Parking Lot Redesign & Culvert Replacement

Waldoboro, Maine

Prepared for:

The Town of Waldoboro, Maine

Mr. Maxwell Johnstone

Prepared by:

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April 29, 2021

Mr. Maxwell Johnstone
1600 Atlantic Highway
P.O. Box J Waldoboro, ME 04572

Dear Mr. Johnstone,

Enclosed are CT-PAC's senior capstone recommendations for the parking lot redesign located at 877 Main Street and the culvert replacement located at the Duckpuddle Stream crossing. Recommendations for the sites are based on research and design work completed during the Spring of 2021 and are detailed in the following report.

We would like to thank you and the Town of Waldoboro for providing a challenging and exciting set of projects that allowed us to test our engineering skills. It is our hope that the design work detailed in this report will provide you with detailed information that may be used as a resource for future development of both sites. If you have any questions, please feel free to contact me by either phone (207-212-2560) or email (tanner.binette@maine.edu).

Best Regards,

Tanner Binette

Tanner Binette
Co-Project Manager, CT-PAC

Table of Contents

List of Figures

List of Tables

1 Introduction

1.1 Acknowledgements

CT-PAC would like to acknowledge all of the people who helped to make this project possible. We are extremely grateful for all of the guidance that was provided to us by professionals in multiple fields. We would like to thank the following individuals for their contributions to our team:

Thank you to our client, Maxwell Johnstone, and the Town of Waldoboro for providing us with two amazing projects that allowed us to use our engineering skills in a real-world application.

Thank you to the individuals who assisted with aspects of Transportation Engineering:
- Mr. Derek Nener-Plante
- Dr. Per Garder, P.E.

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- Mr. Jeremy Croteau, P.L.S.
- Mr. Ethan Hyder

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- Dr. Shalleen Jain, P.E.
- Dr. Kimberly Huguenard

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- Mr. Mark Andrews, Dirigo Timberlands

Thank you to the individuals who assisted us with Project Management, and Professional Guidance
- Dr. Edwin Nagy, S.E., P.E.,
- Mr. Jeff Aceto, P.E.

1.2 Executive Summary

This report exhibits CT-PACs recommendation to the Town of Waldoboro Maine to increase parking and greenspace at the parking lot at 877 Main Street and to stop flooding at the culvert at Duckpuddle Road. The parking lot has no striping plan to define spots, an inconsistent traffic flow, and is not ADA compliant. The culvert at Duckpuddle road is not able to reach its maximum flow capacity due to the low point in the road on the Waldoboro side which causes the road to flood from the wetland.

The recommendations for the parking lot were based on the existing site conditions, site layout options, and final parking lot layout plan. Our primary goals for this site was to increase the amount of parking spots, greenspace, and enhance the view of the Medomak River.

Existing Site Conditions
The purpose of examining the site conditions was to determine what work needed to be done to satisfy the clients goals for the site.

- *Existing Conditions Plan-* The parking lot currently is not paved, stripped, or ADA compliant.

Site Layout Option Analysis
The purpose of the site layout option analysis was to produce three parking lot layouts from different perspectives and disturbances. By analyzing the layout it helped determine what aspects worked out and looked the best from each layout. These aspects of interest were combined to produce the final layout options.

- *Analysis of Three Theoretical Options-* Three preliminary design layout options were made of the parking lot. Each design was evaluated on the number of parking spaces, aesthetics, greenspace percentage of the lot area, disturbance of the lot, safety, and usability. The option with the best rank was used as a reference to create the final parking lot layout which was option #1.

Final Parking Lot Layout Plan
The purpose of the final parking lot layout plan was to combine all aspects within the lot that have been examined.

- *Grading-* The parking lot was graded to have a maximum 5% slope.
- *Stormwater Management-* No stormwater treatment is needed. The runoff from the lot will infiltrate into the greenspace at the end of the lot and/or will eventually go into the Medomak River.

- *Erosion and Sedimentation Control Plan-* Silt fencing should be used at the base of any disturbed slope of the project site as a temporary erosion control measure. The silt fencing should remain in-place and functional until approximately 70% of the sloped land is covered with vegetation.
- *Lighting Plan-* Two light poles were added to the lot to increase visibility.
- *ADA Compliance-* Two ADA parking spots were added to the lot. One of the spots is van Accessible. The two parking spots were placed beside a pathway that leads to the existing sidewalk on Main Street.

The recommendations for the culvert and roadway design at Duckpuddle Road were based on the existing site conditions, culvert option analysis, and final culvert and road plan design. The primary goals for this site was to stop the roadway from flooding and to allow for safe fish passage.

Existing Site Conditions

The hydrologic data, pipe arch, and road dimensions were taken from the *General Culvert Design Plan 1981.* That information was used to investigate the existing flow condition of the culvert.

- *Geometric Characteristics of Stream Channel-* StreamStats was used to determine the cross sections of the waterway which were used to further analyze the site.
- *Steady Flow Through the Culvert-* Using the Software HEC-RAS it was found that the pipe arch culvert is able to withstand a flow of 300 cfs and not it's designed flow of 700 cfs as stated on the *Duck Puddle Bridge Nobleboro-Waldoboro General Plan1981.*

Culvert Option Analysis

The purpose of the culvert option analysis was based on designing three culvert designs. Each design was examined based on their flow capacity and fish passage through the culvert which was then used to develop the final design.

- *Preliminary Designs-* Three preliminary design options were made: a pipe arch, ellipse, and open bottom box culvert. Option #3 was picked to be used to create the final culvert design.

Final Culvert and Road Plan Design

The purpose of the culvert and road plan design was to redesign Duckpuddle road after choosing the final culvert design. The road plan will show all aspects of the culvert and roadway that have been examined.

- *Final Culvert Design-* The final culvert design is an open bottom box culvert which is excellent for fish passage and allows optimal flow through the culvert.
- *Geotechnical Analysis-* The footing dimensions of the abutment blocks of the culvert are adequate for bearing capacity and settlement of the box culvert structure.

- *Surface Grading*- The grade changes were made to prevent the flooding with the addition of the new culvert.
- *Road Plan*- The part of the road that is being designed is 400’ long. The new designed section at the smallest width is 19.2’ and at the culvert the road is 22.5’ wide. The guardrails are being removed and replaced under *MDOT Specifications*.
- *Lighting*- The utility pole that currently sits on the edge of the road has been moved to six feet from the right-of-way then the lights can be installed.

Estimated Cost

- Parking Lot at 877 Main Street: $145,000
- Culvert at Duckpuddle Road: $230,000

1.3 Introduction and Purpose

CT-PAC is a student civil engineering team at the University of Maine, who was given the opportunity to design engineering solutions for the Town of Waldoboro, Maine. CT-PAC worked in coordination with Maxwell Johnstone, who is the Planning and Development Director for the Town of Waldoboro. These engineering solutions are part of CT-PAC's capstone requirements. Based on client recommendations, CT-PAC has designed a culvert replacement for the Duckpuddle Stream crossing on Duckpuddle Road., as well as a new design for the parking lot located at 877 Main St. Waldoboro, Maine. These two projects are located in different parts of Waldoboro, and are unrelated. Because of their physical separation, all design work was compartmentalized by each project location. CT-PAC's report is formatted so that all work for each project is separate.

For the parking lot, the client has requested that CT-PAC creates a new design for the 877 Main Street parking lot. This design will include a new layout plan, a grading plan, a pavement structure design, a lighting plan, and stormwater management recommendations. The client has also requested that CT-PAC designs a new culvert at the Duckpuddle Stream crossing that eliminates flooding during peak flow events. This new design will include a redesign of road profiles, a redesign of pavement structure, a lighting plan, and an analysis of risk for the client. CT-PAC has created a list of permit requirements, a cost estimate, and a risk analysis for each project based on our designs. These designs are not to be formally used by the town unless checked and stamped by a licensed engineer. Please see the project disclaimer in Section 7 for more information.

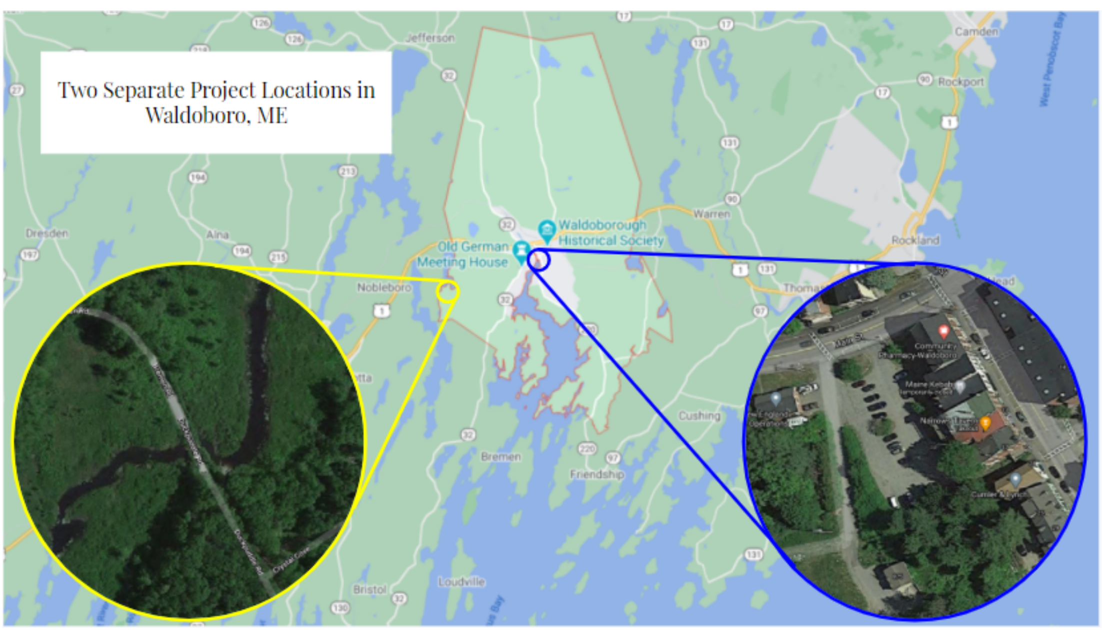


Figure 1.1 - *Culvert project location (Left), Parking Lot project location (Right)*

1.4 Project Background and Description

The Town of Waldoboro is currently looking into the possibility of purchasing the parking lot that is located at 877 Main Street. The current parking lot does not have adequate striping or lighting and is not ADA compliant. This has led to the site being difficult to use and does not use the available area of the lot efficiently to maximize the useability of the lot. The lot has two entrances along Main street, one of these entrances is shared with the easement that is connected to the Town of Waldoboro's utility building located adjacent to the lot. This has led to unorganized vehicle flow throughout the lot. The lack of striping in the lot has led to unorganized parking which reduces the capacity of the lot. The existing lot has one light located on the southern edge of the lot which does not adequately illuminate the entire lot. The objective of this part of our capstone project was to create a layout design for the Town of Waldoboro to maximize the useability of the lot and to maximize the parking. *Figure 1.2* shows an aerial view of the existing parking lot.

Figure 1.2 - *Aerial view of parking lot located at 877 Main Street*

CT-PAC strove to create a layout design that was both functional as well aesthetically pleasing. The client requested that the lot be designed to increase parking while still maintaining a large portion of usable green space that would highlight the view of the Medomak river. The Town of Waldoboro's *Land Use Ordinance* was consulted to ensure that all designs were compliant. All designs were made to comply with ADA accessibility requirements.

The current stream crossing located on Duckpuddle road on the border of Waldoboro and Nobelboro floods annually due to being undersized as well as a section of the roadway being lower than the top of the culvert. The largest flooding occurs approximately 100 feet from the channel in the direction of Nobelboro. The section of roadway over the culvert is very narrow and only allows for one vehicle to pass at a time. Guard rails on either side of the road are also badly damaged due to collisions. The site also does not have any lighting which can make it difficult to determine when it is flooded at night, this creates a serious safety concern. The objective of this part of our project was to create a design for a culvert replacement and roadway design that would eliminate the flooding that this site is experiencing and increase the overall safety of the roadway. *Figure 1.3* shows an aerial view of the site location.

Figure 1.3 - *Aerial view of stream crossing at Duckpuddle Road*

CT-PAC focused on creating a culvert design that was adequately sized to handle the peak flow values of the stream without flooding and increased roadway safety. Designs were created to be in compliance with Maine Department of Environmental Protection and Department of Transportation standards.

2 Design for the Parking Lot Located at 877 Main Street

2.1 Existing Site Conditions

The first step in the design process of the Parking Lot was to create an existing conditions plan to portray the current conditions of the parking lot located at 877 Main Street in Waldoboro, Maine.

The existing conditions plan was created by using lidar topographic data, property lines gathered from the town tax maps, Google Earth imagery, and measurements that were taken in the field. All maps and references used are attached. An official survey of the area was not conducted, so there is a level of uncertainty for the measurements on the drawing This is because all of the maps used had small differences in spacing and layout. To mitigate this, the four resources mentioned above were all layered onto each other. The differences were then approximated and adjusted to match the other layers. Once the maps have aligned an outline was created. It is believed that through this process, CT-PAC has created an accurate existing conditions plan for the site.

CT-PAC found an approximate area of greenspace as well as the number of existing parking spaces based on current parking trends. The greenspace was calculated in AutoCad by outlining the greenspace area and using a calculation tool. The different shading regions represent different ground surfaces and are labeled accordingly. The topographic map shown underneath has two-foot contour lines. Parcel numbers are included in the plan for property purposes. Theoretical parking spots were drawn based on the orientation of vehicles during CT-PAC's site visit on October 3rd, 2020. The parking spaces shown were drawn based on the standard 9'x18.5' parking space described in the *Town of Waldoboro Land Use Ordinance (2019)*. Utilities were added to the plans to show where they are located in the event they need to be modified in the final design.

The number of parking spaces and green space area was used by CT-PAC to get a baseline of parking lot metrics to use in the final design; please see Table 2.1-1 for findings. The "hilly brush" area was not considered usable greenspace because it has a very steep grade and is very overgrown. A tax map from the town displayed a right-of-way in the middle of the parking lot extending from one of the buildings on Friendship Street, which is owned by a Mr. Henry Cabot. Upon further investigation, the dimensions of the right-of-way were found in the property deed and the actual size was drawn on the plan. With some communication, it was determined that the purpose of the right-of-way was for deliveries and parking for the business adjacent. Please see Appendix A: *Existing Conditions* Plan..

Table 2.1-1 - Parking Lot Findings from the Existing Condition Plans

Parking Spaces	20 +/- 2
Greenspace (Square Feet)	6250

2.2 Analysis of Preliminary Design Options

The next step in the design process was to create three preliminary layout designs for the parking lot located at 877 Main Street Waldoboro, Maine. Each of the three designs modified the layout of the existing parking lot to increase the number of available parking spaces to be in accordance with the *Town of Waldoboro Land Use Ordinance*. As well as maintaining the area of greenspace, increasing safety, and usability of the lot. Each of the three designs added striping, new greenspace locations, curbing, and in some cases preliminary grading of elevations. By creating three different preliminary designs, different design aspects and the impacts that they had on the overall layout of the lot were considered. This information was used by CT-PAC for the final layout plan.

CT-PAC created three preliminary Site Layout Drawings, labelled *Site Layout Option 1, 2, and 3*. Each design created had benefits associated with it. *Site Layout Option 1* provided a minimal impact design with conventional 90-degree parking stalls. The main objective of *Site Layout Option 2* was also to provide a minimal impact design, but with angled parking stalls. Having the stalls angled often allows for an increased number of parking stalls within the lot. The design for *Site Layout Option 3* focused on utilizing as much of the property as feasible, which would involve large amounts of grading and fill in the back portion of the lot.

CT-PAC conducted a quantitative options analysis based on each Site Layout Option. Each preliminary drawing was evaluated on the number of parking spaces, aesthetics, greenspace percentage of the lot area, disturbance of the lot (which is how much the lot changes from the existing design), safety, and usability (which is a measure for how easy the lot is to use for vehicle operators and pedestrians). Each metric for the site layout options was assigned a score based on how well it did compared to the other options. This was because some aspects of the parking lots have legitimate values, like the number of parking spots and percent green space, while other metrics like usability is more arbitrary, but still valued in the option analysis. A common grading scale allowed for CT-PAC to compare different metrics that are unrelated. Each grading metric was assigned a weighting corresponding to how important it was for the success of the new parking lot design. The weighting is based on CT-PAC's analysis of how important each aspect of the design is to the success of the parking lot. For example, the number of parking spaces was viewed as a very important aspect of the design to the client so CT-PAC weighed this factor on a scale of ten, please see *Table 2.1-2 - Site Layout Options Analysis.*

Table 2.1-2- Site Layout Options Analysis

Properties	Weighting (1-10)	Option #1	Option #2	Option #3
Number of Parking Spaces	10	1	2	3
Aesthetic	8	3	1	3
Percent Greenspace	7	3	1	2
Disturbance Rating (1-10)	7	3	2	1
General Safety Rating (1-10)	7	3	2	1
Useability Rating (1-10)	8	3	2	1
	Final Scores:	121.0	79.0	90.0

After analysis of the preliminary designs, it was found that *Site Layout Option 1* provided the best theoretical solution for the parking lot at 877 Main Street in Waldoboro Maine. CT-PAC utilized *Site Layout Option 1* as a baseline for the final design of the parking lot since it was believed that *Site Layout Option 1* allowed for safe and clear vehicle movement within the lot.

Site Layout Option 1 increases the total number of spots in the parking lot by 15 spots, compared to the existing conditions lot. The layout does not meet the calculated required number of parking spaces according to the *Town of Waldoboro Land Use Ordinance*. Due to the unique nature of this parking lot, with the mixture of residential and commercial uses, it is not expected that the parking lot will reach its calculated capacity since the different users often use the lot at different times of the day.

Site Layout Option 2 utilized diagonal parking to maximize the number of spots in the lot, curbs to prevent vehicles from crossing the lot and going the wrong direction of flow, and provided a 37-foot radius that would allow delivery trucks to traverse through the lot. However, in order to exit the parking lot, there was an awkward U-Turn with a turning radius of 15 ft. This would have to be adjusted in future designs since the minimum turning radius of a passenger car is 24 feet per AASHTO specifications. This may be able to be redesigned in the future, but CT-PAC thought it would be best to move forward with a different Site Layout Option.

Site Layout Option 3 provided the greatest number of spots and the highest percentage of greenspace, but had low scores in disturbance and usability. The low score in the disturbance was due to requiring a large amount of fill and grading to make the construction possible. This would increase the time and costs of construction, and may have been out of scope to what the client was expecting. The usability of the lot was also low because there may not be ample room for cars to turn around in the southeast corner of the lot. This may lead to cars having to back out of this section of the lot if all spaces are occupied.

2.3 Final Layout Plan

CT-PAC will now discuss the transition to the final design of the parking lot. The final design is based on *Site Option Layout 1*. Changes had to be made to the layout due to grading considerations. Additional elements introduced in the final layout plan include a lighting plan, final grading plan, erosion control measures, and stormwater management practices.

2.3.1 Grading

The next step in the design process was to create a grading plan for the parking lot, as well as surrounding areas that will be disturbed during construction. This grading plan will have adequate slopes for greenspace and pavement areas. From this plan, CT-PAC was able to analyze stormwater drainage data in future designs. This grading plan ties into the current contour elevations which shows that all proposed elevations are coherent with the existing conditions.

CT-PAC used AutoCAD, a lidar topographic map of the area, and previously proposed layouts to create the Final Grading Plan. Design constraints that had to be met were maximum slopes for greenspace areas (3:1), minimum slopes for paved areas (1.0%), and maximum slopes for paved areas (5%) (USGSA, 2021). For greenspace areas, 2’ proposed contours were drawn and offset at a minimum of 6’. This was used in order to keep the designed greenspace slope to a maximum of 3:1, per *Town of Waldoboro LUO (2019)*. In order for the parking area to be in compliance with the American’s with Disabilities Act (ADA) all handicap accessible spots and access aisles were designed to have a slope no greater than 1:48, or approximately 2%. The minimum and maximum slopes for paved areas were provided by the United States General Services Administration (USGSA). The USGSA is not a transportation engineering entity, but they provide specifications for government-owned facilities. USGSA standards were used for maximum slopes because a published standard for maximum parking lot slopes could not be found.

The grading of the parking area was sloped so that contours were spaced as evenly as possible. Having a constant slope along the parking lot ensures that water sheds off of the pavement in one direction, and provides a path for water to take if stormwater management practices are necessary for the parking area. This slope also allows water to shed off the parking so that no stormwater pools in the parking lot area. Shallow slopes (not less than 1% for drainage considerations) were preferred because they are safer. This is because cars are less likely to slide during icy conditions and shallow slopes are easier for pedestrians to traverse. This ultimately allows for the parking lot to be safer and easier to use.

An initial analysis of our chosen option showed that the grading was too steep, roughly 10%.. This was because earlier designs increased the width of the parking lot into steeper areas. Please see Appendix A: Void Preliminary Grading plan. In order to counteract this, the entrance of the lot was moved further up, towards Friendship Street, and separated from the easement and the width of the lot was reduced.Separating the entrance of the parking lot from the easement was necessary to bring the entrance up to a higher elevation, which is closer to the elevation of the parking lot. Reducing the size of the lot allowed for CT-PAC to maintain a constant grade of 3:1 on the greenspace areas, which acts as a step down from the parking lot to the easement. After corrections were made to the layout of the parking lot, CT-PAC designed contour elevations so that the maximum slope of the parking lot was 5%. This layout change decreased the total number of parking stalls proposed in earlier designs. However, CT-PAC was still able to increase the number of parking stalls from the 22 stalls in the existing lot to 30 stalls in the proposed lot. The final layout with grading changes also increased the greenspace area from 6,250 ft^2 to 13,816 ft^2. Handicap accessible spots and access aisles were designed to have a maximum slope of 2%. Please see Appendix A: *Final Layout Plan*.

2.3.2 Subgrade Design for Pavement Structure

The next step was to design the pavement structure for the parking lot on 877 Main Street in Waldoboro, Maine. The pavement design is intended to have a service life of 12-20 years and is adequate for use in the lot. A secondary goal of this design was to calculate the quantities of Hot Mixed Asphalt (HMA) and Subbase Aggregate which will be needed for the construction of the lot. This information was used by CT-PAC to estimate costs.

The design of the pavement structure was based on the *Maine Department of Transportation's Standards and Specifications for Pavement Design (MDOT, 2019)*. MDOT's Standards are based on Equivalent Single Axle Loads (ESALs), which are measurements of how many vehicles run over the pavement within the pavement's lifespan. It was assumed that the lot would be a low traffic area because it is a small off-street parking area with no vehicles larger than a delivery truck utilizing it. Using that information it was also assumed that the lot should be designed to handle 0-500,000 ESALs. When designing the pavement CT-PAC gathered data from the *United States Department of Agriculture's* (USDA) *Web Soil Survey Tool*, to determine the type of native soil of the lot. The native soil affects the thickness of HMA and Subbase Aggregate, see *Figure 2.3-1* which displays a map from the USDA that shows the type of soil found in the lot, all of which is classified as soil type "Ud".

Figure 2.3-1 - *USDA Web Soil Survey Area of Interest*

One type of pavement was designed for the parking lot. The parking area pavement has the minimum required thickness for a parking lot as specified by MDOT (*Pavement Practices and Procedures Table 8-2.07*). The parking areas will only be used by personal vehicles and small and medium trucks, which is why the minimum thickness is being applied to this part of the design. Please see *Table 2.3-1* for the final Pavement Structure Dimensions. The final quantities of material needed for the pavement structure were also calculated. This was done by finding the area of each pavement zone in AutoCad and multiplying by the depth of those sections. The final Pavement Structure Quantities of the materials needed are located in *Table 2.3-2.*

Table 2.3-1 - Pavement Structure Dimensions for Parking Lot

HMA:	3 inches
Subbase Aggregate:	12 inches

Table 2.3-2 - Pavement Structure Quantities for Parking Lot

Pavement Structure Quantities					
	Pavement Areas (ft^2)	**Subbase Depth (ft)**	**Pavement Depth (ft)**	**Subbase Totals (cubic yard)**	**Pavement Totals (cubic Yard)**
Parking Area:	17,920	1.00	0.25	531	166
Note: 359 ft^2 was added to the Parking Area to account for the sidewalk. This was calculated in the grading plan deliverable.					

2.3.3 Stormwater Analysis Report

The next step was to analyze the stormwater runoff flows for the proposed layout plan for the parking lot located at 877 Main Street in Waldoboro, Maine. To comply with the State of Maine Department of Environmental Protection (DEP) Stormwater Management Law, CT-PAC determined the stormwater runoff rates for both the existing and proposed layout for the project site. HydroCAD software was used to analyze the site and produce runoff flow rates for a 100-year-storm event. The 100-year-storm event is a storm that has a 1% chance of being exceeded in a given year. In order to use HydroCAD certain inputs needed to be determined which consisted of the soil types, land use categories, and the time of concentration for the runoff.

The land use and soil type breakdown for the watershed are both necessary inputs for HydroCAD to calculate the peak flow. Different soil types have different permeability properties which have a direct impact on the infiltration rates. The type of land use for an area also has an impact on the infiltration rates, since the type of land cover that the runoff flow over has a direct impact on the velocity and infiltration of the runoff.

From Maine's Web Soil Survey, the entire location was found to be classified with a hydrologic soil rating "A". The total area of the site was divided into three types of land use for both of the site layouts, Paved area, green space (classified as fair grass cover), and undeveloped land (classified as fair brush). For the existing layout, the values for these areas were gathered from the *Existing Conditions Plan* that was created by CT-PAC. For the proposed layout, the values for these areas were gathered from Appendix A: *Final Layout Plan*.

To determine the time of concentration for the existing and proposed layouts, CT-PAC started at the point hydraulically furthest from the lowest point of the parcel, which is where the runoff will flow to, and traced a line to simulate how the water would drain from that point. The flow path was split into two segments: Sheet Flow and Shallow Concentrated Flow. Sheet flow occurs as flow over plane surfaces and occurs at the start of the flow path. Shallow concentrated flow is defined as flow that is no longer classified as Sheet Flow but has yet to infiltrate into a defined channel.

The expected runoff for the existing layout of the site was calculated to equal 4.54 cubic feet per second (cfs) for a 100-year-storm event, as seen in *Figure 2.3-2*. The expected runoff for the proposed layout of the site was calculated to equal 4.62 cfs for a 100-year-event, as seen in *Figure 2.3-3*. This represents an approximately 2% increase in stormwater runoff.

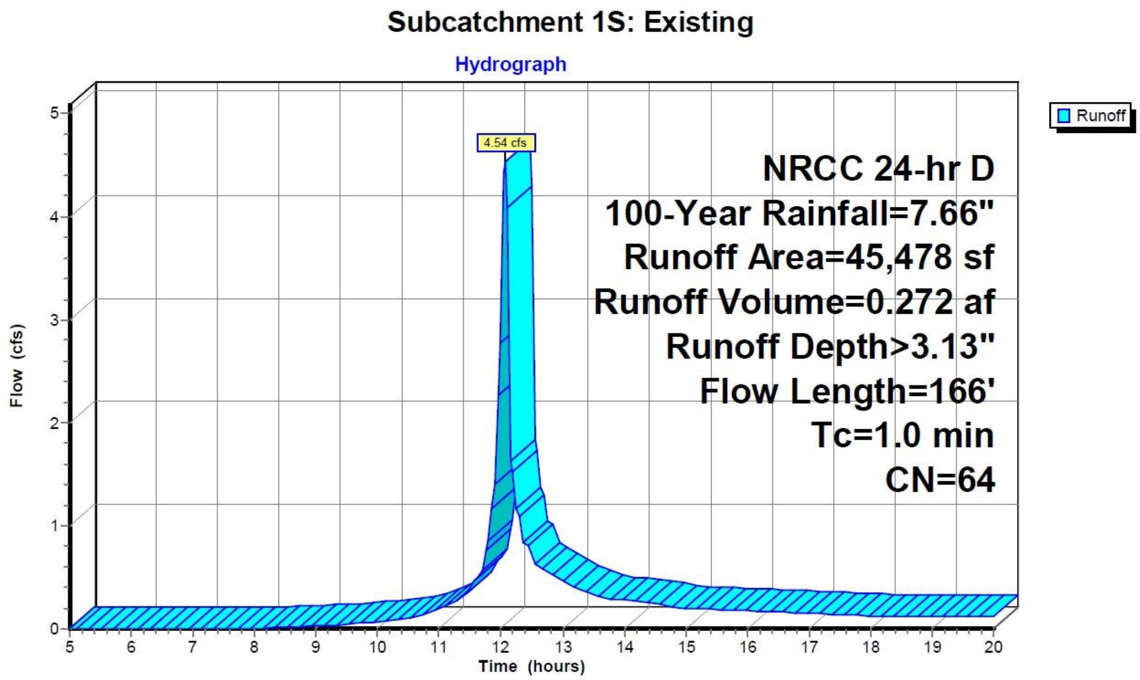


Figure 2.3-2 - *Hydrograph for existing runoff, displaying a peak stormwater runoff rate of 4.54 cfs for a 100 year storm event.*

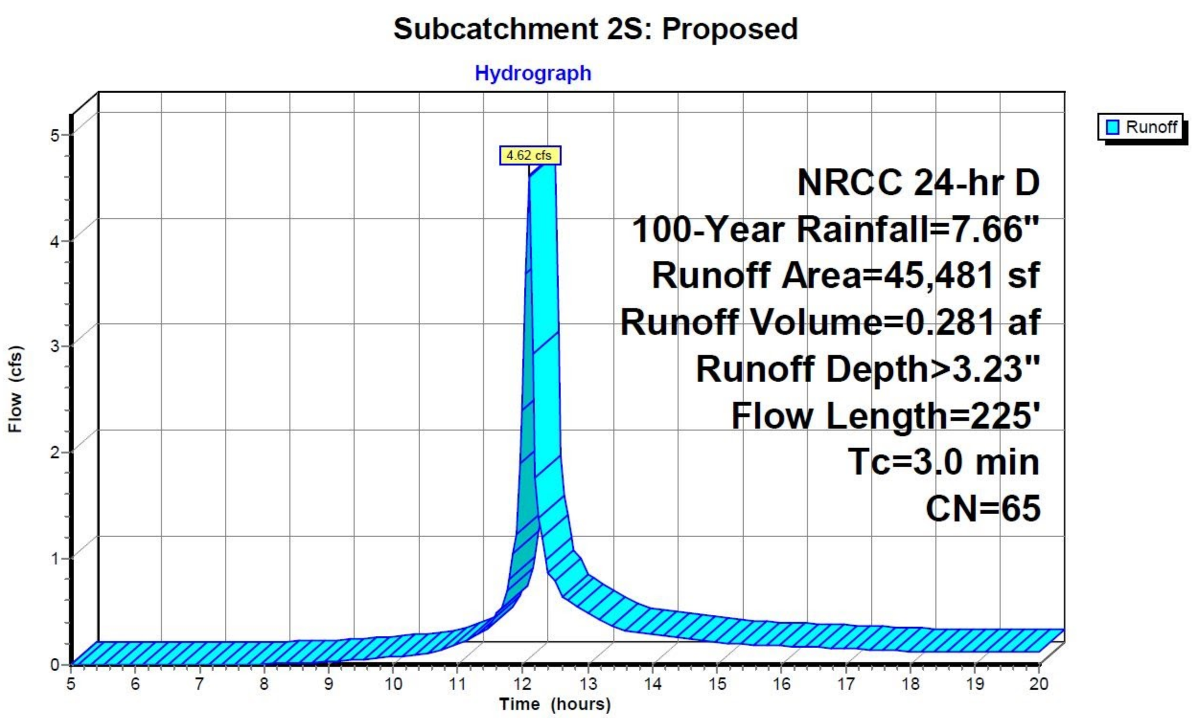


Figure 2.3-3 - *Hydrograph for proposed runoff, displaying a peak stormwater runoff rate of 4.62 cfs for a 100 year storm event.*

2.3.4 Conceptual Stormwater Drainage Plan

The next step was to create a Conceptual Stormwater Drainage Plan for the proposed parking lot layout located at 877 Main Street. The drainage plan was made to be in accordance with the *Maine Department of Environmental Protection: Stormwater Management Standards*.

The *Maine Stormwater Best Practice Manual: Maine DEP's Chapter 500* was used to determine the final level of stormwater treatment of the proposed parking lot design. The treatment levels were based on the existing and proposed lot. Each of the total areas were split into two subareas. One of the sub areas being a medium-use parking lot area with a pollutant rank of 4 and the other being a mowed grass area with a pollutant rank of 2. These pollutant rank values were obtained from *Maine DEP's Chapter 500: Table 2.* The pollutant rankings along with the areas were used to find the total weighted average impact for both the existing and proposed parking lot. Then the total weighted average of the existing lot was subtracted from the total weighted average of the proposed lot giving the final treatment level. It was found by using *Maine Stormwater Best Practice Manual (BMP): Maine DEP's Chapter 500* that the ranked impact due to redevelopment changes was less than zero. This negative ranked impact means that the parking lot does not need any treatment as stated in *Maine DEP's Chapter 500: Table 3*. CT-PACs Stormwater Analysis Report found that the stormwater runoff slightly increased from the existing parking lot to the proposed parking lot. This information indicates that no stormwater management/treatment is required for the proposed layout of the lot. All water will drain from the upper portion of the lot into the lower green space area and then eventually off site similar to the way that it currently does.

2.3.5 Erosion and Sedimentation Control Plan

The next step in the design process was to create an Erosion and Sedimentation Control Plan for the proposed parking lot layout design for 877 Main Street in Waldoboro, Maine. While a plan such as this is necessary for any project that involves soil disturbance, the necessity is heightened for this project since it is located close to the Medomak River. The river is a protected natural resource and any sediment transport from the project site to the river must be prevented, so as to not reduce water quality in the Medomak River. The erosion control measures depicted in this plan must be constructed before any soil displacement can occur on the site. All measures must be properly inspected and maintained so that they may remain functional until permanent soil stabilization is achieved.

CT-PAC used guidance from the Maine Department of Environmental Protection's (DEP) *Maine Erosion and Sediment Control Best Management Practices Manual* to ensure that no damaging erosion or sediment loss occurs from the proposed parking layout design.

CT-PAC recommends that silt fencing be used at the base of any disturbed slope of the project site as a temporary erosion control measure. Details of the silt fencing, obtained from Maine DEP, can be seen in *Figure 2.3-4*. The following construction specifications were gathered from the *Best Management Practices Manual*:

- The fence should be anchored to resist pull-out, and be stretched tightly between stakes to prevent sagging.
- A 6” wide, 6” deep trench should be excavated upgradient of the fence line to key the “flap” of the fabric. The trench is backfilled and compacted.
- When joints are necessary, filter cloth should be spliced by wrapping end stakes together.
- In areas where the flap cannot be keyed properly (due to frozen ground, bedrock, stony soil, roots, near a protected natural resource, etc.), the silt fence should be anchored with aggregate, crushed stone, erosion control mix, or other material.

The silt fencing should remain in-place and functional until approximately 70% of the sloped land is covered with vegetation. The proposed locations of all silt fencing can be seen on the final site plan for the parking lot, which is to be completed in the drainage portion of this project.

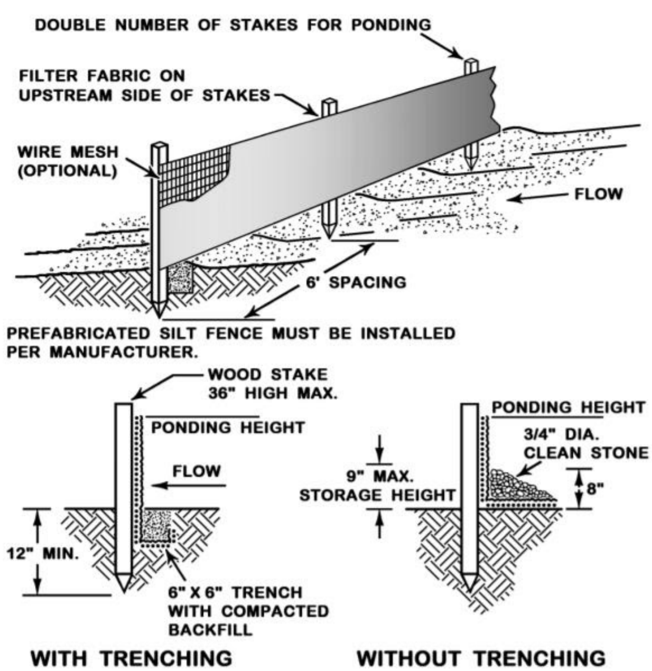


Figure 2.3-4 - *Silt fence detail*

CT-PAC also recommends that erosion control blanket is used on any disturbed slopes at the project site. The blanket consists of a manufactured organic fiber that retains soil moisture for seed germination. This recommendation is based on the characteristics of the expected disturbed slopes. For the recommended layout, these slopes will be rather steep, currently proposed at 3:1 on the southwest portion of the lot. Erosion control blankets are proven effective for steep slopes, with a maximum slope capacity of 2:1, as stated in the *Best Management Practices Manual*. Erosion control blankets are also a recommended measure for protected natural resource areas, which is a necessary concern for this project due to the adjacent presence of the Medomak River. Details of the erosion control blanket, obtained from Maine DEP, can be seen in *Figure 2.3-5*.

The two main drawbacks for the erosion control blanket is the cost, and issues associated with proper misplacement of the blankets. Due to the small size of the 877 Main Street parcel, the cost of this form of mulch (erosion control blanket) is not expected to be an issue when compared to the other forms of mulch, please see Section 4 *Cost Estimate*. The other main limitation for an erosion control blanket is a need for good contact between the blanket and underlying soil. In order to avoid problems with improper placement of the material, CT-PAC is recommending that the erosion control blanket is a smooth clear slope. A clear slope will allow for complete contact between the mulch and the seeded loam.The erosion control blankets should be installed immediately after the slopes are graded and seeded. Since the mats are biodegradable, removal is not a concern as the mat will naturally decompose over time.

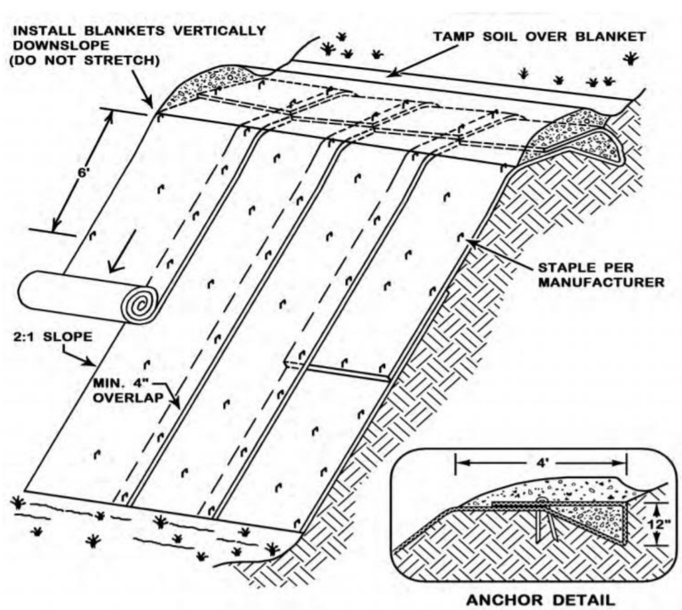


Figure 2.3-5 - *Erosion control blanket detail*

2.3.6 Lighting Plan

The next step in the design was to design a lighting plan for the parking lot at 877 Main Street Waldoboro, Maine. The lighting plan must provide adequate light in the lot to increase visibility during times of insufficient sunlight..

This design process started by choosing one source for light poles, fixtures, and luminaires. Utilizing one source for all materials was chosen so that all parts are ensured to be compatible. *Light Poles Plus* was the company that CT-PAC decided to utilize for design . *Light Pole Plus*, produces all materials in accordance with the American Society of Testing Materials (ASTM) and The American Association of State Highway and Transportation Officials (AASHTO) standards.. CT-PAC decided that LED lights would be an effective long-term solution, as they require less power to operate and have a long life. The LED lights from the supplier have an aluminum housing. The aluminum fixtures and poles (as opposed to steel and wood) were chosen for the design to avoid corrosion due to mismatched materials.

The strength requirements for light fixtures and poles were calculated by CT-PAC. The design was based on *Light Poles Plus's Estimated Projected Area (EPA) Map*. This map gives EPA loading requirements based on *AASHTO 2009* requirements for regions of America. The lighting was designed to be in accordance with the *Town of Waldoboro Land Use Ordinance (LUO) Section 7.7*. In order to maximize the area of light that each luminaire would shine onto, 18' poles were chosen. This satisfies the requirement that lighting must not exceed 20' above ground surface. The lights should be installed facing directly down so that the light does not exceed 75 degrees above nadir, as prescribed by *LUO Section 7.7.1.3*. Tapered Poles were chosen so that the bullhorn fixtures could fit onto the poles, while being in accordance with *Light Poles Plus* standards of 90 mile per hour wind with 1.3 gust requirements for EPA and weight. Straight poles could not be used because the outer diameter of the pole needed to satisfy wind requirements would be too large for the bull horn fixtures. For product information and pricing please see *Table 2.3-3*.

Table 2.3-3 - Lighting Item Summary

Item Summary	Product Number	Quantity	Item Price	Total Price
Direct Burial Tapered Aluminum Poles	VA-RTAD-18-6040-FFP-DB	(2)	$711.00	$1422.00
2 @ 180 Degrees Aluminum Bullhorn Brackets	VA-A-BLH-R40-2-180-FP-DB	(2)	$227.00	$454.00
12 inch,120W, Shoebox LED Lights	12-SBHC-120-50-MV-5	(4)	$537.00	$2148.00
			Total:	$4024.00

2.3.7 ADA Compliance

Upon the site visit at 877 Main Street, it was observed by CT-PAC that there are no current ADA accommodations within the parking lot. One of the goals for the parking lot is to make it as accessible as possible while only changing the parking lot and not the buildings surrounding the lot.

The *2010 ADA Standard* was used to obtain the following information about the accessible spots. The total number of accessible and van accessible parking was found using the *2010 Standard Table 208.2* according to the total parking spaces previously calculated by the team. One out of every six accessible spaces will be van accessible.

The following data can be seen in *Table 2.3-4*. The proposed final design includes a total of two accessible parking spaces and one of those spaces is van accessible. The non-van accessible space is 9' wide and the accessible aisle is 5' wide. The van accessible space is 11' wide and the accessible aisle is 5' wide. The buildings do not have any accessible entrances or routes from the parking lot. These accessible spaces were placed at the safest route possible which has been determined by the CT-PAC. The pavement of the parking lot where these spaces are to be located will have no more than a slope of 1:50. There will be signs to identify each spot with the International Symbol of Accessibility. For the parking space that is van accessible, the sign will include an additional "van-accessible" sign. In order to ensure visibility, the signs will be placed so the bottom edge of the sign is at least 5' from the ground surface.

Table 2.3-4 - ADA Compliance Requirements

	Total Accessible Spaces	**Non Van Accessible Spaces**	**Van Accessible Spaces**
Number of Spaces	2	1	1
Size of Spaces	-	9' Wide Space 5' Wide Aisle	11' Wide Space 5' Wide Aisle

2.4 Permitting Requirements

A list of permit requirements for the redesign of the parking lot on 877 Main Street in Waldoboro, Maine was created. This provided a list of permits that will have to be acquired and submitted by the client for the project, as well as requirements that the parking lot will have to have in order to be in compliance with the Town of Waldoboro Land Use Ordinance. Through our research, CT-PAC also looked into the Maine Department of Transportation's Permit Requirements.

In CT-PAC's analysis, it was determined that the following permits will need to be acquired:

- Site plan review and subdivision ordinance preliminary application submitted to Town of Waldoboro
- Sign permit application submitted to Town of Waldoboro
- MaineDOT driveway/entrance permit Submitted to Maine Department of Transportation

The following fees will also have to be paid to the Town of Waldoboro, based on the Town of Waldoboro Land Use Ordinance Fee Schedule:

- Renovation: Commercial District $30+$0.15 per square feet
- Signs: $40 per permanent sign and $50 temporary sign deposit
- Driveway entrance permit: $100

3 Design for the Culvert Replacement at Duckpuddle Stream Crossing

3.1 Existing Site Conditions

3.1.1 Existing Conditions Plan

The goal of the existing conditions plan is to accurately portray the current conditions of the Duckpuddle Road stream crossing. This plan was used as a baseline that CT-PAC used for future design work.

The existing conditions plan was drawn by using lidar topographic data, Google Earth imagery, the *Duck Puddle Bridge Nobleboro-Waldoboro General Plan 1981* for grading and dimensions, and field measurements which were taken on 10/3/20 during CT-PAC's site visit. An official survey of the area was not conducted, there may be some errors in the measurements in the drawing. CT-PAC used a grade rod and laser in the field to determine the lowest point on the road. CT-PAC also took some minor measurements to determine the width of the road in a few locations.

There were small differences in the resources when finding dimensions. The lidar data and a tax map took priority in matching the references. Once the maps were aligned in AutoCad, an outline was able to be created. The topographic data shown has two-foot contour lines and is used to show the general layout of the area. The wetland vegetation area was outlined from Google Earth. The town tax map was used to determine the property lines surrounding the project location surrounding the project location. The flow path of the water is shown with arrows and was determined in the field. The guardrail dimensions were measured in the field. There is a boat ramp located on the Waldoboro side of the stream, consisting mostly of gravel material. CT-PAC measured the slope of the ramp during the site visit. A parcel map, provided by Maine DOT was aligned for the addition of the parcels and lot numbers. The reference maps are attached.

Duckpuddle Road currently has a flooding issue at the location of the stream crossing. Seen on the *Existing Conditions* Plan is the low point, represented by the hatched area. This low point is 0.4' lower than the top of the culvert, meaning that the road floods during large precipitation events before the culvert reaches capacity. This low point is approximately 100' away from the culvert towards the direction of Nobelboro. This leads to the road flooding beginning at the low point of the road and expanding in the direction of the culvert. This flooding pattern was confirmed by a local homeowner. The grading of the road is shown to the nearest tenth of a foot.

The grades were gathered from the *Duck Puddle Bridge Nobleboro-Waldoboro General Plan 1981*, supplied by the client. CT-PAC's design for the new road is based on these grades. The boat ramp and parking lot are both private property, according to a local homeowner and this was confirmed after reviewing the Town's tax records. It was also noted by CT-PAC that there is a utility pole near the culvert which appears in poor condition.

3.1.2 Performance of Existing Culvert

The next step in the design process was to model the existing culvert at the stream crossing under the current loading condition. The Hydrologic Engineering Center's River Analysis System (HEC-RAS) software was used to determine the flow capacity that can be supported by the existing culvert. Additionally, the current flow at the site was inputted into the software to model the flooding conditions that are occuring at the site. The outcome from this process allowed for CT-PAC to determine the appropriate size/type for the proposed culvert so that it can perform successfully during the expected storm events.

The following hydrologic data is from the *Duck Puddle Bridge Nobleboro-Waldoboro General Plan 1981* which was given to CT-PAC from the Town Planning and Development Director of Waldoboro, Max Johnstone:

- There is a drainage area of 8.22 square miles. This corresponds to the drainage area as determined by StreamStats software.
- The design discharge for a 50 year flood flow is 700 cubic feet per second.
- The backwater for a 50 year flood flow is 1.9' and for a ten year flood flow is 0.8'.
- The ordinary high water elevation is 80'.

The size of the culvert is from the *Duck Puddle Bridge Nobleboro-Waldoboro Pipe Arch Details 1981.* The existing culvert is a structural pipe arch. It has a span of 14.08', a rise of 8.75', and length of 52'.

Using the given information, along with topographical data gathered from StreamStats software, CT-PAC modeled the stream channel on HEC-RAS**.** A reach was modeled to replicate the local geometry of the stream bed surrounding the culvert of interest on Duckpuddle Road. Five channel cross sections were created using topographic data gathered from StreamStats software, with stationing of 100', 75', 50', 25', and -25'. The origin for stationing was decided to be located at the center of the roadway over the center of the culvert.

The creation of the cross-sections was accomplished by creating an elevation profile running perpendicular to the flow of the stream. With the elevation points provided by the profile from StreamStats, the approximate dimensions of the cross-sections were input into HEC-RAS. To fully model the channel, HEC-RAS was used to interpolate the cross-sections every five feet between the five created stations.

The barrel centerline of the culvert for the upstream and downstream ends were determined to be located at a stationing of ± 25', respectively. The high chord stationing of the road deck was determined by analyzing the road stations from the *Duck Puddle Bridge Nobleboro-Waldoboro Pipe Arch Details 1981* and the low chord stationing was taken from the interpolated cross sections at 5' and -5**'**, which were produced through HEC-RAS. The same high chord and low chord were used for both the upstream and downstream stations of the culvert

The existing culvert was designed in 1981 for a 50 year flood flow of 700 cubic feet per second. When that data was inputted into the flow profile it showed that the water floods over the road at the culvert as seen in Figure 3.1-1. After going back through and constantly changing the flow profile it was determined that the culvert is only able to handle a flow of 300 cubic feet per second which can be seen in *Figure 3.1-2*.

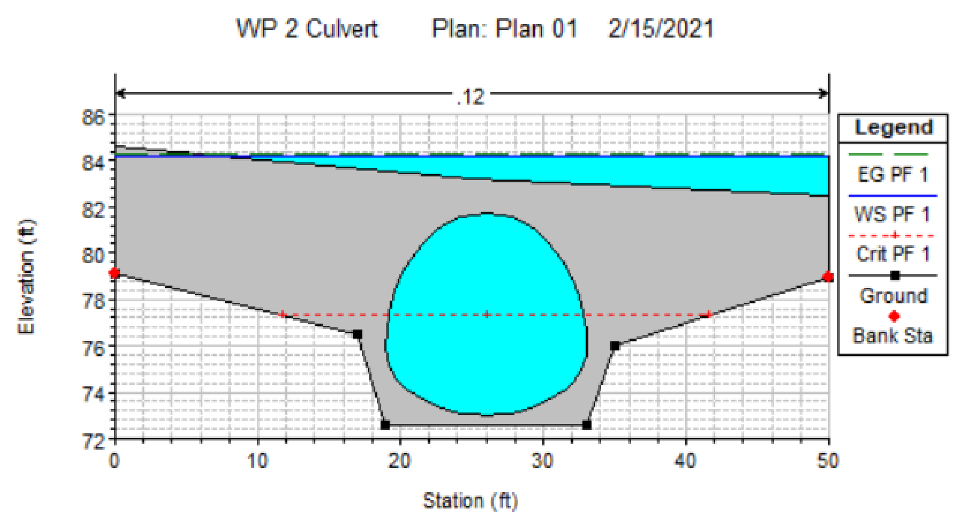


Figure 3.1-1 - *700 cfs flow through existing culvert*

This figure shows the culvert, looking downstream. The flow going through the culvert is 700 cubic feet per second. The gray area represents the roadway structure the culvert goes through. The blue represents the water flowing through the culvert. The water has not only filled the culvert, but is flooding over the road deck. This means that the culvert is not able to withstand the flow that it was assumed to be designed for.

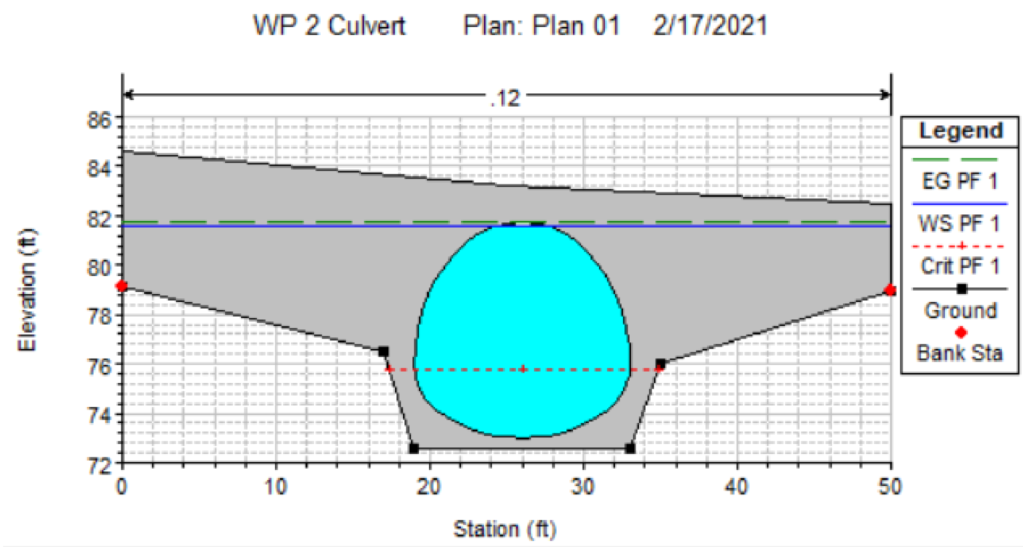


Figure 3.1-2 - *300 cfs flow through existing culvert*

This figure shows the culvert, looking downstream. The flow going through the culvert is 300 cubic feet per second. The water has filled the culvert, but is not overflowing to the point where the water floods over the road deck. This is the maximum flow that the existing culvert can handle without flooding, as determined through the HEC-RAS software.

3.1.3 Native Plants and Species List

Before any designs could be created, it was necessary to assess the native ecosystem surrounding the stream crossing. To do this, CT-PAC is providing a list of native plants and animal species that are present in the Duckpuddle waterway, so that this information could be taken into consideration for the culvert replacement design.

The research was conducted via online resources and databases. The *Maine Department of Inland Fisheries and Wildlife* website provides maps that catalog ponds based on the significance of the habitat. This map database was used to get the classification of the Duckpuddle Pond and Stream waterway. *Maine Inland Fisheries and Wildlife* lake survey was also used to obtain a report of fish species present in the waterway, The *Maine Department of Environmental Protection's* (MDEP) website was accessed to gain additional information on wetland classification at the site as well as information on endangered fish species.

CT-PAC's research has found that Duckpuddle Pond and Duckpuddle Stream are classified as an Inland Wading Bird and Waterfowl Habitat (moderate grade), please see *Culvert Existing Conditions Plan* View. This means that Duckpuddle Stream is protected under the Natural Resources Protection Act. Additional permits that are required in order to work within this protected habitat were determined to be necessary, and are addressed during CT-PAC's permitting evaluation later in this report.

CT-PAC has also found a number of fish species that are present in Duckpuddle Pond. The *Maine Department of Inland Fisheries and Wildlife* reports that Duckpuddle Pond supports Brown Trout, Small/Largemouth Bass, White/Yellow Perch, Chain Pickerel, Minnows, Golden Shiner, White Sucker, Hornpout, Pumpkinseed Sunfish, American eel, and Sea-run alewife. With Sea-run alewife present in the waterway, it will be important to design the stream crossing to allow fish to pass freely. These fish passage requirements were taken into consideration when CT-PAC designed the culvert options, which can be seen in the following sections of this report. MDEP reports that none of the above are listed as endangered or threatened species, and does not include Duckpuddle Pond as an endangered fish species location.

The impact to the waterway due to the new culvert has also been considered. During construction the waterway will have to be dammed with the use of cofferdams to stop the flow of water. This will help to ensure that there is no reduction of water quality in Duckpuddle Stream due to increased sedimentation. The new culvert will stop the flooding of Duckpuddle Road due to its increased flow capacity. Because of this, water quality will be improved because it will not flow over the road surface. The new culvert will have a larger cross sectional area which reduces the speed of water flowing through the culvert. This will benefit fish swimming both ways through the culvert, and should allow for more fish passage. Slower water speeds will also reduce the amount of sediments suspended in the soil, which will improve the water quality of Duckpuddle Stream.

3.1.4 Peak Flow Calculation

In order to properly size the culvert, the peak flow magnitude had to be determined. This value is dependent on the expected stormwater runoff flow magnitudes, which had to be determined for the surrounding area. This computation involves a large amount of variables that summarize the physical characteristics of the watershed, including the soil types, land use categories, and the time of concentration for the runoff. HydroCad software was used to analyze the waterway and produce peak flow rates for a 100 year storm event. This 100-year storm event is a storm that has a 1% chance of happening in a given year.

To begin, the watershed for the culvert was delineated with the use of StreamStats software. StreamStats delineated the watershed to be an approximately 8.3 square mile area that drains to the Duckpuddle Stream crossing. The watershed was divided into five sub catchment areas based on contour elevations. This allowed for the software to focus on different areas with different properties concurrently, producing more accurate peak flow magnitude for CT-PAC to base culvert designs off of.

The land use and soil type breakdown for the watershed was a necessary input for HydroCad to calculate the peak flow. Different soil types have different permeability properties which have a direct impact on the infiltration rates. Similarly, the type of land use for an area also has an impact on the infiltration rates. This is due to the type of land cover that the runoff flows through to reach the outlet. For example, water travels faster and with little infiltration if flowing through a paved parking lot when compared to a densely covered forest floor.

To determine the soil and land use characteristics, CT-PAC obtained a soil map from *Maine's Web Soil Survey*. This displays the hydrologic soil group data for the entire 8.3 square mile drainage area for the project location. Once the map was obtained, it was overlaid into AutoCad and scaled to represent it's true size. The lines of the map were then traced to determine the soil areas specific to the project location.

The time of concentration is another important variable that was calculated through HydroCad. This value is defined as the time required for the most hydraulically distant water to reach the Duckpuddle Stream crossing. This time was determined by breaking the flow path into three categories: Sheet Flow, Shallow Concentrated Flow, and Channel Flow. Sheet flow occurs as flow over plane surfaces and usually occurs at the headwater of streams. Shallow concentrated flow is defined as the transition flow between sheet flow and channel flow and occurs between the two. Channel flow is simply defined as water flowing in a defined channel and usually occurs when the runoff infiltrates into a stream channel.

To determine these values, CT-PAC started at the point hydraulically furthest from the culvert for each sub area and traced a line to simulate how the water would drain from that point. An AutoCAD drawing was created to scale with a topographic map of the area in order to calculate the lengths and slopes of these flow paths. CT-PAC entered these values into HydroCad, which then computed the time of concentration.

A less conventional factor that is contributing to the watershed is Duckpuddle Pond, which acts as a significant source of runoff storage. Since Duckpuddle Stream is the sole outlet for Duckpuddle Pond, the pond also had to be modeled in HydroCad to represent the additional runoff retention time that it provides. The required physical properties of the pond[1], as well as the stream[2], were inputted into the software.

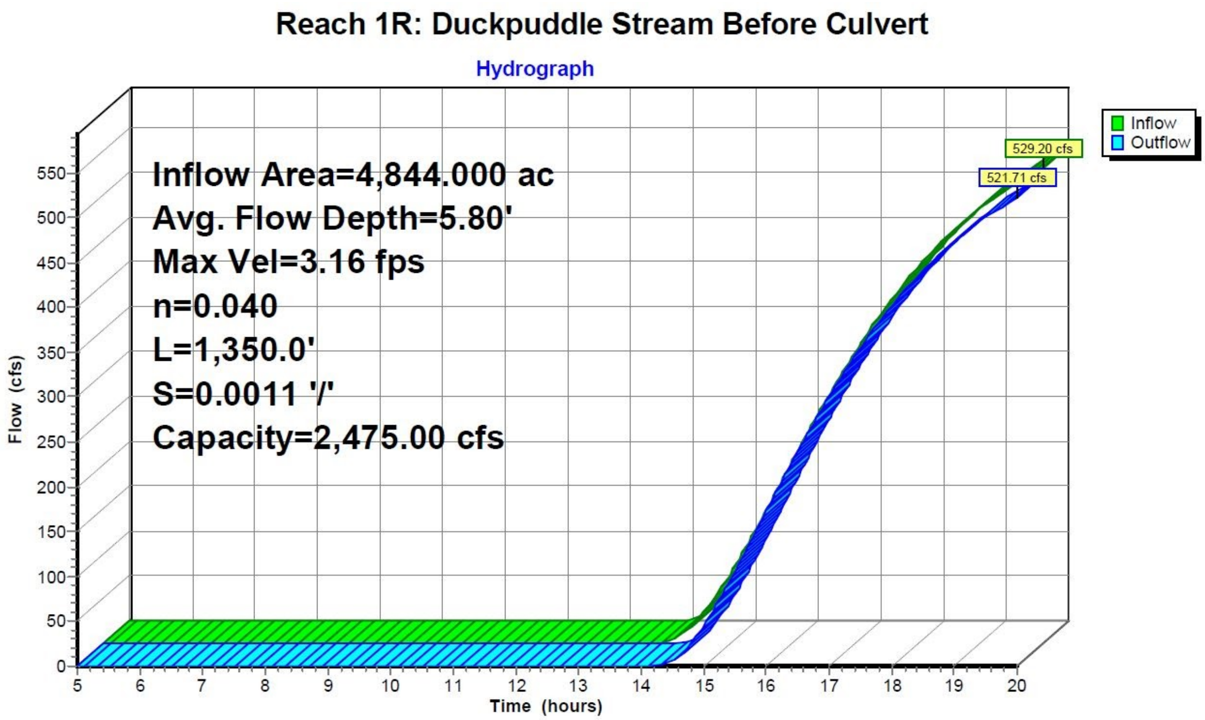


Figure 3.1-3- *Stream channel hydrograph depicting the peak runoff volume of 530 cfs*

The expected peak flow during a 100-year-storm event through the channel at the location of the Duckpuddle Stream crossing was determined to be approximately 530 cfs (cubic feet per second). This result can be seen in *Figure 3.1-3*, which consists of the output hydrograph for Duckpuddle Stream. CT-PAC was able to use this value as a minimum flow capacity for the proposed culvert designs.

[1] *Obtained from lakesofmaine.org*
[2] *Obtained through elevation measurements from StreamStats*

3.2 Analysis of Culvert Design Options

3.2.1 Culvert Sizing Options

The next step in the design process for the culvert on Duckpuddle Road was to produce a culvert design that can handle a 100 year flow of 530 cubic feet per second (cfs) using the data from HydroCad. The proposed design would cause minimal disturbance to the wetland during construction and also provide a safe fish passage. More specifically, the Alewive fish population that uses the stream to travel between Duckpuddle Pond and Pemaquid Pond.

The existing culvert at Duckpuddle Road has a capacity of about 300 cfs before the road starts to flood, which was previously found using HEC-RAS. The *Duckpuddle Bridge Nobleboro-Waldoboro General Plan 981* states that the design discharge for the culvert should handle a 50-year-flow of 700 cfs, but looking back at the MATLAB code it could not. CT-PAC designed the proposed culvert for a 100-year-flow level, per the Maine Department of Transportation's (MDOT) *Stream Smart Pocket Guide*.

Three culvert options were designed by CT-PAC. Each of the culverts were designed to withstand a peak flow of at least 530 cfs. The three designs included an elliptical concrete culvert, a concrete pipe arch, and an open bottom box culvert. MDOT recommends for culverts to be made out of concrete or reinforced concrete. This eliminates the option of metal for CT-PAC's designs. CT-PAC utilized sizing tables to size the elliptical and pipe arch designs. The ellipse concrete culvert was sized using *Peterson Products Company sizing sheet*. The size was chosen by looking for a similar size to the existing culvert. Using the dimensions given, it was drawn in AutoCad. The concrete pipe arch was sized using a HydroCad sizing sheet. The size was chosen by looking for a similar size to the existing culvert. Using the dimensions given, it was drawn in AutoCad. For the open box culvert design, a local company that designs and installs modular precast culverts, *Dirigo Timberlands* was consulted. After the necessary cross section for flow of the open bottom culvert was calculated by CT-PAC and the dimensions were given to *Dirigo Timberlands*. They were able to provide drawings of a proposed box culvert option, seen in Figures 3.2-1 and 3.2-2 Box Culvert Drawings. *Dirigo Timberlands was* also able to provide a cost estimate for the box culvert, which is included in the *Cost Estimate* portion of this report.

When determining the length of the ellipse culvert and pipe arch culvert, the width of the road including guardrail was considered. For these two designs, the length of the culvert was set at 26' which made the length of the culvert equal the width of the road plus guardrail. When determining the slope of the channels, the lowest slope for a culvert should be 0.5%. CT-PAC used the minimum slope of 0.5% to maintain the closest slope of the channel, which is 0.11%.

The *Duckpuddle Bridge Nobleboro-Waldoboro General Plan 1981* states that the design slope of the existing culvert is 2%. CT-PAC decided to use a slope of 0.2% in the analysis of peak flow for the existing culvert. This was because the peak flow for a 2% slope would be approximately 2500 cfs which is extremely unlikely. This also did not match the slope of the culvert that CT-PAC recorded during our initial site visit. It was noticed that the flow and velocity of the existing culvert was much lower than calculated based on a 2% slope. Having changed the slope to 0.2% CT-PAC found that the design flow of the existing culvert was 632 cfs. CT-PAC assumed this was the correct value as it was much closer to the given value in *Duckpuddle Bridge Nobleboro-Waldoboro General Plan 1981* of 700 cfs. This difference could have been a typo on the original plans, or the existing culvert could have changed from the design specifications in 1981.

CT-PAC determined that the existing road and bank surface is not high enough during peak flow events. This means that the road floods before the culvert can reach peak flow. Based on this the actual capacity of the culvert is approximately 300 cfs. This was found in the HEC-RAS analysis Work Package. See sheet 1 of 4 in the Culvert Details drawings for existing culvert.

Culvert Option #1- Concrete Ellipse Pipe was designed by CT-PAC to have a span of 12.58’, a rise of 8.08’, concrete thickness of 0.917’, a length of 26’, and with a weight of 140,400 pounds. The flow was calculated to be 1267 cfs. See sheet 2 of 4 in the Culvert Details drawings.

Culvert Option #2- Concrete Pipe Arch was designed by CT-PAC to have a span of 13.3’, a rise of 8.8’, a concrete thickness of 10”, a length of 26’, and with a weight of 140,200 pounds. The flow was calculated to be 1709 cfs. See sheet 3 of 4 in the Culvert Details drawings.

Culvert Option #3- Open Bottom was designed by CT-PAC to have a bottom width of 18’ Box Culvert’, a height of 6’, and a length of 24.5’, and with a weight of 207,500 pounds. The flow was calculated to be 1316 cfs. See sheet 4 of 4 in the Culvert Details drawings.

All three culvert designs have been deemed acceptable through flow capacity calculations.

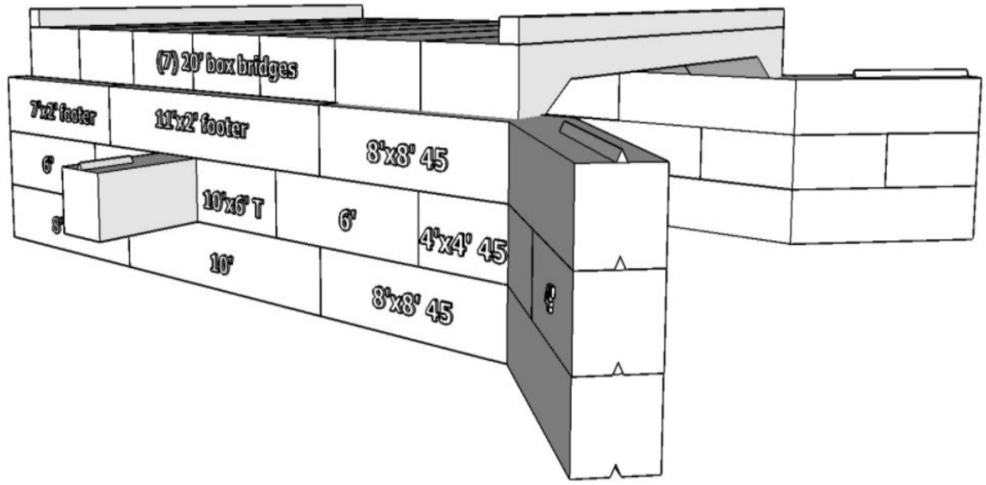


Figure 3.2-1 - *Front view of Culvert Option #3*

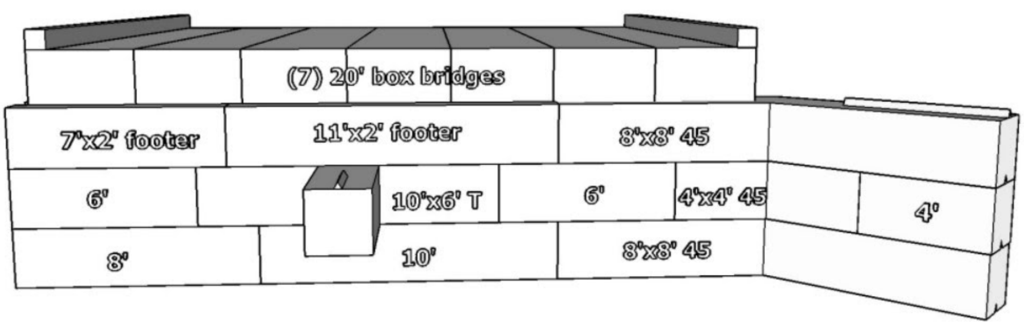


Figure 3.2-2 - *Side view of Culvert Option #3*

3.3 Final Design for Duckpuddle Stream Crossing

3.3.1 Final Culvert Design

The open bottom box culvert was chosen to be the final culvert design. This was because this culvert had met adequate flow requirements and allowed for adequate fish passage in the waterway due to its natural bottom. CT-PAC then moved on to designing the road over the culvert.

3.3.2 Geotechnical Analysis of Final Design

This geotechnical analysis looked into how the areas under the abutments should be prepared prior to setting the precast abutment blocks. Both bearing capacity and settlement were checked to ensure that the structure does not experience excessive settlements. CT-PAC determined if the footing area of the abutment blocks was adequate to support the structure. Recommendations were also made for how the areas under the abutment blocks should be prepared prior to setting.

CT-PAC started by using information collected from the *United States Department of Agriculture's (USDA) Web Soil Survey* to determine the characteristics of the soil profile surrounding the site. It can be seen in *Figure 3.3-1* that the soil surrounding the culvert site is classified as Bp which is Borosaprists: ponded. The *Web Soil Survey* shows this soil type to consist of organic material for a depth of up to 5.4'. When other soil structures were examined it was found that both soil types TrC and TrB which are on either side of the stream crossing had bedrock present at a depth ranging frm 2.3' to 3.2'.

Figure 3.3-1 - *Web Soil Survey for area of interest*

Based on the soil information, CT-PAC felt that it was safe to assume that there would be bedrock present at a relatively shallow depth at this location. For the purposes of completing settlement calculations, a depth to bedrock of 8’ was assumed by CT-PAC. A geotechnical investigation of the site should be conducted prior to construction to determine the depth of bedrock. After an accurate depth to bedrock is found, the settlement calculations produced by CT-PAC should be reassessed. If bedrock is found at a shallower depth, blasting and hammering may be required to set the abutment blocks at their required depth.

Assuming that bedrock was present at a depth of 8’, CT-PAC recommends excavating all of the organic material to the depth of bedrock and replacing the material under the abutments with compacted gravel. With the elevations of the installed box culvert, this would result in a 2’ layer of compacted gravel being placed between the bottom of the box culvert abutments and the bedrock layer.

CT-PAC then calculated the maximum loading that each abutment would experience. This was done by analyzing the structure based on *AASHTO LRFD Bridge Design*. In order to do this the deck of the box culvert was modeled as a simply supported span supporting dead and live loads. The dead loads considered were the self weight of the reinforced concrete structure and the weight of the pavement superstructure. Per *AASHTO LRFD Bridge Design*, the live load was based on a truck and trailer driving over the box culvert. This was modeled by having two-three axles loading on the culvert spaced from 14-32' in order to have the maximum reaction at the abutment. Once the live load positions were calculated to find the maximum reaction, the dead and live loads were combined to get the total load that the culvert's abutment is supporting. The self weight of the abutment was added to this to find the maximum load being applied to the soil below the culvert. Geotechnical Engineering course material was used by CT-PAC to complete the Bearing Capacity and Settlement Calculations

Once this maximum loading was determined, the maximum pressure being applied to the soil at the base of the abutment could be found. CT-PAC then used *Terzaghi's Generalized Bearing Capacity Equation* to determine ultimate bearing capacity of the soil structure that CT-PAC is proposing to be constructed under the abutments of the open bottom box culvert. In order to complete these calculations some soil parameters needed to be assumed. The soil friction angle of 32 degrees and a unit weight of 125 pounds per cubic feet (pcf) were assumed (*Geotechdata*).

To calculate the settlement that the box culvert would experience, CT-PAC calculated the immediate settlement that would occur within the soil structure that is being assumed. In order to complete these calculations an elastic modulus for the gravel of 2,500 kips per square feet (ksf) was assumed, according to the *Geotechdata* website which CT-PAC used as a reference for this calculation. The 2' gravel layer was then broken down into four equal layers with a thickness of 0.5' and the stress at a point located midway in each layer was found. CT-PAC used a *Boussinesq Depth Stress Influence Figure* for a continuously loaded area due to the width of the footing area being much less than the overall length to determine the stress influence factors for these four points.

By multiplying these stress influence factors by the stress applied to the surface of this 2' gravel layer the stress at these four points could be found. The stress at these four points was then divided by the assumed elastic modulus of the gravel to obtain the strain at each of these points. The stress at these points was used as an approximate strain for the entire thickness of each layer. The deformation for each layer was then calculated by multiplying this strain by the layer thickness.

From the bearing capacity calculations that CT-PAC performed it was found that the gravel material that will be placed below the abutment will have an ultimate bearing capacity of 22.7 ksf. The bearing resistance being applied to the soil due to the self weight, the roadway structure, and vehicle loading was calculated to be 2.78 ksf. While calculating the factor of safety for the bearing capacity CT-PAC found it to be 8.2. Common target factors of safety for bearing capacity are in the rage of 1.5 to 2. With the calculated factor of safety of 8.2 CT-PAC has determined that the footprint of the abutment blocks will be adequate

From the settlement calculations performed by CT-PAC, the total immediate settlement of the abutments was calculated to be 0.002'. Time dependent settlements were not considered as the gravel that is proposed to be placed between the abutment and bedrock will be a cohesionless soil. With the total settlement of the soil layer beneath the abutment being calculated to be less than three hundredths of an inch, CT-PAC has concluded that the structure will not experience excessive settlements.

CT-PAC has found that the footing dimensions of the abutment blocks are adequate for bearing capacity and settlement of the box culvert structure.

3.3.3 Proposed Duckpuddle Road Plan and Profile

The next step in the design process was to conclude the *Culvert Details* and to redesign Duckpuddle Road so that the safety of the road is increased, and that the road design works with the *Culvert Details*. During this design process, CT-PAC decided to use the open bottom box culvert as the main design. The design details for the open bottom box culvert were made along with a Road Plan, Profile drawing, and Typical Section drawing.

CT-PAC spoke to Derek Nener-Plante, a Professional Engineer and adjunct instructor, about the open bottom box culvert. He provided references and examples of practices that the Maine Department of Transportation (MDOT) uses for box culverts. These include the use of granular burrow, subbase, and pavement. From these recommendations, the culvert details could be made.

After the details of the culvert were finished the culvert could be set in the road layout. This would ultimately give a minimum elevation for the road since the culvert was being set at the channel height and the height of the culvert was known. The orientation of the culvert was maintained from the existing culvert. From the 72' elevation, provided by the *Duckpuddle Bridge General Plan 1981*, the height of the road above the culvert on the centerline would be 82.2 feet. With this elevation, the road in the wetland areas must be at this elevation or higher to prevent road flooding. The existing road is lower in the wetland area than it is at the culvert which leads to flooding.

The grades for the road can be seen in the *Road Plan* drawing, created by CT-PAC, on the centerline. The grades in the wetland areas had to maintain the same elevation or higher than the op of the road. The road grades were then set equal to the top of the road elevation for the areas that needed to be raised. The *Typical Section* Plan, created by CT-PAC, shows a general road cross-section. The centerline is crowned with 2% for runoff to the edges of the road. Then after 18" off of the road the slope goes to 2:1 to even out the area. The *Typical Section* Plan also shows the existing road profile and the proposed road profile. The stations on the *Road Plan* correspond to the stations on the Road Profile Typical Road Section Plan. Once the areas were found that needed to be altered for the grading, the layout could then be finalized. The width of the road at the culvert is the widest part of the road. From there, easy transitions from the width of culvert to the existing road width were made. The *Road Plan* shows the section of road being repaved because of grade changes and poor existing pavement conditions. The fill on the sides of the road represents the areas that need to be built up to provide a 2:1 slope.

The pavement superstructure was designed per *Maine Department of Transportation (MDOT) Standards*. The *USDA Web Soil Survey* was used to obtain the engineering properties of the soil on site, and from this CT-PAC was able to design the pavement superstructure. As no traffic data is available for the site, CT-PAC decided to design the pavement for 0-500,000 ESALs based on *MDOT's Structural Pavement Design.*

In order to improve safety of the site, a *Lighting Plan* was created by CT-PAC. This design included the moving of a utility pole away from the road and adding a light to that pole. Currently, the utility pole sits one to two feet off of the edge of the roadway. This is a potential safety hazard to vehicles and should be moved. This pole is not in compliance with MDOT's Utility Accommodation Rule, which states that all utility poles must be a minimum of six feet away from the right-of-way.

The part of the road that is being redesigned is 400' long from station 10+50 to 14+50. The new designed section at the smallest width is 19.2' and at the culvert the road is 22.5' wide. This allows for two direction travel. The existing road width at the culvert was 15.5' and led to multiple accidents and roughed up guardrail. The guardrail will be removed and replaced under *MDOT Specifications*. All of this will allow for safer travel.

The grade changes were made to prevent the flooding associated with the addition of the proposed culvert. This allows for the road to be clear of flooding for a 100-year-flood event. The channel elevation is to be maintained while the road elevation is to be raised.

CT-PAC's recommendation for the lighting plan is as follows: after the utility pole that is currently located on the edge of the road has been moved to six feet from the right-of-way, lights can be installed. Please see the *Road Plan*. CT-PAC is recommending an aluminum, wood-pole mounted, six foot bracket should be used so to support the light fixture. CT-PAC is also recommending a 73 Watt LED area light to be used as the Luminaire. LED lights are cost efficient and 73 Watts should have ample light for the intended use.

As no traffic data was available for the site, CT-PAC had to assume the number of ESALs that the pavement structure would experience in its life cycle. The pavement structure was designed to support up to 500,000 ESALs. This was decided because the intended use of the pavement is a local town road and it is very unlikely that the pavement will see more than 500,000 ESALs in its life cycle. Please see *Table 3.3-1* for the final dimensions of the pavement superstructure.

Table 3.3-1 - Pavement Structure Dimensions

Work Package 8: Pavement Structure Dimensions	
HMA	4 inches
Subbase Aggregate	20 inches

3.3.4 Signage Plan

The next step in the design process was to update the signage at Duckpuddle Road at the site of the culvert to ensure safety for the CT-PACs Roadway Design.

The *Manual on Uniform Traffic Control Devices (MUTCD) from the United States Department of transportation Federal Highway Administration* was used to determine the correct signage needed for the Roadway Design Plan.

After examination it was concluded that Duckpuddle Road does not need any additional signage near or around the location of the culvert. While redesigning the roadway, CT-PAC made assumptions based off of the Roadway Design to investigate the types of signs that would be needed. The speed limit is not being changed, the shoulder is not being added or removed, and a weight limit is not necessary due to the calculated load capacity of the pavement. The "Flood Warning" sign may be removed since the road should no longer flood. The existing signage around the boat ramp will remain in its current location.

3.4 Permitting Requirements

A list of required permits that will need to be obtained and submitted by the client to complete the culvert replacement located at the Duckpuddle Road stream crossing was created. CT-PAC investigated town, state, and federal permit requirements for the stream crossing. CT-PAC utilized multiple resources including the Town of Waldoboro Land Use Ordinance, the State of Maine Department of Environmental Protection (MDEP) website, and the United States Environmental Protection Agency (EPA) website.

In summary, CT-PAC has determined the following permits will need to be obtained with the associated fees paid:

- Site plan review to be submitted to the town of Waldoboro
    - Fee of $100 paid to the board of appeals.
- NRPA permit (chapter 305 section 20) for inland waterfowl area
    - Processing fee of $253 and licensing fee of $89
- Section 404 permit
    - Standard fee of $10 for non commercial and $100 for commercial paid to the U.S Army Corps of Engineers

4 Summary of Recommendations

Parking Lot at 877 Main Street

CT-PAC recommends the following design for the parking lot at 877 Main Street, which is believed to have met the goals of the client. The proposed lot has a total of 30 stalls. Two of those stalls are ADA compliant, one of which is van accessible. The ADA stalls are located near a paved pathway that allows one to get to the sidewalk on Main Street without walking through the parking lot. The lot has two light poles and is graded to have a maximum slope of 5%. No stormwater management treatments are needed. The existing retaining wall is removed and silt fencing should remain in-place and functional until approximately 70% of the sloped land is covered with vegetation. Trees located at the end of the lot are removed, which allows for an enhanced view of the Medomak River. The cleared greenspace area can be used as a pocket park with benches and/or picnic tables.

Culvert at Duckpuddle Stream Crossing

CT-PAC recommends the following design for the culvert at Duckpuddle Road, which is believed to have met the goals of the client. The proposed culvert is an open bottom box culvert which supports the flow of the waterway and has sufficient fish passage due to its size and natural open bottom. The roadway is raised and widened at its lowest and smallest points. Increasing the size of the culvert and raising the elevation of the road will eliminate flooding at the site. No new signage is needed. The “Flood Warning” sign may be removed, but all other signage is not being moved/removed from the site. The utility pole that currently sits on the edge of the road has been moved to six feet from the right-of-way then the lights can be installed. The existing guardrails are being removed and replaced.

5 Cost Estimate

CT-PAC also provided an estimate of the overall costs associated with the proposed development at both project sites. These costs include labor, materials, and equipment costs.

To find the price of the two projects, CT-PAC used unit cost estimating. Unit costs were obtained using two methods. Some unit costs, like the precast box culvert, were obtained directly from companies, please see Appendix C: *Dirigo Timberlands Invoice.* Other unit costs were obtained from researching the Maine Department of Transportation's (DOT) bid archives, which tabulates all contractor bids on Maine DOT projects. To get accurate bids, CT-PAC utilized bid contracts that were from the last two years that had similar projects (i.e. culvert replacements) and were in the same general location as Waldoboro, Maine. Because contractor bid rates vary for different unit costs CT-PAC decided that it would be best to obtain most of the unit costs from one contractor. This was done to remove some of the variability in bids and to provide a more accurate representation of what a company may bid for a project. Some items could not be retrieved from previous bids of one company, so other companies' bids were used from similar contracts.

Total fill quantities for the parking lot were calculated using the cut and fill plan created by CT-PAC, please see Appendix C: *Cut and Fill Plan.* From this individual material quantities were calculated, please see Appendix C: *Parking Lot Material Volume Calculations.*

To price out labor costs, CT-PAC had to estimate the amount of work that would have to be conducted at each site. To do this, CT-PAC created a preliminary construction plan with an estimated number of days to complete each task. From there the number of billable hours of equipment and personnel on-site could be specified. Please Appendix C: *Construction Time Estimates Sheet.*

CT-PAC estimated that the total cost to complete the parking lot on 877 Main Street Waldoboro, Maine to be approximately $145,000. CT-PAC estimated the total cost to complete the culvert replacement on Duckpuddle Road to be $230,000. For the full breakdown of costs, please Appendix C: *Cost Estimate.*

6 Disclaimer

The materials contained in this document and any supporting documentation were developed by us as students as part of our education in the College of Engineering in order to gain supervised engineering problem-solving experience. Therefore, information and recommendations, while useful for understanding a particular project's scope and possibilities for implementing solutions, should not be relied upon solely for the purposes of advancing a project beyond conceptual levels.Furthermore, such material should not substitute for or replace the services of a design professional practicing in the areas of engineering or architecture, particularly for projects whose direct or indirect impact may affect the safety, health, or welfare of the public.

We, the students who prepared this information, look forward to the opportunity to serve with fidelity the public, our future employers, and clients. In providing you with this information, our intention is to uphold and enhance the honor, integrity, and dignity of the engineering profession.

We thank you for the opportunity to develop our skills through our work on this project.

7 Bibliography

Accessible Parking. (2017). ADA National Network. https://adata.org/factsheet/parking

Accessible parking spaces. (2015). Retrieved February 05, 2021, from https://www.ada.gov/restriping_parking/restriping2015.html

Lidar topographic maps. J. Croteau P.L.S January 29, 2021.

Town Of Waldoboro Land Use Ordinance (2005).

Town of Waldoboro. (FY 2019). Tax Maps FY 2019-2020 (U-3, p. 31) (United States of America, Maine, Town of Waldoboro). Waldoboro, Maine: Town of Waldoboro.

Lakes of Maine - Lake Overview - Duckpuddle Pond - Nobleboro, Waldoboro, Lincoln, Maine. Lakesofmaine.org. (2021). Retrieved 13 February 2021, from https://www.lakesofmaine.org/lake-overview.html?m=5702.

Maine Department of Environmental Protection. (2021). *GIS Maps & Other Data Files, Geographic Information System, Maine DEP*. Www1.maine.gov. Retrieved 11 February 2021, from https://www1.maine.gov/dep/gis/datamaps/index.html#nrpa_bird.

Maine Department of Inland Fisheries and Wildlife. (2006). *DuckPuddle Pond Lake Survey* (pp. 1-2). Nobleboro and Waldoboro, Lincoln County.

Maps – Beginning with Habitat. Maine.gov. (2021). Retrieved 11 February 2021, from https://www.maine.gov/ifw/fish-wildlife/wildlife/beginning-with-habitat/maps/index.html.

Natural Resources Protection Act ("NRPA Page"), Bur. of Land & Water Quality, Maine Department of Environmental Protection. Www1.maine.gov. (2019). Retrieved 11 February 2021, from https://www1.maine.gov/dep/land/nrpa/index.html.

StreamStats software data, https://streamstats.usgs.gov/ss/. Retrieved February 09, 2021.

Duckpuddle Bridge Plan. Plan numbers RS96-21 and RS96-22. MDOT. 1981.

Issue profile natural resources Protection Act (NRPA). (n.d.). Retrieved February 20, 2021, from https://www.maine.gov/dep/land/nrpa/ip-nrpa.html

Permit program under cwa section 404. (2020, June 17). Retrieved February 20, 2021, from https://www.epa.gov/cwa-404/permit-program-under-cwa-section-404

Permits, licenses, certifications. (n.d.). Retrieved February 20, 2021, from https://www.maine.gov/dep/permits/index.html

Accessible parking spaces. (2015). Retrieved February 05, 2021, from

https://www.ada.gov/restriping_parking/restriping2015.html

Light Poles Plus .com (2021)

P. Gårder, Ph.D., P.E., Professor March 3, 2021

Chow, V. T., Maidment, D. R., & Mays, L. W. (2013). Applied hydrology. New York: McGraw-Hill Professional.

DOT FHA, US (n.d.). Hydraulic Design of Highway Culverts. Retrieved March 21, 2021, from https://www.fhwa.dot.gov/engineering/hydraulics/pubs/12026/hif12026.pdf

Duckpuddle pond. (n.d.). Retrieved March 20, 2021, from https://www.lakesofmaine.org/lake-overview.html?m=5702

Elliptical cement Pipe. (n.d.). Retrieved March 20, 2021, from https://www.petersenproducts.com/category-s/2046.htm

Hydrocad. (n.d.). Arch Pipes. Retrieved March 21, 2021, from https://www.hydrocad.net/archpipe.htm

MATLAB® R2019b

MOGLEN, G. E. (2017). FUNDAMENTALS OF OPEN CHANNEL FLOW. CRC Press.

Stream Smart Road Crossing Pocket Guide: Main DOT. (n.d.). Retrieved from https://www.maine.gov/mdot/publications/docs/brocures/pocket_guide_stream_smart_web.pdf

The national map - data delivery. (n.d.). Retrieved March 20, 2021, from https://www.usgs.gov/core-science-systems/ngp/tnm-delivery/topographic-maps

Dirigo Timberlands https://www.precastmaine.com/culverts.htm

Maine Department of Environmental Protection. (2016, October). Maine Erosion Control and Sedimentation Control Best Management Practices (BMPs) Manual for Designers and Engineers. Retrieved March 25, 2021, from https://www.maine.gov/dep/land/erosion/escbmps/esc_bmp_engineers.pdf

Maine Department of Transportation. (2019, August 13). Highway Program, Design Guidance - Structural Pavement Design. Retrieved March 20, 2021, from https://www.maine.gov/mdot/engineering/highway/

Maine Department of Transportation. (2019, August 3). Highway Program, Pavement Design, Practices and Procedures. Retrieved March 20, 2021, from https://www.maine.gov/mdot/engineering/highway/

United States Environmental Protection Agency. (2012, April). Stormwater Best Management Practice Silt Fences. Retrieved March 25, 2021, from https://www3.epa.gov/npdes/pubs/siltfences.pdf

United States Geological Survey. Web Soil Survey, Engineering Properties---Knox and Lincoln Counties, Maine. Retrieved March 20, 2021, from https://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

Maine Erosion and Sediment Control Best Management Practices. (2016, October). Retrieved March 22, 2021, from https://www.maine.gov/dep/land/erosion/escbmps/esc_bmp_engineers.pdf

United States General Services Administration. (2017, August 13). 2.5 grading. Retrieved April 02, 2021

USDA NRCS. (n.d.). Web Soil Survey. Retrieved April 01, 2021, from https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

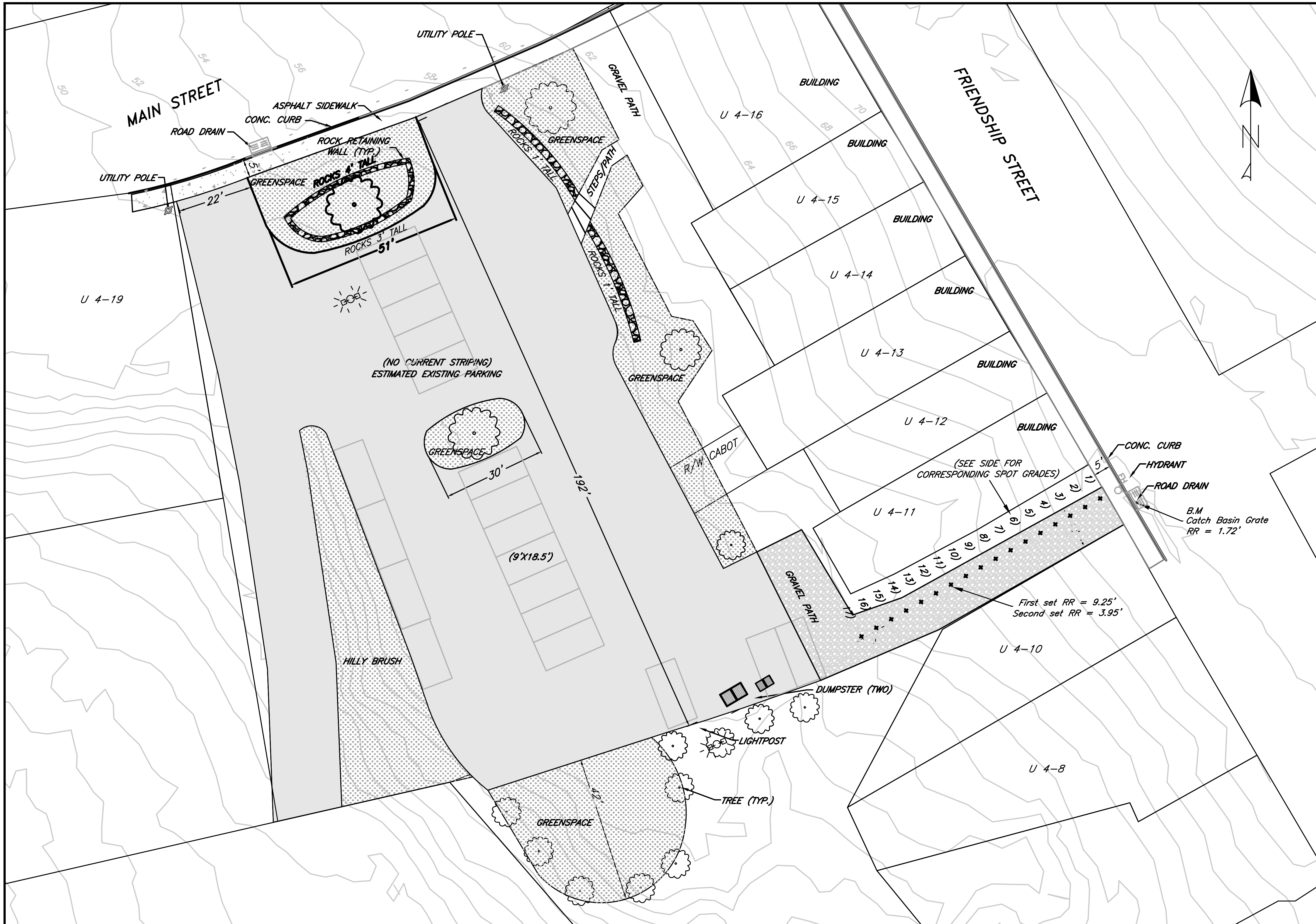
Soil Parameters Retrieved April 12, 2021, from http://www.geotechdata.info/

United States Geological Survey. Web Soil Survey, Engineering Properties---Knox and Lincoln Counties, Maine. Retrieved March 20, 2021, from https://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

2009 edition CHAPTER 2C. warning signs and Object Markers. (n.d.). Retrieved April 16, 2021, from https://mutcd.fhwa.dot.gov/htm/2009/part2/part2c.htm

APPENDIX A:

Drawings for 877 Main Street Parking Lot Redesign



Rod Readings (RR)

1) RR = 1.29'
2) RR = 1.99'
3) RR = 2.80'
4) RR = 3.55'
5) RR = 4.46'
6) RR = 5.32'
7) RR = 6.15'
8) RR = 7.08'
9) RR = 7.84'
10) RR = 8.60'
11) RR = 4.02'
12) RR = 4.72'
13) RR = 5.39'
14) RR = 6.14'
15) RR = 6.74'
16) RR = 7.72'
17) RR = 7.91

Note:
The wall height stated is referenced to the ground at the base of the wall.

GRAPHIC SCALE

30 0 15 30 60 120

(IN FEET)
1 inch = 30 ft.

EXISTING CONDITIONS
PARKING LOT
877 MAIN STREET
TOWN OF WALDOBORO
LINCOLN COUNTY, MAINE

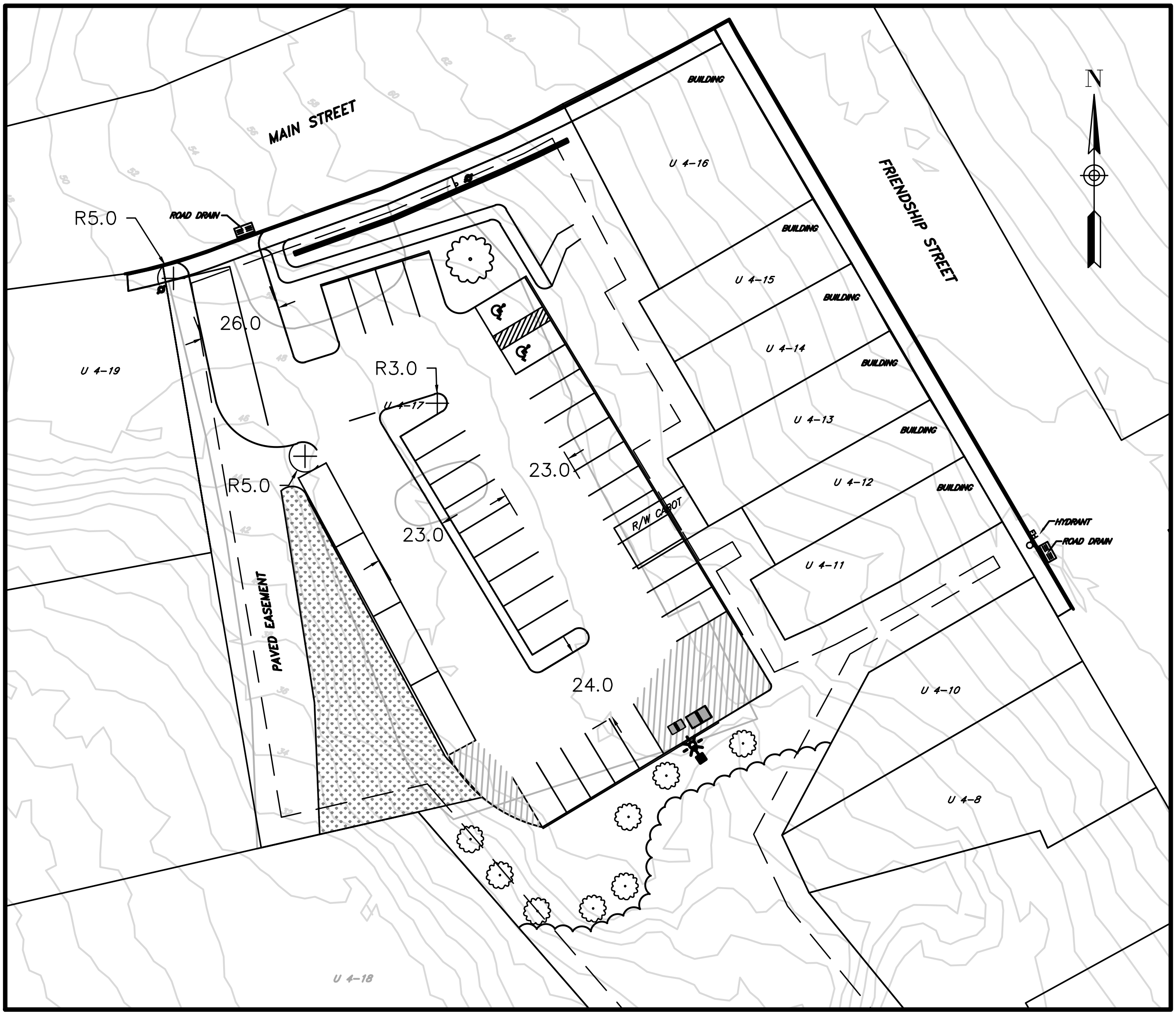
CT-PAC

~ Claire Klaus ~ Tanner Binette ~
~ Paul Dezii ~ Andrew Guimond ~
~ Clayton Mason ~

REVISIONS	
No.	DATE
1	4/26/21

CIE 413 & CIE 411	DRAWN BY: CT-PAC	WORK PACKAGE: 1
DATE: 2/2/21	SCALE: 1" = 30'	SHEET: 1 OF 1

PRODUCED BY AN AUTODESK STUDENT VERSION
PRODUCED BY AN AUTODESK STUDENT VERSION



TRUE INCH

SITE PLAN OPTION 1

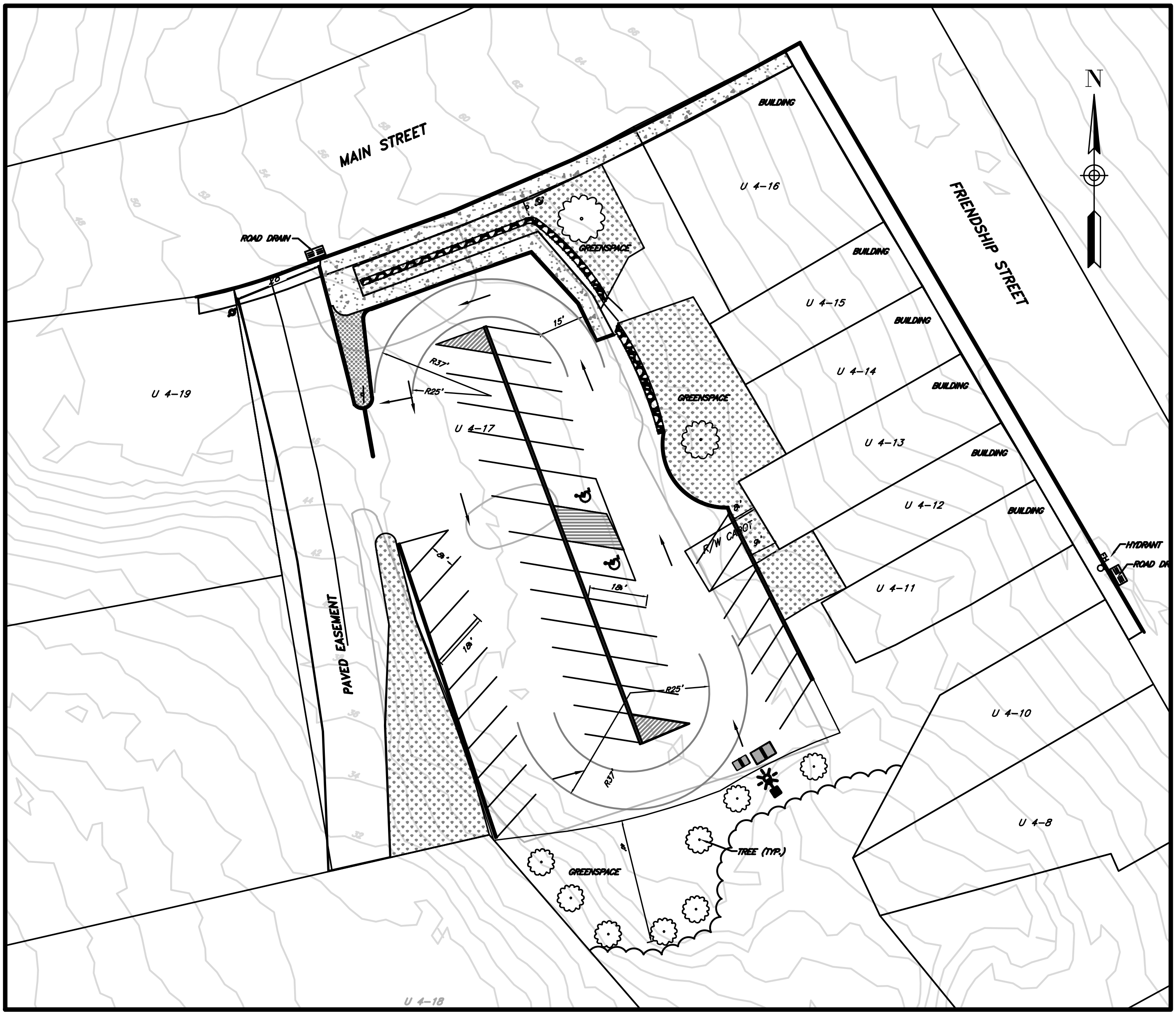
PARKING LOT
877 MAIN STREET
TOWN OF WALDOBORO
LINCOLN COUNTY, MAINE

CT-PAC

REVISIONS	
No.	DATE

~ Claire Klaus ~ Tanner Binette ~
~ Paul Dezii ~ Andrew Guimond ~
~ Clayton Mason ~

CIE 413 & CIE 411	DRAWN BY: CT-PAC	WORK PACKAGE: 4
DATE: 3/5/21	SCALE: 1" = 50'	SHEET: 1 OF 1

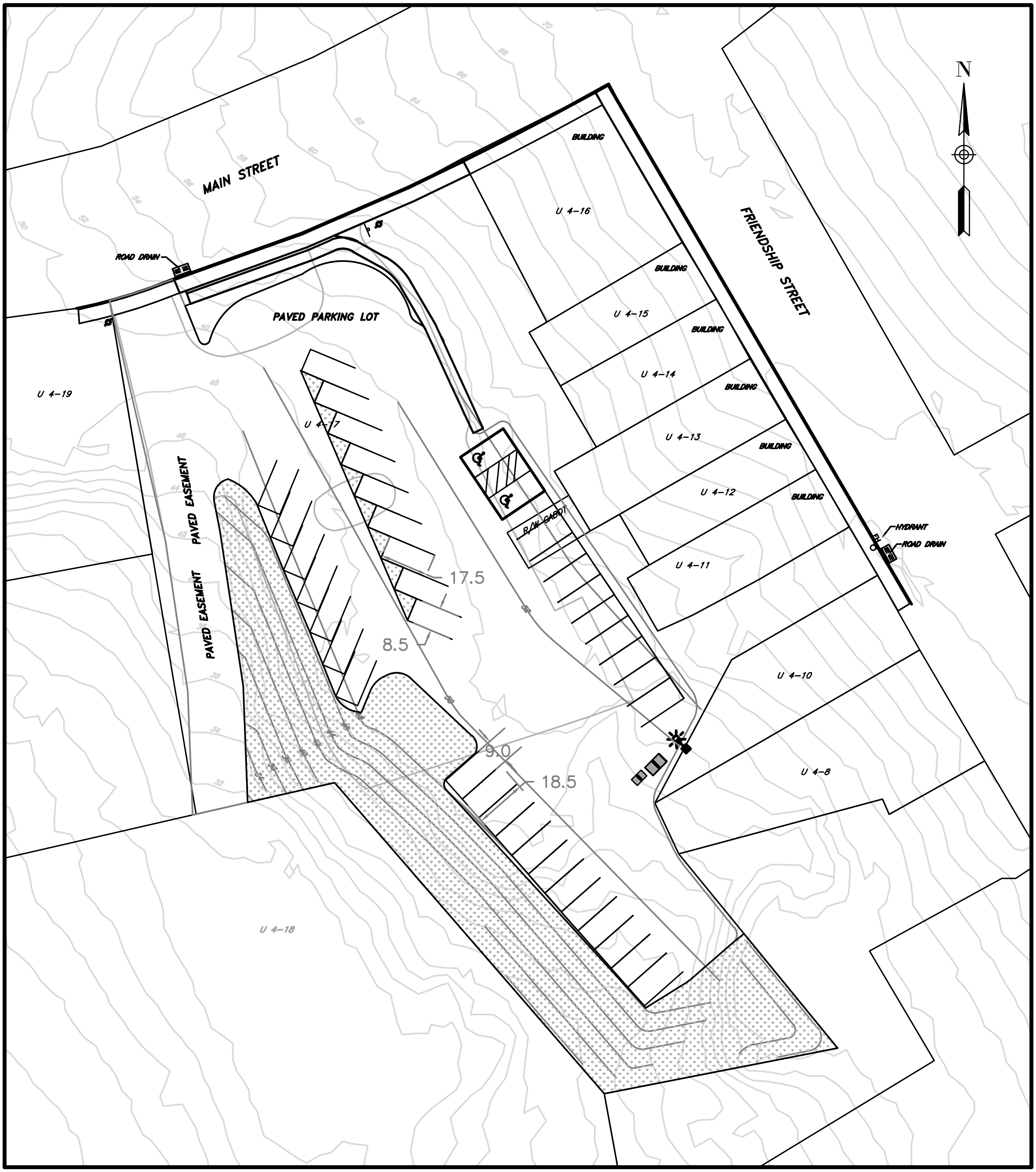


TRUE INCH

SITE PLAN OPTION 2 **PARKING LOT** **877 MAIN STREET** **TOWN OF WALDOBORO** **LINCOLN COUNTY, MAINE**	CT-PAC	REVISIONS No. DATE	~ Claire Klaus ~ Tanner Binette ~ ~ Paul Dezii ~ Andrew Guimond ~ ~ Clayton Mason ~

CIE 413 & CIE 411	DRAWN BY: CT–PAC	WORK PACKAGE: 4
DATE: 3/5/21	SCALE: 1" = 50'	SHEET: 1 OF 1

PRODUCED BY AN AUTODESK STUDENT VERSION
PRODUCED BY AN AUTODESK STUDENT VERSION



TRUE INCH

SITE PLAN OPTION 3

PARKING LOT
877 MAIN STREET
TOWN OF WALDOBORO
LINCOLN COUNTY, MAINE

CT-PAC

REVISIONS	
No.	DATE

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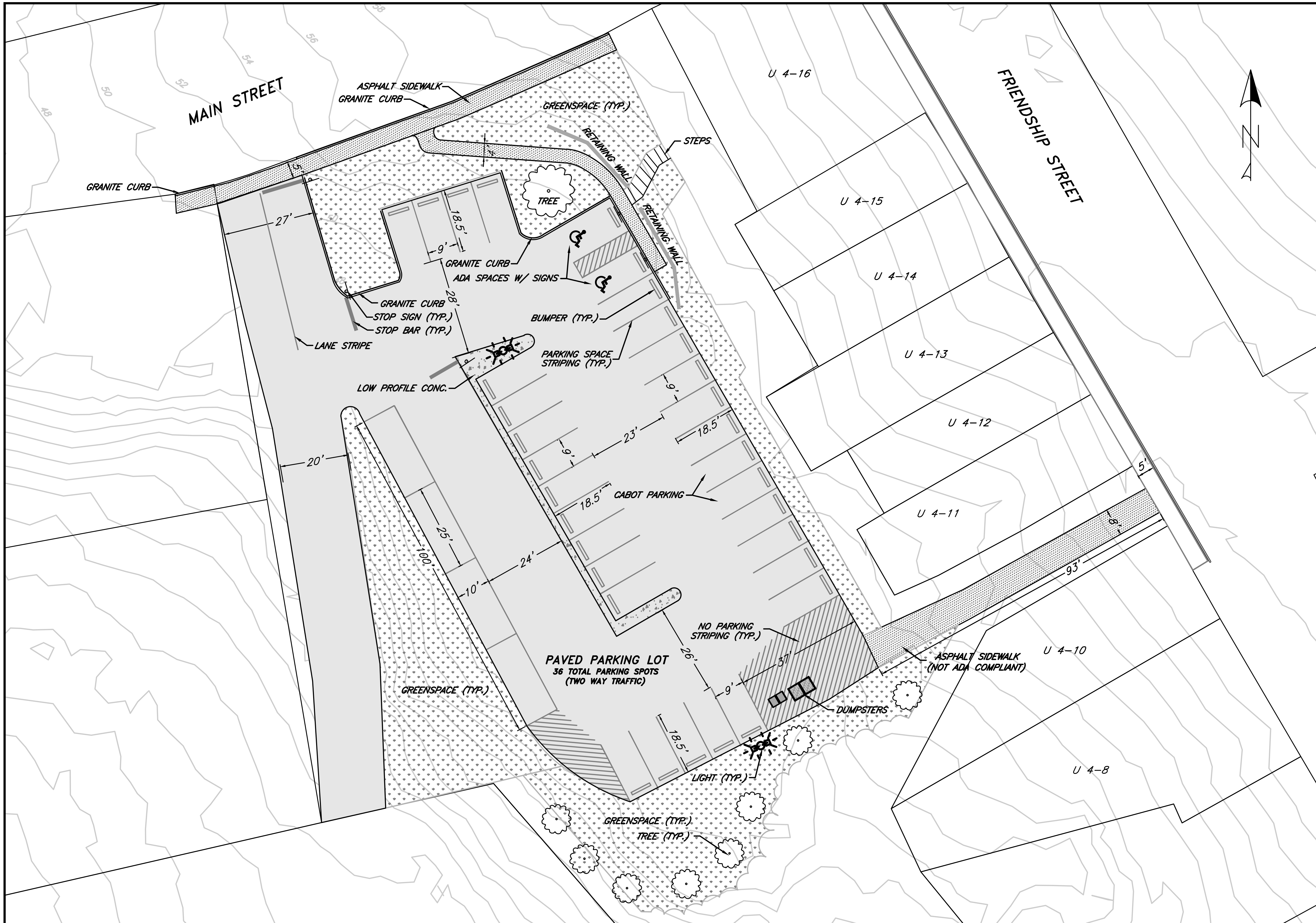
~ Paul Dezii ~ Andrew Guimond ~
~ Clayton Mason ~

CIE 413 & CIE 411	DRAWN BY: CT-PAC	WORK PACKAGE: 4
DATE: 3/5/21	SCALE: 1" = 50'	SHEET: 1 OF 1

PRODUCED BY AN AUTODESK STUDENT VERSION

PRODUCED BY AN AUTODESK STUDENT VERSION



Notes:
Existing Contour Lines are shown, see Grading Plan for Proposed Contours.

GRAPHIC SCALE

30 0 15 30 60 120

(IN FEET)
1 inch = 30 ft.

FINAL PRELIMINARY SITE PLAN
PARKING LOT
877 MAIN STREET
TOWN OF WALDOBORO
LINCOLN COUNTY, MAINE

CT-PAC

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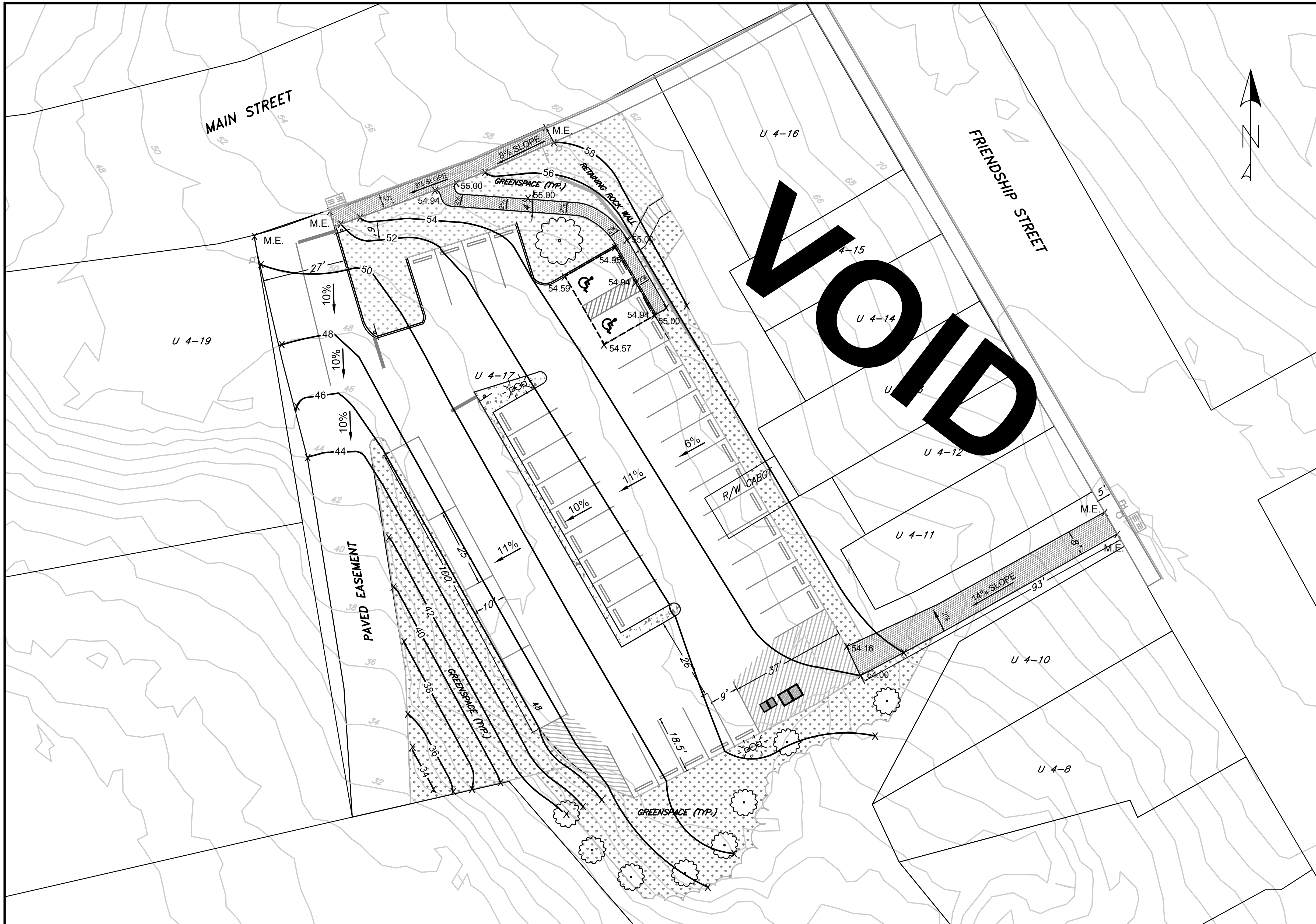
~ Paul Dezii ~ Andrew Guimond ~
~ Clayton Mason ~

REVISIONS	
No.	DATE
1	4/16/21

CIE 413 & CIE 411	DRAWN BY: CT-PAC	WORK PACKAGE: 4
DATE: 3/10/21	SCALE: 1" = 30'	SHEET: 1 OF 1

PRODUCED BY AN AUTODESK STUDENT VERSION



GRAPHIC SCALE

30 0 15 30 60 120

(IN FEET)
1 inch = 30 ft.

VOID PRELIMINARY GRADING
PARKING LOT
877 MAIN STREET
TOWN OF WALDOBORO
LINCOLN COUNTY, MAINE

CT-PAC

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~ Paul Dezii ~ Andrew Guimond ~
~ Clayton Mason ~

REVISIONS	
No.	DATE

CIE 413 & CIE 411	DRAWN BY: CT-PAC	WORK PACKAGE: 7
DATE: 4/2/21	SCALE: 1" = 30'	SHEET: 1 OF 1

Notes:

Proposed contour lines are marked with 'X' on the ends where they meet the existing contours.
Contour lines are for every 2ft.
The ADA parking spaces must have no more than a 2% slope in any direction.
Asphalt path from ADA parking spaces has a 2% cross-slope.
The retaining wall is 1ft tall.
Arrows point downhill (water path) and have the slope in percent.
M.E. is for 'Match Existing', meaning to match the grade.
Easement contours have been smoothed out but will match existing grades.
Easement may not be required to be redone.

GRAPHIC SCALE

30 0 15 30 60 120

(IN FEET)
1 inch = 30 ft.

GRADING PLAN

PARKING LOT
877 MAIN STREET
TOWN OF WALDOBORO
LINCOLN COUNTY, MAINE

CT-PAC

~ Claire Klaus ~ Tanner Binette ~
~ Paul Dezii ~ Andrew Guimond ~
~ Clayton Mason ~

REVISIONS	
No.	DATE
1	4/2/21

CIE 413 & CIE 411	DRAWN BY: CT-PAC	WORK PACKAGE: 7
DATE: 4/2/21	SCALE: 1" = 30'	SHEET: 1 OF 1

Notes:
High Traffic Areas have a dotted pattern.
Low Traffic Areas have a triangle pattern.
Total High Traffic Area = 11100 ft^2
Total Low Traffic Area = 7980 ft^2

GRAPHIC SCALE

30 0 15 30 60 120

(IN FEET)
1 inch = 30 ft.

PAVEMENT DESIGN AREAS
PARKING LOT
877 MAIN STREET
TOWN OF WALDOBORO
LINCOLN COUNTY, MAINE

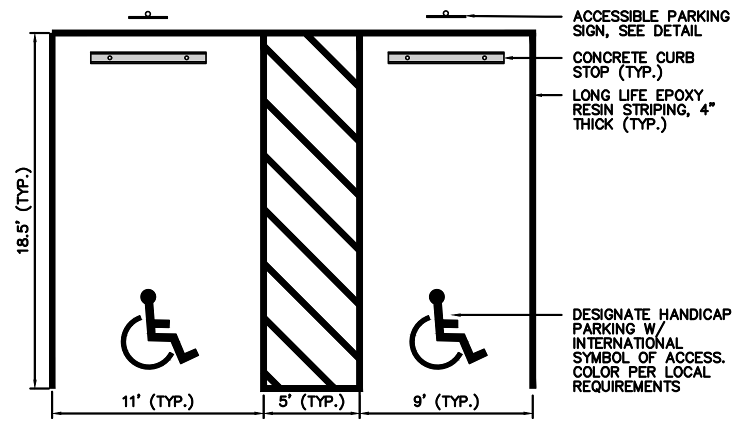
CT-PAC

~ Claire Klaus ~ Tanner Binette ~
~ Paul Dezii ~ Andrew Guimond ~
~ Clayton Mason ~

REVISIONS	
No.	DATE
1	4/16/21

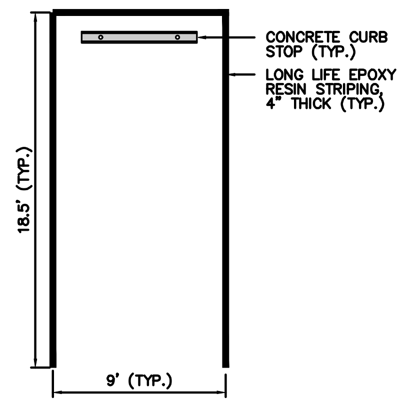
CIE 413 & CIE 411	DRAWN BY: CT-PAC	WORK PACKAGE: 6
DATE: 3/25/21	SCALE: 1" = 30'	SHEET: 1 OF 1

PRODUCED BY AN AUTODESK STUDENT VERSION
PRODUCED BY AN AUTODESK STUDENT VERSION
PRODUCED BY AN AUTODESK STUDENT VERSION



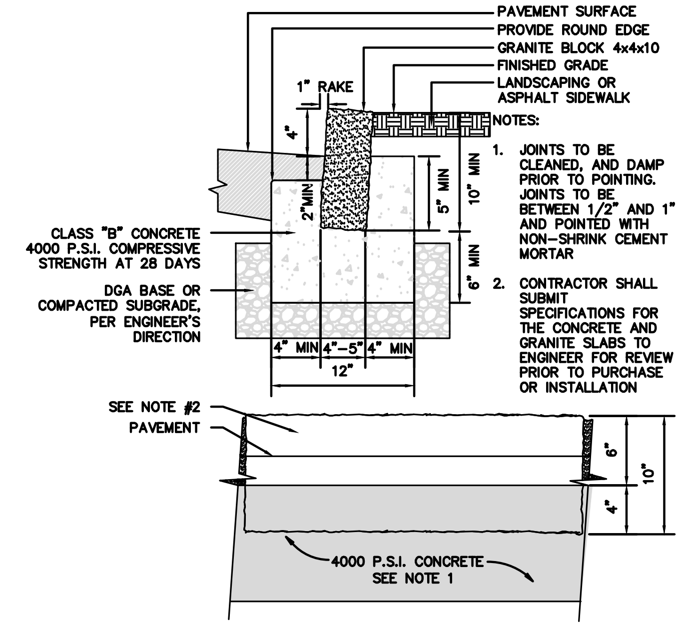
NOTES:
1. SEE PLANS FOR ACCESSIBLE PARKING SPACE LOCATIONS AND LAYOUT.
2. STRIPING SHALL BE LONG LIFE EPOXY RESIN WITH A BLUE COLOR.
3. SLOPE IN ALL DIRECTIONS SHALL NOT EXCEED 2%, SEE GRADING PLANS.

ADA PARKING SPACES SCALE: N.T.S.



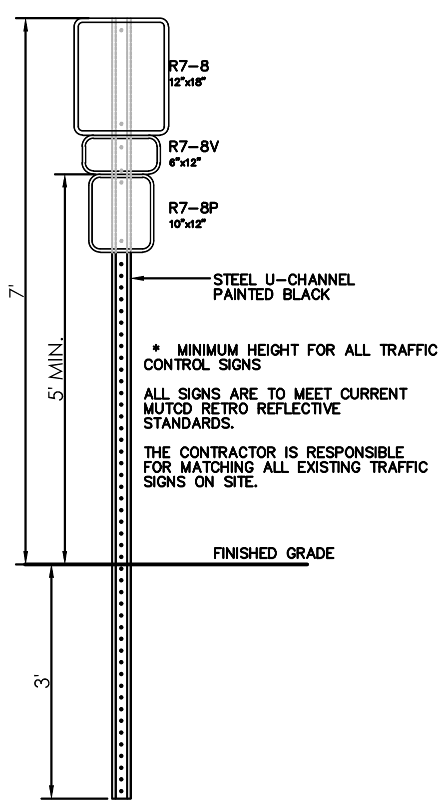
NOTES:
1. SEE PLANS FOR SPACE LOCATIONS AND LAYOUT.
2. STRIPING SHALL BE LONG LIFE EPOXY RESIN WITH A WHITE COLOR.
3. PARALLEL PARKING SPACES ARE 25'X10'

TYPICAL PARKING SPACE SCALE: N.T.S.



NOTES:
1. JOINTS TO BE CLEANED, AND DAMP PRIOR TO POINTING. JOINTS TO BE BETWEEN 1/2" AND 1" AND POINTED WITH NON-SHRINK CEMENT MORTAR
2. CONTRACTOR SHALL SUBMIT SPECIFICATIONS FOR THE CONCRETE AND GRANITE SLABS TO ENGINEER FOR REVIEW PRIOR TO PURCHASE OR INSTALLATION

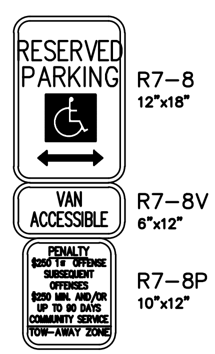
GRANITE CURB SCALE: N.T.S.



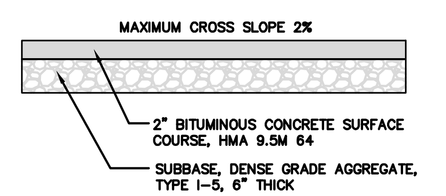
* MINIMUM HEIGHT FOR ALL TRAFFIC CONTROL SIGNS

ALL SIGNS ARE TO MEET CURRENT MUTCD RETRO REFLECTIVE STANDARDS.

THE CONTRACTOR IS RESPONSIBLE FOR MATCHING ALL EXISTING TRAFFIC SIGNS ON SITE.

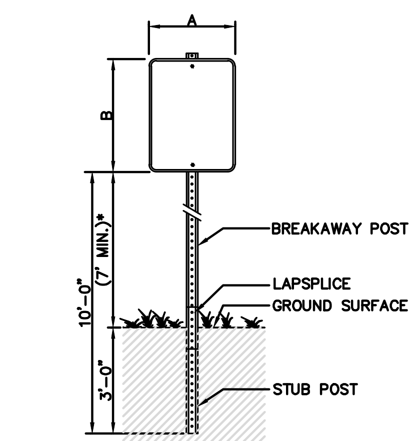


ADA SIGN MOUNTING WITH SIGNS SCALE: N.T.S.



PROPOSED PATH NOTES:
A. PAVING SECTION BASED ON C.B.R. OF TEN OR BETTER.
B. PRIME COAT TO BE APPLIED AT A RATE OF 0.10 GAL./S.Y.

ASPHALT PATH/SIDEWALK SCALE: N.T.S.



NOTE:
* MINIMUM HEIGHT FOR ALL TRAFFIC CONTROL SIGNS

SIGN POST SCALE: N.T.S.

CONSTRUCTION DETAILS
PARKING LOT
877 MAIN STREET
TOWN OF WALDOBORO
LINCOLN COUNTY, MAINE

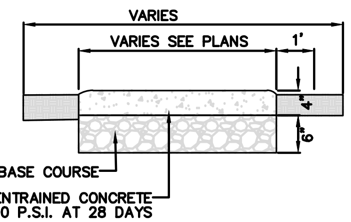
CT-PAC

~ Claire Klaus ~ Tanner Binette ~
~ Paul Dezii ~ Andrew Guimond ~
~ Clayton Mason ~

REVISIONS	
No.	DATE

CIE 413 & CIE 411	DRAWN BY: CT-PAC	WORK PACKAGE: 6
DATE: 3/25/21	SCALE: N/A	SHEET: 1 OF 2

PRODUCED BY AN AUTODESK STUDENT VERSION
PRODUCED BY AN AUTODESK STUDENT VERSION
PRODUCED BY AN AUTODESK STUDENT VERSION



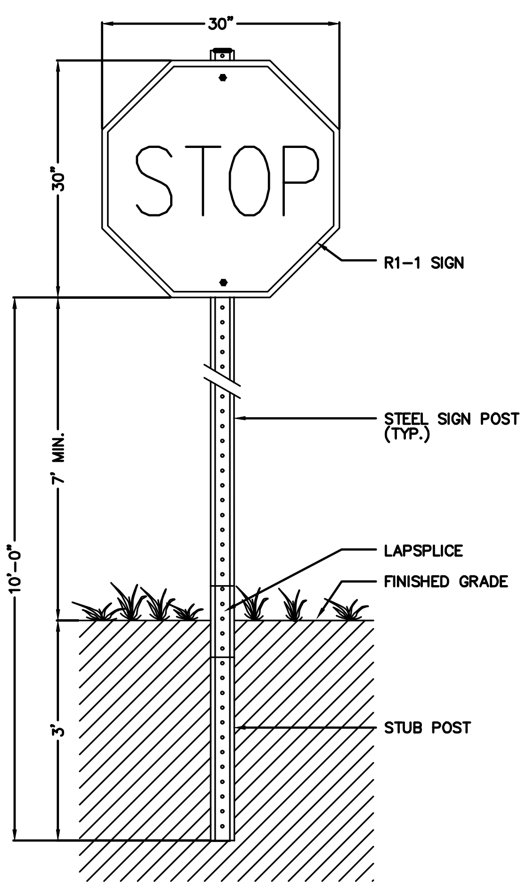
NOTES:

1. CONCRETE SHALL HAVE A BROOM FINISH AND 2" EXPOSED ABOVE ASPHALT
2. CONTRACTOR TO PROVIDE EXPANSION AND CONTROL JOINTS AS NECESSARY.
3. WHERE CONCRETE ISN USED IN ACCESSIBLE PARKING OR ROUTES OF TRAVEL SLOPES SHALL NOT EXCEED 2%, SEE PLANS FOR GRADING.
4. CONTRACTOR SHALL SUBMIT SHOP DRAWINGS TO ENGINEER FOR REVIEW AND APPROVAL PRIOR TO PURCHASE AND INSTALLATION.

LOW PROFILE CONCRETE SCALE: N.T.S.

NOTE:
STOP BAR SHALL BE THERMOPLASTIC , COLOR WHITE, IMPREGNATED GLASS BEADS

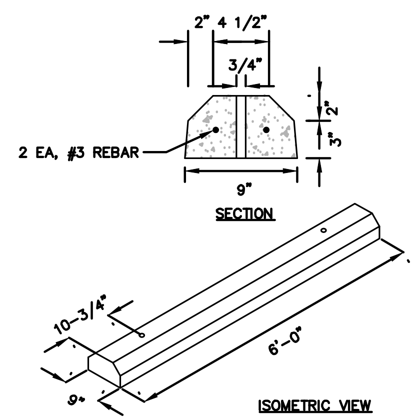
STOP BAR SCALE: N.T.S.



NOTE:

1. MINIMUM HEIGHT FOR ALL TRAFFIC CONTROL SIGNS (8' MAX.)
2. ALL SIGNS ARE TO MEET CURRENT MUTCD RETRO REFLECTIVE STANDARDS.
3. THE CONTRACTOR IS RESPONSIBLE FOR MATCHING ALL EXISTING TRAFFIC SIGNS ON SITE.
4. SEE PLAN FOR LOCATIONS.
5. ALL SIGNS SHALL BE LOCATED A MINIMUM OF 2' OFF EDGE OF TRAIL EDGE.

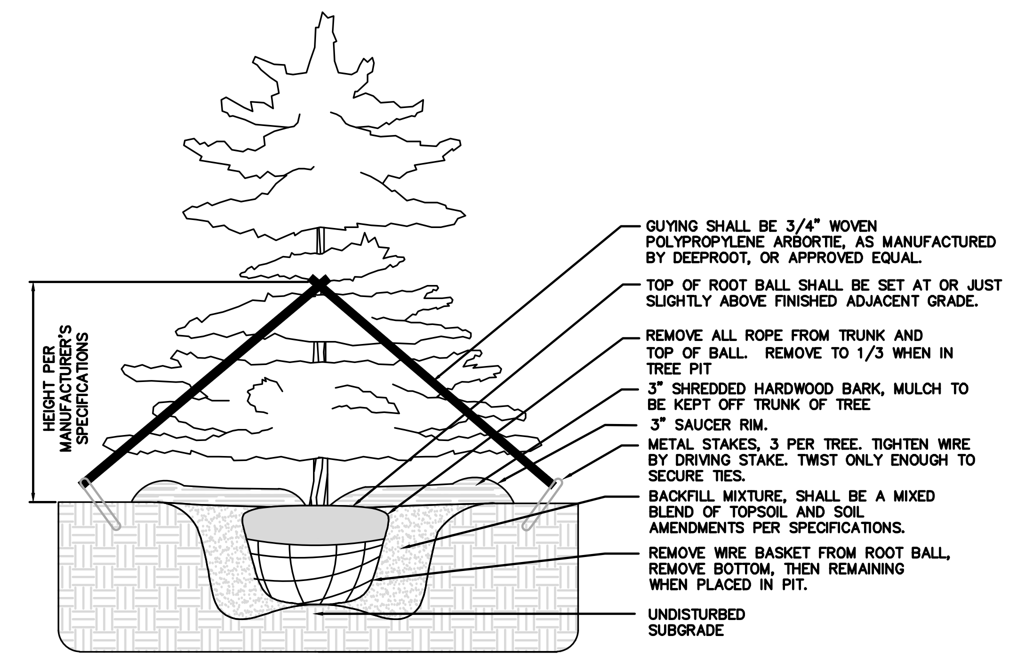
STOP SIGN AND POST SCALE: N.T.S.



NOTES:

1. REBAR SHALL BE AMERICAN GRADE 60 SIZE #3.
2. 4000 PSI CONCRETE AT 28 DAYS.
3. CONTRACTOR SHALL SUBMIT SHOP DRAWINGS TO ENGINEER FOR REVIEW AND APPROVAL PRIOR TO PURCHASE AND INSTALLATION.

CONCRETE CURB BUMPER SCALE: N.T.S.



EVERGREEN TREE SCALE: N.T.S.

CONSTRUCTION DETAILS
PARKING LOT
877 MAIN STREET
TOWN OF WALDOBORO
LINCOLN COUNTY, MAINE

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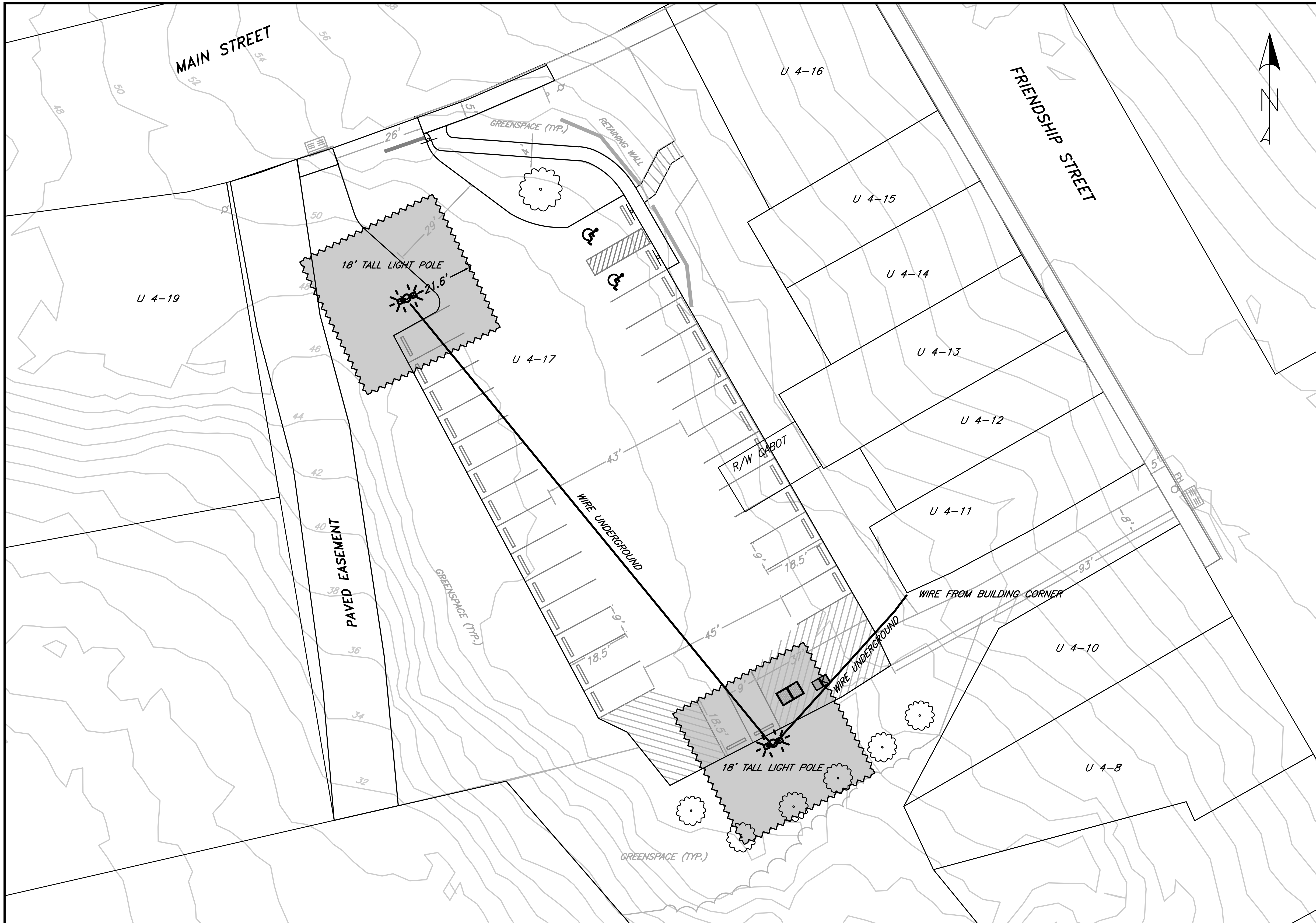
~ Clayton Mason ~

REVISIONS	
No.	DATE

CIE 413 & CIE 411	DRAWN BY: CT-PAC	WORK PACKAGE: 6
DATE: 3/25/21	SCALE: N/A	SHEET: 2 OF 2



Notes:
Existing Topographic Map Shown Under Parking Lot.
Shaded Region Shown Around Light Represents the Lit Region Around the Light.
Electrical Wire Comes from the Building and needs to be Routed Underground in Conduit to Light Poles.
Refer to Calculation Pages.

GRAPHIC SCALE

30 0 15 30 60 120

(IN FEET)
1 inch = 30 ft.

LIGHTING PLAN
PARKING LOT
877 MAIN STREET
TOWN OF WALDOBORO
LINCOLN COUNTY, MAINE

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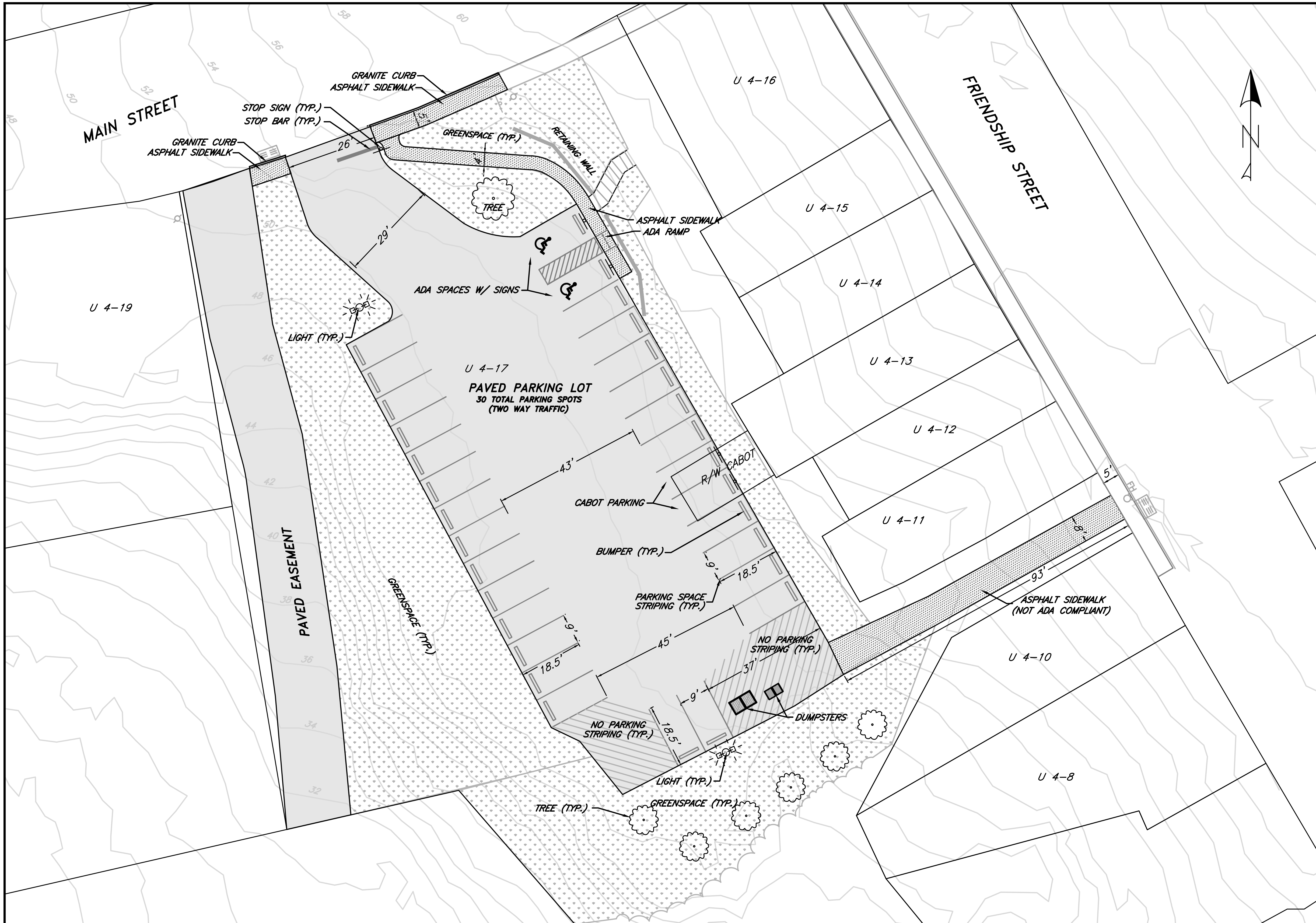
REVISIONS	
No.	DATE
1	4/16/21

CIE 413 & CIE 411	DRAWN BY: CT-PAC	WORK PACKAGE: 4
DATE: 3/5/21	SCALE: 1" = 30'	SHEET: 1 OF 1



Notes:
Existing Contour Lines are shown, see Grading Plan for Proposed Contours.

GRAPHIC SCALE

30 0 15 30 60 120

(IN FEET)
1 inch = 30 ft.

FINAL SITE PLAN
PARKING LOT
877 MAIN STREET
TOWN OF WALDOBORO
LINCOLN COUNTY, MAINE

CT-PAC

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REVISIONS	
No.	DATE
1	4/16/21

CIE 413 & CIE 411	DRAWN BY: CT-PAC	WORK PACKAGE: 4
DATE: 3/10/21	SCALE: 1" = 30'	SHEET: 1 OF 1

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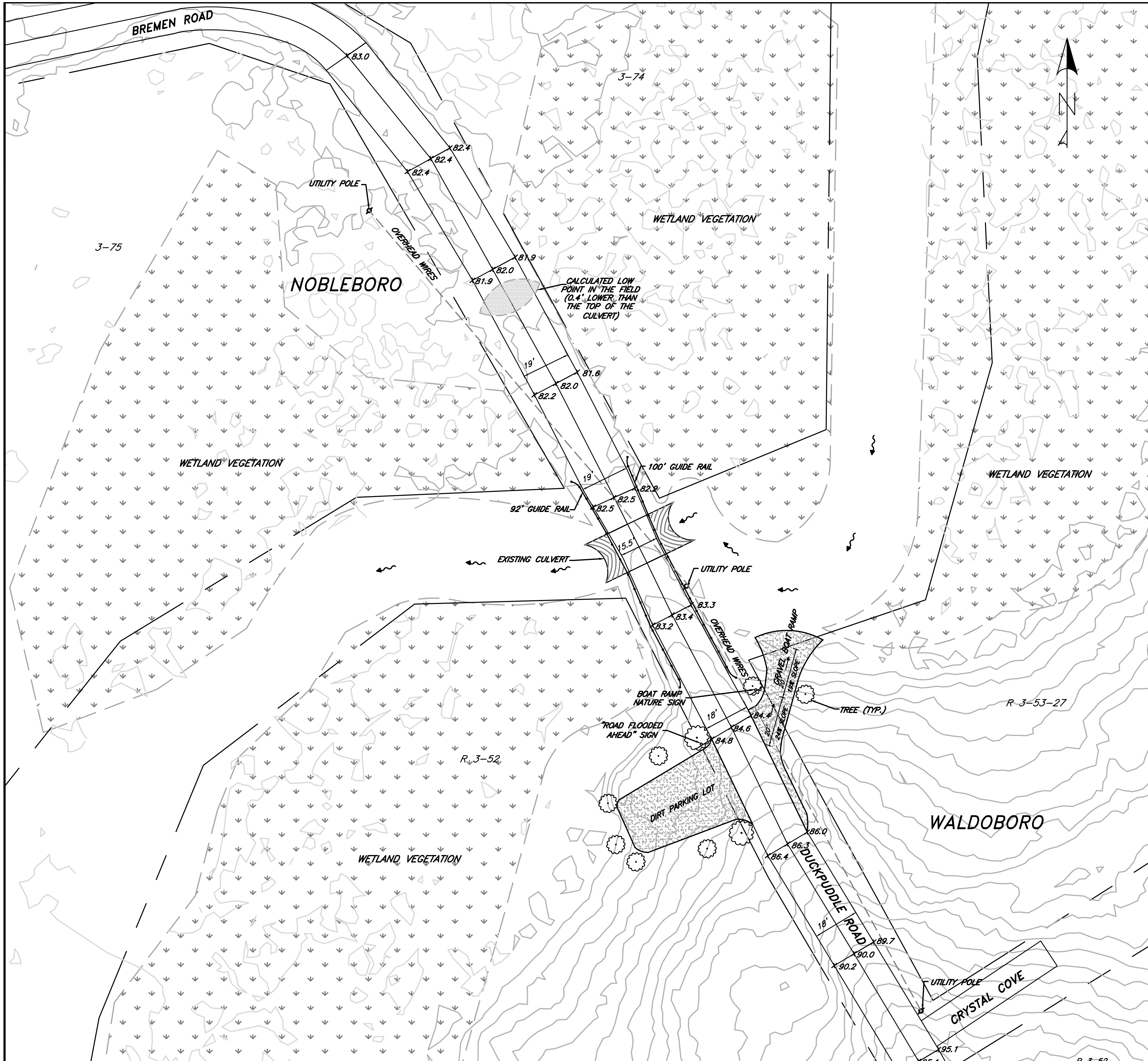
APPENDIX B:

Drawings for Duckpuddle Stream Crossing Culvert Replacement



Note:
The grades provided are in feet and are from a proposed Duckpuddle Bridge Plan (1981).

GRAPHIC SCALE

40 0 20 40 80 160

(IN FEET)
1 inch = 40 ft.

EXISTING CONDITIONS
DUCKPUDDLE CULVERT
DUCKPUDDLE POND
TOWN OF WALDOBORO
LINCOLN COUNTY, MAINE

CT-PAC

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REVISIONS	
No.	DATE

CIE 413 & CIE 411	DRAWN BY: CT-PAC	WORK PACKAGE: 2
DATE: 2/18/21	SCALE: 1" = 40'	SHEET: 1 OF 1

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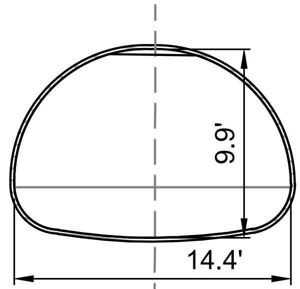
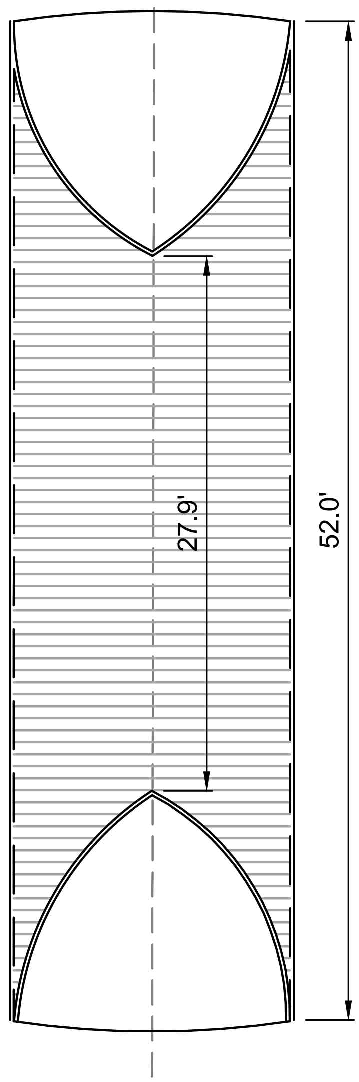
PRODUCED BY AN AUTODESK STUDENT VERSION

SECTION VIEW



PLAN VIEW



Notes:
The material of the existing culvert is annular corrugated metal piping.
The shape is a pipe arch.
The assumed slope is .002.

TRUE INCH

CONCEPTUAL CULVERTS
EXISTING CULVERT
DUCKPUDDLE ROAD
TOWN OF WALDOBORO
LINCOLN COUNTY, MAINE

CT–PAC

REVISIONS	
No.	DATE

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~ Clayton Mason ~

CIE 413 & CIE 411	DRAWN BY: CT–PAC	WORK PACKAGE: 1
DATE: 3/20/21	SCALE: 1" = 10'	SHEET: 1 OF 4

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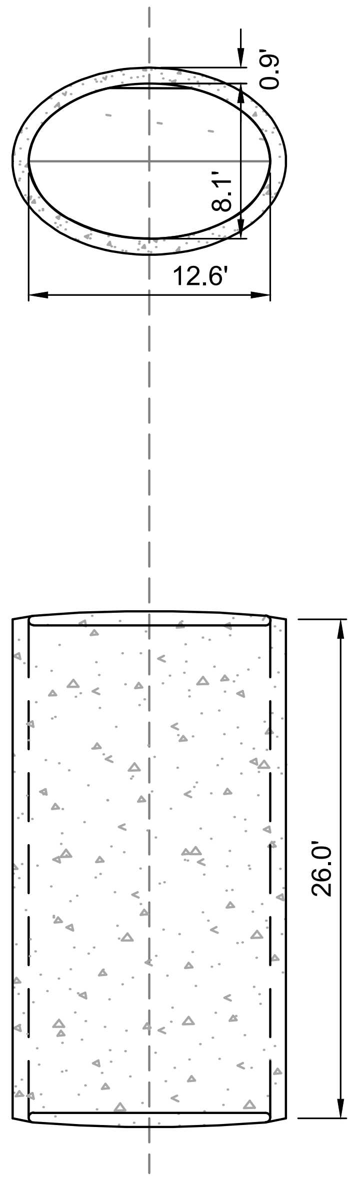
PRODUCED BY AN AUTODESK STUDENT VERSION

SECTION VIEW

PLAN VIEW



Notes:

The material of the Ellipse Culvert is Reinforced Concrete Piping (RCP).
The Thickness of the Concrete is 10 inches.
The shape is an ellipse.
The Designed Slope is .005.

TRUE INCH

CONCEPTUAL CULVERTS

OPTION #1 ELLIPSE CULVERT
DUCKPUDDLE ROAD
TOWN OF WALDOBORO
LINCOLN COUNTY, MAINE

CT-PAC

REVISIONS	
No.	DATE

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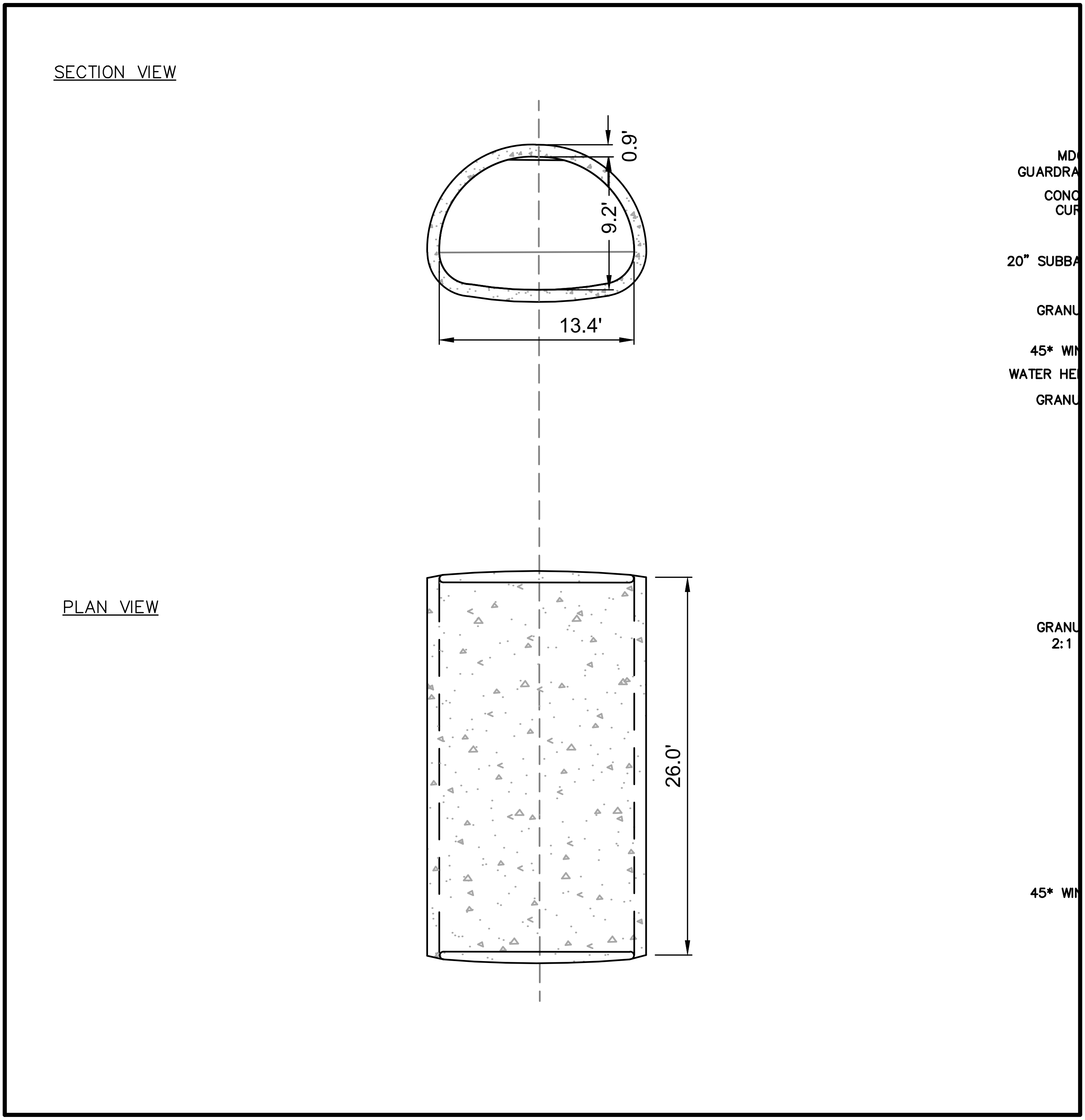
~ Paul Dezii ~ Andrew Guimond ~
~ Clayton Mason ~

CIE 413 & CIE 411	DRAWN BY: CT-PAC	WORK PACKAGE: 1
DATE: 3/20/21	SCALE: 1" = 10'	SHEET: 2 OF 4



Notes:
The material of the Pipe Arch Culvert is Reinforced Concrete Piping (RCP).
The Thickness of the Concrete is 10 inches.
The shape is a Pipe Arch as defined by Hanson Engineering.
The Designed Slope is .005.

TRUE INCH

CONCEPTUAL CULVERTS
OPTION #2 PIPE ARCH CULVERT
DUCKPUDDLE ROAD
TOWN OF WALDOBORO
LINCOLN COUNTY, MAINE

CT-PAC

REVISIONS	
No.	DATE

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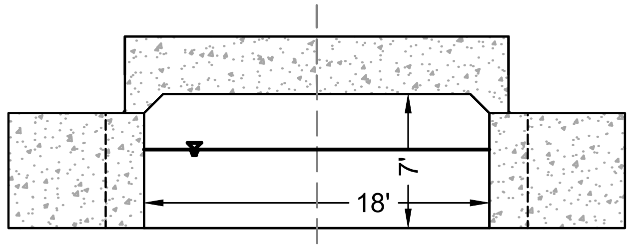
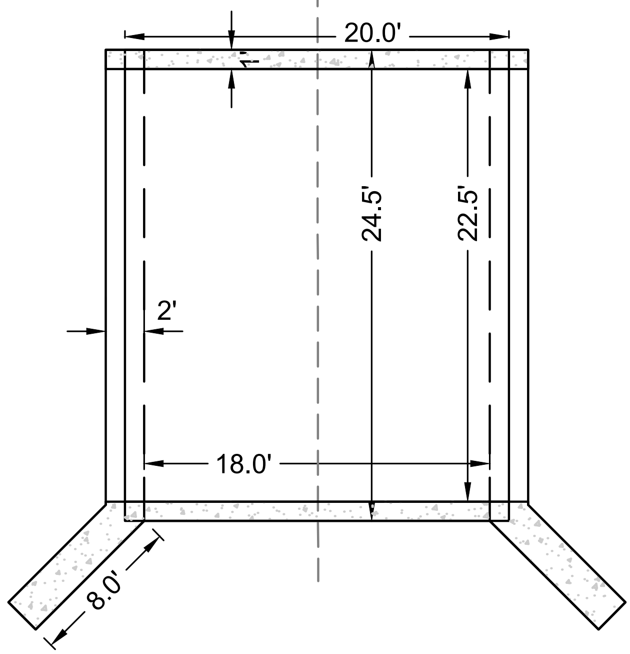
~ Paul Dezii ~ Andrew Guimond ~
~ Clayton Mason ~

CIE 413 & CIE 411	DRAWN BY: CT-PAC	WORK PACKAGE: 1
DATE: 3/20/21	SCALE: 1" = 10'	SHEET: 3 OF 4

SECTION VIEW



PLAN VIEW



Notes:
The material of the Open Bottom Box Culvert is Reinforced Concrete Blocks.
The Concrete Blocks vary in dimensions, see plans.
The angle of the walls are 45˚.
The Designed Slope is .005.

TRUE INCH

CONCEPTUAL CULVERTS
OPTION #3
OPEN BOTTOM BOX CULVERT
DUCKPUDDLE ROAD
TOWN OF WALDOBORO
LINCOLN COUNTY, MAINE

CT-PAC

REVISIONS	
No.	DATE

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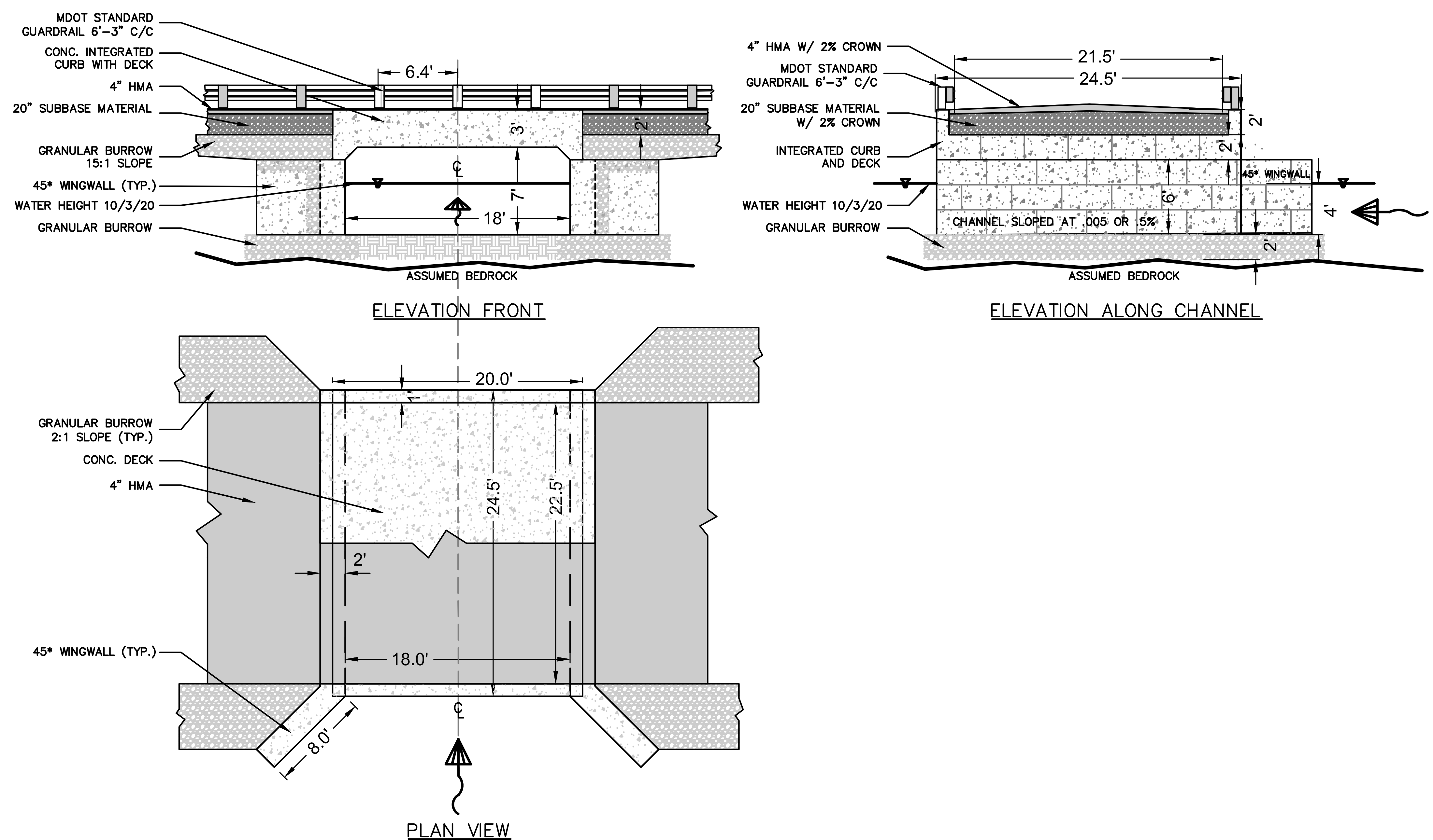
~ Clayton Mason ~

CIE 413 & CIE 411	DRAWN BY: CT–PAC	WORK PACKAGE: 1
DATE: 3/20/21	SCALE: 1" = 10'	SHEET: 4 OF 4



Notes:
The material of the Open Box Culvert is Concrete.

Granular Burrow Gravel will be used under Subbase of road and under Abutments.

2% Crown in the Road and Subbase must be maintained.

Guardrail must be to MDOT Standard Code Specifications and Spaced at 6'–3".

Keep clean and usable Excavation Fill for backfilling around the Granular Burrow Gravel.

Backfill using existing materials if and where possible.

4" Hot Mix Asphalt has been specified.

Slope of Channel is set at .005 or .5% Downstream.

Water Height provided from site visit 10/3/20.

Assumed Bedrock from Soil Stats (USGS).

Box Culvert from Dirigo Bridge Company.

Channel Bed is Existing Materials.

GRAPHIC SCALE

(IN FEET)
1 inch = 10 ft.

CULVERT DETAILS
DUCKPUDDLE CULVERT
DUCKPUDDLE POND
TOWN OF WALDOBORO
LINCOLN COUNTY, MAINE

CT-PAC

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~ Paul Dezii ~ Andrew Guimond ~
~ Clayton Mason ~

REVISIONS	
No.	DATE

CIE 413 & CIE 411	DRAWN BY: CT–PAC	WORK PACKAGE: 8
DATE: 4/16/21	SCALE: 1" = 10'	SHEET: 1 OF 1

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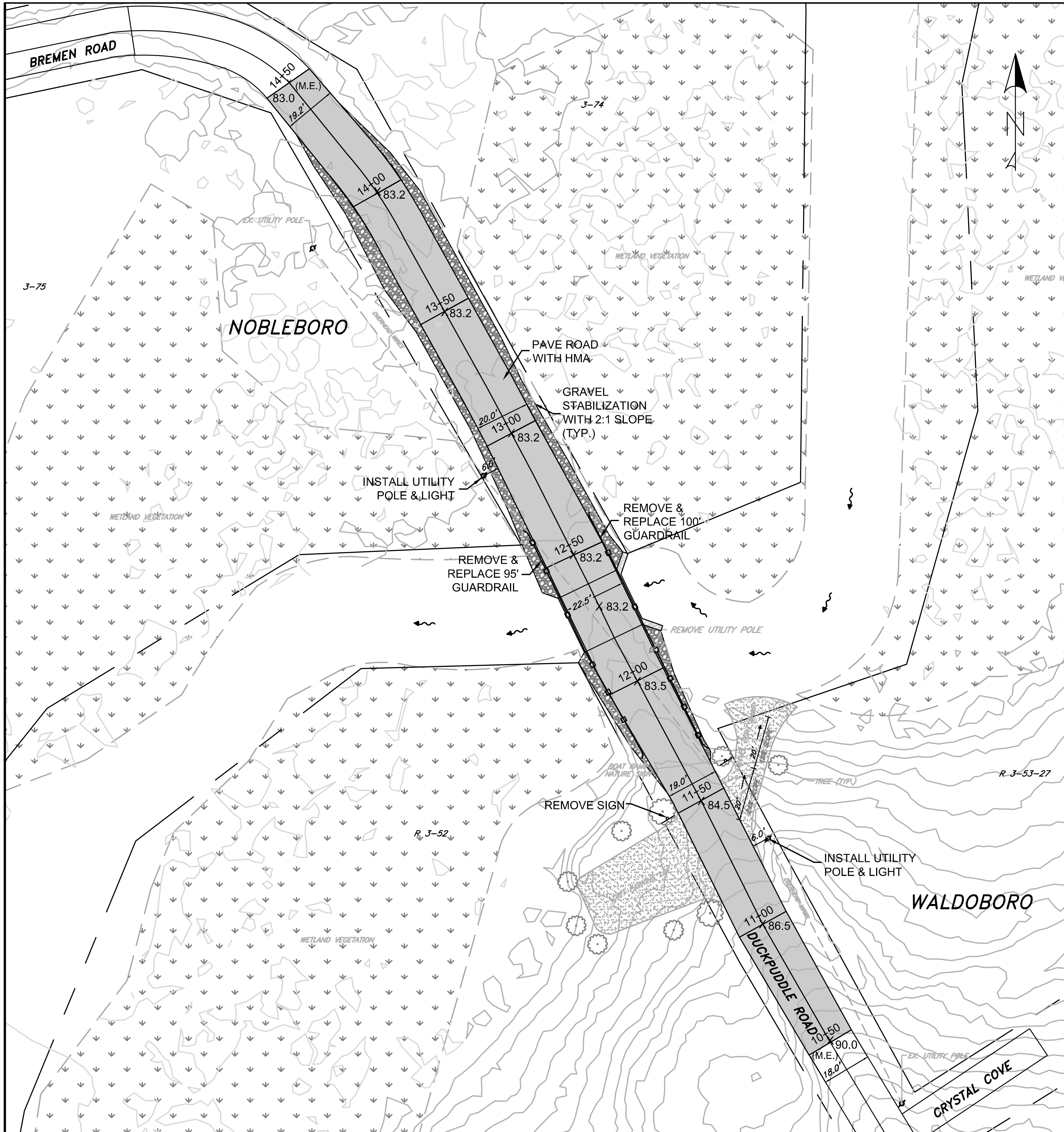
PRODUCED BY AN AUTODESK STUDENT VERSION
PRODUCED BY AN AUTODESK STUDENT VERSION



Notes:

Centerline has stations every 50 feet.
M.E. is "Match Existing". Match grade elevations.
Road Grades are based off of 1981 Culvert Road Plan. Existing Grades may vary.
Contour Lines are for general layout of land. Do not use as measurement.
Grades provided are in feet and for the centerline of the road. From the centerline, grade road 2% to the edge of the road.
See Subgrade design for specifications for road HMA mix.
See Typical Section on Road Profile for Road Details.
The North Side of the Culvert Road must be raised to meet new grades. Fill with gravel off the sides of the road at a 2:1 slope.
New Utility Pole Locations are shown and specified in Lighting Plan.
New Guardrail must be met with Maine Department of Transportation Specification Guidelines. On the Culvert the Guardrail will be attached in curbing sides. Guardrail must be paved under for stabilization and safety.
New Culvert is in the same footprint as the Existing Culvert.
Excavated Materials may be used to backfill if clean and usable.
Soil Erosion Techniques must be used following Maine Department of Environmental Protection Guidelines. This includes but is not limited to hay bails, silt fence, rip rap, and geotextile wrap.

GRAPHIC SCALE

(IN FEET)
1 inch = 40 ft.

ROAD PLAN
DUCKPUDDLE CULVERT
DUCKPUDDLE POND
TOWN OF WALDOBORO
LINCOLN COUNTY, MAINE

CT-PAC

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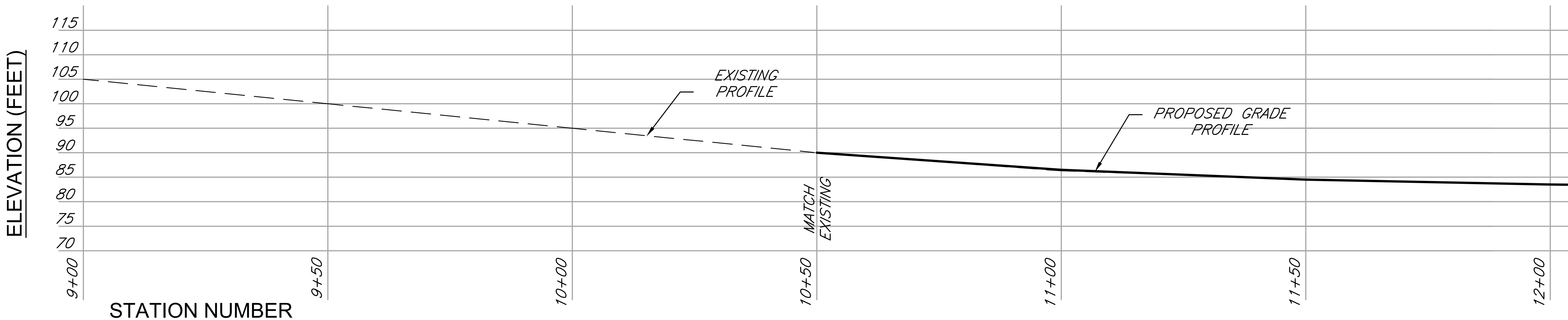
~ Clayton Mason ~

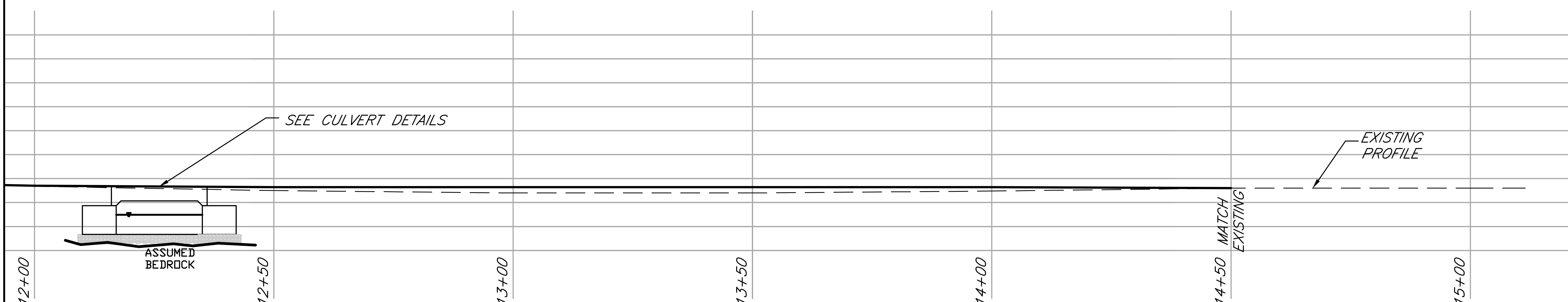
REVISIONS	
No.	DATE

CIE 413 & CIE 411	DRAWN BY: CT-PAC	WORK PACKAGE: 8
DATE: 4/16/21	SCALE: 1" = 40'	SHEET: 1 OF 1

PRODUCED BY AN AUTODESK STUDENT VERSION
PRODUCED BY AN AUTODESK STUDENT VERSION
PRODUCED BY AN AUTODESK STUDENT VERSION



PROFILE 9+00 TO 12+00



PROFILE 12+00 TO 15+00

GRAPHIC SCALE

(IN FEET)
1 inch = 20 ft.

Notes:
Profiles follow centerline and the corresponding stations.
Elevation lines are in 5' increments.
Stations are in 50' increments.
See Culvert Details for Culvert Specifications.
Road must be set at or above culvert road height.

ROAD PROFILE
DUCKPUDDLE CULVERT
DUCKPUDDLE POND
TOWN OF WALDOBORO
LINCOLN COUNTY, MAINE

CT-PAC

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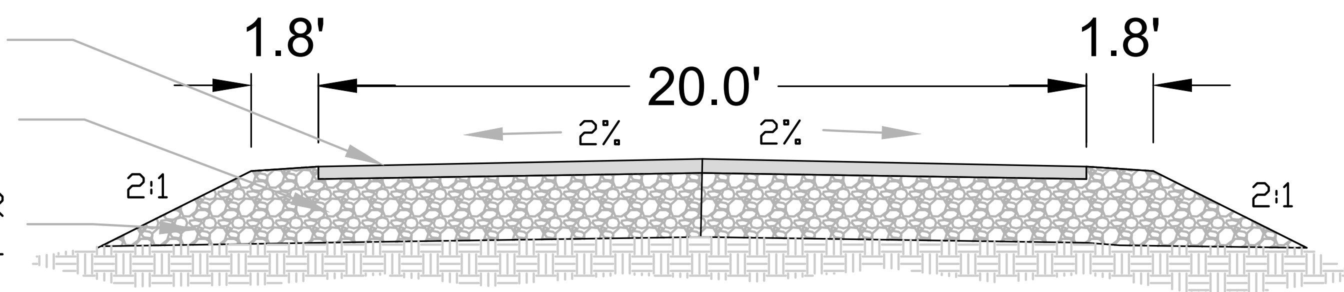
REVISIONS	
No.	DATE

CIE 413 & CIE 411	DRAWN BY: CT-PAC	WORK PACKAGE: 8
DATE: 4/16/21	SCALE: 1" = 20'	SHEET: 1 OF 1



TYPICAL SECTION

GRAPHIC SCALE

(IN FEET)
1 inch = 5 ft.

Notes;
Road width varies, see Road Plan.
Subbase must be 20", if 20" is met, no need to excavate.
Side Slope off of road is 2:1. Fill may need to be added to maintain this slope.
2% required for crowning from centerline and includes a 2% sloped subbase.

TYPICAL SECTION
DUCKPUDDLE CULVERT
DUCKPUDDLE POND
TOWN OF WALDOBORO
LINCOLN COUNTY, MAINE

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~ Clayton Mason ~

REVISIONS	
No.	DATE

CIE 413 & CIE 411	DRAWN BY: CT-PAC	WORK PACKAGE: 8
DATE: 4/16/21	SCALE: 1" = 5'	SHEET: 1 OF 1

APPENDIX C:

Cost Estimate for Both Project Sites

Notes:
Green Section is Fill.
Red Section is Cut.

GRAPHIC SCALE

30	0	15	30	60	120

(IN FEET)
1 inch = 30 ft.

CUT & FILL
PARKING LOT
877 MAIN STREET
TOWN OF WALDOBORO
LINCOLN COUNTY, MAINE

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REVISIONS	
No.	DATE

CIE 413 & CIE 411	DRAWN BY: CT-PAC	WORK PACKAGE: 9
DATE: 4/13/21	SCALE: 1" = 30'	SHEET: 1 OF 1

BREAKDOWN OF COSTS

SITE	MATERIAL DESCRIPTION	QUANTITY UNIT	PRICE UNIT	COST	CONTRACTOR ESTIMATE Date	Maine DOT Contract Contract ID Number
877 Main Street	Fill (delivered)	514 CY	$11.00	$5,654.00	Geo.C.Hall & Sons 4/16/21	N/A N/A
	Asphalt for lot and sidewalk	166 CY	$345.00	$57,270.00	Sargent Corporation 12/30/20	STOCKTON SPRINGS, LARGE CULVERT REPLACEMENT, RTE 1A 024285.00
	Curb Stops (Shipping included)	30	$75.00 EA	$2,400.00	Precast of Maine 4/16/21	Direct Consultation N/A
	Aggregate Base Course	531 CY	$40.00 CY	$21,240.00	Sargent Corporation 12/30/20	STOCKTON SPRINGS, LARGE CULVERT REPLACEMENT, RTE 1A 024285.00
	Erosion Control Geotextile	727 SY	$3.00	$2,182.00	Sargent Corporation 4/17/2019	Harrington, Johnson Br Replacement 021693.00
	Loam	175 CY	$28.00 CY	$4,900.00	Geo.C.Hall & Sons 4/16/21	N/A N/A
	Grass Seed	2 EA	$90.00 EA	$180.00	Ace Hardware 4/16/21	N/A N/A
	Sugar Maple trees (6-7')	4 EA	$170.00	$752.00	www.fast-growing-trees.com 4/16/21	N/A N/A
	Signage and Striping	1 LS	1 LS	$3,250.00	Fine Line Pavement Striping 4/15/21	Direct Consultation N/A
	Tree Removal	16 HR	$250.00 HR	$4,000.00	Maine DOT Tree Removal Bid :	N/A N/A
	Lights	1 LS	1 LS	$4,024.00	Light Poles Plus 03/12/21	N/A N/A
	Bull Dozer	104 HR	$135.00 HR	$14,040.00	Sargent Corporation 4/17/2019	Harrington, Johnson Br Replacement 021693.00
	Excavator	112 HR	$165.00 HR	$18,480.00	Sargent Corporation 12/30/20	STOCKTON SPRINGS, LARGE CULVERT REPLACEMENT, RTE 1A 024285.00
	Vibratory Roller	40 HR	$100.00 HR	$4,000.00	Sargent Corporation 4/17/2019	Harrington, Johnson Br Replacement 021693.00
	Hand Labor	56 HR	$40.00 HR	$2,240.00	Sargent Corporation 12/30/20	STOCKTON SPRINGS, LARGE CULVERT REPLACEMENT, RTE 1A 024285.00
	TOTAL COST FOR SITE			$145,000		

COST ESTIMATE
PARKING LOT & CULVERT
877 MAIN STREET & DUCKPUDDLE POND
TOWN OF WALDOBORO
LINCOLN COUNTY, MAINE

CT-PAC

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~ Paul Dezii ~ Andrew Guimond ~
~ Clayton Mason ~

REVISIONS	
No.	DATE

CIE 413 & CIE 411	DRAWN BY: CT-PAC	WORK PACKAGE: 9
DATE: 4/16/21	SCALE: N/A	SHEET: 1 OF 3

BREAKDOWN OF COSTS

SITE	MATERIAL DESCRIPTION	QUANTITY UNIT	PRICE UNIT	COST	CONTRACTOR ESTIMATE Date	Maine DOT Contract Contract ID Number
Duckpuddle Stream Crossing	Removing Pavement Surface	911 SY	$22.00 SY	$20,044.44	Sargent Corporation 04/17/2019	Harrington, Johnson Br Replacement 021693.00
	Common Excavation	480 CY	$22.00 CY	$10,560.00	Sargent Corporation 12/30/20	STOCKTON SPRINGS, LARGE CULVERT REPLACEMENT, RTE 1A 024285.00
	Granular Borrow	130 CY	$44.00 CY	$5,720.00	Sargent Corporation 12/30/20	STOCKTON SPRINGS, LARGE CULVERT REPLACEMENT, RTE 1A 024285.00
	Common Fill	60 CY	$30.00 CY	$1,800.00	Sargent Corporation 4/17/2019	Harrington, Johnson Br Replacement 021693.00
	Aggregate Base Course	150 CY	$40.00 CY	$6,000.00	Sargent Corporation 12/30/20	STOCKTON SPRINGS, LARGE CULVERT REPLACEMENT, RTE 1A 024285.00
	12.5 MM Hot Mix Assphalt (Base)	62.5 CY	$345.00 CY	$21,562.50	Sargent Corporation 12/30/20	STOCKTON SPRINGS, LARGE CULVERT REPLACEMENT, RTE 1A 024285.00
	12.5 MM Hot Mix Assphalt (Surface)	37.5 CY	$345.00 CY	$12,937.50	Sargent Corporation 12/30/20	STOCKTON SPRINGS, LARGE CULVERT REPLACEMENT, RTE 1A 024285.00
	Precast Concrete Box Culvert (shipping included)	1 EA	$37,810.00 EA	$37,810.00	Dirigo Timberlands 44303	Direct Consultation N/A
	Truck-Large (Including Operator)	248 HR	$90.00 HR	$22,320.00	Sargent Corporation 12/30/20	STOCKTON SPRINGS, LARGE CULVERT REPLACEMENT, RTE 1A 024285.00
	All Purpose Excavator (Including Operator)	120.00 HR	$165.00 HR	$19,800.00	Sargent Corporation 12/30/20	STOCKTON SPRINGS, LARGE CULVERT REPLACEMENT, RTE 1A 024285.00
	Hand-Labor, Straight time	240 HR	$40.00 HR	$9,600.00	Sargent Corporation 12/30/20	STOCKTON SPRINGS, LARGE CULVERT REPLACEMENT, RTE 1A 024285.00
	Bull Dozer - (Operator Included)	0 HR	$135.00 HR	$0.00	Sargent Corporation 04/17/2019	Harrington, Johnson Br Replacement 021693.00
	80 Ton Crane - (Operator Included)	10 HR	$260.00 HR	$2,600.00	Cote Corporation 5/16/21	Direct Consultation N/A
	Crane Mobilization Fee	1 LS	$75.00 LS	$75.00	Cote Corporation 5/16/21	Direct Consultation N/A
	Guiderail Removed and Reset	195 LF	$50.00 LF	$9,750.00	Wyman & Simpson, INC. 09/11/2019	Lewiston, Hart Brook Bridge Culvert Rehabilitation 022322.00
	Cofferdam - Upstream	1 LS	$25,100.00 LS	$25,100.00	Sargent Corporation 12/30/20	STOCKTON SPRINGS, LARGE CULVERT REPLACEMENT, RTE 1A 024285.00
	Cofferdam - Downstream	1 LS	$18,700.00 LS	$18,700.00	Sargent Corporation 12/30/20	STOCKTON SPRINGS, LARGE CULVERT REPLACEMENT, RTE 1A 024285.00
	Aluminum Light Bracket, Wood Pole Mount	1 EA	$295.00 EA	$295.00	Light Poles Plus 04/12/21	N/A N/A
	Lights (LED Luminaires 73W)	1 EA	$322.00 EA	$322.00	Light Poles Plus 04/12/21	N/A N/A
	TOTAL COST FOR SITE			***$230,000***		

COST ESTIMATE
PARKING LOT & CULVERT
877 MAIN STREET & DUCKPUDDLE POND
TOWN OF WALDOBORO
LINCOLN COUNTY, MAINE

CT–PAC

~ Claire Klaus ~ Tanner Binette ~
~ Paul Dezii ~ Andrew Guimond ~
~ Clayton Mason ~

REVISIONS	
No.	DATE

CIE 413 & CIE 411	DRAWN BY: CT–PAC	WORK PACKAGE: 9
DATE: 4/16/21	SCALE: N/A	SHEET: 2 OF 3

Construction Time Estimate (877 Main Street)

Task	Work Days Required	Hours per Machine/Person					
		Excavator	Truck*	Bulldozer	Vibratory Roller	Skidsteer	Hand Labor**
Strip pavement & organic material	4	32	64	16	0	0	0
Placing fill	6	40	96	48	24	0	0
Place gravel, compact	4	32	64	24	16	0	24
Grading	3	8	0	16	0	16	16
Place Precast wheel stops	1	0	0	0	0	8	16
Total	18	112	224	104	40	24	56

*Note: Two trucks per excavator was the convention used in most tasks. However for grading, three trucks was used as this task is largely dependant on the trucks bringing fill in.

**Note: Hand labor was estimated by assuming the minimum number of people needed for completion for each task.

Construction Time Estimate (Duckpuddle Road)

Task	Work Days Required	Hours per Machine/Person				
		Excavator*	Truck*	Bulldozer	Hand Labor**	Crane
Strip pavement	2	16	32	0	0	0
Prep for setting	3	24	48	0	48	0
place gravel, compact	2	16	8	0	0	0
Place Precast Sections	4	0	0	0	32	8
Backfill culvert	4	32	64	0	96	0
Grading	4	32	96	32	64	
Total	19	120	248	32	240	8

*Note: Two trucks per excavator was the convention used in most tasks. However for grading, three trucks was used as this task is largely dependant on the trucks bringing fill in.

**Note: Hand labor was estimated by assuming the minimum number of people needed for completion for each task.

COST ESTIMATE
PARKING LOT & CULVERT
877 MAIN STREET & DUCKPUDDLE POND
TOWN OF WALDOBORO
LINCOLN COUNTY, MAINE

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REVISIONS	
No.	DATE

CIE 413 & CIE 411	DRAWN BY: CT–PAC	WORK PACKAGE: 9
DATE: 4/16/21	SCALE: N/A	SHEET: 3 OF 3