TECHNICAL MEMORANDUM

DATE April 30, 2020 **Project No.** 19117796

TO Gary Schwerin
Michigan Department of Environment, Great Lakes, and Energy

CC Brad Runkel, Harold Register, Caleb Batts

FROM John Puls **EMAIL john_puls@golder.com**

J.C. WEADOCK GENERATING FACILITY REVISED CLOSURE PLAN REVISION 01, J.C. WEADOCK LANDFILL, BAY COUNTY, MICHIGAN, WDS 395457

1.0 INTRODUCTION

On behalf of Consumers Energy Company (CEC), Golder Associates Inc. (Golder) is providing this Technical Memorandum (Memo) to the Michigan Department of Environment, Great Lakes, and Energy (EGLE) Materials Management Division (MMD) to facilitate a resolution to the planned closure activities at the J.C. Weadock Generating Facility (JC Weadock) Solid Waste Disposal Area (Weadock Disposal Area). This Memo is intended to:

- Provide historical background and regulatory status of the Weadock Disposal Area
- Summarize the findings of the existing transmission tower distribution system
- Establish basis for why achieving 2% grades inside slurry wall isn't prudent and/or feasible
- Evaluate three final closure design alternatives
- Propose final design alternative criteria and associated variance requests

1.1 Facility Background

The JC Weadock Disposal Area went into service at the time the JC Weadock Power Plant first started to generate electricity in 1940 (AECOM, 2009). The disposal area divided into Ponds A-F was hydraulically operated on approximately 156-acres located to the east of the now decommissioned JC Weadock generating plant. The JC Weadock Disposal Area was laterally expanded to the east in 1972 when an additional 136-acres were enclosed with constructed perimeter containment dikes forming the current day boundaries of the disposal area. The disposal area is bounded on three sides by the Saginaw Bay, Taycee Drain, and the Combined Discharge Channel.

In April 1992, the Michigan Department of Natural Resources (MDNR) issued Construction Permit 0260 to construct a vertical expansion of the Weadock Disposal Area and change operations to a Type III low hazardous industrial waste landfill. Engineering improvements to the Weadock Landfill since the construction permit was issued include installation of the soil-bentonite slurry wall, which was largely constructed in 2008. Additionally, operational improvements to the Weadock Landfill were realized in February 2009 when CEC discontinued the sluiced fly ash operation and switched exclusively to a dry fly ash handling system that sent fly ash to a single storage silo located adjacent to the Weadock Bottom Ash Pond. This mechanical system was replaced in 2014 when DE Karn Units 1&2 were upgraded to a Spray Dry Absorber (SDA) system, and the commingled SDA and fly ash were sent to a storage silo dedicated each for Karn 1&2 located adjacent to the generating unit.

The first revision to the final closure plan originally approved in the construction permit was developed by AECOM in 2011 (2011 Revised Closure Plan) to accommodate provisions of License Special Condition 20.d (from Operating License No. 9233). This special condition specifically requested that CEC "submit a revised closure plan that included evaluations of the potential benefits of improving the final cover design to an impermeable cover of the ash landfill cells, to reduce precipitation infiltration and pollutant source minimization and migration to leachates, groundwaters, and surface waters." The 2011 Revised Closure Plan was submitted to the Michigan Department of Environmental Quality (MDEQ) in December 2011 and the closure plan was incorporated by reference as documentation approved subsequent to the Construction Permit in the most recent Solid Waste Disposal Operating License No. 9440 (issued June 26, 2019). Subsequently, License Special Condition 20.d (as well as other special license conditions) was satisfied with the issuance of Solid Waste Disposal Operating License No. 9440.

In addition to the engineering and operational improvements described above, CEC has continually worked towards the timely and efficient closure of the JC Weadock Landfill. Beginning in July 2015, CEC regraded and stabilized the northeast corner of the Weadock Landfill, historically referred to as Pond F, to convey stormwater run-off to the improved stormwater drainage structures and route it to the National Pollutant Discharge Elimination System (NPDES) outfall generally on the north side of the landfill. Additionally, the vent closure project occurred in 2018 which extended the slurry wall between the 2008 endpoints, and the slurry wall now fully encompasses the Weadock Disposal Area.

Early in 2018, the new CCR generation rates were determined to have been significantly reduced with the decommissioning of JC Weadock Units 7&8 and the planned decommissioning of DE Karn Units 1&2 by 2023. CEC has a limited potential volume of CCR from Karn Units 1&2 available to reach the closure grades shown in AECOM's 2011 Revised Closure Plan, which allows 11,200,000 cubic yards (CY). Other sources of CCR authorized by the current operating license include CCR collected from the DE Karn and JC Weadock Bottom Ash Ponds which collectively only provide approximately 650,000 CY towards the air space requirement for final grades. One additional source of approved company-generated CCRs is from the BC Cobb site, however it is limited to 750,000 CY, still less than the air space need.

While the significant reduction in required airspace is typically considered an additional improvement, the reduction in available CCR material to meet planned closure grades implies that either clean, offsite borrow must be imported to meet the grades or the presently planned grades must be revised. Since funds generated through public ratepayers ultimately supports site closure work and after other natural resource, environmental, and practical considerations; CEC ultimately decided to undertake the redesign effort to reduce the potential need for offsite fill and to make additional design improvements similar to those implemented at the DE Karn Landfill. Additionally, the significant reduction in landfill volume, waste, and accelerated closure timeline achieved by reducing the required volume is perceived as an environmental benefit.

1.2 November 2018 Revised Closure Plan

In November 2018, Golder submitted the proposed 2018 Revised Closure Plan. The primary objective was to minimize the impact to the design, given the limited volume of CCR available to achieve closure grades, inclusive of interior stormwater drainage features, as an improvement to the 2011 Revised Closure Plan. These features were geometrically constrained by the number and location of transmission towers. The presence of the towers limits excavation near each tower's base and also limits fill around the base and under wire alignments. In many locations, therefore, stormwater drainage discharge is governed by the tower's lines and base relative to the elevation of the perimeter outlet. The November 2018 Revised Closure Plan and final cover design was developed as a substantial improvement over the existing AECOM 2011 Revised Closure Plan by reducing the airspace required for closure to 2,400,000 CY (8,800,000 CY reduction). Additional improvements consisted of a reduction of final cover areas sloped less than two percent (reduced from 22 acres to only 2 acres) and elimination of 22,000 lineal feet (LF) of interior ditches sloped at 0.1 percent (with proposed ditches primarily sloped at 0.5 percent and only a single central ditch sloped at 0.3 percent). The proposed 2018 Revised Closure Plan used positive design features successfully constructed at the DE Karn Landfill, including liner offsets of 10 feet from transmission towers, central ditching with minimum 0.3 percent slopes, augmented drainage materials, and strategic placement of drain tile along engineered drainage corridors.

2.0 SUMMARY OF EVENTS SINCE 2018 REVISED CLOSURE PLAN SUBMITTAL

EGLE did not approve the 2018 Revised Closure Plan and instead, requested CEC to investigate:

- Options to provide full coverage of the solid waste with geomembrane liner,
- Options to increase waste slopes within the landfill footprint,
- Options to eliminate or minimize ditches located over solid waste,
- Options to provide 1% minimum slopes in all ditches within and around the landfill, and
- Options to maintain all areas of the landfill above the 100-year floodplain.

Subsequently, CEC and Golder have been actively engaged with EGLE over the past 16 months addressing comments, attending meetings, and evaluating multiple design modifications striving towards an approvable closure plan design. Appendix A provides a summary of events beginning with the submittal of the 2018 Revised Closure Plan.

3.0 KARN-WEADOCK DISTRIBUTION SYSTEM

A significant design element of the investigation requested by EGLE was determining the best way to resolve constraints presented by the transmission infrastructure. In December 2019, CEC and Golder provided the infrastructure owner, International Transmission Company (ITC) with closure alternatives to be evaluated for timing, permitting/ regulatory approvals, engineering/risk considerations and cost.

Consideration was given for relocation of all transmission infrastructure from Weadock Landfill. This option is not considered prudent or feasible for the following reasons:

- Timing: Six to seven years are required for ITC to plan, design, and construct the transmission infrastructure relocation which would significantly delay closure of the landfill, assuming this option would be permissible
- Permitting: Significant permitting uncertainty exists for relocation of all transmission infrastructure related to Midcontinent Independent System Operator (MISO) approval, wetland and waterway impacts, and Federal Aviation Administration (FAA) considerations
- Engineering: Concerns exist with constructability to locate the new alignment for the transmission infrastructure with limited space available
- Cost: ITC is unable to estimate a cost for relocation of all transmission infrastructure given the magnitude of the project and the many uncertainties noted above

However, ITC was able to determine that replacing lattice towers and existing monopoles in kind with raised monopoles to provide sufficient line clearance is constructible and does not significantly impact the closure schedule for the landfill. Therefore, three final alternatives were evaluated as provided in Section 4.0.

4.0 FINAL ALTERANTIVES SUMMARY

Once the lattice towers and existing monopoles were eliminated as a design constraint, investigation of options focused primarily on how final closure grades and stormwater drainage could be optimized relative to the May 6, 2019 request. Three primary final cover design and stormwater drainage considerations discussed in detail with EGLE remained – Consolidation Design, No Interior Ditch Design, and Interior Ditch Design. Each of these alternatives is discussed in further detail below.

4.1 Alternative 1 – Consolidation Design

Alternative 1 (Figure 1) considered consolidating the landfill footprint by excavating CCR from the Northeast Section of the Eastern Disposal Area (commonly referred to as Pond F) to effectively clean close a section of the landfill in order to reduce the acreage of CCR disposal that would need to receive final cover and necessitate long-term care. The potential benefits of consolidating the landfill footprint are:

(1) The excavated CCR from the Pond F location would eliminate the need for Interior Ditching at less than 2% slopes. As depicted in Figure 1 below, the location and extents of the excavation can be integrated with the final cover design for the remainder of the Weadock Landfill. One of the critical elements of analysis for the final cover design necessitates analysis for design offsets to not meeting the regulatory requirement for 2% minimum grades over waste. The consolidation alternative is conceptually designed to eliminate interior ditching at less than 2% grades but still necessitates exterior ditching that would be designed with minimum 1% slopes to the stormwater stilling basins.

(2) The utilization of the excavated CCR to achieve 2% minimum final grades in the remainder of the landfill. The excavated CCR would act as a direct replacement for imported clean offsite soil used as backfill.

(3) The potential for restoration of the consolidation footprint back to prevailing regional usage as shoreline along Saginaw Bay. This would lead to reduced acreage of land necessitating long-term institutional and/or engineering controls.

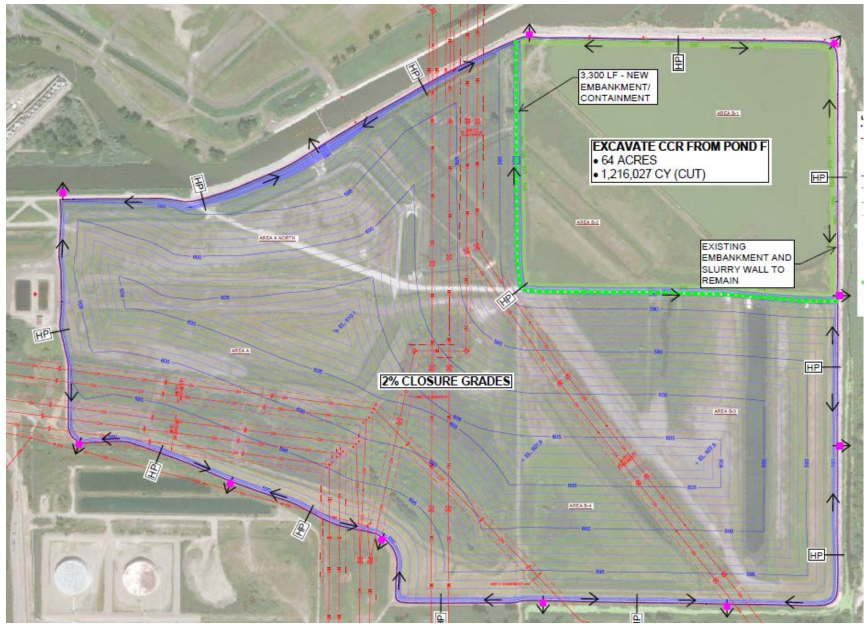

Figure 1 - Consolidation Design Option

A similar concept of excavating stored or disposed CCR at the Karn-Weadock complex with the intent of consolidating the disposal into an existing, on-site disposal unit was used to complete closure of the DE Karn Bottom Ash Pond in 2019 and work is anticipated to be completed for the JC Weadock Bottom Ash Pond in 2020. The work generally proceeds by lowering the water table within the area of excavation to maintain stability of the base and then excavating the stored CCRs and other solids residuals "in-the-dry" so that they may be readily transported to the JC Weadock Landfill for disposal. The multiple lines of evidence approach described in the work plans used to document CCR removal provided a predictable and reliable means to objectively measure concentrations of CCR based on physical sample properties. Once solid residuals are removed, source area controls would have been effectively implemented leaving residual groundwater contamination that can be managed through longer-term monitoring and corrective action.

4.1.1 Consolidation Design Risks

To evaluate the feasibility of excavating CCRs from Pond F to consolidate in the JC Weadock Landfill, the existing environmental controls, construction effort, and short-term and long-term environmental impacts were evaluated.

1) **Efficacy of Developing Clean Closure Removal Standard for Excavation Footprint**
One of the benefits from the consolidation scenario is the attainment of Clean Closure that would provide for restoring the disposal footprint to similar adjacent land-use (i.e. shoreline for Saginaw Bay). In terms of CCR materials, CEC and Golder have defined (with EGLE approval) that clean closure means 10% of CCR left in place based on a colorimetric method calibrated for site conditions once the excavation has been completed to the target elevation (first line of evidence) and visual comparison documented through photographic evidence (second line of evidence). This requires

some over excavation beyond the known limits of CCR for confirmation purposes. In the case of the Weadock Landfill, this would require excavation into the native sediment layer present as part of the historic shoreline of Saginaw Bay. This over excavation will make the site subject to the additional testing and monitoring requirements associated with a sediment removal project. Water Resources Division developed the *Sediment Testing for Dredging Projects* Policy and Procedure WRD-048 dated April 13, 2018 (Appendix B) that defines the Dioxins and Furans Test Area that encompasses the area inclusive of the Weadock Landfill and develops a *presumption* of contamination that must be rebutted through analytical testing in order to approve dredge projects.

Since the basis and criteria for achieving a clean closure will necessitate sediment testing for contaminants such as dioxins, furans, and polychlorinated biphenyls (PCBs) to determine if removal has been achieved, meeting a clean closure standard without the need for further institutional and engineering controls is not reasonable for the existing extent of CCR disposal of the Weadock Landfill. Therefore, any post-excavation state for the Pond F excavation would maintain the existing berm and soil-bentonite slurry wall to ensure water quality standards are protected and sediment mobilization is minimized as a result of an excavation project consistent with WRD-048.

A stability evaluation of the existing berm and slurry wall with CCR removed from the consolidation footprint and a stability evaluation for a new berm and slurry wall was completed and included in Appendix C. The stability evaluation concluded that both the existing berm/slurry wall and new berm/slurry wall would be stable to execute the consolidation of the Weadock Landfill.

2) **Efficacy of Achieving Clean Closure Groundwater Standard for Excavation Footprint**
Related to achieving the standard of removing CCR, the regulatory standard for achieving clean closure also necessitates meeting groundwater protection standard (i.e. standards promulgated for drinking water or risk associated with no controls present). One of the potential benefits from the consolidation scenario is the attainment of Clean Closure that would provide for restoring the disposal footprint to similar adjacent land-use (i.e. shoreline for Saginaw Bay). This benefit would include restoring groundwater within the excavation footprint to a point where it would no longer require obligations for administrative and/or engineering controls once the closure (excavation of CCR and other residuals) was completed.

In terms of CCR materials, CEC and Golder have defined with EGLE approval that clean closure means 10% of CCR left in place based on a colorimetric method calibrated for site conditions once the excavation has been completed to the target elevation (first line of evidence) and visual comparison documented through photographic evidence (second line of evidence). This requires some over excavation beyond the known limits of CCR for confirmation purposes. In the case of the Weadock Landfill, this would require excavation into the native sediment layer present as part of the historic shoreline of Saginaw Bay. This over excavation will make the site subject to the additional testing and monitoring requirements associated with a sediment removal project. Water Resources Division developed the *Sediment Testing for Dredging Projects* Policy and Procedure WRD-048 dated April 13, 2018 (Appendix B) that defines the Dioxins and Furans Test Area that encompasses the area inclusive of the Weadock Landfill and develops a *presumption* of contamination that must be rebutted through analytical testing in order to approve dredge projects.

Since the basis and criteria for achieving a clean closure will necessitate sediment testing for contaminants such as dioxins, furans, and polychlorinated biphenyls (PCBs) to determine if removal has been achieved, meeting a clean closure standard utilizing the colorimetric standard calibrated against a list of CCR constituents would not reasonably establish a basis of removal for the additional list of constituents for the Dioxin and Furan Test Area. Additionally, based on the presumption of contamination from historic sources unrelated to power generation at the Karn-Weadock complex, it is reasonable to believe that any post-excavation state for the Pond F excavation will require the need for further institutional and engineering controls as part of the final long-term environmental stewardship.

3) **Efficacy of Achieving Long-Term Environmental Benefit from Consolidation Excavation**
The long-term environmental policy perspective supporting excavating a portion of the landfill is land re-use and redevelopment (US EPA, 80 FR 21301, pg. 21,412). However, based on the lack of feasibility of achieving Observations No. 1 and No. 2 above, it is reasonable to conclude that the clean closure standard of achieving removal of CCR, decontamination of the unit and the area, and attainment of Groundwater Protection Standard at each of the downgradient monitoring wells is not achievable. At a minimum, it is reasonable to conclude that the existing perimeter embankment and slurry wall will need to remain in place since that engineered system has been demonstrated to be competently eliminating venting groundwater discharges. The long-term maintenance of the Pond F excavation footprint necessitating the continued land-use restrictions of use within the excavation footprint and maintenance of the engineered berm and soil-bentonite slurry wall limits the re-use and redevelopment potential of the Pond F excavated footprint to ancillary facilities to primarily support stormwater management.

4) **Construction Dewatering Effort**
In order to conduct excavation “in-the-dry” to minimize redistribution of excavated solids and other residuals and collect representative solid media for quality assurance testing, a substantial construction dewatering program will be necessary. In order to complete the excavation, the groundwater table will require lowering by 7-feet to as much as 11-feet over 64-acres.

The scale and duration of this construction dewatering program is not considered prudent because it represents an unreasonable risk to operational compliance to the outfall due to the sustained increase in flow volume through outfall. Additional treatment may be necessary prior to discharge and would be considerable difficult on this scale over this time period. Therefore, the risks associated with a significant dewatering effort for the sake of supporting the construction of 2% grades over waste is not prudent.

5) **Containment and Stability of Relocated Materials**
A subsurface investigation within Pond F in the past indicates that the bulk of the sluiced ash has a very low strength. Boring logs taken from Pond F recorded the strength relative to the Standard Penetration Test (STP), ASTM D-1586, with an "N-value" or blow counts to achieve a 12-inch penetration as low as 0 (weight of hammer). Appendix C provides the boring logs for the subsurface investigation near Pond F. That material once excavated would be hauled to the balance of the Weadock Landfill footprint and be deposited. The estimated volume of the displaced material is approximately 1,200,000 CY or may be thought of in terms of the subgrade across the remaining Weadock Landfill footprint of approximately 3.7 feet that will be supporting the construction of the final cover. The process of excavating, hauling, depositing, and containing the material while it is allowed to drain and gain strength would likely pose other environmental challenges. These challenges include adequately managing the sedimentation from the gravity drained material prior to discharge through the NPDES outfall or suspension of ash near the surface when it dries at a faster rate due to the surface area contact causing the CCR to be at risk for aerial dispersion and potentially contributing to increased fugitive dust emissions. Therefore, the risks associated with excavating 1,200,000 CY of stable, in place CCR for the sake of supporting the construction of 2% grades over waste is not prudent.

6) **Closure Timeline**
There is a 1-2-year increase in closure timing as compared to Alternative 3 as summarized in Table 1 below.

Table 1 - Closure Timeline Comparison

Alternative	CCR Excavation (MCY)	CCR Disposal Volume (MCY)[1]	Offsite Clean Fill (MCY)	Excavation/ Placement Rate (CY/Day)	Fill Duration (Years)
Alternative 1 – Consolidation Design	1.2	1.5	1.4	3,500	4.5
Alternative 2 – No Interior Ditch Design	0	1.5	2.5	3,500	4.4
Alternative 3 – Interior Ditch Design	0	1.5	1.3	3,500	3.1

Notes: 1) Includes 4-years of Karn 1-2 generation (100,000 cy/year), BCC Cobb and JC Weadock Bottom Ash Pond

Therefore, CEC and Golder conclude that the closure timeline will be extended between 1-2 years for both Alternatives 1 and 2 when compared to Alternative 3. Based on this estimate, closure timeline is not a critical factor for determining prudent and feasible alternatives.

4.1.2 Consolidation Option End State Evaluation

Three conceptual options were developed for the end state of the consolidation excavation footprint. Conceptualization starts with the least amount of risk mitigation (unlined pond put into service without any other appurtenances except a principal spillway) to backfilled excavation area that is graded to capture stormwater runoff in a “clean” footprint and convey it into a perimeter stormwater ditch system. These options are identified and explained in greater detail below.

Option 1 – Unlined Pond: The unlined pond concept consisting of the excavated Pond F footprint and new interior berm graded to stabilize the new stormwater pond fully enclosed by a soil-bentonite slurry wall to isolate the excavated Pond F footprint from the rest of the Weadock Landfill. This newly created pond would have an outlet structure designed with a minimum discharge elevation of 586.0 (NAVD88), 1-ft above the 100-year flood elevation resulting in the creation of a 768-acre-ft dam necessitating regulation under Michigan’s Dam Safety Act (Part 315 of Act 451 NREPA). Michigan’s Dam Safety Act regulates all dams greater than 6-ft high that impound 5 or more surface acres at the design flood elevation. Lower discharge elevations were considered but are not considered prudent given a discharge elevation set at the Ordinary High Water Mark of 581.61 ft would impound water at a depth of more than 7-ft covering the 64-acre footprint without the offsetting benefit of eliminating regulation under the Michigan’s Dam Safety Act. Lowering the discharge elevation also induces additional risk for backing water up into the pond from shorter return period events. The risk of the water backing into the pond is currently even greater with recent high Great Lakes water levels.

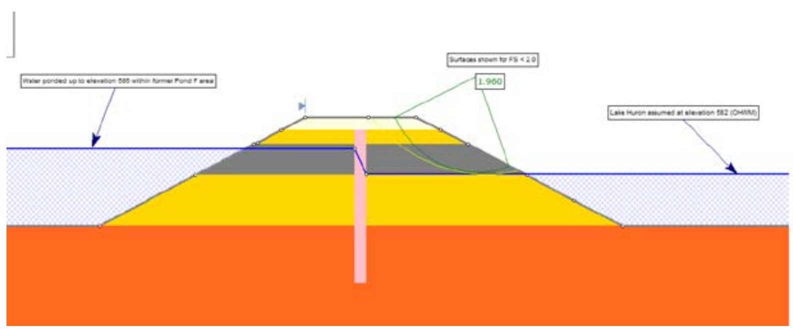

Figure 1 - Pond Cross Section

Therefore, an unlined pond is not considered to be prudent due to the long-term hazard of constructing and operating a large stormwater storage and treatment basin immediately adjacent to Saginaw Bay (Lake Huron). The risk associated with a potential dam breach are considered substantial and unwarranted. Additionally, long-term environmental impacts are present due to the remaining potentially contaminated sediment that may also resuspend within the pond and be discharged to Saginaw Bay.

Option 2 – Lined Pond: The lined pond concept is identical to Option 1 with the improved design component that adds a geomembrane liner and 1-ft of aggregate ballast designed for the pond bottom. This design improvement would improve interior slope stabilization and mitigate the potential for potentially impacted natural sediment from the base of the pond to resuspend through operation within the pond; however, this pond design would remain a significant dam (704 acre-ft) regulated under Michigan's Dam Safety Act. The lined pond concept is not considered to be prudent due to the long-term hazard of constructing and operating a large stormwater storage and treatment basin immediately adjacent to Saginaw Bay (Lake Huron). The risk associated with a potential dam breach are considered substantial and unwarranted.

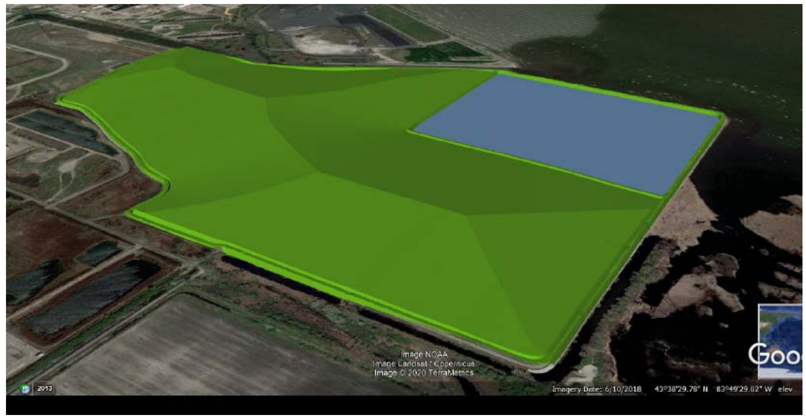

Figure 3 – Lined Pond Rendering

Option 3 – Backfilled Area: The backfilled area concept eliminates the risk of creating a regulated dam by backfilling the excavation area. Option 3 requires importing a minimum of 1,400,000 CY of offsite clean soil to be used as fill graded to drain to an outlet structure with a minimum discharge elevation of 586.0 (NAVD88). This end-stage concept eliminates the risk of resuspended sediments at the base of the unlined pond concept presented in Option 1 and eliminates the risks and hazards of constructing a large volume dam as presented in Options 1 and 2 but adds a new risk for obtaining 1,400,000 CY of offsite clean soil for backfill. Backfill volumes may be reduced by 400,000 CY if the stormwater discharge elevation was lowered to the OHWM of 581.61. However, backfill volumes remain substantial and unwarranted risk is induced for the potential to back water into the backfilled area from Saginaw Bay.

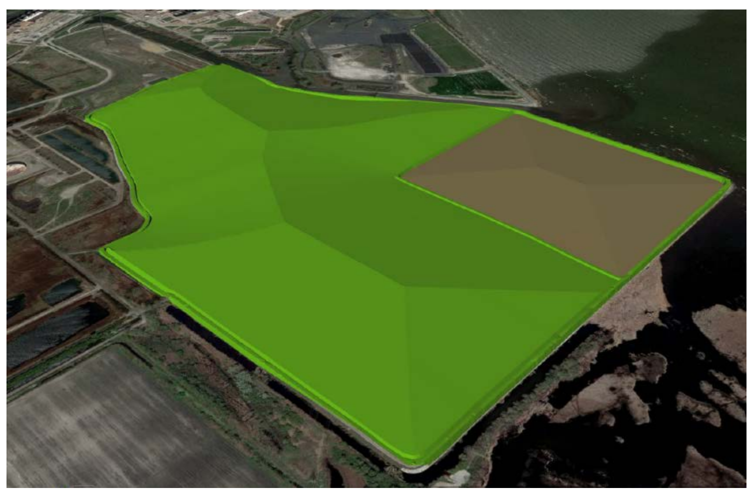

Figure 4 – Backfilled Pond Rendering

Therefore the total volume of material to be managed under Option 3 is substantially greater than material management under Options 1 or 2. The total volume is measured in two major divisions of work consisting of 1) excavation of 1,200,000 CY of CCR and potentially contaminated sediment to achieve the removal of CCR from the Pond F footprint similar to Options 1 and 2 and 2) utilization of the excavation materials to construct final closure grades in the remainder of the Weadock Landfill to a minimum of 2.0% interior grades. The additional earthwork to backfill with 1,400,000 CY of clean soil from an offsite source considered necessary to identify a risk-benefit trade-off or this alternative – in the case of Option 3 (Backfilled Area) the stormwater feature is constructed in a manner that doesn't create a significant dam. Based on the associated environmental and sustainability considerations leading to Option 3 – Backfilled Area presenting the least risk based on existing environmental controls, construction effort, and short-term and long-term environmental impacts, Alternative 1 (Consolidation) is not considered feasible and prudent:

- (*Prudent*) Environmental containment of a large volume (1,200,000CY) of extremely low shear strength waste material deposited across the surface of an existing landfill and that by necessity must drain to gain strength to support closure operations all while proximate to a significant natural resource (Lake Huron) is a risk that should be avoided if possible.
- (*Prudent*) Procuring, excavating, and transporting 1,400,000 CY of clean soil to place in the excavated footprint associated with the removal of 1,200,000 CY of CCR and presumably contaminated sediment for the sake of meeting 2% grades over waste even though the filled area still requires monitoring and long-term management.
- (*Prudent*) Excavating (approximately 1,200,000 CY) and backfilling with clean soil (approximately 1,400,000 CY) for a total of approximately 2,600,000 CY of moved material – an excess of 5 yr of total solid waste disposal capacity identified in the Bay County Solid Waste Management Plan without eliminating the need to continue administrative and engineering controls for the area of excavation and backfill. The scale of clean soil procurement combined with excavation and replacement of CCRs and presumed contaminated sediment is inconsistent with Michigan's policy on resource conservation.
- (*Prudent*) The construction of a lined pond will constitute the development of a dam under Michigan's Dam Safety Act (Part 115 of Act 451 of NREPA) and necessitate 64-acres of geomembrane liner that would be designed to hold 704 acre-ft of water compared to 3 acres of water for all internal ditches, noting that the ditches would hold no more than 2-ft of water for the 25-yr, 24-hour design storm event (6 acre-ft equivalent).

4.2 Alternative 2 – No Interior Ditch Design

Alternative 2 (shown on Figure 5) provides a design with two percent minimum overland slopes that drain to a series of one percent perimeter ditches that outlet via stilling basins. ITC confirmed that impacted transmission towers that needed to be replaced with a monopole structure and/or raised, could be replaced within three to four years based on the Alternative 2 layout with no major permitting or constructability issues. However, this alternative would require CEC to secure approximately 2,500,000 CY of clean soil from offsite sources to achieve the final closure grades. This tremendous clean fill volume would require approximately 230,000 roundtrips for haul trucks to and from the borrow source along with emitting over 39 million pounds of CO_2 into the atmosphere. Securing such a large volume of fill also brings risk on the timely closure of the landfill to secure reliable fill sources and increases the overall closure timing of the landfill by approximately 2-years when compared to Alternative 3. To put the fill volume in perspective, the 2,500,000 CY is equivalent to 10 years of industrial waste disposal and 5 years of solid waste disposal needs for Bay County. Therefore, due to the offsite fill volume necessary to close the landfill with a minimum of 2.0% interior grades and the associated environmental and sustainability considerations Alternative 2 is not considered feasible and prudent because:

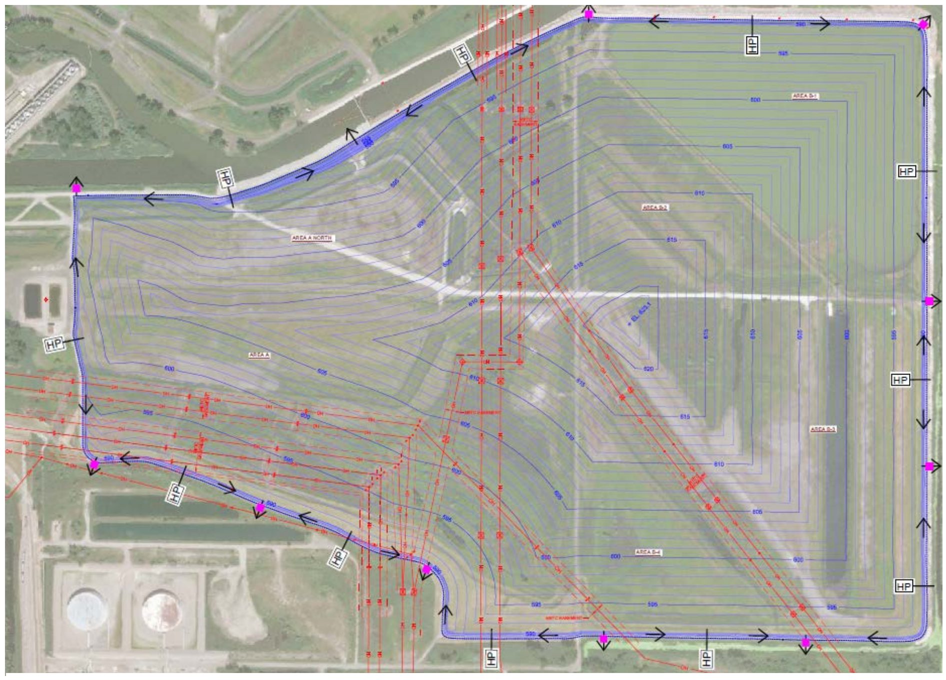

Figure 5: Alternative 2 - No Interior Ditch Design

- (*Feasible*) Procuring, excavating, and transporting 2,500,000 CY of clean soil to place in waste disposal air space for the sake of meeting 2% grades may not be achievable as Consumers Energy has not identified a source for this much material.
- (*Prudent*) Utilizing 2,500,000 CY of air space – the equivalent of 5 yr of total solid waste disposal capacity identified in the Bay County Solid Waste Management Plan with clean soil is inconsistent with Michigan's policy on resource conservation.
- (*Prudent*) The approval of the 1992 construction permit was based on a final cover that did not meet "infiltration minimization" standards. Improvements proposed in Alternative 3 to Alternative 2 final cover design have not only substantially improved the ability to minimize infiltration through materials

(geomembrane, geonet) but also include increased positive drainage to the overland flow and restricted stormwater ditching to channel ditching to no more than 6,000 LF (previously 20,200 LF).

- (Prudent) The approval of the 1992 construction permit was based on a final cover that did not meet "infiltration minimization" standards. Procuring, excavating, and transporting 2,500,000 CY of clean soil to place in waste disposal air space for the sake of meeting 2% grades to meet a regulatory standard of minimizing infiltration is not prudent when the construction permit authorization did not require meeting the regulatory standard and improvements proposed in Alternative 3 to the final cover design for stormwater drainage achieve an equivalent degree of protection.

4.3 Alternative 3 – Interior Ditch Design

Alternative 3 proposes 2,000 LF of 0.5% concrete lined ditch and 4,000 LF of 1.0% interior grassed lined ditches as a means to minimize both disposal airspace and the need to import a large volume of offsite clean soil. Figure 6 provides a rendering of Alternative 3 depicting the general layout and interconnection of key design elements in the vicinity of the concrete lined interior ditch, 2.0% overland grade, 1.0% grass lined perimeter ditch, and the stormwater discharge outfall. These key design concepts are incorporated as a design basis in the conceptual grading plan depicting final grades over completed fill surfaces provided in Figure 7. Potential risks associated with a closed landfill with slopes less than 2.0% have been mitigated through a demonstration of hydraulic equivalency provided in Section 4.4.

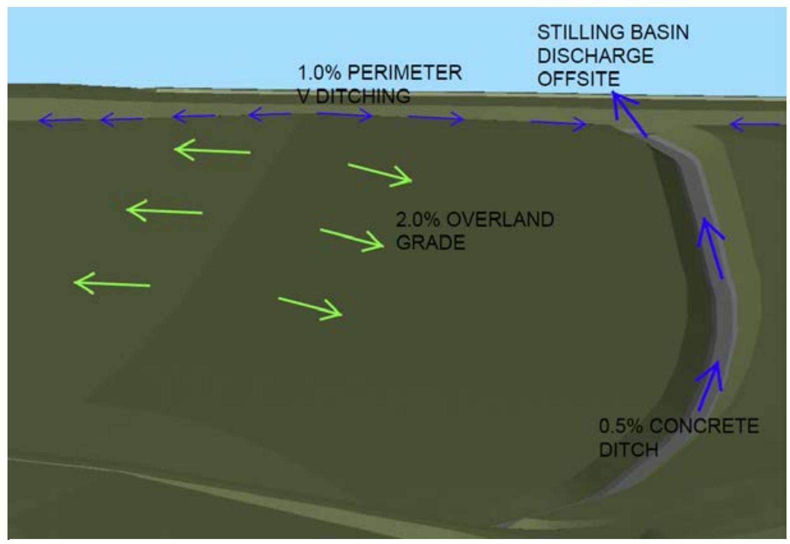

Figure 6: Alternative 3 Rendering

Inspection and survey schedule of the diches will be finalized and further defined in the final Revised Closure Plan.

4.4 Hydraulics

Golder has prepared a hydraulics model to demonstrate equivalent hydraulic performance of the channel and ditch designs. Table 2 provides a summary of the channel hydraulics for the 25-Year-24-Hour storm event and the hydraulic model output data is provided in Appendix D.

Table 2: Hydraulics Summary

Channel Type	Manning's Number	Length (ft)	Slope (%)	Flow Depth (ft)	Flow Velocity (ft/sec)	Flow Duration* (Hours)
Concrete Trapezoidal	**0.015**	**2000**	**0.50**	**0.94**	**5.81**	**28.0**
Grassed Trapezoidal	0.03	2000	1.0	1.12	4.54	28.0
Grassed Trapezoidal	0.03	2000	2.0	0.94	5.81	28.0
Perimeter V Ditch	**0.03**	**1000**	**1.0**	**0.41**	**1.72**	**25.0**
Perimeter V Ditch	0.03	1000	2.0	0.37	2.29	25.0

Note: Flow duration represents the approximate time the structure is conveying stormwater.

Table 1 demonstrates the following key conclusions from the design basis of the revised final cover design:

- A concrete channel sloped at 0.50 percent provides for equivalent hydraulic performance when compared to 1.0 and 2.0 percent grass lined channels
- A perimeter grass lined V ditch sloped at 1.0 percent provides equivalent hydraulic performance when compared to a 2.0 percent grassed lined V dich

Based on EGLE's request to investigate options to establish all ditching within and around the landfill to at least 1% slope, this hydraulic equivalency demonstration indicates that 1% ditching for the Perimeter V Ditch and Interior Grass-Lined Trapezoidal Ditch options are hydraulically equivalent when increased to 2% slope. The hydraulic equivalency also demonstrates that the 0.5% Interior Concrete Trapezoidal Ditch design performs equivalently to the Interior Grass-Lined Trapezoidal Ditch sloped at either 1% or 2% grade. The hydraulics equivalency demonstration presented in Table 1 assures stormwater internal drainage ditching provides an equivalent degree of protection for the public health and environment relative to the regulatory requirement of constructing final slopes at 2% or greater over completed fill surfaces. Therefore, Golder recommends

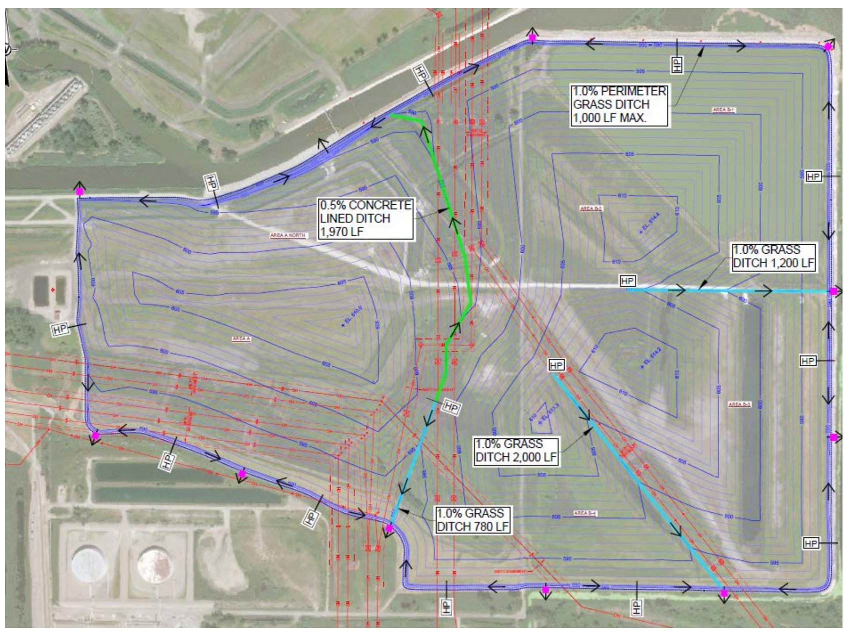

Figure 7: Alternative 3 – Interior Ditch Design

retaining the interior and exterior ditch design specifications through detailed design to improve or optimize other design elements as described in Section 4.3 and depicted in Figure 7.

5.0 COST CONSIDERATIONS

Conceptual cost estimates were developed for each of the alternatives. The two principal components driving the cost differential between each of the alternatives were the number of transmission tower modifications and the volume of offsite fill required to reach design final grades. Since the sensitivity of the cost is most closely related to the fill requirements, Figure 7 was generated to provide a basis of comparison for each of the alternatives based on fill requirements to construct to final grades.

Additional costs may be incurred due to new or on-going regulatory and monitoring requirements based on the discussion of each Alternative.

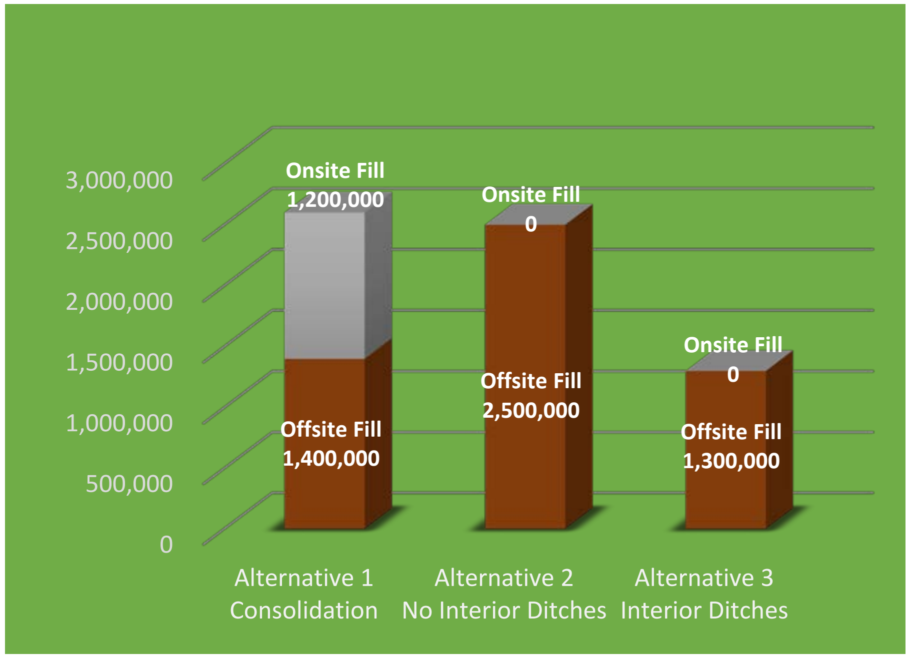

Figure 7: Final Cover Design Fill Requirement Comparison

6.0 CONCLUSIONS

Golder evaluated three different potential options for final cover design elements after consideration for relocation of all transmission infrastructure from Weadock Landfill was determined to be neither prudent or feasible as summarized in Section 3.0. The potential regulatory requirements that may not be able to be achieved through these final cover designs, but could be addressed through potential variance(s) pursuant to Rule 108 of Part 115 are as follows:

Rule 304(5) Final cover slope for perimeter ditches that overly CCR disposal

Rule 304(5) Final cover slopes for interior ditches that overly CCR disposal;

Rule 304(4) Time to reach final grades; and

Rule 317(1) Closure time period.

Each of the final cover design concepts were able to incorporate perimeter ditch system slopes designed at no less than 1% slope to facilitate stormwater drainage to one of the stormwater outfall structures. Additionally, the adjustment of the closure time period based on sequence of construction was common to all three of the alternatives. Therefore, the only variable between the three alternatives potentially requiring a variance was the final cover slope for internal channel ditching. Two of the final cover alternatives eliminated internal ditching to meet the regulatory requirement of maintaining at least 2% slope on final cover within the landfill. Alternative 1 – Consolidation –eliminates the need for internal ditches by consolidating the landfill footprint and promoting overland drainage of at least 2% grade towards perimeter ditches, while Alternative 2 – No Internal Ditches – eliminates the need for internal ditches by creating a high point within the landfill and providing overland drainage of at least 2% to the perimeter ditch system that discharges to one of the perimeter stormwater outfall structures. However, the analysis supported by this memo and appended documents determined that Alternative 1 and Alternative 2 were not prudent or feasible as summarized in Sections 4.1 and 4.2, respectively.

Alternative 3 – Internal Ditching Design – requires a potential variance for perimeter ditching designed to at least 1% and additional time for the closure time period, but also potentially requires a variance because it does not meet the 2% slope design consideration for slopes over waste within the landfill. Analysis summarized in Section 4.3 demonstrates that reasonable and prudent offsets can be realized and integrated into this design concept by:

- Eliminating previous valley design concepts for the southern portion of Pond A by amending the final cover grades to overland drainage of a minimum of 2% that will be collected by the perimeter ditch design and discharged through one of the stormwater outfall structures.
- Minimizing the need to obtain offsite clean soil by optimizing the remaining landfill airspace through strategic placement of internal stormwater ditching of limited length and extent that does not meet the 2% slope over final grades of waste but can be demonstrated to provide hydraulic equivalency compared to a 2% stormwater ditch standard (Table 1). Therefore, CEC and Golder conclude that a variance request in conformance with Rule 108(4)(b) from final cover slope and 108(4)(j) from closure time period are both prudent and reasonable.

6.1 Variance Request

CEC intends to submit a variance request as part of the Revised JC Weadock Closure Plan response in that would be public noticed with the renewed Solid Waste Operating License. The renewal application form will be submitted no later than 30 days from the existing license expiration on June 26, 2020. Based on the design elements evaluated at the current level of design for Alternative 3, Golder recommends the following limiting criteria for the variance request:

1) Rule 108(4)(b) final cover slopes; limited to stormwater channel ditching as follows

Perimeter Ditches	No less than 1% Grass Lined Ditches, 1,000 LF Max Flow Path
Internal Ditches	No less than 0.5% Concrete Lined Ditches no more than 2,000 LF
	No less than 1.0% Grass Lined Ditches no more than 6,000 LF
	No more than 6,000 LF of concrete and grassed lined ditches in total

CEC and Golder believe that the requested variances listed above will satisfy the applicable rule requirements as follows:

Perimeter Stormwater Ditches constructed to at least 1% slope perform hydraulically equivalently to 2% sloped grass-lined V-ditch of the same geometry based on the hydraulic analysis summarized in Section 4.4 and included in Appendix D. This variance request is reasonable to grant because the stormwater ditching system is limited to the perimeter of the landfill where the potential to infiltrate water into the waste mass and potential mass migration from the infiltration is very limited. The perimeter of the landfill is also contained by a soil-bentonite slurry wall that is keyed into the underlying clay confining unit.

Internal concrete lined ditches constructed to no less than 0.5% slope at no more than 2,000 LF and no less than 1.0% sloped grass lined ditching at no more than 6,000 LF (6,000 LF of interior ditching in total) as depicted in Figure 7 perform hydraulically equivalent to a 2.0% sloped grass-lined ditch of the same geometry based on the hydraulic analysis summarized in Section 4.4 and included in Appendix D. This variance request is reasonable for EGLE to grant because the internal stormwater ditching is limited to no more than 2,000 LF of 0.5% concrete lined ditches and 6,000 LF grass-lined ditches (6,000 LF of interior ditching in total) geographically limited to the corridors depicted in Figure 6 and thus present very limited potential of infiltration water reaching the waste mass.

2) Rule 108(4)(a), (j) closure time period; request alternate closure time period after reaching final grade

The time for closing a coal ash landfill necessitates that placement of landfill cover materials described in R 299.4317 (i.e. final cover) over each portion of the final lift not more than 6 months after the placement of solid waste within that portion. The design standards for a Type III landfill final cover described in R 299.4304 also require that the landfill must be designed and operated so as to bring the active portion up to final grade as soon as possible.

CEC and Golder is *not* requesting a variance for the closure time period or the time to reach final grades based on our current understanding of selecting Alternative 3 (Internal Ditching Design):

- Alternative 3 was found to have 1-2 years shorter work duration (Table 1) than Alternative 1 and 2 to construct to an equally protective final cover design, so the time to reach final grades has been evaluated and the time to reach those grades by Alternative 3 has been optimized; and
- Alternative 3, upon EGLE acceptance to proceed with more detailed final cover design, will revise final closure plan to include a more detailed staged fill construction sequence that will address timely placement of final cover over those final grades.

Upon satisfying EGLE concerns raised in the July 6, 2019 comment letter by accepting the analysis presented in this memo and appendices and receiving written agreement to proceed with completing the final closure plan with the design element specifications and limitations, Golder will resubmit the revised closure plan with the final cover design and schedule within 90 days of receiving EGLE approval in writing. Golder and CEC are confident that all viable alternatives have been thoroughly evaluated and as a result of the evaluations, Alternative 3 provides an equivalent degree of protection for the public health and environment and should be considered the approvable option for the Weadock Landfill based on resubmittal of the final closure plan design with design variances discussed in Section 6.1 submitted with the JC Weadock Disposal Area Solid Waste Operating License renewal by May 27, 2020.

Appendix:

Appendix A – Table 1 – Summary of Events
Appendix B – Sediment Testing for Dredging Projects Policy
Appendix C – Consolidation Option Stability Evaluation
Appendix D – Hydraulic Model Output

APPENDIX A

Table 1 – Summary of Events

Table 1: Summary of Events Since November 2018 Submittal

Date	Event	Summary
November 15, 2018	CEC submittal of the 2018 Revised Closure Plan	The 2018 Revised Closure Plan was developed as a substantial improvement over the existing AECOM 2011 Revised Closure Plan by reducing airspace and improving drainage. An overview of the 2018 Revised Closure Plan is provided in Attachment 1.
February 7, 2019	EGLE comments on the 2018 Revised Closure Plan	EGLE's primary concerns were the central ditch sloped at 0.3 percent, areas of the landfill below the 100-year flood elevation, and overland final cover slopes of less than two percent. EGLE comments are provided in Attachment 2.
February 11, 2019	EGLE/CEC/Golder meeting onsite to discuss EGLE comments	EGLE reinforced their concerns with shallow interior slopes less than two percent. CEC/Golder explained the design intent to maintain transmission line clearance, minimize fill around transmission towers, and minimize airspace given the limited available volume of CCR for disposal.
May 6, 2019	EGLE submittal of letter to CEC	EGLE submitted letter requesting that CEC investigate options to provide full coverage of the solid waste with geomembrane liner, options to increase waste slope within the landfill footprint, options to eliminate or minimize ditches located over solid waste, options to provide one percent minimum slopes in all ditches within and around the landfill, and options to maintain all areas of the landfill above the 100-year elevation. The letter is provided in Attachment 3.
June 14, 2019	CEC/Golder submittal of technical memo to respond to EGLE May 6, 2019 letter	Golder completed a Design Alternative Evaluation that included four alternatives and recommended a design that minimized clean fill requirements, minimized open (unlined) area, eliminated 100-year event run-on, preserved the integrity of the perimeter slurry wall, and maximized grades. The memo is provided in Attachment 4.
July 15-16, 2019	Email comments received by EGLE	EGLE submitted two emails with follow-up questions to the June 14, 2019 memo. EGLE's questions were related to the existing transmission tower infrastructure, material the towers were built upon (CCR or native material), approximate ash depths across the landfill, and a request to provide detailed profiles for the existing towers and the associated sag heights of all transmission lines. The emails are included in Attachment 5.
September 11, 2019	CEC/Golder submittal of memo including a	CEC/Golder submitted a memo to EGLE to resolve the remaining comments received via email from EGLE on the

Date	Event	Summary
	variance request and final proposed design revision	planned closure activities and to provide a variance request for landfill slopes less than two percent. The memo is included in Attachment 6.
October 9, 2019	CEC/EGLE meeting – Lansing, Michigan	EGLE expressed concern that CEC did not adequately provide an alternatives evaluation to allow EGLE to approve the variances associated with the final proposed design revision submitted in the September 11, 2019 memo.
November 13, 2019	EGLE/CEC/Golder - alternatives evaluation meeting	Seven closure plan alternatives were presented to EGLE as provided in Attachment 7. The intent of the meeting was to collaborate as a team to identify which options were feasible to advance forward and propose to ITC Holdings Corp. (ITC). ITC would then evaluate the feasibility of relocating or replacing the existing transmission tower infrastructure located throughout the landfill to facilitate the design alternatives.
December 9, 2019	CEC/Golder provide ITC with final four options	ITC was tasked to evaluate the four selected alternatives and provide information on the following key components related to transmission infrastructure relocation/improvements: ■ Timing ■ Permitting/regulatory approvals ■ Engineering/risk considerations ■ Cost The closure options provided to ITC are provided in Attachment 8.
February 28, 2020	ITC completion of transmission modification alternative analysis summary	ITC provided information necessary for CEC to consider and evaluate the final four options to be presented to EGLE. ITC's submittal is provided in Attachment 9.
March 16, 2020	Conference call with EGLE, CEC, ITC and Golder	CEC and Golder presented the final cover improvement progression, information from ITC on the Karn-Weadock distribution system, summary of alternatives with associated risks and mitigation measures and the final proposed design for a maximum of 6,000 feet of interior ditching. The presentation is provided in Attachment 10.

Attachments:

Attachment 1 - Overview of the 2018 Revised Closure Plan
Attachment 2 - EGLE comments to the 2018 Revised Closure Plan
Attachment 3 - EGLE Letter dated May 6, 2019
Attachment 4 - CEC/Golder Technical Memo dated June 14, 2019
Attachment 5 - EGLE emails dated July 15-16, 2019
Attachment 6 - CEC/Golder memo dated September 11, 2019
Attachment 7 - Alternatives Summary Table and Associated Plans
Attachment 8 - Closure Options Submittal to ITC
Attachment 9 - ITC Alternatives Evaluation Table
Attachment 10 - EGLE Presentation

APPENDIX B

Sediment Testing for Dredging Projects Policy

<table>
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POLICY AND PROCEDURE</td><td>DEPARTMENT OF
ENVIRONMENTAL QUALITY</td></tr>
<tr><td rowspan="3">Original Effective Date:
April 13, 2018

Revised Date:

Reformatted Date:</td><td colspan="2">Subject: Sediment Testing for Dredging Projects</td><td rowspan="2">Category:
☐ Internal/Administrative
☐ External/Non-Interpretive
☒ External/Interpretive</td></tr>
<tr><td colspan="2">Program Name: Water Resources Program</td></tr>
<tr><td>Number: WRD-048</td><td>Page: 1 of 9</td><td>Type:
☐ Policy
☐ Procedure
☒ Policy and Procedure</td></tr>
</table>

A Department of Environmental Quality (DEQ) Policy and Procedure cannot establish regulatory requirements for parties outside of the DEQ. This document provides direction to DEQ staff regarding the implementation of rules and laws administered by the DEQ. It is merely explanatory; does not affect the rights of or procedures and practices available to the public, and does not have the force and effect of law. DEQ staff shall follow the directions contained in this document.

ISSUE:

Identify when sediment testing is required and how results will be used when processing applications for permits under authority of Part 301, Inland Lakes and Streams; Part 303, Wetlands Protection; and Part 325, Great Lakes Submerged Lands, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA). Sediment testing results are used as one avenue to determine whether a proposed project will result in an unacceptable negative impact on aquatic resources, related either to the mobilization of contaminants to a new location or by exposing wildlife (including fish and other aquatic life) to contaminants previously buried. The specific permit decision criteria are stated differently in each part of the NREPA but each part requires an assessment of the project's impact on the aquatic resource and related organisms. In addition, state permits under these parts may also provide authorization under Section 404 of the federal Clean Water Act, which requires that the project must not violate water quality standards. Michigan's water quality standards require the protection of designated uses including, but not limited to, aquatic life, wildlife, and public health.

This policy applies to projects that can mobilize or expose contaminated sediments including, but not limited to, sediment removals using dredges, draglines, excavators, etc., and other projects that may not directly remove sediment from the aquatic system but may result in sediment being mobilized to other areas of the aquatic system.

AUTHORITY:

Part 31, Water Resources Protection, of the NREPA
Part 301, Inland Lakes and Streams, of the NREPA
Part 303, Wetlands Protection, of the NREPA
Part 325, Great Lakes Submerged Lands, of the NREPA

STAKEHOLDER INVOLVEMENT:

This policy was placed on public notice for 30 days beginning June 26, 2017. Notification was made in the DEQ Calendar; on the DEQ dredging Web site; and to specific stakeholder groups known to have an interest in this policy, including Michigan Manufacturers Association, dredging contractors, resource consultants, environmental groups, Michigan Townships Association, Michigan Association of Counties, Michigan Association of County Drain Commissioners, Department of Natural Resources (Fisheries, Wildlife, and Parks and Recreation Divisions), and Michigan Boating Industries Association. Comments received were used to finalize this document.

DEFINITIONS:

Area of known or suspected contamination: An area identified in MiWaters or other databases as containing contaminated or polluted sediment, or a facility, as defined in Part 201 (may show up as Act 307 in MiWaters), Environmental Remediation, of the NREPA, or a National Priorities List Superfund site, or any site that has known or suspected contamination as determined by DEQ staff or the applicant. This may include project sites within Great Lakes Areas of Concern, where designated uses are currently impaired by a pollutant, in areas where a historical dredge area is being expanded vertically and/or horizontally into areas of suspected contamination, new sites in areas of historically known or suspected contamination, sites in proximity and downstream of chemical storage/handling facilities, agricultural or industrial operations, or other sites where contaminants are suspected to be present in the water body's sediments within the project dredge area due to past or current land use practice, at DEQ staff's discretion. In addition, project areas greater than 2,000 cubic yards are assumed to be in sites of suspected contamination because large projects pose a greater risk of negative aquatic impacts should undetected contaminants be present.

Dioxins and Furans Test Area: The Tittabawassee River downstream of the city of Midland, the Saginaw River downstream of the Tittabawassee River, and the portion of Saginaw Bay that lies between the mouth of the Saginaw River and a line drawn between the tip of Fish Point (Tuscola County) and the tip of the unnamed point east of the lakeward end of East Pinconning Road (Bay County) (Figure 1).

MiWaters: The permit tracking and information system used by the Water Resources Division (WRD) staff to electronically record permit file information, such as locations, that are cross-referenced against spatial information stored in multiple databases.

PROCEDURE:

1. Projects involving dredging may require sediment testing, and permit applications submitted for these projects under Parts 301, 303, and 325 will not be considered administratively complete until the WRD determines that either:

   a. Testing is not required.

   b. The required testing results have been received.

2. WRD district staff reviews the proposed dredging project to determine if sediment testing is required. Sediment testing is required for dredging proposed in areas of known or suspected contamination and in the Dioxins and Furans Test Area.

3. Sediment testing may be waived if one of the following conditions is met:

    a. The applicant provides approved previous test data from the site, or from a site immediately adjacent to (i.e., within 100 feet) and representative of the proposed dredge area, including project depth. The test data must include results for all default parameters identified in step 5.b., below; polychlorinated biphenyl (PCB) if the project site is in a water body identified in step 5.b., below, as requiring PCB testing; and for dioxins and furans if the proposed dredging site is in the Dioxins and Furans Test Area. The test data must have been collected and analyzed within the last ten years.

    b. The total dredge volume is 2,000 cubic yards or less and the applicant has agreed to permit conditions in an applicable general permit or minor project category that isolate the area to be dredged and prevent downstream movement of sediment, or the project area is not within an area of known or suspected contamination or in the Dioxins and Furans Test Area.

    c. The total dredge volume is greater than 2,000 cubic yards but due to the specific details of the project site and implementation methods, WRD district staff determines that there is minimal risk of impacts to the aquatic resources at or downstream of the project site should contaminants be present. Note that this waiver is expected to occur only rarely. An example of when this waiver may be appropriate is dredging of a small regulated pond that is entirely on one property and has no outlet or has an outlet and the applicant proposes to use silt screens or other technology to prevent downstream movement of sediment.

4. If testing is not required (and the permit application meets all other administrative completeness criteria), WRD district staff marks the application file in MiWaters as administratively complete and continues processing the application file outside of this policy and procedure. If testing is required and results have not been provided by the applicant, the file remains incomplete and WRD district staff continues processing per this policy and procedure, continuing to step 5.

5. WRD district staff sends a Sediment Testing for Dredging Projects letter to the applicant, which contains the following guidance:

    a. Applicant may opt to conduct sieve grain analysis test for sand content, or move to step 5.b., below, if the sediment is believed to be less than 90 percent sand. For all sieve grain analysis testing for dredging projects of less than 10,000 cubic yards, the applicant shall collect sample sediment cores to project depth from 6 discrete locations within the proposed dredge area. If more than 10,000 cubic yards of dredging is proposed, at least 1 additional sample shall be obtained and analyzed for each 10,000 cubic yards of additional material proposed for dredging. Typically, each core sample will be composited and a subset will be analyzed using United States Standard Sieve Number 200 (Number 200 Sieve). WRD district staff may mandate specific sampling criteria, locations, and/or depth intervals based on their site-specific knowledge. Applicant reports the results for each of the six (or more) discrete sample locations as a mass percentage of retained sediments. If the average mass percentage retained on the Number 200 Sieve is 90 percent sand or greater, no additional sediment testing is required unless the project is located in the Dioxins and Furans Test Area; in which case, dioxins and furans must also be analyzed. The sieve grain analysis test is a pass/fail test. If the average mass percentage of sand is less than 90 percent, then the material must be analyzed according to step 5.b., below, for at least 6 discrete sampling locations.

b. If the result of the mass percentage retained on the Number 200 Sieve is less than 90 percent sand, on average, or the applicant opted not to conduct sieve grain analysis, contaminant testing is required. For all analytical testing of dredging projects of less than 10,000 cubic yards, applicant shall sample sediments from 6 discrete locations within the proposed dredge area. If more than 10,000 cubic yards of dredging is proposed, at least 1 additional sample shall be obtained and analyzed for each 10,000 cubic yards of additional material proposed for dredging. Typically, each sample will consist of a subset of a composited core taken to full project depth. WRD district staff may mandate specific sampling criteria, locations, and/or depth intervals based on their site-specific knowledge.

   The default analytical parameters include nine heavy metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, and zinc), polycyclic aromatic hydrocarbons (PAH) listed in Table 1, and biochemical oxygen demand (BOD). Additionally, phosphorus will be required if the proposed dredge spoil disposal location is in a surface water of the state as defined in the Part 4 Rules, Water Quality Standards, promulgated under Part 31, Water Resources Protection, of the NREPA. Default analytical parameters also include PCBs if the project is on one of the following bodies of water: Detroit River, Rouge River, Raisin River, Kalamazoo River, Saginaw River, Saginaw Bay, or Manistique Harbor; or canals that connect to any of the listed bodies of water or canals in the St. Clair Shores area between 11 Mile and 10 Mile Roads.

   Additions or deletions to the default testing parameters can be made on a project-specific basis if district staff or the applicant has additional information related to the project. WRD district staff shall coordinate with other WRD and DEQ staff as needed to determine appropriate testing criteria if WRD district staff believes it should be different than the default parameters.

   For projects in the Dioxins and Furans Test Area, dioxins and furans must also be analyzed.

c. Sediment testing must be conducted according to a United States Environmental Protection Agency-approved laboratory method and reported results must specify the reporting limits.

6. The applicant forwards the sediment analysis results to WRD district staff for review.

7. If the test data is for grain size analysis as detailed in step 5.a., above, WRD district staff performs an arithmetic mean on the grain size results of all samples to determine if the project dredge materials consist of 90 percent sand or greater by grain size.

8. If the sediment to be dredged is 90 percent sand or greater and the project is not located in a Dioxin and Furans Test Area, sediment contaminant testing is not required. Placement of dredged materials is subject to review under Parts 31, 301, 303, and 325 of the NREPA as part of a Joint Permit Application review conducted by WRD district staff.

9. If the sediment to be dredged is less than 90 percent sand or dioxins and furans testing is required, WRD district staff reviews sediment test results:

   a. If any sample test result exceeds any screening guidelines in Table 2, results shall be sent to the Lakes Erie, Huron, and Superior Unit (LEHSU) supervisor, Surface Water Assessment Section, WRD, for review pursuant to Part 31. If sediment results show PCB and/or mercury concentrations greater than 1 part per million or metals, PAH, or dioxin/furan concentrations greater than the screening guidelines in Table 2, additional sediment testing may be required to evaluate the newly exposed sediment quality or potential downstream impacts. Any additional sediment testing data will be used to evaluate potential impacts to surface water designated uses, as defined in the Part 4 Rules. The LEHSU staff will advise WRD district staff, generally within two weeks, as to the next steps based on the test results.

   b. If any BOD sample result is 250 milligrams per liter or greater, results shall be sent to the Groundwater Permits Unit (GPU) supervisor, Permits Section, WRD. The GPU supervisor will instruct WRD district staff as to the next steps based on the test results.

10. WRD staff considers the proposed placement of dredged material subject to Parts 31, 301, 303, and 325 of the NREPA, if applicable.

11. If the proposed dredge project is permittable, WRD district staff drafts the permit, including any conditions related to protection of designated uses and the disposal of dredged material, forwards the permit and information related to dredged material disposal requirements under Part 115, Solid Waste Management, of the NREPA, to the applicant, and updates MiWaters.

ATTACHMENTS:

Table 1. Required PAH Testing
Table 2. Aquatic Life and Wildlife Screening Guidelines
Figure 1. Dioxins and Furans Test Area

DIVISION DIRECTOR APPROVAL:

Teresa Seidel, Director
Water Resources Division

DEPUTY DIRECTOR APPROVAL:

Michael McClellan, Environment Deputy Director

Table 1. Required PAH Testing

Acenaphthene
Acenaphthylene
Anthracene
Benzo(a)anthracene
Benzo(b)fluoranthene
Benzo(k)fluoranthene
Benzo(g,h,i)perylene
Benzo(a)pyrene
Chrysene
Dibenzo(a,h)anthracene
Fluoranthene
Fluorene
Indeno(1,2,3-cd)pyrene
2-Methylnaphthalene
Naphthalene
Phenanthrene
Pyrene

Table 2. Aquatic Life and Wildlife Screening Guidelines

CHEMICAL	CONCENTRATION
Metals (mg/kg)	
Arsenic*	33.00
Cadmium*	4.98
Chromium	111.00
Copper*	149.00
Lead*	128.00
Mercury*	1.06
Nickel*	48.60
Selenium**	1.90
Zinc*	459.00
PAH (ug/kg)	
Anthracene*	845
Benz(a)anthracene*	1,050
Benzo(a)pyrene*	1,450
Chrysene*	1,290
Fluorene*	536
Fluranthene*	2,230
Naphthalene*	561
Phenanthrene*	1,170
Pyrene*	1,520
Total PAH*	22,800
Total PCB (mg/kg)	0.676
Dioxin/furans as 2,3,7,8 TCDD TEQ (ug/kg)***	0.00012

References:

*Probable Effect Concentrations (PEC) from MacDonald et al., 2000. Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. Arch. Environ. Contam. Toxicol. 39. 20-31.

**Thompson, P.A., J. Kurias, and S. Mihok. 2005. Derivation and Use of Sediment Quality Guidelines for Ecological Risk Assessment of Metals and Radionuclides Released to the Environment from Uranium Mining and Milling Activities in Canada. Environmental Monitoring and Assessment 110:71-85.

***United States Environmental Protection Agency, Region 5, RCRA Ecological Screening Levels. August 22, 2003. Toxic Equivalency should be calculated using the 2005 World Health Organization Toxic Equivalency Factor in Table 1 of Van den Berg et al., Toxicological Sciences 93(2), 223-241 (2006). The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxin and Dioxin-Like Compounds.

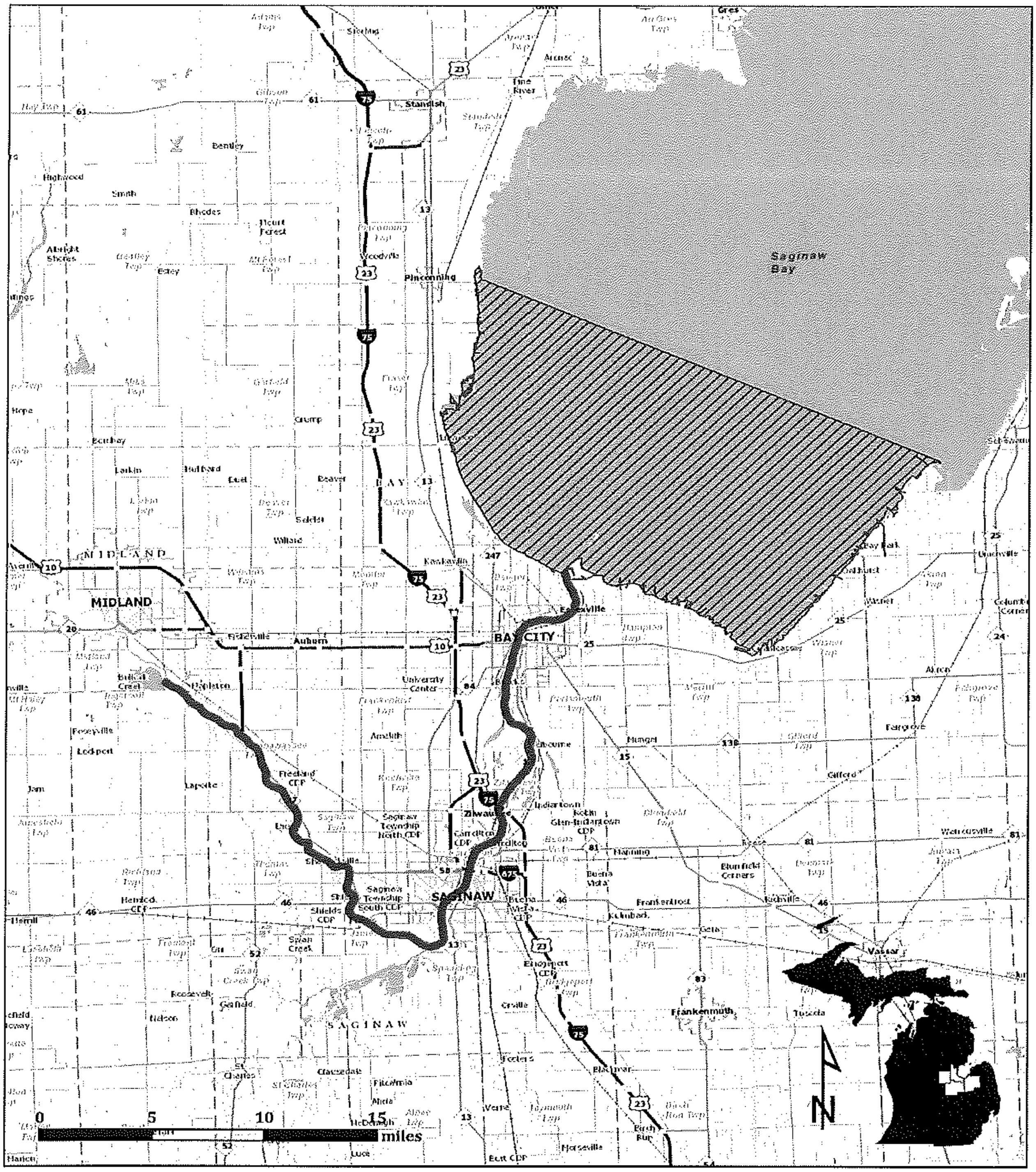


Figure 1. Dioxins and Furans Test Area

APPENDIX C

Consolidation Option Stability Evaluation

Slope Stability Analyses for the Consolidation Closure Alternative for J.C. Weadock Landfill in Bay County, Michigan

Objective:

Analyze short-term static conditions for the consolidation closure alternative for Consumers Energy Corporation (CEC) J.C. Weadock Landfill in Bay County, Michigan. The consolidation closure alternative consists of consolidating the footprint of the J.C. Weadock Landfill by closing the former Pond F area.

Analysis Methods:

The static stability of the consolidation closure alternative for J.C. Weadock Landfill in Bay County, Michigan was evaluated using the computer program SLIDE Version 2018 8.032 (Rocscience, 2020). Generalized limit equilibrium method of stability analysis developed by Morgenstern and Price (Abramson et al., 2002) was utilized for the analysis. Circular search patterns were utilized to find failure surfaces that resulted in the minimum calculated factor of safety.

Minimum required values of FoS for this analysis were taken as 1.5 as recommended in the Naval Facilities Engineering Command Design Manual 7.01: Soil Mechanics (NAVFAC DM7.01, 1986). The soil profile developed for the analysis was based on previous subsurface investigations (SME, 2010; Geosyntec/CTI, 2014; Golder, 2017). Based on the available data, the base of CCR was conservatively assumed at elevation 575 feet. It is expected that an additional foot of material beyond the base of CCR would be excavated if the former Pond F area is closed by removal; therefore, the excavation elevation within the landfill area was assumed at 574 feet. A groundwater elevation of 582 feet (Ordinary High Water Mark, OHWM, for Lake Huron) was assumed outside of the landfill area. Groundwater within the landfill area was varied between 586 feet (representing the highest anticipated elevation) and 573 feet (representing interim conditions due to dewatering activites). All elevations presented are based on plant datum.

Global slip surfaces or those impacting the crest of the slope were considered "Critical" surfaces that may compromise the stability of the impoundment. Shallow or surficial slip surfaces along the slope surface (i.e., not global or impacting the crest of the slope) with factors of safety lower than the "Critical" surface were often generated during the analyses; the shallow slip surfaces were considered "Non-Critical" and issues that could likely be addressed by maintenance (e.g. local regrading, riprap armoring, etc.). Both "Critical" and "Non-Critical" surfaces (as required) are shown on the stability output figures.

Analysis Sections:

A representative section of the existing external embankment was developed to evaluate stability for the scenarios described below.

Analysis Cases:

The following stability cases were analyzed using short-term strength parameters (i.e., undrained conditions):

- Dewatered scenario - CCR excavated from former Pond F area and dewatered down to elevation 574 feet
- "Dam" scenario - CCR excavated from former Pond F area and allowed to retain ponded water up to elevation 586 feet
- New berm with landfilled CCR - CCR placed up to elevation 615 feet at 2% side slope with maximum anticipated groundwater elevation of 586 feet

Material Properties:

The material properties used for this analysis are provided in the table below.

Material	Unit Weight (pcf)		Strength Properties		
	Dry	Saturated	Peak ϕ′ (°)	Cohesion (psf)	Undrained Shear Strength (psf)
Slurry Wall Cap/Road	115	120	26	-	-
Slurry Wall	100		No strength		
Fill (Sandy Clay)	115	125	-	-	500
Fill (Sand)	-	115	27	-	-
Fill (Clay - New Berm)	115	125	-	-	1000
Dry Conditioned CCR	100		35	-	-
Native Glacial Till	125	140	-	-	4500
Sandstone Bedrock	140		Infinite strength		

Material properties including unit weight, friction angle, and cohesion were developed from correlations with SPT N-values provided in the NAVFAC DM7.01 and the Electric Power Research Institute Manual on Estimating Soil Properties for Foundation Design (EPRI, 1990). Parameters for the sluiced fly ash and compacted CCR were based on direct shear and CU triaxial results provided in a 2010 report by Soil and Materials Engineers, Inc. (SME) titled “Report on Dike Slope Stability Analyses” (SME, 2010). Strength parameters for the native glacial till were obtained from consolidated triaxial test data from a 2017 investigation by Golder (Golder, 2017).

GOLDER	SUBJECT:	Stability Analyses - Closure Plan R.D. Morrow Landfill	
	Job No.:	19118065	Prepared: MMJ
	Ref.:	Consumers/JC Weadock LF Closure/MI	Checked: JP
	Date:	Apr-03-2020	Reviewed: DM

Summary of Stability Analyses Results

Analysis Scenario	Method	Calculated Value	Required FoS	Evaluation	Figure
Dewatered Scenario	Circular	2.0	1.5	OK	1A
"Dam" Scenario	Circular	2.0	1.5	OK	1B
New Berm with Landfilled CCR	Circular	>3.0	1.5	OK	1C

References:

1. Rocscience (2020), SLIDE Version 2018 8.032.

2. Abramson, L.W., T.S. Lee, S. Sharma, and G.M. Boyce (2002), Slope Stability and Stabilization Methods, 2nd edition, John Wiley & Sons, New York.

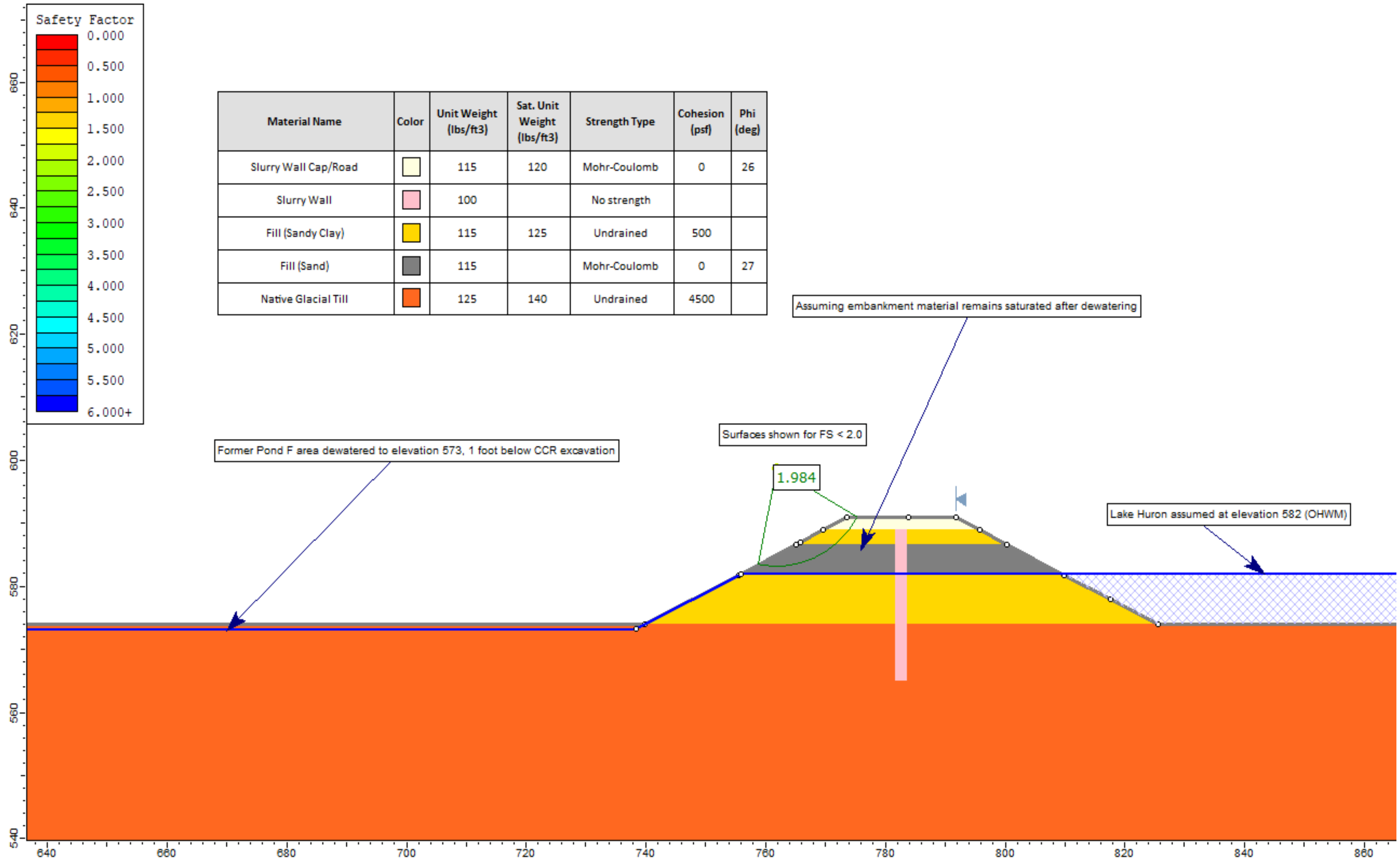
3. Naval Facilities Engineering Command (NAVFAC), 1986, Design Manual 7.01 (DM7.01): Soil Mechanics.

4. Electric Power Research Institute (EPRI), 1990, Manual on Estimating Soil Properties for Foundation Design.

5. Soil and Materials Engineers, Inc. (SME), 2010, Report on Dike Slope Stability Analyses.

6. Geosyntec Consultants/CTI and Associates, 2014, 2013 Subsurface Investigation and Laboratory Testing Program Factual Data Summary.

7. Golder Associates Inc. (Golder), 2017, J.C. Weadock Discharge Channel Slope Stability.



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Slurry Wall Cap/Road		115	120	Mohr-Coulomb	0	26
Slurry Wall		100		No strength		
Fill (Sandy Clay)		115	125	Undrained	500	
Fill (Sand)		115		Mohr-Coulomb	0	27
Native Glacial Till		125	140	Undrained	4500	

GOLDER

Golder Associates Inc.

SCALE	AS SHOWN
DATE	Apr 2020
MADE BY	MJ
CAD	SA
CHECK	JP
REVIEW	DM

FILE STABILITY

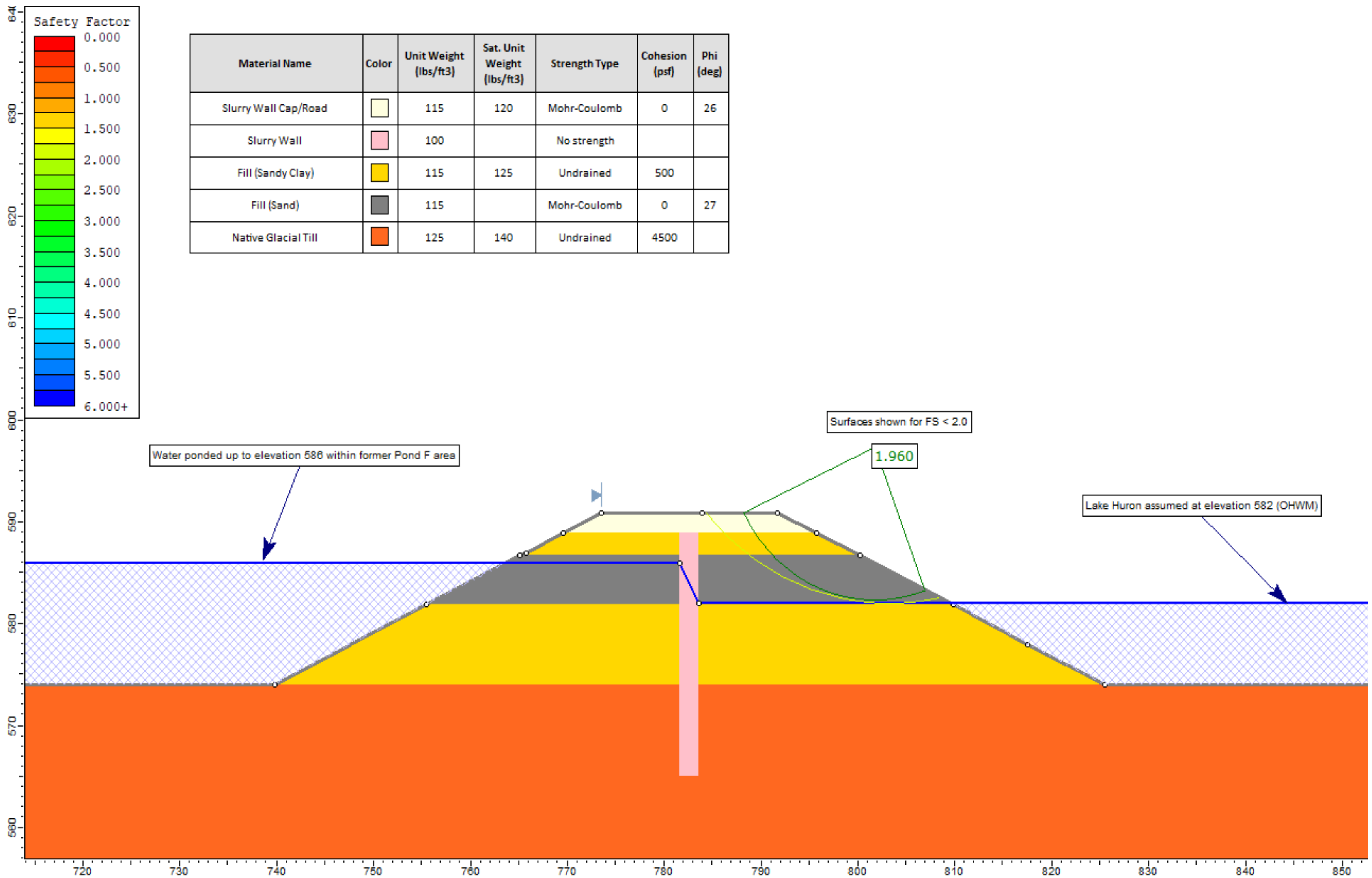
PROJECT No. 19118065 REV. 0

TITLE

Dewatered Scenario - Static, Short-Term (Undrained) Conditions - Circular Failure Search

Consumers Energy **Consumers Energy Corporation**

FIGURE **1A**



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Slurry Wall Cap/Road		115	120	Mohr-Coulomb	0	26
Slurry Wall		100		No strength		
Fill (Sandy Clay)		115	125	Undrained	500	
Fill (Sand)		115		Mohr-Coulomb	0	27
Native Glacial Till		125	140	Undrained	4500	

GOLDER

Golder Associates Inc.

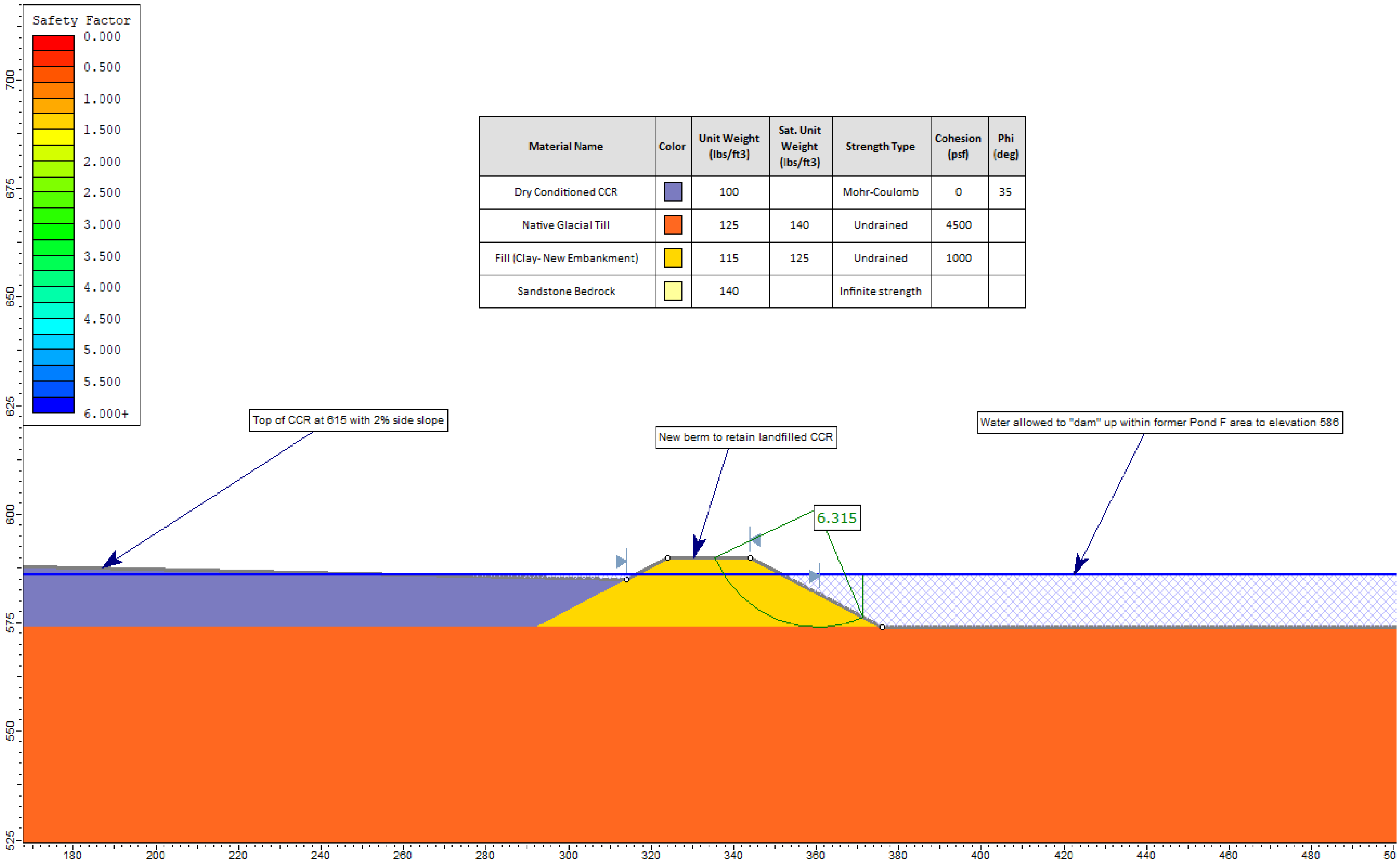
SCALE	AS SHOWN
DATE	Apr 2020
MADE BY	MJ
CAD	SA
CHECK	JP
REVIEW	DM
FILE	STABILITY
PROJECT No.	19118065
REV.	0

TITLE

"Dam" Scenario - Static, Short-Term (Undrained) Conditions - Circular Failure Search

Consumers Energy **Consumers Energy Corporation**

FIGURE **1B**



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Dry Conditioned CCR		100		Mohr-Coulomb	0	35
Native Glacial Till		125	140	Undrained	4500	
Fill (Clay- New Embankment)		115	125	Undrained	1000	
Sandstone Bedrock		140		Infinite strength		

GOLDER

Golder Associates Inc.

SCALE	AS SHOWN
DATE	Apr 2020
MADE BY	MJ
CAD	SA
CHECK	JP
REVIEW	DM
FILE	STABILITY
PROJECT No.	19118065
REV.	0

TITLE

New Berm with Landfilled CCR - Static, Short-Term (Undrained) Conditions - Circular Failure Search

Consumers Energy **Consumers Energy Corporation**

FIGURE **1C**

HISTORIC RECORDS OF BOREHOLES AND CPT SOUNDINGS FROM 2013 INVESTIGATION BY GEOSYNTEC AND CTI

BORING NUMBER B-2013-01

CTI and Associates Inc

CLIENT Consumers Energy
PROJECT NAME J.C. Weadock Fly Ash Geotechnical Investigation
PROJECT NUMBER 2138070019
PROJECT LOCATION Essexville, MI
DATE STARTED 9/5/13 **COMPLETED** 9/5/13
GROUND ELEVATION 590.61
DRILLING CONTRACTOR Stearns Drilling
GROUND WATER LEVELS:
DRILLING METHOD Mud Wash Rotary
DURING DRILLING None
LOGGED BY K. Ebenstein **CHECKED BY** T. Marsik
AFTER DRILLING N/A
NOTES Boring backfilled with grout
COLLAPSE DEPTH N/A

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)
0	Black moist very loose FLY ASH with trace organics and occasional hair roots - (FILL)	SS	100	5-2-1 (3)		
3.5	Black moist very loose FLY ASH with traces of peat, occasional hair roots and occasional very moist sand partings - (FILL)	SS	100	0-0-1 (1)		33
		SH	30			
		SS	100	0-0-0 (0)		
		SH	80			
13.5	Mottled brown and dark gray very moist medium dense fine to medium SAND with traces of silt, clay, organics, and fly ash; and occasional shells - (SP/poss. FILL)	SS	100	5-5-5 (10)		21
18.5	Mottled brown and gray moist hard CLAY with silt and traces of gravel and sand - (CL)	SS	78	7-9-16 (25)	4.0	
		SS	89	8-15-19 (34)	4.5 +	
25						

Bottom of borehole at 25.0 feet.

BORING NUMBER B-2013-02

CTI and Associates Inc

CLIENT Consumers Energy

PROJECT NAME J.C. Weadock Fly Ash Geotechnical Investigation

PROJECT NUMBER 2138070019

PROJECT LOCATION Essexville, MI

DATE STARTED 9/3/13 **COMPLETED** 9/4/13

GROUND ELEVATION 595.37'

DRILLING CONTRACTOR Stearns Drilling

GROUND WATER LEVELS:

DRILLING METHOD 4-1/4 inch Hollow Stem Auger

DURING DRILLING 3' 6"

LOGGED BY K. Ebenstein **CHECKED BY** T. Marsik

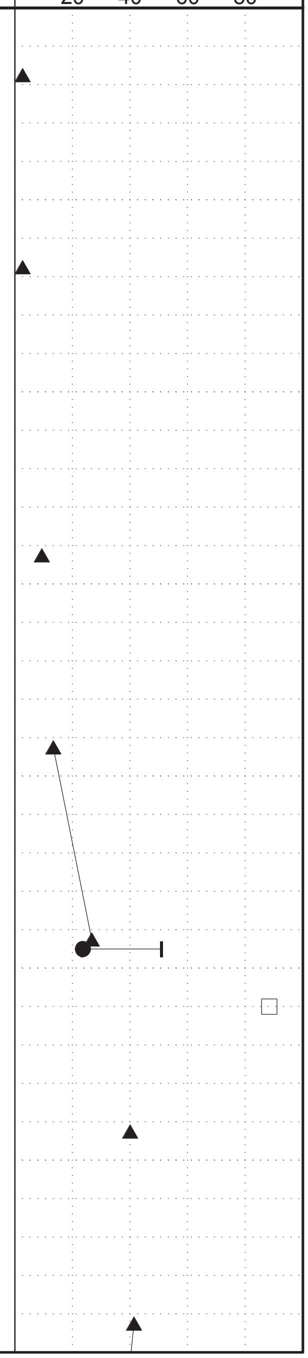
AFTER DRILLING N/A

NOTES Boring backfilled with grout

COLLAPSE DEPTH N/A

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)
0		Gray moist very loose to loose FLY ASH - (FILL)	SS	78	2-1-1 (2)		
		Gray wet very loose to loose FLY ASH - (FILL)	SH	44			
5			SS	111	2-1-1 (2)		
10			SH	81			
15			SS	89	3-4-3 (7)		
			SH	94			
20		Mottled brown and gray moist stiff CLAY with silt, some sand, and traces of gravel - (CL)	SS	89	3-4-6 (10)	2.25	
25		Mottled brown and gray moist very stiff to hard CLAY with silt, traces of gravel and sand, and occasional wet sand seams - (CL)	SS	89	6-9-11 (20)		12
			SH	0			
30			SS	67	14-15-15 (30)	1.5	
			SH	50			
35		Gray moist hard to very stiff CLAY with silt, traces of sand and gravel, and occasional wet sand seams and partings - (CL)	SS	100	12-13-18 (31)	4.5+	

▲ SPT N VALUE ▲ 15 30 45 60; PL MC LL 10 20 30 40; □ FINES CONTENT (%) □ 20 40 60 80



(Continued Next Page)

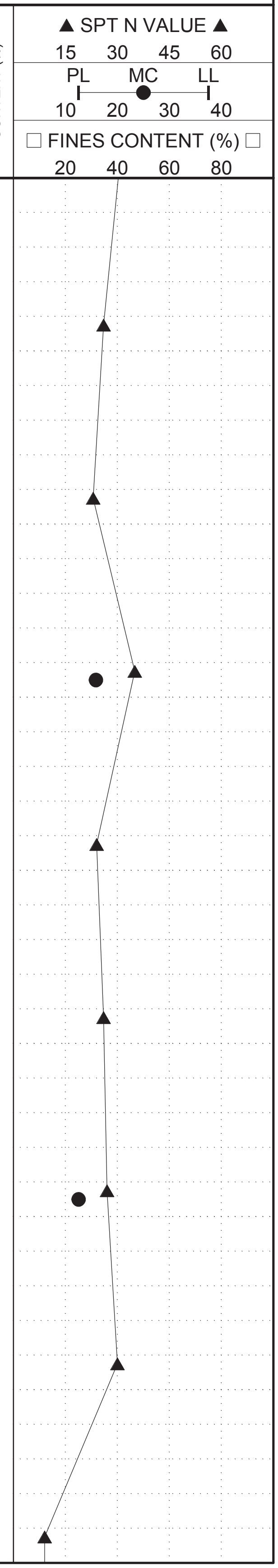
CLIENT Consumers Energy

PROJECT NAME J.C. Weadock Fly Ash Geotechnical Investigation

PROJECT NUMBER 2138070019

PROJECT LOCATION Essexville, MI

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)
35		Gray moist hard to very stiff CLAY with silt, traces of sand and gravel, and occasional wet sand seams and partings - (CL) *(continued)*					
40			SS	89	7-11-15 (26)	4.5+	
45			SS	67	6-10-13 (23)	4.5+	
50			SS	44	9-14-21 (35)		16
55			SS	67	6-11-13 (24)	3.0	
60			SS	67	7-11-15 (26)	3.5	
65			SS	78	10-14-13 (27)	3.0	13
70			SS	100	7-13-17 (30)	4.5+	
75		Gray very moist stiff to medium stiff sandy CLAY with silt, some gravel, and occasional wet sand partings - (CL)	SS	78	4-4-5 (9)	0.5	



(Continued Next Page)

BORING NUMBER B-2013-02

CTI and Associates Inc

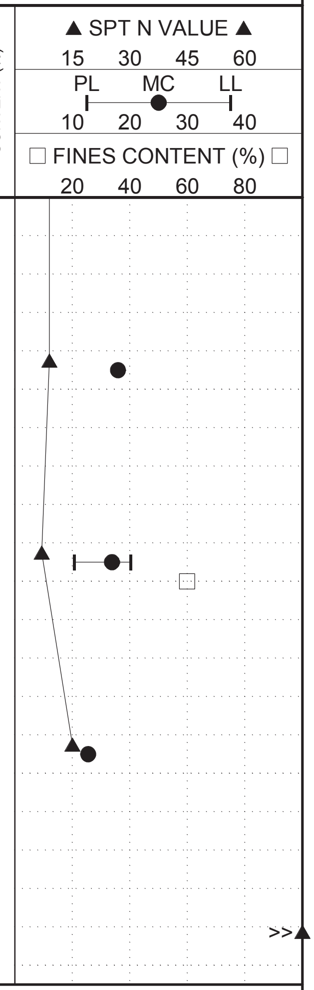
CLIENT Consumers Energy

PROJECT NAME J.C. Weadock Fly Ash Geotechnical Investigation

PROJECT NUMBER 2138070019

PROJECT LOCATION Essexville, MI

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)
75		Gray very moist stiff to medium stiff sandy CLAY with silt, some gravel, and occasional wet sand partings - (CL) *(continued)*					
80			SS	111	2-4-5 (9)	1.0	18
85			SS	111	3-3-4 (7)		17
90			SS	100	6-7-8 (15)		13
			SH	75			
95		Gray wet SANDSTONE	SS	80	28-22-75/3"		



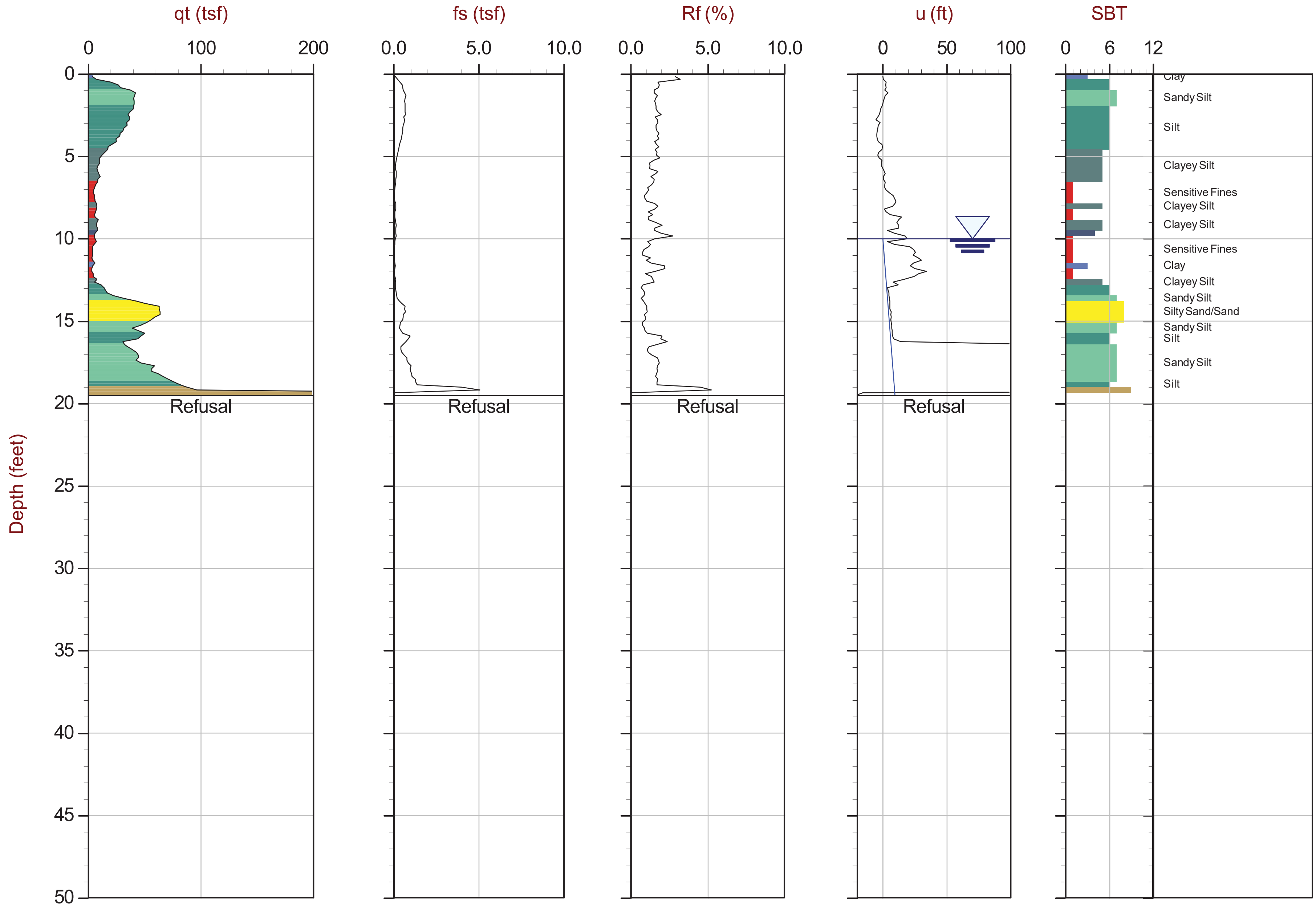
Refusal at 95.5 feet.
Bottom of borehole at 95.5 feet.

CONETEC

CTI and Associates

Job No: 13-53056
Date: 09:04:13 15:53
Site: Weadock Ash Pond

Sounding: SCPT2013-06
Cone: 224:T1500F15U500



Max Depth: 5.950 m / 19.52 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.100 m

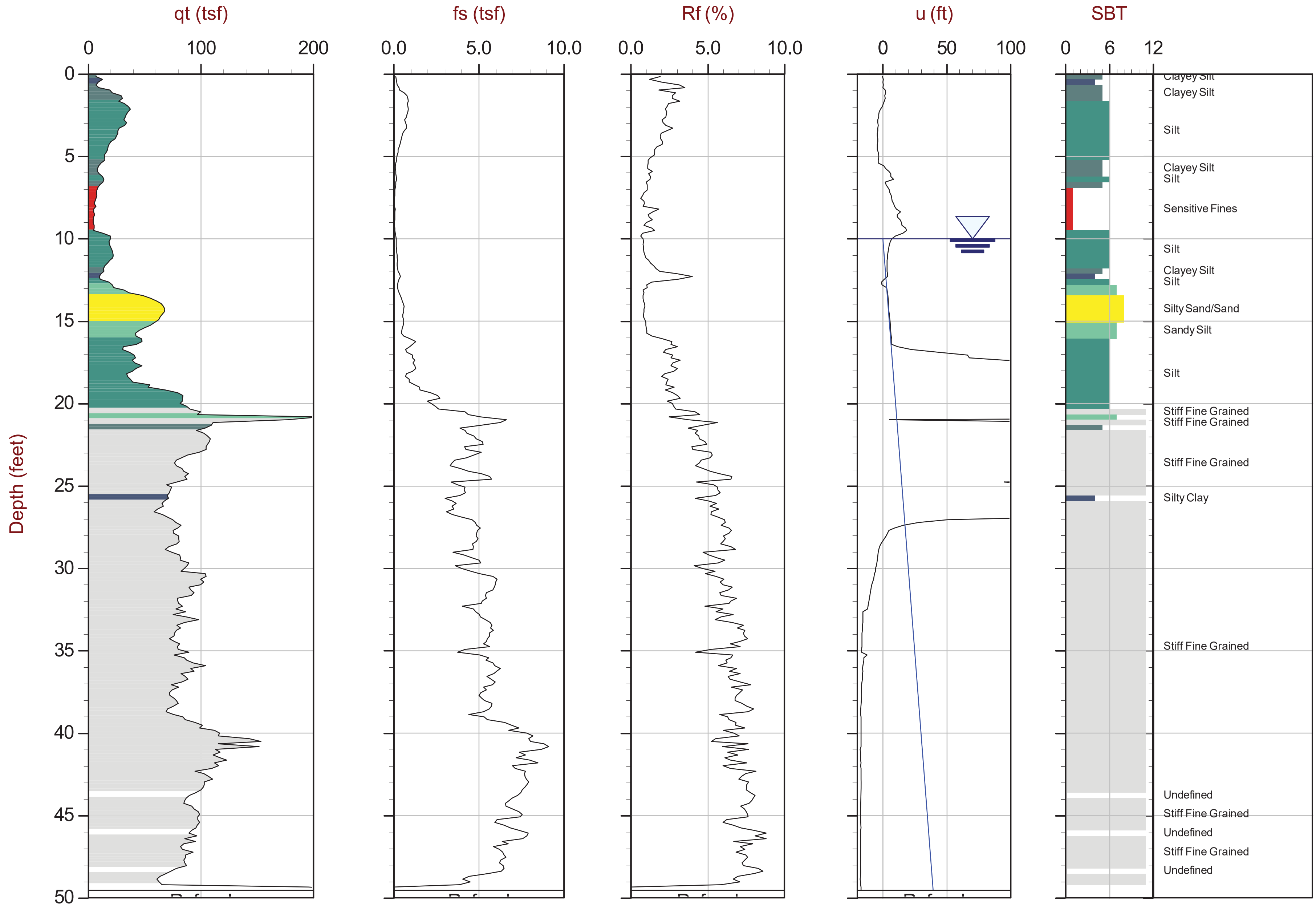
File: 13-53056_SP06.COR

SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 17 N: 4836073 E: 272293
Page No: 1 of 1

CTI and Associates

Job No: 13-53056
Date: 09:04:13 16:31
Site: Weadock Ash Pond

Sounding: SCPT2013-06A
Cone: 224:T1500F15U500



Max Depth: 15.100 m / 49.54 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.100 m

File: 13-53056_SP06A.COR

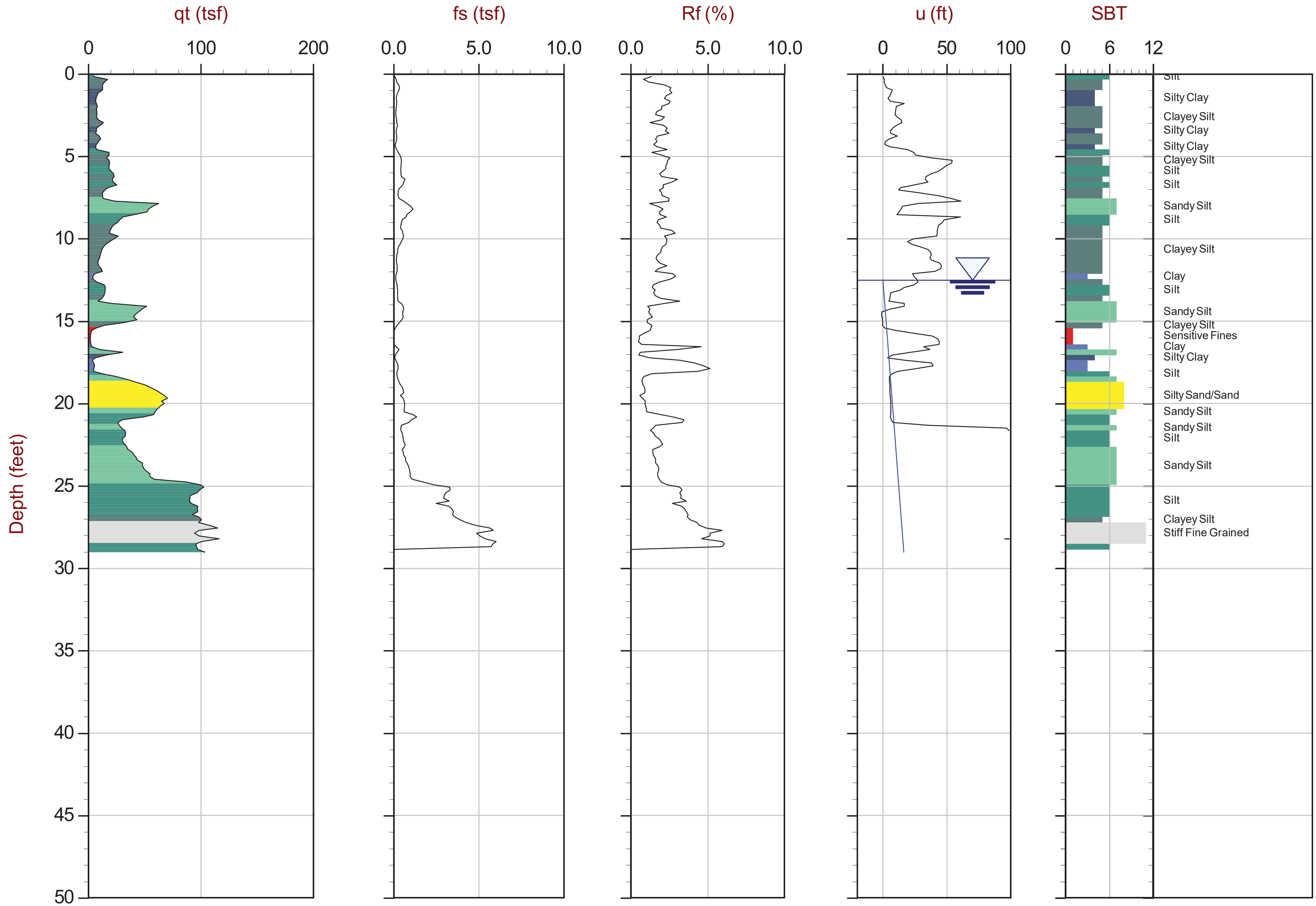
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 17 N: 4836073 E: 272291
Page No: 1 of 1

ConeTec

CTI and Associates

Job No: 13-53056
Date: 09:05:13 07:57
Site: Weadock Ash Pond

Sounding: CPT2013-07
Cone: 224:T1500F15U500



Max Depth: 8.850 m / 29.04 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.100 m

File: 13-53056_CP07.COR

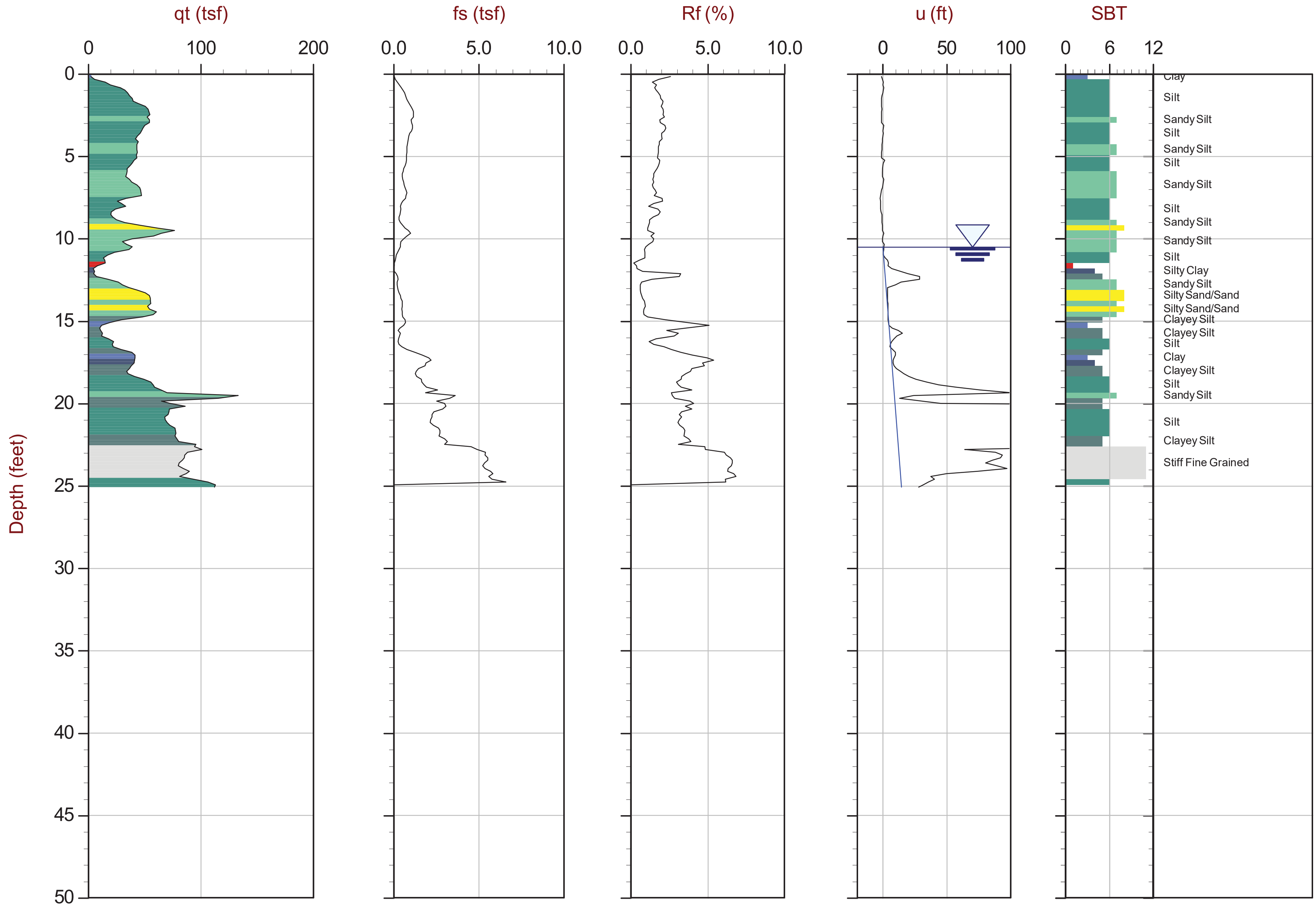
SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 17 N: 4835926 E: 272357
Page No: 1 of 1

ConeTec

CTI and Associates

Job No: 13-53056
Date: 09:05:13 08:46
Site: Weadock Ash Pond

Sounding: SCPT2013-09
Cone: 224:T1500F15U500



Max Depth: 7.650 m / 25.10 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: 0.100 m

File: 13-53056_SP09.COR

SBT: Lunne, Robertson and Powell, 1997
Coords: UTM Zone 17 N: 4835777 E: 272588
Page No: 1 of 1

APPENDIX D

Hydraulic Model Output

Summary for Reach 25R: 0.5% CONCRETE

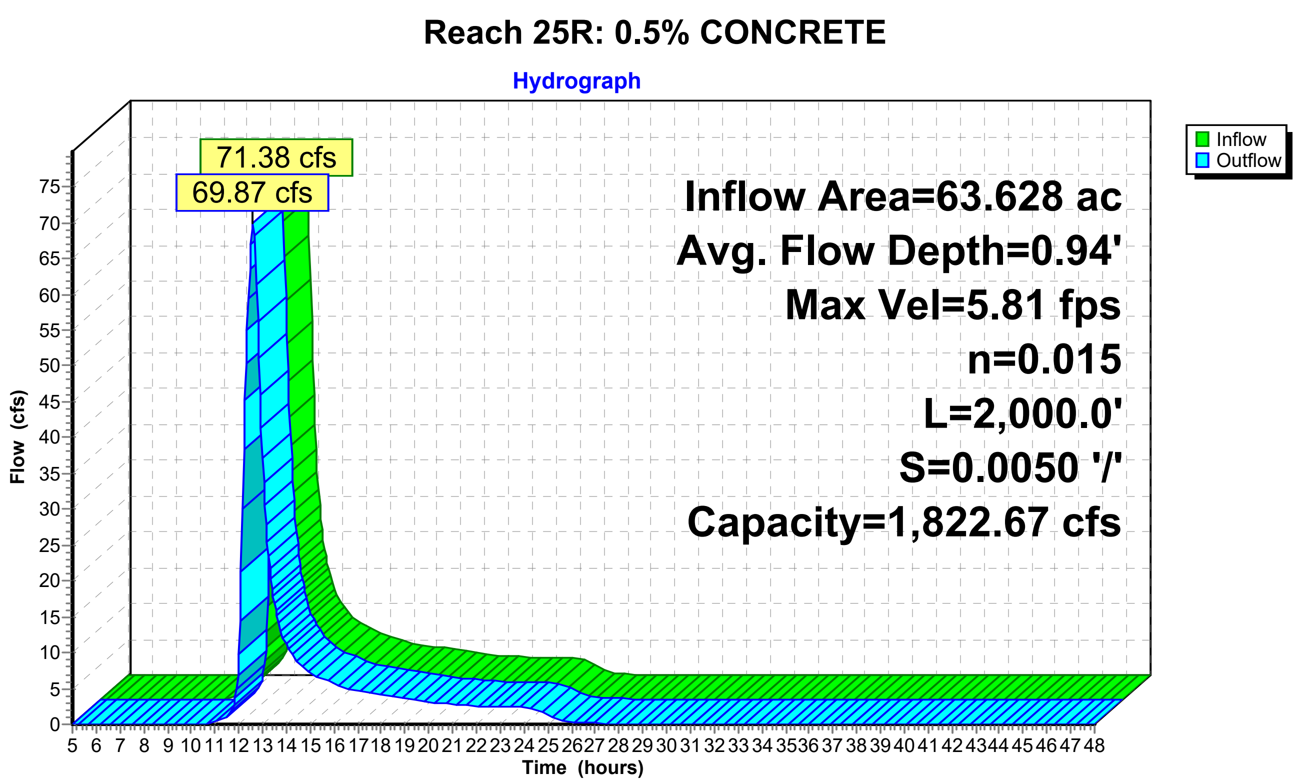
Inflow Area = 63.628 ac, 0.00% Impervious, Inflow Depth = 1.81" for 25-YEAR event
Inflow = 71.38 cfs @ 12.44 hrs, Volume= 9.609 af
Outflow = 69.87 cfs @ 12.59 hrs, Volume= 9.609 af, Atten= 2%, Lag= 9.2 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.81 fps, Min. Travel Time= 5.7 min
Avg. Velocity = 1.71 fps, Avg. Travel Time= 19.5 min

Peak Storage= 24,075 cf @ 12.50 hrs
Average Depth at Peak Storage= 0.94'
Bank-Full Depth= 5.00' Flow Area= 125.0 sf, Capacity= 1,822.67 cfs

10.00' x 5.00' deep channel, n= 0.015 Concrete, trowel finish
Side Slope Z-value= 3.0 '/' Top Width= 40.00'
Length= 2,000.0' Slope= 0.0050 '/'
Inlet Invert= 591.39', Outlet Invert= 581.39'

‡



Hydrograph for Reach 25R: 0.5% CONCRETE

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)
5.00	0.00	0	591.39	0.00
6.00	0.00	0	591.39	0.00
7.00	0.00	0	591.39	0.00
8.00	0.00	0	591.39	0.00
9.00	0.00	0	591.39	0.00
10.00	0.05	20	591.39	0.00
11.00	0.87	744	591.43	0.27
12.00	**35.76**	**10,634**	**591.86**	**9.70**
13.00	**25.89**	**13,848**	**591.98**	**37.26**
14.00	9.83	6,884	591.70	11.14
15.00	6.75	5,317	591.64	7.17
16.00	5.40	4,597	591.61	5.70
17.00	4.44	4,051	591.58	4.63
18.00	3.94	3,734	591.57	4.06
19.00	3.48	3,459	591.55	3.60
20.00	3.00	3,178	591.54	3.12
21.00	2.66	2,920	591.53	2.73
22.00	2.54	2,812	591.52	2.57
23.00	2.45	2,744	591.52	2.47
24.00	2.36	2,678	591.52	2.38
25.00	0.70	1,637	591.47	1.24
26.00	0.14	693	591.42	0.36
27.00	0.04	247	591.40	0.13
28.00	0.02	88	591.39	0.05
29.00	0.01	36	591.39	0.02
30.00	0.00	17	591.39	0.01
31.00	0.00	8	591.39	0.00
32.00	0.00	4	591.39	0.00
33.00	0.00	2	591.39	0.00
34.00	0.00	1	591.39	0.00
35.00	0.00	0	591.39	0.00
36.00	0.00	0	591.39	0.00
37.00	0.00	0	591.39	0.00
38.00	0.00	0	591.39	0.00
39.00	0.00	0	591.39	0.00
40.00	0.00	0	591.39	0.00
41.00	0.00	0	591.39	0.00
42.00	0.00	0	591.39	0.00
43.00	0.00	0	591.39	0.00
44.00	0.00	0	591.39	0.00
45.00	0.00	0	591.39	0.00
46.00	0.00	0	591.39	0.00
47.00	0.00	0	591.39	0.00
48.00	0.00	0	591.39	0.00

Summary for Reach 25R: 1.0% GRASS

Inflow Area = 63.628 ac, 0.00% Impervious, Inflow Depth = 1.81" for 25-YEAR event
Inflow = 70.35 cfs @ 12.45 hrs, Volume= 9.609 af
Outflow = 68.08 cfs @ 12.65 hrs, Volume= 9.609 af, Atten= 3%, Lag= 11.8 min

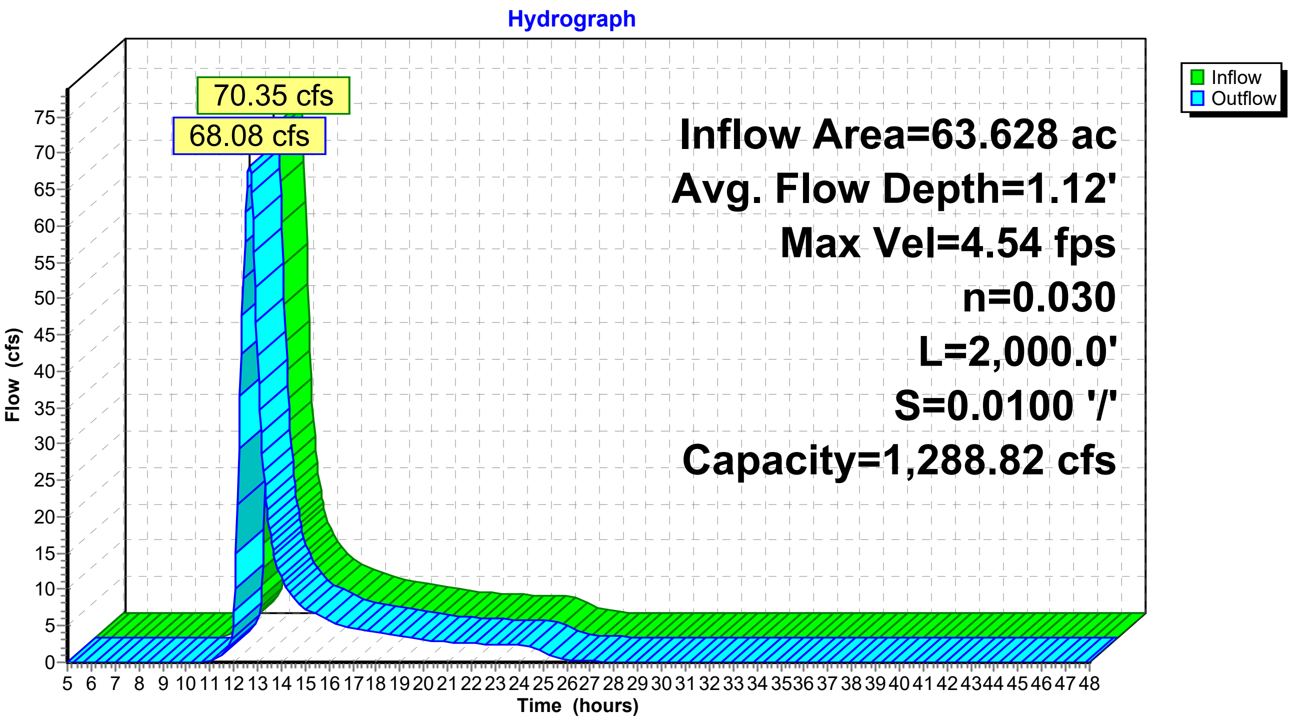
Routing by Stor-Ind+Trans method, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.54 fps, Min. Travel Time= 7.3 min
Avg. Velocity = 1.31 fps, Avg. Travel Time= 25.5 min

Peak Storage= 30,049 cf @ 12.52 hrs
Average Depth at Peak Storage= 1.12'
Bank-Full Depth= 5.00' Flow Area= 125.0 sf, Capacity= 1,288.82 cfs

10.00' x 5.00' deep channel, n= 0.030
Side Slope Z-value= 3.0 '/' Top Width= 40.00'
Length= 2,000.0' Slope= 0.0100 '/'
Inlet Invert= 599.89', Outlet Invert= 579.89'

‡

Reach 25R: 1.0% GRASS



Hydrograph for Reach 25R: 1.0% GRASS

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)
5.00	0.00	0	599.89	0.00
6.00	0.00	0	599.89	0.00
7.00	0.00	0	599.89	0.00
8.00	0.00	0	599.89	0.00
9.00	0.00	0	599.89	0.00
10.00	0.05	21	599.89	0.00
11.00	0.84	807	599.93	0.19
12.00	**34.87**	**12,000**	**600.41**	**6.88**
13.00	**26.59**	**18,346**	**600.64**	**42.26**
14.00	9.90	8,775	600.28	11.69
15.00	6.78	6,685	600.20	7.36
16.00	5.41	5,769	600.16	5.80
17.00	4.45	5,067	600.13	4.69
18.00	3.95	4,668	600.11	4.10
19.00	3.48	4,332	600.09	3.63
20.00	3.01	3,962	600.08	3.17
21.00	2.66	3,634	600.06	2.76
22.00	2.54	3,503	600.06	2.58
23.00	2.45	3,424	600.05	2.48
24.00	2.36	3,347	600.05	2.39
25.00	0.73	2,157	599.99	1.37
26.00	0.15	997	599.94	0.38
27.00	0.05	460	599.91	0.17
28.00	0.02	195	599.90	0.07
29.00	0.01	84	599.89	0.03
30.00	0.00	39	599.89	0.01
31.00	0.00	18	599.89	0.01
32.00	0.00	9	599.89	0.00
33.00	0.00	4	599.89	0.00
34.00	0.00	2	599.89	0.00
35.00	0.00	1	599.89	0.00
36.00	0.00	0	599.89	0.00
37.00	0.00	0	599.89	0.00
38.00	0.00	0	599.89	0.00
39.00	0.00	0	599.89	0.00
40.00	0.00	0	599.89	0.00
41.00	0.00	0	599.89	0.00
42.00	0.00	0	599.89	0.00
43.00	0.00	0	599.89	0.00
44.00	0.00	0	599.89	0.00
45.00	0.00	0	599.89	0.00
46.00	0.00	0	599.89	0.00
47.00	0.00	0	599.89	0.00
48.00	0.00	0	599.89	0.00

Summary for Reach 25R: 2.0% GRASS

Inflow Area = 63.628 ac, 0.00% Impervious, Inflow Depth = 1.81" for 25-YEAR event
Inflow = 71.38 cfs @ 12.44 hrs, Volume= 9.609 af
Outflow = 69.87 cfs @ 12.59 hrs, Volume= 9.609 af, Atten= 2%, Lag= 9.2 min

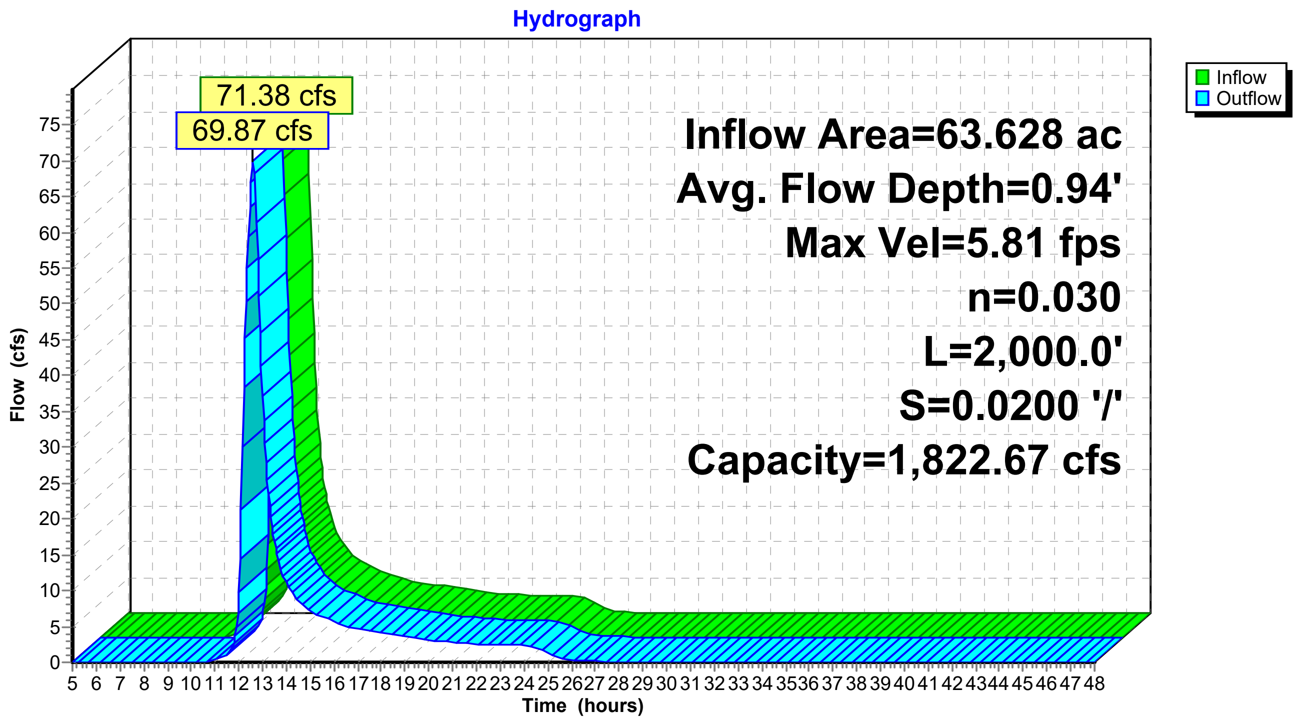
Routing by Stor-Ind+Trans method, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.81 fps, Min. Travel Time= 5.7 min
Avg. Velocity = 1.71 fps, Avg. Travel Time= 19.5 min

Peak Storage= 24,075 cf @ 12.50 hrs
Average Depth at Peak Storage= 0.94'
Bank-Full Depth= 5.00' Flow Area= 125.0 sf, Capacity= 1,822.67 cfs

10.00' x 5.00' deep channel, n= 0.030
Side Slope Z-value= 3.0 '/' Top Width= 40.00'
Length= 2,000.0' Slope= 0.0200 '/'
Inlet Invert= 616.89', Outlet Invert= 576.89'

‡

Reach 25R: 2.0% GRASS



Hydrograph for Reach 25R: 2.0% GRASS

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)
5.00	0.00	0	616.89	0.00
6.00	0.00	0	616.89	0.00
7.00	0.00	0	616.89	0.00
8.00	0.00	0	616.89	0.00
9.00	0.00	0	616.89	0.00
10.00	0.05	20	616.89	0.00
11.00	0.87	744	616.93	0.27
12.00	**35.76**	**10,634**	**617.36**	**9.70**
13.00	**25.89**	**13,848**	**617.48**	**37.26**
14.00	9.83	6,884	617.20	11.14
15.00	6.75	5,317	617.14	7.17
16.00	5.40	4,597	617.11	5.70
17.00	4.44	4,051	617.08	4.63
18.00	3.94	3,734	617.07	4.06
19.00	3.48	3,459	617.05	3.60
20.00	3.00	3,178	617.04	3.12
21.00	2.66	2,920	617.03	2.73
22.00	2.54	2,812	617.02	2.57
23.00	2.45	2,744	617.02	2.47
24.00	2.36	2,678	617.02	2.38
25.00	0.70	1,637	616.97	1.24
26.00	0.14	693	616.92	0.36
27.00	0.04	247	616.90	0.13
28.00	0.02	88	616.89	0.05
29.00	0.01	36	616.89	0.02
30.00	0.00	17	616.89	0.01
31.00	0.00	8	616.89	0.00
32.00	0.00	4	616.89	0.00
33.00	0.00	2	616.89	0.00
34.00	0.00	1	616.89	0.00
35.00	0.00	0	616.89	0.00
36.00	0.00	0	616.89	0.00
37.00	0.00	0	616.89	0.00
38.00	0.00	0	616.89	0.00
39.00	0.00	0	616.89	0.00
40.00	0.00	0	616.89	0.00
41.00	0.00	0	616.89	0.00
42.00	0.00	0	616.89	0.00
43.00	0.00	0	616.89	0.00
44.00	0.00	0	616.89	0.00
45.00	0.00	0	616.89	0.00
46.00	0.00	0	616.89	0.00
47.00	0.00	0	616.89	0.00
48.00	0.00	0	616.89	0.00

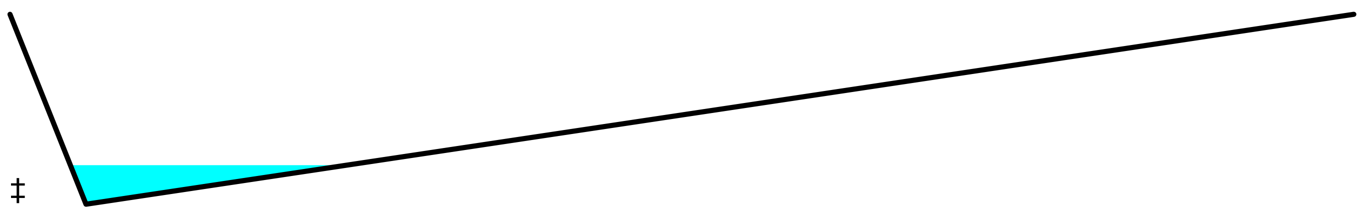
Summary for Reach 02R: 1% Perimeter Ditch

Inflow Area =	3.656 ac,	0.00% Impervious, Inflow Depth = 1.81"	for 25-YEAR event
Inflow =	11.33 cfs @	11.98 hrs, Volume=	0.552 af
Outflow =	7.55 cfs @	12.22 hrs, Volume=	0.552 af, Atten= 33%, Lag= 14.0 min

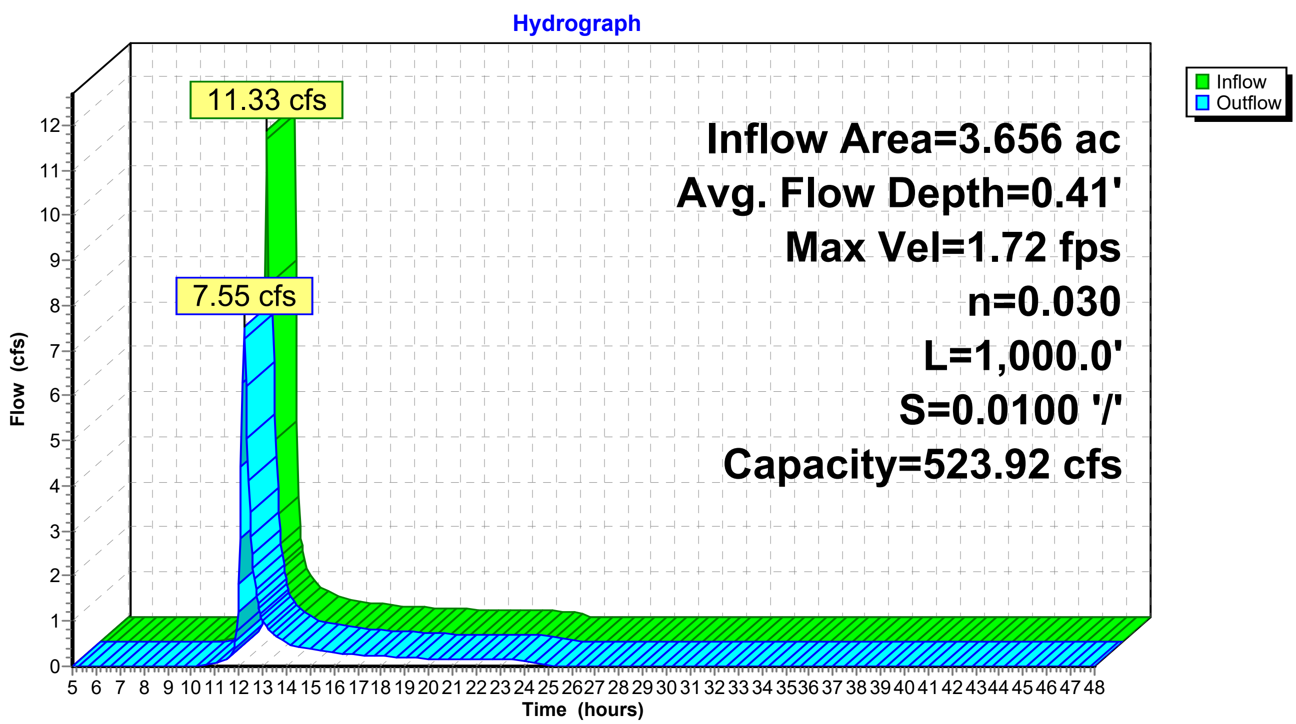
Routing by Stor-Ind+Trans method, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.72 fps, Min. Travel Time= 9.7 min
Avg. Velocity = 0.57 fps, Avg. Travel Time= 29.1 min

Peak Storage= 4,468 cf @ 12.06 hrs
Average Depth at Peak Storage= 0.41'
Bank-Full Depth= 2.00' Flow Area= 106.0 sf, Capacity= 523.92 cfs

0.00' x 2.00' deep channel, n= 0.030 Earth, dense weeds
Side Slope Z-value= 3.0 50.0 '/' Top Width= 106.00'
Length= 1,000.0' Slope= 0.0100 '/'
Inlet Invert= 600.63', Outlet Invert= 590.63'



Reach 02R: 1% Perimeter Ditch



Hydrograph for Reach 02R: 1% Perimeter Ditch

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)
5.00	0.00	0	600.63	0.00
6.00	0.00	0	600.63	0.00
7.00	0.00	0	600.63	0.00
8.00	0.00	0	600.63	0.00
9.00	0.00	0	600.63	0.00
10.00	0.02	11	600.65	0.00
11.00	0.15	151	600.71	0.06
12.00	**11.14**	**4,041**	**601.02**	**1.81**
13.00	0.70	**870**	**600.81**	**1.03**
14.00	0.43	557	600.77	0.52
15.00	0.34	450	600.76	0.37
16.00	0.27	380	600.75	0.30
17.00	0.24	336	600.74	0.25
18.00	0.21	308	600.74	0.22
19.00	0.18	279	600.73	0.20
20.00	0.16	249	600.73	0.17
21.00	0.15	232	600.72	0.15
22.00	0.14	225	600.72	0.15
23.00	0.14	219	600.72	0.14
24.00	0.13	212	600.72	0.13
25.00	0.00	45	600.67	0.02
26.00	0.00	14	600.65	0.00
27.00	0.00	6	600.64	0.00
28.00	0.00	3	600.63	0.00
29.00	0.00	1	600.63	0.00
30.00	0.00	0	600.63	0.00
31.00	0.00	0	600.63	0.00
32.00	0.00	0	600.63	0.00
33.00	0.00	0	600.63	0.00
34.00	0.00	0	600.63	0.00
35.00	0.00	0	600.63	0.00
36.00	0.00	0	600.63	0.00
37.00	0.00	0	600.63	0.00
38.00	0.00	0	600.63	0.00
39.00	0.00	0	600.63	0.00
40.00	0.00	0	600.63	0.00
41.00	0.00	0	600.63	0.00
42.00	0.00	0	600.63	0.00
43.00	0.00	0	600.63	0.00
44.00	0.00	0	600.63	0.00
45.00	0.00	0	600.63	0.00
46.00	0.00	0	600.63	0.00
47.00	0.00	0	600.63	0.00
48.00	0.00	0	600.63	0.00

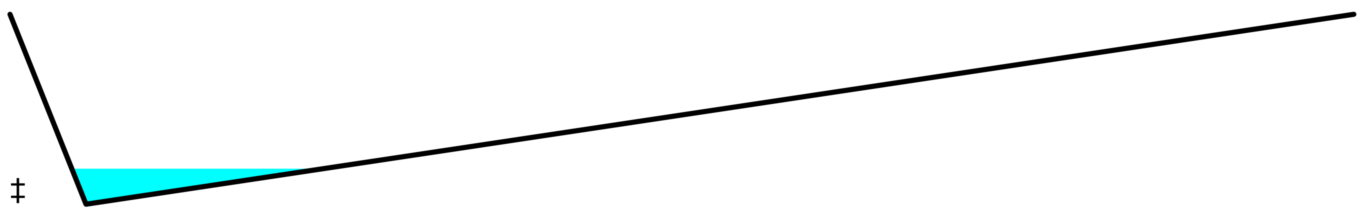
Summary for Reach 9R: 2% Perimeter Ditch

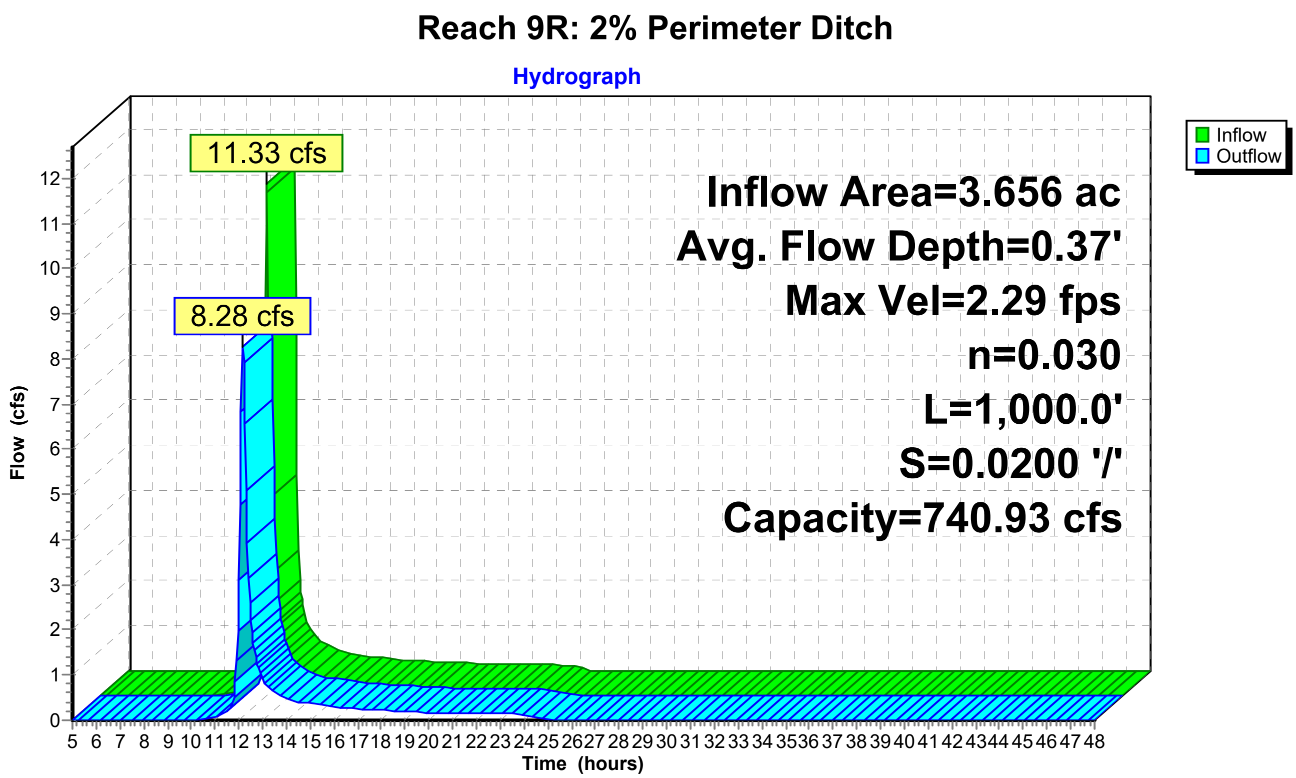
Inflow Area = 3.656 ac, 0.00% Impervious, Inflow Depth = 1.81" for 25-YEAR event
Inflow = 11.33 cfs @ 11.98 hrs, Volume= 0.552 af
Outflow = 8.28 cfs @ 12.17 hrs, Volume= 0.552 af, Atten= 27%, Lag= 11.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-48.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.29 fps, Min. Travel Time= 7.3 min
Avg. Velocity = 0.79 fps, Avg. Travel Time= 21.0 min

Peak Storage= 3,720 cf @ 12.05 hrs
Average Depth at Peak Storage= 0.37'
Bank-Full Depth= 2.00' Flow Area= 106.0 sf, Capacity= 740.93 cfs

0.00' x 2.00' deep channel, n= 0.030 Earth, dense weeds
Side Slope Z-value= 3.0 50.0 '/' Top Width= 106.00'
Length= 1,000.0' Slope= 0.0200 '/'
Inlet Invert= 610.63', Outlet Invert= 590.63'





Hydrograph for Reach 9R: 2% Perimeter Ditch

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)
5.00	0.00	0	610.63	0.00
6.00	0.00	0	610.63	0.00
7.00	0.00	0	610.63	0.00
8.00	0.00	0	610.63	0.00
9.00	0.00	0	610.63	0.00
10.00	0.02	11	610.65	0.00
11.00	0.15	129	610.70	0.08
12.00	**11.14**	**3,466**	**610.99**	**3.09**
13.00	0.70	**635**	**610.78**	**0.90**
14.00	0.43	420	610.76	0.49
15.00	0.34	343	610.74	0.37
16.00	0.27	289	610.73	0.29
17.00	0.24	258	610.73	0.25
18.00	0.21	236	610.72	0.22
19.00	0.18	213	610.72	0.19
20.00	0.16	189	610.71	0.17
21.00	0.15	178	610.71	0.15
22.00	0.14	174	610.71	0.14
23.00	0.14	169	610.71	0.14
24.00	0.13	164	610.71	0.13
25.00	0.00	24	610.66	0.01
26.00	0.00	6	610.64	0.00
27.00	0.00	2	610.63	0.00
28.00	0.00	1	610.63	0.00
29.00	0.00	0	610.63	0.00
30.00	0.00	0	610.63	0.00
31.00	0.00	0	610.63	0.00
32.00	0.00	0	610.63	0.00
33.00	0.00	0	610.63	0.00
34.00	0.00	0	610.63	0.00
35.00	0.00	0	610.63	0.00
36.00	0.00	0	610.63	0.00
37.00	0.00	0	610.63	0.00
38.00	0.00	0	610.63	0.00
39.00	0.00	0	610.63	0.00
40.00	0.00	0	610.63	0.00
41.00	0.00	0	610.63	0.00
42.00	0.00	0	610.63	0.00
43.00	0.00	0	610.63	0.00
44.00	0.00	0	610.63	0.00
45.00	0.00	0	610.63	0.00
46.00	0.00	0	610.63	0.00
47.00	0.00	0	610.63	0.00
48.00	0.00	0	610.63	0.00