the samples submitted under this Alpha Lab Number and meet NELAP requirements for all NELAP accredited parameters unless otherwise noted in the following narrative. The data presented in this report is organized by parameter (i.e. VOC, SVOC, etc.). Sample specific Quality Control data (i.e. Surrogate Spike Recovery) is reported at the end of the target analyte list for each individual sample, followed by the Laboratory Batch Quality Control at the end of each parameter. Tentatively Identified Compounds (TICs), if requested, are reported for compounds identified to be present and are not part of the method/program Target Compound List, even if only a subset of the TCL are being reported. If a sample was re-analyzed or re-extracted due to a required quality control corrective action and if both sets of data are reported, the Laboratory ID of the re-analysis or re-extraction is designated with an "R" or "RE", respectively. When multiple Batch Quality Control elements are reported (e.g. more than one LCS), the associated samples for each element are noted in the grey shaded header line of each data table. Any Laboratory Batch, Sample Specific % recovery or RPD value that is outside the listed Acceptance Criteria is bolded in the report. All specific QC information is also incorporated in the Data Usability format of our Data Merger tool where it can be reviewed along with any associated usability implications. Soil/sediments, solids and tissues are reported on a dry weight basis unless otherwise noted. Definitions of all data qualifiers and acronyms used in this report are provided in the Glossary located at the back of the report.

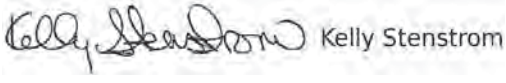
In reference to questions H (CAM) or 4 (RCP) when "NO" is checked, the performance criteria for CAM and RCP methods allow for some quality control failures to occur and still be within method compliance. In these instances the specific failure is not narrated but noted in the associated QC table. The information is also incorporated in the Data Usability format of our Data Merger tool where it can be reviewed along with any associated usability implications.

Please see the associated ADEx data file for a comparison of laboratory reporting limits that were achieved with the regulatory Numerical Standards requested on the Chain of Custody.

HOLD POLICY
For samples submitted on hold, Alpha's policy is to hold samples (with the exception of Air canisters) free of charge for 21 calendar days from the date the project is completed. After 21 calendar days, we will dispose of all samples submitted including those put on hold unless you have contacted your Client Service Representative and made arrangements for Alpha to continue to hold the samples. Air canisters will be disposed after 3 business days from the date the project is completed.

Please contact Client Services at 800-624-9220 with any questions.

I, the undersigned, attest under the pains and penalties of perjury that, to the best of my knowledge and belief and based upon my personal inquiry of those responsible for providing the information contained in this analytical report, such information is accurate and complete. This certificate of analysis is not complete unless this page accompanies any and all pages of this report.

Authorized Signature:  Kelly Stenstrom

Title: Technical Director/Representative Date: 11/21/18

INORGANICS
&
MISCELLANEOUS

Project Name: NECEC-KRC
Project Number: 18-0345

Lab Number: L1846610
Report Date: 11/21/18

SAMPLE RESULTS

Lab ID: L1846610-01
Client ID: BH-4, S-1, 1.0-2.5'
Sample Location: MOXIE GORE, ME

Date Collected: 11/08/18 11:00
Date Received: 11/14/18
Field Prep: Not Specified

Sample Depth:
Matrix: Soil

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Solids, Total	84.7		%	0.100	NA	1	-	11/15/18 10:23	121,2540G	RI
Chloride	ND		mg/kg	11	--	1	-	11/19/18 18:46	1,9251	ML
pH (H)	7.0		SU	-	NA	1	-	11/15/18 18:10	1,9045D	AS
Sulfate	ND		mg/kg	120	--	1	-	11/21/18 12:01	1,9038	BR
Moisture	15.3		%	0.100	NA	1	-	11/15/18 10:23	121,2540G	RI

Project Name: NECEC-KRC
Project Number: 18-0345

Lab Number: L1846610
Report Date: 11/21/18

Method Blank Analysis
Batch Quality Control

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab for sample(s): 01 Batch: WG1181067-1										
Chloride	ND		mg/kg	10	--	1	-	11/19/18 18:44	1,9251	ML
General Chemistry - Westborough Lab for sample(s): 01 Batch: WG1181525-1										
Sulfate	ND		mg/kg	100	--	1	-	11/21/18 12:01	1,9038	BR

Lab Control Sample Analysis
Batch Quality Control

Project Name: NECEC-KRC
Project Number: 18-0345

Lab Number: L1846610
Report Date: 11/21/18

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
General Chemistry - Westborough Lab Associated sample(s): 01 Batch: WG1179936-1								
pH	100		-		99-101	-		
General Chemistry - Westborough Lab Associated sample(s): 01 Batch: WG1181067-2								
Chloride	104		-		89-109	-		35
General Chemistry - Westborough Lab Associated sample(s): 01 Batch: WG1181525-2								
Sulfate	102		-		80-121	-		12

Matrix Spike Analysis
Batch Quality Control

Project Name: NECEC-KRC
Project Number: 18-0345

Lab Number: L1846610
Report Date: 11/21/18

Parameter	Native Sample	MS Added	MS Found	MS %Recovery	Qual	MSD Found	MSD %Recovery	Qual	Recovery Limits	RPD	Qual	RPD Limits
General Chemistry - Westborough Lab Associated sample(s): 01 QC Batch ID: WG1181067-4 QC Sample: L1846610-01 Client ID: BH-4, S-1, 1.0-2.5'												
Chloride	ND	451	460	102		-	-		62-129	-		35
General Chemistry - Westborough Lab Associated sample(s): 01 QC Batch ID: WG1181525-4 QC Sample: L1846610-01 Client ID: BH-4, S-1, 1.0-2.5'												
Sulfate	ND	223	170	76		-	-		22-183	-		12

Lab Duplicate Analysis

Batch Quality Control

Project Name: NECEC-KRC
Project Number: 18-0345

Lab Number: L1846610
Report Date: 11/21/18

Parameter	Native Sample	Duplicate Sample	Units	RPD	Qual	RPD Limits
General Chemistry - Westborough Lab Associated sample(s): 01 QC Batch ID: WG1179774-1 QC Sample: L1846610-01 Client ID: BH-4, S-1, 1.0-2.5'						
Solids, Total	84.7	82.4	%	3		20
Moisture	15.3	17.6	%	14		20
General Chemistry - Westborough Lab Associated sample(s): 01 QC Batch ID: WG1181067-3 QC Sample: L1846610-01 Client ID: BH-4, S-1, 1.0-2.5'						
Chloride	ND	ND	mg/kg	NC		35
General Chemistry - Westborough Lab Associated sample(s): 01 QC Batch ID: WG1181525-3 QC Sample: L1846610-01 Client ID: BH-4, S-1, 1.0-2.5'						
Sulfate	ND	ND	mg/kg	NC		12

Project Name: NECEC-KRC
Project Number: 18-0345

Lab Number: L1846610
Report Date: 11/21/18

Sample Receipt and Container Information

Were project specific reporting limits specified? YES

Cooler Information

Cooler	Custody Seal
A	Present/Intact

Container Information

Container ID	Container Type	Cooler	Initial pH	Final pH	Temp deg C	Pres	Seal	Frozen Date/Time	Analysis(*)
L1846610-01A	Glass 250ml/8oz unpreserved	A	NA		2.7	Y	Present/Intact		CL-9251(28),SO4-9038(28),PH-9045(1),ME-TS-2540(7),MOISTURE(7)

*Values in parentheses indicate holding time in days

Project Name:	NECEC-KRC	**Lab Number:**	L1846610
Project Number:	18-0345	**Report Date:**	11/21/18

GLOSSARY

Acronyms

EDL	- Estimated Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the reporting limit (RL). The EDL includes any adjustments from dilutions, concentrations or moisture content, where applicable. The use of EDLs is specific to the analysis of PAHs using Solid-Phase Microextraction (SPME).
EMPC	- Estimated Maximum Possible Concentration: The concentration that results from the signal present at the retention time of an analyte when the ions meet all of the identification criteria except the ion abundance ratio criteria. An EMPC is a worst-case estimate of the concentration.
EPA	- Environmental Protection Agency.
LCS	- Laboratory Control Sample: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.
LCSD	- Laboratory Control Sample Duplicate: Refer to LCS.
LFB	- Laboratory Fortified Blank: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.
MDL	- Method Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the reporting limit (RL). The MDL includes any adjustments from dilutions, concentrations or moisture content, where applicable.
MS	- Matrix Spike Sample: A sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available.
MSD	- Matrix Spike Sample Duplicate: Refer to MS.
NA	- Not Applicable.
NC	- Not Calculated: Term is utilized when one or more of the results utilized in the calculation are non-detect at the parameter's reporting unit.
NDPA/DPA	- N-Nitrosodiphenylamine/Diphenylamine.
NI	- Not Ignitable.
NP	- Non-Plastic: Term is utilized for the analysis of Atterberg Limits in soil.
RL	- Reporting Limit: The value at which an instrument can accurately measure an analyte at a specific concentration. The RL includes any adjustments from dilutions, concentrations or moisture content, where applicable.
RPD	- Relative Percent Difference: The results from matrix and/or matrix spike duplicates are primarily designed to assess the precision of analytical results in a given matrix and are expressed as relative percent difference (RPD). Values which are less than five times the reporting limit for any individual parameter are evaluated by utilizing the absolute difference between the values; although the RPD value will be provided in the report.
SRM	- Standard Reference Material: A reference sample of a known or certified value that is of the same or similar matrix as the associated field samples.
STLP	- Semi-dynamic Tank Leaching Procedure per EPA Method 1315.
TEF	- Toxic Equivalency Factors: The values assigned to each dioxin and furan to evaluate their toxicity relative to 2,3,7,8-TCDD.
TEQ	- Toxic Equivalent: The measure of a sample¿s toxicity derived by multiplying each dioxin and furan by its corresponding TEF and then summing the resulting values.
TIC	- Tentatively Identified Compound: A compound that has been identified to be present and is not part of the target compound list (TCL) for the method and/or program. All TICs are qualitatively identified and reported as estimated concentrations.

Footnotes

1	- The reference for this analyte should be considered modified since this analyte is absent from the target analyte list of the original method.

Terms

Analytical Method: Both the document from which the method originates and the analytical reference method. (Example: EPA 8260B is shown as 1,8260B.) The codes for the reference method documents are provided in the References section of the Addendum.

Final pH: As it pertains to Sample Receipt & Container Information section of the report, Final pH reflects pH of container determined after adjustment at the laboratory, if applicable. If no adjustment required, value reflects Initial pH.

Frozen Date/Time: With respect to Volatile Organics in soil, Frozen Date/Time reflects the date/time at which associated Reagent Water-preserved vials were initially frozen. Note: If frozen date/time is beyond 48 hours from sample collection, value will be reflected in 'bold'.

Initial pH: As it pertains to Sample Receipt & Container Information section of the report, Initial pH reflects pH of container determined upon receipt, if applicable.

Total: With respect to Organic analyses, a 'Total' result is defined as the summation of results for individual isomers or Aroclors. If a 'Total' result is requested, the results of its individual components will also be reported. This is applicable to 'Total' results for methods 8260, 8081 and 8082.

Report Format: Data Usability Report

Project Name:	NECEC-KRC	**Lab Number:**	L1846610
Project Number:	18-0345	**Report Date:**	11/21/18

Data Qualifiers

A - Spectra identified as "Aldol Condensation Product".

B - The analyte was detected above the reporting limit in the associated method blank. Flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank. For MCP-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank. For DOD-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank AND the analyte was detected above one-half the reporting limit (or above the reporting limit for common lab contaminants) in the associated method blank. For NJ-Air-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte above the reporting limit. For NJ-related projects (excluding Air), flag only applies to associated field samples that have detectable concentrations of the analyte, which was detected above the reporting limit in the associated method blank or above five times the reporting limit for common lab contaminants (Phthalates, Acetone, Methylene Chloride, 2-Butanone).

C - Co-elution: The target analyte co-elutes with a known lab standard (i.e. surrogate, internal standards, etc.) for co-extracted analyses.

D - Concentration of analyte was quantified from diluted analysis. Flag only applies to field samples that have detectable concentrations of the analyte.

E - Concentration of analyte exceeds the range of the calibration curve and/or linear range of the instrument.

G - The concentration may be biased high due to matrix interferences (i.e, co-elution) with non-target compound(s). The result should be considered estimated.

H - The analysis of pH was performed beyond the regulatory-required holding time of 15 minutes from the time of sample collection.

I - The lower value for the two columns has been reported due to obvious interference.

M - Reporting Limit (RL) exceeds the MCP CAM Reporting Limit for this analyte.

NJ - Presumptive evidence of compound. This represents an estimated concentration for Tentatively Identified Compounds (TICs), where the identification is based on a mass spectral library search.

P - The RPD between the results for the two columns exceeds the method-specified criteria.

Q - The quality control sample exceeds the associated acceptance criteria. For DOD-related projects, LCS and/or Continuing Calibration Standard exceedences are also qualified on all associated sample results. Note: This flag is not applicable for matrix spike recoveries when the sample concentration is greater than 4x the spike added or for batch duplicate RPD when the sample concentrations are less than 5x the RL. (Metals only.)

R - Analytical results are from sample re-analysis.

RE - Analytical results are from sample re-extraction.

S - Analytical results are from modified screening analysis.

J - Estimated value. This represents an estimated concentration for Tentatively Identified Compounds (TICs).

ND - Not detected at the reporting limit (RL) for the sample.

Report Format: Data Usability Report

Project Name:	NECEC-KRC	**Lab Number:**	L1846610
Project Number:	18-0345	**Report Date:**	11/21/18

REFERENCES

1 Test Methods for Evaluating Solid Waste: Physical/Chemical Methods. EPA SW-846. Third Edition. Updates I - IV, 2007.

121 Standard Methods for the Examination of Water and Wastewater. APHA-AWWA-WEF. Standard Methods Online.

LIMITATION OF LIABILITIES

Alpha Analytical performs services with reasonable care and diligence normal to the analytical testing laboratory industry. In the event of an error, the sole and exclusive responsibility of Alpha Analytical shall be to re-perform the work at it's own expense. In no event shall Alpha Analytical be held liable for any incidental, consequential or special damages, including but not limited to, damages in any way connected with the use of, interpretation of, information or analysis provided by Alpha Analytical.

We strongly urge our clients to comply with EPA protocol regarding sample volume, preservation, cooling, containers, sampling procedures, holding time and splitting of samples in the field.

Certification Information

The following analytes are not included in our Primary NELAP Scope of Accreditation:

Westborough Facility
EPA 624/624.1: m/p-xylene, o-xylene
EPA 8260C: NPW: 1,2,4,5-Tetramethylbenzene; 4-Ethyltoluene, Azobenzene; SCM: Iodomethane (methyl iodide), Methyl methacrylate, 1,2,4,5-Tetramethylbenzene; 4-Ethyltoluene.
EPA 8270D: NPW: Dimethylnaphthalene,1,4-Diphenylhydrazine; SCM: Dimethylnaphthalene,1,4-Diphenylhydrazine.

EPA 6860: SCM: Perchlorate

SM4500: NPW: Amenable Cyanide; SCM: Total Phosphorus, TKN, NO2, NO3.

Mansfield Facility
SM 2540D: TSS
EPA 8082A: NPW: PCB: 1, 5, 31, 87,101, 110, 141, 151, 153, 180, 183, 187.
EPA TO-15: Halothane, 2,4,4-Trimethyl-2-pentene, 2,4,4-Trimethyl-1-pentene, Thiophene, 2-Methylthiophene, 3-Methylthiophene, 2-Ethylthiophene, 1,2,3-Trimethylbenzene, Indan, Indene, 1,2,4,5-Tetramethylbenzene, Benzothiophene, 1-Methylnaphthalene.
Biological Tissue Matrix: EPA 3050B

The following analytes are included in our Massachusetts DEP Scope of Accreditation

Westborough Facility:

Drinking Water
EPA 300.0: Chloride, Nitrate-N, Fluoride, Sulfate; **EPA 353.2**: Nitrate-N, Nitrite-N; **SM4500NO3-F**: Nitrate-N, Nitrite-N; **SM4500F-C, SM4500CN-CE, EPA 180.1, SM2130B, SM4500Cl-D, SM2320B, SM2540C, SM4500H-B**
EPA 332: Perchlorate; **EPA 524.2:** THMs and VOCs; **EPA 504.1:** EDB, DBCP.
Microbiology: **SM9215B; SM9223-P/A, SM9223B-Colilert-QT,SM9222D**.

Non-Potable Water
SM4500H,B, EPA 120.1, SM2510B, SM2540C, SM2320B, SM4500CL-E, SM4500F-BC, SM4500NH3-BH: Ammonia-N and Kjeldahl-N, **EPA 350.1**: Ammonia-N, **LACHAT 10-107-06-1-B**: Ammonia-N, **EPA 351.1, SM4500NO3-F, EPA 353.2**: Nitrate-N**, SM4500P-E, SM4500P-B, E, SM4500SO4-E, SM5220D, EPA 410.4, SM5210B, SM5310C, SM4500CL-D, EPA 1664, EPA 420.1, SM4500-CN-CE, SM2540D, EPA 300: Chloride, Sulfate, Nitrate.**
EPA 624.1: Volatile Halocarbons & Aromatics,
EPA 608.3: Chlordane, Toxaphene, Aldrin, alpha-BHC, beta-BHC, gamma-BHC, delta-BHC, Dieldrin, DDD, DDE, DDT, Endosulfan I, Endosulfan II, Endosulfan sulfate, Endrin, Endrin Aldehyde, Heptachlor, Heptachlor Epoxide, PCBs
EPA 625.1: SVOC (Acid/Base/Neutral Extractables), **EPA 600/4-81-045**: PCB-Oil.
Microbiology: **SM9223B-Colilert-QT; Enterolert-QT, SM9221E, EPA 1600, EPA 1603.**

Mansfield Facility:

Drinking Water
EPA 200.7: Al, Ba, Cd, Cr, Cu, Fe, Mn, Ni, Na, Ag, Ca, Zn. **EPA 200.8:** Al, Sb, As, Ba, Be, Cd, Cr, Cu, Pb, Mn, Ni, Se, Ag, TL, Zn. **EPA 245.1** Hg.
EPA 522.

Non-Potable Water
EPA 200.7: Al, Sb, As, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Ag, Na, Sr, TL, Ti, V, Zn.
EPA 200.8: Al, Sb, As, Be, Cd, Cr, Cu, Fe, Pb, Mn, Ni, K, Se, Ag, Na, TL, Zn.
EPA 245.1 Hg.
SM2340B

For a complete listing of analytes and methods, please contact your Alpha Project Manager.

CHAIN OF CUSTODY

PAGE 1 OF 1

Date Rec'd in Lab: 11/14/18

ALPHA Job #: L1846610

ALPHA ANALYTICAL
8 Walkup Drive, Westboro, MA 01581, Tel: 508-898-9220
320 Forbes Blvd, Mansfield, MA 02048, Tel: 508-822-9300

Client Information

Client: S.W. Cole Engineering Inc.
Address: 37 Liberty Drive, Hermon, ME
Phone: 207-848-5714
Email: Nate.Strout@swcole.com

Project Information

Project Name: NECEC - KRC
Project Location: Moxie Gore, ME
Project #: 18-0375
Project Manager: Paul Kahler
ALPHA Quote #: ↳ PKahler@swcole.com

Report Information - Data Deliverables

☐ ADEx ☑ EMAIL

Billing Information

☑ Same as Client info PO #:

Regulatory Requirements & Project Information Requirements

☐ Yes ☐ No MA MCP Analytical Methods ☐ Yes ☐ No CT RCP Analytical Methods
☐ Yes ☐ No Matrix Spike Required on this SDG? (Required for MCP Inorganics)
☐ Yes ☐ No GW1 Standards (Info Required for Metals & EPH with Targets)
☐ Yes ☐ No NPDES RGP
☐ Other State /Fed Program _____ Criteria _____

Turn-Around Time

☑ Standard ☐ RUSH (only confirmed if pre-approved)
Date Due:

Additional Project Information:

ANALYSIS

VOC: ☐ 8260 ☐ 624 ☐ 524.2
SVOC: ☐ ABN ☐ PAH
METALS: ☐ MCP 13 ☐ MCP 14 ☐ RCP 15
METALS: ☐ RCRA5 ☐ RCRA8 ☐ PP13
EPH: ☐ Ranges & Targets ☐ Ranges Only
VPH: ☐ Ranges & Targets ☐ Ranges Only
☐ PCB ☐ PEST
TPH: ☐ Quant Only ☐ Fingerprint
S./Ferk - 9038
Chloride - 9251
pH - 9045
Moisture content

SAMPLE INFO

Filtration
☐ Field
☐ Lab to do
Preservation
☐ Lab to do

Sample Comments

TOTAL # BOTTLES

ALPHA Lab ID (Lab Use Only)	Sample ID	Collection Date	Collection Time	Sample Matrix	Sampler Initials	VOC	SVOC	METALS	METALS	EPH	VPH	PCB	TPH	S./Ferk - 9038	Chloride - 9251	pH - 9045	Moisture content	Sample Comments	TOTAL # BOTTLES
46610-4	BH-4, S-1, 1.0-2.5'	11-8-18	11:40	Soil	NDS									✓	✓	✓	✓		
Container Type														6	6	6	6		
Preservative														A	A	A	A		

Container Type
P= Plastic
A= Amber glass
V= Vial
G= Glass
B= Bacteria cup
C= Cube
O= Other
E= Encore
D= BOD Bottle

Preservative
A= None
B= HCl
C= HNO_3
D= H_2SO_4
E= NaOH
F= MeOH
G= $NaHSO_4$
H = $Na_2S_2O_3$
I= Ascorbic Acid
J = NH_4Cl
K= Zn Acetate
O= Other

Relinquished By:	Date/Time	Received By:	Date/Time
	11-14-18 1100		11/14/18 1130
			11/14/18 2350

All samples submitted are subject to Alpha's Terms and Conditions. See reverse side.

FORM NO: 01-01 (rev. 12-Mar-2012)


SCI SPEC
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Committed to Quality Since 1982
Custody Seal Custody Seal Custody Seal Custody Seal
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10 Iron Road
Hermon, Maine 04401

Bill Shipping Charge to

Shipper ☐ ☐ Next Day
Recipient ☐ ☐ Same Day
Special _____

047216

Phone 207•848•7546 ■ Toll-Free 800•427•7547 ■ Fax 207•561•2467

390 US Route One, #3
Falmouth, Maine 04105

FROM: Shipper Alpha	TO: Recipient Alpha
Street	Street 8 Walter Drive
Origin Brewer ME Zip Code	Destination Westbrook ME Zip Code
Phone #	Phone #

No. Pieces	Weight Each	Description of items	Total Weight (Subject to Correction)	Oversize Charge	Shipping Charges
5		1 radar ingsman			
		1 radar TW role			
		1 radar CEG			
		1 radar Environmental Protection			
		1 radar MEMEP			
	◀ TOTAL PIECES	WEIGHT GRAND TOTAL ▶		TOTAL CHARGES ▶	

Shipper authorizes Unishup to deliver this shipment without obtaining a delivery signature.
Shipper's Signature [signature]

Please use complete ship to address.
Unishup can not deliver to P.O. Boxes.

RECEIVED, subject to the classifications and tariffs in effect on the date of the issue of this Bill of Lading, the property described above in apparent good order, except as noted (contents and condition of contents of packages unknown), marked, consigned, and destined as indicated above which said carrier (the word carrier being understood throughout this contract as meaning any person or corporation in possession of the property, under the contract) agrees to carry to its usual place of delivery at said destination, if on its route, otherwise to deliver to another carrier on the route to said destination. It is mutually agreed as to each carrier of all or any of said property overall or any portion of said route to destination and as to each party at any time interested in all or any of said property, that every service to be performed hereunder shall be subject to all the bill of lading terms and conditions in the governing classification on the date of shipment.
Shipper hereby certifies that he is familiar with all the bill of lading terms and conditions in the governing classification and the said terms and conditions are hereby agreed to by the shipper and accepted for himself and his assigns.

SHIPPER	PICK-UP TIME 1500	RECIPIENT	DELIVERY TIME
COURIER SIGNATURE [signature]	DATE 11/14/18	COURIER SIGNATURE [signature]	DATE

RECIPIENT COPY

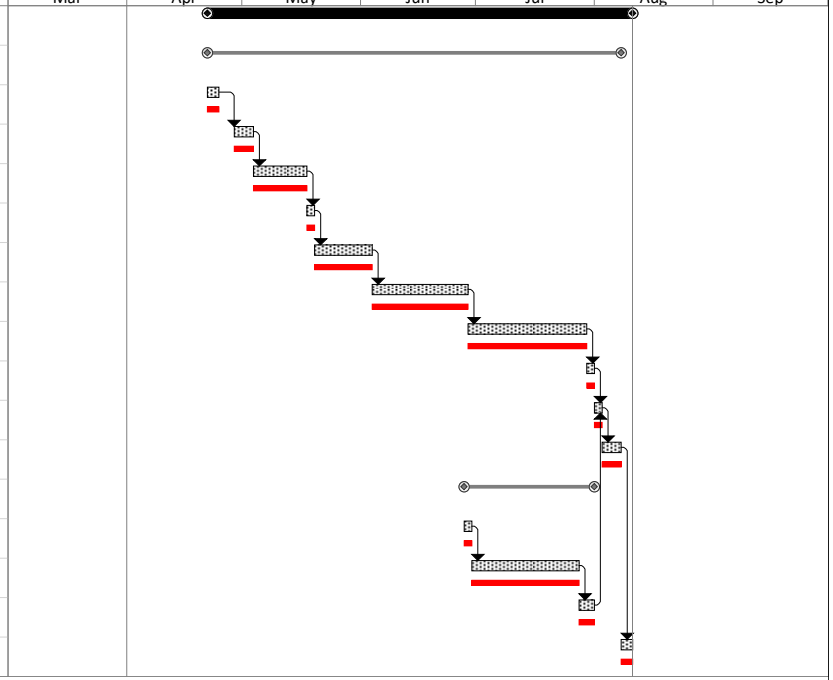
Appendix B - Execution Details

Contents

HDD Construction Schedule
Technical Details

Central Maine Power
New England Clean Energy Connect
HDD Schedule

ID	Task Name	Baseline Duration	Actual Days (Projected)	Start	Finish	Predecessors
0	**Central Maine Power New England Clean Energy Connect**	**111 days**	**111 days**	**Mon 22/04/24**	**Sat 10/08/24**	
1	**Kennebec River HDD 1**	**108 days**	**108 days**	**Mon 22/04/24**	**Wed 07/08/24**	
2	Mobilization	3 days	3 days	Mon 22/04/24	Wed 24/04/24	
3	Rig up	5 days	5 days	Mon 29/04/24	Fri 03/05/24	2
4	Pilot hole	14 days	14 days	Sat 04/05/24	Fri 17/05/24	3
5	Intersect operations	2 days	2 days	Sat 18/05/24	Sun 19/05/24	4
6	Ream pass (30")	15 days	15 days	Mon 20/05/24	Mon 03/06/24	5
7	Ream pass (42")	25 days	25 days	Tue 04/06/24	Fri 28/06/24	6
8	Ream pass (48")	31 days	31 days	Sat 29/06/24	Mon 29/07/24	7
9	Swab pass	2 days	2 days	Tue 30/07/24	Wed 31/07/24	8
10	Pipe installation	2 days	2 days	Thu 01/08/24	Fri 02/08/24	9,15
11	Rig down	5 days	5 days	Sat 03/08/24	Wed 07/08/24	10
12	**Pipe Fusing Activities**	**34 days**	**34 days**	**Fri 28/06/24**	**Wed 31/07/24**	
13	Receive & unload pipe	2 days	2 days	Fri 28/06/24	Sat 29/06/24	
14	Fuse pipe	28 days	28 days	Sun 30/06/24	Sat 27/07/24	13
15	Test pipe	4 days	4 days	Sun 28/07/24	Wed 31/07/24	14
16	Demobilization	3 days	3 days	Thu 08/08/24	Sat 10/08/24	11



The HDD Company, Inc.
HDD-Q19116
Date: Mon 16/10/23

Bid Days | Actual Duration | Projected Remaining | Baseline Summary | Project Summary | Actual Summary

Schedule is based on working 7 days/week, 24 hours/day

TECHNICAL DETAILS

Project **Central Main Power New England Clean Energy Connect (HDD #1: Kennebeck River)**
Location Moxie Gore, Maine **(Latitude 45.37142277° N, Longitude 69.93612083° W)**

Equipment	Rig 7	Vermeer D750x900 **(Pull Rig)** Push/Pull Force: 768,000 lbs Rotary Torque: 99,400 ft-lbs
Geometry	Length Entry/Exit Angle Minimum radius as per owner specifications subject to ground conditions.	3,421’ Dwg No. Design 2023-10-11, sheet HDD-2 15° / 16° Design Radius 1,700’
Conductor Pipe	Entry	60” x ~160’ estimated (final surface casing distances will be dependent on the actual ground encountered)
Pilot Hole	Pilot Hole Drilling Assembly	(1) 12 ¼” TIC Tri-Cone Bit (1) 8” AIBA Inrock mud motor (1) 6 ¾” orienting sub (1) 6 ¾” x 31’ non-magnetic drill collar 5.5” FH, 24.70 ppf, Grade S-135 drill pipe, and/or 6 5/8” FH, 27.7 & 34.02 ppf, Grade S-135 drill pipe, inspected within one year, may be used since last inspection. Required cross-over subs
	Annular Pressure Sensor	Vector Magnetics ParaTrack Pressure Module annulus pressure 0-1000 psi operating, 3000 psi survival
	Guidance System	Vector Magnetics ParaTrack Steering Tool w/ Gyro Module Survey precision: Azimuth: 0.1° Inclination: 0.02° Toolface: 0.5°
Reaming	Reaming Assembly	30” TCI-rock hole opener 42” TCI-rock hole opener 48” TCI-rock hole opener (final Bore hole +/-5%) 6 5/8” FH, 27.7 & 34.02 ppf, Grade S-135 drill pipe, inspected within one year, may be used since last inspection. Required cross-over subs
Product Pull	Product Line Pulling Assembly	(1) Pull head attached to line pipe (1) Swivel (1) DIAMETER” barrel reamer 6 5/8” FH, 27.7 & 34.02 ppf, Grade S-135 drill pipe, inspected within one year, may be used since last inspection. Required cross-over subs
	Expected Line Pipe	(7) 10” DR 14 FPVC Pipeline
Drilling Fluid	Drilling Fluid Composition	High Yield Gel: XXXX sacks estimated Soda Ash: XX sacks estimated Detergent: XX pails estimated
	Cleaning Equipment	(1) AA MCD -1000 Solids Control/Mixing Unit
	Mud Pump(s)	(2) Vermeer SA 400 or equivalent
	Estimated Volumes	Water Use XXXXXX gal Fluids Disposal XXXXX gal Solids Disposal XXXX cy
Schedule	Duration	Approx. 111 days (see Construction Schedule)

TECHNICAL DETAILS

Project **Central Main Power New England Clean Energy Connect (HDD #1: Kennebeck River)**
Location West Forks, Maine (Latitude 45.37530556° N, Longitude 69.94785000° W)

Equipment	Rig 8	AA DD 140B **(Intersect Rig)** Push/Pull Force: 140,000 lbs Rotary Torque: 25,000 ft-lbs		
Geometry	Length Entry/Exit Angle	3,481' 15° / 16°	Dwg No. Design Radius	Design 2023-10-11, sheet HDD-2 1,700'
	Minimum radius as per owner specifications subject to ground conditions.			
Conductor Pipe	Entry	60" x TBD (final surface casing distances will be dependent on the actual ground encountered).		
Pilot Hole	Pilot Hole Drilling Assembly	(1) 12 ¼" TIC Tri-Cone Bit (1) 8" AIBA InRock mud motor (1) 6 ¾" orienting sub (1) 6 ¾" x 31' non-magnetic drill collar 5.5" FH, 24.70 ppf, Grade S-135 drill pipe, inspected within one year, may be used since last inspection. Required cross-over subs		
	Annular Pressure Sensor	Vector Magnetics ParaTrack Pressure Module annulus pressure 0-1000 psi operating, 3000 psi survival		
	Guidance System	Vector Magnetics ParaTrack Steering Tool w/ Gyro Module Survey precision: Azimuth: 0.1° Inclination: 0.02° Toolface: 0.5°		
Reaming	Reaming Assembly	30" TCI-rock hole opener 42" TCI-rock hole opener 48" TCI-rock hole opener (final Bore hole +/-5%) 6 5/8" FH, 27.7 & 34.02 ppf, Grade S-135 drill pipe, inspected within one year, may be used since last inspection. Required cross-over subs		
Product Pull	Product Line Pulling Assembly	(Not Applicable)		
	Expected Line Pipe	(Not Applicable)		
Drilling Fluid	Drilling Fluid Composition	(See Primary Rig)		
	Cleaning Equipment	(1) Vermeer R9x12T Solids Control/Mixing Unit		
	Mud Pump(s)	(2) Vermeer SA 400 or equivalent		
	Estimated Volumes	(See Primary Rig)		
Schedule	Duration	Approx. 111 days (see Construction Schedule)		

THE HDD COMPANY

RIG No.7 EQUIPMENT INVENTORY

SOLIDS CONTROL SYSTEM
American Augers MCD–1000
4x three–layer shakers (414ft² total)

FLUID CIRCULATION SYSTEM
Mechanical tank agitator system
2x 11" desander cones
16x 5" desilter cones
Shale bins (540ft³)
Shale shaker tank (510ft³ capacity)
Settling tank (360ft³ capacity)
Mixing tank (375ft³ capacity)
Dimensions: 53ft x 8.2ft x 13.6ft
Weight: 75,000lbs

GENERATOR
CAT Class 501–1250 or larger

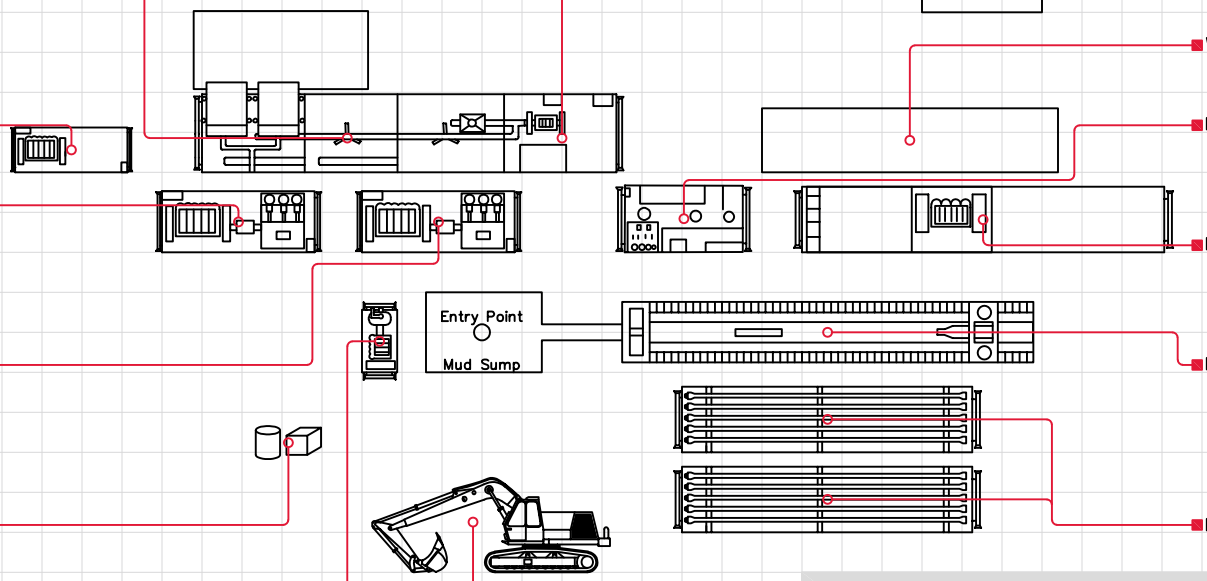
MUD PUMP
Ellis Williams 440 Triplex Mud Pump
8v71 Detroit Engine
400gpm max capacity
Dimensions: 8.13ft x 4ft x 3.62ft
Weight: 9,800lbs

MUD PUMP
Vermeer SA400 High Pressure Mud Pump
CAT C9 350hp motor
550gpm max capacity
Dimensions: 19.1ft x 7.6ft x 6.5ft
Weight: 26,600lbs

SPILL/FRAC CONTAINMENT KIT
1x 4ft x 25ft silt fence
50x sandbags
1x hand shovel
1x 20lb organic oil absorbent

PIT PUMP
Tsurumi EPT4–150
85HP @ 3600 RPM
6" centrifugal pump

EXCAVATOR
CAT Class 240–2320 or larger



WASTE DISPOSAL BIN
Oil, fuel, hydraulic, and filter disposal
Metal scrap container
Recyclable container
Plastic & non–recyclable container

WATER STORAGE
20,000gal open–top frac tank
3" centrifugal pump

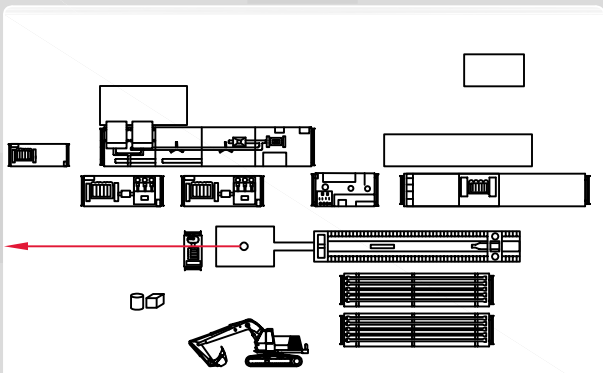
DRILL CABIN
Drilling Console
Dimensions: 11.6ft x 7.9ft x 8ft
Weight: 7,800lbs

DRILL RIG POWER UNIT AND TRAILER
CAT C27 ACERT 800hp engine
Torque: 2330 ft–lbs @ 1800 rpm
Dimensions: 22.4ft x 8ft x 10.3ft (power unit)
Weight: 38,000 lbs

DRILL RIG
Vermeer D750x900
Push/Pull Capacity: 768,000 lb
Rotary Torque: 99,400 ft–lb @ 38 rpm
Breakout Vise: 147,500 ft–lbs
Entry Angle: 10° to 15°
Dimensions: 50.3ft x 8.5ft x 11.5ft
Weight: 95,800 lbs

DRILL PIPE/TOOLING TRAILER
40ft x 8ft x 10ft
Weight: 50,000lbs

RIG WORK PAD LAYOUT



THE HDD COMPANY

RIG No.8 EQUIPMENT INVENTORY

SOLIDS CONTROL SYSTEM
- Triflo MFS 3000 T.I.
- 2x shakers (26ft² each)

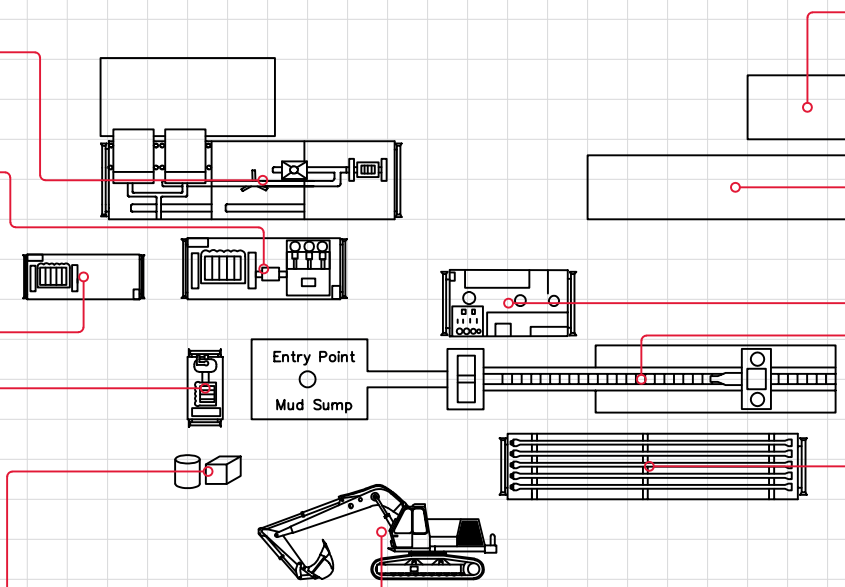
MUD PUMP
- Vermeer SA400 High Pressure Mud Pump
- CAT C9 350hp motor
- Weatherford T425 Triplex Centrifugal Pump
- 550gpm max capacity
- 26cfm @ 120psi compressed air system
- Dimensions: 19.1ft x 7.6ft x 6.5ft
- Weight: 26,600lbs

GENERATOR
- CAT Class 501–1100 or larger

PIT PUMP
- Tsurumi EPT4–150
- 85HP @ 3600 RPM
- 6" centrifugal pump

SPILL/FRAC CONTAINMENT KIT
- 1x 4ft x 25ft silt fence
- 50x sandbags
- 1x hand shovel
- 1x 20lb organic oil absorbent

EXCAVATOR
- CAT Class 240–2320 or larger



WASTE DISPOSAL BIN
- Oil, fuel, hydraulic, and filter disposal
- Metal scrap container
- Recyclable container
- Plastic & non–recyclable container

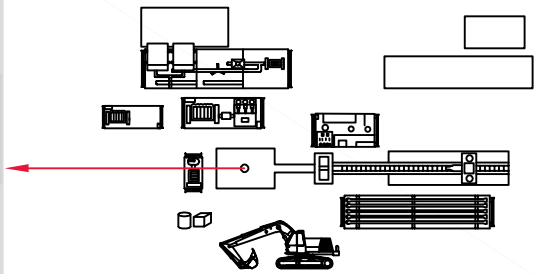
WATER STORAGE
- 20,000gal open–top frac tank
- 3" centrifugal pump

DRILL CABIN
- Dimensions: 10.8ft x 7.8ft x 8.5ft
- Weight: 6,000lbs

DRILL RIG
- American Augers DD–140B
- Caterpillar 3306 DITA turbodiesel 300 hp engine
- Push/Pull Capacity: 140,000 lb
- Rotary Torque: 25,000 ft–lb @ 45 rpm
- Breakout Vise: 60,000 ft–lb
- Entry Angle: 10° to 18°
- Dimensions: 48.5ft x 8.4ft x 13.2ft
- Weight: 58,000 lbs

DRILL PIPE/TOOLING TRAILER
- 40ft x 8.5ft x 12ft
- Weight: 50,000lbs

RIG WORK PAD LAYOUT



Appendix C - Equipment

Contents

HDD Rig 7 - Vermeer D750x900
Rig 7 Reclaimer - AA MCD-1000
Rig 7 Mud Pump (2) - Vermeer SA400 High Pressure Mud Pump
HDD Rig 8 - American Augers DD-140B
Rig 8 Recycler - Vermeer R9 xx 12T
Rig 8 Mud Pump (2) - Vermeer SA400 High Pressure Mud Pump Pump
Pit Pump - Tsunami EPT4-150 Heavy Duty Trash Pump
Excavator - CAT Class 240-2320 or Equivalent
Forklift - CAT Class 460-1060 or Equivalent
Casing Hammer - TT Technologies Grundoram Taurus

D750x900 NAVIGATOR®
HORIZONTAL DIRECTIONAL DRILL





DURABLE HYDRAULIC CIRCUIT. Independent hydraulic circuits are an important factor in limiting contamination to the affected circuit and its respective components.



STAY PRODUCTIVE. Stay productive and efficient due to a hydraulic motor design which allows for full torque and rotary rpm simultaneously.



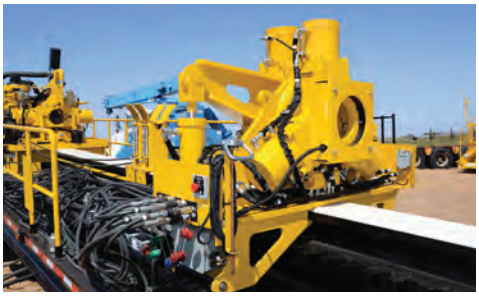
WORK IN COMFORT. Operator console designed for comfort and large windows for exceptional visibility.



MASTER YOUR TERRAIN. Conquer difficult ground conditions with a high-torque design.



BY YOUR SIDE. Our Parts Center has drivemotors, rotation motors, gear boxes, pumps, valves, coolers and many other major components in stock and ready for delivery.



STAY ON SCHEDULE. A floating vise allows the breakout system to clamp the rod fully during breakout, helping to prevent rod wrap and keep your crew on schedule.

D750x900 NAVIGATOR® HORIZONTAL DIRECTIONAL DRILL

DRILL RACK

Min transport length: 50.3' (15.3 m)
Width: 8.5' (2.6 m)
Min transport height: 11.5' (3.5 m)
Weight: 95,800 lb (43,454.1 kg)
Suspension: Triple axle with air ride suspension
Front base anchor length: 20' (6.1 m)
Front base anchor width: 6' (1.8 m)
Front base anchor height: 38.4" (97.5 cm)
Front small anchor length: 10.5' (3.2 m)
Front small anchor width: 5.5' (1.7 m)
Front small anchor height: 22.8" (57.9 cm)
Rear base anchor length: 16' (4.9 m)
Rear base anchor width: 7.8' (2.4 m)
Rear base anchor height: 15.6" (39.6 cm)
Drill rack angle: 10° - 15° (17.5% - 26.2%)

DRILLER'S CABIN

Length: 11.6' (3.5 m)
Width: 7.9' (2.4 m)
Height: 8' (2.4 m)
Weight: 7800 lb (3538 kg)
Heat and air conditioning: 3 ton (10.6 kW) in-wall combination unit

POWER PACK

Make and model: (1) CAT C-27 ACERT
Fuel type: Diesel
Fuel capacity: 500 gal (1892.7 L)
Hydraulic tank capacity: 720 gal (2725.5 L)
Max engine rpm: 2000 rpm
Gross horsepower: 800 hp (597 kW)
EPA certification family: Tier 2 (EU stage II)

POWER PACK OPTION TWO

Make and model: (2) CAT C-18 ACERT
Fuel type: Diesel
Fuel capacity: 1000 gal (3785.4 L)
Hydraulic tank capacity: 720 gal (2725.5 L)
Maximum engine rpm: 2000 rpm
Gross horsepower: 1200 hp (895 kW)
EPA certification family: Tier 3 (EU Stage II) or Tier 4 Final (EU stage IV)

POWER PACK OPTION THREE

Make and model: (2) CAT C-27 ACERT
Fuel type: Diesel
Fuel capacity: 1000 gal (3785.4 L)
Hydraulic tank capacity: 720 gal (2725.5 L)
Max engine rpm: 2000 rpm
Gross horsepower: 1600 hp (1193 kW)
EPA certification family: Tier 2 (EU Stage II)

OPERATIONAL

Thrust/Pullback: 768,000 lb (3,416.2 kN)
Max spindle torque: 99,400 ft-lb (134,768.3 Nm)
Max spindle speed at max engine rpm (with PS800): 38 rpm
Max spindle speed at max engine rpm (with PS1200/PS1600): 57 rpm
Max carriage speed at max engine rpm: 91 fpm (27.7 m/min)
Number of rotation motors: 1
Number of drive motors: 4
Mud swivel: 3" (7.6 cm)

LOWER BREAKOUT VISE

Breakout torque: 147,500 ft-lb (199,983.1 Nm)
Configuration: 3-jaw clamp, 8" (20.3 cm)
Weight: 3800 lb (1723.7 kg)
Travel: 6' (1.8 m)
Inside diameter: 10" (25.3 cm)

UPPER BREAKOUT VISE

Clamp force: 176,000 lb (782.8 kN)
Configuration: 2-jaw clamp
Inside diameter: 10" (25.4 cm)

SAFETY

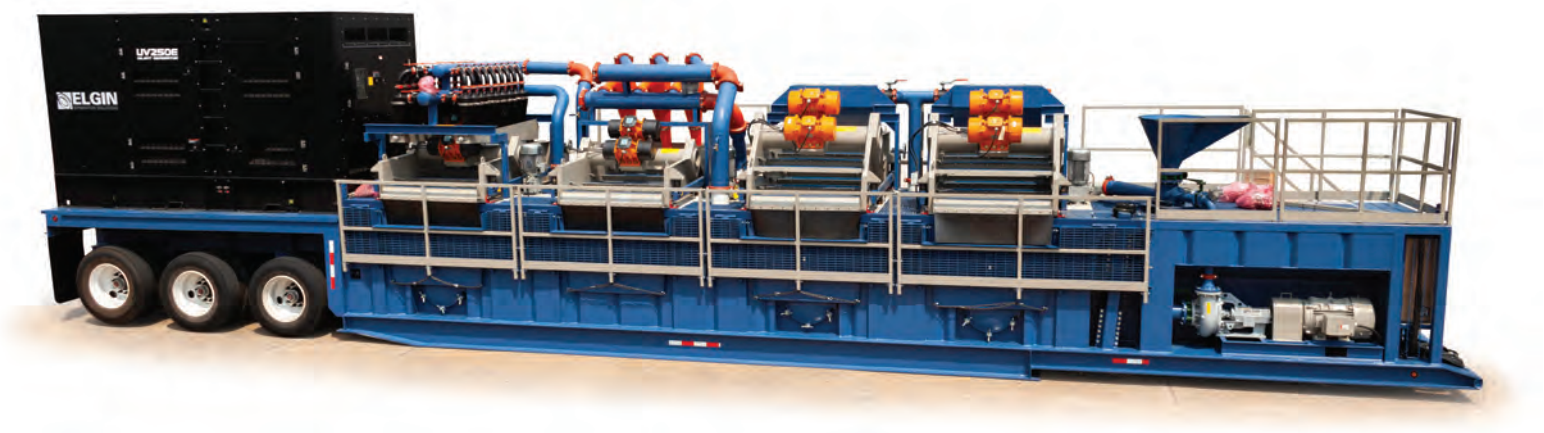
Remote lockout: Yes
Strike alert: Yes

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Vermeer
EQUIPPED TO DO MORE.

ELGIN SEPARATION SOLUTIONS

KEMTRON 1500HDX™ Fluid Recycling System



ELGIN's KEMTRON 1500HDX is the industry's largest and most effective cleaning system in the market. Built on a 56' long triple-axel rock over trailer with an impressive 9,000 gallon tank capacity. With inset pump cabins along the side of the unit, pump pressure is more efficient which reduces hydraulic friction losses during operation. Additionally, inset pump cabins provide an additional advantage of direct maintenance access to each pump. Onsite installation is enhanced with Elgin's proprietary cat-walk lift assist cylinders that allows for two operators to erect and secure the side deck and railing.

Hydraulically Balanced Mud System
With the 9,000 gallon tank capacity, the KEMTRON 1500HDX is able to provide a hydraulically balanced mud system at 1,500 gallons per minute (9,000 gallons / 1,500 gpm = 6 minutes residence time, the design target for a hydraulically tuned mud system). To achieve 1,500 gpm, the hydrocyclone packages are designed with (3) 10" hydrocyclone desanders and eighteen (18) 5" valve-isolated hydrocyclone desilters.

Highest Mixing Power
With the large tank size and reduced pipe congestion, Elgin is able to enhance mixing with one 5HP, top-mounted, 36" hydrofoil agitators in each of the three tank compartments. Coupled with a series of mud guns, the KEMTRON 1500HDX has the highest mixing power per gallon found in the industry. Top mounted agitators are also significantly less expensive to maintain over their life and reduce the horsepower demand on the generator package when compared to submersible mixers.

Dedicated Hydrocyclone Centrifugal Pumps
However, to achieve a 1,500 gpm capacity, both the desilter manifold and desander manifold feed pumps feature 60HP Series 250 6x8 Centrifugal Pumps. These pumps ensure that the unit has the required pressure head to operate the hydrocyclones at 1,500 gpm. Despite the size of the centrifuge pumps, the lowered electrical draw from the top-mounted agitators, allows the KEMTRON 1500HDX to be fitted with a 250KW Tier-4 generator package.

Auto Transfer Pump Control
As a new paradigm in integrated mud system controls, Elgin has developed a proprietary new control panel that features an 'Auto Transfer Pump Control' which will automatically activates/shutsdown the transfer pump during operation, based on high/low level tank sensors in the clean tank. This feature protects the pump from running dry and ensures fluid transfer efficiency to the triplex pump for downhole return.

KEMTRON 1500HDX™ Benefits:

- Multi-pass cleaning system maximizes shaker and hydrocyclone performance helping to maintain target mud weights.
- Two (2) dual-deck scalping shakers, each with 56 sq. ft. of screening surface, providing for substantially more cleaning capacity when dealing with large bores.
- Two (2) 3-panel linear motion mud cleaners, each with 28 sq. ft. of screening surface.
- Three (3) 10" hydrocyclone desanders and eighteen (18) 5" hydrocyclone desilters with pressure guages and dedicated isolation valves for operation efficiency.
- Hyper-G™ shaker with Firestone's Marsh Mellow™ vibration isolators, providing reduced noise, long-lasting, maintenance free operation.
- Most efficient tank agitation per unit volume of mud utilizing top mounted agitators and mud guns ensures complete mixing performance.
- Dedicated centrifugal pumps, inset on the side of the tank for easy maintenance, provide independent transfer, mud circulation/hopper, desander, and desilter operations.
- Proprietary 'Cat-Walk Lift Assist' for easy onsite installation of side deck and rails.

10050 Cash Road
Stafford, Texas 77477 • 281-261-5778
www.elginseparationsolutions.com

ELGIN SEPARATION SOLUTIONS

KEMTRON 1500HDX™ Fluid Recycling System



Pump Pockets
Pumps inset into tank side for unobstructed access for service and maintenance.



Additives Hopper
Large hopper with 6" venturi nozzel for easy chemical loading.



Agitation
Three (3) top-mounted vertical high-efficiency agitators.





Desander / Desilter
Configured with three (3) 10" Desander and eighteen (18) 5" Desilter manifolds.

Model Number:	KEMTRON 1500HDX
Description:	1,500 gpm recycling / cleaning capacity (95 lps)
Screen Type:	Composite Screens KPT28-COM-API Series
Centrifugal Pumps:	Two (2) 5 x 6 40 hp & Two (2) 8 x 6 60 hp 250 Series Pumps
Linear Motion Shaker Motors:	(2) 3.3 hp & (2) 2.0 hp
Number of Screen Panels on Single Deck Shaker:	Three (3) Screens 28 sq. ft. (2.6 m^2) total screening area
Number of Screen Panels on Double Deck Shaker:	Six (6) Screens 56 sq. ft. (5.2 m^2) total screening area
Screen Surface Area:	168 sq. ft. (15.61 m^2) total on all four shakers
Desilter Hydrocyclones:	Eighteen (18) 5" (10.16 cm) high durameter polyurethane
Desander Hydrocyclones:	Three (3) 10" (25.4 cm) high durameter polyurethane
Maximum Flow Rate:	1,500 gpm (95 lps)
Dimensions:	L 56' (17 m) x W 8' (2.4 m) x H 12.5' (3.8 m)
Weight:	79,000 lbs (35,834 kg)
Tank Capacity:	9,000 gallon (34,000 liters)

Upgrade Options:

- For superior fluid cleaning capacity add an Elgin decanter centrifuge and create the perfect closed loop environment.
- Add a 600 gpm (38 lps) triplex pump package to maximize system integration and performance.
- Upgrade to dual-motion shaker motors capable of linear motion and balanced eliptical motion for managing sticky solids.
- Winterization Package - Add full canopy structure to upper deck and pump pockets to protect from elements and immersion tank heaters to severe cold climate environments.
- Submersible Feed Pump - Add a 1500 gpm (95 lps), 20 hp, submersible feed pump to the system to deliver fluid to the recycling system.

Additional Features:

- Triple axel trailer with three (2) 30,000 lb axels distributes load evenly.
- Onboard pressure washer for cleaning screens, tanks and pumps.
- 1/4" ASTM A36 plate steel, with full seam welded, industrial coated construction improving corrosion resistance.
- Phenolic-lined interior tank to expand tank life & minimize corrosion.
- 6" venturi hopper with working table. Hopper discharge diverted away from tank suction conveniently located at ground level, eliminating the need for material handling on the top deck.
- Seven (7) 5/8" high-velocity mixing guns for supplementing tank agitation.
- Fitted with a 250 kW stand-by (225 kW prime) premium-grade generator with extended life diesel tank.
- Uniform working surface across entire working deck to minimize trip hazards with LED lighting.
- Entire upper deck fully surrounded by an OSHA compliant walkway and railings.

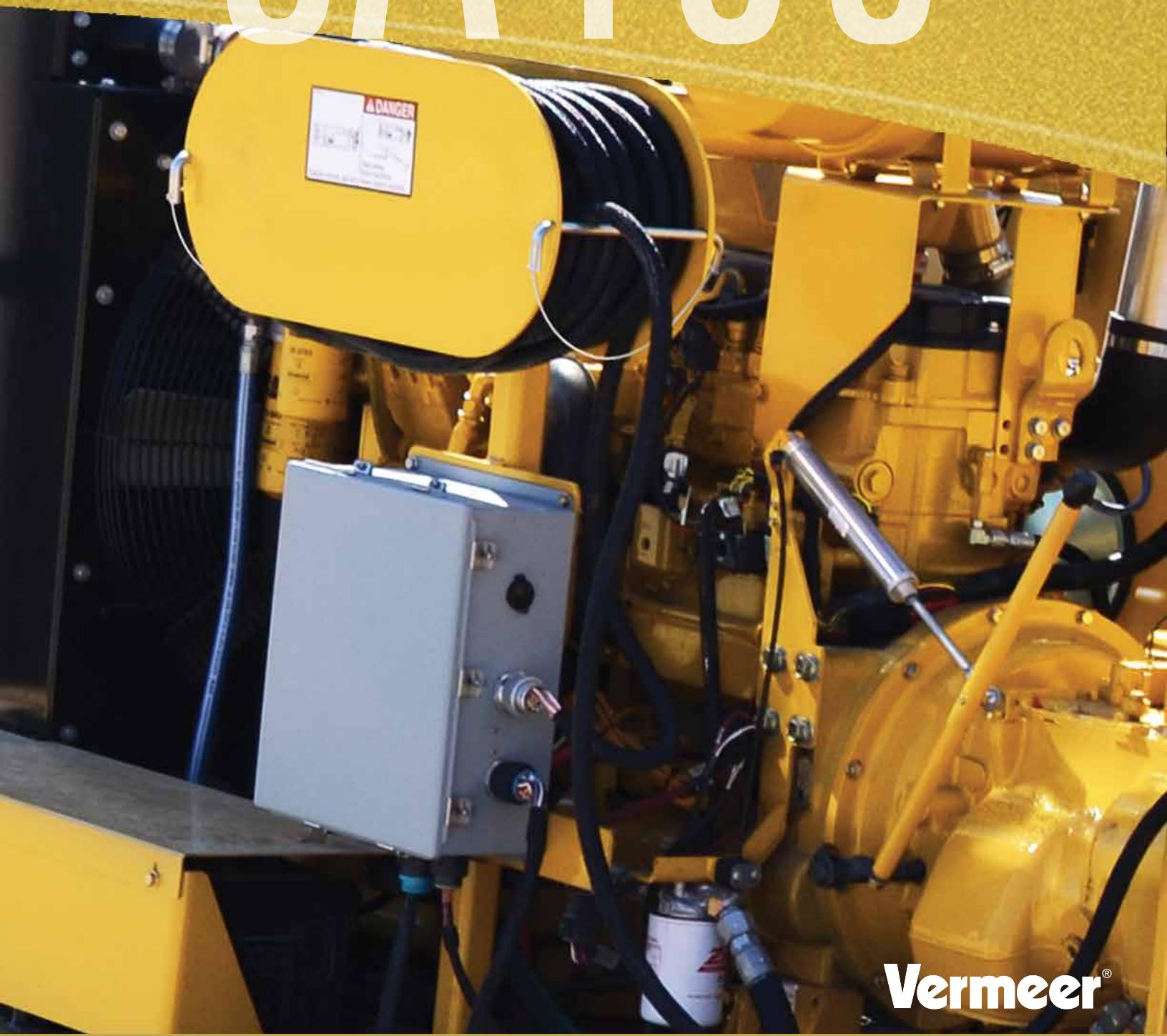


KEMTRON 1500HD2 skid with three (3) dual-deck scalping shakers, single-deck desander mud cleaner, and single-deck desilter mud cleaner.

10050 Cash Road
Stafford, Texas 77477 • 281-261-5778
www.elginseparationsolutions.com

HIGH PRESSURE MUD PUMP

SA400



Vermeer®

SA400



THIS MUD PUMP WILL DELIVER THE CONSISTENT FLOW OF DRILLING FLUID THAT IS VITAL TO HDD PIPELINE DRILLING PROJECTS.



Suction inlet valve suspends charged flow during drill rod makeup and breakout process, keeping excess drilling fluid from escaping as drill pipes separate.



The lubrication pump is driven off the auxiliary pad on the engine. It provides 55 psi (3.8 bar) of continuous crankshaft lubrication. The internal hydraulic reservoir has a capacity of 49 gal (185.5 L).



Clutch with continuous duty throw-out bearing allows for longer pump disengagement during drill rod makeup/breakout.



Lightweight shielding makes for easy maintenance. Each panel of SA400 shielding weighs less than 50 lb (22.7 kg), making maintenance a one-person task.

SA400

A triplex piston pump produces up to 550 gpm (2082 L/min), providing a continuous flow of drilling fluid during drill operations.



An electric centrifugal pump provides constant flow, keeping the pump running cool and leading to a longer life for both pistons and liners.



Remote pendant control allows operator to mount controls where it makes sense for them. The remote pendant control monitors mud rate and eliminates the need for stroke counter.



The integrated liner wash tank eliminates the need for additional water containers or electricity when running the pump.



An engine-mounted air compressor powered by the engine auxiliary pad has a 30 gal (113.6 L) tank and produces 26 cfm @ 120 psi (736.2 L/min @ 8.3 bar) flow. The system is equipped with a quick-connect adapter for pneumatic tools.



Specifications

GENERAL WEIGHTS AND DIMENSIONS
Weight: 26,600 lb (12,065.6 kg)
Length: 19.1' (5.8 m)
Width: 91.1" (231.4 cm)
Height: 78" (198.1 cm)

CONTROLS
Onboard: Open control station
Remote: Tethered control box reaches 120' (36.6 m)

POWER SOURCE
Power source description: Non-detachable, onboard, open engine bay
Engine description: CAT C9 or C9.3 ACERT IOPU
EPA certification family: Tier 3 (EU Stage IIIA) or Tier 4i (EU Stage IIIB)
Fuel type: Diesel
Rated power: 350 hp (257.4 kW)
Rated engine speed: 1800 rpm
Fuel tank capacity: 191 gal (723 L)
Electrical system: 24VDC

HYDRAULIC RESERVOIR
Hydraulic reservoir description: Mud pump power end (internal to mud pump)
Hydraulic reservoir capacity: 49 gal (185.5 L)

OPERATIONAL
Electronic control systems
Remote lockout: Yes

TRANSMISSION SYSTEM
Clutch description: Eaton 15.5" (39.4 cm) dual plate, spring-actuated with pneumatic assist
Number of usable gears: 4
Belt description: 8V 12-groove

FLUID PUMP SYSTEM
Description: Standalone, open skid
High pressure pump
Pump description: Weatherford T425, triplex piston pump
Piston diameter: 6" (15.2 cm)
Stroke length: 7.9" (20.1 cm)
Min flow at 100% efficiency: 78 gpm (295.3 L/min)
Max flow at 100% efficiency: 550 gpm (2082 L/min)
Relief valve setting: 1250 psi (86.2 bar)
Lubrication system (power end)
Power driver description: Engine aux pad
Lubrication system (fluid end)
Power driver description: 24VDC
Pump(s) description: Centrifugal pump

COMPRESSED AIR SYSTEM
Compressor description: Caterpillar
Compressor mounting type: Engine aux pad
Flow at max pressure: 26 cfm @ 120 psi (736.2 L/min @ 8.3 bar)
Air tank volume: 30 gal (113.6 L)

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AMERICAN DIRECTIONAL DRILL

A Division Of American Augers, Inc.

DD-140B™

Track Mounted Directional Drill

30 YEARS 1970 - 2000

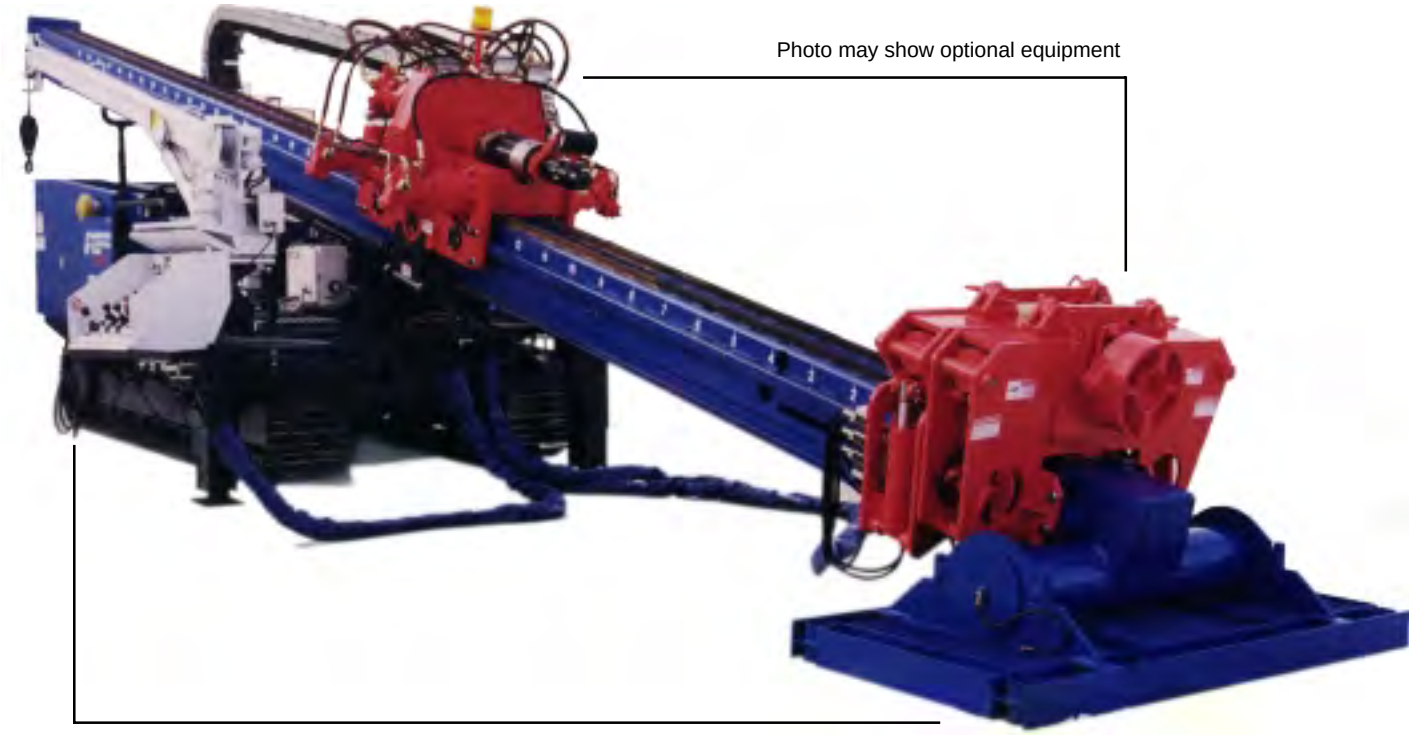
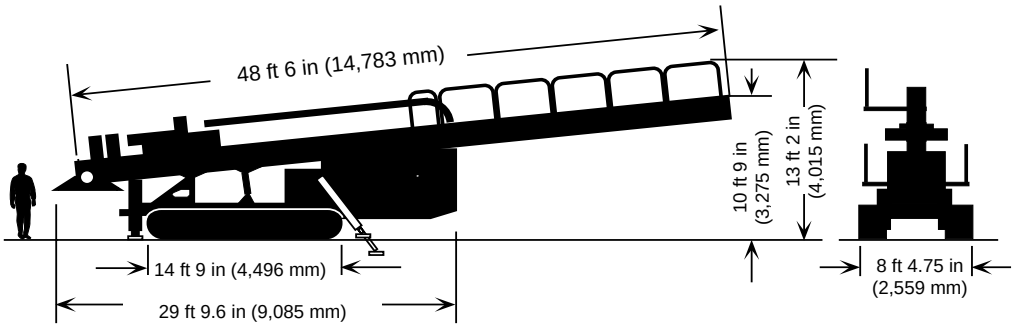


Photo may show optional equipment

Compare These Features To Those Of Any Other Drill

- MANUFACTURED by the world's most experienced builder of large directional drills
- THRUST/ PULLBACK rating of 140,000 lb (622.7 kN)
- HIGH ROTARY TORQUE turns very large reamers in long bores (25,000 lb ft, 33,895 Nm)
- RACK AND PINION thrust/pullback, two pinion drive
- CATERPILLAR® diesel power
- CLAMP & WRENCH can be repositioned within 60" range for most convenient make up and break out
- ADJUSTABLE TORQUE LIMITER for rotary and makeup force
- ADJUSTABLE FORCE LIMITER for thrust and pullback
- REAR DOWNRIGGER hydraulic thrust stabilizers
- INDEPENDENT CONTROLS and hydraulic circuits for thrust/pullback, torque and auxiliary operations permits simultaneous full power operation
- WIRELINE COMMUTATOR for speedy hookup of wireline guidance equipment with terminals at driller's console
- TRACK MOUNTED with on board engine
- FIELD PROVEN PIPE HANDLING with remote control hydraulic crane
- FACTORY DIRECT SERVICE for fast support by knowledgeable technicians
- MATCH UP WITH MUD SYSTEMS designed and built by American Augers such as the MP-300 or MP-400. These systems have integral mixing, cleaning and pumping capability, and enough capacity for mud motor work and use of large reamers

DD-140B Directional Drill



Engine

Engine	Caterpillar® 3306 DITA 6-cylinder turbodiesel, aftercooled
Rating	300 HP (224 kW) continuous duty
Fuel capacity	150 U.S. gallons (568 L)

Rotary Drive

Rotary system	Pinion and gear drive Infinitely variable torque
Rotary (high torque)	25,000 ft-lb (33,750 Nm) @ 0-45 rpm
Rotary (low torque)	10,000 ft-lb (13,500 Nm) @ 0-95 rpm
Max. rotary speed	95 rpm
Other features	Rear mounted mud swivel, 3" (76mm) internal diameter, dual drive brakes, slip sub, digital tachometer, wireline commutator, 5-1/2" API full hole box connection, adjustable torque limiter

Carriage Drive

Max. thrust/pullback	140,000 lb (622.7 kN)
Carriage system	Rack and pinion, four pinion drive, with adjustable force limiter
Max. carriage speed	95 ft (29 m)/min

Drill Pipe

Length	Range 2 (to 34 ft) 10,360 mm

Tooling

American Augers supplies a full range of dirt and rock bits, tri-cones, sonde housings, swivels, cutters, hole openers and reamers developed from making thousands of feet of bores.

Drill Rig

Wrench/clamp	Open top type, 10" (254 mm) separation. Wrench can travel 60" (1,524 mm) fore and aft
Max. breakout torque	60,000 ft-lb (81,000 Nm)
Max. makeup torque	25,000 ft-lb (33,750 Nm)
Clamp grip range	2-3/4 - 10-3/4" outside diameter
Operator's controls	Rig mounted console with gauges
Drill angle	10°—18°
Travel system	Self propelled on Caterpillar® 320L excavator tracks
Drill mounted crane	8,000 lb (3,629 kg) rating
Shipping weight	58,000 lb (26,300 kg)
Hold down stakes	H-beam type

Protective Equipment

Each drill comes with safety mats and electrical grounding rods. A Zap-Alert system is standard equipment. Emergency shut down switch at driller's console and at remote control console. Carriage over ride switch disables carriage during wireline hookup, maintenance, etc. Halogen work lights are standard. The **es!lok®** exit side lockout system is standard equipment.

Driller's Cabin (optional)

With heat and air conditioning, power distribution panel with circuit breakers, surveyor's table. Exterior steel siding. Insulation 3-1/2" in walls. Extra large windows with vandalism shields. Lifting eyes for job site mobility. Cabin size: 7 ft 9 in wide x 10 ft 10 in long x 8 ft 6 in high (2.4 x 3.3 x 2.6 m). Approx. shipping weight: 6,000 lb. (2,725 kg).

AMERICAN AUGERS®
an Astec company

Due to our continuing product improvement, specifications are subject to change without notice.

American Augers, Inc.,135 U.S. Route 42, P.O. Box 814, West Salem, OH 44287
TEL: (419) 869-7107 • FAX: (419) 869-7425 • USA Toll Free (800) 324-4930
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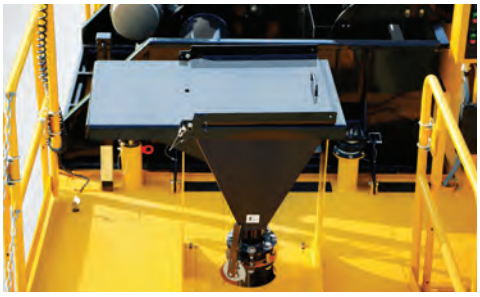
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R9x12T
RECLAIMER





IMPROVE PERFORMANCE. Depending on the drilling conditions, the operator can select either a linear or orbital shaker motion to improve recycling performance.



IN THE MIX. An integrated mixing hopper offers simultaneous mixing and recycling within a single system, helping to eliminate the need for an additional onsite drilling fluid mixing system.



LIGHT UP YOUR JOBSITE. Equipped with telescoping lights for around-the-clock operations.



FLUID PROTECTION. Inlet fluid is routed through mud boxes helping reduce premature wear to shaker decks/screens caused by larger material.



A CLEAR VIEW. Controls for the main system functions and optional mix hopper are located on a single working level. Design considerations centralize access to main controls to a single-level work area to reduce movement by crew members.



PROTECTION FROM THE ELEMENTS. An enclosure helps protect critical components, such as the generator set, fuel tank and electrical equipment from the elements. The enclosure features a service entry for accessibility and helps reduce noise.

R9x12T RECLAIMER

GENERAL WEIGHTS AND DIMENSIONS

Weight: 65,500 lb (29,710.3 kg)

Length: 51.8' (15.8 m)

Width: 8.5' (2.6 m)

Height: 13.4' (4.1 m)

FRAME

Type: Fifth-wheel trailer

Suspension: Triple axle with air-ride

Axles: 10-bolt, hub-piloted, ABS

Certifications: DOT lighting and braking

TANK CAPACITIES

Max capacity: 8560 gal (32,403.1 L)

Number of tanks: 3

Clean/Mix tank capacity: 3197 gal (12,102 L)

CLEANING SYSTEM

Shaker type: Linear or orbital

Number of shakers: 4 (2 motors/shakers)

Shaker bed area – each: 26 sq ft (2.4 sq m)

Number of screens per shaker: 3

Screen dimension: 25" x 49.3" (63.5 cm x 125.2 cm)

Cleaning capacity (first cut): 600 gpm (2271 L/min)

Desander capacity: 1500 gpm (5678.1 L/min)

Desander quantity/size: 3 - 10" (25.4 cm) cones

Desilter capacity: 1280 gpm (4542.5 L/min)

Desilter quantity/size: 16 - 5" (12.7 cm) cones

GENERATOR SET

Generator: 3 phase 250 kW (313 kVA)

FEATURES

Agitator system: 3 – 2 hp (1.5 kW) stainless steel bladed mixers

Ancillary electrical system: 120/240 VAC

Work lights: 3 – 42W 12V LED

NOTES:

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Vermeer

EQUIPPED TO DO MORE.



Specifications

GENERAL WEIGHTS AND DIMENSIONS
Curb weight: 63,900 lb (28,985 kg)
Length: 53' (16.2 m)
Width: 8.5' (2.6 m)
Height: 13.4' (4.1 m)

FRAME
Type: Triple axle trailer
Suspension: Air-ride
Axles: 10 bolt hub-piloted ABS ready
Certifications: DOT lighting & braking

FEATURES
Agitator system: 3 – 4.4 hp (3.3 kW) stainless steel bladed motors
Air compressor: 150 max psi (10.3 bar)
Ancillary electrical system: 120/240 volt circuit for accessory equipment (heaters, tools, etc.)
Working lights: 4 – 500 W

TANK CAPABILITIES
Maximum capacity: 8361 gal (31,649.8 L)
Number of tanks: 3
Clean/mix tank capacity: 3128 gal (11,840.8 L)

CLEANING SYSTEM
Shaker type: Linear or oribital
Number of shakers: 4 (2 motors/shaker)
Shaker bed area – each: 26 sq ft (2.4 m^2)
Number of screens per shaker: 3
Screen dimension: 25" x 49.25" (63.5 cm x 125.1 cm)
Cleaning capacity (first cut): Up to 500 gpm/shaker (1892.7 L/min)
Desander capacity: 1500 gpm (5678.1 L/min)
Desander quantity/size: 3 – 10" Cones (3 – 25.4 cm)
Desilter capacity: 1280 gpm (4845.3 L/min)
Desilter quantity/size: 16 – 5" Cones (16 – 12.7 cm)

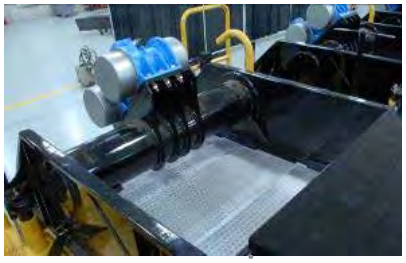
GENERATOR SET
60 Hz Tier 3 (Stage IIIA)
Make and model: John Deere 6090HF484
Engine power: 422 hp (314.8 kW) @ 1800 rpm
Generator: 3 phase 250 kW (313 kVA)

60 Hz Tier 4i (Stage IIIB)
Make and model: John Deere 6090HFG95
Engine power: 440 hp (328.2 kW) @ 1800 rpm
Generator: 3 phase 260 kW (325 kVA)

50 Hz Tier 2 (Stage II)
Make and model: John Deere 6090HF475
Engine power: 408 hp (304.4 kW) @ 1500 rpm
Generator: 3 phase 245 kW (306 kVA)

Performance Specifications

FIRST CUT SHAKERS
Shaker decks 1, 2



DESANDER CONES (3)
Shaker deck 3



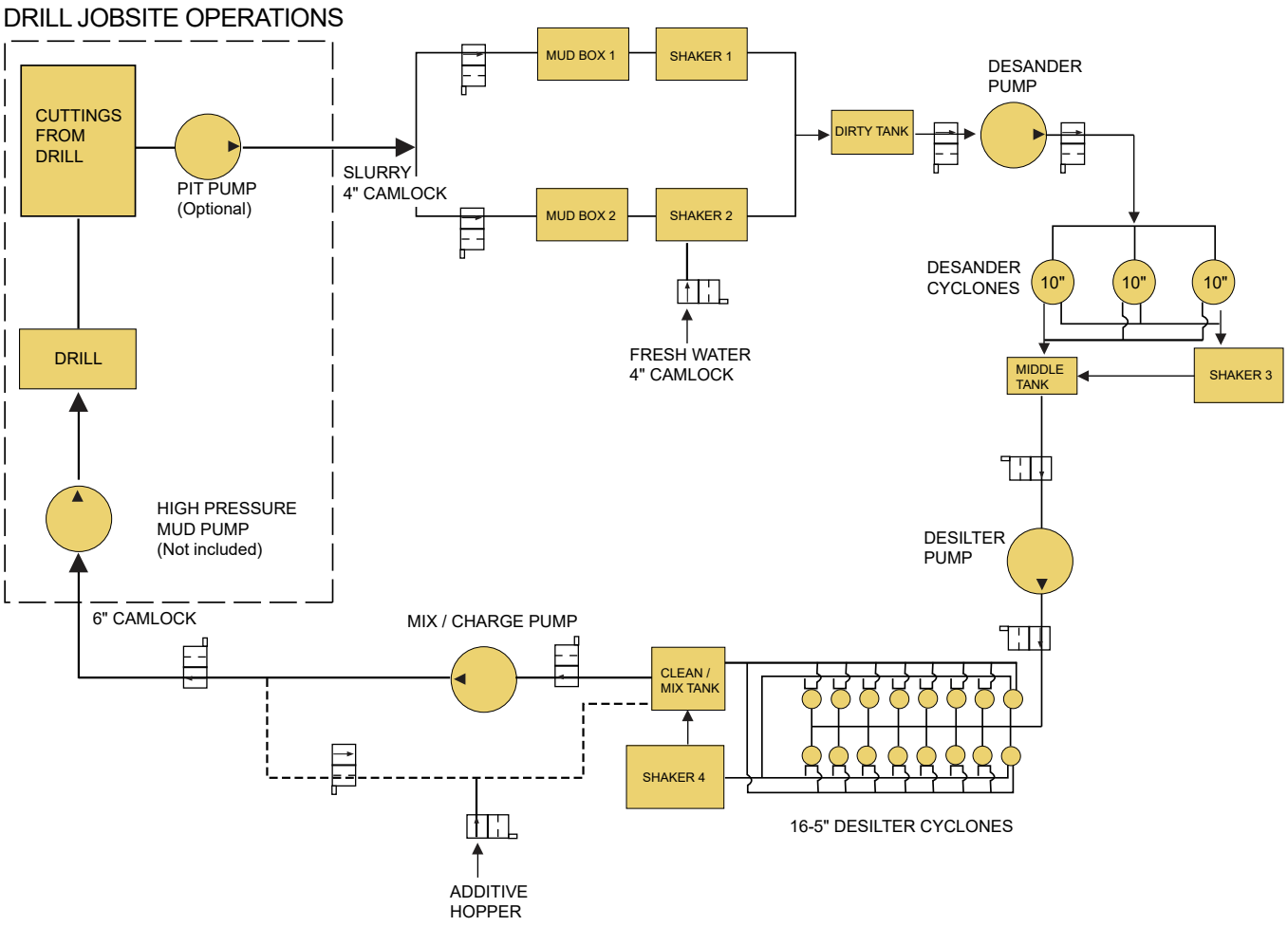
DESILTER CONES (16)
Shaker deck 4





THREE SCREENS PER SHAKER
26 sq ft (2.4 m²) per deck

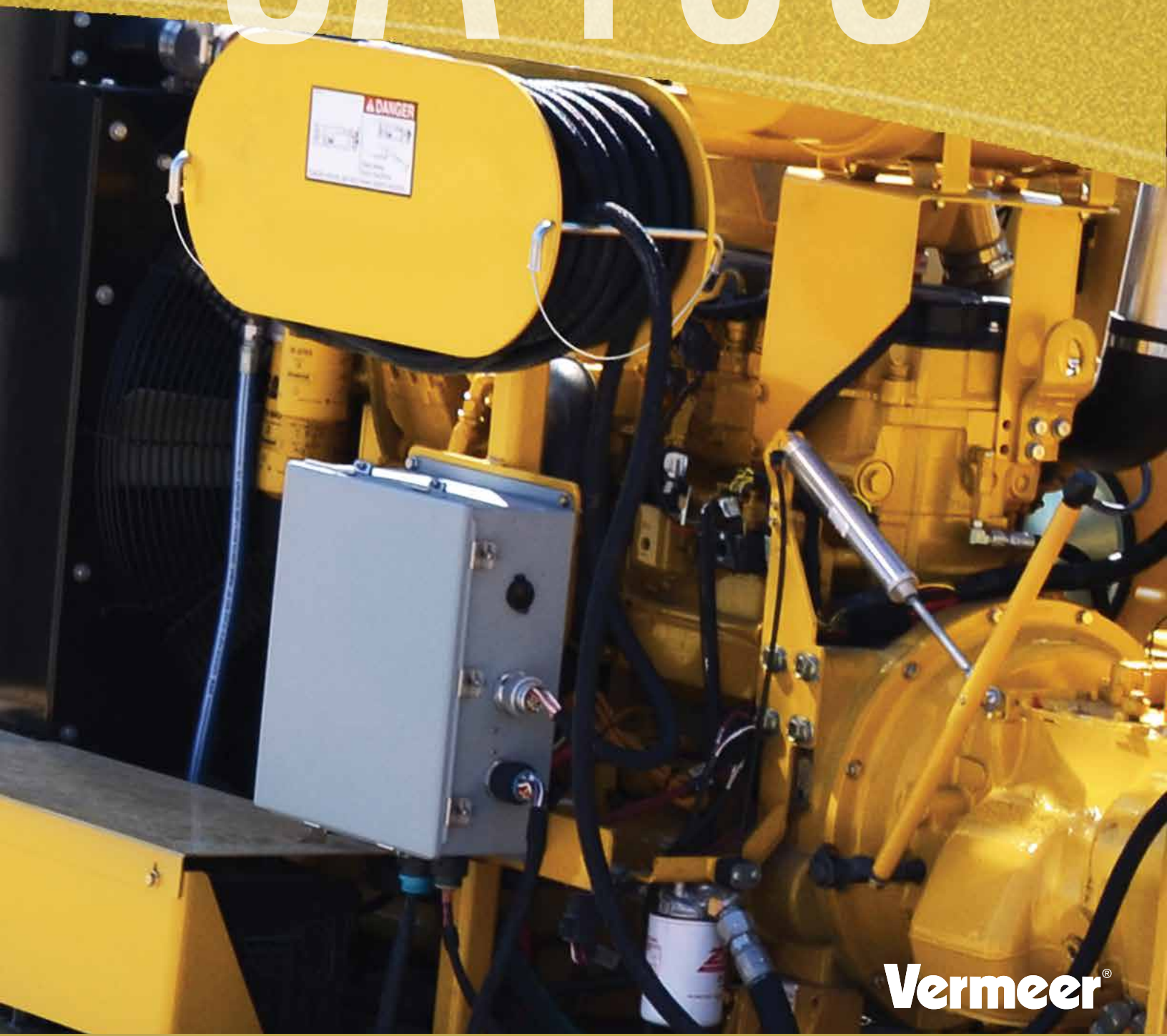
Jobsite Flow Chart



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HIGH PRESSURE MUD PUMP

SA400



Vermeer®

SA400



THIS MUD PUMP WILL DELIVER THE CONSISTENT FLOW OF DRILLING FLUID THAT IS VITAL TO HDD PIPELINE DRILLING PROJECTS.



Suction inlet valve suspends charged flow during drill rod makeup and breakout process, keeping excess drilling fluid from escaping as drill pipes separate.



The lubrication pump is driven off the auxiliary pad on the engine. It provides 55 psi (3.8 bar) of continuous crankshaft lubrication. The internal hydraulic reservoir has a capacity of 49 gal (185.5 L).



Clutch with continuous duty throw-out bearing allows for longer pump disengagement during drill rod makeup/breakout.



Lightweight shielding makes for easy maintenance. Each panel of SA400 shielding weighs less than 50 lb (22.7 kg), making maintenance a one-person task.

SA400

A triplex piston pump produces up to 550 gpm (2082 L/min), providing a continuous flow of drilling fluid during drill operations.



An electric centrifugal pump provides constant flow, keeping the pump running cool and leading to a longer life for both pistons and liners.



Remote pendant control allows operator to mount controls where it makes sense for them. The remote pendant control monitors mud rate and eliminates the need for stroke counter.



The integrated liner wash tank eliminates the need for additional water containers or electricity when running the pump.



An engine-mounted air compressor powered by the engine auxiliary pad has a 30 gal (113.6 L) tank and produces 26 cfm @ 120 psi (736.2 L/min @ 8.3 bar) flow. The system is equipped with a quick-connect adapter for pneumatic tools.



Specifications

GENERAL WEIGHTS AND DIMENSIONS
Weight: 26,600 lb (12,065.6 kg)
Length: 19.1' (5.8 m)
Width: 91.1" (231.4 cm)
Height: 78" (198.1 cm)

CONTROLS
Onboard: Open control station
Remote: Tethered control box reaches 120' (36.6 m)

POWER SOURCE
Power source description: Non-detachable, onboard, open engine bay
Engine description: CAT C9 or C9.3 ACERT IOPU
EPA certification family: Tier 3 (EU Stage IIIA) or Tier 4i (EU Stage IIIB)
Fuel type: Diesel
Rated power: 350 hp (257.4 kW)
Rated engine speed: 1800 rpm
Fuel tank capacity: 191 gal (723 L)
Electrical system: 24VDC

HYDRAULIC RESERVOIR
Hydraulic reservoir description: Mud pump power end (internal to mud pump)
Hydraulic reservoir capacity: 49 gal (185.5 L)

OPERATIONAL
Electronic control systems
Remote lockout: Yes

TRANSMISSION SYSTEM
Clutch description: Eaton 15.5" (39.4 cm) dual plate, spring-actuated with pneumatic assist
Number of usable gears: 4
Belt description: 8V 12-groove

FLUID PUMP SYSTEM
Description: Standalone, open skid
High pressure pump
Pump description: Weatherford T425, triplex piston pump
Piston diameter: 6" (15.2 cm)
Stroke length: 7.9" (20.1 cm)
Min flow at 100% efficiency: 78 gpm (295.3 L/min)
Max flow at 100% efficiency: 550 gpm (2082 L/min)
Relief valve setting: 1250 psi (86.2 bar)
Lubrication system (power end)
Power driver description: Engine aux pad
Lubrication system (fluid end)
Power driver description: 24VDC
Pump(s) description: Centrifugal pump

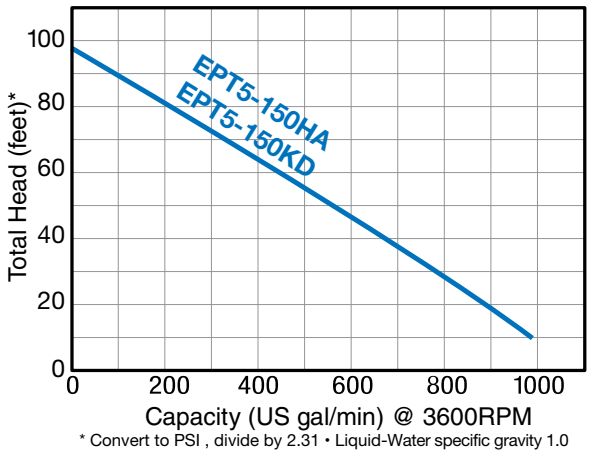
COMPRESSED AIR SYSTEM
Compressor description: Caterpillar
Compressor mounting type: Engine aux pad
Flow at max pressure: 26 cfm @ 120 psi (736.2 L/min @ 8.3 bar)
Air tank volume: 30 gal (113.6 L)

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EPT5 MOUNTED TRASH PUMP

Industrial duty 6-inch trash pump: Powered by Honda gas engine / Kohler diesel engine.





* Convert to PSI , divide by 2.31 • Liquid-Water specific gravity 1.0

EPT5-150HA (Honda Gas Engine)
EPT5-150KD (Kohler Diesel Engine) Trash Pump Features

- Cast Aluminum Casing and Adapter
- Cast Iron Wear Plate, Volute and Manifold
- Stainless Steel Impeller
- Silicon Carbide Mechanical Seal and Buna O-Rings and Flapper / Check Valve
- 6" NPT Port Size
- Self Priming to 20ft
- Available with Honda GX670 Gas Engine or Kohler KDW1003 Diesel Engine (Final Tier 4)
- Solids Handling to 3" Diameter
- Unique Slide Mechanism permits complete service of pump without removing hoses or removing pump components from railer
- Includes Seal Wash Feature for extended seal life
- 12 VDC Electric Start; Digital Tachometer / hourmeter included
- D.O.T. Approved Trailer - See your state and local codes for registration

Model	Discharge Suction Size (inches)	Engine Type	Engine	Max. Output (hp/rpm)	Dimensions (inches)			Shipping Weight (lbs.)
					Length	Width	Height	
ETP5-150HA	6" NPT Coupling	Unleaded Gasoline	Honda GX670	24.0 / 3600	99	48	60	1125
EPT5-150KD	6" NPT Coupling	Diesel	Kohler KDW1003	23.4 / 3600	99	48	60	1250

EPT4-150 - HEAVY DUTY TRASH PUMP

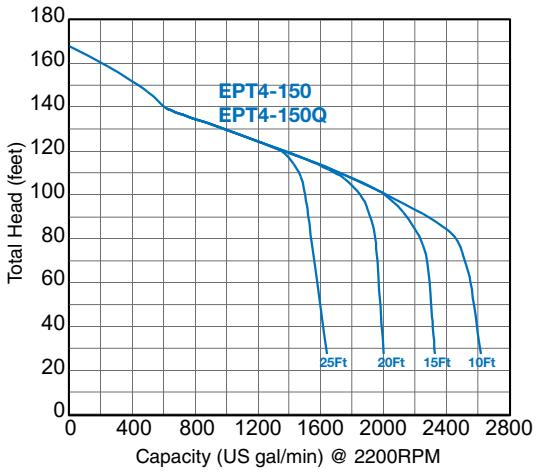
Heavy Duty Prime Assisted & Sound Attenuated Priming Assisted Trash Pump

Priming Assisted
EPT4-150



Sound Attenuated
Priming Assisted
EPT4-150Q





EPT4-150 / EPT4-150Q Features

- Vacuum assisted pump that primes and re-primes by use of a compressor running high pressure air across a venturi which creates a vacuum
- Heavy-duty engine: Consult factory for more details
- With electric start and 60 gallon fuel tank for a runtime at full of load of 24 hours
- Passes 3" spherical solids
- Mechanical seal is tungsten and silicon carbide seal faces, viton elastomers, a 303 stainless steel hardware and spring. Seal system designed for dry running
- Heavy duty road trailer
- DOT Trailer
- LOFA auto start control panel with 50' floats assembly
- **Also available in 4", 8", and 12" versions - Please consult Factory**

Model	Discharge / Suction Size (inches)	Engine	Max. Output (hp/rpm)	Dimensions (inches)			Shipping Weight (lbs.)
				Length	Width	Height	
EPT4-150	6" ANSI Flange	Consult Factory	Consult Factory / 2200	136 1/2	67	67 7/8	Consult Factory
EPT4-150Q	6" ANSI Flange	Consult Factory	Consult Factory / 2200	161 1/2	76 1/8	79 13/16	Consult Factory

MEDIUM RANGE EXCAVATORS

VOLVO



VOLVO / **EW60E**

- Versatile wheeled excavator for wide range of jobs and applications
- Top speed up to 18.4 mph and 4WD for optimal on and off-road for mobility
- Ideal machine for road construction and municipal projects



VOLVO / **ECR88D**

- Reduced tail swing for access to tight job spaces
- Dozer blade with float function for improved leveling control and fuel efficiency.
- Increased productivity and efficiency with enhanced hydraulic system matched to Volvo engine

MAKE	MODEL	LIFT CAPACITY	HORSE POWER	TAIL SWING	MAX DIG DEPTH	MAX DUMP HEIGHT	DIMENSIONS (LWH)	WEIGHT	MAX SPEED	CAT CLASS
Volvo	EW60E	3,130 lb	63.4 hp, Diesel	Conventional	10′ 10″	14′ 7″	231″ x 76″ x 112″	12,970 lb	18.6 mph	240-1620
Volvo	ECR88D	8,570 lb	58 hp, Diesel	Minimal	14′ 10″	17′ 2″	253″ x 91″ x 107″	19,600 lb	3.0 mph	240-1710

EXCAVATORS

VOLVO



VOLVO / **EC140EL**

- Rigid X lower design provides increased stability
- Superior hydraulic controls to match engine power, reduce power loss and improve response time
- Boom float function reduces cycle time and increases productivity



VOLVO / **ECR200**

- Durable design maximizes uptime
- Redesigned cab keeps operators comfortable and productive
- Optimized hydraulics system improves controllability and delivers faster cycle times

MAKE	MODEL	STICK ARM LENGTH	HORSE POWER	MAX DUMP HEIGHT	MAX DIG DEPTH	MAX REACH	TRAVEL SPEED	TAIL SWING	DIMENSIONS (LWH)	WEIGHT	CAT CLASS
Volvo	EC140EL	9′ 10″	89 hp	19′ 6″	18′ 3″	27′	3.4 mph	Conventional	25.4″ x 8′ 6″ x 9′ 2″	31,660 lb	240-2000
Volvo	ECR145EL	8′ 2″	89 hp	22′ 7″	18′ 2″	26′ 11″	3.4 mph	Reduced	24′ 4″ x 8′ 10″ x 9′ 6″	33,950 lb	240-2020
Volvo	EC160EL	9′ 10″	109 hp	20′ 8″	19′ 11″	28′ 11″	3.5 mph	Conventional	28′ 9″ x 8′ 9″ x 9′ 5″	39,390 lb	240-2100
Volvo	EC200E	9′ 6″	154 hp	21′ 8″	22′ 3″	32′ 9″	3.5 mph	Conventional	31′ 9″ x 9′ 10″ x 9′ 7″	50,090 lb	240-2200
Volvo	EC220EL	9′ 6″	128 hp	21′ 10″	22′ 1″	32′ 1″	3.5 mph	Conventional	31′ 10″ x 10′ 6″ x 9′ 8″	49,490 lb	240-2200
Volvo	ECR235EL	9′ 6″	128 hp	25′ 10″	22′ 2″	31′ 11″	3.4 mph	Reduced	29′ 7″ x 10′ 2″ x 9′ 9″	55,780 lb	240-2320
Volvo	EC300EL	10′	179 hp	23′ 1″	24′ 1″	34′ 6″	3.4 mph	Conventional	34′ 6″ x 11′ 2″ x 10′ 2″	68,330 lb	240-2400
Volvo	EC350EL	10′ 6″	225 hp	23′ 5″	24′ 11″	36′ 2″	3.3 mph	Conventional	36′ 10″ x 11′ 2″ x 10′ 7″	82,180 lb	240-2500

TELEHANDLERS



JLG/**G5-18A**

- 5,500 lb lift capacity, 18-foot lift height
- Compact design ideal for tight job sites
- Universal skid steer adapter compatible with existing skidsteer attachments



SKYTRAK/**6036**

- 6,000 lb lift capacity, 36-foot lift height
- Single joystick controls all boom functions
- 74 HP engine doesn't require DEF



SKYTRAK/**10042**

- 10,000 lb lift capacity, 42-foot lift height
- Outriggers required for max lift and full height
- If equipped with optional 74 HP engine, DEF is not required



GENIE/**GTH-5519**

- 5,500 lb lift capacity, 19-foot lift height
- Lift shackle standard
- No DEF or regen required



GENIE/**GTH-1056**

- 10,000 lb lift capacity, 56-foot lift height
- Outriggers required for max lift and full height
- 13'3" in outside turning radius



JLG/**1255**

- 12,000 lb lift capacity, 55-foot height
- Outriggers required for max lift and full height
- Reverse sensing system

MAKE	MODEL	TYPE	MAX LOAD CAPACITY	MAXIMUM LIFT HEIGHT	MAXIMUM FORWARD REACH	DIMENSIONS (LWH)	WEIGHT	CAT CLASS
JLG	G5-18A	Telescopic	5,512 lbs	18'	11'	12' x 6' x 6' 4"	11,000 lbs	460-1010
Genie	GTH-5519	Telescopic	5,500 lbs	18' 10"	11' 3"	12' 3" x 5' 11" x 6' 6"	10,360 lbs	460-1010
Skytrak	6036	Telescopic	6,000 lbs	36' 1"	22' 4"	18' x 9' 4" x 8' 3"	21,300 lbs	460-1020
Skytrak	8042	Telescopic	8,000 lbs	41' 11"	26' 7"	19' x 8' 3" x 8' 3"	27,100 lbs	460-1040
Skytrak	10042	Telescopic	10,000 lbs	42' 1"	26' 7"	20' 8" x 8' 6" x 8' 4"	27,300 lbs	460-1060
Skytrak	10054	Telescopic	10,000 lbs	53' 2"	38' 9"	21' x 8' 6" x 8' 4"	28,200 lbs	460-1070
Genie	GTH-1056	Telescopic	10,000 lbs	56' 10"	42'	22' x 8' 6" x 8' 6"	30,000 lbs	460-1070
JLG	1255	Telescopic	12,000 lbs	55'	42'	20' 1" x 8' 5" x 8' 4"	33,960 lbs	460-1080
Skyjack	ZB2044	Telescopic	20,000 lbs	44' 10"	27' 5"	20' 3" x 8' 6" x 9'	45,000 lbs	460-1090

MAKE	MODEL	TYPE	LOAD CAPACITY	MAX FORK HEIGHT	DIMENSIONS (LWH)	WEIGHT	CAT CLASS
CASE	586H	Rough Terrain Straight Mast	6,000 lbs	22'	16' 2" x 6' 9" x 10' 6"	13,360 lbs	450-1020

HercRentals®

Call 888-777-2700 for rates and reservations

GRUNDORAM

PNEUMATIC PIPE RAMMING SYSTEM



BUILT FOR POWER & PERFORMANCE



Casings are installed without surface slump.

Pipe Ramming Strike Force! For trenchless casing installations from 4 to 96 inches in diameter & larger, choose the proven performance & power of GRUNDORAM. No open cutting or surface slump, just straight, accurate pipe rams. The GRUNDORAM is also ideal for assistance in directional drilling. Use it for conductor barrel installation, pipe pullback assist, pipe removal, & drill stem recovery.

TT Technologies, Inc.





The Proven Ramming Syste

More power. More possibilities.

GRUNDORAM® Advantages

GRUNDORAM pipe ramming tools are ideal for the trenchless installation of steel pipe through a wide variety of soil types, without any rise or fall in the ground's surface.

While some casing installation methods are impaired or even rendered inoperable by rock- or boulder-filled soils, boulders and rocks as large as the casing itself are "swallowed up" during the pipe ramming process. Spoil is then removed after the installation is complete.

TT Technologies, Inc.

Built for Power & Performance

The Casing

GRUNDORAM pipe ramming tools are manufactured from the highest quality steel alloys. The one-piece GRUNDORAM casing is made from a solid block of steel alloy giving it extremely high anti-corrosion properties and a long life expectancy. The inside of the casing is perfectly machined to prevent any metal-to-metal friction.

The Piston

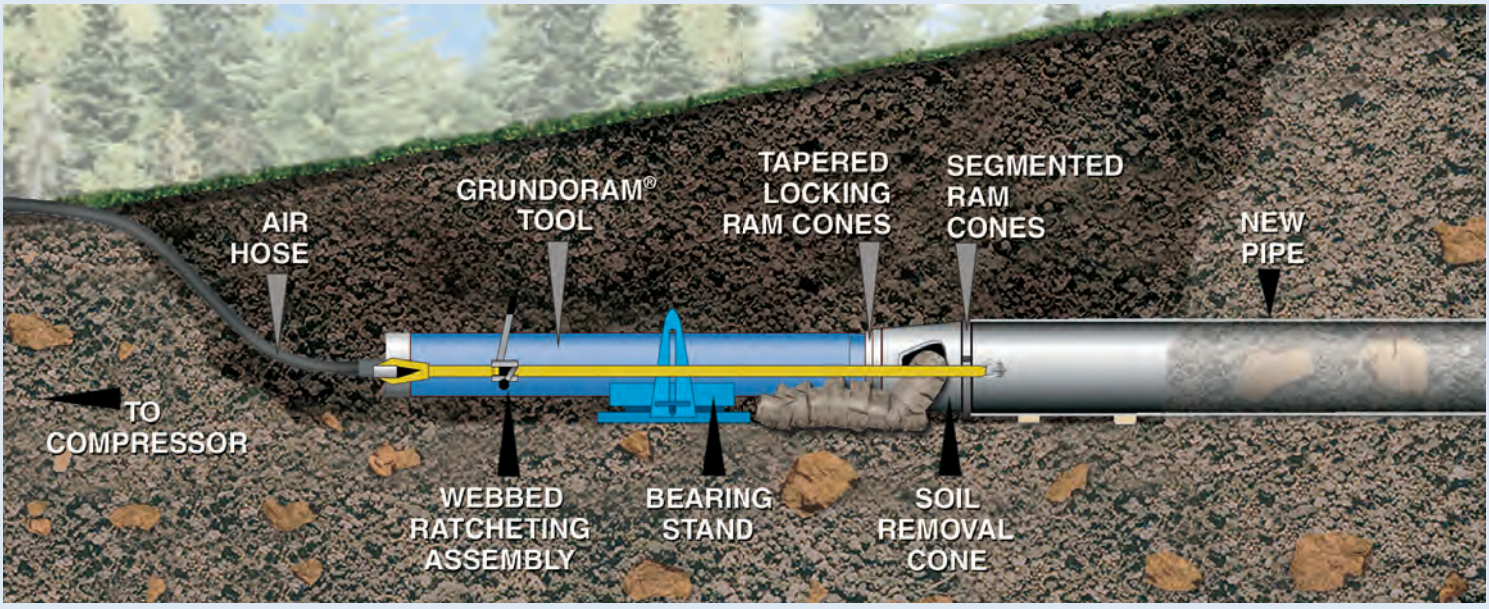


The piston is subject to a large amount of stress and is designed to handle it. During manufacturing, the piston goes through a special heat treatment process that optimizes the strength and durability of the steel alloy and increases its resistance to corrosion. The piston is also fitted with Teflon® seals. These seals help limit wear and fatigue, and help maximize ramming power by allowing the impact energy generated by the piston to transfer smoothly to the casing. In addition, the seals ensure that air consumption is optimized.

The Control Stud

The control stud is designed for strength and durability. A self-aligning housing holds the control stud in place, cushioning it from the recoil of the piston and protecting its components from fatigue. The control stud also allows the user to easily reverse the GRUNDORAM.

The GRUNDORAM® System



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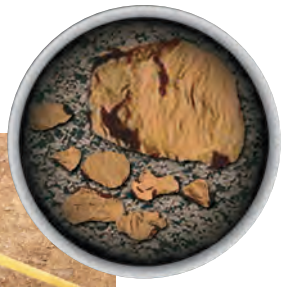


Versatile Tool

Sixteen GRUNDORAM models are available for installing casings from 4 to 96 inches in diameter, with diameters as large as 147 inches possible! Individual tools can be used to install a range of casing diameters. In addition, the GRUNDORAM can be used in several ways to provide assistance during directional drilling operations.



Obstructions as large as the casing itself are "swallowed





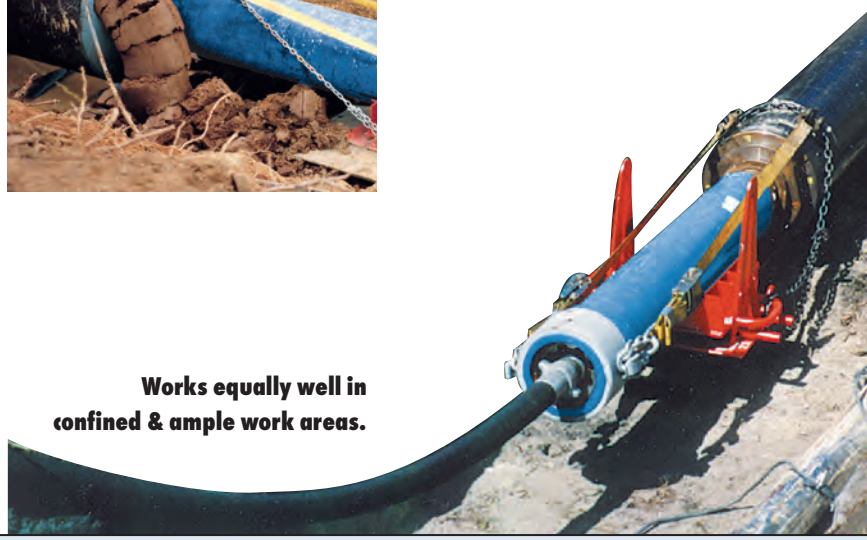
Fast, Effective Pipe Clean-out



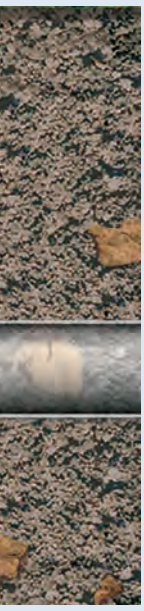
Pipe clean-out requires minimal equipment and can be accomplished in a number of ways. Soil from casings up to 30 inches in diameter can be expelled by using compressed air and/or water with a seal plate. Augers work well too. Depending on soil conditions, vacuum excavation equipment can be used to remove spoil. And, depending on the casing size, mini-excavators and skid steers are ideal for large diameter rams.







Works equally well in confined & ample work areas.



Drive in Any Direction

In addition to horizontal pipe ramming beneath roads and railroad lines, GRUNDORAM can also be used for angled ramming and vertical pile driving. Several GRUNDORAM models are specifically designed for operation in confined areas.

MINI-GRUNDORAM

Powerful percussion to drive steel casings, even in confined spaces.

VERTICAL RAMMING

Drive in any direction—including down! Use GRUNDORAM for vertical pipe and pile driving.

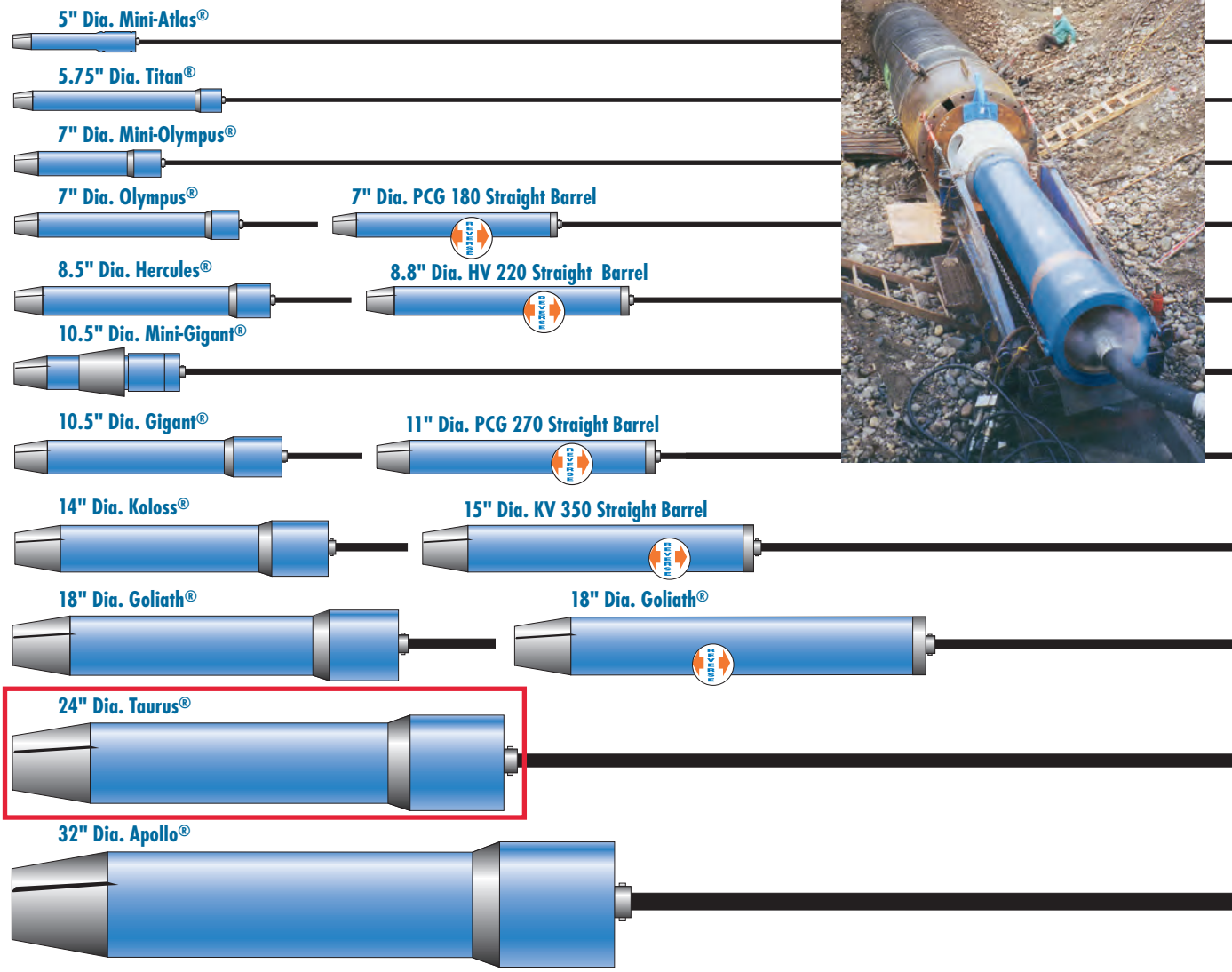




Specifications

The right tool for the job





Technical details

Tool Model	Tool Diameter in. (mm)	Length in. (mm)	Weight lbs. (kg)	Strokes/ Minute	Air Cons. cfm (m3/min)	Recomm. Pipe Dia. In. (mm)	Max. Bore Length ft. (m)
Mini-Atlas	5 (125)	37 (946)	132 (60)	580	60 (1.7)	2–8 (50–200)	50 (15)
Titan	5.75 (146)	61 (1545)	302 (137)	310	141 (4.0)	8–15 (200–400)	80 (25)
Mini-Olympus	7 (180)	43 (1080)	385 (175)	500	124 (3.5)	4–16 (100–400)	80 (25)
Olympus	7 (180)	66 (1690)	507 (230)	280	177 (5.0)	8–20 (200–500)	115 (35)
REVERSIBLE PCG 180	7 (180)	66 (1690)	490 (222)	280	159 (4.5)	8–20 (200–500)	115 (35)
Hercules	8.5 (216)	75 (1913)	811 (368)	340	282 (6.5)	12–20 (300–500)	130 (40)
REVERSIBLE HV 220	8.8 (224)	79 (2010)	945 (429)	300	282 (6.5)	12–20 (300–500)	130 (40)
Mini-Gigant	10.5 (270)	48 (1230)	1014 (460)	430	353 (10.0)	8–24 (200–600)	115 (35)
Gigant	10.5 (270)	79 (2010)	1356 (615)	310	424 (12.0)	15–32 (400–800)	165 (50)
REVERSIBLE PCG 270	11 (280)	84 (2134)	1540 (699)	310	424 (12.0)	15–32 (400–800)	165 (50)
Koloss	14 (350)	92 (2341)	2601 (1180)	220	706 (20.0)	20–48 (500–1200)	230 (70)
REVERSIBLE KV 350	15 (381)	102 (2591)	3375 (1531)	220	706 (20.0)	20–48 (500–1200)	230 (70)
Goliath	18 (460)	112 (2852)	5434 (2465)	180	1236 (35.0)	24–56 (600–1400)	265 (80)
REVERSIBLE Goliath	18 (460)	112 (2852)	5434 (2465)	180	1236 (35.0)	24–56 (600–1400)	265 (80)
Taurus	24 (600)	144 (3645)	10,580 (4800)	180	1766 (50.0)	56–78 (1400–2000)	265 (80)
Apollo	32 (813)	174 (4420)	25,000 (11500)	180	3500 (99.1)	56–122 (1400–3050)	300 (90)

Maximum bore lengths will vary depending on actual pipe diameter installed and GRUNDORAM tool used to install it.
Contact TT Technologies for more detailed tool vs. bore length information.

Specifications subject to change at any time.



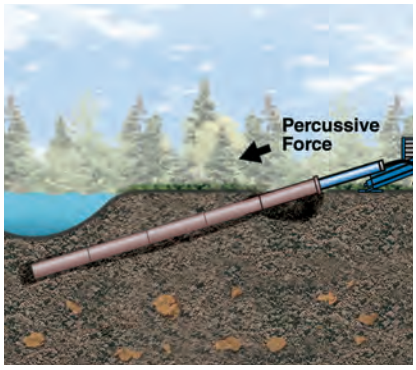
Percussive Power

for directional drilling assist

Conductor Barrel™

A sure start for your bore even in the worst soil.

- Ram casings through difficult soil conditions to more desirable drill starting points.
- Guide down-hole or mud motors to rocky soils through the conductor barrel.
- Provides friction-free section for product pullback.

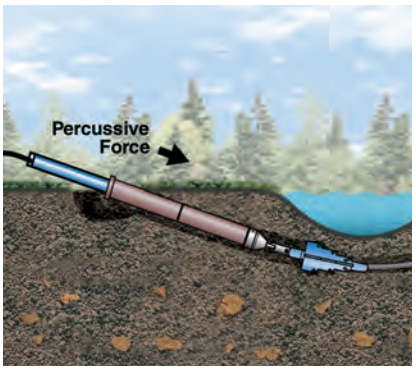




Pullback Assist

Overcome hydrolock with a pipe rammer.

- Rammer attached to product pipe during pullback.
- Percussive action keeps pipe moving and helps prevent high levels of pullback stress.
- Percussive power frees immobilized product pipes.

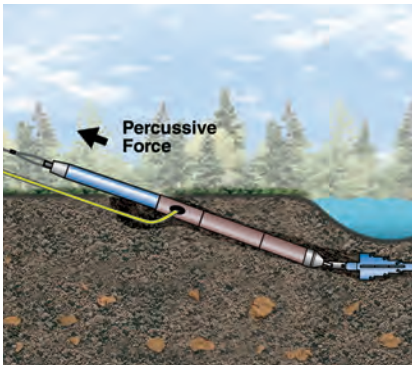




Pipe Removal

Remove stuck product pipe and bore again.

- Rammer attached to product pipe after pullback fails.
- Percussive action pulls product pipe, removing it from the bore.
- Salvage the job and bore again.

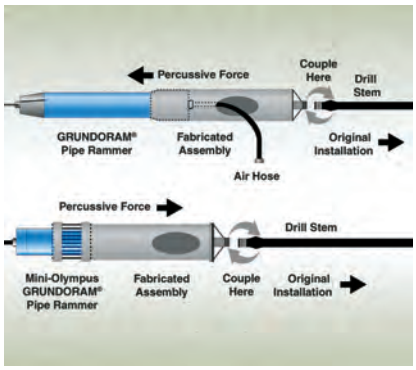




Drill Stem Recovery

Retrieve stuck drill stems.

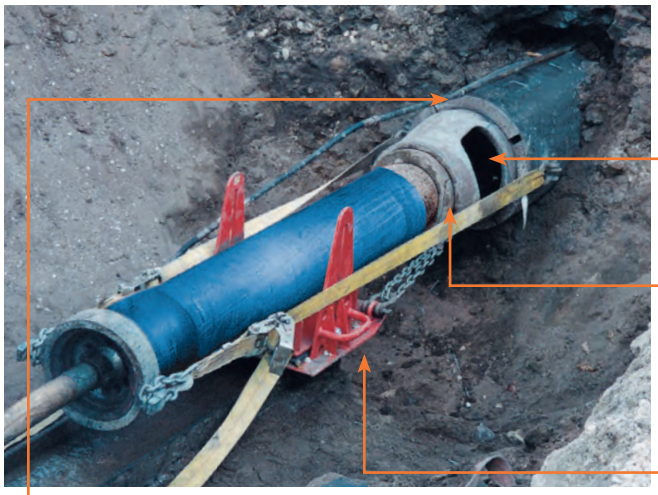
- Pipe Rammer fitted with a special sleeve.
- Stuck drill stem welded to the back of the rammer sleeve.
- Percussive power frees drill stem, saving time and money.

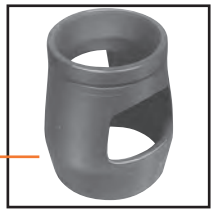




Accessories

for a complete ramming system





Soil Removal Cone

Adapts the GRUNDORAM to the pipe and provides an escape route for spoils.



Tapered Locking Ram Cones

They allow one size GRUNDORAM tool to be adapted to fit many size casings. Used singularly, or in multiples, these cones provide a tight fit which helps deliver all of the GRUNDORAM's power to the casing.



Segmented Ram Cones

These cones ensure a tight fit between the GRUNDORAM and the pipe as well as help minimize pipe flaring. They are especially useful for thin wall pipe in drives of less than 50 feet or when used in combination with soil removal cones.



Adjustable Bearing Stand

Heavy-duty stand provides support and alignment for the GRUNDORAM and casing in the start pit. Features an air bladder to easily raise assembly to correct grade.

GRUNDOMUDD®

Bentonite Mixing & Delivery System



GRUNDOMUDD portable bentonite mixing/delivery systems use a Venturi mixer/filtration system to quickly mix bentonite and water into slurry. An in-tank re-circulating valve prevents the mixture from settling.

The GRUNDOMUDD is available in 225-, twin 225-, 500- and 1,000-gallon capacity models. All models are designed for use with pneumatic trenchless tools including GRUNDORAM pipe ramming.

Each self-contained unit comes complete and ready to use. A tank isolation valve allows pump lines to be cleaned without draining the tank(s). All models feature easy-to-clean round poly tanks.



Proper bentonite usage can mean the difference between ramming success and failure. GRUNDOMUDD systems meet all your mixing and delivery needs.

TT Technologies, Inc.

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HUNTING

'Excellence in **Energy Services** for over 100 years'

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Denver, CO (303) 228-9406
Odessa, TX (432) 257-7545
Williston, ND (701) 572-9942
Nisku, AB Canada (780) 979-6799

Mud Motor Specification Sheet

8" 7/8 3.4 (.09) 8" OD, 7/8 Lobe, 3.4 Stages

Physical Data

Bit size range	Bit box connection	Top sub connection	Maximum weight on bit	Maximum overpull
9 7/8" - 12 1/4"	6 5/8" Reg	6 5/8" Reg Box	87,000 lbs	327,000 lbs

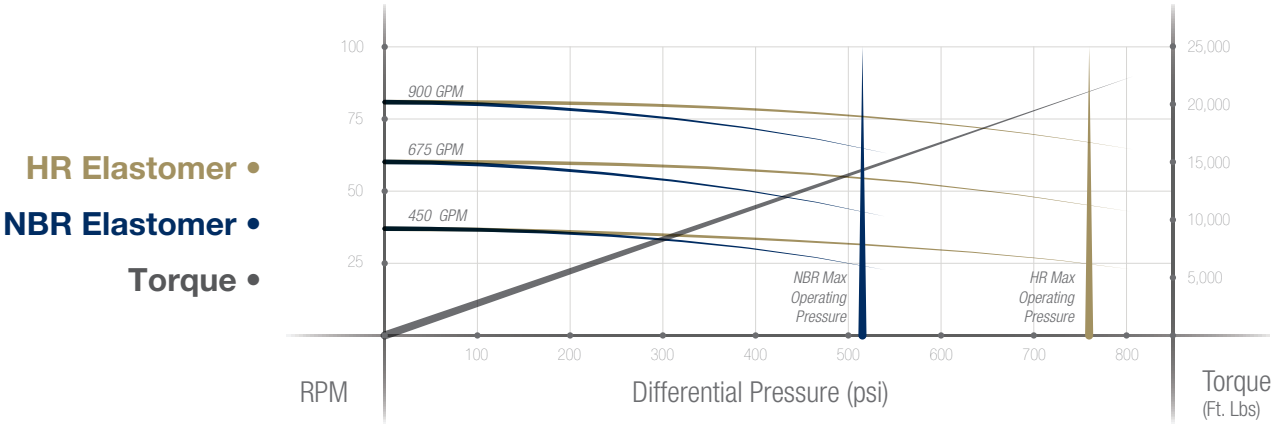
Recommended Drilling Fluid Properties

Sand content (Maximum)	Low gravity solids (LGS) (Maximum)	Total solids (Maximum)	pH	Aniline point (OBM) (Minimum)	Chlorides (Maximum)	Lost circulation material (LCM)
Trace	4%	8%	8 to 10	165° F	150,000 ppm	Thoroughly mix before pumping downhole

Performance Specifications

	Rev / Gal	Flow range	Speed range	Max operating diff pressure	Torque at max operating diff pressure	Stall diff pressure	Torque at stall pressure	Max temp for max operating diff pressure
NBR	0.09	450 - 900 GPM	41 - 81 RPM	510 psi	14,300 ft. lbs	765 psi	21,451 ft. lbs	150° F*
HR	0.09	450 - 900 GPM	41 - 81 RPM	765 psi	21,451 ft. lbs	1,148 psi	32,176 ft. lbs	150° F*

** For temperatures exceeding 150° F, please refer to Hunting's derating of differential pressure due to downhole temperature.*



Dimensional Data

Continuous Maximum Rotary RPM

	Bit to Bend	Bit to Stabilizer	Overall Length	1.25° Bend	1.50° Bend	1.83° Bend	2.12° Bend	2.38° Bend
Straight	NA	42"	42 ft. 6 in	Straight Configuration: 80 RPM				
Fixed Bend	98"	42"	38 ft	60	50	40	30	20
Adjust-able	98"	42"	38 ft	60	40	Not Recommended	Not Recommended	Not Recommended

Predicted Build Rates *Degrees / 100 Ft.*

Hole Size	Configuration	1.25° Bend	1.50° Bend	1.83° Bend	2.12° Bend	2.38° Bend
9 7/8" Hole	Slick	4.13	5.46	7.22	8.77	10.15
	Stabilized	5.85	6.96	8.42	9.70	10.85
12 1/4" Hole	Slick	0.43	1.76	3.55	5.07	6.45
	Stabilized	6.71	7.81	9.27	10.56	11.71

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www.hunting-intl.com/drilling-tools/mud-motors

Appendix D – Steering Equipment

Contents

ParaTrack 2 – Surface Box
ParaTrack 2 – High Resolution Steering Tool
Probe ParaTrack 2 – Annular Pressure Steering
Tool ParaTrack 2 – Gyro Module

PARATRACK2 AC GUIDANCE SYSTEM

INDEPENDENT SURVEY VERIFICATION

The ParaTrack2 Guidance System is the evolution of magnetic wire guidance. Based on low current AC power, driven by a compact and lightweight power supply, and utilizing inexpensive, light gauge wire, ParaTrack2 saves money by significantly reducing set-up and survey time, while also offering superior survey quality at deeper depths or in magnetically noisy environments vs. antiquated DC-powered systems.

ParaTrack2 may be deployed as a single wire with earth return, as a closed coil on the surface, or with one leg in an existing line to enable precision pilot hole tracking from entry to exit.

In cases where placing a wire along the entire length of the bore is not feasible, ParaTrack2 integrates seamlessly with our other guidance and tracking sources including the Beacon Tracker System and the ParaTrack Gyro Module.



FEATURES

- Precision tracking from entry to exit
- Integrates seamlessly with the entire ParaTrack offering of magnetic and gyro tracking methods

BENEFITS

- Provides an independent reference verifying the accuracy of downhole surveys
- Precision tracking at greater depths than competing systems

APPLICATIONS

- Pilot hole tracking
- Gyro survey verification

TECHNICAL SPECIFICATIONS

Input Voltage	100-240 VAC, 50-60 Hz
Output	0-7 Amps
Wire Gauge	10-14 AWG (typical)
Maximum Depth	>1500 ft (with optimal coil design)

SURVEY PRECISION

Location Accuracy	+/- 2% distance wire to probe

PARATRACK STEERING TOOL

PRECISION SURVEYING AND TRACKING

The ParaTrack Steering Tool is the heart of the Vector Magnetics suite of tools for the Horizontal Directional Driller. State of the art magnetic and gravity sensors in a lightweight yet rugged housing provide surveying and tracking in one compact package.

MAGNETIC TRACKING SOURCES INCLUDE:

- AC surface wires in loop or single-wire configuration
- Wires placed in a parallel bore
- Passive Magnetic Ranging to adjacent drillstrings for intersections
- The Beacon Tracker System, allowing for precision surface tracking without wires including otherwise blind shore departures and approaches

FEATURES

- Integrated survey and tracking package for the horizontal driller
- Precision tracking to external magnetic references

BENEFITS

- Compatible with a wide array of magnetic tracking sources
- Rugged, field-proven design
- Verifies VM and 3rd party gyro surveys

APPLICATIONS

- Steering, surveying, and borehole tracking
- Annular and drillpipe pressure monitoring (requires optional Pressure Module)



TECHNICAL SPECIFICATIONS

Outside Diameter	1.75 in (4.45 cm)
Length	Head to foot: 52.8 in (134 cm) Head to sensors: 41 in (104 cm)
Weight	19 lbs (8.6 kg)
Electrical Connection	1-3/16 in, 12 tpi female (standard wet connect)
Internal Operating Temperature	32-185 °F (0-85 °C)
Pressure Rating	17,000 psi (1200 bar)

SURVEY PRECISION

Inclination	+/- 0.02°
Azimuth	+/- 0.05°
Toolface	+/- 0.5°

OPTIONAL ADD-ONS:

- ABIA; providing inclination measurements directly at the bit
- Pressure Module; providing annular and pipe pressures while drilling
- ParaTrack Gyro Module; precision surveying under magnetic interference or at extended reach

PRESSURE MODULE

REAL-TIME PRESSURE MONITORING

The Pressure Module is an optional add-on to the ParaTrack Steering Tool and a component of the Pressure Gravity Tool, bringing real-time monitoring of annular and drillpipe pressure to drilling and reaming operations.

Annular and pipe pressure are plotted in RivCross software and displayed graphically. Options include real-time pressure gauges with limit warnings and plotting of pressure variations over time. All data is logged to the RivCross job database for later reporting or verification purposes. Data may be displayed through a variety of methods including iOS and Android applications.

The Pressure Module requires a drill string pressure orienting sub to maintain steering tool operation and to port annular borehole pressure to the Pressure Module's sensors.

FEATURES

- Real-time monitoring of annular and pipe pressure
- Data logged to RivCross job database

BENEFITS

- Reduces the risk of costly frack-outs
- Monitor motor performance

APPLICATIONS

- Reaming in hard rock or environmentally sensitive areas
- Projects requiring pressure verification



TECHNICAL SPECIFICATIONS

Outside Diameter	1.75 in (4.45 cm) centralizers in custom sizes
Length	35.5 in (90 cm)
Borehole Annulus Gauge	0-1,000 psi Full Scale 3,000 psi survival, 5,000 psi burst
Drillpipe Gauge	0-3,300 psi Full Scale 10,000 psi survival, 10,000 psi burst
Non-linearity	+/- 0.1% FS
Hysterisis	+/- 0.015% FS

COMPATIBLE WITH:

- Pressure Gravity Tool; providing real-time monitoring of pressure and RPM while reaming
- RivCross Driller's Display; remote display of Toolface, Pressure, RPM and more. Available for Windows, Android, and iOS

PARATRACK GYRO MODULE

SURVEY WITH CONFIDENCE

Running in conjunction with the existing ParaTrack Steering Tool, the ParaTrack Gyro Module (PGM) is the latest innovation from the Guidance Specialists at Vector Magnetics.

Designed to withstand the same harsh drilling environment as the proven ParaTrack Steering Tool, yet simple to operate in the familiar RivCross environment, the PGM can be deployed quickly, maximizing operator value.

With no impact from surrounding interference, the PGM reduces survey uncertainty, increasing operator confidence even in difficult conditions.

Prior to punch-out, absolute bit position may be verified by the ParaTrack2 Guide Wire or Beacon Tracker System, eliminating any risk of exceeding project tolerances.

FEATURES

- Fiber-optic north seeking gyro system
- Compatible with the entire ParaTrack line of Steering, Tracking, and Surveying tools and accessories

BENEFITS

- Accurate surveying in cases of severe magnetic interference
- Reliable even in high-vibration environments
- No specialized handling or personnel required

APPLICATIONS

- Surveying in densely populated urban areas
- Verification and correction of magnetic azimuth in long unguided sections



TECHNICAL SPECIFICATIONS

Outside Diameter	2.75 in (requires 3.5 in collar)
Length	Head to foot: 48 in (122 cm)
Weight	39 lbs (17.7 kg)
Electrical Connection	1-3/16 in, 12 tpi female (standard wet connect)
Internal Operating Temperature	32–158 °F (0–70 °C)
Pressure Rating	10,000 psi (690 bar)

SURVEY PRECISION

Inclination	+/- 0.02°
Azimuth	+/- 0.1°
Toolface	+/- 0.5°

COMPATIBLE WITH:

- ABIA; providing inclination measurements directly at the bit
- Pressure Module; providing annular and pipe pressures while drilling
- Beacon Tracker System; precision exit point verification with no surface wires

ROTATING MAGNET RANGING SYSTEM



LONG DISTANCE MAGNETIC RANGING

Vector Magnetics' Rotating Magnet Ranging System (RMRS) is the most accurate wellbore locating method available, allowing for controlled intersections and precision wellbore placement in any orientation.

Field-proven with more than 1000 successful intersections since its first introduction more than 20 years ago, RMRS is the choice when success is the only option.

Compatible with any drilling configuration with minimal impact on directional control and equipment.

FEATURES

- Proven accuracy in cased and open-hole wells
- Ranging measurements taken during normal drilling operations means minimal time cost

BENEFITS

- Measurements taken at the bit allow for immediate feedback and maximum directional control
- Field-proven design; thousands of successful intersections of targets as small as 3.5 in

APPLICATIONS

- Well intersections in any orientation
- Controlled separation and well avoidance

VECTOR MAGNETICS™

vectormagnetics.com

RMRS

ELIMINATE THE GUESSWORK



TECHNICAL SPECIFICATIONS

Outside Diameter (Probe)	1.75 in (4.45 cm)	Distance Accuracy (0-75 ft)	1-3%
Length (Probe)	48 in (122 cm)	Distance Accuracy (75-220 ft)	3-5%
Electrical Connection	1-3/16 in, 12 tpi GO (standard wireline connector)	Detection Range	>300 ft (90 m)
Wireline	Mono conductor	Outside Diameter (bit sub)	3.25 - 8 in (custom sizes available)
Internal Operating Temperature	0-85°C (125°C optional)	Length (bit sub)	~16 in (length varies by size)
Pressure Rating	17,000 psi (1200 bar)	Software	Proprietary (licensed to end-user)

PRECISION WELLBORE PLACEMENT. EVERY TIME.



VECTOR MAGNETICS™

vectormagnetics.com

Appendix E - In-Hole Tooling

Contents

Drill Pipe
Pilot Hole Drill Bits
Mud Motors
Hole Openers
Barrel Reamers Swivel
Pull Head
Rollers

WORKSTRINGS INTERNATIONAL
A SUPERIOR ENERGY SERVICES COMPANY

Asset Number: WS43-02

Drill Pipe Performance Sheet

Size and Weight: 6.625" 34.02 ppf 0.522" wall IEU
Grade: S-135
Range: 2
Tool Joint: 8.500" x 4.250" 6 5/8" FH

Pipe Body:

	Nominal 100% RBW	95% RBW	Ultra Class 90% RBW	Premium 80% RBW
OD (in):	6.625	6.573	6.521	6.416
Wall Thickness (in):	0.522	0.496	0.470	0.418
Nominal ID (in):	5.581	5.581	5.581	5.581
Tensile Strength (lbs):	1,351,130	1,278,084	1,205,616	1,062,414
Torsional Strength (ft-lbs):	183,962	173,788	163,728	143,939
Burst Capacity (psi):	18,615	20,210	19,147	17,019
Collapse Capacity (psi):	18,500	17,020	15,516	12,435

Notes: Body properties are calculated based on uniform OD and wall thickness.
Burst capacity for Nominal (100% RBW) based on 87.5% RBW per API.

Tubular Assembly:

Adjusted Weight (lbs/ft):	47.54	Fluid Displacement (gal/ft):	0.73
Approximate Length (ft):	32.5	Fluid Displacement (bbls/ft):	0.0173
Box TJ Length (in):	18	Fluid Capacity w/IPC (gal/ft):	1.18
Pin TJ Length (in):	14	Fluid Capacity w/IPC (bbls/ft):	0.0281
Upset Type:	IEU	Fluid Capacity w/o IPC (gal/ft):	1.19
Max Upset OD (in):	6.906	Fluid Capacity w/o IPC (bbls/ft):	0.0283
Drift Size (in):	4.125		

Note: These are OEM values that may vary with actual values due to mill tolerances, IPC tolerances, OEM rounding, and other factors. Pipe is purchased at a guaranteed 95% RBW. IPC is applied to a nominal thickness of 0.009". Pipe will have an ID of 5.505", which is smaller than pipe purchased at 87.5%.

Connection: 6 5/8" FH

TJ OD (in): **8.500**
TJ ID (in): **4.250**
MYS (ksi): 120

Maximum MUT is recommended based on thread compound friction factor (unless stated). Lower than maximum MUT should only be used when MUT is limited by rig equipment or connection tensile. Lower than minimum MUT should never be used.

	1.0 FF	1.1 FF	1.15 FF
Maximum MUT (ft-lbs):	**65,000**	**71,500**	**74,750**
Tension at Shoulder Separation @ Max MUT (lbs):	Tensile Limited	Tensile Limited	Tensile Limited
Tension at Connection Yield @ Max MUT (lbs):	1,843,000	1,843,000	1,843,000
Minimum MUT (ft-lbs):	**54,200**	**59,620**	**62,330**
Tension at Shoulder Separation @ Min MUT (lbs):	1,934,090	1,934,090	1,934,090
Tension at Connection Yield @ Min MUT (lbs):	2,102,266	2,102,266	2,102,266
Tool Joint Torsional Strength (ft-lbs):	108,353	119,188	124,606
Tool Joint Tensile Strength (lbs):	2,102,266	2,102,266	2,102,266

Note: There is no published pressure rating for this connection.

***ADJUST makeup torque according to thread compound friction factor (FF) greater than 1.0 up to 1.15 FF. Not to exceed 1.15 regardless of dope FF.* Reference Page 3**

Elevator Shoulder:

Smooth Edge Height (in):	3/32
Smooth Edge OD (in):	8.688
SE Elevator Shoulder Capacity (lbs):	2,251,500
Nominal TJ OD (in):	8.500
Nominal TJ OD Elevator Shoulder Capacity (lbs):	1,972,800
Assumed Elevator Bore (in):	7.031

Note: Elevator capacity based on assumed elevator bore, no wear factor, and contact stress of 110, 100 psi. An increased elevator shoulder OD increases elevator capacity without affecting make-up torque.

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WORKSTRINGS INTERNATIONAL
A SUPERIOR ENERGY SERVICES COMPANY

Asset Number: WS43-03

Drill Pipe Performance Sheet

Size and Weight: 6.625" 27.70 ppf 0.362" wall IEU
Grade: S-135
Range: 2
Tool Joint: 8.500" x 4.250" 6 5/8" FH

Pipe Body:

	Nominal 100% RBW	95% RBW	Ultra Class 90% RBW	Premium 80% RBW
OD (in):	6.625	6.589	6.553	6.480
Wall Thickness (in):	0.362	0.344	0.326	0.290
Nominal ID (in):	5.901	5.901	5.901	5.901
Tensile Strength (lbs):	961,555	910,838	860,398	760,352
Torsional Strength (ft-lbs):	137,330	130,007	122,735	108,344
Burst Capacity (psi):	12,909	14,016	13,278	11,803
Collapse Capacity (psi):	7,813	6,731	6,010	4,562

Notes: Body properties are calculated based on uniform OD and wall thickness.
Burst capacity for Nominal (100% RBW) based on 87.5% RBW per API.

Tubular Assembly:

Adjusted Weight (lbs/ft):	36.18	Fluid Displacement (gal/ft):	0.55
Approximate Length (ft):	31.9	Fluid Displacement (bbls/ft):	0.0132
Box TJ Length (in):	14	Fluid Capacity w/IPC (gal/ft):	1.33
Pin TJ Length (in):	11	Fluid Capacity w/IPC (bbls/ft):	0.0318
Upset Type:	IEU	Fluid Capacity w/o IPC (gal/ft):	1.34
Max Upset OD (in):	6.906	Fluid Capacity w/o IPC (bbls/ft):	0.0320
Drift Size (in):	4.125		

Note: These are OEM values that may vary with actual values due to mill tolerances, IPC tolerances, OEM rounding, and other factors. Pipe is purchased at a guaranteed 95% RBW. IPC is applied to a nominal thickness of 0.009". Pipe will have an ID of 5.843", which is smaller than pipe purchased at 87.5%.

Connection: 6 5/8" FH

TJ OD (in): **8.500**
TJ ID (in): **4.250**
MYS (ksi): 120

Maximum MUT is recommended based on thread compound friction factor (unless stated). Lower than maximum MUT should only be used when MUT is limited by rig equipment or connection tensile. Lower than minimum MUT should never be used.

	1.0 FF	1.1 FF	1.15 FF
Maximum MUT (ft-lbs):	**65,000**	**71,500**	**74,750**
Tension at Shoulder Separation @ Max MUT (lbs):	Tensile Limited	Tensile Limited	Tensile Limited
Tension at Connection Yield @ Max MUT (lbs):	1,843,000	1,843,000	1,843,000
Minimum MUT (ft-lbs):	**54,200**	**59,620**	**62,330**
Tension at Shoulder Separation @ Min MUT (lbs):	1,934,090	1,934,090	1,934,090
Tension at Connection Yield @ Min MUT (lbs):	2,102,266	2,102,266	2,102,266
Tool Joint Torsional Strength (ft-lbs):	108,353	119,188	124,606
Tool Joint Tensile Strength (lbs):	2,102,266	2,102,266	2,102,266

Note: There is no published pressure rating for this connection.

***ADJUST makeup torque according to thread compound friction factor (FF) greater than 1.0 up to 1.15 FF. Not to exceed 1.15 regardless of dope FF.* Reference Page 3**

Elevator Shoulder:

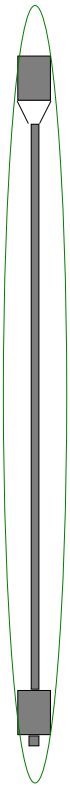
Smooth Edge Height (in):	3/32
Smooth Edge OD (in):	8.688
SE Elevator Shoulder Capacity (lbs):	2,251,500
Nominal TJ OD (in):	8.500
Nominal TJ OD Elevator Shoulder Capacity (lbs):	1,972,800
Assumed Elevator Bore (in):	7.031

Note: Elevator capacity based on assumed elevator bore, no wear factor, and contact stress of 110, 100 psi. An increased elevator shoulder OD increases elevator capacity without affecting make-up torque.

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Operational Limits of Drill Pipe

Connection	6-5/8 FH	Tool Joint OD (in)	8.500	Tool Joint ID (in)	4.250	Tool Joint Specified Minimum Yield Strength (psi)	120,000
Pipe Body	80 % Inspection Class	Pipe Body OD (in)	6.625	Wall Thickness (in)	0.362	Pipe Body Grade	S-135



Combined Loading for Drill Pipe at

Maximum Make-up Torque = 65,000 (ft-lbs)

Operational Torque (ft-lbs)	Assembly Max Tension (lbs)	Pipe Body Max Tension (lbs)	Connection Max Tension (lbs)
0	760,400	760,400	1,822,400
3,400	760,000	760,000	1,822,400
6,800	758,900	758,900	1,822,400
10,100	757,000	757,000	1,822,400
13,500	754,400	754,400	1,822,400
16,900	751,000	751,000	1,822,400
20,300	746,900	746,900	1,822,400
23,600	742,100	742,100	1,822,400
27,000	736,400	736,400	1,822,400
30,400	729,800	729,800	1,822,400
33,800	722,400	722,400	1,822,400
37,200	714,100	714,100	1,822,400
40,500	705,200	705,200	1,822,400
43,900	695,100	695,100	1,822,400
47,300	684,100	684,100	1,822,400
50,700	672,000	672,000	1,822,400
54,000	659,200	659,200	1,822,400
57,400	644,900	644,900	1,822,400
60,800	629,300	629,300	1,822,400
64,200	612,600	612,600	1,822,400

Operational drilling torque is limited by the Make-up Torque.

Combined Loading for Drill Pipe at

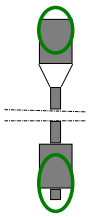
Minimum Make-up Torque = 54,200 (ft-lbs)

Operational Torque (ft-lbs)	Assembly Max Tension (lbs)	Pipe Body Max Tension (lbs)	Connection Max Tension (lbs)
0	760,400	760,400	1,911,300
2,800	760,100	760,100	1,911,300
5,600	759,300	759,300	1,911,300
8,400	758,100	758,100	1,911,300
11,200	756,300	756,300	1,911,300
14,000	754,000	754,000	1,911,300
16,800	751,200	751,200	1,911,300
19,600	747,800	747,800	1,911,300
22,400	743,900	743,900	1,911,300
25,300	739,300	739,300	1,911,300
28,100	734,300	734,300	1,911,300
30,900	728,800	728,800	1,911,300
33,700	722,600	722,600	1,911,300
36,500	715,900	715,900	1,911,300
39,300	708,600	708,600	1,911,300
42,100	700,600	700,600	1,911,300
44,900	692,000	692,000	1,911,300
47,700	682,700	682,700	1,911,300
50,500	672,700	672,700	1,911,300
53,300	662,000	662,000	1,911,300

Operational drilling torque is limited by the Make-up Torque.

Connection

Make-up Torque Range



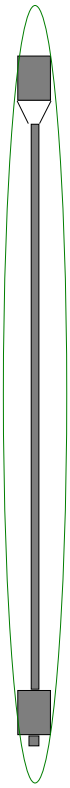
	Make-up Torque (ft-lbs)	Connection Max Tension (lbs)
Min MUT	54,200	1,911,300
	55,400	1,953,600
	56,600	1,995,900
	57,800	2,038,200
	59,000	2,074,500
	60,200	2,024,100
	61,400	1,973,700
	62,600	1,923,300
	63,800	1,872,900
Max MUT	65,000	1,822,400

Note: Recommended MUT should always be used when possible. If not possible, MUT should be as close to Recommended MUT as possible.

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Operational Limits of Drill Pipe

Connection	6-5/8 FH	Tool Joint OD (in)	8.500	Tool Joint ID (in)	4.250	Tool Joint Specified Minimum Yield Strength (psi)	120,000
Pipe Body	80 % Inspection Class	Pipe Body OD (in)	6.625	Wall Thickness (in)	0.522	Pipe Body Grade	S-135



Combined Loading for Drill Pipe at

Maximum Make-up Torque = 65,000 (ft-lbs)

Operational Torque (ft-lbs)	Assembly Max Tension (lbs)	Pipe Body Max Tension (lbs)	Connection Max Tension (lbs)
0	1,062,400	1,062,400	1,822,400
3,400	1,062,100	1,062,100	1,822,400
6,700	1,061,300	1,061,300	1,822,400
10,100	1,059,800	1,059,800	1,822,400
13,400	1,057,800	1,057,800	1,822,400
16,800	1,055,200	1,055,200	1,822,400
20,100	1,052,000	1,052,000	1,822,400
23,500	1,048,200	1,048,200	1,822,400
26,800	1,043,800	1,043,800	1,822,400
30,200	1,038,800	1,038,800	1,822,400
33,500	1,033,200	1,033,200	1,822,400
36,900	1,026,900	1,026,900	1,822,400
40,200	1,020,100	1,020,100	1,822,400
43,600	1,012,500	1,012,500	1,822,400
46,900	1,004,400	1,004,400	1,822,400
50,300	995,400	995,400	1,822,400
53,700	985,700	985,700	1,822,400
57,000	975,600	975,600	1,822,400
60,400	964,400	964,400	1,822,400
63,700	952,700	952,700	1,822,400

Operational drilling torque is limited by the Make-up Torque.

Combined Loading for Drill Pipe at

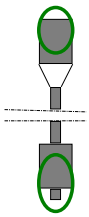
Minimum Make-up Torque = 54,200 (ft-lbs)

Operational Torque (ft-lbs)	Assembly Max Tension (lbs)	Pipe Body Max Tension (lbs)	Connection Max Tension (lbs)
0	1,062,400	1,062,400	1,911,300
2,800	1,062,200	1,062,200	1,911,300
5,600	1,061,600	1,061,600	1,911,300
8,300	1,060,600	1,060,600	1,911,300
11,100	1,059,300	1,059,300	1,911,300
13,900	1,057,400	1,057,400	1,911,300
16,700	1,055,200	1,055,200	1,911,300
19,500	1,052,600	1,052,600	1,911,300
22,300	1,049,600	1,049,600	1,911,300
25,000	1,046,300	1,046,300	1,911,300
27,800	1,042,400	1,042,400	1,911,300
30,600	1,038,100	1,038,100	1,911,300
33,400	1,033,400	1,033,400	1,911,300
36,200	1,028,300	1,028,300	1,911,300
39,000	1,022,700	1,022,700	1,911,300
41,700	1,016,900	1,016,900	1,911,300
44,500	1,010,400	1,010,400	1,911,300
47,300	1,003,400	1,003,400	1,911,300
50,100	996,000	996,000	1,911,300
52,900	988,200	988,200	1,911,300

Operational drilling torque is limited by the Make-up Torque.

Connection

Make-up Torque Range



	Make-up Torque (ft-lbs)	Connection Max Tension (lbs)
Min MUT	54,200	1,911,300
	55,400	1,953,600
	56,600	1,995,900
	57,800	2,038,200
	59,000	2,074,500
	60,200	2,024,100
	61,400	1,973,700
	62,600	1,923,300
	63,800	1,872,900
Max MUT	65,000	1,822,400

Note: Recommended MUT should always be used when possible. If not possible, MUT should be as close to Recommended MUT as possible.

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Grant Prideco | NOV Wellbore Technologies

WORKSTRINGS INTERNATIONAL
A SUPERIOR ENERGY SERVICES COMPANY

Asset Number: WS41-41

Drill Pipe Performance Sheet

Size and Weight: 5.500" 24.70 ppf 0.415" wall IEU
Grade: S-135
Range: 2
Tool Joint: 7.250" x 4.250" XT-M57

Pipe Body:

	Nominal 100% RBW	95% RBW	Ultra Class 90% RBW	Premium 80% RBW
OD (in):	5.500	5.459	5.417	5.334
Wall Thickness (in):	0.415	0.394	0.374	0.332
Nominal ID (in):	4.670	4.670	4.670	4.670
Tensile Strength (lbs):	894,999	846,779	798,925	704,312
Torsional Strength (ft-lbs):	101,833	96,231	90,688	79,776
Burst Capacity (psi):	17,826	19,354	18,335	16,298
Collapse Capacity (psi):	17,023	15,595	14,145	11,177

Notes: Body properties are calculated based on uniform OD and wall thickness.
Burst capacity for Nominal (100% RBW) based on 87.5% RBW per API.

Tubular Assembly:

Adjusted Weight (lbs/ft):	29.09	Fluid Displacement (gal/ft):	0.44
Approximate Length (ft):	31.9	Fluid Displacement (bbls/ft):	0.0106
Box TJ Length (in):	15	Fluid Capacity w/IPC (gal/ft):	0.85
Pin TJ Length (in):	10	Fluid Capacity w/IPC (bbls/ft):	0.0203
Upset Type:	IEU	Fluid Capacity w/o IPC (gal/ft):	0.86
Max Upset OD (in):	5.688	Fluid Capacity w/o IPC (bbls/ft):	0.0205
Drift Size (in):	4.125		

Note: These are OEM values that may vary with actual values due to mill tolerances, IPC tolerances, OEM rounding, and other factors. Pipe is purchased at a guaranteed 95% RBW. IPC is applied to a nominal thickness of 0.009". Pipe will have an ID of 4.61", which is smaller than pipe purchased at 87.5%.

Connection: XT-M57

TJ OD (in): **7.250**
TJ ID (in): **4.250**
MYS (ksi): 120

Maximum MUT is recommended based on thread compound friction factor (unless stated). Lower than maximum MUT should only be used when MUT is limited by rig equipment or connection tensile. Lower than minimum MUT should never be used.

	1.0 FF	1.1 FF	1.15 FF
Maximum MUT (ft-lbs):	**51,500**	**56,650**	**59,225**
Tension at Shoulder Separation @ Max MUT (lbs):	Tensile Limited	Tensile Limited	Tensile Limited
Tension at Connection Yield @ Max MUT (lbs):	1,024,000	1,024,000	1,024,000
Minimum MUT (ft-lbs):	**42,900**	**47,190**	**49,335**
Tension at Shoulder Separation @ Min MUT (lbs):	1,129,900	1,129,900	1,129,900
Tension at Connection Yield @ Min MUT (lbs):	1,200,500	1,200,500	1,200,500
Tool Joint Torsional Strength (ft-lbs):	85,800	94,380	98,670
Tool Joint Tensile Strength (lbs):	1,200,500	1,200,500	1,200,500

Internal Pressure Rating (psi): 15,000
External Pressure Rating (psi): 10,000

XT-M57 is a trademark of NOV Grant Prideco.

***ADJUST makeup torque according to thread compound friction factor (FF) greater than 1.0 up to 1.15 FF. Not to exceed 1.15 regardless of dope FF.* Reference Page 3**

Elevator Shoulder:

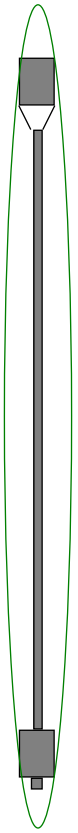
Smooth Edge Height (in):	N/A
Smooth Edge OD (in):	N/A
SE Elevator Shoulder Capacity (lbs):	N/A
Nominal TJ OD (in):	7.250
Nominal TJ OD Elevator Shoulder Capacity (lbs):	1,623,200
Assumed Elevator Bore (in):	5.813

Note: Elevator capacity based on assumed elevator bore, no wear factor, and contact stress of 110, 100 psi. An increased elevator shoulder OD increases elevator capacity without affecting make-up torque.

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Operational Limits of Drill Pipe

Connection	XT-M57	Tool Joint OD (in)	7.250	Tool Joint ID (in)	4.250	Tool Joint Specified Minimum Yield Strength (psi)	120,000
Pipe Body	90 % Inspection Class	Pipe Body OD (in)	5.5	Wall Thickness (in)	0.415	Pipe Body Grade	S-135



Combined Loading for Drill Pipe at Maximum Make-up Torque = 51,500 (ft-lbs)

Operational Torque (ft-lbs)	Assembly Max Tension (lbs)	Pipe Body Max Tension (lbs)	Connection Max Tension (lbs)
0	798,900	798,900	1,024,000
2,200	798,700	798,700	1,024,000
4,500	797,900	797,900	1,024,000
6,700	796,700	796,700	1,024,000
9,000	795,000	795,000	1,024,000
11,200	792,800	792,800	1,024,000
13,400	790,200	790,200	1,024,000
15,700	786,900	786,900	1,024,000
17,900	783,200	783,200	1,024,000
20,200	778,900	778,900	1,024,000
22,400	774,200	774,200	1,024,000
24,700	768,700	768,700	1,024,000
26,900	763,000	763,000	1,024,000
29,100	756,700	756,700	1,024,000
31,400	749,500	749,500	1,024,000
33,600	742,100	742,100	1,024,000
35,900	733,700	733,700	1,024,000
38,100	725,000	725,000	1,024,000
40,300	715,700	715,700	1,024,000
42,600	705,400	705,400	1,024,000

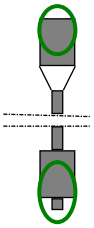
Operational drilling torque is limited by the Make-up Torque.

Combined Loading for Drill Pipe at Minimum Make-up Torque = 42,900 (ft-lbs)

Operational Torque (ft-lbs)	Assembly Max Tension (lbs)	Pipe Body Max Tension (lbs)	Connection Max Tension (lbs)
0	798,900	798,900	1,129,900
1,800	798,800	798,800	1,129,900
3,500	798,300	798,300	1,129,900
5,300	797,600	797,600	1,129,900
7,100	796,500	796,500	1,129,900
8,800	795,200	795,200	1,129,900
10,600	793,400	793,400	1,129,900
12,300	791,500	791,500	1,129,900
14,100	789,200	789,200	1,129,900
15,900	786,600	786,600	1,129,900
17,600	783,700	783,700	1,129,900
19,400	780,400	780,400	1,129,900
21,200	776,800	776,800	1,129,900
22,900	773,000	773,000	1,129,900
24,700	768,700	768,700	1,129,900
26,500	764,100	764,100	1,129,900
28,200	759,300	759,300	1,129,900
30,000	753,900	753,900	1,129,900
31,800	748,200	748,200	1,129,900
33,500	742,400	742,400	1,129,900

Operational drilling torque is limited by the Make-up Torque.

Connection
Make-up Torque Range



	Make-up Torque (ft-lbs)	Connection Max Tension (lbs)
Min MUT	42,900	1,129,900
	43,900	1,156,200
	44,800	1,179,900
	45,800	1,194,000
	46,700	1,167,100
	47,700	1,137,300
	48,600	1,110,400
	49,600	1,080,600
	50,500	1,053,800
Max MUT	51,500	1,024,000

Note: Recommended MUT should always be used when possible. If not possible, MUT should be as close to Recommended MUT as possible.

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02-04-2014

NOV Grant Prideco

WORKSTRINGS INTERNATIONAL
A SUPERIOR ENERGY SERVICES COMPANY

Asset Number: WS41-14

Drill Pipe Performance Sheet

Size and Weight: 5.000" 19.50 ppf 0.362" wall IEU
Grade: S-135
Range: 2
Tool Joint: 6.625" x 3.250" NC50

Pipe Body:

	Nominal 100% RBW	95% RBW	Ultra Class 90% RBW	Premium 80% RBW
OD (in):	5.000	4.964	4.928	4.855
Wall Thickness (in):	0.362	0.344	0.326	0.290
Nominal ID (in):	4.276	4.276	4.276	4.276
Tensile Strength (lbs):	712,070	673,826	635,861	560,763
Torsional Strength (ft-lbs):	74,100	70,043	66,026	58,113
Burst Capacity (psi):	17,105	18,571	17,593	15,638
Collapse Capacity (psi):	15,672	14,292	12,892	10,029

Notes: Body properties are calculated based on uniform OD and wall thickness.
Burst capacity for Nominal (100% RBW) based on 87.5% RBW per API.

Tubular Assembly:

Adjusted Weight (lbs/ft):	24.11	Fluid Displacement (gal/ft):	0.37
Approximate Length (ft):	31.5	Fluid Displacement (bbls/ft):	0.0088
Box TJ Length (in):	12	Fluid Capacity w/IPC (gal/ft):	0.70
Pin TJ Length (in):	9	Fluid Capacity w/IPC (bbls/ft):	0.0167
Upset Type:	IEU	Fluid Capacity w/o IPC (gal/ft):	0.71
Max Upset OD (in):	5.125	Fluid Capacity w/o IPC (bbls/ft):	0.0169
Drift Size (in):	3.125		

Note: These are OEM values that may vary with actual values due to mill tolerances, IPC tolerances, OEM rounding, and other factors. Pipe is purchased at a guaranteed 95% RBW. IPC is applied to a nominal thickness of 0.009". Pipe will have an ID of 4.218", which is smaller than pipe purchased at 87.5%.

Connection: NC50

TJ OD (in): **6.625**
TJ ID (in): **3.250**
MYS (ksi): 120

Maximum MUT is recommended based on thread compound friction factor (unless stated). Lower than maximum MUT should only be used when MUT is limited by rig equipment or connection tensile. Lower than minimum MUT should never be used.

	1.0 FF	1.1 FF	1.15 FF
Maximum MUT (ft-lbs):	**30,700**	**33,770**	**35,305**
Tension at Shoulder Separation @ Max MUT (lbs):	Tensile Limited	Tensile Limited	Tensile Limited
Tension at Connection Yield @ Max MUT (lbs):	1,117,600	1,117,600	1,117,600
Minimum MUT (ft-lbs):	**25,600**	**28,160**	**29,440**
Tension at Shoulder Separation @ Min MUT (lbs):	1,132,000	1,132,000	1,132,000
Tension at Connection Yield @ Min MUT (lbs):	1,250,000	1,250,000	1,250,000
Tool Joint Torsional Strength (ft-lbs):	51,200	56,320	58,880
Tool Joint Tensile Strength (lbs):	1,250,000	1,250,000	1,250,000

Note: There is no published pressure rating for this connection.

***ADJUST makeup torque according to thread compound friction factor (FF) greater than 1.0 up to 1.15 FF. Not to exceed 1.15 regardless of dope FF.* Reference Page 3**

Elevator Shoulder:

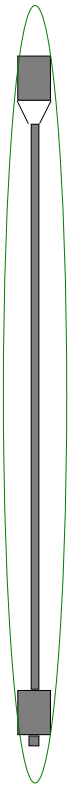
Smooth Edge Height (in):	3/32
Smooth Edge OD (in):	6.813
SE Elevator Shoulder Capacity (lbs):	1,629,800
Nominal TJ OD (in):	6.625
Nominal TJ OD Elevator Shoulder Capacity (lbs):	1,411,900
Assumed Elevator Bore (in):	5.250

Note: Elevator capacity based on assumed elevator bore, no wear factor, and contact stress of 110, 100 psi. An increased elevator shoulder OD increases elevator capacity without affecting make-up torque.

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Operational Limits of Drill Pipe

Connection	NC50	Tool Joint OD (in)	6.625	Tool Joint ID (in)	3.250	Tool Joint Specified Minimum Yield Strength (psi)	120,000
Pipe Body	80 % Inspection Class	Pipe Body OD (in)	5	Wall Thickness (in)	0.362	Pipe Body Grade	S-135



Combined Loading for Drill Pipe at

Maximum Make-up Torque = 30,700 (ft-lbs)

Operational Torque (ft-lbs)	Assembly Max Tension (lbs)	Pipe Body Max Tension (lbs)	Connection Max Tension (lbs)
0	560,800	560,800	1,117,600
1,600	560,600	560,600	1,117,600
3,200	559,900	559,900	1,117,600
4,800	558,800	558,800	1,117,600
6,300	557,500	557,500	1,117,600
7,900	555,600	555,600	1,117,600
9,500	553,200	553,200	1,117,600
11,100	550,400	550,400	1,117,600
12,700	547,200	547,200	1,117,600
14,300	543,500	543,500	1,117,600
15,900	539,400	539,400	1,117,600
17,500	534,700	534,700	1,117,600
19,000	529,900	529,900	1,117,600
20,600	524,400	524,400	1,117,600
22,200	518,200	518,200	1,117,600
23,800	511,600	511,600	1,117,600
25,400	504,400	504,400	1,117,600
27,000	496,600	496,600	1,117,600
28,600	488,200	488,200	1,117,600
30,200	479,400	479,400	1,117,600

Operational drilling torque is limited by the Make-up Torque.

Combined Loading for Drill Pipe at

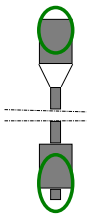
Minimum Make-up Torque = 25,600 (ft-lbs)

Operational Torque (ft-lbs)	Assembly Max Tension (lbs)	Pipe Body Max Tension (lbs)	Connection Max Tension (lbs)
0	560,800	560,800	1,132,000
1,300	560,600	560,600	1,132,000
2,600	560,200	560,200	1,132,000
4,000	559,400	559,400	1,132,000
5,300	558,400	558,400	1,132,000
6,600	557,100	557,100	1,132,000
7,900	555,600	555,600	1,132,000
9,200	553,700	553,700	1,132,000
10,500	551,500	551,500	1,132,000
11,900	548,900	548,900	1,132,000
13,200	546,100	546,100	1,132,000
14,500	543,000	543,000	1,132,000
15,800	539,600	539,600	1,132,000
17,100	535,900	535,900	1,132,000
18,400	531,900	531,900	1,132,000
19,800	527,200	527,200	1,132,000
21,100	522,500	522,500	1,132,000
22,400	517,400	517,400	1,132,000
23,700	512,000	512,000	1,132,000
25,000	506,100	506,100	1,132,000

Operational drilling torque is limited by the Make-up Torque.

Connection

Make-up Torque Range



	Make-up Torque (ft-lbs)	Connection Max Tension (lbs)
Min MUT	25,600	1,132,000
	26,200	1,158,500
	26,700	1,180,600
	27,300	1,207,200
	27,900	1,233,700
	28,400	1,242,800
	29,000	1,210,200
	29,600	1,177,500
	30,100	1,150,300
Max MUT	30,700	1,117,600

Note: Recommended MUT should always be used when possible. If not possible, MUT should be as close to Recommended MUT as possible.

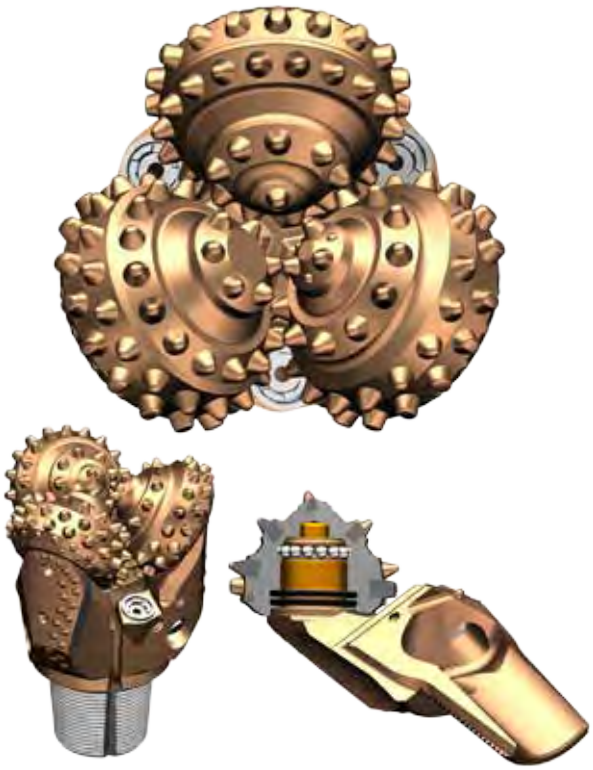
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SANDVIK RR640 SERIES
12 1/4" (311 MM) HDX40
PREMIUM SEALED HDD PILOT BIT

TECHNICAL SPECIFICATION

DRILLING APPLICATIONS

Designed to drill medium-hard to hard formations that are massive, well compacted and abrasive. Also for drilling formations that respond well to high weights. These include hard limestone, sandstone, siliceous siltstone, chert, schist and granite formations. Medium to high compressive strengths up to 40,000 psi (276 MPa).



FEATURES / BENEFITS

PATENTED CHARGER HDX TECHNOLOGY BEARING SYSTEM

Advanced Pfi nodal® metallurgy dramatically increases the weight and rotation speed capacities. Superior dual seal technology on 6 3/4" and larger sizes.

FULL LEG AND SHIRTAIL PROTECTION

Increased bit life and reliability due to Semi Round Top inserts that protect the leg and shirttail in dirty hole conditions and long service hour environments. The inserts also act to clean the hole wall.

SWEDISH QUALITY CARBIDE

Sandvik's own developed insert shapes and carbide grades for optimal performance. Using proprietary carbide resulting in longer insert life.

SANDVIK'S UNIQUE HIGH-PERFORMANCE GREASE

Specially designed grease for use in fast-turning sealed roller bearings for optimum bearing life and minimum seal wear. The bit do not need to be re-greased unless the seal has already failed, as generic grease can have a negative impact on bearing life.

HIGH QUALITY CARBIDE NOZZLES

Industry standard screw-in carbide nozzles for mud application. Made with carbide to prevent mud erosion and screwed in to prevent loss of nozzle.

PRODUCT SPECIFICATIONS	
Size	12 1/4" (311 mm)
Bit Design Diameter	319.5 mm
Ring Gage	317.5 - 319.5 mm
Type	HDX40 (IADC 617)
Approximate Weight	98 kg (216 lb)

DESIGN SPECS	
Bearing Type	Dual Sealed Journal
Inner Gage Rows	9/3
Inner Gage Inserts	99/54
Pin Connection Types	6 5/8" API

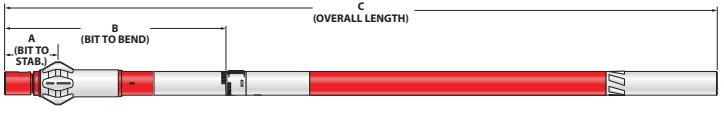
OPERATING PARAMETERS	MIN	MAX
Weight on Bit, Pounds	30,000	100,000
Per Leg on Reamer	10,000	33,333
Weight on Bit, Kilograms	13,608	45,359
Per Leg on Reamer	4,536	15,120
Rotation Speed (RPM)	50	120

Sandvik Mining and Rock Technology reserves the right to make changes to the information on this data sheet without prior notification to users. Please contact a Sandvik representative for clarification on specifications and options.

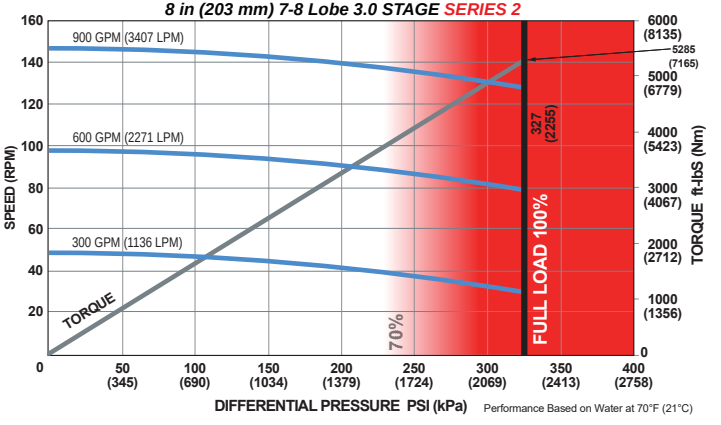
ROCKTECHNOLOGY.SANDVIK

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8 in (203 mm) 7-8 Lobe 3.0 Stage SERIES 2



Bit Size Range		9-7/8 - 12-1/4 in	251 - 311 mm
Bit Box Connection		6-5/8 REGULAR	
Bearing Load On Bottom	**Dynamic**	162510 lbf	72290 daN
	Static	573485 lbf	255100 daN
Bearing Load Off Bottom	**Dynamic**	162510 lbf	72290 daN
	Static	573485 lbf	255100 daN
Max. Overpull (for re-run)		554100 lbf	246000 daN
Absolute Overpull		923500 lbf	411000 daN
Adjustable Makeup Torque		40000 ft-lbs	54233 Nm
A = Bit to Stabilizer (centre)		16.87 in	428 mm
B = Bit to Bend	**Adjustable**	74.7 in	1897 mm
	Fixed	60.1 in	1527 mm
C = Overall (Rotor Catch/ Float Sub)		300.4 in	7630 mm
Weight		3304 lbs	1498.7 kg



Lobe Configuration	7-8 Lobe 3.0 Stage	
Displacement (NO LOAD)	0.16 rev/gal	0.04 rev/l
Max. Differential @ FULL LOAD	327 psi	2,255 kPa
Max. Torque	5,285 ft-lbs	7,165 Nm
Max. Power	121 HP	90 kW

Flow Rate		**Speed**
GPM	**LPM**	**RPM**
300	1,136	21 - 48
600	2,271	71 - 97
900	3,407	120 - 146

ADJUSTABLE BUILD RATE: 8 in (203 mm) 7-8 Lobe 3.0 Stage SERIES 2

Hole Size	SLICK			STABILIZED		
	9-7/8 (251 mm)	10-5/8 (270 mm)	12-1/4 (311 mm)	9-7/8 (251 mm)	10-5/8 (270 mm)	12-1/4 (311 mm)
BEND ANGLE	Degrees per 100 Feet (30 m)			Degrees per 100 Feet (30 m)		
0.39	-	-	-	1.47	2.03	3.23
0.78	2.09	0.28	-	3.74	4.3	5.5
1.15	4.79	2.98	-	6.94	6.45	7.65
1.50	7.34	5.53	1.61	10.02	9.47	9.69
1.83	9.75	7.94	4.02	12.93	12.37	11.61
2.12	11.86	10.05	6.14	15.48	14.93	13.73
2.38	13.76	11.95	8.03	17.77	17.21	16.01
2.60	15.36	13.56	9.64	19.7	19.15	17.95
2.77	16.6	14.79	10.88	21.2	20.65	19.45
2.90	17.55	15.74	11.82	22.34	21.79	20.59
2.97	18.06	16.25	12.33	22.96	22.41	21.2
3.00	18.28	16.47	12.55	23.22	22.67	21.47

FBH BUILD RATE: 8 in (203 mm) 7-8 Lobe 3.0 Stage SERIES 2

Hole Size	SLICK			STABILIZED		
	9-7/8 (251 mm)	10-5/8 (270 mm)	12-1/4 (311 mm)	9-7/8 (251 mm)	10-5/8 (270 mm)	12-1/4 (311 mm)
BEND ANGLE	Degrees per 100 Feet (30 m)			Degrees per 100 Feet (30 m)		
1.25	4.79	2.61	-	7.37	7.5	8.7
1.50	6.61	4.44	-	9.48	9.05	10.25
1.75	8.43	6.26	1.55	11.59	11.03	11.8
2.00	10.26	8.08	3.37	13.69	13.14	13.35

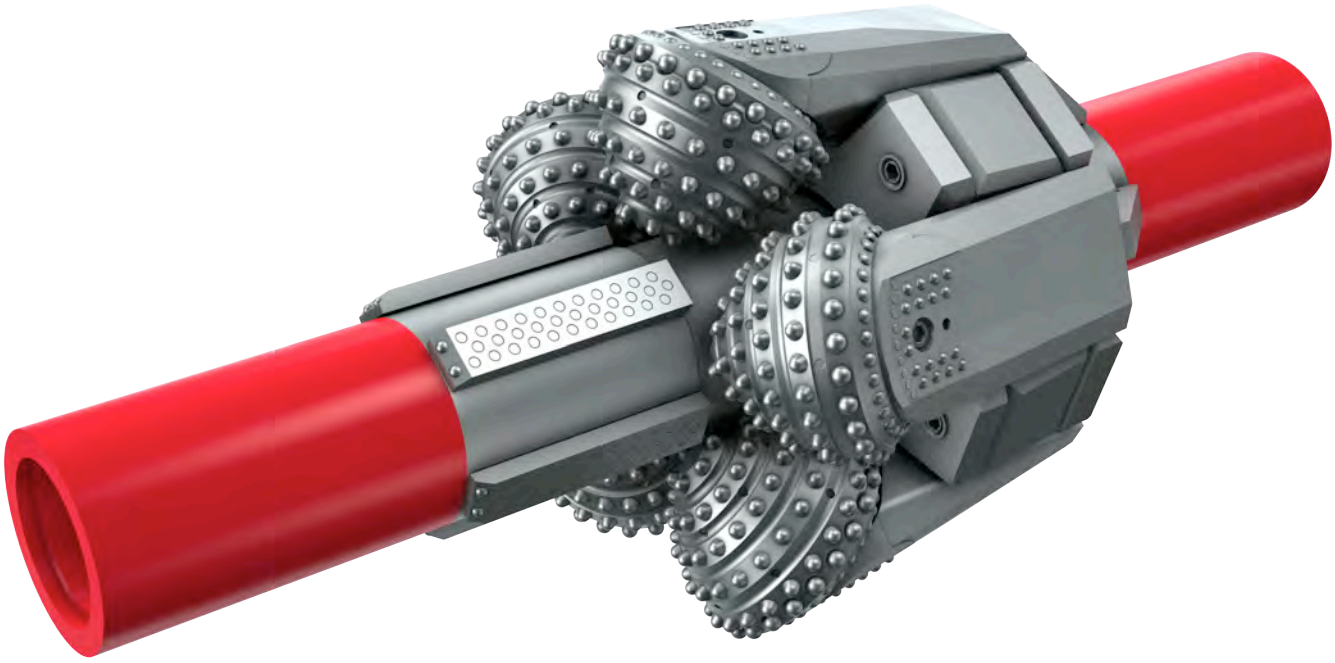
Possible damage may occur when motor is run higher than 70% of Maximum Differential Pressure.

This information is for reference only. Build rates are theoretical calculations using three-point geometry and new motor builds. Actual rate predictions will depend on formation characteristics, bit profiles, and WOB.

For custom motor configurations and build rates, please contact your INROCK office.

HIGH-PERFORMANCE AND HIGH-QUALITY

XTR-W® HARD ROCK FORMATION



INROCK'S patented XTR-W® reaming platform provides a high-quality alternative to traditional "split bit" reamers to an affordable price. The streamlined design utilizes INROCK's proven segment technology to deliver a performance drilling tool at an attractive price point. It can be reused with the change of cutters and can be used with a variety of rig sizes. It is a fully flexible solution where the cutter is replaceable to fit different geologies leading to an optimal penetration rate and maximum service life.

The XTR-W® HF Cutter for hard rock is especially well suited for medium rig customers and complements already existing cutters for soft and medium rock formations.

BENEFITS

- Cost effective
- Fully flexible and easy to use
- Reusable with the change of cutters
- Optimal for any rock formation

XTR-W® SMALL/MEDIUM RIGS

XTR-W® TCI REAMERS - HARD FORMATION TCI CONES				
TOOL SIZE		STANDARD BODY DESCRIPTION		
TOOL SIZE	PILOT HOLE	TOOL SPECS	SEGMENT SIZE	SEGMENT COUNT
12.75”	5-1/2”	2 7/8” IF Box x 2 7/8” IF Box	8.50”	4
15”	5-1/2”	3 1/2” IF Box x 3 1/2” IF Box	10”	4
16”	6-1/2”	3 1/2” IF Box x 3 1/2” IF Box	10”	5
18”	6-1/2”	3 1/2” IF Box x 3 1/2” IF Box	13”	5
18”	12-3/4”	3 1/2” IF Box x 3 1/2” IF Box	10”	5
20”	12-3/4”	3 1/2” IF Box x 3 1/2” IF Box	10”	5
24”	15”	3 1/2” IF Box x 3 1/2” IF Box	13”	5

XTR-W® LARGE RIGS

XTR-W® TCI REAMERS - HARD FORMATION TCI CONES				
TOOL SIZE		STANDARD BODY DESCRIPTION		
TOOL SIZE	PILOT HOLE	TOOL SPECS	SEGMENT SIZE	SEGMENT COUNT
18”	8 1/2”	4-1/2” IF Box x 4-1/2” IF Box	13”	4
20”	9 7/8”	4-1/2” IF Box x 4-1/2” IF Box	13”	5
20”	9 7/8”	5-1/2” FH Box x 5-1/2” FH Box	13”	5
24”	18”	4-1/2” IF Box x 4-1/2” IF Box	13”	5
24”	9 7/8”	5-1/2” FH Box x 5-1/2” FH Box	16”	5
24”	10 5/8”	6-5/8” FH Box x 6-5/8” FH Box	16”	5
30”	20” / 24”	5-1/2” IF Box x 5-1/2” IF Box	16”	5
30”	20” / 24”	5-1/2” or 6-5/8” FH Box x Box	16”	5
36”	24”	6-5/8” FH Box x 6-5/8” FH Box	16”	6
36”	30”	6-5/8” FH Box x 6-5/8” FH Box	16”	6
42”	36”	6-5/8” FH Box x 6-5/8” FH Box	16”	7
48”	36”	6-5/8” FH Box x 6-5/8” FH Box	16”	8
48”	42”	6-5/8” FH Box x 6-5/8” FH Box	16”	8

All of these tool configurations can be provided with milled tooth cutters, standard TCI cutters or HF TCI cutters.
Other sizes and configurations are available upon request.

INROCK reserves the right to make changes to the information on this data sheet without prior notification to users. Please contact your INROCK representative for clarification on specifications and options.

IF-005:01/ENG © INROCK 2020

INROCK®

INROCK.COM

INROCK XTR-W® REAMER SEGMENTS 16” (406 MM)

TECHNICAL SPECIFICATION

ITS-004:01/ENG © INROCK 2020

MT



TCI



TCI HR



DRILLING APPLICATIONS

Complete line of segments specifically engineered for HDD reaming applications. Designed for the full spectrum of geology from soft rock to hard rock drilling including fractured or abrasive formations, including segments designed for compressive strengths ranging from 5,000 PSI (35 MPa) to 35,000 PSI (241 MPa).

FEATURES / BENEFITS

HDD GEOMETRY

Cone attack angle tailored to HDD reamer applications delivering increased cutter life. Design results in proper loading of bearing and smoother reamer operation.

SEALED JOURNAL BEARING

Proprietary sealed bearing system designed to better withstand shock loading in hard rock formations.

HARD ROCK CARBIDE

Insert shape and chemistry engineered for optimal performance in rock environments leading to longer cutter life. Proprietary carbide grade meets specific challenges of HDD reaming.

HDD LEG DESIGN

Recessed cone bore and enhanced shirttail protection using TCI inserts & hard metal to increase seal life and drilling hours in HDD drilling applications. Leg designed to transfer and distribute loads to reamer body.

REPLACEABLE DESIGN

Modular leg geometry designed specifically for interchangeable reamer platform.

PRODUCT SPECIFICATIONS			
	MT	**TCI**	**TCI HR**
Equivalent Bit Size	16"/406 mm	16”/406 mm	16”/406 mm
Type [IADC]	127	537	637
Bearing type	Sealed journal bearing		
Cutter Diameter	9.4”/239 mm	9.5”/242 mm	9.6”/243 mm
Max Cut Path	7.2”/182 mm	6.9”/174 mm	6.7”/171 mm
Approximate Weight	114.6 lbs/ 52.0 kg	136.4 lbs/ 61.9 kg	124.1 lbs/ 56.3 kg
Rows (MT Only)	2	N/A	N/A
DESIGN SPECS			
Gage Rows/Inserts	N/A	1/18	1/22
Inner Rows/Inserts	N/A	5/57	5/80
Heel Rows/Inserts	N/A	1/18	1/30
OPERATING PARAMETERS			
Max Cone RPM[1]	100	80	60
Weight on Bit[1]	16 000 lbs	24 000 lbs	24 000 lbs

[1] Optimum range based on tool size and cutter configuration, please contact your INROCK representative for reccomendations.

INROCK reserves the right to make changes to the information on this data sheet without prior notification to users. Please contact your INROCK representative for clarification on specifications and options.



Barrel reamer/stabilizer

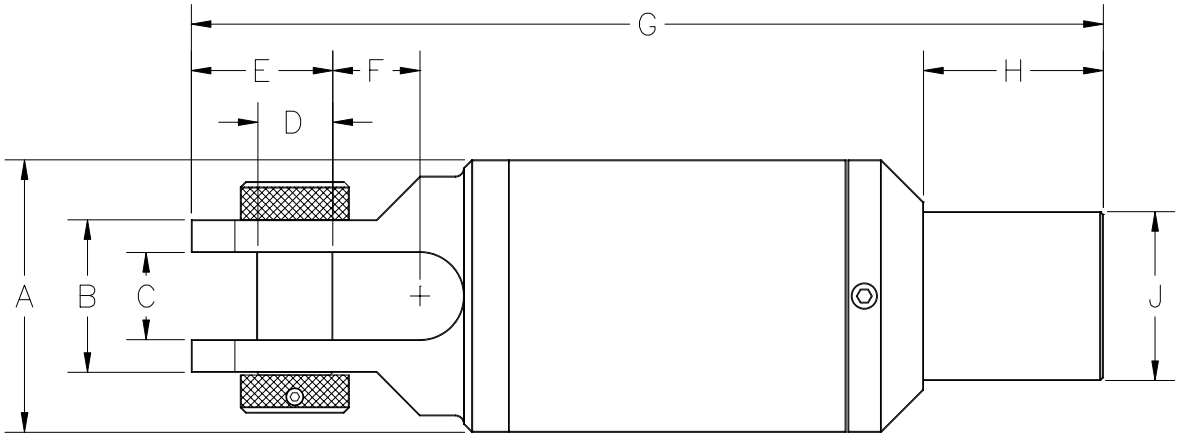
OPERATING SPECIFICATIONS

DCD Design & Manufacturing Ltd.

SERIES 00508 MAXI DUB-SWIVEL® STYLE 1

1. The MAXI DUB Swivel® is specifically designed for directional drilling applications. It is intended for coupling the reamer head to the utility being pulled back. The swivel permits rotation of the drill pipe while protecting the utility from twisting.

2. The style 1 swivel has a clevis located on one end and an API box connection on the other.



Part Number	Safe Working Limit	Ultimate Load	Box Thread	A	B	C	D	E	F	G	H	J	Net Weight
00508-1110	**110 TON** 100 TONNE	**400 TON** 360 TONNE	**4-1/2 IF API**	**10-3/4** 275	**6** 150	**3-1/4** 83	**2-1/2** 63	**4-3/4** 121	**2-3/4** 70	**35** 889	**7-1/2** 191	**6-5/8** 168	**420 lb** 190 kg
00508-1165	**165 TON** 150 TONNE	**600 TON** 540 TONNE	**4-1/2 IF API**	**10-3/4** 275	**6-1/2** 165	**3-1/2** 89	**3** 76	**5-1/2** 140	**3** 76	**38** 965	**7-1/2** 191	**6-5/8** 168	**580 lb** 260 kg
00508-1220	**220 TON** 200 TONNE	**750 TON** 680 TONNE	**6-5/8 REG API**	**12-1/2** 320	**7** 178	**4** 102	**3-1/2** 89	**6-1/2** 165	**4** 102	**42** 1070	**8-1/4** 210	**7-3/4** 197	**860 lb** 390 kg
00508-1350	**350 TON** 320 TONNE	**1250 TON** 1130 TONNE	**7-5/8 REG API**	**16** 405	**9** 229	**5** 127	**4-1/2** 114	**8-1/2** 216	**4-1/2** 114	**50-3/4** 1290	**9-1/2** 241	**9-1/4** 235	**1,690 lb** 770 kg
00508-1351	**350 TON** 320 TONNE	**1250 TON** 1130 TONNE	**6-5/8 FH API**	**16** 405	**9** 229	**5** 127	**4-1/2** 114	**8-1/2** 216	**4-1/2** 114	**50-11/16** 1287	**8-7/8** 225	**8-1/2** 216	**1,690 lb** 770 kg
00508-1500	**500 TON** 450 TONNE	**1750 TON** 1580 TONNE	**7-5/8 REG API**	**19-1/2** 495	**10-1/2** 267	**5-1/2** 140	**5-1/2** 140	**9-3/4** 248	**5-1/4** 133	**55-1/2** 1410	**9-1/2** 241	**9-1/4** 235	**2,700 lb** 1,230 kg
00508-1700	**700 TON** 640 TONNE	**2500 TON** 2270 TONNE	**7-5/8 REG API**	**23** 585	**12** 305	**6-1/2** 165	**6-1/2** 165	**11-1/4** 285	**5-3/4** 140	**65-1/2** 1660	**9-1/2** 241	**9-1/4** 235	**4,120 lb** 1,880 kg

Dimensions and weights subject to change without notice.
Bold linear dimensions in inches, non-bold in millimeters.
The **Ultimate Load** is the tensile loading required to separate the DUB Swivel® into two or more parts.




11/17/2009 06:40

Appendix F - Sample Reports & Logs

Contents

Daily Work Report
Job Safety Analysis
Driller's Log
Survey Tabulation Sheet
Drilling Fluid Report

PROJECT:

Job#

The HDD Company

THE HDD COMPANY
Horizontal Directional Drilling

DAILY WORK REPORT

CLIENT/OWNER: DATE:

WORK PRFM'D. BY: 811 DIG TICKET. :

DESCPT'N. OF WORK: WORK SHFT NUM:

QTY.	A - EQUIPMENT	HRS.
	Company Owned Equipment & P.O. Number	
	Drilling Rig/Cab/Power unit	
	Mud Tank/Solids Control Unit	
	Sump Pit Pump	
	Mud Pumping Units	
	Tool Van / Tools	
	Dump Truck	
	Vac. Truck (Peterbuilt and International)	
	Misc. Trailers	
	Haul Trucks (White Freightliner)	
	Non Mag Drill Collar w/Jet Assembly	
	Drill Pipe Jts on location (5.5 FH)	
	Misc X-O Sub Rack (All X-Subs for Spread)	
	F-250	
	Steering Tool (North Reference w/TruGyde)	
	Rollers @ 10.00/Day/Roller	
	HDD Kamatso 210 Excavator	
	F-150	
	Third Party Rental Equipment w/P.O Number	HRS.

B - MATERIALS

MATERIALS DESCRIPTION W/P.O. NUMBER	QTY. USED
Bentonite (Total Sxs on location) (PO#)	
Hydro-Ease (PO#)	
Mud Additives (PO#)	
SAP	
Cement (PO#)	
Tool Joint Grease (5 Gal Bucket) (PO#)	

C - SUBCONTRACT / WORK BY SPECIALISTS / 3RD PRTY. SRVS.

Work Description	Individual / Company

THE HDD COMPANY: _____
(Signature)

DATE: _____

CLIENT: _____
(Signature)

DATE: _____

NO.	D - LABOR	HRS.	SUB	TOTAL
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				

E - MISCELLANEOUS ITEMS

MISC. DESCRIPTIONS		
Hotel		
Single Rooms		
Double Rooms		

HDD DAILY REPORTS

Time	Comments

Job No. _____ **Job Address:** _____

The Jobsite Hazard analysis must be completed by The HDD Company and reviewed by all the crew on site and any visitors. When tasks change, make the appropriate changes on this document as needed.

Jobsite location:	**Customer:**	**Date Issued (MM/DD/YY):**	
Client Contact Name and Phone #:	**ALT Contact Name and Phone #:**	**Time Issued:**	**No. of HDD Employees:**

Description of work to be done: _____

List of equipment/tools to be used: _____

Site EMR ☐ Posted in Drill Cabin ☐ Posted in Job Trailer

SITE HAZARDS

Yes ☐ No ☐ Is there a Site-Specific Safety Program in place?

Required P. P. E ☐ Hard Hat ☐ Safety Glasses ☐ Reflective Clothing ☐ Gloves ☐ Steel-toe Boots
☐ Face Shield ☐ Hearing Protection ☐ FRC's ☐ Other: _____ ☐ Other: _____

Activities

- ☐ Pilot Hole
- ☐ Tripping out of hole
- ☐ Rigging up drill rig
- ☐ Reaming
- ☐ Making up or breaking tools exit
- ☐ Pumping drill mud for any above
- ☐ Working mud tank, mix mud
- ☐ Maintenance, repairs
- ☐ Loading/unloading materials
- ☐ Making up BHA, Reamers
- ☐ Welding/Cutting/Grinding
- ☐ Other: _____
- ☐ Other: _____
- ☐ Other: _____

Identified Hazards

- ☐ Slips/Trips/Falls, uneven terrain
- ☐ Fall from Heights
- ☐ Mobile equipment operating
- ☐ Overhead Hazards
- ☐ Rotating equipment, drill stem at exit
- ☐ Environmental, Wildlife, Weather
- ☐ Electric shock
- ☐ High pressure lines
- ☐ Flammable materials
- ☐ Limited visibility
- ☐ Driving
- ☐ Manual lifting
- ☐ Hands, Fingers pinch points
- ☐ Slippery Surfaces, unbalanced load
- ☐ Pinch points, moving equipment, heavy lifting
- ☐ High torque, pinch fingers, back injury
- ☐ Loss of limb, death
- ☐ Dust exposure, loud noises, overflow
- ☐ Rolling pipe
- ☐ Flash burn, sparks, fire
- ☐ Other: _____
- ☐ Other: _____
- ☐ Other: _____

Controls/Preventive measures

- ☐ Eye contact with operator
- ☐ Use stripping rubbers, rinse mud off the rig, stack and chalk drill pipe
- ☐ Use a spotter, proper hand singles, eye contact with operator, inspection rigging
- ☐ Eye contact with operator, keep work area clean
- ☐ Inspect rigging and tong links, use equipment to lift tongs
- ☐ Communications, simple radios commands, handling tongs with equipment
- ☐ Keep high PSI hoses insulated from hard surfaces or chafing
- ☐ Use dust mask, safety glasses, keep walkways clean and free of trip hazards
- ☐ Proper clothing
- ☐ De-Energize (Lockout/Tagout)
- ☐ P. P. E
- ☐ Routing
- ☐ Bug – spray / Sunscreen
- ☐ Spotter / hand signals
- ☐ Other: _____
- ☐ Other: _____

- ☐ Speed
- ☐ Welding/cutting/grinding
- ☐ Two – person lift
- ☐ Spacing
- ☐ 100% communication
- ☐ Hands-free zone
- ☐ Lighting
- ☐ 3 – Point contact
- ☐ Signage
- ☐ Guards
- ☐ Hydration
- ☐ Whip-Check
- ☐ Housekeeping
- ☐ Inspection report
- ☐ Proper lifting technique
- ☐ Back-up alarm
- ☐ Barricades
- ☐ Buddy system
- ☐ Monitoring
- ☐ Proper fire extinguisher
- ☐ Positioning
- ☐ Road conditions
- ☐ Other: _____
- ☐ Other: _____

Agreement: I have reviewed this jobsite hazard analysis with the HDD supervisor. I understand the nature and extent of the Hazard/Controls and agree to abide by conditions and precautions as stated above to complete the safety.

SIGN IN SHEET

Print Name	Sign Name	Print Name	Sign Name

THE HDD COMPANY
Going to Greater Lengths™

4525 Serrano Parkway Suite 210
El Dorado Hills, CA 95762

Phone: 530-676-5705
Fax: 530-676-3605
www://http.hddcompany.com

PROJECT: _____

DATE: _____ TOTAL FT. DRILLED TODAY _____

DAILY DRILLERS LOG

Jt. No.	Jt. Length	Start Time	End Time	Station No.	Inclination Target	Inclination Actual	Azimuth Target	Azimuth Actual	Thrust (PSI)	Rotary Torque (PSI	Pull Back (PSI)	Mud Pressure (PSI)	Est. Flow (GPM)	Comments *(Any Trips, Re-drilling, Fluid Loss at Sump Pit Noted Here)*

THE HDD COMPANY
Horizontal Directional Drilling

3161 Cameron Park Dr.
Suite 215
Cameron Park, CA 95682
Phone: 530-676-5705
Fax: 530-676-3605

SURVEY TABULATION SHEET

Customer:									Entry	Exit	TF Offset:			Joint CT.					
Project Job. No.		Motor		GPM		Away:					Horiz. Dist.:			NMDC CT.					
Engineer		Deg. Of Bend		Min. GPM		Elev.:					Measured Dist.:			Motor CT.					
Supt.		Bit Dia.		Diff.		Angle:					Depth:			Ft./Degree					
Crossing:		Nozzle No.		Lobe		Radius:					Rig Size:			R.O.B.					
Probe No.																			
BHA Length.=		Vice to Entry:		Bit to Probe:		Length Added to #1 STL.			#1 STL.					#1 CL:					

Start Jt.	End Jt.	Pipe Lengths Jt. #	CL.	MD.	AZ.	Remarks Drilling Patterns	Survey Inc.	Az.	Mag.	Dip	Station Away	Elevation Calc.	TT	Offset Left/Right Calc.	TT

THE HDD COMPANY
Horizontal Directional Drilling

3161 Cameron Park Drive
Suite 215
Cameron Park, CA 95682

Phone: 530-676-5705
Fax: 530-676-3605

DRILLING FLUID REPORT

Date:		Client:		Ream To Exit (m)	Hole Dia.	Report No.

Mud Properties

		Check 1	Check2	Check 3	Check 4
Sample Taken From					
Time					
Length	Ft.				
Density	Lbs./Gal				
Funnel Vis	(sec/L)				
Apparent Vis	(cP)				
Plastic Vis	(mPa.s)				
Yield Point	(Pa)				
Ø600					
Ø300					
Ø200					
Ø100					
Ø6					
Ø3					
Gels 10 Sec	(lb/100ft²)				
Gels 10 Min	(lb/100ft²)				
API Fluid Loss	(ml)				
pH					
Solids Content	(%)				
Sand Content	(%)				
Total Hardeness	(kg/m3)				
MW Centrifuge (IN/OUT)	(kg/m3)				

Chemical Consumption To Date

GEL	
ROD EASE	
PLATINUM DD	

Initial Chemical Stock

GEL	
ROD EASE	
PLATINUM DD	

Losses To Date (m3) Centrifuge Pumphouse Spills Dumping Formation Shaker

Recommendations

Appendix H – Inadvertent Drilling Fluid Release Contingency Plan

NECEC Note 02.09.2024:

Refer to the NECEC Condition Compliance Application for an updated copy of this Plan.

Appendix I - Safety Data Sheets

Contents

Cetco Super Gel-X
Cetco Soda Ash (sodium carbonate)
Cetco Drill Terge

Drilling fluid additives for potential use, as needed

SUPER GEL-X®

HIGH YIELD BENTONITE

Certified to NSF/ANSI 60

DESCRIPTION

SUPER GEL-X is an easy mixing, high viscosity 200 bbl yield freshwater drilling fluid produced from the highest grade Wyoming sodium bentonite. SUPER GEL-X is certified to NSF/ANSI Standard 60, Drinking Water Treatment Chemicals - Health Effects.

RECOMMENDED USE

May be used for all types of freshwater mud rotary drilling.

CHARACTERISTICS

- Cools and lubricates bit
- Helps prevent loss circulation
- Highly concentrated for maximum yield
- Mixes quickly and easily
- Reduces solids and increases lifting power
- Removes cuttings
- Stabilizes boreholes
- Helps prevent loss circulation

MIXING AND APPLICATION

Mixing ratios are based on 200 bbl yield material using freshwater. Level of water purity will affect bentonite performance. Prior to mixing, acidic and hard water should be treated with SODA ASH to a pH of 8.5-9.5. For best results, add SUPER GEL-X slowly through a jet/hopper mixer.

PACKAGING

~50 lb (~22.7 kg) bags, 48 per pallet, ~1 ton or ~2 ton supersacks, or bulk. All pallets are plastic-wrapped.

DRILLING FLUID AND SLURRY TRENCHING - SUPER GEL-X mixing ratio in pounds (kg) per 100 gallons (378.54 L) of water		
Condition	Lbs (kg) of SUPER GEL-X	% Solids
Normal Conditions	15 - 25 lbs (18 - 28 kg)	1.8 - 2.9%
Sand and Gravel	25 - 35 lbs (28 - 42 kg)	2.9 - 4.0%
Fluid Loss Control	35 - 40 lbs (40 - 47 kg)	4.0 - 4.6%

SLURRY PROPORTIES - 2.78% SOLIDS		
Property	Typical Value	Specification/Procedure
Viscosity FANN 600 rpm	35 cps	30 cps Min - ACC TP-2005
Viscosity FANN 6 rpm	14 cps	ACC TP-2055
Viscosity FANN 3 rpm	13 cps	ACC TP-2055
Yield - 42 gal bbl of 15 cps slurry/ton	217	200 Min - ACC TP-2001
Marsh Funnel, seconds/quart	41 seconds	ACC TP-1014
Apparent Viscosity (AV)	17	15 Min - ACC TP-2005
Plastic Viscosity (PV)	5	ACC TP-2005
Yield Point, lb/100 ft^2	21	ACC TP-2005
Filtrate, 30 minutes @ 100 psi, mi	25 ml	ACC TP-2003
Filter Cake, in	2/32	N/A
pH	9.0	ACC TP-1018

GENERAL PROPERTIES		
Property	Typical Value	Specification/Procedure
Moisture %	7.5%	ACC TP-2006
Free Swell	29 ml	ASTM D-5890
Plate Water Absorption	810.05%	ASTM E946-92
Specific Gravity	2.5 g/cc	Generally Recognized
Bulk Density Non-compacted	53 lbs/ft^3	ACC TP-1005
Bulk Density Compacted	72 lbs/ft^3	ACC TP-1005
Grit % (<75 micron)	2.8%	4.0% Max - ACC TP-2004
Particle Sizing	70% Min passing #200 mesh sieve	ACC TP-1015

North America: 847.851.1800 | 800.527.9948 | www.CETCO.com

UPDATED: JANUARY 2021

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FORM: TDS_SUPER_GEL-X_AM_EN_202103

SAFETY DATA SHEET

1. Identification

Product identifier	**SUPER GEL-X®**
Other means of identification	None.
Recommended use	Not available.
Recommended restrictions	Workers (and your customers or users in the case of resale) should be informed of the potential presence of respirable dust and respirable crystalline silica as well as their potential hazards. Appropriate training in the proper use and handling of this material should be provided as required under applicable regulations.

Manufacturer/Importer/Supplier/Distributor information

Manufacturer

Company name	CETCO, an MTI Company	
Address	2870 Forbs Avenue Hoffman Estates, IL 60192 United States	
Telephone	General Information	800 527-9948
Website	http://www.cetco.com/	
E-mail	safetydata@mineralstech.com	
Emergency phone number	Emergency	1.866.519.4752/1 760 476 3962
Americas	1.866.519.4752 (US, Canada, Mexico) 1 760 476 3962	

2. Hazard(s) identification

Physical hazards	Not classified.	
Health hazards	Carcinogenicity	Category 1A
	Specific target organ toxicity, repeated exposure	Category 1
Environmental hazards	Not classified.	
OSHA defined hazards	Not classified.	

Label elements



Signal word	Danger
Hazard statement	May cause cancer. Causes damage to organs through prolonged or repeated exposure.
Precautionary statement	
Prevention	Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Do not breathe dust. Do not breathe dust/fume/gas/mist/vapors/spray. Wash thoroughly after handling. Do not eat, drink or smoke when using this product. Wear protective gloves/protective clothing/eye protection/face protection.
Response	If exposed or concerned: Get medical advice/attention.
Storage	Store in accordance with local/regional/national regulations.
Disposal	Dispose of contents/container in accordance with local/regional/national/international regulations.
Hazard(s) not otherwise classified (HNOC)	None known.
Supplemental information	6.96% of the mixture consists of component(s) of unknown acute oral toxicity. 7.99% of the mixture consists of component(s) of unknown acute dermal toxicity. 7.99% of the mixture consists of component(s) of unknown acute hazards to the aquatic environment.

3. Composition/information on ingredients

Mixtures

Chemical name	Common name and synonyms	CAS number	%
QUARTZ (SIO2)		14808-60-7	5 - < 10
CRISTOBALITE		14464-46-1	1 - < 3
Other components below reportable levels			90 - 100

*Designates that a specific chemical identity and/or percentage of composition has been withheld as a trade secret.

Composition comments Occupational Exposure Limits for constituents are listed in Section 8.

4. First-aid measures

Inhalation Move to fresh air. Call a physician if symptoms develop or persist.

Skin contact Wash off with soap and water. Get medical attention if irritation develops and persists.

Eye contact Rinse with water. Get medical attention if irritation develops and persists.

Ingestion Rinse mouth. Get medical attention if symptoms occur.

Most important symptoms/effects, acute and delayed Prolonged exposure may cause chronic effects.

Indication of immediate medical attention and special treatment needed Provide general supportive measures and treat symptomatically. Keep victim under observation. Symptoms may be delayed.

General information IF exposed or concerned: Get medical advice/attention. If you feel unwell, seek medical advice (show the label where possible). Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves.

5. Fire-fighting measures

Suitable extinguishing media Water fog. Foam. Dry chemical powder. Carbon dioxide (CO2).

Unsuitable extinguishing media Do not use water jet as an extinguisher, as this will spread the fire.

Specific hazards arising from the chemical During fire, gases hazardous to health may be formed.

Special protective equipment and precautions for firefighters Self-contained breathing apparatus and full protective clothing must be worn in case of fire.

Fire fighting equipment/instructions Move containers from fire area if you can do so without risk.

Specific methods Use standard firefighting procedures and consider the hazards of other involved materials.

General fire hazards No unusual fire or explosion hazards noted.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures Keep unnecessary personnel away. Keep people away from and upwind of spill/leak. Wear appropriate protective equipment and clothing during clean-up. Ensure adequate ventilation. Local authorities should be advised if significant spillages cannot be contained. For personal protection, see section 8 of the SDS.

Methods and materials for containment and cleaning up Stop the flow of material, if this is without risk. Following product recovery, flush area with water. Put material in suitable, covered, labeled containers. For waste disposal, see section 13 of the SDS.

Environmental precautions No special environmental precautions required. Prevent discharge of larger quantity to drain.

7. Handling and storage

Precautions for safe handling Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Keep formation of airborne dusts to a minimum. Provide appropriate exhaust ventilation at places where dust is formed. Do not breathe dust. Avoid prolonged exposure. When using, do not eat, drink or smoke. Should be handled in closed systems, if possible. Wear appropriate personal protective equipment. Wash hands thoroughly after handling. Observe good industrial hygiene practices.

Conditions for safe storage, including any incompatibilities Store locked up. Store in tightly closed container. Keep out of the reach of children. Store away from incompatible materials (see Section 10 of the SDS).

8. Exposure controls/personal protection

Occupational exposure limits

The following constituents are the only constituents of the product which have a PEL, TLV or other recommended exposure limit. At this time, the other constituents have no known exposure limits.

US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000)

Components	Type	Value	Form
QUARTZ (SIO2) (CAS 14808-60-7)	PEL	0.05 mg/m3	Respirable dust.

US. OSHA Table Z-3 (29 CFR 1910.1000)

Components	Type	Value	Form
QUARTZ (SIO2) (CAS 14808-60-7)	TWA	0.1 mg/m3	Respirable.
		2.4 mppcf	Respirable.

Constituents	Type	Value	Form
INERT OR NUISANCE DUSTS	TWA	5 mg/m3	Respirable fraction.
		15 mg/m3	Total dust.
		50 mppcf	Total dust.
		15 mppcf	Respirable fraction.

US. ACGIH Threshold Limit Values

Components	Type	Value	Form
QUARTZ (SIO2) (CAS 14808-60-7)	TWA	0.025 mg/m3	Respirable fraction.

US. NIOSH: Pocket Guide to Chemical Hazards

Components	Type	Value	Form
QUARTZ (SIO2) (CAS 14808-60-7)	TWA	0.05 mg/m3	Respirable dust.

Biological limit values No biological exposure limits noted for the ingredient(s).

Exposure guidelines Occupational exposure to nuisance dust (total and respirable) and respirable crystalline silica should be monitored and controlled.

Appropriate engineering controls Good general ventilation should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level.

Individual protection measures, such as personal protective equipment

Eye/face protection Applicable for industrial settings only. Wear safety glasses with side shields (or goggles).

Skin protection

Hand protection Applicable for industrial settings only. Wear appropriate chemical resistant gloves.

Other Applicable for industrial settings only. Use of an impervious apron is recommended.

Respiratory protection Applicable for industrial settings only. Use a particulate filter respirator for particulate concentrations exceeding the Occupational Exposure Limit.

Thermal hazards Wear appropriate thermal protective clothing, when necessary.

General hygiene considerations Observe any medical surveillance requirements. Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants.

9. Physical and chemical properties

Appearance

Physical state Solid.

Form Solid.

Color Not available.

Odor Not available.

Odor threshold Not applicable.

pH 8.5 - 11

Melting point/freezing point > 842 °F (> 450 °C) / Not applicable.

Initial boiling point and boiling range Not applicable.

Flash point	Not applicable.
Evaporation rate	Not available.
Flammability (solid, gas)	Not available.
Upper/lower flammability or explosive limits	
Flammability limit - lower (%)	Not applicable.
Flammability limit - upper (%)	Not applicable.
Explosive limit - lower (%)	Not available.
Explosive limit - upper (%)	Not available.
Vapor pressure	Not applicable.
Vapor density	Not applicable.
Relative density	2.6 g/cm³
Solubility(ies)	
Solubility (water)	< 0.9 mg/l
Partition coefficient (n-octanol/water)	Not applicable.
Auto-ignition temperature	Not applicable.
Decomposition temperature	> 932 °F (> 500 °C)
Viscosity	Not applicable.
Viscosity temperature	Not applicable.
Other information	
Bulk density	0.9 - 1.4 g/cm³
Explosive limit	Not applicable.
Explosive properties	Not explosive.
Explosivity	Not applicable.
Flame extension	Not applicable.
Flammability	Not applicable.
Flammability (flash back)	Not applicable.
Flammability (Heat of combustion)	Not applicable.
Flammability (Train fire)	Not applicable.
Flammability class	Not applicable.
Flash point class	Not flammable
Molecular formula	UVCB Substance
Molecular weight	Not applicable.
Oxidizing properties	Not oxidizing.
Percent volatile	0 %
pH in aqueous solution	8.5 - 11
Specific gravity	Not applicable.
VOC	CARB 0 %

10. Stability and reactivity

Reactivity	The product is stable and non-reactive under normal conditions of use, storage and transport.
Chemical stability	Material is stable under normal conditions.
Possibility of hazardous reactions	No dangerous reaction known under conditions of normal use.
Conditions to avoid	Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. Avoid temperatures exceeding the decomposition temperature. Contact with incompatible materials.
Incompatible materials	Powerful oxidizers. Chlorine.

Hazardous decomposition products No hazardous decomposition products are known.

11. Toxicological information

Information on likely routes of exposure

Inhalation Prolonged inhalation may be harmful.

Skin contact No adverse effects due to skin contact are expected.

Eye contact Direct contact with eyes may cause temporary irritation.

Ingestion Expected to be a low ingestion hazard.

Symptoms related to the physical, chemical and toxicological characteristics Direct contact with eyes may cause temporary irritation.

Information on toxicological effects

Acute toxicity Not known.

Product	Species	Test Results
Bentonite		
Acute		
Inhalation		
Dust		
LC50	Rat	> 5.27 mg/l, 4 hr OECD 436
Oral		
Dust		
LD50	Rat	> 2000 mg/kg OECD 425

Skin corrosion/irritation Prolonged skin contact may cause temporary irritation.

Serious eye damage/eye irritation Direct contact with eyes may cause temporary irritation.

Respiratory or skin sensitization

Respiratory sensitization Not a respiratory sensitizer.

Skin sensitization This product is not expected to cause skin sensitization.

Germ cell mutagenicity No data available to indicate product or any components present at greater than 0.1% are mutagenic or genotoxic.

Carcinogenicity In 1997, IARC (the International Agency for Research on Cancer) concluded that crystalline silica inhaled from occupational sources can cause lung cancer in humans. However in making the overall evaluation, IARC noted that "carcinogenicity was not detected in all industrial circumstances studied. Carcinogenicity may be dependent on inherent characteristics of the crystalline silica or on external factors affecting its biological activity or distribution of its polymorphs." (IARC Monographs on the evaluation of the carcinogenic risks of chemicals to humans, Silica, silicates dust and organic fibres, 1997, Vol. 68, IARC, Lyon, France.) In June 2003, SCOEL (the EU Scientific Committee on Occupational Exposure Limits) concluded that the main effect in humans of the inhalation of respirable crystalline silica dust is silicosis. "There is sufficient information to conclude that the relative risk of lung cancer is increased in persons with silicosis (and, apparently, not in employees without silicosis exposed to silica dust in quarries and in the ceramic industry). Therefore, preventing the onset of silicosis will also reduce the cancer risk..." (SCOEL SUM Doc 94-final, June 2003) According to the current state of the art, worker protection against silicosis can be consistently assured by respecting the existing regulatory occupational exposure limits. May cause cancer. Occupational exposure to respirable dust and respirable crystalline silica should be monitored and controlled.

IARC Monographs. Overall Evaluation of Carcinogenicity

QUARTZ (SIO2) (CAS 14808-60-7) 1 Carcinogenic to humans.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1053)

QUARTZ (SIO2) (CAS 14808-60-7) Cancer

US. National Toxicology Program (NTP) Report on Carcinogens

QUARTZ (SIO2) (CAS 14808-60-7) Known To Be Human Carcinogen.

Reproductive toxicity This product is not expected to cause reproductive or developmental effects.

Specific target organ toxicity - single exposure Not classified.

Specific target organ toxicity - repeated exposure Causes damage to organs through prolonged or repeated exposure.

Aspiration hazard Not an aspiration hazard.

Chronic effects Prolonged inhalation may be harmful. Causes damage to organs through prolonged or repeated exposure. Prolonged exposure may cause chronic effects.

12. Ecological information

Ecotoxicity The product is not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment.

Product		Species	Test Results
Bentonite			
Aquatic			
Algae	EC50	Freshwater algae	> 100 mg/l, 72 hours
Crustacea	EC50	Coon stripe shrimp (Pandalus danae)	24.8 mg/l, 96 hours
		Daphnia	> 100 mg/l, 48 hours
		Dungeness or edible crab (Cancer magister)	81.6 mg/l, 96 hours
Fish	LC50	Freshwater fish	16000 mg/l, 96 hours
		Marine water fish	2800 - 3200 mg/l, 24 hours

Persistence and degradability No data is available on the degradability of any ingredients in the mixture.

Bioaccumulative potential

Mobility in soil No data available.

Other adverse effects No other adverse environmental effects (e.g. ozone depletion, photochemical ozone creation potential, endocrine disruption, global warming potential) are expected from this component.

13. Disposal considerations

Disposal instructions Dispose of contents/container in accordance with local/regional/national/international regulations.

Local disposal regulations Dispose in accordance with all applicable regulations.

Hazardous waste code The waste code should be assigned in discussion between the user, the producer and the waste disposal company.

Waste from residues / unused products Dispose of in accordance with local regulations. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe manner (see: Disposal instructions).

Contaminated packaging Since emptied containers may retain product residue, follow label warnings even after container is emptied. Empty containers should be taken to an approved waste handling site for recycling or disposal.

14. Transport information

DOT

Not regulated as dangerous goods.

IATA

Not regulated as dangerous goods.

IMDG

Not regulated as dangerous goods.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code Not applicable.

15. Regulatory information

US federal regulations This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

Toxic Substances Control Act (TSCA)

TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)

Not regulated.

CERCLA Hazardous Substance List (40 CFR 302.4)

Not listed.

SARA 304 Emergency release notification

Not regulated.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1053)

QUARTZ (SIO2) (CAS 14808-60-7)	Cancer lung effects immune system effects kidney effects

Superfund Amendments and Reauthorization Act of 1986 (SARA)

SARA 302 Extremely hazardous substance

Not listed.

SARA 311/312 Hazardous chemical	No (Exempt)

SARA 313 (TRI reporting)

Not regulated.

Other federal regulations

Clean Air Act (CAA) Section 112 Hazardous Air Pollutants (HAPs) List

Not regulated.

Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130)

Not regulated.

Safe Drinking Water Act (SDWA)	Not regulated.
Food and Drug Administration (FDA)	Total food additive Direct food additive GRAS food additive

US state regulations

California Proposition 65



WARNING: This product can expose you to QUARTZ (SIO2), which is known to the State of California to cause cancer. For more information go to www.P65Warnings.ca.gov.

California Proposition 65 - CRT: Listed date/Carcinogenic substance

QUARTZ (SIO2) (CAS 14808-60-7)	Listed: October 1, 1988

US. California. Candidate Chemicals List. Safer Consumer Products Regulations (Cal. Code Regs, tit. 22, 69502.3, subd. (a))

QUARTZ (SIO2) (CAS 14808-60-7)

International Inventories

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	No
Canada	Domestic Substances List (DSL)	No
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	No
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	No
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	No
Korea	Existing Chemicals List (ECL)	No
New Zealand	New Zealand Inventory	No
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	No
Taiwan	Taiwan Chemical Substance Inventory (TCSI)	No
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	No

*A "Yes" indicates that all components of this product comply with the inventory requirements administered by the governing country(s)
A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. Other information, including date of preparation or last revision

Issue date	10-October-2013

Revision date	19-August-2020
Version #	41
HMIS® ratings	Health: 3* Flammability: 0 Physical hazard: 0
NFPA ratings	Health: 2 Flammability: 0 Instability: 0
Disclaimer	CETCO, an MTI Company cannot anticipate all conditions under which this information and its product, or the products of other manufacturers in combination with its product, may be used. It is the user's responsibility to ensure safe conditions for handling, storage and disposal of the product, and to assume liability for loss, injury, damage or expense due to improper use. The information in the sheet was written based on the best knowledge and experience currently available.
Revision information	Disposal considerations: Disposal instructions

SODA ASH

SODIUM CARBONATE

Certified to NSF/ANSI 60

DESCRIPTION

SODA ASH is the common name for sodium carbonate, which separates calcium into sodium and carbonate ions in solution. SODA ASH is certified to NSF/ANSI Standard 60, Drinking Water Treatment Chemicals - Health Effects.

RECOMMENDED USE

SODA ASH is used to raise the pH of make-up water for bentonite and polymer drilling fluids by precipitating soluble calcium. Using SODA ASH will increase the performance of bentonite and polymer drilling fluids.

ADVANTAGES

- Easy to mix and use
- Economical method to increase pH
- Maximizes yield of drilling fluid

MIXING AND APPLICATION

SODA ASH should be added slowly through a hopper or chemical barrel. When using a barrel, mix SODA ASH into a full barrel of freshwater and provide adequate agitation. Add SODA ASH until pH of 8.5-9.5 is obtained. Suggested ratio is 0.33 to 0.5 lb per 100 gallons (0.25 kg to 0.5 kg per 380 liters) water.

MIXING AND APPLICATION	
Physical Appearance	White Powder
pH (1 % solution)	11.4
Specific gravity	2.51
Solubility	51 g/100 ml at 86 °F (30 °C)

CHARACTERISTICS

PACKAGING

50 lb (22.7 kg) bags, 49 per pallet or 50 lb (22.7 kg) pails, 32 per pallet. All pallets are plastic-wrapped.

North America: 847.851.1800 | 800.527.9948 | www.CETCO.com

UPDATED: APRIL 2019

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FORM: TDS_SODA_ASH_AM_EN_201905

SAFETY DATA SHEET

1. Identification

Product identifier **SODA ASH**

Other means of identification

Synonyms DISODIUM CARBONATE * SODIUM CARBONATE

Recommended use Not available.

Recommended restrictions None known.

Manufacturer/Importer/Supplier/Distributor information

Manufacturer

Company name CETCO, an MTI Company

Address 2870 Forbs Avenue
Hoffman Estates, IL 60192
United States

Telephone General Information 800 527-9948

Website http://www.cetco.com/

E-mail safetydata@mineralstech.com

Emergency phone number Emergency 1.866.519.4752/1 760 476 3962

Americas 1.866.519.4752 (US, Canada, Mexico) 1 760 476 3962

2. Hazard(s) identification

Physical hazards Not classified.

Health hazards Serious eye damage/eye irritation Category 1

Environmental hazards Not classified.

OSHA defined hazards Not classified.

Label elements



Signal word Danger

Hazard statement Causes serious eye damage.

Precautionary statement

Prevention Wear eye protection/face protection.

Response If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a poison center/doctor.

Storage Store away from incompatible materials.

Disposal Dispose of waste and residues in accordance with local authority requirements.

Hazard(s) not otherwise classified (HNOC) None known.

Supplemental information 100% of the mixture consists of component(s) of unknown acute dermal toxicity. % of the mixture consists of component(s) of unknown acute inhalation toxicity. 100% of the mixture consists of component(s) of unknown acute hazards to the aquatic environment. 100% of the mixture consists of component(s) of unknown long-term hazards to the aquatic environment.

3. Composition/information on ingredients

Substances

Chemical name	Common name and synonyms	CAS number	%
SODIUM CARBONATE	DISODIUM CARBONATE SODA ASH SODIUM CARBONATE ANHYDROUS	497-19-8	100

*Designates that a specific chemical identity and/or percentage of composition has been withheld as a trade secret.

4. First-aid measures

Inhalation	Move to fresh air. Call a physician if symptoms develop or persist.
Skin contact	Wash off with soap and water. Get medical attention if irritation develops and persists.
Eye contact	Do not rub eyes. Immediately flush eyes with plenty of water for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Get medical attention immediately.
Ingestion	Rinse mouth. Get medical attention if symptoms occur.
Most important symptoms/effects, acute and delayed	Severe eye irritation. Symptoms may include stinging, tearing, redness, swelling, and blurred vision. Permanent eye damage including blindness could result. Dusts may irritate the respiratory tract, skin and eyes.
Indication of immediate medical attention and special treatment needed	Provide general supportive measures and treat symptomatically. Keep victim under observation. Symptoms may be delayed.
General information	Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves.

5. Fire-fighting measures

Suitable extinguishing media	Water fog. Foam. Dry chemical powder. Carbon dioxide (CO2).
Unsuitable extinguishing media	Do not use water jet as an extinguisher, as this will spread the fire.
Specific hazards arising from the chemical	During fire, gases hazardous to health may be formed.
Special protective equipment and precautions for firefighters	Self-contained breathing apparatus and full protective clothing must be worn in case of fire.
Fire fighting equipment/instructions	Use water spray to cool unopened containers.
Specific methods	Use standard firefighting procedures and consider the hazards of other involved materials.
General fire hazards	No unusual fire or explosion hazards noted.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures	Keep unnecessary personnel away. Keep people away from and upwind of spill/leak. Wear appropriate protective equipment and clothing during clean-up. Use a NIOSH/MSHA approved respirator if there is a risk of exposure to dust/fume at levels exceeding the exposure limits. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Ensure adequate ventilation. Local authorities should be advised if significant spillages cannot be contained. For personal protection, see section 8 of the SDS.
Methods and materials for containment and cleaning up	Avoid the generation of dusts during clean-up. Collect dust using a vacuum cleaner equipped with HEPA filter. Stop the flow of material, if this is without risk. Large Spills: Wet down with water and dike for later disposal. Absorb in vermiculite, dry sand or earth and place into containers. Shovel the material into waste container. Following product recovery, flush area with water. Small Spills: Sweep up or vacuum up spillage and collect in suitable container for disposal. Wipe up with absorbent material (e.g. cloth, fleece). Clean surface thoroughly to remove residual contamination. Never return spills to original containers for re-use. For waste disposal, see section 13 of the SDS.
Environmental precautions	Avoid discharge into drains, water courses or onto the ground.

7. Handling and storage

Precautions for safe handling	Minimize dust generation and accumulation. Provide appropriate exhaust ventilation at places where dust is formed. Do not get this material in contact with eyes. Wear appropriate personal protective equipment. Observe good industrial hygiene practices.
Conditions for safe storage, including any incompatibilities	Store in original tightly closed container. Store in a well-ventilated place. Store away from incompatible materials (see Section 10 of the SDS).

8. Exposure controls/personal protection

Occupational exposure limits

US. OSHA Table Z-3 (29 CFR 1910.1000)

Additional components	Type	Value	Form
INERT OR NUISANCE DUSTS	TWA	5 mg/m3	Respirable fraction.
		15 mg/m3	Total dust.
		50 mppcf	Total dust.
		15 mppcf	Respirable fraction.

Biological limit values No biological exposure limits noted for the ingredient(s).

Appropriate engineering controls Good general ventilation (typically 10 air changes per hour) should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level. If material is ground, cut, or used in any operation which may generate dusts, use appropriate local exhaust ventilation to keep exposures below the recommended exposure limits. Provide eyewash station.

Individual protection measures, such as personal protective equipment

Eye/face protection Wear safety glasses with side shields (or goggles) and a face shield.

Skin protection

Hand protection Wear appropriate chemical resistant gloves.

Other Wear suitable protective clothing.

Respiratory protection Use a NIOSH/MSHA approved respirator if there is a risk of exposure to dust/fume at levels exceeding the exposure limits.

Thermal hazards Wear appropriate thermal protective clothing, when necessary.

General hygiene considerations Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants.

9. Physical and chemical properties

Appearance

Physical state Solid.

Form Powder.

Color Colorless. white

Odor Odorless.

Odor threshold Not available.

pH 11.3 - 11.5 (1% aqueous solution)

Melting point/freezing point 1563.8 °F (851 °C)

Initial boiling point and boiling range 2912 °F (1600 °C)

Flash point Not available.

Evaporation rate Not available.

Flammability (solid, gas) Not available.

Upper/lower flammability or explosive limits

Flammability limit - lower (%) Not available.

Flammability limit - upper (%) Not available.

Explosive limit - lower (%) Not available.

Explosive limit - upper (%) Not available.

Vapor pressure < 0.0000001 kPa (77 °F (25 °C))

Vapor density Not available.

Relative density Not available.

Solubility(ies)

Solubility (water)	Not available.
Partition coefficient (n-octanol/water)	Not available.
Auto-ignition temperature	Not available.
Decomposition temperature	752 °F (400 °C)
Viscosity	Not available.

Other information

Bulk density	> 1 g/cm3 @ 20 °C
Density	2.53 g/cm3 estimated
Explosive properties	Not explosive.
Molecular formula	C-Na2-O3
Molecular weight	105.99
Oxidizing properties	Not oxidizing.
Specific gravity	2.4 - 2.53 @ 20 C
VOC	CARB

10. Stability and reactivity

Reactivity	The product is stable and non-reactive under normal conditions of use, storage and transport.
Chemical stability	Material is stable under normal conditions.
Possibility of hazardous reactions	No dangerous reaction known under conditions of normal use.
Conditions to avoid	Contact with incompatible materials.
Incompatible materials	Strong oxidizing agents.
Hazardous decomposition products	No hazardous decomposition products are known.

11. Toxicological information

Information on likely routes of exposure

Inhalation	Dust may irritate respiratory system.
Skin contact	Dust or powder may irritate the skin.
Eye contact	Causes serious eye damage.
Ingestion	Expected to be a low ingestion hazard.
Symptoms related to the physical, chemical and toxicological characteristics	Severe eye irritation. Symptoms may include stinging, tearing, redness, swelling, and blurred vision. Permanent eye damage including blindness could result. Dusts may irritate the respiratory tract, skin and eyes.

Information on toxicological effects

Acute toxicity Not known.

Components	Species	Test Results
SODIUM CARBONATE (CAS 497-19-8)		
Acute		
Inhalation		
LC50	Rat	2.3 mg/l, 2 Hours
Oral		
LD50	Rat	4090 mg/kg

Skin corrosion/irritation	Prolonged skin contact may cause temporary irritation.
Serious eye damage/eye irritation	Causes serious eye damage.

Respiratory or skin sensitization

Respiratory sensitization	Not a respiratory sensitizer.
Skin sensitization	This product is not expected to cause skin sensitization.
Germ cell mutagenicity	No data available to indicate product or any components present at greater than 0.1% are mutagenic or genotoxic.

Carcinogenicity Not classifiable as to carcinogenicity to humans.

IARC Monographs. Overall Evaluation of Carcinogenicity

Not listed.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1053)

Not listed.

US. National Toxicology Program (NTP) Report on Carcinogens

Not listed.

Reproductive toxicity This product is not expected to cause reproductive or developmental effects.

Specific target organ toxicity - single exposure Not classified.

Specific target organ toxicity - repeated exposure Not classified.

Aspiration hazard Not an aspiration hazard.

12. Ecological information

Ecotoxicity The product is not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment.

Product		Species	Test Results
SODA ASH			
Aquatic			
Crustacea	EC50	Water flea (Ceriodaphnia dubia)	156.6 - 298.9 mg/l, 48 hours
Fish	LC50	Bluegill (Lepomis macrochirus)	300 mg/l, 96 hours

Components		Species	Test Results
SODIUM CARBONATE (CAS 497-19-8)			
Aquatic			
Fish	LC50	Bluegill (Lepomis macrochirus)	300 mg/l, 96 hours

Persistence and degradability No data is available on the degradability of this substance.

Bioaccumulative potential No data available.

Mobility in soil No data available.

Other adverse effects No other adverse environmental effects (e.g. ozone depletion, photochemical ozone creation potential, endocrine disruption, global warming potential) are expected from this component.

13. Disposal considerations

Disposal instructions Dispose of contents/container in accordance with local/regional/national/international regulations.

Local disposal regulations Dispose in accordance with all applicable regulations.

Hazardous waste code The waste code should be assigned in discussion between the user, the producer and the waste disposal company.

Waste from residues / unused products Dispose of in accordance with local regulations. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe manner (see: Disposal instructions).

Contaminated packaging Since emptied containers may retain product residue, follow label warnings even after container is emptied. Empty containers should be taken to an approved waste handling site for recycling or disposal.

14. Transport information

DOT

Not regulated as dangerous goods.

IATA

Not regulated as dangerous goods.

IMDG

Not regulated as dangerous goods.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code Not applicable.

15. Regulatory information

US federal regulations This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

Toxic Substances Control Act (TSCA)

TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)

Not regulated.

CERCLA Hazardous Substance List (40 CFR 302.4)

Not listed.

SARA 304 Emergency release notification

Not regulated.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1053)

Not listed.

Superfund Amendments and Reauthorization Act of 1986 (SARA)

SARA 302 Extremely hazardous substance

Not listed.

SARA 311/312 Hazardous chemical Yes

Classified hazard categories Acute toxicity (any route of exposure)
Serious eye damage or eye irritation

SARA 313 (TRI reporting)

Not regulated.

Other federal regulations

Clean Air Act (CAA) Section 112 Hazardous Air Pollutants (HAPs) List

Not regulated.

Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130)

Not regulated.

Safe Drinking Water Act (SDWA) Contains component(s) regulated under the Safe Drinking Water Act.

US state regulations

California Proposition 65

California Safe Drinking Water and Toxic Enforcement Act of 2016 (Proposition 65): This material is not known to contain any chemicals currently listed as carcinogens or reproductive toxins. For more information go to www.P65Warnings.ca.gov.

International Inventories

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	Yes
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	Yes
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	Yes
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	Yes
Taiwan	Taiwan Chemical Substance Inventory (TCSI)	Yes
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates that all components of this product comply with the inventory requirements administered by the governing country(s)
A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. Other information, including date of preparation or last revision

Issue date 13-April-2018

Revision date	20-August-2020
Version #	06
HMIS® ratings	Health: 3 Flammability: 0 Physical hazard: 0
NFPA ratings	Health: 3 Flammability: 0 Instability: 0
Disclaimer	The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The manufacturer expressly does not make any representations, warranties, or guarantees as to its accuracy, reliability or completeness nor assumes any liability, for its use. It is the user's responsibility to verify the suitability and completeness of such information for each particular use. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text. CETCO, an MTI Company cannot anticipate all conditions under which this information and its product, or the products of other manufacturers in combination with its product, may be used. It is the user's responsibility to ensure safe conditions for handling, storage and disposal of the product, and to assume liability for loss, injury, damage or expense due to improper use. The information in the sheet was written based on the best knowledge and experience currently available.
Revision information	Disposal considerations: Disposal instructions GHS: Classification

DRILL-TERGE™

DRILLING DETERGENT/WETTING AGENT

DESCRIPTION

DRILL-TERGE is a liquid solution of nonionic surfactants formulated to increase detergency and wetting properties of drilling fluids.



RECOMMENDED USE

Designed to control interfacial tension and inhibit the hydration and dispersion of clay and shale.

CHARACTERISTICS

- Assists in keeping the drill bit clean and prevents bit balling
- Designed to work in fresh or saltwater
- Mixes very easily
- Promotes settling of clays at the reserve pit/tank
- Reduces torque and drag associated with drilling in swelling clays

MIXING AND APPLICATION

Add 0.5 - 0.75 quarts (1-4 liters) of DRILL-TERGE per 100 gallons (per 1000 L) of existing bentonite drilling fluid.

PACKAGING

~40 lb (18.2 kg) pail, 48 per pallet, or ~495 lb (224.5 kg) drum, 4 per pallet. All pallets are plastic-wrapped.

North America: 847.851.1800 | 800.527.9948 | www.CETCO.com

UPDATED: MAY 2020

© 2020 CETCO. IMPORTANT: The information contained herein supersedes all previous printed versions, and is believed to be accurate and reliable. For the most up-to-date information, please visit www.CETCO.com. CETCO accepts no responsibility for the results obtained through application of this product. All products are sold on the understanding that the user is solely responsible for determining their suitability for the intended use and for proper use and disposal of the product. CETCO MAKES NO WARRANTY OF MERCHANTABILITY OR SUITABILITY FOR ANY PARTICULAR PURPOSE IN CONNECTION WITH ANY SALE OF THE PRODUCTS DESCRIBED HEREIN. CETCO reserves the right to update information without notice.

FORM: TDS_DRILL-TERGE_AM_EN_202005

SAFETY DATA SHEET

1. Identification

Product identifier	**DRILL-TERGE™**
Other means of identification	None.
Recommended use	Not available.
Recommended restrictions	None known.

Manufacturer/Importer/Supplier/Distributor information

Manufacturer

Company name	CETCO, an MTI Company	
Address	2870 Forbs Avenue Hoffman Estates, IL 60192 United States	
Telephone	General Information	800 527-9948
Website	http://www.cetco.com/	
E-mail	safetydata@mineralstech.com	
Emergency phone number	Emergency	1.866.519.4752/1 760 476 3962
Americas	1.866.519.4752 (US, Canada, Mexico) 1 760 476 3962	

2. Hazard(s) identification

Physical hazards	Not classified.	
Health hazards	Acute toxicity, oral	Category 4
	Serious eye damage/eye irritation	Category 1
	Sensitization, skin	Category 1
Environmental hazards	Hazardous to the aquatic environment, acute hazard	Category 3
OSHA defined hazards	Not classified.	

Label elements



Signal word	Danger
Hazard statement	Harmful if swallowed. May cause an allergic skin reaction. Causes serious eye damage. Harmful to aquatic life.

Precautionary statement

Prevention	Wash thoroughly after handling. Do not eat, drink or smoke when using this product. Contaminated work clothing must not be allowed out of the workplace. Avoid release to the environment. Wear eye protection/face protection. Wear protective gloves.
Response	If swallowed: Rinse mouth. Do NOT induce vomiting. If on skin: Wash with plenty of water. If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a poison center/doctor. If skin irritation or rash occurs: Get medical advice/attention. Take off contaminated clothing and wash it before reuse.
Storage	Store away from incompatible materials.
Disposal	Dispose of contents/container in accordance with local/regional/national/international regulations.

Hazard(s) not otherwise classified (HNOC)	None known.
Supplemental information	5% of the mixture consists of component(s) of unknown acute dermal toxicity. 5% of the mixture consists of component(s) of unknown long-term hazards to the aquatic environment.

3. Composition/information on ingredients

Mixtures

Chemical name	Common name and synonyms	CAS number	%
TRADE SECRET*		Proprietary*	5
Diethanolamine		111-42-2	<0.25
Other components below reportable levels			94.98

Composition comments This product is not considered to be a carcinogen by IARC, ACGIH, NTP, or OSHA.

4. First-aid measures

Inhalation If gas/fume/vapor/dust/mist from the material is inhaled, remove the affected person immediately to fresh air. Call a physician if symptoms develop or persist.

Skin contact Remove contaminated clothing immediately and wash skin with soap and water. In case of eczema or other skin disorders: Seek medical attention and take along these instructions.

Eye contact Immediately flush eyes with plenty of water for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Get medical attention immediately.

Ingestion Rinse mouth. If vomiting occurs, keep head low so that stomach content doesn't get into the lungs. Get medical advice/attention if you feel unwell.

Most important symptoms/effects, acute and delayed Severe eye irritation. Symptoms may include stinging, tearing, redness, swelling, and blurred vision. Permanent eye damage including blindness could result. May cause an allergic skin reaction. Dermatitis. Rash.

Indication of immediate medical attention and special treatment needed Provide general supportive measures and treat symptomatically. Keep victim warm. Keep victim under observation. Symptoms may be delayed.

General information Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves. Show this safety data sheet to the doctor in attendance. Wash contaminated clothing before reuse.

5. Fire-fighting measures

Suitable extinguishing media Dry chemical, CO2, water spray or regular foam. Use methods for the surrounding fire.

Unsuitable extinguishing media Do not use water jet as an extinguisher, as this will spread the fire.

Specific hazards arising from the chemical During fire, gases hazardous to health may be formed.

Special protective equipment and precautions for firefighters As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

Fire fighting equipment/instructions Move containers from fire area if you can do it without risk. Cool containers with flooding quantities of water until well after fire is out.

Specific methods Use standard firefighting procedures and consider the hazards of other involved materials.

General fire hazards No unusual fire or explosion hazards noted. This material will not burn.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures Keep unnecessary personnel away. Keep people away from and upwind of spill/leak. Wear appropriate protective equipment and clothing during clean-up. Avoid breathing mist/vapors. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Ensure adequate ventilation. Local authorities should be advised if significant spillages cannot be contained. For personal protection, see section 8 of the SDS.

Methods and materials for containment and cleaning up Stop leak if you can do so without risk. Flush with plenty of water.

Large Spills: Dike the spilled material, where this is possible. Absorb in vermiculite, dry sand or earth and place into containers. Following product recovery, flush area with water.

Small Spills: Wipe up with absorbent material (e.g. cloth, fleece). Clean surface thoroughly to remove residual contamination.

Never return spills to original containers for re-use. Absorb spill with inert material (e.g., dry sand or earth), then place in a chemical waste container. For waste disposal, see section 13 of the SDS.

Environmental precautions No special environmental precautions required. Contact local authorities in case of spillage to drain/aquatic environment. Prevent discharge of larger quantity to drain.

7. Handling and storage

Precautions for safe handling Do not get this material in contact with eyes. Do not taste or swallow. Avoid breathing mist/vapors. Avoid contact with eyes, skin, and clothing. Avoid prolonged exposure. When using, do not eat, drink or smoke. Provide adequate ventilation. Wear appropriate personal protective equipment. Wash hands thoroughly after handling. Avoid release to the environment. Observe good industrial hygiene practices. Keep away from heat and flame.

Conditions for safe storage, including any incompatibilities Store in tightly closed container. Keep out of the reach of children. Store away from incompatible materials (see Section 10 of the SDS). Keep in a cool, well-ventilated place.

8. Exposure controls/personal protection

Occupational exposure limits

The following constituents are the only constituents of the product which have a PEL, TLV or other recommended exposure limit. At this time, the other constituents have no known exposure limits.

US. ACGIH Threshold Limit Values

Components	Type	Value	Form
Diethanolamine (CAS 111-42-2)	TWA	1 mg/m3	Inhalable fraction and vapor.

US. NIOSH: Pocket Guide to Chemical Hazards

Components	Type	Value
Diethanolamine (CAS 111-42-2)	TWA	15 mg/m3
		3 ppm

Biological limit values No biological exposure limits noted for the ingredient(s).

Exposure guidelines

US - California OELs: Skin designation

Diethanolamine (CAS 111-42-2) Can be absorbed through the skin.

US ACGIH Threshold Limit Values: Skin designation

Diethanolamine (CAS 111-42-2) Can be absorbed through the skin.

Appropriate engineering controls Good general ventilation should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level. Provide eyewash station. Good general ventilation should be sufficient to control airborne levels. Local exhaust is suggested for use, where possible, in enclosed or confined spaces.

Individual protection measures, such as personal protective equipment

Eye/face protection Applicable for industrial settings only. Wear eye/face protection. Wear safety glasses with side shields (or goggles) and a face shield. Face shield is recommended.

Skin protection

Hand protection Applicable for industrial settings only. For prolonged or repeated skin contact use suitable protective gloves. Suitable gloves can be recommended by the glove supplier.

Other Applicable for industrial settings only. Wear suitable protective clothing. Wear appropriate chemical resistant gloves. Use of an impervious apron is recommended. The use of natural rubber gloves is recommended.

Respiratory protection Applicable for industrial settings only. In case of insufficient ventilation, wear suitable respiratory equipment. Not normally needed. If ventilation is not sufficient to effectively prevent buildup of aerosols or vapors, appropriate NIOSH/MSHA respiratory protection must be provided.

Thermal hazards Wear appropriate thermal protective clothing, when necessary.

General hygiene considerations Keep away from food and drink. Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants. Contaminated work clothing should not be allowed out of the workplace. Use good industrial hygiene practices in handling this material. Eye wash fountain is recommended.

9. Physical and chemical properties

Appearance Clear.

Physical state Liquid.

Form Liquid.

Color	Blue.
Odor	Slight.
Odor threshold	Not available.
pH	8.7 - 9.3
Melting point/freezing point	Not available.
Initial boiling point and boiling range	212 °F (100 °C)
Flash point	Not available.
Evaporation rate	Not available.
Flammability (solid, gas)	Not applicable.
Upper/lower flammability or explosive limits	
Flammability limit - lower (%)	Not available.
Flammability limit - upper (%)	Not available.
Explosive limit - lower (%)	Not available.
Explosive limit - upper (%)	Not available.
Vapor pressure	0.00001 hPa estimated
Vapor density	Not available.
Relative density	Not available.
Solubility(ies)	
Solubility (water)	Not available.
Partition coefficient (n-octanol/water)	Not available.
Auto-ignition temperature	Not available.
Decomposition temperature	Not available.
Viscosity	Not available.
Other information	
Density	1.10 g/cm3 estimated
Explosive properties	Not explosive.
Oxidizing properties	Not oxidizing.
Percent volatile	94.98 % estimated
Specific gravity	1.02
VOC	CARB

10. Stability and reactivity

Reactivity	The product is stable and non-reactive under normal conditions of use, storage and transport.
Chemical stability	Stable at normal conditions.
Possibility of hazardous reactions	Will not occur.
Conditions to avoid	Contact with incompatible materials. Avoid temperatures above 190°F (87.8°C).
Incompatible materials	Peroxides. Phenols. strong acids and strong bases
Hazardous decomposition products	Upon decomposition, this product may yield oxides of nitrogen and ammonia, carbon dioxide, carbon monoxide and other low molecular weight hydrocarbons.

11. Toxicological information

Information on likely routes of exposure

Inhalation	Prolonged inhalation may be harmful.
Skin contact	May cause an allergic skin reaction.
Eye contact	Causes serious eye damage.
Ingestion	Harmful if swallowed.

Symptoms related to the physical, chemical and toxicological characteristics Severe eye irritation. Symptoms may include stinging, tearing, redness, swelling, and blurred vision. Permanent eye damage including blindness could result. May cause an allergic skin reaction. Dermatitis. Rash.

Information on toxicological effects

Acute toxicity Harmful if swallowed.

Components	Species	Test Results
Diethanolamine (CAS 111-42-2)		
Acute		
Oral		
LD50	Rat	710 mg/kg
TRADE SECRET		
Acute		
Oral		
LD50	Rat	> 5000 mg/kg

Skin corrosion/irritation Due to partial or complete lack of data the classification is not possible.

Serious eye damage/eye irritation Causes serious eye damage.

Respiratory or skin sensitization

Respiratory sensitization Due to partial or complete lack of data the classification is not possible.

Skin sensitization May cause an allergic skin reaction.

Germ cell mutagenicity Due to partial or complete lack of data the classification is not possible.

Carcinogenicity Risk of cancer cannot be excluded with prolonged exposure.

IARC Monographs. Overall Evaluation of Carcinogenicity

Diethanolamine (CAS 111-42-2)	2B Possibly carcinogenic to humans.
TRADE SECRET (CAS Proprietary)	2B Possibly carcinogenic to humans.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1053)

Not listed.

US. National Toxicology Program (NTP) Report on Carcinogens

Not listed.

Reproductive toxicity Due to partial or complete lack of data the classification is not possible.

Specific target organ toxicity - single exposure Due to partial or complete lack of data the classification is not possible.

Specific target organ toxicity - repeated exposure Knowledge about health hazard is incomplete.

Aspiration hazard Due to partial or complete lack of data the classification is not possible.

Chronic effects Prolonged inhalation may be harmful. Prolonged exposure may cause chronic effects.

12. Ecological information

Ecotoxicity Harmful to aquatic life. This product is not expected to produce significant ecotoxicity upon exposure to aquatic organisms and aquatic systems.

Components		Species	Test Results
Diethanolamine (CAS 111-42-2)			
Aquatic			
Algae	IC50	Algae	7.8 mg/L, 72 Hours
Crustacea	EC50	Daphnia	55 mg/L, 48 Hours
Fish	LC50	Fathead minnow (Pimephales promelas)	100 mg/l, 96 hours
		Fish	4710 mg/L, 96 Hours

Persistence and degradability No data is available on the degradability of this product.

Bioaccumulative potential

Partition coefficient n-octanol / water (log Kow)

Diethanolamine	-1.43

Mobility in soil No data available.

Other adverse effects No other adverse environmental effects (e.g. ozone depletion, photochemical ozone creation potential, endocrine disruption, global warming potential) are expected from this component.

13. Disposal considerations

Disposal instructions Do not allow this material to drain into sewers/water supplies. Do not contaminate ponds, waterways or ditches with chemical or used container. Dispose of contents/container in accordance with local/regional/national/international regulations.

Local disposal regulations Dispose in accordance with all applicable regulations.

Hazardous waste code The waste code should be assigned in discussion between the user, the producer and the waste disposal company.

Waste from residues / unused products Dispose of in accordance with local regulations. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe manner (see: Disposal instructions).

Contaminated packaging Since emptied containers may retain product residue, follow label warnings even after container is emptied. Empty containers should be taken to an approved waste handling site for recycling or disposal.

14. Transport information

DOT

Not regulated as dangerous goods.

IATA

Not regulated as dangerous goods.

IMDG

Not regulated as dangerous goods.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code Not established.

15. Regulatory information

US federal regulations This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

Toxic Substances Control Act (TSCA)

TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)

Not regulated.

CERCLA Hazardous Substance List (40 CFR 302.4)

Diethanolamine (CAS 111-42-2) Listed.

SARA 304 Emergency release notification

Not regulated.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1053)

Not listed.

Superfund Amendments and Reauthorization Act of 1986 (SARA)

SARA 302 Extremely hazardous substance

Not listed.

SARA 311/312 Hazardous chemical No (Exempt)

SARA 313 (TRI reporting)

Not regulated.

Other federal regulations

Clean Air Act (CAA) Section 112 Hazardous Air Pollutants (HAPs) List

Diethanolamine (CAS 111-42-2)

Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130)

Not regulated.

Safe Drinking Water Act (SDWA) Not regulated.

US state regulations

California Proposition 65



WARNING: This product can expose you to Diethanolamine, which is known to the State of California to cause cancer. For more information go to www.P65Warnings.ca.gov.

California Proposition 65 - CRT: Listed date/Carcinogenic substance

Diethanolamine (CAS 111-42-2) Listed: June 22, 2012

US. California. Candidate Chemicals List. Safer Consumer Products Regulations (Cal. Code Regs, tit. 22, 69502.3, subd. (a))

Diethanolamine (CAS 111-42-2)
TRADE SECRET (CAS Proprietary)

International Inventories

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	Yes
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	Yes
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	Yes
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	Yes
Taiwan	Taiwan Chemical Substance Inventory (TCSI)	Yes
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates that all components of this product comply with the inventory requirements administered by the governing country(s)
A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. Other information, including date of preparation or last revision

Issue date	05-September-2013
Revision date	20-August-2020
Version #	15
Further information	This safety datasheet only contains information relating to safety and does not replace any product information or product specification.
HMIS® ratings	Health: 1 Flammability: 1 Physical hazard: 0
NFPA ratings	Health: 1 Flammability: 1 Instability: 0

Disclaimer

CETCO, an MTI Company cannot anticipate all conditions under which this information and its product, or the products of other manufacturers in combination with its product, may be used. It is the user's responsibility to ensure safe conditions for handling, storage and disposal of the product, and to assume liability for loss, injury, damage or expense due to improper use. The information in the sheet was written based on the best knowledge and experience currently available. The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The manufacturer expressly does not make any representations, warranties, or guarantees as to its accuracy, reliability or completeness nor assumes any liability, for its use. It is the user's responsibility to verify the suitability and completeness of such information for each particular use.

Third party materials: Insofar as materials not manufactured or supplied by this manufacturer are used in conjunction with, or instead of this product, it is the responsibility of the customer to obtain, from the manufacturer or supplier, all technical data and other properties relating to these and other materials and to obtain all necessary information relating to them. No liability can be accepted in respect of the use of this product in conjunction with materials from another supplier. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

Revision information

Hazard(s) identification: Response
Disposal considerations: Disposal instructions

SAFETY DATA SHEET

SDS DATE: 1-1-2022

SECTION 1: PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: **TROL FORCE**

CAS: Proprietary

MANUFACTURER: Right Turn Supply
ADDRESS: 2265 Graceland Cemetery Road, Pella, IA 50219

EMERGENCY PHONE: 281-413-1939
E mail: Info@rightturnsupply.com

CHEMICAL FAMILY: Polysaccharides

RECOMMENDED USE: Fluid Loss Control/Rheology Modfifciation

SECTION 2: HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW:

IMMEDIATE CONCERNS: May cause eye and respiratory irritation.

POTENTIAL HEALTH EFFECTS

EYES: Contact may cause eye irritation

SKIN: This product is unlikely to cause skin irritation

INGESTION: This product is unlikely to cause harmful effects from ingestion

INHALATION: May cause irritation to the respiratory tract if inhaled. May cause coughing, sneezing or nasal irritation.

ACUTE HEALTH HAZARDS: None.

CHRONIC HEALTH HAZARDS: Excessive inhalation or eye exposure over long periods may cause harmful irritation

SLIP HAZARD: If the material becomes wet, it could produce a slip hazard.

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE: Particulate inhalation may lead to pulmonary problems.

SECTION 3: COMPOSITION/INFORMATION ON INGREDIENTS

COMPONENTS:

	CAS NO.	% WT
Proprietary		

SECTION 4: FIRST AID MEASURES

EYES: Immediately flush with large amounts of cold water, holding eye-lids open. Flush for 15 minutes if possible. Remove contact lenses if present.

SKIN: Rinse contact area with cold water. Remove contaminated clothing, and wash with soap and water. If irritation develops, seek medical attention.

INGESTION: Do not induce vomiting. Have exposed individual rinse mouth thoroughly with water. Never give anything by mouth to an unconscious person. Consult physician if symptoms persist.

INHALATION: Move exposed person to fresh air and call 911. Give artificial respiration if not breathing and administer oxygen if breathing is difficult.

NOTES TO PHYSICIANS OR FIRST AID PROVIDERS: Treat Symptomatically. Ensure that medical personnel are aware of the materials involved and take precautions to protect themselves. First aid responders are advised to wear protective equipment as found in section 8 of this SDS.

SECTION 5: FIRE-FIGHTING MEASURES

FLASH POINT: No data available

AUTOIGNITION TEMPERATURE: No data available

EXTINGUISHING MEDIA: Use alcohol foam, CO2, water fog, or dry chemicals when fighting fires involving this material. Do not use a direct stream if dust is if formed. Dust dispersed by a direct stream in the presence of an ignition source could ignite.

SPECIAL FIRE FIGHTING PROCEDURES: Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Persons involved in fire-fighting response involving this product and its containers/packaging should refer to Section 8 of this SDS for the proper selection of exposure controls and personal protective equipment.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Dust-air mixtures may be explosive. Avoid open flames, sparks etc.

HAZARDOUS DECOMPOSITION PRODUCTS: Carbon oxides (COx).

SECTION 6: ACCIDENTAL RELEASE MEASURES

SPILLS: Wet material is slippery! Avoid generating and spreading of dust. Shovel into dry containers. Cover and move the containers. Wash away with water or vacuum with a high efficiency filter to recover and reuse the material. If product is contaminated, collect in suitable containers for disposal. Do not contaminate drainage or waterways. Repackage or recycle if possible.

ENVIRONMENTAL PRECAUTIONS: Prevent entry into waterways, sewers, basements or confined areas. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air). Avoid allowing water runoff to contact spilled material. If sweeping of a contaminated area is necessary, use a dust suppressant agent that does not react with the product. Contaminated surfaces will be extremely slippery.

SPECIAL PROTECTIVE EQUIPMENT: In case of dust generation, wear goggles and ensure adequate ventilation and/or use breathing apparatus. Dust in high concentrations may form explosive mixtures with air. Review Sections 5 and 7 of this SDS with personnel before starting any cleanup operations.

SECTION 7: HANDLING AND STORAGE

HANDLING: Avoid dust generation. Ensure adequate ventilation or breathing apparatus before handling material. Gloves should be worn.

STORAGE: Store in dry conditions, do not let product get wet, wet material could produce a slip hazard. Store in original packaging, or appropriate alternative. If repackaged, label new packaging. Store at ambient temperature and pressure.

OTHER PRECAUTIONS: Keep away from ignition source.

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

ENGINEERING CONTROLS: Provide adequate general and local exhaust ventilation. Provide readily accessible eye wash stations and emergency showers. Where explosive mixtures may be present, electrical systems safe for such locations must be used.

VENTILATION: Ensure area of use is well ventilated.

RESPIRATORY PROTECTION: Depending on airborne concentration, wear an OSHA approved N95 half-face dust respirator.

EYE PROTECTION: Employees should be provided with and required to use safety goggles where there is any possibility of product coming in contact with eyes. Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of contact lenses. Ensure that an eye wash station is operable and nearby.

SKIN PROTECTION: Depending on the conditions of use, protective gloves, apron, boots, head and face protection should be worn. Remove contaminated clothing immediately, wash skin with soap and water, and launder clothing before reuse.

WORK HYGIENIC PRACTICES: Use good personal hygiene practices. Avoid repeated and/or prolonged skin exposure. Wash hands before eating, drinking, smoking, or using toilet facilities. Promptly remove contaminated clothing and launder before reuse. Shower after work using plenty of soap and water.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

FORM: solid powder.

APPEARANCE: white to off white.

ODOR: odorless or no characteristic odor.

pH (2% solution): 8-11

BOILING POINT: No data available

MELTING POINT: No data available

FREEZING POINT: No data available

SPECIFIC GRAVITY: 1.5 typical

EVAPORATION RATE: No data available

FLAMABILITY LIMITS: No data available

AUTOIGNITION TEMPERATURE: No data available

FLASH POINT: No data available

SOLUBILITY IN WATER: 100%

SECTION 10: STABILITY AND REACTIVITY

STABILITY: Stable. Hazardous polymerization does not occur.

CONDITIONS TO AVOID: Ignition sources may cause exothermic reaction. Wet material can be a slip hazard.

MATERIALS TO AVOID: Oxidizing agents

HAZARDOUS DECOMPOSITION OR BY-PRODUCTS: Carbon oxides (COx)

SECTION 11: TOXICOLOGICAL INFORMATION

TOXICOLOGICAL INFORMATION:

ORAL LD50 (RAT); No data available

DERMAL LD50 (RABBIT): No data available

INHALATION LC50 (RAT): No data available

CARCINOGENICITY:

NTP	Not listed
IARC	Not listed
OSHA	Not listed

SENSITIZATION: No data available

NEUROTOXICITY: No data available

GENETIC EFFECTS: No data available

REPRODUCTIVE EFFECTS: No data available

TERATOGENIC EFFECTS: No data available

MUTAGENICITY: No data available

SECTION 12: ECOLOGICAL INFORMATION

ENVIRONMENTAL DATA: MOBILITY IN SOIL POTENTIAL - No data available

ECOTOXICOLOGICAL INFORMATION: TERRESTRIAL/MICROORGANISM TOXICITY –
ACUTE: No data available
CHRONIC: No data available

BIOACCUMULATION/ACCUMULATION: No data available
AQUATIC TOXICITY: No data available

CHEMICAL FATE INFORMATION: PERSISTENCE & DEGRADABILITY – Material breaks down naturally.

GENERAL COMMENTS: Any other adverse environmental effects, such as environmental fate (exposure), ozone depletion potential, photochemical ozone creation potential, endocrine disrupting potential, and global warming potential are indicated in this section if data exists. Otherwise, this data has not been established.

SECTION 13: DISPOSAL CONSIDERATIONS

DISPOSAL METHOD: This product does not meet the criteria of a hazardous waste if discarded in its purchased form. Under RCRA, it is the responsibility of the user of the product to determine at the time of disposal, whether the product meets RCRA criteria for hazardous waste. This is because product uses, transformations, mixtures, processes, etc. may render the resulting materials hazardous.

PRODUCT DISPOSAL: Recover and reclaim or recycle, if practical. Should this product become a waste, dispose of in a permitted industrial landfill. Ensure that containers are empty by RCRA criteria prior to disposal in a permitted industrial landfill.

EMPTY CONTAINER: Empty containers may retain residues. All label precautions must be observed.

COMMENTS: Dispose of material in accordance with national, state, regional, and local regulations. Never discharge directly into sewers or surface water. Consult with environmental regulatory agencies for guidance on acceptable disposal practices for the product, in any form, and its containers/packaging.

SECTION 14: TRANSPORT INFORMATION

DOT (DEPARTMENT OF TRANSPORTATION)
PROPER SHIPPING NAME: Not regulated as a dangerous good.

ROAD AND RAIL (ADR/RID)
SHIPPING NAME: Not regulated as a dangerous good.
AIR (ICAO/IATA)
SHIPPING NAME: Not regulated as a dangerous good.

VESSEL (IMO/IMDG)
SHIPPING NAME: Not regulated as a dangerous good.

SECTION 15: REGULATORY INFORMATION

UNITED STATES:

SARA TITLE III (SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT)
311/312 HAZARD CATEGORIES: None of the components are listed.
313 REPORTABLE INGREDIENTS: None of the components are listed.

CERCLA (COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT)
CERCLA REGULATORY: None of the components are listed.

TSCA (TOXIC SUBSTANCE CONTROL ACT)
TSCA REGULATORY: All components are listed and registered.

CALIFORNIA PROPOSITION 65: This product does not contain any chemicals that are known to the State of California to cause cancer, birth defects or other reproductive harm at concentrations that trigger the warning requirements of California Proposition 65.

CARCINOGEN: This product is not listed as a carcinogen under NTP, IARC, or OSHA.
CANADA
WHMIS (WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM): Not a controlled product.

SECTION 16: OTHER INFORMATION

REVISION SUMMARY: This SDS replaces the 06/16/2014 SDS.

NFPA

Health Hazard:	1
Fire Hazard:	1
Reactivity Hazard:	0

HMIS

Health Hazard:	1
Flammability:	1
Physical Hazard:	0

HMIS RATINGS NOTES: Please refer to Section 8 of this SDS for recommended personal protective equipment.

GENERAL STATEMENTS: Other information not included anywhere else in this SDS is included in this section if, in fact, such data exists.
MANUFACTURER DISCLAIMER: This information relates to the specific material designated and may not be valid for such material used in combination with any other materials or in any process. Such information is to the best of our knowledge and belief, accurate and reliable as of the date compiled. However, no representation, warranty or guarantee is made as to its accuracy, reliability or completeness. NO WARRANTY OF MERCANTABILITY, FITNESS FOR ANY PARTICULAR PURPOSE, OR ANY OTHER WARRANTY, EXPRESSED OR IMPLIED, IS MADE CONCERNING THE INFORMATION HEREIN PROVIDED. It is the user's responsibility to satisfy himself as to the suitability and completeness of such information for his own particular use. We do not accept liability for any loss or damage that may occur from the use of this information nor do we offer warranty against patent infringement.

SAFETY DATA SHEET
DRILPLEX HDD

1 IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND OF THE COMPANY/UNDERTAKING

PRODUCT NAME: DRILPLEX HDD

APPLICATION: Rheology modifier

SUPPLIER:
M-I SWACO.
Endeavour Drive
Arnhall Business Park
Westhill
Aberdeen AB32 6UF
Scotland UK
T = +44 (0)1224-742200
F = +44 (0)1224-742288
E-mail =
MBXMSDS-EH@miswaco.com

EMERGENCY TELEPHONE: (24 Hour) Europe +44 (0) 1235 239 670, Asia Pacific +65 3158 1074, China +86 10 5100 3039, Middle East and Africa +44 (0) 1235 239 671, Australia +61 2801 44558.

2 HAZARDS IDENTIFICATION

Irritating to eyes.

CLASSIFICATION (1999/45): Xi;R36.

3 COMPOSITION/INFORMATION ON INGREDIENTS

Name	EC No.	CAS-No.	Content	Classification (67/548)
SODIUM CARBONATE	207-838-8	497-19-8	30-60%	Xi;R36
MAGNESIUM OXIDE	215-171-9	1309-48-4	10-30%	-
ALUMINIUM OXIDE/HYDROXIDE	215-691-6	1344-28-1	10-30%	-
CALCIUM HYDROXIDE	215-137-3	1305-62-0	1-5%	Xi;R37/38,R41.

The Full Text for all R-Phrases are Displayed in Section 16

COMPOSITION COMMENTS

The data shown is in accordance with the latest EC Directives.

4 FIRST-AID MEASURES

INHALATION

Move the exposed person to fresh air at once. If respiratory problems, artificial respiration/oxygen. Get medical attention if any discomfort continues.

INGESTION

Immediately give a couple of glasses of water or milk, provided the victim is fully conscious. Do not induce vomiting. Get medical attention if any discomfort continues.

SKIN CONTACT

Remove contaminated clothing immediately and wash skin with soap and water. Get medical attention promptly if symptoms occur after washing.

EYE CONTACT

Make sure to remove any contact lenses from the eyes before rinsing. Promptly wash eyes with plenty of water while lifting the eye lids. Continue to rinse for at least 15 minutes and get medical attention.

5 FIRE-FIGHTING MEASURES

EXTINGUISHING MEDIA

Water spray, foam, dry powder or carbon dioxide.

SPECIAL FIRE FIGHTING PROCEDURES

Containers close to fire should be removed immediately or cooled with water.

UNUSUAL FIRE & EXPLOSION HAZARDS

High concentrations of dust may form explosive mixture with air.

SPECIFIC HAZARDS

During fire, toxic gases (CO, CO2) are formed.

PROTECTIVE MEASURES IN FIRE

Self contained breathing apparatus and full protective clothing must be worn in case of fire.

6 ACCIDENTAL RELEASE MEASURES

PERSONAL PRECAUTIONS

Wear protective clothing as described in Section 8 of this safety data sheet.

ENVIRONMENTAL PRECAUTIONS

Do not allow to enter drains, sewers or watercourses.

SPILL CLEAN UP METHODS

Avoid generation and spreading of dust. Shovel into dry containers. Cover and move the containers. Flush the area with water. Product becomes slippery when wet.

7 HANDLING AND STORAGE

USAGE PRECAUTIONS

Avoid inhalation of dust and contact with skin and eyes. Avoid handling which leads to dust formation.

STORAGE PRECAUTIONS

Store in tightly closed original container in a dry, cool and well-ventilated place.

8 EXPOSURE CONTROLS/PERSONAL PROTECTION

Name	Std	TWA - 8 hrs		STEL - 15 min		Notes
ALUMINIUM OXIDE/HYDROXIDE	WEL		4 mg/m3			
CALCIUM HYDROXIDE	WEL		5 mg/m3			
MAGNESIUM OXIDE	WEL		4 mg/m3		10 mg/m3	as Mg

WEL = Workplace Exposure Limit.

PROTECTIVE EQUIPMENT



ENGINEERING MEASURES

Provide adequate general and local exhaust ventilation.

RESPIRATORY EQUIPMENT

No specific recommendation made, but respiratory protection may still be required under exceptional circumstances when excessive air contamination exists. Wear mask supplied with: Dust filter P2 (for fine dust).

HAND PROTECTION

For prolonged or repeated skin contact use suitable protective gloves. Use protective gloves made of: Nitrile. or Neoprene.

EYE PROTECTION

Wear approved chemical safety goggles where eye exposure is reasonably probable.

OTHER PROTECTION

Wear appropriate clothing to prevent any possibility of skin contact. Provide eyewash station.

9 PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE	Powder, dust		
COLOUR	White / off-white		
ODOUR	Odourless		
SOLUBILITY	Moderate		
RELATIVE DENSITY	2.0-2.5 g/cm3	pH-VALUE, DILUTED SOLUTION	11 - 11.5 @ 1%

10 STABILITY AND REACTIVITY

STABILITY

Stable under normal temperature conditions and recommended use.

11 TOXICOLOGICAL INFORMATION

INHALATION

Dust may irritate respiratory system or lungs.

INGESTION

May irritate and cause stomach pain, vomiting and diarrhoea.

SKIN CONTACT

Prolonged and frequent contact may cause redness and irritation.

EYE CONTACT

Irritating to eyes. Particles in the eyes may cause irritation and smarting.

12 ECOLOGICAL INFORMATION

ECOTOXICITY

Contact M-I SWACO's QHSE Department for ecological information at env@miswaco.com.

13 DISPOSAL CONSIDERATIONS

DISPOSAL METHODS

Recover and reclaim or recycle, if practical. Dispose of waste and residues in accordance with local authority requirements.

14 TRANSPORT INFORMATION

GENERAL	The product is not covered by international regulation on the transport of dangerous goods (IMDG, IATA, ADR/RID).

15 REGULATORY INFORMATION

LABELLING



Irritant

RISK PHRASES

R36	Irritating to eyes.

SAFETY PHRASES

S25	Avoid contact with eyes.
S26	In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.

UK REGULATORY REFERENCES

Chemicals (Hazard Information & Packaging) Regulations. Control of Substances Hazardous to Health Regulations 2002 (as amended) Workplace Exposure Limits EH40.

EU DIRECTIVES

Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC, including amendments.

INTERNATIONAL CHEMICAL INVENTORIES

Contact REACH@miswaco.com for REACH information. Complies with the following national/regional chemical inventory requirements: AICS, DSL / NDSL, IECSC, EINECS / ELINCS, METI ENCS, TCCL ECL, NZIoC, PICCS, TSCA

16 OTHER INFORMATION

GENERAL INFORMATION

HMIS Health - 2 HMIS Flammability - 1 HMIS Physical Hazard - 0 E - Safety glasses, Gloves, Dust Respirator

INFORMATION SOURCES

Product information provided by the commercial vendor(s). Material Safety Data Sheet, Misc. manufacturers. Micromedex. European Chemicals Bureau - ESIS (European Chemical Substances Information).

REVISION COMMENTS

General revision. Compiled or revised by Laura McDonald

DRILPLEX HDD

ISSUED BY

Bill Cameron

REVISION DATE	16-08-10
REV. NO./REPL. SDS GENERATED	3
SDS NO.	10842

RISK PHRASES IN FULL

R36	Irritating to eyes.
R37/38	Irritating to respiratory system and skin.
NC	Not classified.
R41	Risk of serious damage to eyes.

DISCLAIMER

MSDS furnished independent of product sale. While every effort has been made to accurately describe this product, some of the data are obtained from sources beyond our direct supervision. We cannot make any assertions as to its reliability or completeness; therefore, user may rely only at user's risk. We have made no effort to censor or conceal deleterious aspects of this product. Since we cannot anticipate or control the conditions under which this information and product may be used, we make no guarantee that the precautions we have suggested will be adequate for all individuals and/or situations. It is the obligation of each user of this product to comply with the requirements of all applicable laws regarding use and disposal of this product. Additional information will be furnished upon request to assist the user; however, no warranty, either expressed or implied, nor liability of any nature with respect to this product or to the data herein is made or incurred hereunder.

Safety Data Sheet

Magma Fiber

SDS Revision Date: 01/01/2017

1. Identification

1.1. Product identifier

Product Identity	MagmaFiber
Alternate Names	Mineral Wool

1.2. Relevant identified uses of the substance or mixture and application method

Intended use	**Lost Circulation**
Application Method	See Technical Data Sheet.

1.3. Details of the supplier of the safety data sheet

Company Name	NorthStar Fluid Solutions P.O. Box 271036 Louisville, Colorado 80027, USA
Emergency	
CHEMTREC (USA)	(800) 424-9300
24 hour Emergency Telephone No.	International +1-703-527-3887
Customer Service: NorthStar Fluid Solutions	(303) 495-3130

2. Hazard(s) identification

2.1. Classification of the substance or mixture

Not Classified

2.2. Label elements

Not Classified. Contains no hazardous substances.

[Prevention]: Not classified.
[Response]: Not classified.
[Storage]: Not classified.
[Disposal]: Not classified.

3. Composition/information on ingredients

Substances	CAS Number	PERCENT (w/w)	GHS Classification - US
Mineral Wool	65997-17-3	60 - 100%	Not classified

In accordance with paragraph (i) of §1910.1200, the specific chemical identity and/or exact percentage (concentration) of composition has been withheld as a trade secret.
[1] Substance classified with a health or environmental hazard.
[2] Substance with a workplace exposure limit.
[3] PBT-substance or vPvB-substance.
*The full texts of the phrases are shown in Section 16.

4. First aid measures

4.1. Description of first aid measures

Inhalation	If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.
Eyes	In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.
Skin	Wash with soap and water. Get medical attention if irritation persists.
Ingestion	Under normal conditions, first aid procedures are not required.

4.2. Most important symptoms and effects, both acute and delayed

No significant hazards expected. May cause mild eye, skin, and respiratory irritation.

5. Fire-fighting measures

5.1. Extinguishing media

All standard fire fighting media.

5.2. Special hazards arising from the substance or mixture

Special Exposure hazards

Not applicable.

5.3. Advice for fire-fighters

Full protective clothing and approved self contained breathing apparatus required for fire fighting personnel.

6. Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Use appropriate protective equipment. Avoid contact with skin, eyes and clothing. Avoid creating and breathing dust. Ensure adequate ventilation.
See section 8 for additional information.

6.2. Environmental precautions

Prevent from entering sewers, waterways, or low areas.

6.3. Methods and material for containment and cleaning up

Scoop up and remove.

7. Handling and storage

7.1. Precautions for safe handling

Avoid contact with eyes, skin, or clothing. Avoid creating or inhaling dust. Ensure adequate ventilation. Wash hands after use. Launder contaminated clothing before reuse. Use appropriate protective equipment.

Hygiene Measures

Handle in accordance with good industrial hygiene and safety practice.

7.2. Conditions for safe storage, including any incompatibilities

Store in dry location.

7.3. Specific end use(s)

Exposure Scenario No information available.
Other Guidelines No information available.

8. Exposure controls and personal protection

8.1. Control parameters

Exposure

Substances	CAS Number	OSHA PEL-TWA	ACGIH TLV-TWA
Contains no hazardous substances	NA	Not applicable	Not applicable

8.2. Exposure controls

Personal Protective Equipment If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

Respiratory Not normally needed. But if significant exposures are possible then the following respirator is recommended: Dust/mist respirator. (N95, P2/P3)

Eyes Wear safety glasses or goggles to protect against exposure.

Skin Normal work gloves and coveralls.

Engineering Controls Use in a well ventilated area.

Other Work Practices Not known.

See section 2 for further details. - [Prevention]:

9. Physical and chemical properties

Appearance Fibers. White to gray
Odor Odorless
Odor threshold No information available
pH No data available

Melting point / freezing point	No data available
Initial boiling point and boiling range	No data available
Flash Point	No data available
Evaporation rate (Ether = 1)	No data available
Flammability (solid, gas)	No data available
Upper/lower flammability or explosive limits	No data available
	No data available
Vapor pressure (Pa)	No data available
Vapor Density	No data available
Specific Gravity	2.6
Solubility in Water	Insoluble in water
Partition coefficient n-octanol/water (Log Kow)	No data available
Auto-ignition temperature	No data available
Decomposition temperature	No data available
Viscosity (cSt)	No data available
Density (lbs/gal)	No data available

9.2. Other information

VOC Content (%)	No data available
Bulk Density	12-26 lbs/ft3

10. Stability and reactivity

10.1. Reactivity

Not applicable

10.2. Chemical stability

Stable

10.3. Possibility of hazardous reactions

Will not occur

10.4. Conditions to avoid

None anticipated

10.5. Incompatible materials

Strong acids

10.6. Hazardous decomposition products

Carbon monoxide and carbon dioxide

11. Toxicological information

11.1 Information on toxicological effects

Acute oral toxicity:	No data available
Acute dermal toxicity:	No data available

Acute inhalation toxicity: No data available

Skin corrosion/irritation: May cause mechanical irritation to skin.

Serious eye damage/eye irritation: May cause mechanical irritation to eye.

Respiratory/skin sensitization: No data available to indicate product or components present at greater than 1% are chronic health hazards.

Mutagenicity: No data available to indicate product or components present at greater than 1% are chronic health hazards.

Carcinogenicity: No data available to indicate product or components present at greater than 1% are chronic health hazards.

Reproductive toxicity: No data available to indicate product or components present at greater than 1% are chronic health hazards.

STOT - single exposure: No known effects.

STOT - repeated exposure: No known effects.

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Contains no hazardous substances	NA	No data available	No data available	No data available

12. Ecological information

12.1. Toxicity

Ecotoxicity Effects

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Contains no hazardous substances	NA	No information available	No information available	No information available	No information available

12.2. Persistence and degradability

Substances	CAS Number	Persistence and Degradability
Contains no hazardous substances	NA	No information available

12.3. Bioaccumulative potential

Substances	CAS Number	Log Pow
Contains no hazardous substances	NA	No information available

12.4. Mobility in soil

No information available

12.5. Results of PBT and vPvB assessment

No information available

12.6. Other adverse effects

No information available

13. Disposal considerations

13.1. Waste treatment methods

Disposal Method

Bury in a licensed landfill according to federal, state, and local regulations.

Contaminated Packaging

Follow all applicable national or local regulations.

14. Transport information

	DOT (Domestic Surface Transportation)	IMO / IMDG (Ocean Transportation)	ICAO/IATA
14.1. UN number	Not restricted	Not restricted	Not restricted
14.2. UN proper shipping name	Not restricted	Not restricted	Not restricted
14.3. Transport hazard class(es)	**DOT Hazard Class:** Not applicable	**IMDG:** Not applicable **Sub Class:** Not applicable	**Air Class:** Not applicable
14.4. Packing group	Not applicable	Not applicable	Not applicable

14.5. Environmental hazards

IMDG Not applicable

14.6. Special precautions for user

None

15. Regulatory information

US TSCA Inventory	All components listed on inventory or are exempt.
EPA SARA Title III Extremely Hazardous Substances	Not applicable
EPA SARA (311,312) Hazard Class	None
EPA SARA (313) Chemicals	This product does not contain a toxic chemical for routine annual "Toxic Chemical Release Reporting" under Section 313 (40 CFR 372).
EPA CERCLA/Superfund Reportable Spill Quantity	Not applicable

EPA RCRA Hazardous Waste Classification	If product becomes a waste, it does NOT meet the criteria of a hazardous waste as defined by the US EPA.
California Proposition 65	All components listed do not apply to the California Proposition 65 Regulation.
MA Right-to-Know Law	Does not apply.
NJ Right-to-Know Law	Does not apply.
PA Right-to-Know Law	Does not apply.

Canadian Regulations

Canadian DSL Inventory	All components listed on inventory or are exempt.

16. Other information

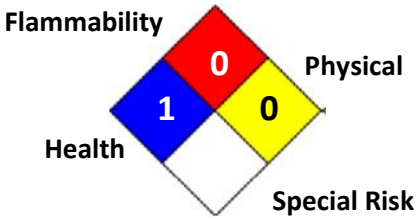
This is the first version in the GHS SDS format. Listings of changes from previous versions in other formats are not applicable.

The information and data herein are believed to be accurate and have been compiled from sources believed to be reliable. It is offered for your consideration, investigation and verification. Buyer assumes all risk of use, storage and handling of the product in compliance with applicable Federal, State and local law and regulations. NorthStar Fluid Solutions makes no warranty of any kind, express or implied, concerning the accuracy of completeness of the information and data herein. The implied warranties of merchantability and fitness for a particular purpose are specifically excluded. NorthStar Fluid Solutions will not be liable for claims relating to any use of this product.

Emergency Overview:

Risk Classification System:

HEALTH	**1**
FLAMMABILITY	**0**
PHYSICAL	**0**
PPE	**B**



End of Document

Safety Data Sheet
MAX GEL*

1. Identification of the substance/preparation and of the Company/undertaking

1.1 Product identifier

Product name MAX GEL*
Product code PID1046

1.2 Relevant identified uses of the substance or mixture and uses advised against

Recommended Use Viscosifier.

Uses advised against Consumer use

1.3 Details of the supplier of the safety data sheet

Supplier
M-I Drilling Fluids UK Limited
C/O Schlumberger
Enterprise Drive
Westhill Industrial Estate
Westhill, AB32 6TQ
Scotland UK
+47 51577424

MISDS@slb.com

1.4 Emergency Telephone Number

Emergency telephone - (24 Hour) Australia +61 2801 44558, Asia Pacific +65 3158 1074, China +86 10 5100 3039, Europe +44 (0) 1235 239 670, Middle East and Africa +44 (0) 1235 239 671, New Zealand +64 9929 1483, USA 001 281 561 1600

Norway	Poison information centre: +47 22 59 13 00

2. Hazards identification

2.1 Classification of the substance or mixture

Regulation (EC) No. 1272/2008

Health hazards Not classified

Environmental hazards Not classified

Physical Hazards Not classified

2.2 Label elements

Signal word
None

Hazard statements

This product is not classified as hazardous therefore no (H) hazard statements assigned.

Precautionary Statements - EU (§28, 1272/2008)
This product is not classified as hazardous therefore has no (P) precautionary statements assigned.

-

-

Contains
Crystalline silica (impurity)

Silica - crystalline, tridymite

2.3 Other data

Not classified as PBT/vPvB by current EU criteria

Australian statement of hazardous/dangerous nature
Classified as Non-Hazardous according to the criteria of NOHSC.
NON-HAZARDOUS SUBSTANCE. NON-DANGEROUS GOODS.

3. Composition/information on ingredients

3.1 Substances

Component	EC-No.	CAS-No	Weight % - range	Classification (67/548)	Classification (Reg. 1272/2008)	REACH registration number
Crystalline silica (impurity)	238-878-4	14808-60-7	1-5	Xn; R48/20	STOT Rep. 2 - H373	Exempt
Silica - crystalline, tridymite	239-487-1	15468-32-3	0-1	Xn; R48/20	STOT RE 2 (H373)	No data available

3.2 Mixtures

Not Applicable

Comments
Naturally occuring mineral.

The product contains other ingredients which do not contribute to the overall classification.

This product contains a small quantity of quartz, crystalline silica. Prolonged and repeated exposure to concentrations of crystalline silica exceeding the workplace exposure limit (WEL) may lead to chronic lung disease such as silicosis. IARC Monographs, Vol. 68, 1997, concludes that there is sufficient evidence that inhaled crystalline silica in the form of quartz or cristobalite from occupational sources causes cancer in humans. IARC Classification Group I.

4. First aid measures

4.1 First Aid

Inhalation If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Ingestion Rinse mouth. Do not induce vomiting without medical advice. Never give anything by mouth to an unconscious person. Get medical attention if symptoms occur.

Skin contact Wash skin thoroughly with soap and water. Get medical attention if irritation persists.

Eye contact Promptly wash eyes with lots of water while lifting eye lids. Remove contact lenses. Get medical attention if any discomfort continues.

4.2 Most important symptoms and effects, both acute and delayed

General advice The severity of the symptoms described will vary dependant of the concentration and the length of exposure. If adverse symptoms develop, the casualty should be transferred to hospital as soon as possible.

Main symptoms

Inhalation Please see Section 11. Toxicological Information for further information.

Ingestion Please see Section 11. Toxicological Information for further information.

Skin contact Please see Section 11. Toxicological Information for further information.

Eye contact Please see Section 11. Toxicological Information for further information.

4.3 Indication of any immediate medical attention and special treatment needed

Notes to physician Treat symptomatically.

5. Fire-fighting measures

5.1 Extinguishing media

Suitable extinguishing media
Use extinguishing media appropriate for surrounding material.

Extinguishing media which shall not be used for safety reasons
None known.

5.2 Special hazards arising from the substance or mixture

Unusual fire and explosion hazards
None known.

Hazardous combustion products
Thermal decomposition can lead to release of irritating gases and vapours

5.3 Advice for firefighters

Special protective equipment for fire-fighters

As in any fire, wear self-contained breathing apparatus and full protective gear.

Special Fire-Fighting Procedures
Containers close to fire should be removed immediately or cooled with water.

6. Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

Use personal protective equipment. See also section 8.

6.2 Environmental precautions

Disposal should be in accordance with applicable regional, national and local laws and regulations. Large spills released to the environment may disturb the natural chemical balance of soil/fresh water.

Environmental exposure controls
Avoid release to the environment. Local authorities should be advised if significant spillages cannot be contained.

6.3 Methods and materials for containment and cleaning up

Methods for containment
Prevent further leakage or spillage if safe to do so. Cover powder spill with plastic sheet or tarp to minimise spreading.

Methods for cleaning up
Sweep up and shovel into suitable containers for disposal. After cleaning, flush away traces with water.

6.4 Reference to other sections

See section 13 for more information.

7. Handling and storage

7.1 Precautions for safe handling

Handling
Handle in accordance with good industrial hygiene and safety practice. Avoid contact with skin and eyes. Avoid dust formation.

Hygiene measures
Use good work and personal hygiene practices to avoid exposure When using do not smoke, eat or drink. Wash hands and face before breaks and immediately after handling the product Remove contaminated clothing

7.2 Conditions for safe storage, including any incompatibilities

Technical measures/precautions	Ensure adequate ventilation. Keep airborne concentrations below exposure limits.
Storage precautions	Keep containers tightly closed in a dry, cool and well-ventilated place Protect from moisture
Storage class	Chemical storage.
Packaging material	Use specially constructed containers only

7.3 Specific end uses

See Section 1.2.

8. Exposure controls/personal protection

8.1 Control parameters

Exposure Limits No biological limit allocated

Component	EU OEL - Third List	Austria	Australia	Denmark
Crystalline silica (impurity)	Not determined	0.15 mg/m³ TWA alveolar dust, respirable fraction	0.1mg/m³TWArespirable dust	0.1mg/m³
Silica - crystalline, tridymite	Not determined	0.15 mg/m³ TWA alveolar dust, respirable fraction	0.1mg/m³TWArespirable dust	0.15 mg/m³ TWA 0.05 mg/m³ TWA K
Component	**Malaysia**	**France**	**Germany**	**Hungary**
Crystalline silica (impurity)	0.1 mg/m³ TWA	0.1 mg/m³TWA	Not determined	0.15mg/m³TWA
Silica - crystalline, tridymite	0.05 mg/m³ TWA	0.05 mg/m³TWA	Not determined	0.15mg/m³TWA
Component	**New Zealand**	**Italy**	**Netherlands**	**Norway**
Crystalline silica (impurity)	0.2 mg/m³ TWA Known or presumed human carcinogen	Not determined	0.075 mg/m³	0.3 mg/m³ TWA total dust 0.1 mg/m³ TWA respirable dust 0.3 mg/m³ STEL total dust 0.1 mg/m³ STEL respirable dust Carcinogen
Silica - crystalline, tridymite	0.1 mg/m³ TWA Known or presumed human carcinogen	Not determined	0.075 mg/m³	0.15 mg/m³ TWA total dust 0.05 mg/m³ TWA respirable dust 0.45 mg/m³ STEL total dust 0.15 mg/m³ STEL respirable dust Carcinogen
Component	**Poland**	**Portugal**	**Romania**	**Russia**
Crystalline silica (impurity)	2 mg/m³ TWA NDS >50% free crystalline silica 0.3 mg/m³ TWA NDS >50% free crystalline silica 4.0 mg/m³ TWA NDS 2% to 50% free crystalline silica 1.0 mg/m³ TWA NDS 2% to 50% free crystalline silica	0.025 mg/m³ TWA respirable fraction	0.1mg/m³TWArespirable fraction, dust	3 mg/m³ STEL 1123 disintegration aerosol, total mass of aerosols 3 mg/m³ STEL 1124 total mass of aerosols 1 mg/m³ TWA 1123 1 mg/m³ TWA 1124 Fibrogenic substance glass;regulated under Quartz 1123, 1124
Silica - crystalline, tridymite	2 mg/m³ TWA NDS >50% free crystalline silica 0.3 mg/m³ TWA NDS >50% free crystalline silica 4.0 mg/m³ TWA NDS 2% to 50% free crystalline silica 1.0 mg/m³ TWA NDS 2% to 50% free crystalline silica	Not determined	0.05mg/m³TWArespirable fraction, dust	3 mg/m³ STEL 1124 total mass of aerosols 1 mg/m³ TWA 1124 Fibrogenic substance 1124
Component	**Spain**	**Switzerland**	**Turkey**	**UK**

Crystalline silica (impurity)	0.05 mg/m³ TWA VLA-ED	0.15 mg/m³ TWA MAK	Not determined	Not determined
Silica - crystalline, tridymite	Not determined	0.15 mg/m³ TWA MAK	Not determined	Not determined

8.2 Exposure controls

All chemical Personal Protective Equipment (PPE) should be selected based on an assessment of both the chemical hazard present and the risk of exposure to those hazards. The PPE recommendations below are based on an assessment of the chemical hazards associated with this product. Where this product is used in a mixture with other products or fluids, additional hazards may be created and as such further assessment of risk may be required. The risk of exposure and need of respiratory protection will vary from workplace to workplace and should be assessed by the user in each situation.

Engineering measures to reduce exposure
Ensure adequate ventilation. Mechanical ventilation or local exhaust ventilation is required.

Personal protective equipment

Eye protection	Safety glasses with side-shields. Tightly fitting safety goggles.
Hand protection	Repeated or prolonged contact:, Use protective gloves made of:, Neoprene, Nitrile, Frequent change is advisable.
Respiratory protection	No personal respiratory protective equipment normally required, In case of insufficient ventilation wear suitable respiratory equipment, Suitable mask with particle filter P3 (European Norm 143), At work in confined or poorly ventilated spaces, respiratory protection with air supply must be used.
Skin and body protection	Wear suitable protective clothing, Eye wash and emergency shower must be available at the work place.

Hygiene measures Wash hands before eating, drinking or smoking, Remove and wash contaminated clothing before re-use.



9. Physical and chemical properties

9.1 Information on basic physical and chemical properties

Physical state	Solid
Appearance	Powder
Odour	Odourless
Colour	Tan - Grey
Odour threshold	Not applicable

Property	Values	Remarks
pH	No information available	
pH @ dilution		
Melting/freezing point	No information available	
Boiling point/range	No information available	
Flash point	No information available	
Evaporation rate	No information available	

Flammability (solid, gas)	Not Applicable	
Flammability Limits in Air		Not applicable
Upper flammability limit	Not applicable	
Lower flammability limit	Not applicable	
Vapour pressure	No information available	
Vapour density	No information available	
Specific gravity	No information available	
Bulk density	No information available	
Relative density	2.3 - 2.5 sg	@ 20 °C.
Water solubility	Insoluble in water	
Solubility in other solvents	No information available	
Autoignition temperature	No information available	
Decomposition temperature	No information available	
Kinematic viscosity	No information available	
Dynamic viscosity	No information available	
Log Pow	No information available	

Explosive properties	Not Applicable
Oxidising properties	None known

9.2 Other information

Pour point	No information available
Molecular weight	No information available
VOC content(%)	None
Density	No information available

10. Stability and reactivity

10.1 Reactivity

No specific reactivity hazards associated with this product.

10.2 Chemical stability

Stable under normal temperature conditions and recommended use.

10.3 Possibility of Hazardous Reactions

Hazardous polymerisation
Hazardous polymerisation does not occur.

10.4 Conditions to avoid

Avoid dust formation. Protect from moisture.

10.5 Incompatible materials

No materials to be especially mentioned.

10.6 Hazardous decomposition products

See Section 5.

11. Toxicological information

11.1 Information on toxicological effects

Acute toxicity

Product information This product contains a small quantity of quartz, crystalline silica. Prolonged and repeated exposure to concentrations of crystalline silica exceeding the workplace exposure limit (WEL) may lead to chronic lung disease such as silicosis.

Inhalation Inhalation of dust in high concentration may cause irritation of respiratory system.

Eye contact Dust may cause mechanical irritation.

Skin contact Prolonged contact may cause redness and irritation.

Ingestion Ingestion may cause stomach discomfort.

Unknown acute toxicity Not Applicable.

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Crystalline silica (impurity)	= 500 mg/kg (Rat)	No data available	No data available
Silica - crystalline, tridymite	No data available	No data available	No data available

Sensitisation This product does not contain any components suspected to be sensitizing.

Mutagenic effects This product does not contain any known or suspected mutagens.

Carcinogenicity Crystalline silica dust is listed by IARC in Group 1 as known to cause lung cancer in humans, if inhaled.

Reproductive toxicity This product does not contain any known or suspected reproductive hazards.

Routes of exposure Inhalation.

Routes of entry Inhalation.

Specific target organ toxicity (single exposure) Not classified

Specific target organ toxicity (repeated exposure) Not classified.

Aspiration hazard Not Applicable.

12. Ecological information

12.1 Toxicity

The product component(s) are not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment. Listed on PLONOR list of OSPAR

Toxicity to algae
This product is not considered toxic to algae.

Toxicity to fish
This product is not considered toxic to fish.

Toxicity to daphnia and other aquatic invertebrates
This product is not considered toxic to invertebrates.

Component	Toxicity to fish	Toxicity to algae	Toxicity to daphnia and other aquatic invertebrates
Crystalline silica (impurity)	No information available	No information available	No information available
Silica - crystalline, tridymite	No information available	No information available	No information available

12.2 Persistence and degradability

Not Applicable - Inorganic chemical.

12.3 Bioaccumulative potential

Not Applicable - Inorganic chemical.

12.4 Mobility in soil

Mobility
Insoluble in water.

12.5 Results of PBT and vPvB assessment

Not classified as PBT/vPvB by current EU criteria.

12.6 Other adverse effects.

None known.

13. Disposal considerations

13.1 Waste treatment methods

Waste from residues / unused products	Dispose of in accordance with local regulations.
Contaminated packaging	Empty containers should be transported/delivered using a registered waste carrier for local recycling or waste disposal.
EWC waste disposal No.	According to the European Waste Catalogue, Waste Codes are not product specific, but application specific. Waste codes should be assigned by the user based on the application for which the product was used The following Waste Codes are only suggestions: EWC waste disposal No: 01 05 99 - wastes not otherwise specified

14. Transport information

14.1 UN number
Not regulated

14.2 Proper shipping name
The product is not covered by international regulation on the transport of dangerous goods

14.3. Hazard class(es)

ADR/RID/ADN/ADG Hazard class	Not regulated
IMDG Hazard class	Not regulated
ICAO Hazard class/division	Not regulated

14.4 Packing group

ADR/RID/ADN/ADG Packing Group	Not regulated
IMDG Packing group	Not regulated
ICAO Packing group	Not regulated

14.5 Environmental hazard
No

14.6 Special precautions
Not Applicable

14.7 Transport in bulk according to Annex I/II of MARPOL 73/78 and the IBC Code
Please contact MISDS@slb.com for info regarding transport in Bulk.

15. Regulatory information

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

Germany, Water Endangering Classes (VwVwS)	Water endangering class = 1

Australian Standard for the Uniform Scheduling of Drugs and Poisons
No Poisons Schedule number allocated

New Zealand hazard classification Not classified.

HSNO approval no. Not required.

Group number Not required.

Commission Regulation (EU) No 453/2010 of 20 May 2010 amending Regulation (EC) No 1907/2006 of the European Parliament and of the Council on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH). Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC, including amendments.

This safety data sheet complies with the requirements of Regulation (EC) No. 1272/2008.

National Code of Practice for the Preparation of Material Safety Data Sheets 2nd Edition [NOHSC: 2011 (2003)].

National Occupational Health and Safety Commission's Approved Criteria for Classifying Hazardous Substances [NOHSC:1008 (2004) 3rd Edition].

National Occupational Health and Safety Commission's Exposure Standards for Atmospheric Contaminants in the occupational Environment [NOHSC:1003 (1995)].

Safe Work Australia.

Standard for the Uniform Scheduling of Drugs and Poisons (SUSDP).

Not classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for transport by road or rail.

International inventories

USA, Toxic Substances Control Act inventory (TSCA)	Complies
European Union - EINECS and ELINCS	Complies
Canada (DSL)	Complies.
Philippines (PICCS)	Complies
Inventory - Japan - Existing and New Chemicals list	Complies
China (IECSC)	Complies
Australia (AICS)	Complies
Korea (KECL)	Complies
Inventory - New Zealand - Inventory of Chemicals (NZIoC)	Complies

Contact REACH@miswaco.slb.com for REACH information.

15.2 Chemical Safety Report

No information available

16. Other information

Prepared by	Global Regulatory Compliance - Chemicals (GRC - Chemicals) , Anne Karin (Anka) Fosse
Supercedes date	14/Feb/2016
Revision date	28/Oct/2016
Version	4
The following sections have been revised:	3,, 5,, 6,, 7,, 9,, 10,, 11,, 16, No changes with regard to classification have been made.

Text of R phrases mentioned in Section 3
R48/20 - Harmful: danger of serious damage to health by prolonged exposure through inhalation

Full text of H-Statements referred to under sections 2 and 3

This product is not classified as hazardous therefore no (H) hazard statements assigned.

H373 - May cause damage to organs through prolonged or repeated exposure if inhaled

*A mark of M-I L.L.C., a Schlumberger Company

Disclaimer
The information contained herein is considered in good faith as reliable of the date issued and is based upon on measurements, tests or data derived from supplier's own study or furnished by others. In providing this SDS information, Supplier makes no express or implied warranties as to the information or product; merchantability or fitness of purpose; any express or implied warranty; or non-infringement of intellectual property rights; and supplier assumes no responsibility for any direct, special or consequential damages, results obtained, or the activities of others. To the maximum extent permitted by law, supplier's warranty obligations and buyer's sole remedies are as stated in separate agreement between the parties.

SAFETY DATA SHEET
PLATINUM PAC* (ALL GRADES)

SECTION 1: IDENTIFICATION OF THE SUBSTANCE/MIXTURE AND OF THE COMPANY/UNDERTAKING

1.1. Product identifier

Product name PLATINUM PAC* (ALL GRADES)

Synonyms, Trade Names PLATINUM PAC*, PLATINUM PAC UL*

1.2. Relevant identified uses of the substance or mixture and uses advised against

Identified uses Oil well drilling fluid additive.

1.3. Details of the supplier of the safety data sheet

Supplier

M-I SWACO
A Schlumberger Company
Woodlands Drive,
Kirkhill Industrial Estate,
Dyce, Aberdeen AB21 0GW.
Scotland UK
T = +44 (0)1224-246600
F = +44 (0)1224-246699
E-mail = MBXMSDS-EH@miswaco.slb.com

1.4. Emergency telephone number

(24 Hour) Australia +61 2801 44558, Asia Pacific +65 3158 1074, China +86 10 5100 3039, Europe +44 (0) 1235 239 670, Middle East and Africa +44 (0) 1235 239 671, New Zealand +64 9929 1483, USA 001 281 561 1600.

SECTION 2: HAZARDS IDENTIFICATION

2.1. Classification of the substance or mixture

Classification (1999/45/EEC) Not classified.

2.2. Label elements

Risk Phrases

NC Not classified.

Safety Phrases

NC Not classified.

2.3. Other hazards

Not Classified as PBT/vPvB by current EU criteria.

SECTION 3: COMPOSITION/INFORMATION ON INGREDIENTS

3.2. Mixtures

POLYANIONIC CELLULOSE	60-100%
Classification (EC 1272/2008) Not classified.	Classification (67/548/EEC) Not classified.

The Full Text for all R-Phrases and Hazard Statements are Displayed in Section 16.

Composition Comments

The data shown is in accordance with the latest EC Directives.

SECTION 4: FIRST AID MEASURES

4.1. Description of first aid measures

Inhalation

Move the exposed person to fresh air at once. If respiratory problems, artificial respiration/oxygen. Get medical attention if any discomfort continues.

Ingestion

Do not induce vomiting. Immediately give a couple of glasses of water or milk, provided the victim is fully conscious. Get medical attention if any discomfort continues.

Skin contact

Remove contaminated clothing immediately and wash skin with soap and water. Get medical attention promptly if symptoms occur after washing.

Eye contact

Make sure to remove any contact lenses from the eyes before rinsing. Promptly wash eyes with plenty of water while lifting the eye lids. Continue to rinse for at least 15 minutes. Get medical attention if any discomfort continues.

4.2. Most important symptoms and effects, both acute and delayed

Inhalation.

Irritation of nose, throat and airway.

Ingestion

May cause discomfort if swallowed.

Skin contact

Prolonged skin contact may cause redness and irritation.

Eye contact

May cause temporary eye irritation.

4.3. Indication of any immediate medical attention and special treatment needed

Get medical attention if any discomfort continues.

SECTION 5: FIREFIGHTING MEASURES

5.1. Extinguishing media

Extinguishing media

Use fire-extinguishing media appropriate for surrounding materials.

5.2. Special hazards arising from the substance or mixture

Hazardous combustion products

When heated, vapours/gases hazardous to health may be formed.

Unusual Fire & Explosion Hazards

High concentrations of dust may form explosive mixture with air.

5.3. Advice for firefighters

Special Fire Fighting Procedures

Containers close to fire should be removed immediately or cooled with water.

Protective equipment for fire-fighters

Self contained breathing apparatus and full protective clothing must be worn in case of fire.

SECTION 6: ACCIDENTAL RELEASE MEASURES

6.1. Personal precautions, protective equipment and emergency procedures

Wear protective clothing as described in Section 8 of this safety data sheet.

6.2. Environmental precautions

Do not allow to enter drains, sewers or watercourses.

6.3. Methods and material for containment and cleaning up

Avoid generation and spreading of dust. Remove spillage with vacuum cleaner. If not possible, collect spillage with shovel, broom or the like. Ensure that waste and contaminated materials are collected and removed from the work area as soon as possible in a suitably labelled container. Product becomes slippery when wet.

6.4. Reference to other sections

Wear protective clothing as described in Section 8 of this safety data sheet.

SECTION 7: HANDLING AND STORAGE

7.1. Precautions for safe handling

Avoid inhalation of dust and contact with skin and eyes. Avoid handling which leads to dust formation.

7.2. Conditions for safe storage, including any incompatibilities

Store in tightly closed original container in a dry, cool and well-ventilated place.

7.3. Specific end use(s)

The identified uses for this product are detailed in Section 1.2.

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1. Control parameters

Ingredient Comments

NUI = Nuisance dust, WEL TWA 4mg/m3 Respirable Dust, 10 mg/m3 Total Dust.

8.2. Exposure controls

Protective equipment



Process conditions

All chemical Personal Protective Equipment (PPE) should be selected based on an assessment of both the chemical hazard present and the risk of exposure to those hazards. The PPE recommendations below are based on an assessment of the chemical hazards associated with this product. Where this product is used in a mixture with other products or fluids, additional hazards may be created and as such further assessment of risk may be required. The risk of exposure and need of respiratory protection will vary from workplace to workplace and should be assessed by the user in each situation.

Engineering measures

Provide adequate general and local exhaust ventilation.

Respiratory equipment

In case of inadequate ventilation or risk of inhalation of dust, use suitable respiratory equipment with particle filter (type P2).

Hand protection

For prolonged or repeated skin contact use suitable protective gloves. Use protective gloves made of: Nitrile. or Neoprene.

Eye protection

Wear approved chemical safety goggles where eye exposure is reasonably probable.

Other Protection

Wear appropriate clothing to prevent any possibility of skin contact. Provide eyewash station.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

9.1. Information on basic physical and chemical properties

Appearance	Solid
Colour	White to yellow
Odour	Odourless.
Solubility	Soluble in water.
Relative density	0.3-0.5 sg
Bulk Density	300-900 kg/m3
pH-Value, Diluted Solution	6.0-8.5 @ 1%

9.2. Other information

Not relevant

SECTION 10: STABILITY AND REACTIVITY

10.1. Reactivity

There are no known reactivity hazards associated with this product.

10.2. Chemical stability

Stable under normal temperature conditions and recommended use.

10.3. Possibility of hazardous reactions

Not known.

10.4. Conditions to avoid

Avoid heat, flames and other sources of ignition. Avoid contact with water.

10.5. Incompatible materials

Materials To Avoid

Avoid contact with: Strong oxidising substances.

10.6. Hazardous decomposition products

When heated, vapours/gases hazardous to health may be formed.

SECTION 11: TOXICOLOGICAL INFORMATION

11.1. Information on toxicological effects

Aspiration hazard:

Not anticipated to present an aspiration hazard based on chemical structure.

Inhalation

Dust may irritate respiratory system or lungs.

Ingestion

May cause discomfort if swallowed.

Skin contact

Prolonged and frequent contact may cause redness and irritation.

Eye contact

Particles in the eyes may cause irritation and smarting.

Route of entry

No route of entry noted.

Target Organs

No specific target organs noted

SECTION 12: ECOLOGICAL INFORMATION

Ecotoxicity

Contact M-I SWACO's QHSE Department for ecological information at env@miswaco.slb.com.

12.1. Toxicity

Acute Fish Toxicity

Not considered toxic to fish.

12.2. Persistence and degradability

Degradability

There are no data on the degradability of this product.

12.3. Bioaccumulative potential

Bioaccumulative potential

No data available on bioaccumulation.

12.4. Mobility in soil

Mobility:

The product is soluble in water.

12.5. Results of PBT and vPvB assessment

Not Classified as PBT/vPvB by current EU criteria.

12.6. Other adverse effects

None known.

SECTION 13: DISPOSAL CONSIDERATIONS

13.1. Waste treatment methods

Recover and reclaim or recycle, if practical. Dispose of waste and residues in accordance with local authority requirements.

SECTION 14: TRANSPORT INFORMATION

General The product is not covered by international regulation on the transport of dangerous goods (IMDG, IATA, ADR/RID).

14.1. UN number

Not applicable.

14.2. UN proper shipping name

Not applicable.

14.3. Transport hazard class(es)

Not applicable.

14.4. Packing group

Not applicable.

14.5. Environmental hazards

Environmentally Hazardous Substance/Marine Pollutant

No.

14.6. Special precautions for user

Not applicable.

14.7. Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code

Not applicable.

SECTION 15: REGULATORY INFORMATION

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

Uk Regulatory References

Chemicals (Hazard Information & Packaging) Regulations. Control of Substances Hazardous to Health Regulations 2002 (as amended) Workplace Exposure Limits EH40.

EU Legislation

Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC, including amendments.

Water hazard classification

WGK 1

15.2. Chemical Safety Assessment

International Chemical Inventories

Contact REACH@miswaco.slb.com for REACH information. Complies with the following national/regional chemical inventory requirements: Australia (AICS), Canada (DSL / NDSL), China (IECSC), Europe (EINECS / ELINCS), Japan (METI / ENCS), Korea (TCCL / ECL), New Zealand (NZIoC), Phillipines (PICCS), United States (TSCA).

SECTION 16: OTHER INFORMATION

Abbreviations and acronyms used in the safety data sheet

*a mark of M-I L.L.C.

General information

HMIS Health -1 HMIS Flammability - 1 HMIS Physical Hazard - 0 E - Safety glasses, Gloves, Dust Respirator

Information Sources

Product information provided by the commercial vendor(s). Material Safety Data Sheet, Misc. manufacturers. LOLI. European Chemicals Bureau - ESIS (European Chemical Substances Information).

Revision Comments

General revision. Compiled or revised by Sarah Malone

PLATINUM PAC* (ALL GRADES)

Issued By	Bill Cameron
Revision Date	15-Jun-12
Revision	1
Supersedes date	13-May-12
SDS No.	12588

Risk Phrases In Full

NC Not classified.

Disclaimer

MSDS furnished independent of product sale. While every effort has been made to accurately describe this product, some of the data are obtained from sources beyond our direct supervision. We cannot make any assertions as to its reliability or completeness; therefore, user may rely only at user's risk. We have made no effort to censor or conceal deleterious aspects of this product. Since we cannot anticipate or control the conditions under which this information and product may be used, we make no guarantee that the precautions we have suggested will be adequate for all individuals and/or situations is the obligation of each user of this product to comply with the requirements of all applicable laws regarding use and disposal of this product. Additional information will be furnished upon request to assist the user; however, no warranty, either expressed or implied, nor liability of any nature with respect to tl product or to the data herein is made or incurred hereunder.

SDS no. PID1231
Version 4
Revision date 14/Dec/2018
Supersedes date 11/Apr/2017

Safety Data Sheet
POLY-PLUS*

1. Identification of the Substance/Preparation and of the Company/Undertaking

1.1 Product identifier

Product name POLY-PLUS*

Product code PID1231

1.2 Relevant identified uses of the substance or mixture and uses advised against

Recommended Use Shale control agent.

Uses advised against Consumer use

1.3 Details of the supplier of the safety data sheet

Supplier
M-I L.L.C.
P.O.Box 42842
Houston, TX 77242
www.miswaco.slb.com
Telephone: 1 281-561-1511

M-I SWACO, A Schlumberger Company
200 - 125, 9th Avenue SE
Calgary, Alberta T2G 0P6, Canada
Telephone: 1-780-962-8221

E-mail address SDS@slb.com

Prepared by
Global Regulatory Compliance - Chemicals (GRC - Chemicals)

1.4 Emergency Telephone Number

Emergency telephone (24 Hour) Asia Pacific +65 3158 1074, Europe +44 (0) 1235 239 670, Middle East and Africa +44 (0) 1235 239 671, USA +1 281 561 1600, Canada +1 800 579 7421, Argentina: +54 11 5984 3690, Brazil : 0800-720-8000/0800-777-2323 (WGRA)

2. Hazards Identification

2.1 Classification of the substance or mixture

GHS - Classification

Health hazards Not classified

Environmental hazards Not classified

Physical Hazards Not classified

2.2 Label elements

Signal word
None

Hazard Statements
This product is not classified as hazardous therefore no (H) hazard statements assigned.

Precautionary Statements
This product is not classified as hazardous therefore has no (P) precautionary statements assigned.

Unknown acute toxicity 36% of the mixture consists of ingredient(s) of unknown toxicity.

3. Composition/information on Ingredients

3.1 Substances

Not applicable

3.2 Mixtures

Chemical Name	CAS No	Weight-%
Distillates, petroleum, hydrotreated light	64742-47-8	10-30
Alcohols, C11-14-iso, C13-rich, ethoxylated	78330-21-9	1-5

Comments
The product contains other ingredients which do not contribute to the overall classification. The exact percentage (concentration) of composition has been withheld as a trade secret

4. First Aid Measures

4.1 First aid measures

Inhalation If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Ingestion Rinse mouth. Do not induce vomiting without medical advice. Never give anything by mouth to an unconscious person. Seek medical attention if irritation occurs.

Skin contact Wash off immediately with soap and plenty of water while removing all contaminated clothes and shoes. Get medical attention immediately if symptoms occur.

Eye Contact Remove contact lenses, if worn. Promptly wash eyes with lots of water while lifting eye lids. Continue to rinse for at least 15 minutes. Get medical attention if any discomfort continues.

4.2. Most important symptoms and effects, both acute and delayed

General advice The severity of the symptoms described will vary dependant of the concentration and the length of exposure. If adverse symptoms develop, the casualty should be transferred to hospital as soon as possible.

Symptoms

Inhalation	Please see Section 11. Toxicological Information for further information.
Ingestion	Please see Section 11. Toxicological Information for further information.
Skin contact	Please see Section 11. Toxicological Information for further information.
Eye contact	Please see Section 11. Toxicological Information for further information.

4.3 Indication of any immediate medical attention and special treatment needed

Notes to physician Treat symptomatically

5. Fire-Fighting Measures

5.1 Extinguishing media

Suitable extinguishing media
Use extinguishing media appropriate for surrounding material.

Extinguishing media which must not be used for safety reasons
None known.

5.2. Special hazards arising from the substance or mixture

Unusual fire and explosion hazards
None known.

Hazardous combustion products
Carbon oxides (COx), Nitrogen oxides (NOx).

5.3 Advice for firefighters

Special protective equipment for fire-fighters
As in any fire, wear self-contained breathing apparatus and full protective gear.

Special Fire-Fighting Procedures
Containers close to fire should be removed immediately or cooled with water.

6. Accidental Release Measures

6.1. Personal precautions, protective equipment and emergency procedures

Use personal protective equipment. See also section 8.

6.2 Environmental precautions

Disposal should be in accordance with applicable regional, national and local laws and regulations. Refer to applicable federal, state and local regulations.

Environmental exposure controls
Local authorities should be advised if significant spillages cannot be contained.

6.3 Methods and material for containment and cleaning up

Methods for containment
Prevent further leakage or spillage if safe to do so. Dike far ahead of liquid spill for later disposal.

Methods for cleaning up
Absorb with earth, sand or other non-combustible material and transfer to containers for later disposal. After cleaning, flush away traces with water.

6.4 Reference to other sections

See section 13 for more information.

7. Handling and Storage

7.1 Precautions for safe handling

Handling
Handle in accordance with good industrial hygiene and safety practice. Avoid contact with skin and eyes. Do not breathe vapors or spray mist. Avoid spills and splashing during use.

7.2 Conditions for safe storage, including any incompatibilities

Technical measures/precautions Ensure adequate ventilation. Keep airborne concentrations below exposure limits.

Storage precautions Keep containers tightly closed in a dry, cool and well-ventilated place.

Packaging materials Use specially constructed containers only.

8. Exposure Controls/Personal Protection

8.1 Control parameters

Component Information

Chemical Name	ACGIH TLV	OSHA PEL	Argentina - Occupational Exposure Limits - TWAs (CMPs)	Brazil - Occupational Exposure Limits - TWAs (LTs)	Mexico - Occupational Exposure Limits - TWAs (LMPE-PPTs)
Distillates, petroleum, hydrotreated light	Not determined	Not determined	Not determined	Not determined	Not determined
Alcohols, C11-14-iso, C13-rich, ethoxylated	Not determined	Not determined	Not determined	Not determined	Not determined

IDLH (Immediately Dangerous to Life or Health)
Immediately Dangerous to Life or Health (IDLH) is established by the US National Institute for Occupational Safety and Health (NIOSH). The purpose of establishing an IDLH value is to ensure that the worker can escape from a given contaminated environment in the event of failure of the most protective respiratory protection equipment. In the event of failure of respiratory protection equipment every effort should be made to exit immediately.

Chemical Name	IDLH (Immediately Dangerous to Life or Health)
Distillates, petroleum, hydrotreated light 64742-47-8	-
Alcohols, C11-14-iso, C13-rich, ethoxylated 78330-21-9	-

8.2 Exposure controls

A risk assessment is recommended to be performed by a qualified and trained personnel to analyze the worksite and recommends the appropriate controls such as engineering controls, work practice controls, and administrative controls as primary means of reducing employee exposure. When there is a remaining hazards after applying the primary controls, Personal Protective Equipment (PPE) must be used.

All chemical Personal Protective Equipment (PPE) should be selected based on an assessment of both the chemical hazard

present and the risk of exposure to those hazards. The PPE recommendations below are based on an assessment of the chemical hazards associated with this product. Where this product is used in a mixture with other products or fluids, additional hazards may be created and as such further assessment of risk may be required. The risk of exposure and need of respiratory protection will vary from workplace to workplace and should be assessed by the user in each situation.

Engineering Controls
Ensure adequate ventilation.

Personal protective equipment

Eye protection	It is good practice to wear goggles when handling any chemical. Tightly fitting safety goggles.
Hand protection	Use protective gloves made of: Nitrile Neoprene PVC Be aware that liquid may penetrate the gloves. Frequent change is advisable.
Respiratory Protection	All respiratory protection equipment should be used within a comprehensive respiratory protection program that meets the requirements of 29 CFR 1910.134 (U.S. OSHA Respiratory Protection Standard) or local equivalent.If exposed to airborne mist/aerosol of this product, use an organic vapor cartridge with a P-95 pre-filter attached. In work environments containing oil mist/aerosol, use an organic vapor cartridge with a P-95 pre-filter attached.If exposed to vapors from this product, use a NIOSH/MSHA-approved respirator with an organic vapor cartridge.
Skin and body protection	Wear suitable protective clothing, Provide eyewash station.
Hygiene Measures	Wash hands before eating, drinking or smoking, Remove and wash contaminated clothing before re-use.

9. Physical and Chemical Properties

9.1 Information on basic physical and chemical properties

Physical state	Liquid
Appearance	Cloudy
Color	White
Odor	Faint hydrocarbon
Odor threshold	Not applicable

Property	**Values**	**Remarks**
pH	6 - 8	
pH @ dilution		
Melting / freezing point	No information available	
Boiling point/range	100 °C / 212 °F	
Flash point	> 93 °C / 200 °F	PMCC
Evaporation rate (BuAc =1)	No information available	
Flammability (solid, gas)	Not applicable	
Flammability Limit in Air		
Upper flammability limit	No information available	
Lower flammability limit	No information available	
Vapor pressure	No information available	
Vapor density	No information available	
Specific gravity	1.07 - 1.10	
Bulk density	No information available	
Water solubility	slightly soluble	
Solubility in other solvents	No information available	
Autoignition temperature	No information available	
Decomposition temperature	No information available	
Kinematic viscosity	> 20.5 mm2/s @ 40 °C	
Dynamic viscosity	No information available	
log Pow	Not determined	

Explosive properties	Not applicable
Oxidizing properties	None known.

9.2 Other information

Pour point	-29°C / -20°F
Molecular weight	No information available
VOC content(%)	None
Density	No information available

Comments
The data listed above are typical physical and chemical properties and should not be construed as product specification.

10. Stability and Reactivity

10.1 Reactivity

No specific reactivity hazards associated with this product.

10.2 Chemical stability

Stable under normal temperature conditions and recommended use.

10.3 Possibility of Hazardous Reactions

Hazardous polymerization
Hazardous polymerization does not occur.

10.4 Conditions to avoid

None known.

10.5 Incompatible materials

Strong oxidizing agents.

10.6 Hazardous decomposition products

Carbon oxides (COx). Nitrogen oxides (NOx).

11. Toxicological Information

11.1 Information on toxicological effects

Acute toxicity

Inhalation	May cause irritation of respiratory tract.
Eye contact	Irritating to eyes.
Skin contact	Prolonged skin contact may defat the skin and produce dermatitis.
Ingestion	Ingestion may cause gastrointestinal irritation, nausea, vomiting and diarrhea.

Toxicology data for the components

Chemical Name	LD50 Oral	LD50 Dermal	LC50 Inhalation
Distillates, petroleum, hydrotreated light	> 5000 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	> 5.2 mg/L (Rat) 4 h
Alcohols, C11-14-iso, C13-rich, ethoxylated	No data available	No data available	No data available

Chemical Name	IARC Group 1 or 2	ACGIH - Carcinogens	OSHA listed carcinogens	NTP
Distillates, petroleum, hydrotreated light	No data available	No data available	No data available	No data available
Alcohols, C11-14-iso, C13-rich, ethoxylated	No data available	No data available	No data available	No data available

Sensitization	This product does not contain any components suspected to be sensitizing.
Mutagenic effects	This substance has no evidence of mutagenic properties.
Carcinogenicity	This substance has no evidence of carcinogenic properties.
Reproductive toxicity	None known.
Developmental toxicity	Not known to cause birth defects or have a deleterious effect on a developing fetus.
Routes of exposure	Skin contact. Eye contact.
Routes of entry	No route of entry noted.
Specific target organ toxicity - Single exposure	Not classified
Specific target organ toxicity - Repeated exposure	Not classified.
Aspiration hazard	No hazard from product as supplied.

12. Ecological Information

12.1 Toxicity

Toxicity to algae
See component information below.

Toxicity to fish
See component information below.

Toxicity to daphnia and other aquatic invertebrates
See component information below.

Chemical Name	Toxicity to fish	Toxicity to algae	Toxicity to daphnia and other aquatic invertebrates
Distillates, petroleum, hydrotreated light	= 45 mg/L LC50 Pimephales promelas 96 h = 2.2 mg/L LC50 Lepomis macrochirus 96 h = 2.4 mg/L LC50 Oncorhynchus mykiss 96 h	No information available	= 4720 mg/L LC50 Den-dronereides heteropoda 96 h
Alcohols, C11-14-iso, C13-rich, ethoxylated	No information available	No information available	No information available

12.2 Persistence and degradability

No product level data available.

12.3 Bioaccumulative potential

No data available.

12.4 Mobility

No information available.

12.5 Results of PBT and vPvB assessment

This preparation contains no substance considered to be persistent, bioaccumulating nor toxic (PBT)
This preparation contains no substance considered to be very persistent nor very bioaccumulating (vPvB)

12.6 Other adverse effects.

None known.

13. Disposal Considerations

13.1 Waste treatment methods

Disposal Method	Disposal should be made in accordance with federal, state and local regulations.
Contaminated packaging	Empty containers should be taken for local recycling, recovery or waste disposal.

14. Transport information

14.1. UN number

UN No. (DOT)	Not regulated
UN No. (MT/ANTT)	Not regulated
UN No. (TDG)	Not regulated
UN/ID No. (ADR/RID/ADN/ADG)	Not regulated
UN No. (IMDG/ANTAQ)	Not regulated
UN No. (ICAO/ANAC)	Not regulated
UN No. (DPC)	Not regulated

14.2. UN proper shipping name

Not regulated for transportation by DOT, TDG, IMDG and ICAO/IATA.

14.3 Hazard class(es)

DOT Hazard class	Not regulated
ANTT Hazard class	Not regulated
TDG Hazard class	Not regulated
ADR/RID/ADN/ADG Hazard class	Not regulated
IMDG/ANTAQ Hazard class	Not regulated
ICAO/ANAC Hazard class/division	Not regulated
DPC Hazard class	Not regulated

14.4 Packing group

DOT Packing group	Not regulated
ANTT Packing group	Not regulated
TDG Packing group	Not regulated
ADR/RID/ADN/ADG Packing group	Not regulated
IMDG/ANTAQ Packing group	Not regulated
ICAO/ANAC Packing group	Not regulated
DPC Packing group	Not regulated

14.5 Environmental hazard

No

14.6 Special precautions

Not applicable

15. Regulatory Information

International inventories

USA (TSCA)	Complies
Canada (DSL)	Complies
Philippines (PICCS)	Complies
Japan (ENCS)	Complies
China (IECSC)	Complies
Australia (AICS)	Complies
Korean (KECL)	Complies
New Zealand (NZIoC)	Complies

Europe - REACH
All products supplied from the European Economic Area (EEA) are compliant with the REACH Regulation EC 1907/2006.For products supplied from the EEA, Schlumberger and/or its suppliers have pre-registered and is registering all of the substances that it and/or its suppliers manufactures in or imports into the EEA that are subject to Title II of the REACH Regulation. All products supplied from outside the EEA are subject to REACH only if imported into the EEA. The importer of the products must comply with REACH for each imported substance. Contact REACH@slb.com for REACH information.

U.S. Federal and State Regulations

SARA 311/312 Hazard Categories
Should this product meet EPCRA 311/312 Tier reporting criteria at 40 CFR 370, refer to Section 2 of this SDS for appropriate classifications. Under the amended regulations at 40 CFR 370, EPCRA 311/312 Tier II reporting for the 2017 calendar year will need to be consistent with updated hazard classifications.

Chemical Name	SARA 302 / TPQs	SARA 313	CERCLA RQ
Distillates, petroleum, hydrotreated light	N/A	N/A	N/A
Alcohols, C11-14-iso, C13-rich, ethoxylated	N/A	N/A	N/A

California Proposition 65

This product does not contain chemical[s] which is [are] known to the State of California to cause cancer, birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

This Safety Data Sheet has been prepared in compliance with the Hazardous Products Regulations.

Brazilian Regulations

Brazil Regulation	This SDS was prepared in accordance with Brazil law NBR 14725.
Federal Police	Not determined
Army	Not determined
ANVISA	Not Listed
MTE (NR 15)	No information available

16. Other Information

Supersedes date	11/Apr/2017
Revision date	14/Dec/2018
Version	4

This SDS has been revised in the following section(s)	3, 15, 16

HMIS classification

Health	0
Flammability	1
Physical hazard	0
PPE	B

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SAFETY DATA SHEET
RINGFREE*

SECTION 1: IDENTIFICATION OF THE SUBSTANCE/MIXTURE AND OF THE COMPANY/UNDERTAKING

1.1. Product identifier

Product name RINGFREE*

1.2. Relevant identified uses of the substance or mixture and uses advised against

Identified uses Drilling fluid additive

1.3. Details of the supplier of the safety data sheet

Supplier

M-I Australia Pty Ltd
ABN: 67 009 214 162
Level 5
256 St. George Tce
Perth
WA 6000
T = +61 08 9440 2900
F = +61 08 9322 3080

Contact Person MISDS@slb.com

1.4. Emergency telephone number

(24 Hour) Australia +61 2801 44558, Asia Pacific +65 3158 1074, China +86 10 5100 3039, Europe +44 (0) 1235 239 670, Middle East and Africa +44 (0) 1235 239 671, New Zealand +64 9929 1483, USA 001 281 561 1600.

SECTION 2: HAZARDS IDENTIFICATION

2.1. Classification of the substance or mixture

Classification (1999/45/EEC) Not classified.

2.2. Label elements

Risk Phrases

NC Not classified.

Safety Phrases

NC Not classified.

Australian statement of hazardous/dangerous nature

Classified as Non-Hazardous according to the criteria of NOHSC.
NON-HAZARDOUS SUBSTANCE. NON-DANGEROUS GOODS.

2.3. Other hazards

Not Classified as PBT/vPvB by current EU criteria.

SECTION 3: COMPOSITION/INFORMATION ON INGREDIENTS

3.2. Mixtures

Composition Comments

The data shown is in accordance with the latest EC Directives. This product does not contain any hazardous ingredients, or ingredients with national workplace exposure limits.

SECTION 4: FIRST AID MEASURES

4.1. Description of first aid measures

Inhalation

Move the exposed person to fresh air at once. If respiratory problems, artificial respiration/oxygen. Get medical attention if any discomfort continues.

Ingestion

Do not induce vomiting. Immediately give a couple of glasses of water or milk, provided the victim is fully conscious. Get medical attention if any discomfort continues.

Skin contact

Remove contaminated clothing immediately and wash skin with soap and water. Get medical attention promptly if symptoms occur after washing.

Eye contact

Make sure to remove any contact lenses from the eyes before rinsing. Promptly wash eyes with plenty of water while lifting the eye lids. Continue to rinse for at least 15 minutes. Get medical attention if any discomfort continues.

4.2. Most important symptoms and effects, both acute and delayed

General information

The severity of the symptoms described will vary dependant of the concentration and the length of exposure. If adverse symptoms develop as described the casualty should be transferred to hospital as soon as possible. For further information, please refer to section 11.

4.3. Indication of any immediate medical attention and special treatment needed

Treat Symptomatically.

SECTION 5: FIREFIGHTING MEASURES

5.1. Extinguishing media

Extinguishing media

Water spray, foam, dry powder or carbon dioxide.

5.2. Special hazards arising from the substance or mixture

Hazardous combustion products

Fire or high temperatures create: Vapours/gases/fumes of: Carbon monoxide (CO). Carbon dioxide (CO2).

Specific hazards

In case of spills, beware of slippery floors and surfaces.

5.3. Advice for firefighters

Special Fire Fighting Procedures

Containers close to fire should be removed immediately or cooled with water.

Protective equipment for fire-fighters

Self contained breathing apparatus and full protective clothing must be worn in case of fire.

SECTION 6: ACCIDENTAL RELEASE MEASURES

6.1. Personal precautions, protective equipment and emergency procedures

Wear protective clothing as described in Section 8 of this safety data sheet.

6.2. Environmental precautions

Do not allow to enter drains, sewers or watercourses.

6.3. Methods and material for containment and cleaning up

Stop leak if possible without risk. Dike far ahead of larger spills for later disposal. Absorb spillage with suitable absorbent material. Shovel into dry containers. Cover and move the containers. Flush the area with water. In case of spills, beware of slippery floors and surfaces.

6.4. Reference to other sections

For waste disposal, see section 13.

SECTION 7: HANDLING AND STORAGE

7.1. Precautions for safe handling

Avoid spilling, skin and eye contact. Avoid inhalation of vapours and spray mists. In case of spills, beware of slippery floors and surfaces. Avoid contact with: Strong oxidising substances. Good personal hygiene is necessary. Wash hands and contaminated areas with water and soap before leaving the work site. Remove contaminated clothing. Do not eat, drink or smoke when using the product.

7.2. Conditions for safe storage, including any incompatibilities

Store in tightly closed original container in a dry, cool and well-ventilated place.

Storage Class

Chemical storage.

7.3. Specific end use(s)

The identified uses for this product are detailed in Section 1.2.

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1. Control parameters

Ingredient Comments

No exposure limits noted for ingredient(s).
No biological limit allocated.

8.2. Exposure controls

Protective equipment



Process conditions

All chemical Personal Protective Equipment (PPE) should be selected based on an assessment of both the chemical hazard present and the risk of exposure to those hazards. The PPE recommendations below are based on an assessment of the chemical hazards associated with this product. Where this product is used in a mixture with other products or fluids, additional hazards may be created and as such further assessment of risk may be required. The risk of exposure and need of respiratory protection will vary from workplace to workplace and should be assessed by the user in each situation.

Engineering measures

Provide adequate general and local exhaust ventilation.

Respiratory equipment

No specific recommendation made, but respiratory protection may still be required under exceptional circumstances when excessive air contamination exists. Chemical respirator with organic vapour cartridge.

Hand protection

For prolonged or repeated skin contact use suitable protective gloves. Rubber gloves are recommended.

Eye protection

Wear approved chemical safety goggles where eye exposure is reasonably probable.

Other Protection

Wear appropriate clothing to prevent any possibility of skin contact. Provide eyewash station.

Hygiene measures

Wash hands at the end of each work shift and before eating, smoking and using the toilet. Wash hands after handling. Promptly remove any clothing that becomes wet or contaminated.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

9.1. Information on basic physical and chemical properties

Appearance	Liquid
Colour	Clear Colourless to Light (or pale) Yellow
Odour	Slight odour.
Solubility	Completely soluble in water
Relative density	1.3 s.g @ 25°C
Bulk Density	10.8 lb/gal
pH-Value, Conc. Solution	7-9
Viscosity	100-400 cP @ 77°F

9.2. Other information

Not relevant

SECTION 10: STABILITY AND REACTIVITY

10.1. Reactivity

There are no known reactivity hazards associated with this product.

10.2. Chemical stability

Stable under normal temperature conditions and recommended use.

10.3. Possibility of hazardous reactions

Not known.

10.4. Conditions to avoid

Not known.

10.5. Incompatible materials

Materials To Avoid

Avoid contact with: Strong oxidising substances.

10.6. Hazardous decomposition products

Fire or high temperatures create: Vapours/gases/fumes of: Carbon monoxide (CO). Carbon dioxide (CO2).

SECTION 11: TOXICOLOGICAL INFORMATION

11.1. Information on toxicological effects

Acute toxicity:

Acute Toxicity (Oral LD50)

> 2000 mg/kg Rat

Aspiration hazard:

Not anticipated to present an aspiration hazard based on chemical structure.

Inhalation

Gas or vapour in high concentrations may irritate respiratory system.

Ingestion

May cause discomfort if swallowed.

Skin contact

Prolonged and frequent contact may cause redness and irritation.

Eye contact

Spray and vapour in the eyes may cause irritation and smarting.

Route of entry

No route of entry noted.

Target Organs

No specific target organs noted

SECTION 12: ECOLOGICAL INFORMATION

Ecotoxicity

Contact M-I SWACO's QHSE Department for ecological information at M-ISWACOenv@slb.com.

12.1. Toxicity

Acute Toxicity - Fish

LC50 96 hours > 100 mg/l Brachydanio rerio (Zebra Fish)

EC 50, 48 Hrs, Daphnia, mg/l >100

12.2. Persistence and degradability

Degradability

The product is not readily biodegradable.

12.3. Bioaccumulative potential

Bioaccumulative potential

The product does not contain any substances expected to be bioaccumulating.

12.4. Mobility in soil

Mobility:

The product is soluble in water.

12.5. Results of PBT and vPvB assessment

Not Classified as PBT/vPvB by current EU criteria.

12.6. Other adverse effects

None known.

SECTION 13: DISPOSAL CONSIDERATIONS

13.1. Waste treatment methods

Recover and reclaim or recycle, if practical. Dispose of waste and residues in accordance with local authority requirements.

Waste Class

The definitive European Waste code for this product will depend upon the final use that is made of this material. EWC-code: 07 01 99.

SECTION 14: TRANSPORT INFORMATION

General The product is not covered by international regulation on the transport of dangerous goods (IMDG, IATA, ADR/RID). and (ADG).

14.1. UN number

Not applicable.

14.2. UN proper shipping name

Not applicable.

14.3. Transport hazard class(es)

Not applicable.

14.4. Packing group

Not applicable.

14.5. Environmental hazards

Environmentally Hazardous Substance/Marine Pollutant

No.

14.6. Special precautions for user

Not applicable.

14.7. Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code

Not applicable. Please contact MISDS@slb.com for info regarding transport in Bulk.

SECTION 15: REGULATORY INFORMATION

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

Uk Regulatory References

Chemicals (Hazard Information & Packaging) Regulations. Control of Substances Hazardous to Health Regulations 2002 (as amended) Workplace Exposure Limits EH40.

EU Legislation

Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC, including amendments.

Water hazard classification

WGK 1

Australian Standard for the Uniform Scheduling of Drugs and Poisons

No Poisons Schedule number allocated.

Australian Regulations

National Code of Practice for the Preparation of Material Safety Data Sheets 2nd Edition [NOHSC: 2011 (2003)]. National Occupational Health and Safety Commission's Approved Criteria for Classifying Hazardous Substances [NOHSC:1008 (2004) 3rd Edition]. National Occupational Health and Safety Commission's Exposure Standards for Atmospheric Contaminants in the occupational Environment [NOHSC:1003 (1995)]. Safe Work Australia. Standard for the Uniform Scheduling of Drugs and Poisons (SUSDP). ADG Code – Australian Dangerous Goods Code.

15.2. Chemical Safety Assessment

International Chemical Inventories

Contact REACH@miswaco.slb.com for REACH information. Complies with the following national/regional chemical inventory requirements: Australia (AICS), Canada (DSL / NDSL), China (IECSC), Europe (EINECS / ELINCS), Japan (METI / ENCS), Korea (TCCL / ECL), New Zealand (NZIoC), Phillipines (PICCS), United States (TSCA).

SECTION 16: OTHER INFORMATION

Abbreviations and acronyms used in the safety data sheet

*a mark of M-I L.L.C.

General information

HMIS Health -1 HMIS Flammability - 1 HMIS Physical Hazard - 0 J - Splash Goggles, Gloves, Synthetic Apron, Dust and Vapour Respirator.

Information Sources

Product information provided by the commercial vendor(s). Material Safety Data Sheet, Misc. manufacturers. LOLI. European Chemicals Bureau - ESIS (European Chemical Substances Information).

Revision Comments

Updated according to REACH Annex II.

Issued By	Sandra McWilliam
Revision Date	27-06-2013
Revision	3
Supersedes date	03-11-2009
SDS No.	11023
Safety Data Sheet Status	Approved.
	28-06-2013
Signature	Sandra McWilliam
Signature 2	Sarah Malone

Risk Phrases In Full

NC	Not classified.

Disclaimer

MSDS furnished independent of product sale. While every effort has been made to accurately describe this product, some of the data are obtained from sources beyond our direct supervision. We cannot make any assertions as to its reliability or completeness; therefore, user may rely only at user's risk. We have made no effort to censor or conceal deleterious aspects of this product. Since we cannot anticipate or control the conditions under which this information and product may be used, we make no guarantee that the precautions we have suggested will be adequate for all individuals and/or situations. It is the obligation of each user of this product to comply with the requirements of all applicable laws regarding use and disposal of this product. Additional information will be furnished upon request to assist the user; however, no warranty, either expressed or implied, nor liability of any nature with respect to this product or to the data herein is made or incurred hereunder.

SAFETY DATA SHEET

SDS DATE: 1-1-2022

SECTION 1: PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: **SAND FORCE**

CAS: Proprietary

MANUFACTURER: Right Turn Supply
ADDRESS: 2265 Graceland Cemetery Road, Pella, IA 50219

EMERGENCY PHONE: 281-413-1939
E mail: Info@rightturnsupply.com

CHEMICAL FAMILY: Polysaccharides

RECOMMENDED USE: Rheology Modifier/Fluid Loss Agent

SECTION 2: HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW: None

IMMEDIATE CONCERNS: None

POTENTIAL HEALTH EFFECTS

EYES: Based on available data, the classification criteria are not met

SKIN: Based on available data, the classification criteria are not met

INGESTION: Based on available data, the classification criteria are not met

INHALATION: Based on available data, the classification criteria are not met

ACUTE HEALTH HAZARDS: None.

CHRONIC HEALTH HAZARDS: None

SLIP HAZARD: If the material becomes wet, it could produce a slip hazard.

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE: None

SECTION 3: COMPOSITION/INFORMATION ON INGREDIENTS

COMPONENTS:

	CAS NO.	% WT
Proprietary		

SECTION 4: FIRST AID MEASURES

EYES: Immediately flush with cold water, holding eye-lids open. Flush for 15 minutes if possible. Remove contact lenses if present.

SKIN: Rinse contact area with cold water. Remove contaminated clothing and wash with soap and water. If irritation develops seek medical attention.

INGESTION: Do not induce vomiting. Have exposed individual rinse mouth thoroughly with water. Never give anything by mouth to an unconscious person. Consult physician if symptoms persist.

INHALATION: Move exposed person to fresh air and call 911. Give artificial respiration if not breathing and administer oxygen if breathing is difficult.

NOTES TO PHYSICIANS OR FIRST AID PROVIDERS: Treat Symptomatically. Ensure that medical personnel are aware of the materials involved and take precautions to protect themselves. First aid responders are advised to wear protective equipment as found in section 8 of this SDS.

SECTION 5: FIRE-FIGHTING MEASURES

FLASH POINT: No data available

AUTOIGNITION TEMPERATURE: No data available

EXTINGUISHING MEDIA: Use alcohol foam, CO2, water fog, or dry chemicals when fighting fires involving this material. Do not use a direct stream if dust is if formed. Dust dispersed by a direct stream in the presence of an ignition source could ignite.

SPECIAL FIRE FIGHTING PROCEDURES: Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Persons involved in fire-fighting response involving this product and its containers/packaging should refer to Section 8 of this SDS for the proper selection of exposure controls and personal protective equipment.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Dust-air mixtures may be explosive. Avoid open flames, sparks etc.

HAZARDOUS DECOMPOSITION PRODUCTS: Carbon oxides (COx).

SECTION 6: ACCIDENTAL RELEASE MEASURES

SPILLS: Wet material is slippery! Avoid generating and spreading of dust. Shovel into dry containers. Cover and move the containers. Wash away with water or vacuum with a high efficiency filter to recover and reuse the material. If product is contaminated, collect in suitable containers for disposal. Do not contaminate drainage or waterways. Repackage or recycle if possible.

ENVIRONMENTAL PRECAUTIONS: Prevent entry into waterways, sewers, basements or confined areas. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air). Avoid allowing water runoff to contact spilled material. If sweeping of a contaminated area is necessary, use a dust suppressant agent that does not react with the product. Contaminated surfaces will be extremely slippery.

SPECIAL PROTECTIVE EQUIPMENT: In case of dust generation, wear goggles and ensure adequate ventilation and/or use breathing apparatus. Dust in high concentrations may form explosive mixtures with air. Review Sections 5 and 7 of this SDS with personnel before starting any cleanup operations.

SECTION 7: HANDLING AND STORAGE

HANDLING: Avoid dust generation. Ensure adequate ventilation or dust masks are available. Gloves should be worn.

STORAGE: Store in dry conditions, do not let product get wet. Wet material could produce a slip hazard. Store in original packaging, or appropriate alternative. If repackaged, label new packaging. Store at ambient temperature and pressure.

OTHER PRECAUTIONS: Keep away form ignition source.

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

ENGINEERING CONTROLS: Provide adequate general and local exhaust ventilation. Provide readily accessible eye wash stations and emergency showers. Where explosive mixtures may be present, electrical systems safe for such locations must be used.

VENTILATION: Ensure area of use is well ventilated.

RESPIRATORY PROTECTION: Depending on airborne concentration, wear an OSHA approved N95 half-face dust respirator.

EYE PROTECTION: Employees should be provided with and required to use safety goggles where there is any possibility of product coming in contact with eyes. Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of contact lenses. Ensure that an eye wash station is operable and nearby.

SKIN PROTECTION: Depending on the conditions of use, protective gloves, apron, boots, head and face protection should be worn. Remove contaminated clothing immediately, wash skin with soap and water, and launder clothing before reuse.

WORK HYGIENIC PRACTICES: Use good personal hygiene practices. Avoid repeated and/or prolonged skin exposure. Wash hands before eating, drinking, smoking, or using toilet facilities. Promptly remove contaminated clothing and launder before reuse. Shower after work using plenty of soap and water.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

FORM: Solid powder.

APPEARANCE: White to off white.

ODOR: Odorless or no characteristic odor.

pH (2% solution): 8-11

BOILING POINT: No data available

MELTING POINT: No data available

FREEZING POINT: No data available

SPECIFIC GRAVITY: 1.5 typical

EVAPORATION RATE: No data available

FLAMABILITY LIMITS: No data available

AUTOIGNITION TEMPERATURE: No data available

FLASH POINT: No data available

SOLUBILITY IN WATER: 100%

SECTION 10: STABILITY AND REACTIVITY

STABILITY: Stable. Polymerization does not occur.

CONDITIONS TO AVOID: Ignition sources may cause exothermic reaction. Wet material can be a slip hazard.

MATERIALS TO AVOID: Oxidizing agents

HAZARDOUS DECOMPOSITION OR BY-PRODUCTS: Carbon oxides (COx)

SECTION 11: TOXICOLOGICAL INFORMATION

TOXICOLOGICAL INFORMATION:

ORAL LD50 (RAT); No data available

DERMAL LD50 (RABBIT): No data available

INHALATION LC50 (RAT): No data available

CARCINOGENICITY:

NTP Not listed
IARC Not listed
OSHA Not listed

SENSITIZATION: No data available

NEUROTOXICITY: No data available

GENETIC EFFECTS: No data available

REPRODUCTIVE EFFECTS: No data available

TERATOGENIC EFFECTS: No data available

MUTAGENICITY: No data available

SECTION 12: ECOLOGICAL INFORMATION

ENVIRONMENTAL DATA: MOBILITY IN SOIL POTENTIAL - No data available

ECOTOXICOLOGICAL INFORMATION: TERRESTRIAL/MICROORGANISM TOXICITY –
ACUTE: No data available
CHRONIC: No data available

BIOACCUMULATION/ACCUMULATION: No data available

AQUATIC TOXICITY: No data available

CHEMICAL FATE INFORMATION: PERSISTENCE & DEGRADABILITY – Material breaks down naturally.

GENERAL COMMENTS: Any other adverse environmental effects, such as environmental fate (exposure), ozone depletion potential, photochemical ozone creation potential, endocrine disrupting potential, and global warming potential are indicated in this section if data exists. Otherwise, this data has not been established.

SECTION 13: DISPOSAL CONSIDERATIONS

DISPOSAL METHOD: This product does not meet the criteria of a hazardous waste if discarded in its purchased form. Under RCRA, it is the responsibility of the user of the product to determine at the time of disposal, whether the product meets RCRA criteria for hazardous waste. This is because product uses, transformations, mixtures, processes, etc. may render the resulting materials hazardous.

PRODUCT DISPOSAL: Recover and reclaim or recycle, if practical. Should this product become a waste, dispose of in a permitted industrial landfill. Ensure that containers are empty by RCRA criteria prior to disposal in a permitted industrial landfill.

EMPTY CONTAINER: Empty containers may retain residues. All label precautions must be observed.

COMMENTS: Dispose of material in accordance with national, state, regional, and local regulations. Never discharge directly into sewers or surface water. Consult with environmental regulatory agencies for guidance on acceptable disposal practices for the product, in any form, and its containers/packaging.

SECTION 14: TRANSPORT INFORMATION

DOT (DEPARTMENT OF TRANSPORTATION)
PROPER SHIPPING NAME: Not regulated as a dangerous good.

ROAD AND RAIL (ADR/RID)
SHIPPING NAME: Not regulated as a dangerous good.
AIR (ICAO/IATA)
SHIPPING NAME: Not regulated as a dangerous good.

VESSEL (IMO/IMDG)
SHIPPING NAME: Not regulated as a dangerous good.

SECTION 15: REGULATORY INFORMATION

UNITED STATES:

SARA TITLE III (SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT)
311/312 HAZARD CATEGORIES: None of the components are listed.
313 REPORTABLE INGREDIENTS: None of the components are listed.

CERCLA (COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT)
CERCLA REGULATORY: None of the components are listed.

TSCA (TOXIC SUBSTANCE CONTROL ACT)
TSCA REGULATORY: All components are listed and registered

CALIFORNIA PROPOSITION 65: This product does not contain any chemicals that are known to the State of California to cause cancer, birth defects or other reproductive harm at concentrations that trigger the warning requirements of California Proposition 65.

CARCINOGEN: This product is not listed as a carcinogen under NTP, IARC, or OSHA.
CANADA
WHMIS (WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM): Not a controlled product.

SECTION 16: OTHER INFORMATION

REVISION SUMMARY: This SDS replaces the 06/27/2014 SDS.

NFPA

Health Hazard:	0
Fire Hazard:	0
Reactivity Hazard:	1

HMIS

Health Hazard:	0
Flammability:	0
Physical Hazard:	0

HMIS RATINGS NOTES: Please refer to Section 8 of this SDS for recommended personal protective equipment.

GENERAL STATEMENTS: Other information not included anywhere else in this SDS is included in this section if, in fact, such data exists.
MANUFACTURER DISCLAIMER: This information relates to the specific material designated and may not be valid for such material used in combination with any other materials or in any process. Such information is to the best of our knowledge and belief, accurate and reliable as of the date compiled. However, no representation, warranty or guarantee is made as to its accuracy, reliability or completeness. NO WARRANTY OF MERCANTABILITY, FITNESS FOR ANY PARTICULAR PURPOSE, OR ANY OTHER WARRANTY, EXPRESSED OR IMPLIED, IS MADE CONCERNING THE INFORMATION HEREIN PROVIDED. It is the user's responsibility to satisfy himself as to the suitability and completeness of such information for his own particular use. We do not accept liability for any loss or damage that may occur from the use of this information nor do we offer warranty against patent infringement.

SAFETY DATA SHEET

SDS DATE: 1-1-2022

SECTION 1: PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: **CLAY FORCE NSF**

CAS: Proprietary

MANUFACTURER: Right Turn Supply
ADDRESS: 2265 Graceland Cemetery Road, Pella, IA 50219

EMERGENCY PHONE: 281-413-1939
E mail: Info@rightturnsupply.com

CHEMICAL FAMILY: Proprietary

RECOMMENDED USE: Clay / Shale Inhibitor

SECTION 2: HAZARDS IDENTIFICATION

Classification according to Regulation 2012 OSHA Hazard Communication Standard 1910.1200:

No need for classification according to GHS criteria for this product.

No need for hazard warning labels in accordance with GHS criteria.

EMERGENCY OVERVIEW:

IMMEDIATE CONCERNS: May cause eye and respiratory irritation.

POTENTIAL HEALTH EFFECTS

EYES: Contact may cause eye irritation

SKIN: This product is unlikely to cause skin irritation, unless exposed for a long period

INGESTION: This product is unlikely to cause harmful effects from ingestion

INHALATION: None

ACUTE HEALTH HAZARDS: None.

CHRONIC HEALTH HAZARDS: Excessive inhalation or eye exposure over long periods may cause harmful irritation

SLIP HAZARD: Low to moderate

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE: None

SECTION 3: COMPOSITION/INFORMATION ON INGREDIENTS

COMPONENTS:

	CAS NO.	WT. %
Proprietary	N/A	N/A

SECTION 4: FIRST AID MEASURES

EYES: Immediately flush with large amounts of cold water, holding eye-lids open. Flush for 15 minutes if possible. Remove contact lenses if present. Get medical attention if irritation persists.

SKIN: Rinse contact area with soap and water. Remove contaminated clothing, and wash with soap and water. If irritation develops, seek medical attention.

INGESTION: Do not induce vomiting. Have exposed individual rinse mouth thoroughly with water. Never give anything by mouth to an unconscious person. If conscious, drink plenty of fluids. Consult physician if symptoms persist.

INHALATION: Move exposed person to fresh air and call 911. Give artificial respiration if not breathing and administer oxygen if breathing is difficult.

NOTES TO PHYSICIANS OR FIRST AID PROVIDERS: Treat Symptomatically. Ensure that medical personnel are aware of the materials involved and take precautions to protect themselves. First aid responders are advised to wear protective equipment as found in section 8 of this SDS.

SECTION 5: FIRE-FIGHTING MEASURES

FLASH POINT: No data available

AUTOIGNITION TEMPERATURE: No data available

EXTINGUISHING MEDIA: Use alcohol foam, CO2, water fog, or dry chemicals when fighting fires involving this material.

FIREFIGHTING MEASURES: Cool exposed containers with water spray after extinguishing fire.

SPECIAL PROTECTIVE EQUIPMENT FOR FIREFIGHTERS: Full protective clothing and approved self-contained breathing apparatus required for firefighting personnel.

SPECIAL FIRE FIGHTING PROCEDURES: Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material. Persons involved in fire-fighting response involving this product and its containers/packaging should refer to Section 8 of this SDS for the proper selection of exposure controls and personal protective equipment.

SPECIAL HAZARD: Thermal decomposition (as may be experienced in a fire) may produce hydrogen chloride gas and/or may liberate oxides of nitrogen and carbon. Spills produce slippery surfaces and could present a physical hazard for firemen.

UNUSUAL FIRE AND EXPLOSION HAZARDS: None

HAZARDOUS DECOMPOSITION PRODUCTS: None

SECTION 6: ACCIDENTAL RELEASE MEASURES

SPILLS: Slippery. Wash away with water or vacuum with a high efficiency filter to recover and reuse the material. If product is contaminated, collect in suitable containers for disposal. Do not contaminate drainage or waterways. Repackage or recycle if possible.

ENVIRONMENTAL PRECAUTIONS: Prevent entry into waterways, sewers, basements or confined areas. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air). Avoid allowing water runoff to contact spilled material. If sweeping of a contaminated area is necessary, use a dust suppressant agent that does not react with the product. Contaminated surfaces will be extremely slippery.

SPECIAL PROTECTIVE EQUIPMENT: Wear suitable protective clothing and gloves.

SECTION 7: HANDLING AND STORAGE

HANDLING:

- Avoid spills. Slippery.
- Keep container closed when not in use
- Avoid contact with eyes, skin and clothing
- Personal protective equipment comprising: suitable protective gloves, safety goggles and protective clothing. Wash thoroughly with soap and water after handling.
- Take off contaminated clothing and wash before reuse
- Use only in well-ventilated areas
- Use with adequate ventilation and employ respiratory protection where mist or spray may be generated. Ensure that eyewash stations and safety showers are close to the workstation location

STORAGE:

- Keep container tightly closed when not in use
- Store in a cool, well ventilated area
- Store at 5 - 30° C (41 - 86° F) in original closed containers.
- Avoid storage temperatures below freezing, since product may stratify. Changes in temperature create air pressure changes inside drums. Use proper precaution in unscrewing plug and/or opening container.

OTHER PRECAUTIONS: None

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

ENGINEERING CONTROLS: Provide adequate general and local exhaust ventilation. Provide readily accessible eye wash stations and emergency showers. Where explosive mixtures may be present, electrical systems safe for such locations must be used.

VENTILATION: Ensure area of use is well ventilated.

RESPIRATORY PROTECTION: Not applicable.

EYE PROTECTION: Employees should be provided with and required to use safety goggles where there is any possibility of product coming in contact with eyes. Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of contact lenses. Ensure that an eye wash station is operable and nearby.

SKIN PROTECTION: Depending on the conditions of use, protective gloves, apron, boots, head and face protection should be worn. Remove contaminated clothing immediately, wash skin with soap and water, and launder clothing before reuse.

RESPIRATORY PROTECTION:

- Keep container tightly closed when not in use.
- Store in a cool, well ventilated area
- Store at 5 - 30° C (41 - 86° F) in original closed containers.
- Avoid storage temperatures below freezing, since product may stratify. Changes in temperature create air pressure changes inside drums. Use proper precaution in unscrewing plug and/or opening container.

WORK HYGIENIC PRACTICES: Use good personal hygiene practices. Avoid repeated and/or prolonged skin exposure. Wash hands before eating, drinking, smoking, or using toilet facilities. Promptly remove contaminated clothing and launder before reuse. Shower after work using plenty of soap and water.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

FORM:	Liquid
APPEARANCE:	Clear to slight yellow cast
ODOR:	Odorless
pH (as is):	6-7

BOILING POINT: Like water (approx. 210F)

MELTING POINT: No data available

FREEZING POINT: Like water (appox 32F)

SPECIFIC GRAVITY: ~1.1 typical

EVAPORATION RATE: Like water

FLAMABILITY LIMITS: No data available

AUTOIGNITION TEMPERATURE: No data available

FLASH POINT: No data available

SOLUBILITY IN WATER: 100%

SECTION 10: STABILITY AND REACTIVITY

STABILITY: Stable. Hazardous polymerization does not occur.

CONDITIONS TO AVOID: Spills, slippery

MATERIALS TO AVOID: Strong oxidizers. Contact with copper, copper alloys, aluminum, mild steel or iron may cause corrosion/degradation.

HAZARDOUS DECOMPOSITION OR BY-PRODUCTS: Carbon oxides (COx)

SECTION 11: TOXICOLOGICAL INFORMATION

TOXICOLOGICAL INFORMATION:

ORAL LD50 (RAT); No data available

DERMAL LD50 (RABBIT): No data available

INHALATION LC50 (RAT): No data available

CARCINOGENICITY:

NTP Not listed
IARC Not listed
OSHA Not listed

SENSITIZATION: No data available

NEUROTOXICITY: No data available

GENETIC EFFECTS: No data available

REPRODUCTIVE EFFECTS: No data available

TERATOGENIC EFFECTS: No data available

MUTAGENICITY: No data available

SECTION 12: ECOLOGICAL INFORMATION

ENVIRONMENTAL DATA: MOBILITY IN SOIL POTENTIAL - No data available

ECOTOXICOLOGICAL INFORMATION: TERRESTRIAL/MICROORGANISM TOXICITY –
ACUTE: No data available
CHRONIC: No data available

BIOACCUMULATION/ACCUMULATION: No data available
AQUATIC TOXICITY: No data available

CHEMICAL FATE INFORMATION: PERSISTENCE & DEGRADABILITY – Material breaks down naturally.

GENERAL COMMENTS: Any other adverse environmental effects, such as environmental fate (exposure), ozone depletion potential, photochemical ozone creation potential, endocrine disrupting potential, and global warming potential are indicated in this section if data exists. Otherwise, this data has not been established.

SECTION 13: DISPOSAL CONSIDERATIONS

DISPOSAL METHOD: This product does not meet the criteria of a hazardous waste if discarded in its purchased form. Under RCRA, it is the responsibility of the user of the product to determine at the time of disposal, whether the product meets RCRA criteria for hazardous waste. This is because product uses, transformations, mixtures, processes, etc. may render the resulting materials hazardous.

PRODUCT DISPOSAL: Recover and reclaim or recycle, if practical. Should this product become a waste, dispose of in a permitted industrial landfill. Ensure that containers are empty by RCRA criteria prior to disposal in a permitted industrial landfill.

EMPTY CONTAINER: Empty containers may retain residues. All label precautions must be observed.

COMMENTS: Dispose of material in accordance with national, state, regional, and local regulations. Never discharge directly into sewers or surface water. Consult with environmental regulatory agencies for guidance on acceptable disposal practices for the product, in any form, and its containers/packaging.

SECTION 14: TRANSPORT INFORMATION

DOT (DEPARTMENT OF TRANSPORTATION)
PROPER SHIPPING NAME: Not regulated as a dangerous good.

ROAD AND RAIL (ADR/RID)
SHIPPING NAME: Not regulated as a dangerous good.
AIR (ICAO/IATA)
SHIPPING NAME: Not regulated as a dangerous good.

VESSEL (IMO/IMDG)
SHIPPING NAME: Not regulated as a dangerous good.

SECTION 15: REGULATORY INFORMATION

UNITED STATES:

SARA TITLE III (SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT)
311/312 HAZARD CATEGORIES: None of the components are listed.
313 REPORTABLE INGREDIENTS: None of the components are listed.

CERCLA (COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT)
CERCLA REGULATORY: All components are registered and listed.

TSCA (TOXIC SUBSTANCE CONTROL ACT)
TSCA REGULATORY: Registered and listed.

CALIFORNIA PROPOSITION 65: This product does not contain any chemicals that are known to the State of California to cause cancer, birth defects or other reproductive harm at concentrations that trigger the warning requirements of California Proposition 65.

CARCINOGEN: This product is not listed as a carcinogen under NTP, IARC, or OSHA.
CANADA
WHMIS (WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM): Not a controlled product.

SECTION 16: OTHER INFORMATION

REVISION SUMMARY: This SDS replaces the 5/13/2014 SDS.

NFPA

Health Hazard:	1
Fire Hazard:	0
Reactivity Hazard:	0

HMIS

Health Hazard:	0
Flammability:	0
Physical Hazard:	1
Personal Protection	B

HMIS RATINGS NOTES: Please refer to Section 8 of this SDS for recommended personal protective equipment.

GENERAL STATEMENTS: Other information not included anywhere else in this SDS is included in this section if, in fact, such data exists.
MANUFACTURER DISCLAIMER: This information relates to the specific material designated and may not be valid for such material used in combination with any other materials or in any process. Such information is to the best of our knowledge and belief, accurate and reliable as of the date compiled. However, no representation, warranty or guarantee is made as to its accuracy, reliability or completeness. NO WARRANTY OF MERCANTABILITY, FITNESS FOR ANY PARTICULAR PURPOSE, OR ANY OTHER WARRANTY, EXPRESSED OR IMPLIED, IS MADE CONCERNING THE INFORMATION HEREIN PROVIDED. It is the user's responsibility to satisfy himself as to the suitability and completeness of such information for his own particular use. We do not accept liability for any loss or damage that may occur from the use of this information nor do we offer warranty against patent infringement.

Safety Data Sheet

Cobble Commander

SDS Revision Date: 01/01/2018

1. Identification

1.1. Product identifier

Product Identity	Cobble Commander
Alternate Names	**Blend of Metal Oxides**

1.2. Relevant identified uses of the substance or mixture and application method

Intended use	Viscosifier
Application Method	See Technical Data Sheet.

1.3. Details of the supplier of the safety data sheet

Company Name	Right Turn Supply LLC P.O. Box 132016 Spring, TX 77393, USA
Emergency	
CHEMTREC (USA)	(800) 424-9300
24 hour Emergency Telephone No.	International +1-703-527-3887
Customer Service: NorthStar Fluid Solutions	(281) 413-1939

2. Hazard(s) identification

2.1 Classification of the substance or mixture
GHS Classification in accordance with 29 CFR 1910 (OSHA HCS)

For the full text of the H-Statements mentioned in this Section, see Section 16.

2.2 GHS Label elements, including precautionary statements

Pictogram-None

Signal word	
Hazard Statement(s)	
Precautionary statement(s)	None

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS

3. Composition/information on ingredients

3.1 Substance
Synonyms: Blend of Metal Oxides

Substances	CAS Number	PERCENT (w/w)	GHS Classification - US
Magnesium compound	1309-48-4	20%	Combustible dust
Sodium compound	1313-59-3	20%	Combustible dust
Aluminum compound	1344-28-1	60%	Combustible dust

In accordance with paragraph (i) of §1910.1200, the specific chemical identity and/or exact percentage (concentration) of composition has been withheld as a trade secret.
[1] Substance classified with a health or environmental hazard.
[2] Substance with a workplace exposure limit.
[3] PBT-substance or vPvB-substance.
*The full texts of the phrases are shown in Section 16.

4. First aid measures

4.1. Description of first aid measures

General Consult a physician. Show this safety data sheet to the doctor in attendance.

Inhalation Remove victim to fresh air. Consult medical personnel.

Eyes Immediately flush with plenty of water for at least 15 minutes. Get medical attention.

Skin Wash off with soap and plenty of water. Consult a physician.

Ingestion Flush oral cavity and give one or two glasses of water to drink. If gastrointestinal symptoms develop, consult medical personnel. (Never give anything by mouth to an unconscious person).

4.2. Most important symptoms and effects, both acute and delayed

The most important known symptoms and effects are described in the labeling (see section 2.2) and/or in section 11.

4.3 Indication of any immediate medical attention and special treatment needed

Product may irritate eyes, skin, mucous membranes and upper respiratory tract with overexposure. Prolonged inhalation (chronic) of dust may result in lung damage.

5. Fire-fighting measures

5.1. Extinguishing media

Suitable for all regular extinguishing materials. Do not use high pressure water jet.

5.2. Special hazards arising from the substance or mixture

Nature of decomposition products not known.

5.3. Advice for fire-fighters

Wear self-contained breathing apparatus for firefighting if necessary.

6. Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Avoid creating dust. Use MSHA-NIOSH approved respirator for dusts, mists and fumes whose TLV is greater than 0.05 mg/m3. Avoid breathing vapors, mist, or gas. For personal protection see section 8.

6.2. Environmental precautions

None known.

6.3. Methods and material for containment and cleaning up

Pick up and arrange disposal without creating dust. Sweep up and shovel. Keep in suitable close containers for disposal.

6.4 Neutralizing Chemicals

Dilute Acid.

7. Handling and storage

7.1. Precautions for safe handling

Further processing of solid materials may result in the formation of combustible dusts. The potential for combustible dust formation should be taken into consideration before additional processing occurs. Provide appropriate exhaust ventilation at places where dust is formed. For precautions see section 2.2.

7.2. Conditions for safe storage, including any incompatibilities

Keep container tightly closed in a dry and well-ventilated place.

Air and moisture sensitive. Keep in a dry place. Storage class (TRGS 510): Non Combustible Solids

7.3. Specific end use(s)

Apart from the uses mentioned in section 1.2 no other specific uses are stipulated.

8. Exposure controls and personal protection

CAS No.	Ingredient	Source	Value
1309-48-4	Magnesium compound	OSHA TLV	15 mg/m3 TWA
		Table 2 limits for air contaminants	
		ACGIH TLV	10 mg/m3 TWA
		Remarks	Upper respiratory tract irritation metal fume fever not classifiable as a human carcinogen
1313-59-3	Sodium compound	None	none
1344-28-1	Aluminum compound	OSHA PEL	15 mg/m3 TWA Total
		OSHA PEL	5 mg/m3 TWA Respirable (Al)
		ACGIH TLV	10 mg/m3 TWA Al

8.2. Exposure controls

Respiratory	Reparatory protection is not required. Where protection from nuisance levels of dusts are desired, use type N95 (US) or type P1 (EN 143) dust masks. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).
Eyes	Use chemical splash goggles or glasses.
Skin	Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.
Engineering Controls	Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.
Other Work Practices	Where splash is possible, full chemically resistant protective clothing and boots are required. Ensure that eyewash stations and safety showers are proximal to the work-station location. Do not let product enter drains.

See section 2 for further details. - [Prevention]:

9. Physical and chemical properties

Appearance	Solid, powder. White to Off-White
Odor	Odorless
Odor threshold	No data available
pH	10.9-11.9
Melting point / freezing point	> 500 C
Initial boiling point and boiling range	No data available
Flash Point	Not known
Evaporation rate (Ether = 1)	No data available
Flammability (solid, gas)	Carbon monoxide and carbon dioxide may form on combustion.
Upper/lower flammability or explosive limits	No data available
Vapor pressure (Pa)	No data available
Vapor Density	No data available
Specific Gravity	No data available
Solubility in Water	Insoluble
Partition coefficient n-octanol/water (Log Kow)	No data available
Auto-ignition temperature	Not known
Decomposition temperature	No data available
Viscosity (cSt)	No data available
Density (lbs/gal)	No data available

9.2. Other information

No data available

10. Stability and reactivity

10.1. Reactivity
No data available
10.2. Chemical stability
Stable under recommended storage conditions.
10.3. Possibility of hazardous reactions
No data available.
10.4. Conditions to avoid
Mixture with strong acids produces considerable heat.
10.5. Incompatible materials
Avoid contact with the following: copper, tin, zinc, aluminum, and their alloys.
10.6. Hazardous decomposition products
Will not occur. In the event of fire: see section 5.

11. Toxicological information

11.1 Information on toxicological effects
Acute Toxicity
Inhalation
No data available

Skin corrosion/irritation
No data available

Serious eye damage/eye irritation
No data available

Respiratory or skin sensitization
No data available

Germ cell mutagenicity
No data available

Carcinogenicity

IARC:	No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
ACGIH:	No component of this product present as levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH.
NTP:	No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.
OSHA:	No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity
No data available

Specific target organ toxicity-single exposure
No data available

Specific target organ toxicity-repeated exposure
No data available

Aspiration hazard
No data available

Additional Information
Ingestion or inhalation of large quantity may cause feverish reaction and leukocytosis-diarrhea. To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

12. Ecological information

12.1. Aquatic Toxicity

Please contact our office for the most up to date information.

12.2. Persistence and degradability

No data available

12.3. Bioaccumulative potential

No data available

12.4. Mobility in soil

No data available

12.5. Results of PBT and vPvB assessment

PBT/vPvB assessment not available as chemical safety assessment not required/ not conducted

12.6. Other adverse effects

When released into the soil, this material is not expected to biodegrade and may leach into groundwater.

13. Disposal considerations

13.1. Waste treatment methods

Methods Product
Do not allow residue to flow into drainage system. Waste disposal according to regulations of responsible local authority.

Contaminated packaging
Waste disposal according to regulations of responsible local authority.

14. Transport information

DOT (US)
Not regulated for transportation by DOT, TDG, IMDG, ICAO/IATA
IMDG
Not regulated for transportation by DOT, TDG, IMDG, ICAO/IATA

IATA
Not regulated for transportation by DOT, TDG, IMDG, ICAO/IATA

15. Regulatory information

SARA 302 Components
None. If no components are listed below, this product is not subject to the referenced SARA and regulations.

SARA 313 Components
None. If no components are listed below, this product is not subject to the referenced SARA and regulations.
SARA 311/312 HAZARDS
No

Massachusetts Right To Know Components
Does not apply.

Pennsylvania Right To Know Components
Does not apply.

New Jersey Right to Know Components
Does not apply.

16. Other information

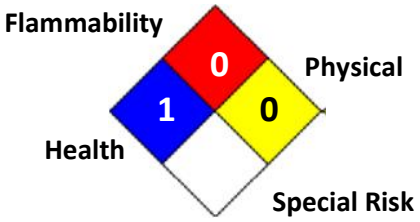
This is the first version in the GHS SDS format. Listings of changes from previous versions in other formats are not applicable.

The information and data herein are believed to be accurate and have been compiled from sources believed to be reliable. It is offered for your consideration, investigation and verification. Buyer assumes all risk of use, storage and handling of the product in compliance with applicable Federal, State and local law and regulations. Right Turn Supply LLC makes no warranty of any kind, express or implied, concerning the accuracy of completeness of the information and data herein. The implied warranties of merchantability and fitness for a particular purpose are specifically excluded. Right Turn Supply LLC will not be liable for claims relating to any use of this product.

Emergency Overview:

Risk Classification System:

HEALTH	**1**
FLAMMABILITY	**0**
PHYSICAL	**0**
PPE	**E**



End of Document

Appendix J - Key Personnel

Contents

Operations Manager – Steve South
General Superintendent – Chris Crough
Rig Managers – • Casey Wainman
• Barry Briggs
• Chris O'Dwyer
Technical Services – Steve Sooley

STEVEN SOUTH

Operations Manager

Steven South has over 22 years of experience in Horizontal Directional Drilling. He joined The Crossing Company in 1999 as a Driller and was promoted to Rig Manager in 2002. As a Rig Manager, Steve managed the execution of several high profile projects including Jackknife Creek for Anadarko Canada, which involved the first ever use of "Blow-Out Preventors" in HDD to control risks associated with shallow natural gas. The project also involved several other "firsts" and significant achievements including deep set and telescopic casing string to 300m depth, and deep pressure cementing. Steve's HDD construction expertise and leadership skills resulted in Steve being promoted to Field Superintendent in early 2007.

Some of the projects that attest to Steve's technical ability and effective leadership are the Albian Sands Expansion Project in Fort McMurray, Alberta and the Phoenix Expansion Project in Arizona, U.S. The Albian Sands Project involved the application of 4 drilling rigs operating 24 hours per day, 7 days per week to complete 14 HDD crossings. In Arizona, Steve worked with Transwestern Pipelines Company and Rockford Pipeline to complete a high risk crossing of the Gila River. Following completion of the project, the customer commented:

"Rockford is very pleased with the performance of your company at the Gila River HDD. Your rig supervisors, Dave Rominick and Steve South, demonstrated their thorough knowledge of the art of horizontal drilling and a knack for innovative solutions to difficult challenges. They also maintained a positive and helpful attitude toward Rockford, the client, and the numerous agencies and third parties that were involved.

This HDD was turned down by numerous other directional drilling companies. The combination of the overlaying sand and gravel layers and the solid bedrock beneath presented many problems to be overcome. Installing sleeves, a difficult task in itself, on both the entrance and exit sides, proved to be instrumental in achieving success. Again, we thank you for your efforts, and appreciate the talent and work ethic of both Dave and Steve."

Most recently, Steve has been supporting The HDD Company throughout the U.S. and was mentioned in the following review from an employee on the project:

I had the pleasure of working on Rig 10 the past few months. It was my first time being on a drill rig and went into it eyes wide open. Your management team of Dave Tetz and Steve South were second to none. The way they ran the entire operation was phenomenal. Steve kept the rig and fellow employees well informed and up to task. I've been part of many heavy highway projects and the way this job was ran, even when something went wrong was very professional.

Steven South

1807-8th Street | Nisku, AB T9E 7S8
Tel: 780.955.5051 Fax: 780.955.5056

Professional Experience

Field Superintendent – The Crossing Company **2007 to Present**

As field Superintendent, Steve is responsible for the coordination of the field activities in a multi-rig operation and for the economic provision and efficient deployment of resources. Steve's principal accountabilities include:

- Demonstrate and promote safety leadership. Attend rig safety meetings and coach Rig Managers in conducting such meetings.
- Plan and manage the efficient and timely provision of support services and supplies to rig operations and to plan and provide logistical support.
- Work with the client's field management to co-ordinate and optimize field activities in a manner which achieves cohesion of the inputs to field operations and creates a spirit of teamwork. Liaise with client's other contractors who are involved in field operations to achieve cohesion in concurrent/simultaneous operations and cross-company teamwork & effectiveness.
- Apply his experience directly in the event of non-routine activities on the rigs and to co-ordinate activities in the event of an incipient or actual emergency or incident.
- Take personal responsibility for and demonstrate leadership in HSE.
- Conduct regular inspections of rigs and follow-up on all remedial actions.
- Establish a culture of continuous improvement in field operations and demonstrate results in this regard. Work with the client's field management and other service providers in the field to develop improved practices which will positively impact on field operations.
- Coach all subordinates in performing their duties and manage their professional development.

Rig Manager – The Crossing Company **2002 to 2008**

- Provide leadership in Safety Excellence, ensuring compliance with client safety program, corporate safety program and OH&S legislation. Contribute affirmatively to The Crossing Company's corporate culture of safety, quality and operational excellence.
- Provide mentorship and direction to the Driller in relation to crew training, task assignment and supervision.
- Oversee maintenance of drilling rig and associated equipment to ensure maximum operating readiness and sustainability, minimizing opportunities for equipment downtime. Ensure equipment is maintained to a state of repair consistent with The Crossing Company's high standards.
- Organize and supervise all mobilization and demobilization operations of the drilling rig and associated equipment. Supervise all rigging and towing operations involved in mobilization and demobilization operations, ensuring safe transportation through rough and steep terrain.

- Direct, monitor and control all drilling operations to ensure compliance with the Construction Plan, and technical and environmental specifications. Work closely with The Crossing Company's Project Manager and Client Representative to ensure effective communication and execution of the Construction Plan and Management of Change.
- Coordinate the acquisition and supply of goods and services in a manner consistent with project cost accounting procedures in close cooperation with the Project manager and Client Representative.

Driller – The Crossing Company **1999 to 2003**

As a Driller, Steve was responsible for training, directing and supervising the rig crew and the use of the rig equipment, in accordance with The Crossing Company's operational policies so as to safely and efficiently execute the HDD Construction Plan. Steve's principal accountabilities as a Driller included:

- Demonstrate and promote safety leadership. Conduct and record Tool Box Talks for the rig crew and achieve the participation and contribution of crew members.
- Conduct safety inspections of rig equipment and hold training drills as directed by Rig Manager. Ensure that all activities, including those of third party contractors, are conducted using safe working practices and using the designated Personal Protection Equipment (PPE).
- Plan the tour operations and conduct pre-job briefings or J.S.A.'s for the crew on activities. Train and direct the crew in fulfilling their designated duties.
- Monitor and adjust the drilling parameters and take necessary actions to optimize the drilling process and safeguard the integrity of the project. Operate the rig equipment within its designed parameters in a manner to optimize the drilling process and associated activities.
- Assign crew members to conduct specific tasks during periods of routine activity and during special operations such as rigging-up/down and rig-moving.
- Keep accurate and complete records in a manner consistent with corporate standards.
- Transport crew to and from work site.

Driller – Canadian Horizontal Drilling **1997 to 1999**

Roughneck – D&K Directional Drilling **1996 to 1997**

NOTABLE COMPLETED PROJECTS FOR HDD COMPANY

(Additional Projects will be provided upon request)

Project: **EQT**

2018

General Contractor: EQT
Contact: Nick Ponzo/ Mark Torbic 412-215-8195
Project Name: EQT/Mountain Valley Pipeline Pigg River Crossing
Totaling (1) 42: Steel Pipeline Installation
Varying Lengths: 3726'
Formation: Mica Shist (Mohns 4-7)
HDD Rigs: Vermeer 750K, 140K
Position: Field Superintendent

Project: **ETC Rover**

2018

General Contractor: Precision Pipeline
Contact: Steven Grice 716-491-1895
Project Name: ETC Rover Pipeline Replacement Line A & B
Totaling (12) 42" Steel Pipeline Installation Projects
Varying Lengths: 1,800' to 2,400'
Formation: Sandstone/Shale Rock
HDD Rigs (4) Vermeer 750, HDD Co. 900, American Auger 660, American Auger 440
Position: Field Superintendent

Select Completed Projects

Owner	HDD Crossing	Drill Detail
Husky Oil Operations	Husky Direct Intake	NPS8, 2018: 738m
Husky Oil Operations	Husky Direct Intake	NPS24, 2018: 742m
Pembina	Unnamed Stream	NPS12, 2017: 758m
Pembina	Paddle River	NPS24, 2017: 621m
Pembina	Iosegun River	NPS24, 2016: 1044m
Crew Energy	Pine River NW-Entry	NPS8, 2016: 2300m
TCPL	Deep Valley Creek	NPS24, 2016: 1355.8m
AltaGas	Townsend Creek	NPS8, 2016: 562m
Ikkuma Resources	Wanyandie Creek	NPS6, 2015: 1582.2m
Husky Oil Operations	NSR	NPS16, 2015: 1231.8m
TCPL	Ruth Lake	NPS12/6, 2015: 783m
Bellatri	Rose Creek	NPS6, 2015: 853m
Pembina Pipeline Corp	Trib 114 to Smoky	NPS12, 2015: 1224m
Encana	Kiskatinaw River	NPS8, 2015: 1036m
Pembina Pipeline Corp	Simonette River	NPS12 ¾, 2015: 819m
Tangle Creek Energy	Athabasca River	NPS4, 2014: 408m
Pembina Pipeline Corp	Wapiti River South Slope	NPS12, 2014: 847m
Inter Pipeline	Petroleum Way	NPS24, 2014: 1357m
ARC Resources	Kiskatinaw River	NPS10, 2014: 963m
Encana	Waskahigan River	NPS8/4, 2014: 668m
Stony Mountain Pipeline	House River	NPS20, 2014: 1003m
Suncor	Horse River	NPS16, 2014: 1000m
Crew Energy	Septimus Creek	NPS10, 2014: 1382m
Devon	Saint John Creek	NPS18, 2013: 1302m
Seven Generations	Smoky River	NPS6/8, 2013: 1894m
Stony Mountain Pipeline	Athabasca River	NPS20, 2013: 1269m
Progress Energy	Sikanni Chief River	NPS24, 2012: 1626m
Bellatrix	North Saskatchewan River	NPS0/8/8, 2012: 1752m
CNRL	Peace River	NPS16, 2011: 1765m
Alta Gas	Pouce Coupe River HDD	NPS10, 2010: 1619m
Transwestern Pipeline	Gila River	NPS36, 2009: 1120m
Focus Energy	Tommy Lakes - Intersect	NPS6, 2008: 1678m
Pembina Pipelines	North Saskatchewan River	NPS12, 2007: 1615m
Storm Energy	Peace River - Intersect	NPS12, 2007: 1300m
Shell Canada	Jackpine Creek	NPS48, 2007: 724m
Talisman Energy	Kakwa River	NPS8/8/6/6/4, 2006: 1221m
Anadarko Canada	Jackknife Creek- Intersect	NPS8, 2005: 1120m

Training and Certification

- Petroleum Safety Training (PST)
- Standard First Aid
- H_2S Alive
- WHMIS 2015
- OSSA Fall Protection
- Global Ground Disturbance Level II
- ACSA Leadership Development Workshop
- ACSA Leadership for Safety Excellence
- Confined Space Entry and Rescue
- Construction Safety Training System (CSTS)
- Pipeline Construction Safety Training (PCST)
- OSSA Regional Orientation Program
- Transportation of Dangerous Goods (TDG)
- ASCA Safety Culture, A Roadmap to Zero
- Accident/Incident Investigation
- Butt Fusion
- Electronic General Safety Orientation (EGSO)
- CannAmm Supervisor Drug & Alcohol Awareness Training
- ABSA Special Oilwell Boiler Certificate

CHRISTOPHER CROUGH

Drilling Rig Superintendent / Rig Manager

Chris Crough has over 15 years of experience in Horizontal Directional Drilling. He joined The HDD Company in 2009 after working in various capacities for six years with our parent company, The Crossing Company in Canada. Currently, Chris has dual roles as Drilling Rig Superintendent / Rig Manager and The HDD Company's General Drilling Superintendent depending on the company's workload of drilling projects. Chris has worked in all drilling positions from rig hand to rig manager and has been a team leader in several significant 42" rock project undertaken by The HDD Company.

Employee Resume

CHRIS CROUGH

155 Garwood Crescent d
Wetaskiwin, AB T9A
780-352-6006

Professional Experience

EMPLOYMENT:

2009 to Present **HDD Company Inc. El Dorado Hills, CA**
Superintendent/ Driller /Operator

January 2007 to 2009 **The Crossing Company Inc. Nisku, AB**
Rig Manager

- Operated and drilled on rigs with capacities from 100K pounds of thrust and pull to 600K pounds of thrust and pull within The Crossing Company's HDD fleet.
- Became a Rig Manager on August 18, 2008 and managed Rig #1 a Maxi drilling rig.
- Given the opportunity on September 11, 2008 to join The HDD Company the North American Division of The Crossing Company.
- Became the Rig Manager of Rig 4 high angle on February 18, 2010
- Became a Rig Manager for Rig 2 (300K pound drilling rig) on August 16, 2010 for the HDD Company in Albany Oregon.

2000 to 2006 **Canadian Horizontal Drilling Wetaskiwin, AB**
Driller

- Drilled primarily on there 300,000 pound rig
- Relief tool pushed in 2005
- Was also introduced to small utility rigs from 12,000 to 80,000 pound Vermeer

1992 to 1997 **Phil Crough & Sons Trucking Wetaskiwin, AB**
Operator

- Operate 416 cat backhoes
- Drive tandem gravel and A-Frame rail picker trucks
- Drive and operate single axle vacuum trucks
- Operate transits on grade and height elevations

REFERENCES:

Lynn Kubicek
Rig Manager for the Crossing Company Rig 5
Phone 780-387-4336
Cell 780-405-7358

Dave Rominick
Rig Manager for the Crossing Company Rig
Phone 780-913-1009

Frans Erikson
Steering Hand for Canadian Horizontal
Phone 7780-352-7596

NOTABLE COMPLETED PROJECTS *(Additional Projects will be provided upon request)*

Project: **ETC Rover**
2018
General Contractor: Precision Pipeline
Contact: Steven Grice 716-491-1895
Project Name: ETC Rover Pipeline Replacement Line A & B
Totaling (12) 42" Steel Pipeline Installation Projects
Varying Lengths: 1,800' to 2,400'
Formation: Sandstone/Shale Rock
HDD Rigs (4) Vermeer 750, HDD Co. 900, AA 660, AA 440
Position: Rig Manager/Project General Superintendent

Project: **Lavalin LLC**
2017
Owner: Northwest Natural
Position: Rig Manager
Contact Brian Conrad 503-721- 2550
Project Name: North Mist Expansion Project
(8) 16" 24, 976' Steel Pipeline HDD Installations w/2.5" HDPE Piggy-backed
Formation: Shale/Sandstone, Silts, Sands, and Clays.
Position: Rig Manager/Project General Superintendent

Project: **TE SUBCOM**
2017
General Contractor: The HDD Company Inc.
Contact: Randy Ashley 603-502-8725
Project Name: MAREA fiber optic
Length & Diameter: Four "drill and leave" bores 3280' each
Formations: Sand & Gravel
HDD Rig: American Augers 440K
Position: Rig Manager/Project General Superintendent

Project: **DAKOTA ACCESS PIPELINE**

2016

General Contractor: Precision Pipeline (Oz Directional Drilling)
Contact: Steve Grice 716-491-1895 or Jim Cunningham 217-251-8440
Project Name: Illinois River Crossing
Length & Diameter: 6500' x 30" steel (intersect)
Formations: Sands , Silts, Gravel
HDD Rig: American Augers 440K
Position: Driller/Rig Manager

Project: **CITY OF CARSBAD, CALIFORNIA**

2016

General Contractor: Pulice Construction, Inc.
Contact: Don Gordon
Project Name: Agua Hedionda Sewer Lift Station
Length & Diameter: 1825' of 36" DR-11 HDPE Pipe
Formations: Claystone and Sandstone
HDD Rig: American Augers 440K
Position: Driller / Rig Manager

Project: **KINDER MORGAN ENERGY PARTNERS, L.P.**

2015

Contact: Renee Coleman 714-560-4771
General Contractor: W.A. Rasic Construction Company
Contact: Jack Quick 562-928-6111
Project Name: 16" LS-1 & 20" LS-108 Pipelines HDD
Location: Pomona, California
Length & Diameter: 1,422 'of 20" and 1614' of 24" Steel Pipe
Formations Sands and Silts
HDD Rig: American Augers 380K
Position: Driller / Rig Manager

Project: **PACIFIC GAS & ELECTRIC COMPANY**

2015

General Contractor: Barnard Pipeline, Inc
Contact: Dan Link 406-679-0134
Project Name: R-405 I-400/I-401 Pipeline Replacement
Location: Capay , California
Length & Diameter: **2560' of 36" Steel and 2560' of 42" Steel**
Formations: Siltstone, Mudstone, Sands and Gravels
HDD Rig: American Augers 440K
Position: Driller / Rig Manager

Project: **NEC CORPORATION OF AMERICA / GOOGLE**

2015

Contact: Ingo Lahnemann 570-836-7371
General Contractor: The HDD Company, Inc.
Contact: Rick Evans 530-676-5705
Project Name: FASTER Cable Project
Location: Bandon, Oregon
Length & Diameter: **5,000' of 5" Steel Pipe**
Formations: Sandstone and Siltstone
HDD Rig: Vermeer 330K
Position: Driller / Rig Manager

Project: **PACIFIC GAS & ELECTRIC COMPANY**

2015

General Contractor: Black & Veatch Construction, Inc.
Contact: Dave Turkington 925-556-2216
Project Name: ZA - 230KV UG Line
Location: San Francisco, California
Length & Diameter: **12" & 3" HDPE Bundle**
Formations: Serpentine Rock and Bay Mud
HDD Rig: American Augers 380K
Position: Driller / Rig Manager

Project: **VICTORVILLE VALLEY WASTEWATER RECLAMATION AUTHORITY**

2014

General Contractor: James W. Fowle5r
Contact: Spencer McClymont 503-623-5373
Engineering Firm: URS
Contact: Bob Sachse 619-733-5354
Project Name: Upper Narrows
Location: Victorville, California
Length & Diameter: **(2) bores 1941' of 16" SDR 18**
Formations: Sand, Silts and Gravel
HDD Rig: American Augers 440K
Position: Driller / Rig Manager

Project: **NW NATURAL**

2014

Contact: Craig Gagner 503-721-2550
Project Name: Monmouth Bare
Project Location: Albany, Oregon
Length & Diameter: **(3) 3420', 3510' and 3560' of 12" Steel Pipe**
Formations: Clay and Mudstone
HDD Rig: American Augers 380K
Position: Driller / Asst. Rig Manager

Project: **Pacific Gas and Electric Company I-880 Bore**

2014

Owner: **Pacific Gas and Electric Company**
General ARB, Inc
Contact: Mark Borgess 925-422-3563
Length & Diameter: 1300' of 36" Steel Pipe
Formations: Sand
HDD Rig: American Augers 440K
Tracking System: Tensor Wireline System
Driller / Asst. Rig Manager

Project: **PNG – TP 1160 Pipeline Replacement**

2013

Position: Operator
Owner: Peoples Gas
General Contractor: Mascaro Corporation
Contact: Brad McKibben 412-321-7901
Length & Diameter: 2167' of 20" Steel Pipe
Formations: Limestone and Sandstone
HDD Rig: HDD Company 900K "American Auger Components"
Tracking System: Tensor Wireline System
Position: Driller / Asst. Rig Manager

Project: **Phase III A/B Corvallis Loop**

2013

Owner: NW Natural
Contact: Craig Gagner 503-721-2550
Length & Diameter: (2) bores 6425' and 1764' of 12" Steel Pipe
Formations: Clay and Siltstone
HDD Rig: American Augers 380k
Tracking System: Tensor Wireline System
Position: Driller / Asst. Rig Manager

Project: **Perrydale / Rickreall Bore Project**

2013

Owner: NW Natural
Contact: Craig Gagner 503-721-2550
Length & Diameter: (3) bores 5289', 3599' and 5886' of 12" Steel Pipe
Formations: Clay
HDD Rig: HDD Company 900K "American Auger Components"
Tracking System: Tensor Wireline System
Position: Driller / Asst. Rig Manager

Project: **Targa Sound Terminal Job# 8631004**

2012

Owner: Targa Sound Terminal
Contact: Kelly Varnado 713-584-1570
General Contractor: Rockford Corporation
Contact: Tim Alwin 360-864-8866
Project Location: Port of Tacoma, Washington

Length & Diameter: **(4) bores 7644', 3500', 2100',and 1200' of 10" Steel Pipe**
Formations: Sand and Silt
HDD Rig: American Augers 440K
Position: Driller / Asst. Rig Manager

Project: **OOI RSN**
2011
Owner: L-3 COMMUNICATIONS MARIPRO
Contact: Geoff Ball 805-879-0105
Project Location: Pacific City, Oregon
Length & Diameter: **2 Beach approaches 5000' each leave drill pipe in hole as conduit**
Formations: Sand and Silt
HDD Rig: American Augers 440K
Position: Driller / Asst. Rig Manager

Project: **Integrated Wetlands Waste Discharge**
2010
Owner ATI WAH CHANG
Contact: Mike Smee 541-971-7927 or
Doug Pennington 541-990-7704
Project Name: Integrated Wetlands Waste Discharge
Project Location: Albany, Oregon
Length & Diameter: **1100' of 18" HDPE Under a Wetlands and Creek**
Formations: Gravel and Silt
HDD Rig: American Augers 440K
Position: Driller

Project: **Western Terminus Pipeline Project**
2010
Owner: LIVERMORE – AMADOR WATER MANAGEMENT AGENCY
General Contractor: K J Woods
Contact: Ron Zelaya 510-303-9591
Engineer: Brown & Caldwell
Construction Manager: Covello Group
Contact: Mike Jaeger 925-382-1950
Project Location: San Leandro, California
Length & Diameter: 1178' of 42" HDPE under wetland
Formations: Bay Mud (Clay)
HDD Rig: American Augers 440K
Position: Driller

Project: **Travis Junction 16" Jet Fuel Pipeline**
2010
Owner: KINDER MORGAN
Contact: Andy Diaz 951-712-8790 (andy_diaz@kindermorgan.com)
Project Location: Travis AFB, Fairfield, California

Length & Diameter **5400' of 16" Steel Pipe under Wetlands**
Formations: Clay, Sand and Silts
HDD Rig: American Augers 440K
Position: Driller

Project: **Line-406001 RSN**

2010

Owner: PACIFIC GAS & ELECTRIC COMPANY
General Contractor: Diamond D General Engineering
Contact: Donald Swank 661-599-0092
Contact: Scott Klapp w/ GTS 530-514-7309
Project Location: Woodland, California
Length & Diameter**: (2) bores 1498' & 1290' of 30" Steel Pipe under I-5, I-505 and a canal**
Formations: Clay, Sand and Gravel
HDD Rig: American Augers 440K
Position: Driller

Project: **North Albany Force Main Improvement**

2009

Owner: City of Albany
Engineer: CH2M Hill
Contact: Craig Massey 541-768-3478
Length & Diameter: 1780' of 24" HDPE
Formations: Silt and Clay
HDD Rig: HDD Company 900K "American Auger Components"
Tracking System: Tensor Wireline System
Position: Driller

Project: **Nacimento Water Line Project**

2009

General Contractor: Teichert Construction
Contact: Chad Fisher 559-647-0788
Length & Diameter: 1850' of 31" Steel Pipe and
Sandstone and 1300' of 31" Steel Pipe - Mudstone
Formations: Silt and Clay
HDD Rig: HDD Company 900K "American Auger Components"
Tracking System: Tensor Wireline System
Position: Driller

Project: **Big Gulch Sanitary Sewer Emergency Repair**

2009

Owner: Mukilteo Water and Wastewater District
Contact: Rick Matthews 425-355-3355
Length & Diameter: 2560' of 21.5" FPVC
Formations: Mudstone – Glacial Till
HDD Rig: American Auger 380K
Tracking System: Tensor Wireline System
Position: Driller

CASEY WAINMAN

Driller / Rig Manager

Casey Wainman has over nine years of experience in Horizontal Directional Drilling from performing duties as a rig laborer and welder to managing The HDD Company's most power drilling rig having approximately 900,000 pounds thrust and pulling capabilities

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Barry Briggs

Rig Manager

Professional Experience

Rig Manager – The Crossing Company **2021 to Present**

As Rig Manager, Barry is responsible for overall management of rig operations to ensure the accomplishment of planned objectives with regards to revenue, expenses, rig operations, development and performance of personnel, safety and environmental management, and equipment maintenance while creating a high degree of customer satisfaction. Barry's principal accountabilities as a Rig Manager include:

- Provide leadership in Safety Excellence, ensuring compliance with client safety programs, corporate safety programs and OH&S legislation. Contribute affirmatively to The HDD Company's corporate culture of safety, quality and operational excellence.
- Provide mentorship and direction to the Driller and Locator in relation to crew training, task assignment and supervision.
- Oversee maintenance of drilling rig and associated equipment to ensure maximum operating readiness and sustainability, minimizing opportunities for equipment downtime. Ensure equipment is maintained to a state of repair consistent with The HDD Company's high standards.
- Organize and supervise all mobilization and demobilization operations of the drilling rig and associated equipment. Supervise all rigging and towing operations involved in mobilization and demobilization operations, ensuring safe transportation through rough and steep terrain.
- Direct, monitor and control all drilling operations to ensure compliance with the Construction Plan, and technical and environmental specifications. Work closely with The HDD Company's Operations Manager and Client Representative to ensure effective communication and execution of the Construction Plan and Management of Change.
- Coordinate the acquisition and supply of goods and services in a manner consistent with project cost accounting procedures in close cooperation with the Operations Manager and Client Representative.

Booker Drilling, Offshore Rigs, Neighbors Drilling, REM, Laney Directional Drilling **1983 – 2021**

Select Completed Projects

Owner / Location	HDD Crossing	Drill Detail
XcL Midstream / West Virginia	Fish Creek, (6) crossings	NPS4 & NPS12: 1,500’ – 3,100’
OSU / Oregon	PacWave South, (1) crossing	NPS30: 2,500’
North Dakota	(2) crossings	NPS36: 4,000’
Pennsylvania	(4) crossings	NPS24: 2,500’
Marathon / Wyoming	(1) crossing	NPS24: 3,100’
Enbridge / Michigan – Indiana	(5) crossings	NPS42
Exxon	(1) crossing	NPS10: 7,200’
Mississippi	(1) crossing	NPS24: 7,000’
WHC Houston	Ship Channel, (1) crossing	NPS30: 8,400’
Kinder Morgan / Texas	Land to Barge, (1) crossing	5,000’
Kinder Morgan / Texas	Barge to Barge, (1) crossing	3,500’
Kinder Morgan / Texas	Barge to Land, (1) crossing	5,000’
Marathon / Texas	(1) crossing	NPS36: 6,000’
Inos / Texas	(1) crossing	NPS30: 6,250’
Texas	(3) crossings	NPS42: 2,500’ – 3,500’
NextEra / Florida	(6) crossings	NPS36: 3,000’ – 4,500’
South Carolina	(1) crossing	NPS48: 6,000’
United Pegasus / Texas	Multiple crossings	NPS24 – NPS42: 2,000’ – 3,000’
Louisiana	(1) crossing	NPS30: 6,200’
Energy Transfer / Ohio	Rover Pipeline, (2) crossings	NPS42: 4,000’
Texas	(3) crossings	3,000’ – 4,000’
Arkansas	Bald Knob, (1) crossing	NPS42: 5,200’

More projects available upon request

Casey Wainman

131 Fairview Blvd.
Farwell, MI 48622
(989) 429-6911

Professional Experience

EDUCATION Farwell High School - Farwell, MI 48622
Graduated 2002

- Welding Skills include: Arc, Tig and Mig welding. Also experienced in using plasma cutter, torch, ban saw, air arc, shear, iron worker and drill press
- Related Welding Skills include: Blueprint reading
- Computer Skills Include: Microsoft Word, Microsoft Excel and Microsoft Power Point

WORK EXPERIENCE

June 2014 to Present **Rig Manager**
HDD Company, Inc – El Dorado Hills, C

Daily responsibilities include:

- Oversee all aspects of HDD operations while on location.
- Safety training for all aspects of work. From new green hands to experienced employees new to the rig and location.
- Production Leader- Make sure project is completed on schedule. Without any extra costs to client or company.
- Heavy duty Mechanic- Ensure drilling rig and components are running at maximum performance and efficiency. Troubleshoot for any issue to prevent any downtime.
- Drilling Rig Operator
- Welder and Heavy Equipment Operator

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2009-2014 **Driller / Mechanic Welder**
HDD Company - El Dorado Hills, CA

Daily responsibilities include:

- Drilling Operator on a 200 ton, 450 ton# and 30 ton American Auger Drill Rig. Operated Ellis Williams Triplex, Operated 150 bbl Mud Tank and solid control equipment. Maintaining Drilling Fluids, and maintenance of all equipment
- Primary control of the drilling apparatus
- Setting up all drilling equipment
- Ensuring proper operation of all drilling equipment
- Supervising all crewmembers, ensuring full compliance with company operational procedures and safety program
- First line supervision of equipment maintenance procedures
- Recording and communicating drilling data to ensure compliance with Quality Assurance program

NOTABLE COMPLETED PROJECTS FOR THE HDD COMPANY

(Additional Projects will be provided upon request)

Project Name: **ETC Rover Pipeline**
2017-2018 General Contractor: Precision Pipeline
Contact: Steven Grice 715-491-1895
Project Name: ETC Rover
Project Location: Ohio
Start Date: March 2017 Completed April 2018
4 Rigs : Line A & B (12) bores +/- 21,754' x 42" steel pipe
Bores range from 1800' to 2400'
Formations: Sandstone, mudstone, alluvial
Position: Rig Manager

Project Name: **Dakota Access Pipeline Illinois River Crossing**
2016 General Contractor: Precision Pipeline (Oz Directional Drilling)
Contact: Steve Grice 716-491-1895 or Jim Cunningham 217-251-8440
Length & Diameter: 6500’ x 30” steel (intersect)
Formations: Sands, Silts, Gravel
Position: Rig Manager/Driller

Project Name: **Pacific gas & Electric Line 407 phase 2**
2016 Position: Operator / Superintendent
General Contractor: Barnard Pipeline
Contact: Dan Link 530-669-5810
Length & diameter:
1. Sacramento River: 3555’ x 30” steel
2. Knights Landing: 2302’ x 30” steel

Project Name: **Pacific Gas & Electric Line 400 Replacement**
2015 Position: Operator / Superintendent
General Contractor: Barnard Pipeline
Contact: Dan Link 530-669-5810
Length & Diameter: 2560' x 42" steel under Cache Creek
Formations: Sandstone / Siltstone
Position: Rig Manager/Driller

Project Name: **Mayport Naval Base**
2014 General Contractor: L-3 Communications - Maripro
Contact: Geoff Ball 805-879-0105
Length & Diameter: 4000' x 5" Drill & leave Outfall into the Atlantic Ocean
Formations: Sands and Silts
Position: Driller

Project Name: **Martin Slough Interceptor Project**
2014 Owner: City of Eureka
General Contractor: Wahlund Construction
Contact: Ken Wahlund 707-268-0150
Length & Diameter: (1) bore 4400' of 26" and (1) 2100' of 26"
Formations: Sands and Gravels
Position: Driller

Project Name: **PNG – TP 1160 Pipeline Replacement**
2013 Owner: Peoples Gas
General Contractor: Mascaro Corporation
Contact: Brad McKibben 412-321-7901
Length & Diameter: 2167' of 20" Steel Pipe
Formations: Limestone and Sandstone
Position: Driller

Project Name: **Enterprise ATEX Segment 1 Mariner West Project**
2013 Owner: Liquid Enterprise Pipeline
Contact: John Ward 850-257-3062
General Contractor: Southeast Construction
Contact: Todd Barton 520-423-2131
Length & Diameter: 3620' and 2700' of 20" Steel Pipe
Formations: Shale and Sandstone
Position: Driller

Project Name: **Linde 24" Stainless Steel Bore**
2013 Owner: Linde Inc.
General Contractor: Rockford Corporation
Contact: Josh Stinson 530-647-0224
Length & Diameter: 800' of 24" Stainless Steel
Formations: Clay
Position: Rig Laborer/Welder

Project Name: **Hwy 221 Water Transmission Main Upgrade**
2012 Owner: City of Napa
Owner Contact: Michael Hether 707-257-9336
Length & Diameter: (6) bores 1750', 1600', 950', 700' and 100' of 24" Steel
Formations: Clay, Cobble and Sand
Position: Rig Laborer/Welder

Project Name: **Central Valley Gas Storage**
2011 Owner: Central Valley Gas Storage
General Contractor: Associated Pipe Line Contractors
Contact: Tom Wilson 713-789-4311
Length & Diameter: 5485' of 24" O.D. (5 Bores)
Formations: Clay
Position: Rig Laborer/Welder

Project Name: **OOI - RSN**
2011 Owner: University of Washington
General Contractor: L-3 Maripro
Contact: Geoff Ball 805-879-0105
Length & Diameter: Two 5000' x 5" beach approaches off the Oregon Coast
Formations: Sand and Silts
Position: Rig Laborer/Welder

Project Name: **Hale Passage Cable Crossing**
2011 Position: Laborer
Owner: Peninsula Light Company
Contact: Dennis Walden 253-853-1386 or Jafar Taghaui 253-83-1386
Length & Diameter: 3550 ' of 12" steel with five 3" and one 2" HDPE Conduits
Formations: Glacial Till
Position: Rig Laborer/Welder

Project Name: **Western Terminus Project #2010-10**
2010 Owner: Livermore-Amador Valley Water Management Agency
General Contractor: KJ Woods
Contact: Mike Jaeger 925-382-1950
Length & Diameter: 1178' of 42" HDPE under wetlands
Formations: Bay Mud (Clay)
Position: Rig Laborer

Project Name: **Travis Junction 16" Jet Fuel Pipeline**
2010 Owner: Travis Air Force Base
General Contractor: Kinder Morgan
Contact: Mike Jaeger Andy Diaz 951-712-8790
Length & Diameter: 5400' of 16" Steel Pipe under wetlands
Formations: Clay, Sands and Silt
Position: Rig Laborer

Project Name: **Line-406**
2010 Position: Laborer
Owner: Pacific Gas & Electric
General Contractor: Southwest Contractors
Contact: Leroy Hahn 661-588-0484
Length & Diameter: 2 Bores 1498' and 1290' of 30" steel under 1-5, 1-505
Formations: Clay, Sands and Gravel

Project Name: **Plains Pipeline**
2010 Position: Laborer
Owner: Plains Pipeline
General Contractor: Southwest Contractors
Contact: Leroy Hahn 661-588-0484
Length & Diameter: 2 Bores 1150' of 10" steel and 1200' of 8" steel
Formations: Sand

Project Name: **Hueneme Outfall Replacement**
2009 Owner: Calleguas Muni Water District
General Contractor: Manson Construction Inc.
Contact: Brad Hunter 562-762-5241
Length & Diameter: 2500’ of 36” HDPE
Formations: Sand, Cobble, Boulder
Position: Rig Laborer

Project Name: **Nacimiento Water Line**
2009 Owner: County of San Luis Obispo, CA
General Contractor: Teichert Construction Sacramento, CA
Contact: Chad Fisher 916-837-6176
Length & Diameter: Two holes 1850’ and 1350’ of 30” Steel pipe
Formations: Sandstone, Soft shale, Cobble
Position: Rig Laborer

Chris O’Dwyer

Rig Manager/Driller

Chris O’Dwyer has over 9 years of experience in Horizontal Directional Drilling. He started his career in HDD as a Roughneck and worked his way through the operational ranks, earning a promotion to Driller in 2011 and finally to Rig Manager in 2014. Chris has managed drilling crews and been personally responsible for drilling some of the largest and most technically demanding crossings in western Canada.

Chris O'Dwyer

1807-8th Street | Nisku, AB T9E 7S8
Tel: 780.955.5051 Fax: 780.955.5056

Professional Experience

Rig Manager – The Crossing Company **2014 to Present**

As a Rig Manager Chris is in charge of the overall management of rig operations to ensure the accomplishment of planned objectives with regards to: revenue, expenses, rig operations, development and performance of personnel, safety and environmental management and equipment maintenance while creating a high degree of customer satisfaction. Chris's principal accountabilities include:

- Provide leadership in Safety Excellence, ensuring compliance with client safety program, corporate safety program and OH&S legislation. Contribute affirmatively to The Crossing Company's corporate culture of safety, quality and operational excellence.
- Provide mentorship and direction to the Driller in relation to crew training, task assignment and supervision.
- Oversee maintenance of drilling rig and associated equipment to ensure maximum operating readiness and sustainability, minimizing opportunities for equipment downtime. Ensure equipment is maintained to a state of repair consistent with The Crossing Company's high standards.
- Organize and supervise all mobilization and demobilization operations of the drilling rig and associated equipment. Supervise all rigging and towing operations involved in mobilization and demobilization operations, ensuring safe transportation through rough and steep terrain.
- Direct, monitor and control all drilling operations to ensure compliance with the Construction Plan, and technical and environmental specifications. Work closely with The Crossing Company's Project Manager and Client Representative to ensure effective communication and execution of the Construction Plan and Management of Change.
- Coordinate the acquisition and supply of goods and services in a manner consistent with project cost accounting procedures in close cooperation with the Project manager and Client Representative.

Driller – The Crossing Company **2011 to 2014**

Responsible for training, directing and supervising the rig crew and the use of the rig equipment, in accordance with The Crossing Company's operational policies so as to safely and efficiently execute the HDD Construction Plan. Chris's principal accountabilities as a Driller included:

- Demonstrate and promote safety leadership. Conduct and record Tool Box Talks for the rig crew and achieve the participation and contribution of crew members.
- Conduct safety inspections of rig equipment and hold training drills as directed by Rig Manager. Ensure that all activities, including those of third party contractors, are conducted using safe working practices and using the designated Personal Protection Equipment (PPE).
- Plan the tour operations and conduct pre-job briefings or J.S.A.'s for the crew on activities. Train and direct the crew in fulfilling their designated duties.

- Monitor and adjust the drilling parameters and take necessary actions to optimize the drilling process and safeguard the integrity of the project. Operate the rig equipment within its designed parameters in a manner to optimize the drilling process and associated activities.
- Assign crew members to conduct specific tasks during periods of routine activity and during special operations such as rigging-up/down and rig-moving.
- Keep accurate and complete records in a manner consistent with corporate standards.
- Transport crew to and from work site.

Tankhand/Lead Roughneck – The Crossing Company **2007 to 2011**

As a Tankhand, Chris was responsible for assisting the Driller by maintaining all equipment related to the circulating system, and maintaining the properties of the drilling fluid. As a Lead Roughneck, Chris was responsible for ensuring that all engines and other machinery were properly maintained, operating and functioning properly. He was also responsible for assisting the Driller in training and supervising Roughnecks, making and breaking drill-pipe connections during drilling, reaming and tripping operations, ensuring that the rig, associated equipment and work site was kept clean and in order, doing repair work and conducting preventative maintenance on the rig and associated equipment. The Lead Roughneck position is also responsible for notifying the Driller of any observations of inadequacies associated with the state of repair or operating behavior of the equipment.

Roughneck – Beaver Drilling **2006**

The Crossing Company Completed Projects

Owner	HDD Crossing	Drill Detail
Ledcor	130 Ave, Clover Bar Creek and Pipelines	NPS20, 2015: 582m
NEP	Ravine Crossing	NPS6, 2015: 716m
TCPL	Highway 63-PPC	NPS12/6, 2015: 333m
Bellatrix	Rose Creek	NPS6, 2015: 853m
Enbridge	Hangingstone River_HPP	NPS16, 2015: 368m
Inter Pipeline	Hangingstone River_IPL	NPS16, 2015: 485m
Tournament Exploration Ltd	Baptiste River	NPS8, 2014: 854m
Progress Energy	Beatton River Exit	NPS10/8, 2014: 1000m
Spectra Energy	South Slope	NPS20, 2014: 978m
Crew Energy	Septimus Creek	NPS10, 2014: 1382m
Encana	Beaverlodge River	NPS4/6/8/10, 2013: 585m
Pennwest	Violet Grove Slope	NPS6, 2013: 656m
Seven Generations	Kakwa RIver	NPS6/8, 2013: 1640m
Progress Energy	Sikanni Chief	NPS24, 2012: 1626m
CNRL	Peace River	NPS16, 2011: 1765m
Storm Exploration	Kiskatinaw River HDD	NPS8, 2010: 944m
Alta Gas	Pouce Coupe	NPS16/4/4, 2010: 1619m
Talisman	Burnt River	NPS6/6/2, 2009: 1178m
ProEx Energy	Trib to Buckinghorse River	NPS6/6, 2008: 949m
Focus Energy	Tommy Lakes Hill Drill	NPS6, 2008: 1475m

The HDD Company (some) Completed Projects

Owner	Crossing	Diameter / Length
City of Albany, OR	Willamette River	24” x 1780’
Niska Gas Storage, Gridley, CA	Various Canals	24” x 1230’, 1470’, 1122’
Nacimiento Water District, CA	Salinas River	32” x 1300’
Northwest Natural Gas, Corvallis, OR	Willamette and Mary’s Rivers	12” x 6320’
ETC Rover Pipeline, Ohio	Sandusky River	42” x 1818’

Training and Certification

- Petroleum Safety Training
- Standard First Aid
- H_2S Alive
- Ground Disturbance Level 2
- Confined Space Entry and Rescue
- ACSA Construction Safety Training System (CSTS)
- Oil Sand Safety Association – Orientation
- ABSA Special Oilwell Boiler Certificate
- Fall Protection
- Level B Trainee Crane Operator Certificate
- Leadership for Safety Excellence (ASCA)

Steve Sooley

Technical Services Specialist

Steve Sooley has over 6 years of experience in Horizontal Directional Drilling. He started his career in HDD as a Roughneck and worked his way through the operational ranks, culminating in his promotion to Technical Services Specialist in 2011.

Steve Sooley

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Professional Experience

Technical Services Specialist – The Crossing Company **2011 to Present**

As a Technical Services Specialist, Steve is responsible for providing the directional drilling services on HDD projects. Reporting to the Rig Manager and Project Manager, the essential job functions are:

- Review drill path design and communicate with the Rig Manager, Project Manager and client representatives to discuss all changes deemed necessary.
- Conduct a land survey of the construction RoW along the intended line of drill and erect surface navigation coils and solenoid(s). Create the overall navigation plan.
- Interpret the MWD information and apply drilling expertise, problem solving ability and drilling experience to ensure the drill path is drilled according to the Construction Plan.
- Provide As-Built summary describing location of survey and geometry of drill path.

Lead Roughneck – The Crossing Company **2010 to 2011**

As a Lead Roughneck, Steve was responsible for ensuring that all engines and other machinery were properly maintained, operating and functioning properly. He was also responsible for assisting the Driller in training and supervising Roughnecks, making and breaking drill-pipe connections during drilling, reaming and tripping operations, ensuring that the rig, associated equipment and work site is kept clean and in order, doing repair work and conducting preventative maintenance on the rig and associated equipment. The Lead Roughneck position is also responsible for notifying the Driller of any observations of inadequacies associated with the state of repair or operating behavior of the equipment.

Completed Projects

Owner	HDD Crossing	Drill Detail
Crew Energy	Pine River NW-Entry	NPS8, 2016: 2300m
Ikkuma Resources	Wanyandie Creek	NPS6, 2015: 1582.2m
Ledcor	CP Rail and CN Yard	NPS36, 2015: 459m
Pembina Pipeline Corp	Morse River	NPS10, 2015: 652m
Bellatrix	Rose Creek	NPS6, 2015: 853m
Pembina Pipeline Corp	Trib 114 to Smoky	NPS12, 2015: 1224m
Pembina Pipeline Corp	Simonette River	NPS12¾, 2015: 819m
Tangle Creek Energy	Athabasca River Entry	NPS4, 2014: 413m
Crew Energy	Septimus Creek	NPS10, 2014: 1382m
Stony Mountain Pipeline	House River	NPS20, 2014: 1003m

Suncor	Horse River	NPS16, 2014: 1000m
Shell	Quest North Saskatchewan River	NPS12, 2013:666m
Pennwest	Unnamed Creek	NPS6, 2013: 656m
Northwest Redwater Partnership	North Saskatchewan River	NPS16, 2013: 578m
Seven Generations	Smoky River	NPS6/8, 2013: 1894m
Devon	Saint John Creek	NPS18, 2013: 1302m
Pembina Pipeline	Alces River HDD	NPS6, 2012: 933m
Encana	Dawson Creek Hill	NPS8, 2012: 840m
Bellatrix Exploration	North Saskatchewan River	NPS10/8/8, 2012: 1752m
Paramount Resources	Kakwa River	NPS8, 2011: 936m
CNRL	South Slope	NPS16, 2011: 1013m
Alta Gas	Pouce Coupe	NPS16/4/4, 2010: 1619m

Training and Certification

- Standard First Aid
- H_2S Alive
- WHMIS
- Petroleum Safety Training (PST)
- Anchor, Descent and Rope Ascent Training
- Construction Safety Training System (CSTS)
- Ground Disturbance for Supervisors and Level II
- Pipeline Construction Safety Training (PCST)

Appendix K – Drilling Mud Plan

Right Turn Supply, LLC.

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October 27, 2023

Mr. Bertolucci,

Further to your recent request regarding a drilling fluids program for the Kennebec River Crossing in Somerset County, NY. We are pleased to enclose the following mud program for your information. This quotation is an estimation of usage and losses of drilling fluid using assumed pump rates and provided geological data. **It assumes best drilling practices and optimum drilling fluids recycling.** As you are aware, the formation to be drilled can be worse than expected or better than expected. Volumes reflect these expectations.

Drilling Fluid Design Considerations

Ensure drilled cuttings are efficiently removed from the borehole by utilizing high LSRV (low shear rate viscosity) fluids to maintain reduced annular pressures while providing excellent bore hole stability and ROP (rate of penetration.)

All drilling fluid components maintain cuttings and borehole integrity and are easily removed by the available solids control system, thus reducing waste volumes.

Drilling fluid components are compliant with local, state and federal criteria for disposal and are all compliant with the appropriate regulatory frameworks.

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Location: Somerset County, NY
Project: New England Clean Energy
Project / Kennebec River Crossing, NY

Overview

All products are developed to provide the best value and ease of use. Products are designed to address a wide range of soil and rock geologies, thus providing stable well bores while removing and suspending drill cuttings during drilling/reaming processes.

From dry and readily dispersible dry products to more concentrated liquid products, the goal is to stay within budget and increase productivity.

With the advancement of new HDD steering and drilling techniques, longer and larger diameter HDD crossings are becoming a reality. An important part of these advancements is the use of drilling fluids that can carry more cuttings faster, across longer distances without allowing them to disperse and/or settle in the flow stream. Thus, annular pressures are minimized while a maximum area is established to accommodate the pipeline.

The drilling fluid should provide excellent hole cleaning, cuttings suspension and bore stability. Entry soils are very unconsolidated, and limestone is possibly permeable. The fluid should be thickened for entry soils and can be maintained at lower viscosity when drilling bedrock.

Running a full mud system will ensure cuttings are quickly removed from the bore and to not accumulate in the bore hole.

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The bentonite-based mud system is designed to address the varying soil conditions to be encountered during the crossing. MaxGel/Super Gel X (Average 15-35 lbs/bbl) will be used as a base along with DrilPlex HDD/Cobble Commander/Sand Force for cuttings suspension, Platinum Pac UL/Trol Force for filtrate control, Poly Plus(sweeps to aid in keeping hole clean) for clay encapsulation and shale control, and Soda Ash for pH control. Clay Force when drilling in reactive clays and shale for clay inhibition and help with bit balling as well as ROP. Lube Force is recommended to help reduce rotational torque and drag.

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Geology

Assumed: Silty Sand, Cobble, Siltstone and Slate

Drilling Fluid System

MaxGel/Super Gel X

MaxGel/Super Gel X are premium Wyoming bentonites, blended with special extenders, producing a product that will yield more than twice as much viscosity as API Wyoming bentonite. MaxGel/Super Gel X are easily mixed with freshwater and extended bentonite systems. It is used to rapidly build mud viscosity and provide superior hole cleaning, as well as to help control lost circulation, formation sloughing and promote hole stability in unconsolidated formations. It is typically used between 15 and 35 lbs./bbl as required.

Yields much faster than API-standard bentonite
Non-toxic and proven suitable for use in all drilling applications
Transportation and storage costs are reduced due to lower treatment
requirements as compared to API bentonite

SODA ASH

SODA ASH is used to condition and soften make-up water and raise pH, allowing drilling fluid additives to mix more efficiently. SODA ASH treats out hardness due to calcium in make-up water and raises pH.

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PLATINUM PAC(all grades)

Platinum Pac polyanionic cellulose is a high-quality, readily dispersible water-soluble polymer designed to control fluid loss, with a minimal increase in viscosity in water-base drilling fluids. Platinum Pac is used where fluid loss control is required, without affecting the beneficial rheological properties of the drilling fluid. Platinum Pac is also effective in flooded reverse drilling where low viscosity fluids are required.

Disperses quickly and produces minimal viscosity increase while providing fluid loss control
Encapsulates shale particles to inhibit swelling and dispersion
Resists bacterial attack, requiring no biocides or preservatives
Functions over a wide range of salinity, hardness and pH levels in most mud systems
Effective in low concentrations for controlling fluid loss and building viscosity
Environmentally acceptable

SAND FORCE

SAND FORCE is a viscosifier designed to be used in HDD. As a rapidly hydrating polymer, it is a functional and economically favorable alternative to xanthan. Unlike Xanthan, SAND FORCE also contributes to fluid loss. SAND FORCE can be used with all HDD slurries and can be added along with other dry additives.

Highly effective viscosifier for carrying cuttings and fluid loss

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DRILPLEX HDD/Cobble Commander

DRILPLEX HDD/Cobble Commander are specialty products used to enhance the gel strengths of bentonite. DRILPLEX HDD/Cobble Commander are inorganic chemical viscosifiers for water-base bentonite drilling fluids.

DRILLPLEX HDD/Cobble Commander viscosifiers allow the formulation of fluids with exceptional shear- thinning properties, resulting in a drilling fluid with both excellent dynamic and static carrying capacity for solids. This is indicated by high-yield point and low plastic-viscosity readings. When not circulating, the mud instantly reverts to a gelled state and results in high suspending capacity indicated by high, non-progressive gel strength readings.

High rate of penetration
Excellent cuttings transport
Excellent cuttings suspension
Borehole stabilization through "gel locking" in the formation

TROL FORCE

TROL FORCE is an anionic fluid loss control agent aimed at HDD. TROL FORCE produces a thin, resilient filter cake which minimizes differential sticking potential. TROL FORCE also provides excellent carrying capacity for cuttings and hole cleaning.

NSF/ANSI 60 approved
Reduces differential sticking
More economical alternative to PAC or CMC
Excellent fluid loss control agent

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POLY PLUS

POLY-PLUS polymer is a high-molecular-weight, anionic liquid designed to provide cuttings encapsulation and shale stabilization. POLY-PLUS additive also acts as a viscosifier, friction reducer and cuttings flocculant. POLY-PLUS polymer can be used in mud systems using makeup waters from freshwater to saltwater.

Effective at concentrations as low as 0.025% by volume
Water soluble
Helps prevent bit-balling on BHA and tooling by coating and lubricating solids
Environmentally friendly

Clay Force

CLAY FORCE Is a liquid clay and shale inhibitor aimed at HDD, water well, and mining applications. CLAY FORCE will reduce bit balling, clay accumulation, and sticking problems experienced when drilling in reactive clay soils. CLAY FORCE can be used with bentonite and non-bentonite based systems and is non-hazardous.

Effective at concentrations as low as 0.025% by volume
Water soluble
Helps inhibit the swelling tendencies of reactive clay
Environmentally friendly

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Lost Circulation

LOST CIRCULATION SPECIALISTS-MAGMA FIBER

MAGMA FIBER is a specially formulated extrusion of spun mineral fiber. The long, flexible fibers will reduce seepage and lost circulation by bridging and plugging off voids, fractures and all types of permeable formation.

Effectively bridges across loss zones
Can be pumped through mud motors
Environmentally safe and non-toxic

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Loss of Circulation Materials (LCM)

LCM pills and sweeps incorporate fibrous and granular products to effectively block the paths of the seepage or whole loss. Magma Fiber will mesh across loss zones and provide a foundation for the blockage where sawdust will further incorporate itself into the structure. High viscosity base bentonite/Drill Plex HDD/Cobble Commander fluid will further slow the migration of drilling fluid into loss zones and form extremely high gel strengths around the loss zone.

Recommended properties and maintenance

As mud engineering is not confirmed for this project, drilling fluids monitoring and maintenance will depend on the experience of the drilling foreman, driller, and tank hands, as well as available testing equipment on location. Wherever possible, API RP 13B-1 should be followed when monitoring drilling fluid parameters. An application guide is provided for field personnel with additions for each section of the bore. All drilling fluid additive concentrations must be maintained for fresh water added, including make-up volume for disposed fluids.

Viscosity

The funnel viscosity of the drilling fluid will depend on the diameter of the section of hole being drilled or reamed and the nature of the drilled cuttings being removed. It is a simple measurement that indicates how much thicker the fluid is in relation to water (26 seconds/quart). Crews can monitor the funnel viscosity of the fluid to maintain recommended mud properties and determine if the formation being drilled is contributing to an increase in viscosity. As a result, clay control additives can be adjusted to further improve clay and shale stability.

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Similarly, in unconsolidated formations like sand, silt and gravel, viscosity increases will improve cuttings transport and suspension. Continuous monitoring of the funnel viscosity in these formations will ensure the drilling fluid maintains optimum performance.

Sand Content

Sand content is normally maintained below 1 %. Excessive sand in the drilling fluid can cause premature wear on circulating pumps, piping, and mud motors. Periodic sand content tests by crews can effectively determine formation (geology) changes as well as deficiencies in the cleaning system. Holes in shaker screens and plugged hydrocyclones can cause rapid increases in the sand content and should be repaired immediately.

Density (mud weight)

The mud density should be maintained as low as possible. Continuous mud density monitoring by tank hands can expose deficiencies in the circulating system such as holes in shaker screens, plugged hydrocyclones and poor centrifuge performance. Excess density will increase hydrostatic pressure and could cause inadvertent losses into weak formations. Excess solids due to higher mud weight can also affect the rate of penetration.

Fluid Loss (API Filtrate)

High yield bentonite on its own does provide some fluid loss control but often additives are required for unconsolidated formations or reactive clay formations demonstrating a higher dispersion potential. PLATINUM PAC provides fluid loss control and crews can monitor fluid loss if there is a filter press on location. Maintaining acceptable parameters for fluid loss can prevent hole collapse and clay/shale hydration.

pH, Hardness & Chlorides

Testing the make-up water before mixing drilling fluid products will determine compatibility and

potential contamination. Recommended drilling fluid additives are designed to mix efficiently in any make-up water but there are exceptions. Very high hardness levels can restrict bentonite and additive hydration and salt content over 5000 ppm can reduce the hydration potential of bentonite products. Soda ash or sodium bicarbonate is normally added to treat contaminated hard water sources. Higher salt content may require the use of specialty additives if the source water cannot be replaced. Resulting pH and hardness following mixing can also be determined by the filtrate from the fluid loss test (API filtrate).

Rheology

Crews are often trained on the use of electric and hand crank viscometers and additional fluid properties can be checked during the shift. Increases in plastic viscosity are often an indication of increases in mud weight due to excess solids and low gravity solids dissolution. Maintaining the mud weight as low as possible will result in a lower plastic viscosity. Slight changes in additive concentrations may better consolidate cuttings and reduce sloughing and swelling in HDD bores.

Yield point and low-end rheology (6/3 RPM) properties determine the ability of the fluid to efficiently clean cuttings from the borehole by maintaining the appropriate flow regime for HDD bore path lengths and angles. Elevated properties may provide solutions to reduce torque, drag, annular pressures, and seepage losses.

Gel strengths (10 sec/10 min) indicate the ability of the drilling fluid to “stiffen” and provide a matrix for effective cuttings suspension. Gel strengths should be higher and flatter in HDD fluids to provide immediate suspension and reduce the tendency of cuttings to form beds. These cuttings beds may accumulate as annular blockages that can affect fluid flow and annular pressures.

These tests are normally performed by mud engineers. We recommend mud engineering on all crossings.

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Crossing Specifications and Mud Volumes

Length:	**3421'**
Pilot:	12.25 inches
Casing:	NA
Product:	(7) 10" DR-14 FPVC Bundled
Reaming Stages:	30", 42", 48", 50"
Formation:	Silty Sand, Cobble, Siltstone and Slate
Mud Motor:	8"
Rig:	750x900 Vermeer and DD 140
Tank Volume:	9300 gal.
Total Fluid:	579,728 gal.

Mud Volume Calculations for Pilot

12.25" Pilot Bore	
Hole Volume per Foot:	6.12 gallons/foot
Recommended Pump Rate: (ROP = 15 mins/joint)	260 GPM
Hole Volume:	20,945 gallons
Mud to Pump:	430,383 gallons
Mud Lost (3%):	12,911 gallons

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Mud Volume Calculations for Ream Pass

30” Ream Pass	
Hole Volume per Foot:	36.72 gallons/foot
Recommended Pump Rate: (ROP = 20 mins/joint)	500 GPM
Hole Volume:	125,620 gallons
Mud to Pump:	1,103,548 gallons
Mud Lost (3%):	33,106 gallons

42” Ream Pass	
Hole Volume per Foot:	71.97 gallons/foot
Recommended Pump Rate: (ROP = 25 mins/joint)	550 GPM
Hole Volume:	246,216 gallons
Mud to Pump:	1,517,379 gallons
Mud Lost (3%):	45,521 gallons

48” Ream Pass	
Hole Volume per Foot:	94.00 gallons/foot
Recommended Pump Rate: (ROP = 30 mins/joint)	550 GPM
Hole Volume:	321,588 gallons
Mud to Pump:	1,820,854 gallons
Mud Lost (3%):	54,625 gallons

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50” Ream Pass	
Hole Volume per Foot:	102.00 gallons/foot
Recommended Pump Rate: (ROP = 35 mins/joint)	600 GPM
Hole Volume:	348,945 gallons
Mud to Pump:	2,317,451 gallons
Mud Lost (3%):	69,523 gallons

Mud Volume Calculations for Swab Pass

42” Swab Pass	
Hole Volume per Foot:	102.00 gallons/foot
Recommended Pump Rate: (ROP = 10 mins/joint)	600 GPM
Hole Volume:	348,945 gallons
Mud to Pump:	662,129 gallons
Mud Lost (2%):	13,242 gallons

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Additive Concentrations

Stage	MAX GEL/Super Gel X	DrilPlex HDD/Cobble Commander	Platinum Pac UL/Trol Force	Poly Plus(Sweeps)	SODA ASH	Lube Force
1000 gal.	7 BAGS	35 lbs. (1 bag + 4 viscups)	4-6 lbs. (2-3 viscups)	½ viscup in DP every 3-4 connection	8-12 lbs. (4-6 viscups)	1 GAL

Batch Mixing per 1000 Gallons

NOTE: Adjust water pH first with Soda Ash. pH level needs to be 9.5 – 10
NOTE: Mix MAX GEL/Super Gel X 2nd and let hydrate for 5 minutes
NOTE: Add DrilPlex HDD/Cobble Commander and Plat Pac UL /Trol Force through the hopper
NOTE: Add PolyPlus Sweeps, every 3-4 connections,1/2 viscup straight into the drill pipe, to sweep the hole as needed
NOTE: Add 1 gallon of Lube Force per 1000 gallons of mud. Drizzle over clean tank while pumps are on and drilling.

Properties

Stage	Stage Funnel Viscosity (sec/qt)	Mud Weight (lb/gal)	Sand Content (%)	Plastic Viscosity (CP)	Yield Point (lb/100 ft2)	Fluid Loss (mL)	Hardness (ppm)	pH
Pilot	**50-55**	**8.8 - 10**	**<1 %**	**9 - 15**	**24+**	**<15**	**< 100**	**9.5 - 10**
Ream (s)	**75-100**	**8.8 - 10**	**<1 %**	**12-18**	**60-90**	**<15**	**< 100**	**9.5 - 10**
Swab Pass	**75-100**	**8.8 - 10**	**<1 %**	**12-18**	**60-90**	**<15**	**< 100**	**9.5 - 10**

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Estimated Usage(including 50" Final Pass) to complete Kennebec River Crossing utilizing the 10:1 Ratio, Cobble Commander/DrilPlex HDD Mud System

Product	Lbs/Unit	Units per pallet	Total # of Units needed	Total # of Pallets needed
MaxGel/Super Gel X	**50**	**70 bags**	**4,194**	**59.92**
Cobble Commander	**25**	**32 buckets**	**839**	**23.30**
Soda Ash	**50**	**32buckets**	**140**	**4.37**
Lube Force	**5 gal**	**32 buckets**	**235**	**7.34**
PlatPac UL/TrolForce	**25**	**32 buckets**	**118**	**4.76**

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