
John Scott Connector

Rehabilitation and Reconstruction Study

Prepared for the City of Steubenville, Ohio

August 12, 2020

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PROJECT UNDERSTANDING

The objective of this report is to provide an engineering analysis of the rehabilitation and reconstruction options for the John Scott Connector highway for the City of Steubenville, Ohio.

Contained within this report are a geotechnical report, cost estimates for reconstruction and rehabilitation and pavement designs for the subject roadway.

EXISTING CONDITIONS

The existing roadway is a 1 mile long, 4 lane concrete roadway opened to traffic in 1993. The roadway connects US 22 to the east with Ohio 43, Sunset Boulevard. The roadway started experiencing settlement and cracking issues within the first 10 years of service. The roadway has been patched in 2003, 2004 and 2011.

In April, 2019 Resource International Inc. (RII) issued a non-destructive testing report for the subject roadway. RII performed a pavement condition rating, falling weight deflectometer testing and ground penetrating radar. The subject report was reviewed and used to determine the best possible solutions for the roadway rehabilitation options. The report is included as Appendix A.

In June 2020, ACA Engineering performed 6 roadway cores and analyzed the subbase and subgrade material. The report is included as Appendix B.

Review of the April 2019 NDT report and the June 2020 geotechnical report indicates the roadway is nearing the end of its intended service life. Roadway pavement life cycle analysis utilize a 30-year return for evaluating the total cost of a pavement during its intended life. The pavement condition rating of 51.4 is a "Poor" designation in accordance with FHWA pavement condition ratings. The ground penetrating radar test shows small to large voids between the concrete slab and the underlying subbase material. The lack of underlying support of the concrete slab correlates with the medium to high severity cracks visible at the concrete surface.

Performing additional concrete patching, dowel bar retrofitting or other concrete rehabilitation techniques will be cost prohibitive and not solve the underlying support issue. Two rehabilitation and two reconstruction options were evaluated based on the findings of the NDT and geotechnical report.

PROPOSED CONDITIONS

RECONSTRUCTION

Probable construction costs are included for reconstructing the roadway with concrete and asphalt. The existing drainage conduits were not evaluated as part of this report. A \$50,000 drainage contingent and a 25% contingency were used for the items not specifically quantified in the estimate.

Pavement designs for each alternative were performed and are included in Appendix C. The rigid pavement design yielded a depth of 8.1 inches. A concrete pavement thickness of 8 inches will be used for the project. The asphalt pavement yielded a structural number of 4.4.

The asphalt section will be as follows:

- Item 441 - 1.5" asphalt surface course
- Item 441 – 1.75" asphalt intermediate course, Type II
- Item 302 – 6.5" asphalt base course
- Item 304 – 6" aggregate base course

The probable construction costs are shown below:

- Rigid Pavement - \$4,495,375.00
- Asphalt Pavement - \$3,367,531.00

REHABILITATION

Probable construction costs are included for rehabilitation of the roadway. The two options evaluated are crack and seat of the existing concrete and URETEK Inc. deep epoxy injection process. The crack and seat process cracks the existing concrete and seats the concrete by rolling a 50 ton roller over the surface, and overlays the pavement with asphalt. The deep injection process injects an epoxy polymer into the subgrade, fills the voids and can level the concrete slabs and also overlays with asphalt. The cost proposal from URETEK is included in Appendix D. The existing drainage conduits were not evaluated as part of this report. A \$50,000 drainage contingent and a 25% contingency were used for the items not specifically quantified in the estimate.

Pavement designs for the crack and seat option were performed and are included in Appendix C. The deep epoxy injection process assumes a minimum asphalt depth for surface and intermediate course. Both options utilize a fiberglass pavement fabric as an interlayer between the concrete and intermediate course.

The asphalt section for the crack and seat option will be as follows:

- Item 441 - 1.25" asphalt surface course
- Item 441 – 3.0" asphalt intermediate course, Type II
- Item 441 – 1.0" asphalt intermediate course, Type I (Scratch)

The probable construction costs are shown below:

- Crack and Seat - \$2,265,477.00
- Epoxy Injection - \$4,427,603.00

RECOMMENDATION

Per the geotechnical report, there are potential issues with the existing subbase. The gradation for Item 310 – Aggregate Base, Type A per the 1991 CMS (see Appendix F) require the percent passing the No. 200 sieve to be between 0 and 10. The sieve analysis for the three borings show the percent passing the No. 200 sieve is 36.4 to 55.9 percent. This is an indication that the existing subbase has degraded and may be washing away creating the underlying voids.

With all the information currently available, the recommendation of this report is to further develop the crack and seat and asphalt reconstruction options. It is recommended to perform durability and soundness testing on the existing subbase to confirm if the crack and seat option is viable. Should the durability and soundness testing determine the subbase will continue to degrade and undermine the existing pavement, the asphalt reconstruction option is recommended.

Appendix A

**Non
Destructive
Testing
Report**



REPORT

John Scott Highway Pavement Evaluation Jefferson County, Ohio

Prepared for:

Operations | Simplified Rail Logistics

100 Industry Drive
Pittsburg, PA 15275

Prepared by:

Resource International, Inc.

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Rii Project # W-19-025

April 10, 2019

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April 10, 2019

Mr. Alex Amaya
Operations | Simplified Rail Logistics
100 Industry Drive
Pittsburg, PA 15275

RE: John Scott Highway Pavement Evaluation
Jefferson County, Ohio

Dear Mr. Amaya:

Resource International, Inc. (Rii) is pleased to submit for your review and comments the final report on the Evaluation of the one mile section of John Scott Highway. This report describes the data collected from the field, the results of the data analysis, and the recommendations on whether the existing pavement can bear super heavy loads.

We sincerely appreciate the opportunity to provide non-destructive testing services, data analysis and recommendations for this project. If you have any questions regarding the contents of this report, please call at 614-823-4949 or e-mail us.

Sincerely,

RESOURCE INTERNATIONAL, INC.

Cherif Amer-Yahia, Ph.D., P.E.

Director – NDE & Technology Division

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Senior Pavement Engineer

ISO 9001: 2015 QMS

Committed to providing a high quality,
accurate service in a timely manner

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John Scott Highway Pavement Evaluation

Jefferson County, Ohio

Rii Project No. W-19-025

1. INTRODUCTION AND PROJECT OBJECTIVES

Resource International, Inc. (Rii) provided nondestructive testing services on a 1 mile concrete pavement section of John Scott Highway, from Kingston Avenue to near US 22 to evaluate the capacity of the pavement to support super heavy loads that exceed 500,000 pounds and determine if there is a risk of causing severe pavement damage in one pass. Rii performed pavement evaluation, non-destructive testing, and provided recommendations on whether the existing pavement can bear such loads.

Rii evaluated all of the collected data, consisting of Ground Penetrating Radar (GPR), Falling Weight Deflectometer (FWD), Pavement Condition Rating (PCR) information, as well as information on the total weight of the load that will be transported through the John Scott Highway and the load on each truck axle, to assess the current pavement condition and deficiencies and determine the bearing capacity of the pavement.

The magnitude of applied stresses was calculated considering the travel speed, wheel location, and pavement condition. The stresses within the pavement structure were calculated by analytical simulation. The field data identified the structural weakness within the existing pavement and the probability of encountering such weaknesses in the travelling lanes. Thus, we conclude that the probability of failure of the pavement is more than 50%.

2. PAVEMENT EVALUATION

2.1 Pavement Condition Rating (PCR)

Rii performed a visual evaluation of the pavement using the Pavement Condition Rating (PCR) methodology developed by Rii in cooperation with the Ohio Department of Transportation (ODOT) and the Federal Highway Administration. The rating method is based upon visual inspection of pavement distress. The rating method provides a procedure for uniformly identifying and describing, in terms of severity and extent, pavement distress. The occurrence of observable distress adversely affects the ability of a pavement to sustain traffic loads in a safe and smooth manner.

A PCR scale was developed to describe the pavement condition using PCR numbers. This scale has a range from 0 to 100; a PCR of 100 represents a perfect pavement with no observable

distress and a PCR of 0 represents a pavement with all distress present at their “High” levels of severity and “Extensive” levels of extent.

The following Table 1 illustrates the PCR Scale and the descriptive condition of a pavement associated with the various ranges of the PCR values.

Table 1. Pavement Condition Rating (PCR) Scale

Pavement Rating	PCR Range
Very Good	90-100
Good	75- 90
Fair	65-75
Fair to Poor	55-65
Poor	40- 55
Very Poor	0-40

According to ODOT PCR manual, the model for computing PCR is based upon the summation of deduct points for each type of observable distress. Deduct values are a function of distress type, severity, and extent. Deduction for each distress type is calculated by multiplying distress weight times the weights for severity and extent of the distress. Distress weight is the maximum number of deductible points for each different distress type. The mathematical expression for PCR is as follows:

$$PCR = 100 - \sum_{i=1}^n Deduct_i \quad (1)$$

Where:

n = number of observable distresses, and

Deduct = (Weight for distress) (Wt. for severity) (Wt. for Extent)

Rii’s field crew collected the PCR data from the site for the roadway section of this project and recorded it in the PCR form (see Table 2). This table shows the observed average of visible distress (PCR) for the entire one mile section.

According to this evaluation, the current condition of this pavement section is **Poor**.

Section: Kingston Ave to SR 22 on Ramp

JOINTED

Date: 3/19/2019

Log mile: _____ to _____

Rated by: Todd R

Sta: _____ to _____

of Utility Cuts: _____

PAVEMENT CONDITION RATING FORM

DISTRESS	DISTRESS WEIGHT	SEVERITY WT.*			EXTENT WT.**			DEDUCT POINTS***
		L	M	H	O	F	E	
SURFACE DETERIORATION	10	0.4	0.7	1	0.6	0.8	1	-
LONGITUDINAL JOINT SPALLING	5	0.4	0.7	1	0.6	0.8	1	2.8
PATCHING	10	0.4	0.7	1	0.5	0.8	1	10
PUMPING	15	1	1	1	0.3	0.7	1	-
FAULTING (JOINTS AND CRACKS)	10	0.4	0.7	1	0.5	0.8	1	8
SETTLEMENTS	0	0.0	0.0	0.0	0.0	0.0	1	0
TRANSVERSE JOINT SPALLING (CIRCLE IF D-CRACKED)	10	0.4	0.7	1	0.5	0.8	1	-
TRANSVERSE CRACKING (Plain Concrete)	15	1	1	1	0.5	0.8	1	15
PRESSURE DAMAGE	5	1	1	1	0.5	0.8	1	-
TRANSVERSE CRACKING (Reinforced Concrete)	15	0.1	0.8	1	0.4	0.8	1	-
LONGITUDINAL CRACKING	10	0.5	0.7	1	0.4	0.9	1	2.8
CORNER BREAKS	10	0.4	0.8	1	0.5	0.8	1	10

*L = LOW **O = OCCASIONAL

M = MEDIUM F = FREQUENT

H = HIGH E = EXTENSIVE

*** DEDUCT POINTS = DISTRESS WEIGHT X SEVERITY WT. X EXTENT WT

TOTAL DEDUCT = 48.6

SUM OF STRUCTURAL DEDUCT (•) = 25

100 - TOTAL DEDUCT = PCR = 51.4

2.2 Ground Penetrating Radar (GPR)

Ground Penetrating Radar (GPR) is a nondestructive testing tool that uses radio wave to acquire subsurface information. GPR has been used for over three decades as a tool for transportation system investigation, particularly to study pavement layer thicknesses, find voids under pavement, evaluate moisture or density variations, detect asphalt stripping zones, and assess the condition of bridge decks and pavements.

Rii used an automated survey vehicle to collect continuous GPR data on pavement layer thicknesses. The type of GPR system used during this project utilizes the non-contact horn antenna with a center frequency of 1 GHz, which is suspended 19 in. over the surface of the pavement and which can perform surveys at highway speed. This system has the advantage of providing near-surface information, and under typical conditions, the depth of signal penetration reaches 24 in.

The GPR system used during data collection is shown in Photograph 1. The GPR survey was conducted on March 15, 2019.



Photograph 1. GPR system used during data collection

When the GPR electromagnetic signal is directed into the ground, a part of it is reflected from interfaces between materials of different dielectric values, and returns to the system receiver where it is displayed. This reflected energy brings a lot of information, including signal amplitude and velocity, but also a visual display of the pavement substructure using a color transform system.

The John Scott Highway pavement is a concrete pavement. The objectives of the GPR survey were to measure the concrete and base layer thicknesses, locate any voids under the concrete slabs, and estimate the level of moisture in the aggregate base layer. Thickness and moisture applications are briefly discussed in the following sections.

2.2.1. Pavement Thickness Evaluation

Pavement thickness survey is one of the most useful applications of GPR to transportation systems for pavement management purposes at the network or project level. The method has been described in ASTM D4748-10 Standard Test Method for Determining the Thickness of Bound Pavement Layers Using Short Pulse Radar. The advantage of using GPR for pavement thickness surveys is that it provides continuous coverage along a linear path, is nondestructive, and can be performed at highway speed.

Over the past decade, GPR thickness has been used for rehabilitation design, FWD back-calculation, pavement management, and density QA (Quality Assurance) determination of new pavement construction. Studies have shown that a few calibration cores taken at locations where GPR tests were conducted help improve the GPR thickness accuracy. Past core data are also important in clarifying pavement layer type. This distinction can have a large impact on the interpretation of the GPR thickness data.

GPR was used in this project to obtain the thickness of the concrete pavement layer and the thickness of the aggregate base layer. The concrete and base layer thicknesses are reported at fifty (50) feet interval, and included in Appendix A. Figure 1 is a typical GPR scan showing the concrete and base layers for a section of the one mile pavement. Table 3 lists the average thicknesses of concrete and base layers for each lane of the John Scott Highway pavement.

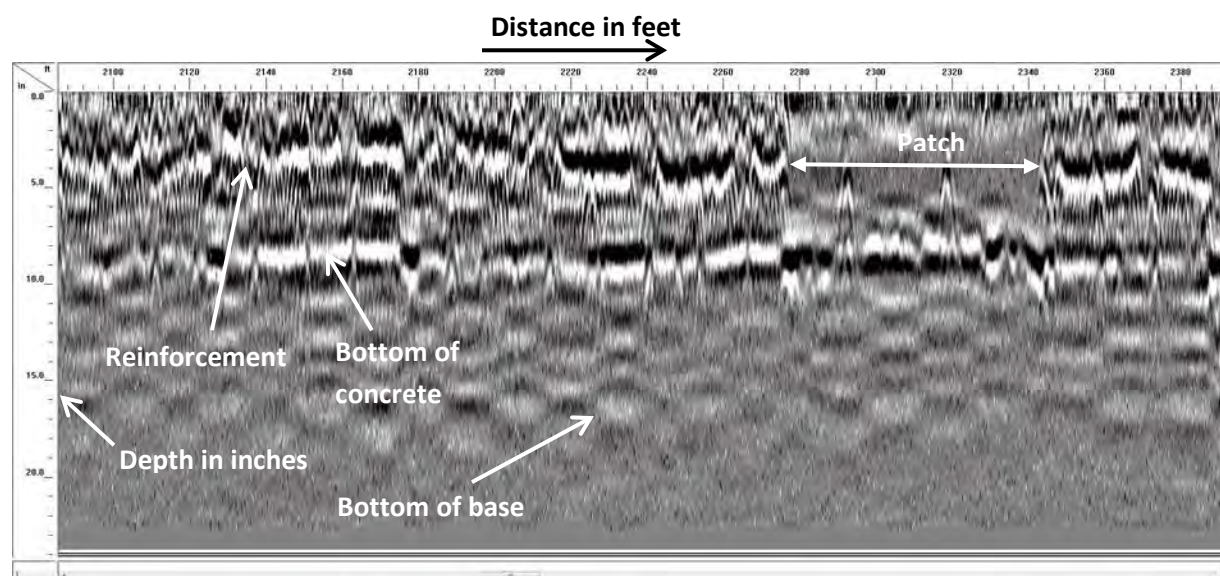


Figure 1. GPR scan showing concrete and base layers and a large patch

Table 3. Concrete and Base Layer Thickness Averages and Average concrete and Base Dielectrics

Direction	Lane	Average Concrete Thickness (in)	Average Concrete Dielectric	Average Base Thickness (in)	Average Base Dielectric
Eastbound	Passing	8.5	9.1	5.5	9.7
Eastbound	Driving	8.4	9.0	5.8	9.6
Eastbound	Shoulder	8.2	9.0	6.5	9.6
Westbound	Passing	8.3	8.9	6.1	9.5
Westbound	Driving	8.0	9.7	5.9	10.3
Westbound	Shoulder	8.2	8.8	6.0	9.5

2.2.2. Base Layer Moisture Content Evaluation

GPR uses radio waves as an energy source which are transmitted into the pavement and reflected at layer interfaces. The radio wavelength spectrum ranges from 10^{-3} meters to 10 meters. GPR operates in the low range of the radio wavelength spectrum (10^{-1} m to 10 m).

As with all electromagnetic waves, radio waves travel through a vacuum at the speed of light. When the radar waves pass through a medium other than a vacuum, the velocity of propagation becomes a function of the dielectric constant of the medium. Some representative dielectric constant values of interest are given in Table 4.

Table 4. Dielectric constants for construction materials

Material	Relative Dielectric Constant (ϵ_r)
Air	1
Water	81
Asphalt	3 - 6
Cured Concrete	6 - 10
Aggregate Base	< 10

The velocity, v , of a radar wave through a given medium varies in inverse proportion to the square root of the material's relative dielectric constant, ϵ_r . The time required for a radar pulse to travel from the source to an interface and back is the two-way travel time, t , and is dependent on the depth, d , of the interface between two materials, and the dielectric constant of the material overlying the interface. The depth is determined by the following equation.

$$d = \frac{vt}{2} \quad (2)$$

The velocity of the radar wave is dependent on the dielectric constant of the medium, and can be calculated by the following formula.

$$v = \frac{c}{\sqrt{\epsilon_r}} \quad (3)$$

Where, c is the speed of light.

As can be seen from the data in Table 4, the moisture content has a large influence on the dielectric constant, and therefore affects the two-way travel time, so that the greater the amount of water saturation, the lower the radar wave velocity, and hence the higher the dielectric constant of the material.

Radar waveforms from the top of the base layer have signal amplitudes that are a function of the dielectric constants of the base layer. The wetter the base, the higher the calculated dielectric values, and the higher the moisture content. Dielectric values of 10 to 16 signify a moist base, while values above 16 indicate wet areas. The average dielectric constant of the base layer is found to be equal to 9.7, overall dry aggregate base. Base moisture content data is included in Appendix A. Table 3 lists the average aggregate base moisture for each lane.

2.2.3. Detection of voids under concrete slabs

Voids under concrete slabs, either air or water-filled, are high contrast targets. However, they have to be at least 0.6 in. thick to produce a reflection. Voids show as strong reflections with a white-black-white sequence of colors (reversed reflection polarity). This happens when the electromagnetic wave travels from a material with a certain dielectric constant to a material with a lower dielectric constant, concrete-air interface, for instance. Reflections at locations with no voids appear dim, revealing a low concrete-base dielectric contrast. All the GPR scans were carefully examined for existence of voids under the concrete slabs. The GPR image of Figure 2 shows air-voids under the concrete slabs of the pavement. All detected voids were mapped on the plan views of the pavement and reported in Appendix B.

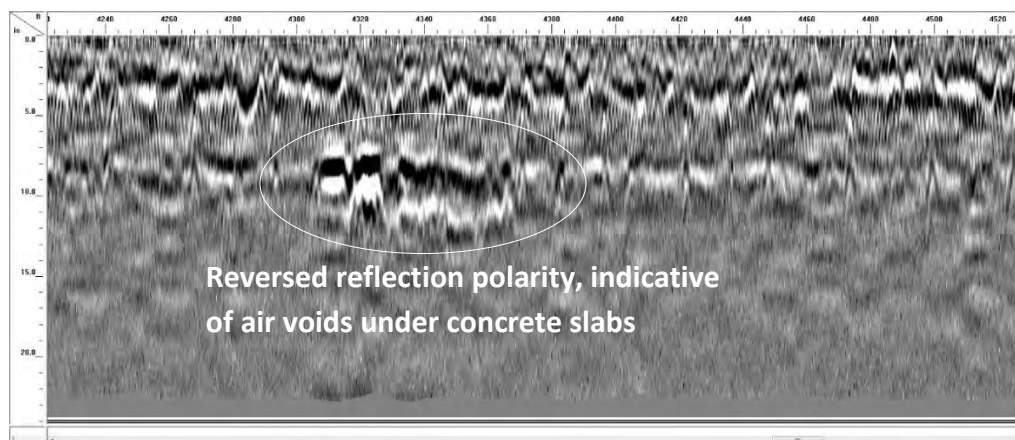


Figure 2. GPR image from JSH pavement showing the existence of air-voids under concrete slabs

2.3 Falling Weight Deflectometer (FWD)

Rii performed Falling Weight Deflectometer (FWD) testing and used the deflection information to back-calculate stiffness-related parameters of the existing pavement structure and the joint load transfer efficiency (LTE). Rii uses a JILS-20HD heavy FWD for use with thick pavement structures and where heavy truck loading is normal. Photograph 2 shows the FWD system used for this project. Drop weights of approximately 16,000 pounds were used in testing the pavement at every 250 feet in the outer wheel path of driving and passing lanes of the roadway.



Photograph 2. FWD system used during data collection

Eight geophones were used during field testing at locations 0, 8, 12, 18, 24, 36, 48, and 60 inches from the center of the load plate. The determination of the LTE makes use of the deflections from the two geophones positioned at each side of the joint (deflections at offsets 0, and 12) while deflections at offsets 0 through 60 inches were used to back-calculate the elastic layer moduli. The elastic moduli of individual layers were calculated based on surface deflections induced by the FWD load and the pavement layer thicknesses determined by GPR data.

These elastic moduli provide critical information regarding the pavement's structural condition. The elastic modulus of subgrade called the "Resilient Modulus, M_R ," is used in the design of pavement.

The process of calculating the elastic moduli of individual layers in a multi-layer system (e.g. concrete on top of a base course on top of the subgrade) based on surface deflections is known

as "back-calculation", as there is no closed-form solution. Instead, initial moduli are assumed, surface deflections calculated, and then the moduli are adjusted in an iterative fashion to converge on the measured deflections.

Table 5 lists the average back-calculated moduli for each lane at approximately 250 feet intervals. Appendix C lists the FWD locations and Appendix D contains a listing of deflection data collected for each lane and the back-calculated elastic Moduli.

Table 5. Average back-calculated moduli for each lane

Direction	Lane	Average Concrete Moduli	Average Base Moduli	Average Subgrade Moduli
Eastbound	Passing	3,606.183	55.738	15.133
Eastbound	Driving	3,891.718	62.282	18.496
Eastbound	Shoulder	2,685.486	48.563	13.212
Westbound	Passing	3,206.439	44.622	14.335
Westbound	Driving	4,639.654	71.526	18.849
Westbound	Shoulder	2,579.165	44.751	14.728
Total Average:		3,434.774	54.580	15.792

FWD was also used to determine the Load Transfer Efficiency (LTE) across selected transverse contraction joints in the driving lane at approximately 500 foot intervals. Loading was applied to each side of the joint and the deflections measured.

Traditionally, LTE at the joint is determined based on the ratio of the maximum deflection at the joint of the loaded slab and the deflection of the unloaded slab measured right across the joint from the maximum deflection. If a joint exhibits a poor ability to transfer load, then the deflection of the unloaded slab is much less than the deflection at the joint of the loaded slab and both LTE indexes have values close to 0. If joint's load transfer ability is very good, then the deflections at the both sides of the joint are equal and both indexes have values close to 100 percent.

The load transfer rating as related to the LTE is shown in Table 6. For joints with LTE rated below 70%, joint replacement or improvement is recommended.

Table 6. LTE rating

LTE	Load transfer rating
$\geq 70\%$	Good
$< 70\%$	Poor

As shown in Table 7, the calculated LTE of the joints in the lanes was high for both directions with an average of 87% for eastbound joints and 88% in the westbound direction. However, the calculated LTE is low in the shoulders with an average of 62% in the eastbound shoulder and 68% in the westbound direction. Appendix E includes the calculated LTE.

Table 7. Calculated LTE of the joints

EB Driving Lane LTE	EB Shoulder LTE	WB Driving Lane LTE	WB Shoulder LTE
96%	26%	80%	24%
89%	32%	91%	87%
83%	57%	99%	85%
81%	66%	85%	90%
74%	85%	87%	69%
84%	86%	86%	75%
96%	90%	88%	75%
89%	83%	91%	61%
92%	46%	88%	86%
88%	50%	84%	27%
--	--	91%	--
Averages			
87%	62%	88%	68%

3. ANALYSIS OF DATA AND THE RESULTS OF ANALYSIS

The data collected by Rii from the field as well as data provided by Simplified Rail Logistics was used to determine the effect of heavy load on the pavement section of John Scott Highway. For this purpose, critical stresses on the pavement developed by the moving load were determined and they were compared with the estimated strength of the concrete slabs of the highway section. The following paragraphs describes the various steps of analysis and the results.

3.1 Placement of vehicle on the highway lanes (EB and WB) during its movement from one end to the other end of the pavement section

According to the drawing of the vehicle that will carry the load on the pavement of the highway, the vehicle has axle width of 19'-11 7/16" (see Appendix F). Since the current lane width of the pavement is 12', therefore, the entire length of each axle of the vehicle will occupy two lanes of the highway. Therefore, it is assumed that on a straight path, the outer wheels of the axle will be within 2' from the edge of the lane. However, on curves, the outer wheels may be some times either on the edge of pavement or even on the shoulders.

Considering the above scenario of the wheel placements, we decided to analyze the effect of load placement on the pavement slabs when the wheels are close to the edge of the pavement or the corner of the slab, as shown in Figure 3 below. The interior load position shown in the sketch below was also included in the analysis for the sake of completeness.

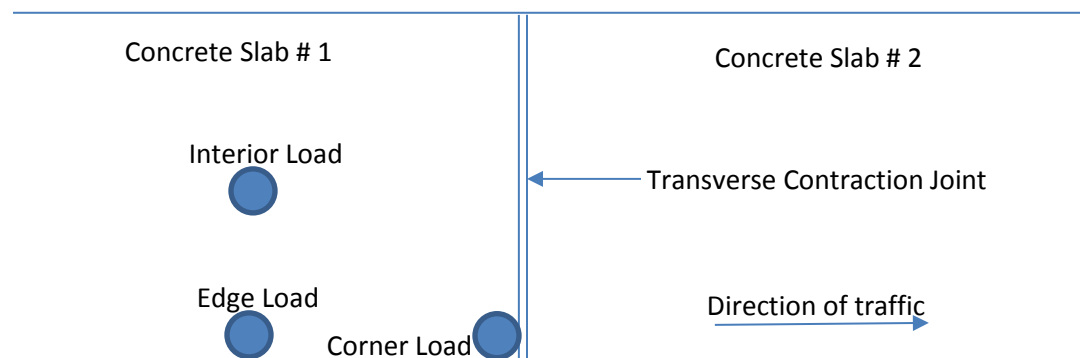


Figure 3. Possible Wheel Load positions on the pavement slabs

GPR data collected from all lanes indicated that there were voids under the concrete slabs at various locations. Also, there are transverse mid-slab cracks throughout the length of all lanes. Since, there are no dowels to transfer the load across these transverse cracks and there is a possibility of voids under the slabs, therefore, it was considered appropriate to analyze the edge and corner load conditions to accommodate these critical field conditions.

3.2 Wheel Loads applied by the vehicle on the Pavement Slab

The data provided by Simplified Rail Logistics was used to estimate the wheel loads that will be applied by the vehicle on the pavement slabs. This data is listed in Table 8.

Table 8. Load applied by the vehicle at various speed of travel

Driving speed [km/h]/[mph]	96 / 59.7	80 / 49.7	40 / 24.9	10 / 6.2
Technical axle load [kg] / [lbs]	18150 / 40013	22500 / 49603	24000 / 52910	28000 / 61728
Pendulum axle load [kg] / [lbs]	9075 / 20007	11250 / 24802	12000 / 26455	14000 / 30864
Wheel load [kg] / [lbs]	2269 / 5002	2813 / 6200	3000 / 6614	3500 / 7716
Tire pressure [bar]/[psi]	9 / 130	9/130	9 / 130	9 / 130

Figure 4 shows the load applied by each wheel of the vehicle when travelling at a speed of 6.2 miles per hour.

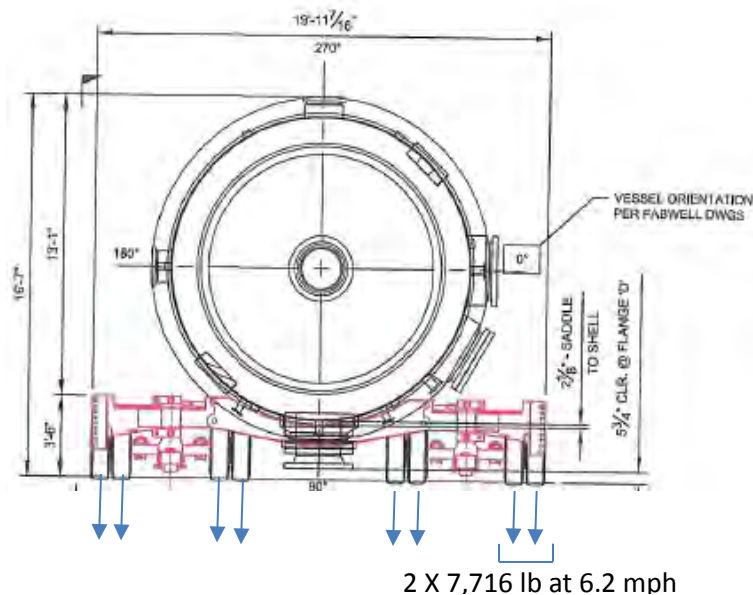


Figure 4. Loads applied by the vehicle on each wheel at 6.2 mph speed.

The data listed in Table 8 indicates that the applied wheel load increases with the slower speed. Since, it is anticipated that the vehicle may travel slower than 6.2 mph, therefore, to accommodate this condition, we used a wheel load of 8,000 lbs on each wheel or 16,000 lbs on the dual wheels of the axle in our analysis.

3.3 Determine critical locations where Pavement may be Structurally weak

A review of FWD data that was collected from the field indicated that along each lane of the highway there were some locations which were structurally weaker (relatively) than other locations. Therefore, we identified these locations and decided to use them so that no more than 5 % – 10 % of the pavement will be weaker than these locations.

Further, it was observed from the FWD deflection data that the pavement of the driving lanes of both directions (EB and WB) was relatively less weak than the pavement of the passing lanes of the same directions. Therefore, for the purpose this analysis, we used the location on the passing lanes of each direction (EB and WB). The locations thus identified are listed in Table 9.

Table 9. Critical locations of weak Pavement (Structurally)

Direction	Lane	Location, ft.	Slab, in.	Sub-base, in
EB	Passing	2,122	8.9	5.5
	Passing	4,109	8.3	5.5
WB	Passing	2,114	8.5	6.1
	Passing	3,361	7.6	6.1

3.4 Calculate Elastic Moduli (E) of Pavement layers at critical locations

The critical locations listed in Table 9 were analyzed to estimate the structural strengths of pavement layers at these locations. The results of this analysis are listed in Table 10.

Table 10. Elastic Moduli (E) of Pavement Layers calculated from FWD data

Direction	Lane	Location, ft.	Conc. E, psi	Sub-base E, psi	Subgrade E, psi
EB	Passing	2,122	1,439,000	29,300	10,300
	Passing	4,109	1,968,000	26,600	9,800
WB	Passing	2,114	1,435,000	21,500	9,700
	Passing	3,361	1,860,000	32,600	12,000

3.5 Calculate Corner, Edge and Interior Load Stresses at critical locations along the Pavement section

The back-calculated elastic moduli along with other data were used to calculate the Corner, Edge and Interior load stresses at critical locations. For this purpose the following equations were used:

$$\text{Corner Stress } \sigma_c = \frac{3P}{h^2} \left[1 - \left(\frac{a\sqrt{2}}{l} \right)^{1.2} \right] \quad (4)$$

$$\text{Edge Stress } \sigma_e = \frac{0.803P}{h^2} \left[4 \log \left(\frac{l}{a} \right) + 0.666 \left(\frac{a}{l} \right) - 0.034 \right] \quad (5)$$

$$\text{Interior Stresses } \sigma_i = \frac{0.316P}{h^2} \left[4 \log \left(\frac{l}{b} \right) + 1.069 \right] \quad (6)$$

Where,

- P = Load, lbs.,
 h = Thickness of Slab, in.,
 a = Load contact radius, in.,
 l = Radius of Relative stiffness, in., defined as:

$$l = [E h^3 / \{12 (1 - \mu^2) k\}]^{0.25},$$

 k = Modulus of subgrade reaction, psi.,
 E = Modulus of Elasticity of Concrete, psi., and
 μ = Poisson's Ratio of concrete, assumed = 0.15.
 b = Calculated by the formula:

$$b = (1.6 a^2 + h^2)^{0.5} - 0.675 h.$$

The values of parameters that were needed for the calculations of Corner, Edge and Interior load stresses at the above listed four locations using equations (4), (5) and (6)., were as follows:

- Load P = 16,000 lbs,
 Slab Thickness = See Table B for various locations,
 Load Contact Radius, a = Calculated for 16,000 lbs. load and 130 psi Tire pressure
 = 6.3 in.
 Rad. of Rel. Stiff., l = Values of this parameter were calculated for each location,
 Mod. Of Subg. Reaction, k = Values of this parameter were calculated for each location,
 Mod. of Elasticity of Conc. E = Values of this parameter for each location are listed in Table C,
 Parameter b = Values of this parameter were calculated for each location.

The calculated stresses for each location are listed in Table 11.

Table 11. Corner, Edge and Interior Load Stresses at critical Locations

Direction	Lane	Location, ft.	Load Stresses, psi.			Flexural Strength, psi.
			Corner	Edge	Interior	
EB	Passing	2,122	488	494	285	189
	Passing	4,109	565	576	295	259
WB	Passing	2,114	530	532	297	189
	Passing	3,361	659	659	325	245

Based on the results of this analysis it is evident that:

1. The interior load stresses are substantially lower than the edge and corner load stresses.
2. The flexural strength of concrete slabs is lower than the estimated load stresses, thus, indicating that no matter where the load position is on the slab, it is likely to cause damage to the slab.

Based on these observations, it is important to note that this analysis was performed at locations where pavement was expected to be weak and only about 5% to 10% areas were estimated to be weaker than this location. Therefore, we also investigated two more locations where the pavement was expected to be about average from structural strength point of view. Or, in other words, half of the pavement area was weaker than this area of the pavement. The results of this analysis are listed in Table 12.

Table 12. Corner, Edge and Interior Load Stresses at Locations of Average Structural Strength

Direction	Lane	Location, ft.	Load Stresses, psi.			Flexural Strength, psi.
			Corner	Edge	Interior	
EB	Passing	2,356	528	530	284	243
WB	Passing	3,602	493	514	271	391

Based on the results of this analysis, it was observed that at 50% probability of failure, the interior stresses may be approximately equal to the flexural strength of the concrete slabs. However, the stresses in the edge and corner load positions are still higher than the flexural strength of concrete slabs.

In summary, we calculated the stresses within the pavement structure by analytical simulation. The field data identified the structural weakness within the existing pavement and the probability of encountering such weaknesses in the travelling lanes. The magnitude of stresses that were calculated on the basis of travel speed, wheel load locations, and pavement conditions are considerably higher than the structural strength of the existing pavement. Thus, in our opinion, we concluded that the probability of failure of the existing pavement is substantially high (more than 50%).

4 LIMITATIONS OF THE STUDY

The findings for this project were developed utilizing information obtained from the tests performed at the proposed site for the current investigations and the relevant data provided by Simplified Rail Logistics. At this time we would like to point out that the data collected from the site only depict the pavement conditions at the specific locations and time at which they were made. The conditions at other locations on the site may differ from those occurring at the location used in this investigation.

The conclusions and recommendations herein have been based upon the available information and the details furnished by a representative of the owner of the project.

The scope of our services does not include any recommendations for the rehabilitation of the existing pavement.

APPENDIX A

GPR Thickness & Dielectric 50 ft Averages

John Scott Highway Eastbound Passing Lane										
GPR File #	Total Distance (ft)		Average Concrete Dielectric			9.13	Average Base Dielectric			9.72
7	4,745		Average Concrete Thickness (in)				Average Base Thickness (in)			
Dist.(ft)	Lat(°)	Long(°)	Average	Max	Min	Standard Deviation	Average	Max	Min	Standard Deviation
0	40.378293	-80.667652	8.7	9.3	7.6	0.3	--	--	--	--
50	40.378253	-80.667484	8.9	10.2	8.2	0.4	--	--	--	--
100	40.378210	-80.667314	9.0	10.2	7.3	0.7	--	--	--	--
150	40.378168	-80.667145	9.2	9.9	8.7	0.2	--	--	--	--
200	40.378127	-80.666976	8.6	9.1	7.5	0.3	--	--	--	--
250	40.378086	-80.666806	9.0	9.7	8.2	0.4	--	--	--	--
300	40.378046	-80.666635	9.3	10.0	8.3	0.5	--	--	--	--
350	40.378005	-80.666466	8.7	9.2	8.1	0.2	--	--	--	--
400	40.377964	-80.666296	8.5	9.3	7.5	0.3	5.5	6.2	4.2	0.5
450	40.377922	-80.666126	8.3	8.9	7.2	0.3	5.7	6.5	5.3	0.3
500	40.377881	-80.665956	8.1	9.2	6.9	0.6	6.5	7.3	5.9	0.3
550	40.377841	-80.665786	8.2	9.0	7.5	0.3	6.4	7.6	5.3	0.7
600	40.377802	-80.665613	8.3	9.0	7.3	0.3	5.9	6.9	4.8	0.5
650	40.377768	-80.665440	8.1	8.6	6.9	0.3	6.1	7.6	4.7	0.6
700	40.377742	-80.665264	7.9	8.9	7.1	0.3	6.0	7.1	5.1	0.4
750	40.377721	-80.665086	7.7	8.5	6.7	0.4	6.3	8.0	5.5	0.5
800	40.377707	-80.664906	7.5	9.2	6.5	0.7	6.6	8.2	5.2	0.8
850	40.377702	-80.664726	6.8	7.5	6.1	0.3	7.6	8.2	6.6	0.5
900	40.377703	-80.664546	7.4	8.2	6.7	0.4	6.9	8.3	5.1	0.9
950	40.377711	-80.664366	8.8	9.4	7.7	0.5	5.6	6.4	4.4	0.5
1000	40.377726	-80.664185	9.1	10.4	8.4	0.4	4.6	6.1	4.2	0.4
1050	40.377750	-80.664011	9.6	10.8	8.1	0.7	4.9	6.6	4.1	0.6
1100	40.377779	-80.663839	8.0	8.6	7.5	0.2	6.4	7.1	5.6	0.4
1150	40.377814	-80.663668	8.5	9.3	7.3	0.5	6.0	7.1	4.6	0.7
1200	40.377858	-80.663501	9.1	10.3	8.0	0.7	5.4	6.9	4.1	0.7
1250	40.377907	-80.663334	8.8	9.3	8.1	0.3	5.6	6.6	4.3	0.5
1300	40.377964	-80.663171	8.4	9.8	7.3	0.6	5.3	6.5	3.7	0.8
1350	40.378027	-80.663013	8.4	9.5	7.6	0.5	5.5	6.9	4.0	0.9
1400	40.378097	-80.662856	8.9	9.5	7.9	0.3	5.0	5.9	4.1	0.5
1450	40.378171	-80.662707	8.0	8.5	7.4	0.2	5.5	6.1	4.6	0.4
1500	40.378248	-80.662559	7.8	8.4	6.2	0.4	5.4	6.9	4.3	0.6
1550	40.378327	-80.662415	7.8	8.1	7.3	0.2	6.0	6.9	4.8	0.5
1600	40.378404	-80.662273	8.0	8.9	7.4	0.4	5.4	6.2	3.8	0.4
1650	40.378482	-80.662127	7.9	9.2	7.1	0.5	5.4	7.1	4.2	0.7
1700	40.378561	-80.661981	8.2	8.9	7.5	0.4	5.6	6.7	4.1	0.7
1750	40.378637	-80.661834	7.5	8.3	6.4	0.5	5.9	6.9	5.0	0.5
1800	40.378714	-80.661686	6.6	7.7	6.0	0.5	7.1	8.3	5.3	0.8
1850	40.378792	-80.661539	7.1	8.0	6.1	0.6	6.4	7.9	5.4	0.8
1900	40.378868	-80.661392	8.3	8.9	7.6	0.3	4.7	5.4	4.4	0.3
1950	40.378938	-80.661240	8.9	10.1	7.9	0.6	--	--	--	--
2000	40.379003	-80.661084	8.6	9.0	7.9	0.2	--	--	--	--
2050	40.379063	-80.660925	8.7	9.2	7.8	0.3	--	--	--	--
2100	40.379115	-80.660766	8.8	9.3	7.9	0.4	--	--	--	--
2150	40.379161	-80.660599	7.5	8.5	6.3	0.7	--	--	--	--
2200	40.379201	-80.660430	7.7	8.8	6.4	0.7	--	--	--	--
2250	40.379234	-80.660258	8.3	8.8	7.6	0.3	--	--	--	--
2300	40.379260	-80.660084	7.8	9.4	6.2	1.0	--	--	--	--
2350	40.379279	-80.659908	9.0	9.8	8.3	0.3	--	--	--	--
2400	40.379290	-80.659731	9.3	9.9	8.1	0.5	--	--	--	--
2450	40.379295	-80.659553	8.8	9.8	8.0	0.6	--	--	--	--
2500	40.379293	-80.659375	8.5	9.2	7.1	0.6	--	--	--	--
2550	40.379283	-80.659197	9.2	9.9	8.3	0.4	--	--	--	--
2600	40.379265	-80.659021	8.5	9.8	7.5	0.6	--	--	--	--
2650	40.379241	-80.658850	9.0	9.7	8.2	0.4	--	--	--	--
2700	40.379210	-80.658676	7.6	8.7	6.6	0.6	--	--	--	--
2750	40.379175	-80.658504	8.7	9.8	8.1	0.5	--	--	--	--
2800	40.379138	-80.658331	8.4	9.2	7.7	0.4	--	--	--	--
2850	40.379100	-80.658159	8.1	8.5	7.1	0.3	--	--	--	--

*Unable to see the bottom of the base in yellow highlighted areas

John Scott Highway Eastbound Passing Lane										
GPR File #	Total Distance (ft)		Average Concrete Dielectric			9.13	Average Base Dielectric			9.72
7	4,745		Average Concrete Thickness (in)				Average Base Thickness (in)			
Dist.(ft)	Lat(°)	Long(°)	Average	Max	Min	Standard Deviation	Average	Max	Min	Standard Deviation
2900	40.379064	-80.657985	7.8	8.6	7.2	0.4	--	--	--	--
2950	40.379027	-80.657812	8.4	10.0	7.3	0.9	--	--	--	--
3000	40.378990	-80.657640	7.0	7.5	6.0	0.4	--	--	--	--
3050	40.378952	-80.657467	7.9	8.5	6.8	0.5	--	--	--	--
3100	40.378915	-80.657295	6.7	7.5	6.0	0.4	--	--	--	--
3150	40.378876	-80.657128	6.9	7.7	6.2	0.3	5.6	5.8	5.4	0.1
3200	40.378837	-80.656957	9.5	10.3	8.0	0.4	4.3	5.6	3.7	0.3
3250	40.378798	-80.656786	9.5	10.0	8.7	0.3	4.1	4.6	3.5	0.2
3300	40.378760	-80.656615	9.5	10.0	8.8	0.3	5.0	6.0	4.0	0.6
3350	40.378722	-80.656444	9.1	10.2	7.4	0.7	5.0	6.7	3.2	1.0
3400	40.378687	-80.656272	8.5	10.1	7.8	0.4	6.2	7.3	4.4	0.8
3450	40.378659	-80.656099	9.1	10.1	8.0	0.7	6.1	7.3	5.1	0.7
3500	40.378638	-80.655924	9.0	10.1	7.9	0.7	5.0	6.3	3.2	0.7
3550	40.378625	-80.655748	9.1	10.3	8.6	0.3	5.2	6.5	4.2	0.6
3600	40.378618	-80.655571	9.5	10.6	8.3	0.6	5.4	7.2	3.5	1.0
3650	40.378618	-80.655395	9.6	10.2	8.9	0.3	4.4	5.4	3.6	0.6
3700	40.378625	-80.655222	9.1	10.2	8.2	0.5	4.9	6.0	3.5	0.7
3750	40.378639	-80.655046	8.7	10.0	7.6	0.6	3.7	4.1	3.0	0.3
3800	40.378658	-80.654872	8.9	9.7	7.6	0.5	4.1	5.6	3.3	0.7
3850	40.378684	-80.654699	9.2	10.3	8.1	0.5	4.6	5.6	3.8	0.6
3900	40.378717	-80.654527	9.2	9.9	8.2	0.5	4.8	5.9	3.2	0.7
3950	40.378758	-80.654358	8.7	9.8	8.0	0.5	5.7	6.9	3.8	0.8
4000	40.378805	-80.654191	9.1	10.4	7.5	0.7	4.3	5.8	3.6	0.4
4050	40.378860	-80.654028	8.7	9.2	8.1	0.3	5.8	6.7	4.9	0.4
4100	40.378920	-80.653869	8.2	9.2	7.6	0.3	6.5	7.2	5.3	0.4
4150	40.378986	-80.653715	8.1	9.1	7.7	0.3	7.0	7.6	5.8	0.4
4200	40.379056	-80.653569	8.8	10.0	7.8	0.5	6.0	6.8	5.1	0.5
4250	40.379134	-80.653424	8.9	10.3	7.9	0.8	5.7	7.3	4.9	0.6
4300	40.379218	-80.653284	8.4	9.1	7.6	0.4	5.4	6.4	3.7	0.6
4350	40.379309	-80.653150	8.3	9.3	7.5	0.6	5.3	6.6	3.9	0.8
4400	40.379404	-80.653023	9.1	10.0	8.4	0.4	4.5	5.3	4.0	0.3
4450	40.379506	-80.652901	8.9	9.8	8.2	0.4	4.3	5.1	3.8	0.3
4500	40.379612	-80.652785	8.8	10.3	7.4	0.8	4.9	6.3	3.9	0.6
4550	40.379722	-80.652680	8.3	8.8	7.9	0.2	5.5	6.0	4.3	0.3
4600	40.379837	-80.652583	9.4	10.3	8.3	0.5	4.4	5.6	3.5	0.6
4650	40.379956	-80.652493	9.2	10.3	8.1	0.6	4.7	6.2	3.6	0.6
4700	40.380078	-80.652411	8.4	9.1	7.5	0.4	6.2	7.6	5.3	0.6

*Unable to see the bottom of the base in yellow highlighted areas

John Scott Highway Eastbound Driving Lane										
GPR File #	Total Distance (ft)		Average Concrete Dielectric			8.95	Average Base Dielectric			9.59
13	4,764		Average Concrete Thickness (in)				Average Base Thickness (in)			
Dist.(ft)	Lat(°)	Long(°)	Average	Max	Min	Standard Deviation	Average	Max	Min	Standard Deviation
0	40.378287	-80.667657	8.8	9.6	8.0	0.3	5.5	6.0	5.0	0.2
50	40.378247	-80.667486	8.7	9.4	8.2	0.3	6.3	7.8	5.4	0.4
100	40.378206	-80.667315	8.9	10.3	7.7	0.6	5.7	7.1	4.1	0.7
150	40.378165	-80.667144	9.6	10.6	8.9	0.4	6.0	7.4	4.9	0.5
200	40.378124	-80.666974	9.0	9.8	8.4	0.4	6.6	7.4	5.5	0.6
250	40.378081	-80.666802	8.6	9.0	7.7	0.3	6.8	7.4	6.2	0.3
300	40.378039	-80.666631	9.1	9.9	8.0	0.6	5.5	7.1	4.2	0.9
350	40.377999	-80.666463	8.5	10.2	8.0	0.4	6.0	6.9	5.1	0.4
400	40.377958	-80.666290	8.4	9.9	7.3	0.6	5.4	6.3	4.3	0.6
450	40.377914	-80.666112	8.7	10.1	7.4	0.7	5.0	6.4	4.0	0.7
500	40.377872	-80.665939	7.8	9.0	6.4	0.7	5.9	7.4	4.9	0.6
550	40.377830	-80.665766	8.3	9.0	7.5	0.4	5.4	6.3	4.0	0.5
600	40.377792	-80.665595	8.0	8.7	7.1	0.3	6.0	6.6	5.2	0.4
650	40.377761	-80.665421	7.8	8.6	7.2	0.2	6.1	7.0	5.3	0.5
700	40.377734	-80.665243	7.8	8.5	7.0	0.3	6.1	6.8	5.5	0.3
750	40.377715	-80.665062	8.2	8.8	7.7	0.3	6.0	6.7	5.3	0.4
800	40.377702	-80.664883	8.5	9.7	7.9	0.3	5.6	6.8	3.9	0.7
850	40.377697	-80.664704	8.5	9.2	7.5	0.4	5.8	6.8	4.4	0.6
900	40.377699	-80.664528	8.1	9.1	7.2	0.5	6.4	7.6	4.7	0.8
950	40.377709	-80.664350	7.8	8.3	7.4	0.2	6.7	7.5	5.6	0.5
1000	40.377729	-80.664173	8.7	9.3	7.6	0.4	6.2	7.2	5.4	0.5
1050	40.377754	-80.663998	8.2	8.9	7.8	0.3	6.8	7.6	5.7	0.4
1100	40.377784	-80.663822	7.9	8.8	6.3	0.6	6.6	8.1	5.6	0.6
1150	40.377818	-80.663653	7.5	7.9	7.0	0.2	7.0	7.8	6.4	0.3
1200	40.377860	-80.663483	7.6	8.4	7.0	0.4	7.2	8.0	6.7	0.3
1250	40.377913	-80.663316	8.5	8.9	7.9	0.2	6.8	7.3	6.0	0.3
1300	40.377970	-80.663155	7.8	8.9	6.5	0.6	7.1	7.9	5.2	0.4
1350	40.378031	-80.662996	8.3	9.3	6.5	0.8	6.0	7.9	4.6	0.8
1400	40.378097	-80.662842	8.9	9.7	8.4	0.2	6.2	6.9	5.1	0.5
1450	40.378171	-80.662692	7.9	8.6	7.4	0.3	6.8	7.3	6.2	0.2
1500	40.378247	-80.662547	7.9	8.4	7.5	0.2	6.5	7.4	5.6	0.5
1550	40.378323	-80.662402	7.7	8.1	7.1	0.2	6.3	7.4	5.6	0.5
1600	40.378400	-80.662257	7.8	8.6	7.2	0.4	6.2	7.1	5.0	0.6
1650	40.378477	-80.662112	7.7	8.7	7.1	0.4	6.4	7.4	5.7	0.4
1700	40.378555	-80.661968	7.6	8.8	6.3	0.7	6.1	7.5	5.1	0.7
1750	40.378633	-80.661824	8.7	9.0	8.3	0.2	4.9	5.8	3.9	0.6
1800	40.378709	-80.661680	8.7	9.8	7.8	0.5	4.7	6.6	3.8	0.7
1850	40.378786	-80.661533	7.7	8.9	7.3	0.3	5.7	6.8	5.0	0.5
1900	40.378861	-80.661385	7.9	8.7	7.2	0.4	5.5	6.6	4.8	0.3
1950	40.378933	-80.661235	8.4	8.9	7.7	0.3	5.2	5.8	4.3	0.4
2000	40.378998	-80.661081	8.3	9.1	7.8	0.3	5.4	6.1	4.4	0.4
2050	40.379059	-80.660920	8.2	9.2	7.6	0.4	5.3	6.1	4.2	0.5
2100	40.379112	-80.660756	8.6	9.2	7.7	0.4	5.5	7.4	4.3	0.7
2150	40.379160	-80.660588	8.2	8.8	7.5	0.4	6.5	7.6	5.4	0.6
2200	40.379200	-80.660417	8.3	9.0	7.7	0.4	6.5	7.9	5.6	0.5
2250	40.379233	-80.660244	8.5	10.1	7.5	0.7	5.9	7.1	4.4	0.7
2300	40.379259	-80.660068	9.4	10.1	8.6	0.5	4.7	5.7	3.8	0.5
2350	40.379277	-80.659894	9.4	10.1	8.7	0.5	4.2	4.7	3.7	0.2
2400	40.379286	-80.659720	9.2	9.9	8.1	0.5	4.4	5.8	3.8	0.4
2450	40.379289	-80.659543	8.1	8.5	7.5	0.2	5.6	6.1	4.9	0.3
2500	40.379286	-80.659368	8.4	9.3	7.6	0.5	6.3	7.5	4.8	0.7
2550	40.379276	-80.659192	8.1	8.7	7.7	0.3	6.7	7.5	5.8	0.4
2600	40.379258	-80.659017	8.8	9.4	7.9	0.3	5.7	6.6	5.1	0.3
2650	40.379234	-80.658843	8.7	9.9	7.8	0.6	5.7	7.1	4.3	0.7
2700	40.379203	-80.658670	8.3	9.4	7.2	0.6	5.4	6.4	4.1	0.6
2750	40.379166	-80.658499	8.3	9.4	7.7	0.4	5.6	6.4	4.7	0.3
2800	40.379127	-80.658329	8.1	8.9	7.2	0.4	6.2	7.2	5.3	0.5
2850	40.379088	-80.658159	7.7	8.3	6.9	0.3	6.7	8.0	5.5	0.7

John Scott Highway Eastbound Driving Lane										
GPR File #	Total Distance (ft)		Average Concrete Dielectric			8.95	Average Base Dielectric			9.59
13	4,764		Average Concrete Thickness (in)				Average Base Thickness (in)			
Dist.(ft)	Lat(°)	Long(°)	Average	Max	Min	Standard Deviation	Average	Max	Min	Standard Deviation
2900	40.379049	-80.657988	7.7	8.3	7.2	0.2	6.9	7.8	5.9	0.5
2950	40.379011	-80.657818	8.3	9.2	7.7	0.3	5.6	6.8	3.8	0.7
3000	40.378972	-80.657650	8.1	8.7	7.0	0.5	5.7	6.8	4.9	0.4
3050	40.378933	-80.657480	7.8	10.0	6.9	0.6	6.3	7.8	3.9	0.7
3100	40.378894	-80.657309	7.3	8.8	6.2	0.8	6.1	8.2	4.0	1.3
3150	40.378855	-80.657137	8.6	9.0	7.9	0.2	4.9	5.9	3.9	0.7
3200	40.378817	-80.656966	9.3	9.9	8.3	0.4	4.4	5.5	3.9	0.3
3250	40.378778	-80.656795	8.3	9.7	7.7	0.4	5.4	6.1	4.1	0.5
3300	40.378738	-80.656625	8.5	9.2	7.9	0.4	5.3	6.0	4.5	0.4
3350	40.378700	-80.656453	8.8	9.5	7.7	0.5	5.2	6.3	4.3	0.4
3400	40.378666	-80.656281	8.1	8.6	7.5	0.3	5.8	6.3	5.0	0.3
3450	40.378639	-80.656106	7.9	8.7	7.5	0.2	5.8	6.5	5.0	0.4
3500	40.378618	-80.655929	7.8	8.6	7.1	0.4	5.9	6.7	5.2	0.4
3550	40.378605	-80.655755	7.9	9.0	7.0	0.5	5.6	6.4	5.1	0.3
3600	40.378600	-80.655576	8.1	8.8	7.3	0.4	5.8	6.4	5.1	0.3
3650	40.378602	-80.655398	9.5	10.3	8.1	0.4	4.3	5.7	3.9	0.3
3700	40.378609	-80.655220	9.7	10.3	8.9	0.4	4.6	5.6	3.8	0.4
3750	40.378624	-80.655043	9.1	9.8	8.1	0.4	5.1	6.5	4.1	0.7
3800	40.378645	-80.654867	9.3	10.3	8.3	0.5	5.0	5.9	4.2	0.5
3850	40.378673	-80.654691	9.6	10.6	8.3	0.7	4.8	5.7	3.8	0.6
3900	40.378708	-80.654517	9.5	10.6	8.7	0.5	4.3	4.9	4.0	0.2
3950	40.378749	-80.654347	9.5	10.4	8.6	0.5	4.3	4.9	3.9	0.2
4000	40.378797	-80.654180	9.4	10.3	8.4	0.4	4.2	5.2	3.8	0.2
4050	40.378852	-80.654015	8.6	9.2	8.0	0.3	5.0	5.9	4.1	0.4
4100	40.378914	-80.653855	8.1	8.7	7.5	0.3	5.6	6.6	4.9	0.4
4150	40.378981	-80.653702	7.9	8.6	7.6	0.2	6.0	6.6	5.4	0.3
4200	40.379055	-80.653549	8.3	8.5	7.6	0.2	5.7	6.6	4.7	0.4
4250	40.379135	-80.653403	8.3	8.9	6.9	0.5	5.6	6.3	4.6	0.4
4300	40.379220	-80.653263	8.7	9.2	8.1	0.2	5.2	6.3	3.9	0.6
4350	40.379311	-80.653129	7.7	8.5	7.0	0.3	6.3	6.7	5.5	0.3
4400	40.379409	-80.653000	8.6	9.7	7.6	0.5	5.4	6.3	4.4	0.5
4450	40.379510	-80.652878	8.0	8.7	7.1	0.3	6.3	7.2	5.0	0.4
4500	40.379614	-80.652761	7.8	9.2	6.8	0.5	6.3	8.0	4.1	0.8
4550	40.379723	-80.652650	8.3	8.9	7.7	0.4	6.1	7.1	4.5	0.5
4600	40.379834	-80.652545	9.0	10.4	8.0	0.5	5.1	6.7	4.0	0.7
4650	40.379945	-80.652441	7.8	8.5	7.2	0.2	6.3	7.2	5.5	0.4
4700	40.380058	-80.652337	7.8	9.2	7.0	0.5	5.6	7.1	4.9	0.4
4750	40.380147	-80.652260	8.0	8.6	7.6	0.3	5.3	5.6	5.0	0.2

John Scott Highway Eastbound Shoulder										
GPR File #	Total Distance (ft)		Average Concrete Dielectric			9.01	Average Base Dielectric			9.57
18	4,397		Average Concrete Thickness (in)				Average Base Thickness (in)			
Dist.(ft)	Lat(°)	Long(°)	Average	Max	Min	Standard Deviation	Average	Max	Min	Standard Deviation
0	40.377939	-80.666355	7.7	8.3	6.9	0.3	6.3	6.9	5.0	0.5
50	40.377897	-80.666190	7.9	8.4	7.3	0.3	6.6	7.1	6.0	0.2
100	40.377859	-80.666019	8.1	8.9	7.2	0.5	6.9	7.5	5.9	0.3
150	40.377821	-80.665849	8.4	8.9	7.3	0.3	7.2	8.1	5.8	0.5
200	40.377782	-80.665680	8.1	9.0	7.0	0.5	6.8	8.1	5.7	0.6
250	40.377746	-80.665508	8.9	9.8	8.0	0.5	6.6	7.8	5.3	0.7
300	40.377718	-80.665333	7.7	8.5	7.3	0.3	7.6	8.9	6.6	0.5
350	40.377696	-80.665158	7.9	8.9	6.9	0.5	7.2	7.7	6.5	0.3
400	40.377681	-80.664980	8.3	8.9	7.6	0.3	7.0	8.1	6.2	0.5
450	40.377671	-80.664802	8.0	8.9	7.1	0.6	7.0	8.7	5.6	0.7
500	40.377669	-80.664625	8.2	9.0	7.0	0.5	6.8	8.9	5.5	0.8
550	40.377676	-80.664448	7.8	8.5	7.4	0.2	6.9	7.7	6.2	0.3
600	40.377690	-80.664272	7.7	8.4	6.9	0.4	7.1	8.3	5.9	0.4
650	40.377711	-80.664095	8.0	8.5	7.2	0.4	6.8	7.6	5.8	0.4
700	40.377739	-80.663920	9.2	10.4	8.3	0.6	6.3	7.7	5.5	0.6
750	40.377774	-80.663746	9.1	10.1	8.3	0.5	6.2	7.6	5.4	0.7
800	40.377813	-80.663579	9.8	10.6	8.9	0.5	5.8	6.5	5.3	0.3
850	40.377857	-80.663409	9.5	10.6	8.4	0.7	5.1	5.8	3.7	0.7
900	40.377910	-80.663240	8.9	9.4	7.8	0.4	6.6	7.5	5.4	0.6
950	40.377968	-80.663077	7.9	9.2	7.1	0.5	7.2	7.8	5.7	0.6
1000	40.378032	-80.662918	8.2	9.4	7.0	0.7	6.5	7.6	5.1	0.7
1050	40.378103	-80.662764	8.6	9.5	8.0	0.4	5.8	7.1	4.3	0.9
1100	40.378177	-80.662615	8.5	9.1	7.8	0.3	6.4	7.2	5.2	0.5
1150	40.378254	-80.662469	7.6	8.9	6.4	0.7	7.1	8.1	5.8	0.6
1200	40.378331	-80.662322	7.6	8.5	6.4	0.6	7.0	7.9	5.6	0.6
1250	40.378409	-80.662174	7.5	8.0	6.7	0.3	6.8	7.9	5.9	0.6
1300	40.378486	-80.662029	7.2	8.1	6.5	0.4	7.6	8.6	6.3	0.5
1350	40.378564	-80.661882	6.7	7.4	6.2	0.3	7.9	9.0	6.8	0.5
1400	40.378643	-80.661735	7.6	8.7	6.5	0.6	7.2	9.2	6.1	0.8
1450	40.378722	-80.661587	6.7	7.4	6.1	0.3	7.5	8.2	6.5	0.4
1500	40.378798	-80.661440	7.8	8.7	7.0	0.5	6.6	7.4	5.8	0.5
1550	40.378872	-80.661291	7.8	9.2	6.8	0.5	6.2	6.9	5.6	0.3
1600	40.378940	-80.661138	8.4	8.9	7.7	0.3	5.8	6.9	4.1	0.7
1650	40.379002	-80.660980	7.7	8.5	6.8	0.4	5.6	6.7	3.9	0.6
1700	40.379059	-80.660817	8.0	8.5	6.7	0.4	6.1	6.8	4.8	0.3
1750	40.379106	-80.660653	7.9	8.9	6.2	0.8	6.4	7.4	5.6	0.6
1800	40.379148	-80.660487	7.4	8.5	6.6	0.5	6.3	7.2	5.0	0.5
1850	40.379183	-80.660318	8.7	10.0	7.1	0.8	5.2	6.8	4.1	0.8
1900	40.379212	-80.660143	9.4	10.5	8.4	0.6	5.5	6.1	4.7	0.3
1950	40.379232	-80.659967	9.4	10.9	8.1	1.0	5.4	6.2	4.5	0.4
2000	40.379247	-80.659791	9.5	11.0	8.2	0.9	4.7	5.5	3.3	0.7
2050	40.379254	-80.659617	9.4	10.3	8.5	0.5	5.2	6.0	3.3	0.6
2100	40.379255	-80.659441	9.3	10.3	8.3	0.6	5.5	6.1	5.1	0.2
2150	40.379248	-80.659264	9.4	9.9	8.9	0.2	5.5	5.9	5.1	0.2
2200	40.379236	-80.659089	9.7	10.8	9.2	0.4	5.6	6.3	5.1	0.2
2250	40.379215	-80.658914	8.6	9.8	7.0	0.8	6.3	7.4	5.1	0.6
2300	40.379188	-80.658741	8.1	9.1	7.5	0.4	6.3	7.5	5.3	0.6
2350	40.379155	-80.658571	7.9	9.2	6.8	0.5	7.1	8.2	5.4	0.7
2400	40.379118	-80.658401	7.6	8.4	7.0	0.4	6.7	7.4	6.0	0.3
2450	40.379080	-80.658233	8.2	8.9	7.4	0.4	6.8	8.0	5.4	0.7
2500	40.379041	-80.658061	9.2	10.6	7.9	0.7	4.5	6.5	3.6	0.6
2550	40.379003	-80.657889	8.8	10.4	7.8	0.6	5.1	6.3	4.0	0.7
2600	40.378964	-80.657719	9.6	11.0	8.3	0.6	4.6	6.3	4.0	0.5
2650	40.378925	-80.657548	8.1	9.0	6.7	0.6	6.4	9.0	5.1	1.0
2700	40.378885	-80.657376	7.1	8.4	6.1	0.7	6.6	8.1	4.6	1.1
2750	40.378846	-80.657206	7.1	8.0	6.4	0.4	5.7	6.7	4.5	0.5
2800	40.378804	-80.657035	8.2	8.9	6.4	0.6	6.0	7.5	4.9	0.6
2850	40.378760	-80.656865	7.8	9.0	7.4	0.4	6.0	7.4	4.6	0.7

John Scott Highway Eastbound Shoulder										
GPR File #	Total Distance (ft)		Average Concrete Dielectric			9.01	Average Base Dielectric			9.57
18	4,397		Average Concrete Thickness (in)				Average Base Thickness (in)			
Dist.(ft)	Lat(°)	Long(°)	Average	Max	Min	Standard Deviation	Average	Max	Min	Standard Deviation
2900	40.378719	-80.656693	7.5	8.4	6.2	0.6	6.2	7.2	5.2	0.5
2950	40.378679	-80.656518	7.8	8.4	6.5	0.5	5.8	7.3	5.0	0.5
3000	40.378645	-80.656345	8.6	9.2	7.7	0.3	5.8	6.6	5.1	0.4
3050	40.378617	-80.656172	9.0	10.3	8.1	0.5	6.1	7.3	5.0	0.7
3100	40.378594	-80.655997	7.9	8.9	7.1	0.5	7.2	9.3	6.0	0.7
3150	40.378579	-80.655819	7.3	8.2	7.0	0.2	7.3	8.5	6.3	0.7
3200	40.378571	-80.655643	7.3	7.9	7.0	0.2	7.1	8.4	6.4	0.5
3250	40.378568	-80.655467	8.3	8.9	7.4	0.4	7.1	8.6	6.2	0.5
3300	40.378571	-80.655294	8.8	9.3	8.4	0.2	7.1	8.0	6.2	0.5
3350	40.378586	-80.655119	8.2	9.0	7.3	0.4	6.9	8.4	5.7	0.6
3400	40.378607	-80.654943	8.0	9.0	7.0	0.4	7.5	8.5	6.4	0.5
3450	40.378633	-80.654768	8.8	9.5	8.2	0.3	6.3	7.2	5.2	0.6
3500	40.378669	-80.654596	9.4	10.3	8.6	0.4	5.7	6.3	5.2	0.2
3550	40.378710	-80.654427	8.9	9.7	8.2	0.4	6.3	7.5	5.3	0.7
3600	40.378757	-80.654258	8.3	9.2	7.4	0.4	6.4	7.6	5.3	0.7
3650	40.378808	-80.654094	7.6	8.4	6.9	0.3	6.0	6.8	5.3	0.4
3700	40.378868	-80.653934	7.7	8.2	7.2	0.3	6.8	7.7	6.2	0.4
3750	40.378935	-80.653778	7.5	8.3	6.6	0.4	7.3	8.6	6.4	0.6
3800	40.379008	-80.653624	8.0	8.5	7.2	0.3	6.9	7.3	6.5	0.2
3850	40.379086	-80.653476	7.4	8.6	6.8	0.4	7.3	8.4	6.3	0.6
3900	40.379168	-80.653334	7.8	8.5	6.9	0.5	6.2	7.3	5.3	0.5
3950	40.379255	-80.653196	8.6	10.4	7.2	1.0	6.7	8.0	5.3	0.8
4000	40.379345	-80.653065	9.1	10.3	8.6	0.4	5.8	6.5	4.7	0.4
4050	40.379441	-80.652941	8.5	9.1	7.9	0.3	6.6	7.5	5.3	0.7
4100	40.379540	-80.652822	8.0	8.4	7.5	0.2	7.0	7.8	6.4	0.4
4150	40.379644	-80.652706	8.3	8.9	7.2	0.4	6.7	7.4	5.3	0.6
4200	40.379749	-80.652590	8.0	8.9	6.7	0.5	7.2	8.4	6.4	0.5
4250	40.379856	-80.652477	8.4	9.8	7.4	0.6	7.0	8.4	5.5	0.7
4300	40.379966	-80.652370	8.0	8.7	7.0	0.3	7.8	8.7	7.0	0.4
4350	40.380080	-80.652268	8.2	8.9	7.7	0.3	7.7	8.5	6.9	0.4

John Scott Highway Westbound Passing Lane										
GPR File #	Total Distance (ft)		Average Concrete Dielectric			8.92	Average Base Dielectric			9.52
10	4,759		Average Concrete Thickness (in)				Average Base Thickness (in)			
Dist.(ft)	Lat(°)	Long(°)	Average	Max	Min	Standard Deviation	Average	Max	Min	Standard Deviation
0	40.380113	-80.652418	8.8	9.4	8.0	0.4	--	--	--	--
50	40.379992	-80.652502	9.0	9.5	8.5	0.2	--	--	--	--
100	40.379873	-80.652589	8.7	9.4	7.9	0.5	--	--	--	--
150	40.379758	-80.652684	9.5	10.3	8.5	0.3	--	--	--	--
200	40.379649	-80.652788	8.7	9.6	7.2	0.5	--	--	--	--
250	40.379543	-80.652900	8.8	9.5	7.8	0.4	--	--	--	--
300	40.379442	-80.653018	8.6	9.2	7.4	0.4	5.9	7.1	5.2	0.4
350	40.379347	-80.653141	8.7	9.6	7.8	0.5	6.1	7.6	4.8	0.8
400	40.379256	-80.653273	8.0	8.4	7.6	0.2	6.5	7.1	5.8	0.3
450	40.379172	-80.653410	7.9	8.9	6.9	0.3	6.8	7.7	5.9	0.4
500	40.379094	-80.653552	7.8	9.2	7.1	0.3	6.6	7.6	5.5	0.5
550	40.379022	-80.653701	8.5	8.9	8.1	0.2	6.0	6.5	5.5	0.3
600	40.378954	-80.653854	8.3	9.1	7.3	0.4	6.2	7.5	5.0	0.5
650	40.378893	-80.654012	7.9	9.1	6.4	0.8	6.1	7.4	5.0	0.5
700	40.378840	-80.654172	7.5	8.7	6.5	0.7	6.4	7.5	5.5	0.6
750	40.378794	-80.654334	8.7	9.3	7.9	0.3	5.8	6.5	4.8	0.3
800	40.378752	-80.654500	8.8	9.4	8.1	0.3	5.5	6.2	4.9	0.3
850	40.378716	-80.654671	7.6	8.6	6.5	0.5	5.9	7.1	4.8	0.6
900	40.378687	-80.654844	8.0	9.1	7.1	0.5	5.2	6.5	3.7	0.6
950	40.378664	-80.655019	8.2	9.4	7.0	0.6	4.6	5.8	3.0	0.7
1000	40.378649	-80.655194	9.2	9.9	8.4	0.4	4.2	5.2	3.0	0.6
1050	40.378643	-80.655372	9.9	10.6	8.8	0.4	4.0	5.0	3.0	0.5
1100	40.378644	-80.655545	9.3	10.0	8.5	0.4	5.1	5.6	4.4	0.3
1150	40.378650	-80.655722	8.7	9.4	8.1	0.3	5.6	6.3	4.4	0.6
1200	40.378662	-80.655897	8.7	9.4	7.8	0.4	5.4	6.3	4.7	0.3
1250	40.378679	-80.656071	9.0	10.3	8.4	0.5	5.4	6.0	3.9	0.6
1300	40.378704	-80.656244	9.2	10.1	8.3	0.5	5.4	6.4	4.5	0.5
1350	40.378737	-80.656416	9.0	9.6	8.1	0.4	5.6	6.8	4.4	0.5
1400	40.378774	-80.656587	9.2	10.3	8.0	0.6	5.3	6.2	4.2	0.6
1450	40.378812	-80.656754	9.4	10.6	8.4	0.6	5.2	6.3	3.7	0.7
1500	40.378851	-80.656924	8.4	9.5	7.6	0.5	6.0	7.5	5.2	0.6
1550	40.378890	-80.657095	8.2	8.6	7.1	0.3	6.0	7.0	5.0	0.4
1600	40.378929	-80.657264	8.1	8.5	7.6	0.2	6.1	6.5	5.8	0.2
1650	40.378967	-80.657434	7.9	8.5	7.3	0.2	6.2	6.9	5.6	0.3
1700	40.379006	-80.657603	7.7	8.3	7.3	0.2	6.5	7.3	5.7	0.3
1750	40.379045	-80.657774	7.3	8.3	6.1	0.5	6.3	7.4	5.0	0.6
1800	40.379084	-80.657945	8.3	8.7	7.6	0.3	5.4	6.0	3.6	0.4
1850	40.379122	-80.658111	8.1	8.9	7.7	0.2	5.9	6.5	3.7	0.4
1900	40.379162	-80.658279	7.6	8.5	6.6	0.4	6.1	7.4	5.2	0.5
1950	40.379201	-80.658450	6.9	7.2	6.5	0.1	7.3	8.0	6.5	0.3
2000	40.379238	-80.658620	7.1	8.0	6.5	0.3	6.9	7.8	6.1	0.5
2050	40.379271	-80.658790	7.7	8.8	6.3	0.6	6.0	7.2	4.3	0.8
2100	40.379297	-80.658965	8.1	9.4	7.4	0.3	6.1	6.8	5.1	0.5
2150	40.379315	-80.659141	7.8	8.7	7.1	0.3	6.3	7.4	5.7	0.4
2200	40.379326	-80.659313	7.1	8.3	6.4	0.5	7.3	8.3	6.0	0.6
2250	40.379332	-80.659491	7.2	8.0	6.7	0.3	7.2	8.0	6.0	0.6
2300	40.379330	-80.659670	6.8	7.6	6.2	0.3	7.5	8.3	6.1	0.5
2350	40.379321	-80.659846	7.0	8.1	5.9	0.6	7.4	8.2	5.8	0.7
2400	40.379304	-80.660023	8.3	9.1	7.1	0.5	6.2	7.3	5.3	0.6
2450	40.379279	-80.660201	8.1	9.0	7.3	0.5	6.3	7.6	5.1	0.6
2500	40.379248	-80.660378	8.0	8.5	7.2	0.3	6.7	7.2	5.5	0.3
2550	40.379210	-80.660551	8.4	9.1	7.8	0.3	6.4	6.9	5.8	0.3
2600	40.379164	-80.660722	8.7	9.3	8.1	0.3	5.8	6.8	4.9	0.5
2650	40.379111	-80.660891	8.2	9.3	7.0	0.5	6.3	7.3	4.9	0.6
2700	40.379049	-80.661051	8.2	9.3	7.3	0.4	5.9	6.8	5.0	0.5
2750	40.378982	-80.661209	7.9	8.7	7.3	0.3	6.5	7.4	5.5	0.3
2800	40.378909	-80.661365	8.1	9.8	7.5	0.5	6.1	6.8	4.8	0.4
2850	40.378834	-80.661512	8.2	9.9	7.3	0.7	6.0	7.0	4.3	0.7

*Unable to see the bottom of the base in yellow highlighted areas

John Scott Highway Westbound Passing Lane										
GPR File #	Total Distance (ft)		Average Concrete Dielectric			8.92	Average Base Dielectric			9.52
10	4,759		Average Concrete Thickness (in)				Average Base Thickness (in)			
Dist.(ft)	Lat(°)	Long(°)	Average	Max	Min	Standard Deviation	Average	Max	Min	Standard Deviation
2900	40.378758	-80.661659	8.4	9.1	7.5	0.5	6.1	7.2	4.6	0.6
2950	40.378682	-80.661801	8.6	9.0	7.9	0.2	6.0	7.1	5.4	0.4
3000	40.378604	-80.661947	8.0	9.1	7.4	0.3	6.9	8.0	6.1	0.4
3050	40.378526	-80.662095	8.3	9.2	7.8	0.3	--	--	--	--
3100	40.378448	-80.662243	9.2	9.9	8.6	0.3	--	--	--	--
3150	40.378370	-80.662390	8.6	10.5	7.5	0.9	--	--	--	--
3200	40.378293	-80.662538	7.8	8.3	6.8	0.3	--	--	--	--
3250	40.378215	-80.662685	7.9	8.5	7.1	0.4	--	--	--	--
3300	40.378140	-80.662831	7.7	8.5	7.3	0.2	6.6	7.8	5.3	0.7
3350	40.378069	-80.662983	8.4	8.9	8.1	0.2	5.7	6.0	5.4	0.2
3400	40.378005	-80.663141	8.4	8.8	8.0	0.2	--	--	--	--
3450	40.377947	-80.663303	7.8	8.6	7.0	0.4	6.5	7.2	5.5	0.4
3500	40.377898	-80.663466	8.3	8.8	7.9	0.3	6.4	7.1	5.3	0.5
3550	40.377852	-80.663634	8.0	8.6	7.2	0.3	7.5	7.9	6.9	0.2
3600	40.377815	-80.663803	8.8	9.5	8.1	0.2	--	--	--	--
3650	40.377784	-80.663973	8.6	9.6	7.6	0.5	6.2	6.2	6.2	0.0
3700	40.377760	-80.664148	8.4	10.3	7.6	0.6	6.5	7.3	5.7	0.3
3750	40.377741	-80.664328	8.1	8.9	7.5	0.4	--	--	--	--
3800	40.377731	-80.664505	7.8	8.3	7.1	0.3	--	--	--	--
3850	40.377728	-80.664682	7.5	8.5	6.7	0.5	--	--	--	--
3900	40.377732	-80.664859	7.8	8.2	7.0	0.3	--	--	--	--
3950	40.377746	-80.665034	8.0	9.1	7.4	0.3	5.5	5.7	5.2	0.2
4000	40.377766	-80.665210	7.8	8.4	7.1	0.3	5.5	6.4	4.8	0.4
4050	40.377791	-80.665380	7.2	8.1	6.0	0.6	6.6	8.0	5.2	0.9
4100	40.377824	-80.665552	6.2	6.8	5.5	0.3	7.4	8.0	6.8	0.4
4150	40.377862	-80.665723	7.3	8.1	5.6	0.6	6.5	8.0	5.1	0.9
4200	40.377902	-80.665894	7.7	8.7	6.5	0.6	7.1	8.1	6.1	0.5
4250	40.377945	-80.666067	8.6	9.0	7.9	0.3	6.1	7.3	5.1	0.5
4300	40.377986	-80.666236	8.6	9.1	7.9	0.2	6.1	7.0	4.7	0.5
4350	40.378023	-80.666410	8.5	9.5	8.0	0.3	6.4	7.6	4.4	0.9
4400	40.378061	-80.666581	8.6	9.7	7.5	0.6	5.4	6.6	4.4	0.5
4450	40.378104	-80.666756	9.2	9.8	8.6	0.2	5.0	5.9	4.0	0.5
4500	40.378145	-80.666928	9.6	10.0	9.3	0.2	5.3	6.6	4.1	0.7
4550	40.378186	-80.667104	10.0	10.5	9.5	0.2	5.1	5.7	4.4	0.3
4600	40.378229	-80.667284	9.6	10.7	8.7	0.6	5.2	6.0	4.8	0.3
4650	40.378271	-80.667452	8.8	9.6	8.2	0.4	--	--	--	--
4700	40.378316	-80.667618	8.0	9.2	6.6	0.7	--	--	--	--
4750	40.378349	-80.667731	7.2	7.6	6.7	0.3	--	--	--	--

*Unable to see the bottom of the base in yellow highlighted areas

John Scott Highway Westbound Driving Lane										
GPR File #	Total Distance (ft)		Average Concrete Dielectric			9.67	Average Base Dielectric			10.25
6	4,749		Average Concrete Thickness (in)				Average Base Thickness (in)			
Dist.(ft)	Lat(°)	Long(°)	Average	Max	Min	Standard Deviation	Average	Max	Min	Standard Deviation
0	40.380114	-80.652456	6.6	7.0	6.2	0.2	--	--	--	--
50	40.379994	-80.652536	6.6	7.3	6.0	0.3	--	--	--	--
100	40.379878	-80.652626	6.7	7.3	5.9	0.3	--	--	--	--
150	40.379764	-80.652724	6.8	7.4	6.1	0.3	6.5	7.5	5.9	0.5
200	40.379655	-80.652828	8.0	9.3	6.9	0.5	6.6	7.4	5.9	0.4
250	40.379549	-80.652939	8.4	9.4	7.4	0.6	6.5	6.8	6.2	0.2
300	40.379447	-80.653057	7.9	8.6	7.3	0.3	--	--	--	--
350	40.379351	-80.653182	8.3	9.2	7.3	0.6	5.2	5.9	4.9	0.2
400	40.379261	-80.653314	8.2	9.1	7.7	0.3	6.5	7.3	5.1	0.4
450	40.379177	-80.653453	8.1	8.6	7.6	0.3	--	--	--	--
500	40.379096	-80.653598	8.2	8.9	7.7	0.3	5.6	6.6	4.9	0.4
550	40.379023	-80.653747	8.0	8.8	7.3	0.4	6.6	7.5	5.3	0.6
600	40.378956	-80.653900	7.5	8.1	6.7	0.4	6.8	7.9	5.9	0.6
650	40.378894	-80.654056	8.0	8.6	7.3	0.4	5.6	5.8	5.1	0.2
700	40.378839	-80.654217	8.3	9.7	7.4	0.7	5.1	6.5	3.8	0.8
750	40.378789	-80.654381	8.3	8.8	7.6	0.3	5.5	6.4	4.9	0.5
800	40.378749	-80.654546	8.4	9.1	7.7	0.3	5.4	6.3	4.2	0.4
850	40.378714	-80.654717	8.1	8.9	6.9	0.6	5.1	6.4	4.2	0.6
900	40.378686	-80.654889	8.2	9.1	7.5	0.4	4.2	4.9	3.3	0.5
950	40.378665	-80.655063	7.9	8.9	6.9	0.5	4.9	6.1	3.8	0.6
1000	40.378653	-80.655238	8.3	9.1	6.8	0.7	4.4	6.0	3.7	0.4
1050	40.378647	-80.655416	7.4	8.4	6.8	0.4	--	--	--	--
1100	40.378648	-80.655593	8.0	8.5	7.0	0.4	--	--	--	--
1150	40.378658	-80.655769	8.3	8.9	7.2	0.3	5.4	6.4	4.4	0.6
1200	40.378675	-80.655944	8.0	9.2	7.4	0.4	5.2	6.2	4.1	0.6
1250	40.378697	-80.656119	8.4	9.4	6.8	0.6	5.5	7.0	4.1	0.6
1300	40.378724	-80.656292	8.3	9.1	7.5	0.4	5.3	6.5	4.3	0.5
1350	40.378758	-80.656463	7.4	8.3	6.8	0.3	6.1	7.4	5.1	0.6
1400	40.378796	-80.656632	8.5	9.8	7.3	0.5	5.2	6.6	4.5	0.4
1450	40.378835	-80.656801	7.7	8.5	6.8	0.5	5.4	6.6	4.6	0.4
1500	40.378874	-80.656970	8.3	9.0	7.7	0.3	5.4	6.4	4.4	0.5
1550	40.378913	-80.657139	7.9	8.6	7.0	0.3	4.7	5.0	4.5	0.2
1600	40.378951	-80.657304	7.8	8.3	6.9	0.3	--	--	--	--
1650	40.378991	-80.657473	7.3	7.7	6.9	0.2	--	--	--	--
1700	40.379031	-80.657644	7.7	8.4	6.8	0.4	5.7	7.0	5.1	0.4
1750	40.379070	-80.657813	8.5	9.3	7.9	0.3	5.2	5.9	4.2	0.5
1800	40.379109	-80.657983	8.2	9.1	7.6	0.3	5.5	6.6	4.6	0.5
1850	40.379147	-80.658152	8.2	9.0	7.4	0.4	5.5	6.3	4.2	0.6
1900	40.379188	-80.658321	7.8	8.6	7.1	0.4	5.6	6.6	4.6	0.5
1950	40.379228	-80.658489	8.6	9.3	7.8	0.3	5.0	6.2	4.3	0.4
2000	40.379266	-80.658660	8.4	9.9	6.8	0.6	5.2	6.7	4.1	0.6
2050	40.379298	-80.658832	7.8	8.2	6.6	0.3	6.0	6.5	5.4	0.3
2100	40.379322	-80.659007	7.9	8.2	7.3	0.2	5.5	6.3	4.6	0.5
2150	40.379338	-80.659183	7.9	8.6	7.0	0.5	6.0	7.1	5.1	0.5
2200	40.379346	-80.659359	7.8	9.3	6.9	0.6	5.9	6.7	4.8	0.5
2250	40.379350	-80.659536	8.1	9.3	6.8	0.7	5.7	7.4	4.5	0.7
2300	40.379347	-80.659715	7.4	8.2	6.8	0.4	6.4	7.6	5.6	0.5
2350	40.379337	-80.659888	7.9	8.5	6.7	0.3	5.8	6.9	4.6	0.5
2400	40.379320	-80.660063	7.4	8.3	6.6	0.4	5.2	6.2	4.2	0.5
2450	40.379297	-80.660236	7.7	8.5	7.2	0.3	5.0	5.6	4.3	0.3
2500	40.379266	-80.660411	7.7	8.1	6.8	0.2	5.3	5.9	4.9	0.2
2550	40.379228	-80.660586	8.0	9.0	7.3	0.3	6.4	7.2	5.4	0.4
2600	40.379181	-80.660759	8.0	8.7	6.7	0.5	6.5	7.8	5.6	0.5
2650	40.379127	-80.660928	7.3	9.1	6.2	0.6	7.3	8.9	5.7	0.8
2700	40.379067	-80.661094	8.3	9.0	7.6	0.4	5.8	6.6	5.2	0.4
2750	40.379001	-80.661255	7.5	8.0	7.0	0.2	6.4	7.0	6.0	0.2
2800	40.378929	-80.661412	8.0	8.7	7.2	0.4	6.5	7.0	5.5	0.3
2850	40.378852	-80.661564	7.6	8.2	7.2	0.3	7.5	8.3	6.6	0.5

*Unable to see the bottom of the base in yellow highlighted areas

John Scott Highway Westbound Driving Lane										
GPR File #	Total Distance (ft)		Average Concrete Dielectric			9.67	Average Base Dielectric			10.25
6	4,749		Average Concrete Thickness (in)				Average Base Thickness (in)			
Dist.(ft)	Lat(°)	Long(°)	Average	Max	Min	Standard Deviation	Average	Max	Min	Standard Deviation
2900	40.378774	-80.661712	7.9	8.9	7.1	0.5	7.0	7.6	6.3	0.4
2950	40.378695	-80.661861	8.4	9.0	7.6	0.4	6.9	7.5	6.3	0.3
3000	40.378619	-80.662007	8.5	9.1	7.8	0.3	7.2	7.7	6.5	0.3
3050	40.378542	-80.662153	7.7	9.2	6.8	0.6	--	--	--	--
3100	40.378464	-80.662298	9.0	9.7	8.2	0.3	--	--	--	--
3150	40.378388	-80.662441	8.5	9.7	8.0	0.4	4.9	5.1	4.8	0.1
3200	40.378310	-80.662587	8.1	8.7	7.3	0.3	5.2	6.3	4.5	0.5
3250	40.378230	-80.662734	8.0	9.0	7.4	0.3	4.7	5.8	3.4	0.5
3300	40.378154	-80.662884	7.8	8.9	6.6	0.7	--	--	--	--
3350	40.378084	-80.663038	8.4	8.9	7.6	0.3	--	--	--	--
3400	40.378018	-80.663198	7.8	8.6	7.2	0.4	--	--	--	--
3450	40.377957	-80.663359	7.9	8.7	7.3	0.4	--	--	--	--
3500	40.377904	-80.663523	7.9	8.5	7.3	0.3	--	--	--	--
3550	40.377860	-80.663692	8.3	8.8	7.5	0.4	--	--	--	--
3600	40.377824	-80.663864	8.2	9.1	7.6	0.3	--	--	--	--
3650	40.377794	-80.664038	8.1	8.8	7.2	0.4	--	--	--	--
3700	40.377769	-80.664214	8.6	9.6	7.7	0.4	5.4	5.9	5.0	0.2
3750	40.377755	-80.664391	8.4	9.1	7.6	0.4	5.6	6.8	4.3	0.7
3800	40.377748	-80.664567	8.7	9.4	7.9	0.3	5.5	6.3	4.4	0.4
3850	40.377746	-80.664744	7.6	8.3	7.1	0.3	7.5	8.8	5.6	0.8
3900	40.377752	-80.664919	7.2	7.6	6.9	0.1	8.4	9.0	7.7	0.3
3950	40.377767	-80.665092	7.3	8.0	6.8	0.3	8.0	8.8	6.5	0.6
4000	40.377788	-80.665266	7.9	8.4	7.2	0.3	6.3	8.3	5.1	0.6
4050	40.377815	-80.665439	7.7	8.4	7.3	0.3	6.5	7.4	5.6	0.4
4100	40.377849	-80.665610	8.2	8.8	7.7	0.3	6.4	7.7	5.0	0.7
4150	40.377888	-80.665779	8.4	9.0	7.9	0.2	5.9	6.7	4.8	0.5
4200	40.377928	-80.665948	8.3	9.0	7.6	0.3	5.7	6.6	4.4	0.5
4250	40.377971	-80.666118	8.2	8.8	7.3	0.4	6.0	6.8	5.3	0.3
4300	40.378014	-80.666288	8.4	9.3	7.7	0.3	5.7	7.0	4.5	0.7
4350	40.378058	-80.666459	8.7	9.6	7.8	0.4	5.7	6.8	4.9	0.5
4400	40.378099	-80.666631	8.5	9.2	7.7	0.3	5.5	6.3	4.6	0.4
4450	40.378138	-80.666801	8.9	9.5	8.6	0.2	--	--	--	--
4500	40.378178	-80.666970	9.3	9.7	9.0	0.2	--	--	--	--
4550	40.378218	-80.667140	9.7	10.2	9.4	0.2	--	--	--	--
4600	40.378258	-80.667310	8.6	9.6	7.9	0.4	--	--	--	--
4650	40.378300	-80.667479	7.9	8.6	7.3	0.3	--	--	--	--
4700	40.378347	-80.667648	8.7	10.2	7.3	0.7	--	--	--	--

*Unable to see the bottom of the base in yellow highlighted areas

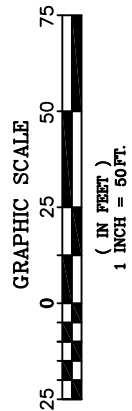
John Scott Highway Westbound Shoulder										
GPR File #	Total Distance (ft)		Average Concrete Dielectric			8.76	Average Base Dielectric			9.46
14	4,329		Average Concrete Thickness (in)				Average Base Thickness (in)			
Dist.(ft)	Lat(°)	Long(°)	Average	Max	Min	Standard Deviation	Average	Max	Min	Standard Deviation
0	40.380130	-80.652515	8.7	10.9	7.1	1.0	6.8	7.6	6.1	0.4
50	40.380009	-80.652600	8.4	9.3	7.6	0.4	5.6	6.7	4.8	0.5
100	40.379892	-80.652691	8.3	9.3	7.5	0.4	5.6	6.6	4.7	0.4
150	40.379779	-80.652791	8.9	9.8	7.8	0.6	5.0	6.1	3.7	0.8
200	40.379671	-80.652898	8.0	8.9	6.8	0.5	5.7	7.3	4.5	0.7
250	40.379566	-80.653013	7.4	8.2	6.7	0.3	6.7	7.5	5.4	0.5
300	40.379466	-80.653136	8.6	9.4	7.1	0.6	5.2	6.7	4.1	0.7
350	40.379372	-80.653265	7.9	9.0	6.9	0.4	5.0	5.5	4.3	0.3
400	40.379282	-80.653399	8.9	11.0	7.8	0.9	4.1	5.3	3.3	0.5
450	40.379198	-80.653546	8.8	10.6	7.8	0.6	3.9	5.8	3.3	0.7
500	40.379119	-80.653697	7.2	9.6	6.3	0.7	4.6	6.1	3.3	0.7
550	40.379051	-80.653844	7.5	8.1	6.8	0.3	6.2	7.6	5.1	0.6
600	40.378988	-80.653994	7.3	8.3	6.2	0.5	6.6	7.8	5.8	0.5
650	40.378931	-80.654151	7.1	8.3	6.3	0.5	7.0	8.4	6.2	0.5
700	40.378880	-80.654313	7.8	9.6	6.8	0.8	6.2	7.4	4.6	0.8
750	40.378836	-80.654475	8.1	9.0	7.4	0.3	6.1	6.8	5.2	0.3
800	40.378800	-80.654645	8.8	9.5	7.9	0.4	5.2	6.4	4.3	0.6
850	40.378769	-80.654815	8.9	9.8	7.9	0.4	5.2	6.3	4.4	0.5
900	40.378745	-80.654988	8.4	9.8	7.2	0.6	5.9	7.0	5.3	0.5
950	40.378728	-80.655161	8.8	9.9	7.7	0.6	5.7	6.8	4.4	0.6
1000	40.378717	-80.655339	9.2	10.2	8.4	0.4	5.1	7.1	4.2	0.5
1050	40.378716	-80.655516	10.0	11.1	9.2	0.5	5.5	6.3	4.6	0.5
1100	40.378722	-80.655689	8.7	9.7	7.7	0.5	5.8	6.9	4.9	0.5
1150	40.378731	-80.655868	9.2	11.1	7.7	1.0	5.4	6.8	3.3	1.1
1200	40.378749	-80.656046	8.5	9.8	7.5	0.5	5.9	7.4	5.1	0.5
1250	40.378775	-80.656222	7.7	8.5	7.0	0.4	6.3	7.5	5.1	0.5
1300	40.378807	-80.656392	8.5	10.8	7.1	0.9	5.5	6.9	4.2	0.9
1350	40.378845	-80.656563	8.1	9.8	7.2	0.7	5.5	6.9	4.3	0.7
1400	40.378884	-80.656734	7.9	8.6	6.9	0.4	5.4	6.4	3.9	0.6
1450	40.378923	-80.656903	8.2	9.4	7.4	0.5	4.7	5.3	3.8	0.4
1500	40.378959	-80.657071	7.9	9.0	6.8	0.4	6.2	8.1	4.8	0.9
1550	40.378996	-80.657240	8.2	9.1	6.7	0.5	6.2	7.4	5.2	0.6
1600	40.379033	-80.657405	9.0	9.6	7.7	0.4	5.4	6.6	4.3	0.5
1650	40.379072	-80.657574	7.7	8.2	7.2	0.2	7.0	7.6	6.6	0.2
1700	40.379114	-80.657749	7.6	8.0	6.5	0.2	7.3	8.1	6.6	0.4
1750	40.379154	-80.657922	7.5	8.9	6.5	0.5	7.1	7.8	5.8	0.5
1800	40.379193	-80.658092	8.0	8.3	7.5	0.2	6.2	6.9	5.0	0.5
1850	40.379232	-80.658261	8.0	8.6	7.3	0.4	6.1	7.4	5.1	0.7
1900	40.379271	-80.658431	8.4	8.9	7.8	0.3	6.2	6.9	5.4	0.3
1950	40.379309	-80.658601	8.2	8.8	7.4	0.3	6.5	7.4	5.4	0.4
2000	40.379340	-80.658771	8.9	9.5	8.5	0.2	5.3	6.6	4.5	0.6
2050	40.379366	-80.658946	8.8	9.6	8.1	0.4	5.7	6.7	4.6	0.6
2100	40.379388	-80.659124	8.9	9.8	8.2	0.4	5.1	5.9	4.1	0.4
2150	40.379401	-80.659295	9.1	9.5	8.1	0.3	5.1	5.9	4.4	0.4
2200	40.379409	-80.659473	8.2	9.2	7.6	0.4	5.8	7.4	4.8	0.7
2250	40.379408	-80.659652	7.8	8.4	7.1	0.4	6.5	7.5	5.4	0.5
2300	40.379399	-80.659829	8.1	8.7	7.3	0.3	6.5	7.7	5.7	0.4
2350	40.379385	-80.660004	7.9	8.8	7.2	0.3	6.9	7.6	6.2	0.3
2400	40.379364	-80.660182	8.0	8.6	7.0	0.3	6.9	7.8	5.7	0.5
2450	40.379335	-80.660357	8.0	8.8	7.0	0.5	6.6	7.6	5.0	0.5
2500	40.379299	-80.660529	8.5	9.1	7.7	0.3	5.9	7.1	4.8	0.6
2550	40.379258	-80.660701	8.5	9.2	7.2	0.4	6.0	6.9	4.6	0.5
2600	40.379211	-80.660867	8.1	9.8	7.1	0.5	6.5	7.4	5.4	0.4
2650	40.379157	-80.661030	7.4	8.5	6.6	0.5	6.4	7.0	5.6	0.4
2700	40.379097	-80.661187	7.0	8.0	6.2	0.5	6.9	7.9	5.7	0.6
2750	40.379032	-80.661344	7.9	8.9	7.1	0.5	6.2	7.4	4.9	0.8
2800	40.378959	-80.661493	8.0	8.8	6.8	0.6	6.1	7.1	4.3	0.6
2850	40.378881	-80.661638	9.1	9.7	8.2	0.3	5.6	6.4	5.0	0.3

John Scott Highway Westbound Shoulder										
GPR File #	Total Distance (ft)		Average Concrete Dielectric			8.76	Average Base Dielectric			9.46
14	4,329		Average Concrete Thickness (in)				Average Base Thickness (in)			
Dist.(ft)	Lat(°)	Long(°)	Average	Max	Min	Standard Deviation	Average	Max	Min	Standard Deviation
2900	40.378801	-80.661781	8.9	9.3	8.3	0.3	5.7	6.3	5.2	0.3
2950	40.378721	-80.661923	8.6	9.3	7.9	0.3	6.2	7.0	5.2	0.5
3000	40.378641	-80.662068	8.3	9.6	7.2	0.6	6.5	7.8	4.9	0.7
3050	40.378562	-80.662213	7.8	8.8	7.1	0.5	6.5	8.1	5.6	0.6
3100	40.378486	-80.662363	8.4	9.3	7.6	0.4	5.5	6.8	4.1	0.5
3150	40.378408	-80.662513	8.0	8.9	7.4	0.4	6.4	7.4	5.1	0.6
3200	40.378330	-80.662651	8.7	10.3	7.1	0.7	5.9	7.3	4.2	0.9
3250	40.378254	-80.662790	8.0	8.9	7.4	0.4	6.6	7.6	5.5	0.4
3300	40.378183	-80.662946	7.6	8.0	6.9	0.3	6.9	7.8	5.8	0.5
3350	40.378116	-80.663100	7.3	7.9	6.8	0.2	6.7	7.7	6.0	0.4
3400	40.378057	-80.663253	7.7	9.0	7.1	0.4	5.8	7.4	4.2	1.0
3450	40.378004	-80.663412	8.0	8.8	7.1	0.4	5.1	5.8	4.4	0.3
3500	40.377957	-80.663581	8.0	9.2	7.2	0.5	5.4	6.3	4.2	0.6
3550	40.377917	-80.663752	7.6	8.5	6.7	0.4	6.6	7.5	5.5	0.6
3600	40.377883	-80.663924	7.7	9.0	6.7	0.5	6.3	7.2	4.1	0.8
3650	40.377857	-80.664096	8.3	9.5	6.6	0.7	6.3	7.6	4.9	0.7
3700	40.377838	-80.664271	8.4	9.1	7.8	0.3	5.9	6.8	5.1	0.5
3750	40.377825	-80.664447	8.4	8.9	7.8	0.2	6.3	8.1	5.7	0.4
3800	40.377819	-80.664623	9.1	9.7	8.1	0.4	5.4	7.0	4.2	0.7
3850	40.377822	-80.664801	8.8	9.3	8.3	0.3	5.1	6.0	4.1	0.5
3900	40.377828	-80.664977	8.6	9.2	7.7	0.4	5.4	7.0	4.8	0.5
3950	40.377846	-80.665153	7.3	8.5	6.2	0.7	7.2	7.9	6.4	0.3
4000	40.377870	-80.665327	7.9	8.7	7.5	0.3	6.2	7.4	5.1	0.5
4050	40.377899	-80.665497	7.6	8.7	6.4	0.5	6.8	7.5	5.2	0.5
4100	40.377935	-80.665668	8.5	9.6	7.1	0.6	6.3	7.8	5.0	0.7
4150	40.377974	-80.665839	8.1	9.1	6.7	0.6	6.6	8.3	5.4	0.7
4200	40.378014	-80.666011	7.9	8.9	7.2	0.3	6.4	7.6	4.9	0.5
4250	40.378055	-80.666183	8.5	9.4	7.8	0.4	5.9	7.2	4.9	0.6
4300	40.378094	-80.666357	7.6	8.6	6.8	0.5	6.5	7.3	5.4	0.4

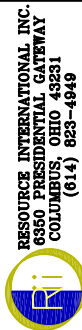
APPENDIX B

GPR Void Maps

GPR VOID MAP
JOHN SCOTT HIGHWAY
FROM KINGSTON AVE TO SR 22 ON RAMP
JEFFERSON COUNTY
STATE OF OHIO



GPR VOID MAP
JOHN SCOTT HIGHWAY
FROM KINGSTON AVE
TO SR 22 ON RAMP
JEFFERSON COUNTY
STATE OF OHIO



DRAWN BY:	DTF	DATE:	3-29-2019
CHECKED BY:	CAY	DRAWING NO.:	1
JOB NO.:	W-19-025	SHEET:	1 OF 1



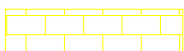
LEGEND



LARGE VOIDS



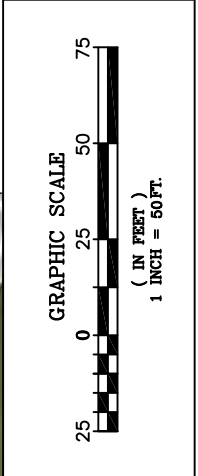
SMALL VOIDS



PATCHES

Figure B-1

GPR VOID MAP
JOHN SCOTT HIGHWAY
FROM KINGSTON AVE TO SR 22 ON RAMP
JEFFERSON COUNTY
STATE OF OHIO



GPR VOID MAP
JOHN SCOTT HIGHWAY
FROM KINGSTON AVE
TO SR 22 ON RAMP
JEFFERSON COUNTY
STATE OF OHIO

RESOURCE INTERNATIONAL INC.
6350 PRESIDENTIAL GATEWAY
COLUMBUS, OHIO 43231
(614) 823-4848

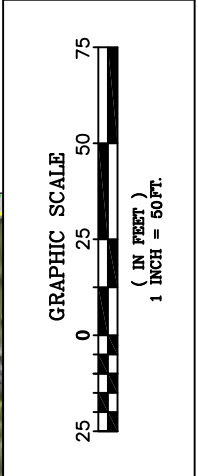
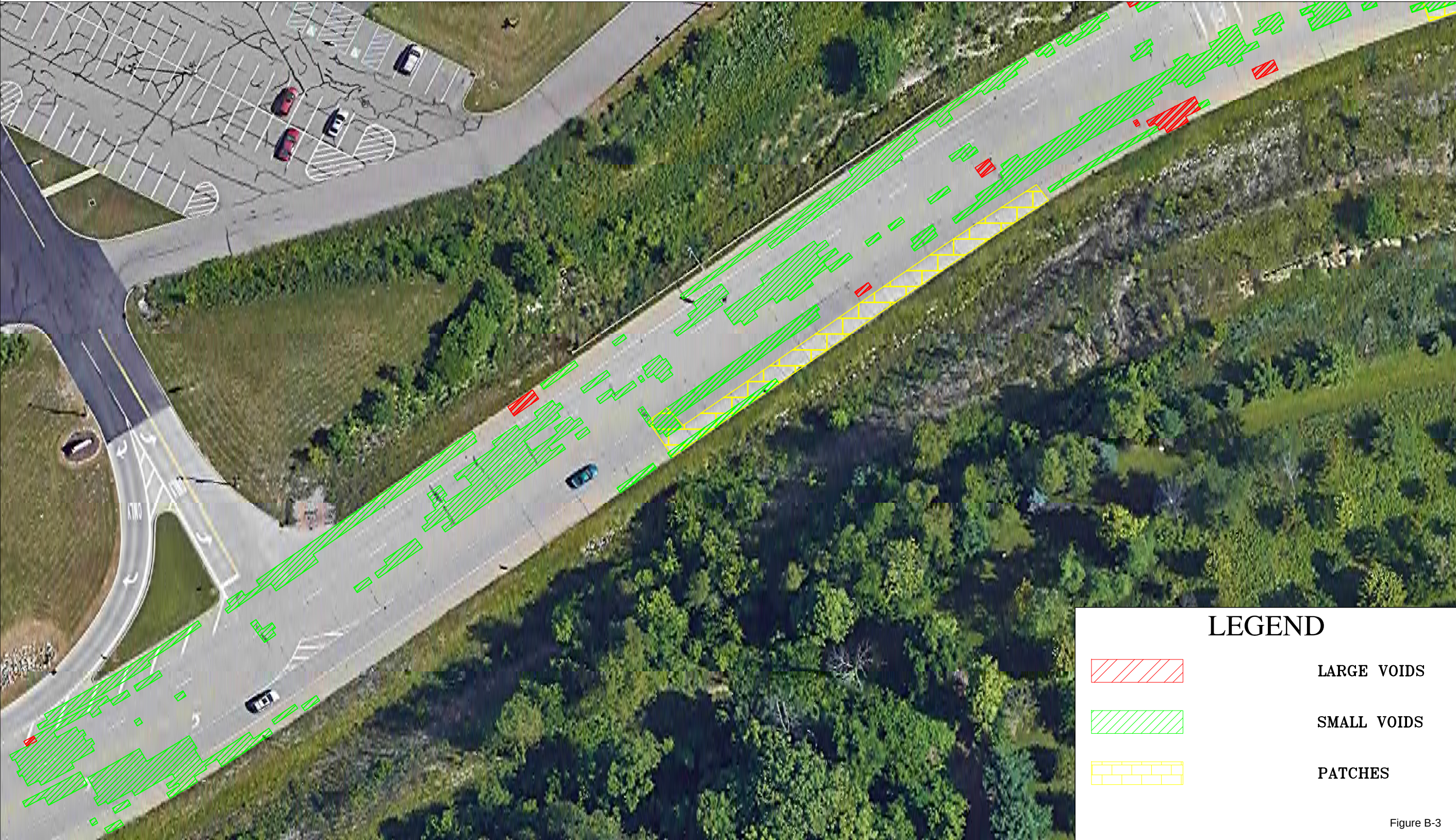
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CHECKED BY:	CAY	DRAWING NO.:	2
JOB NO.:	W-19-025	SHEET:	1 OF 1

LEGEND

- LARGE VOIDS
- SMALL VOIDS
- PATCHES

Figure B-2

GPR VOID MAP
JOHN SCOTT HIGHWAY
FROM KINGSTON AVE TO SR 22 ON RAMP
JEFFERSON COUNTY
STATE OF OHIO



GPR VOID MAP
JOHN SCOTT HIGHWAY
FROM KINGSTON AVE
TO SR 22 ON RAMP
JEFFERSON COUNTY
STATE OF OHIO

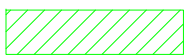


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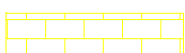
LEGEND



LARGE VOIDS



SMALL VOIDS



PATCHES

DRAWN BY:	DTF	DATE:	3-29-2019
CHECKED BY:	CAY	DRAWING NO.:	3
JOB NO.:	W-19-025	SHEET:	1 OF 1

Figure B-3

GPR VOID MAP
JOHN SCOTT HIGHWAY
FROM KINGSTON AVE TO SR 22 ON RAMP
JEFFERSON COUNTY
STATE OF OHIO





GRAPHIC SCALE
25 0 25 50 75
(IN FEET)
1 INCH = 50 FT.

GPR VOID MAP
JOHN SCOTT HIGHWAY
FROM KINGSTON AVE
TO SR 22 ON RAMP
JEFFERSON COUNTY
STATE OF OHIO

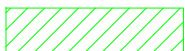


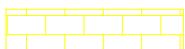
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CHECKED BY:	CAY	DRAWING NO.:	4
JOB NO.:	W-19-025	SHEET:	1 OF 1

LEGEND

- 

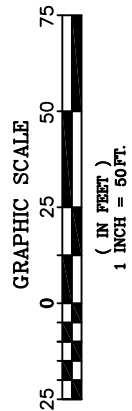
LARGE VOIDS
- 

SMALL VOIDS
- 

PATCHES

Figure B-4

GPR VOID MAP
JOHN SCOTT HIGHWAY
FROM KINGSTON AVE TO SR 22 ON RAMP
JEFFERSON COUNTY
STATE OF OHIO



GPR VOID MAP
JOHN SCOTT HIGHWAY
FROM KINGSTON AVE
TO SR 22 ON RAMP
JEFFERSON COUNTY
STATE OF OHIO

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CHECKED BY:	CAY	DRAWING NO.:	5
JOB NO.:	W-19-025	SHEET:	1 OF 1



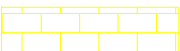
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LARGE VOIDS



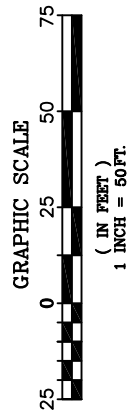
SMALL VOIDS



PATCHES

Figure B-5

GPR VOID MAP
JOHN SCOTT HIGHWAY
FROM KINGSTON AVE TO SR 22 ON RAMP
JEFFERSON COUNTY
STATE OF OHIO



GPR VOID MAP
JOHN SCOTT HIGHWAY
FROM KINGSTON AVE
TO SR 22 ON RAMP
JEFFERSON COUNTY
STATE OF OHIO

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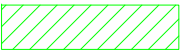


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CHECKED BY:	CAY	DRAWING NO.:	6
JOB NO.:	W-19-025	SHEET:	1 OF 1

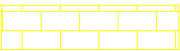
LEGEND



LARGE VOIDS



SMALL VOIDS

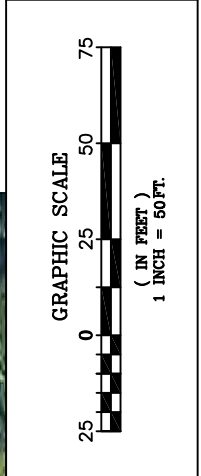


PATCHES



Figure B-6

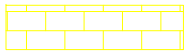
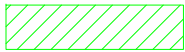
GPR VOID MAP
JOHN SCOTT HIGHWAY
FROM KINGSTON AVE TO SR 22 ON RAMP
JEFFERSON COUNTY
STATE OF OHIO



GPR VOID MAP
JOHN SCOTT HIGHWAY
FROM KINGSTON AVE
TO SR 22 ON RAMP
JEFFERSON COUNTY
STATE OF OHIO



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LEGEND

LARGE VOIDS

SMALL VOIDS

PATCHES

DRAWN BY:	DTF	DATE:	3-29-2019
CHECKED BY:	CAY	DRAWING NO.:	7
JOB NO.:	W-19-025	SHEET:	1 OF 1

Figure B-7

GPR VOID MAP
JOHN SCOTT HIGHWAY
FROM KINGSTON AVE TO SR 22 ON RAMP
JEFFERSON COUNTY
STATE OF OHIO



Legend

Large Voids

Small Voids

Patches

GRAPHIC SCALE

(IN FEET)

1 INCH = 50 FT.

GPR VOID MAP

JOHN SCOTT HIGHWAY

FROM KINGSTON AVE

TO SR 22 ON RAMP

JEFFERSON COUNTY

STATE OF OHIO

RESOURCE INTERNATIONAL INC.

6350 PRESIDENTIAL GATEWAY

COLUMBUS, OHIO 43231

(614) 823-4848

DRAWN BY:	DTF	DATE:	3-29-2019
CHECKED BY:	CAY	DRAWING NO.:	8
JOB NO.:	W-19-025	SHEET:	1 OF 1

Figure B-8

APPENDIX C

FWD & LTE Test Location Maps

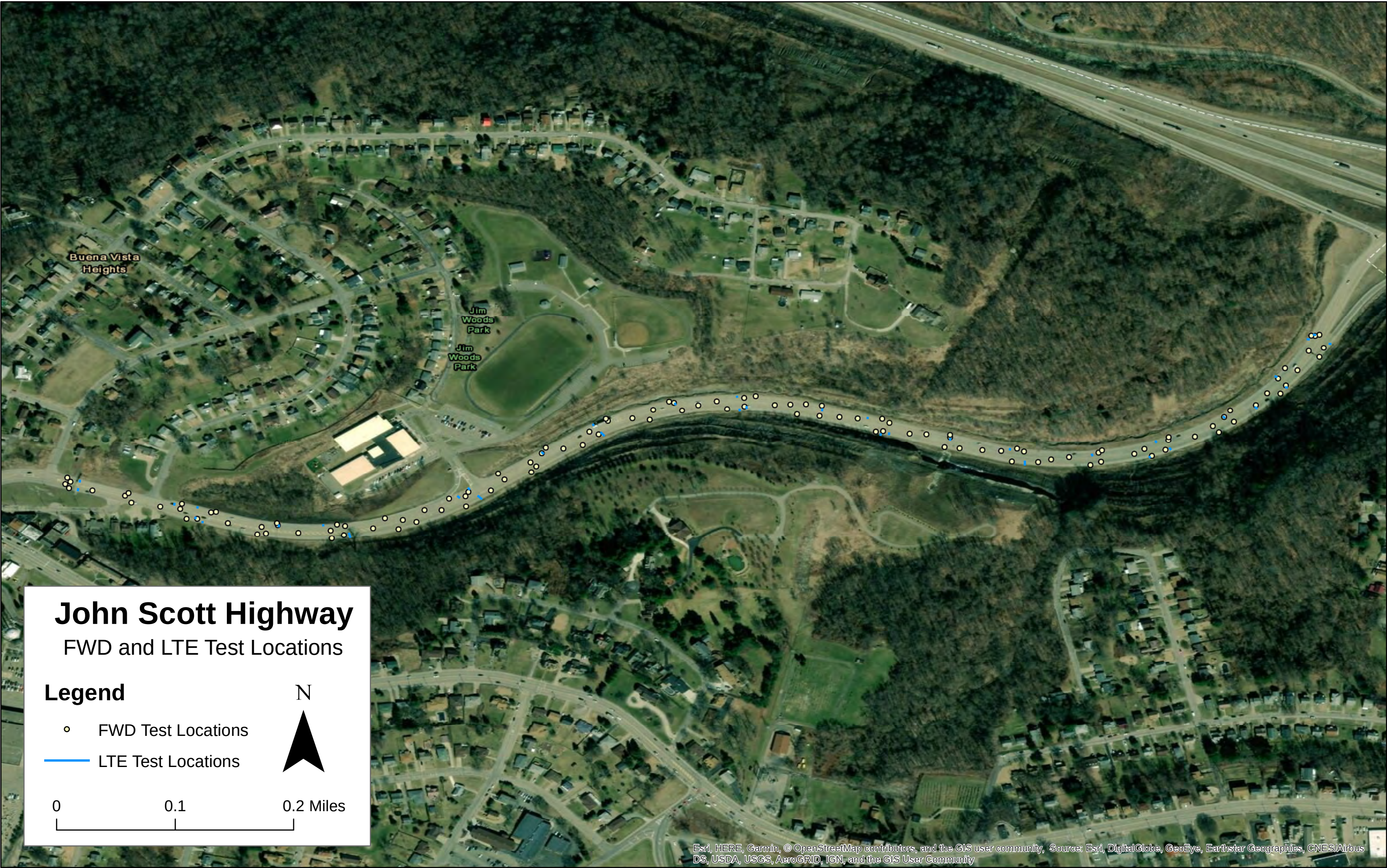
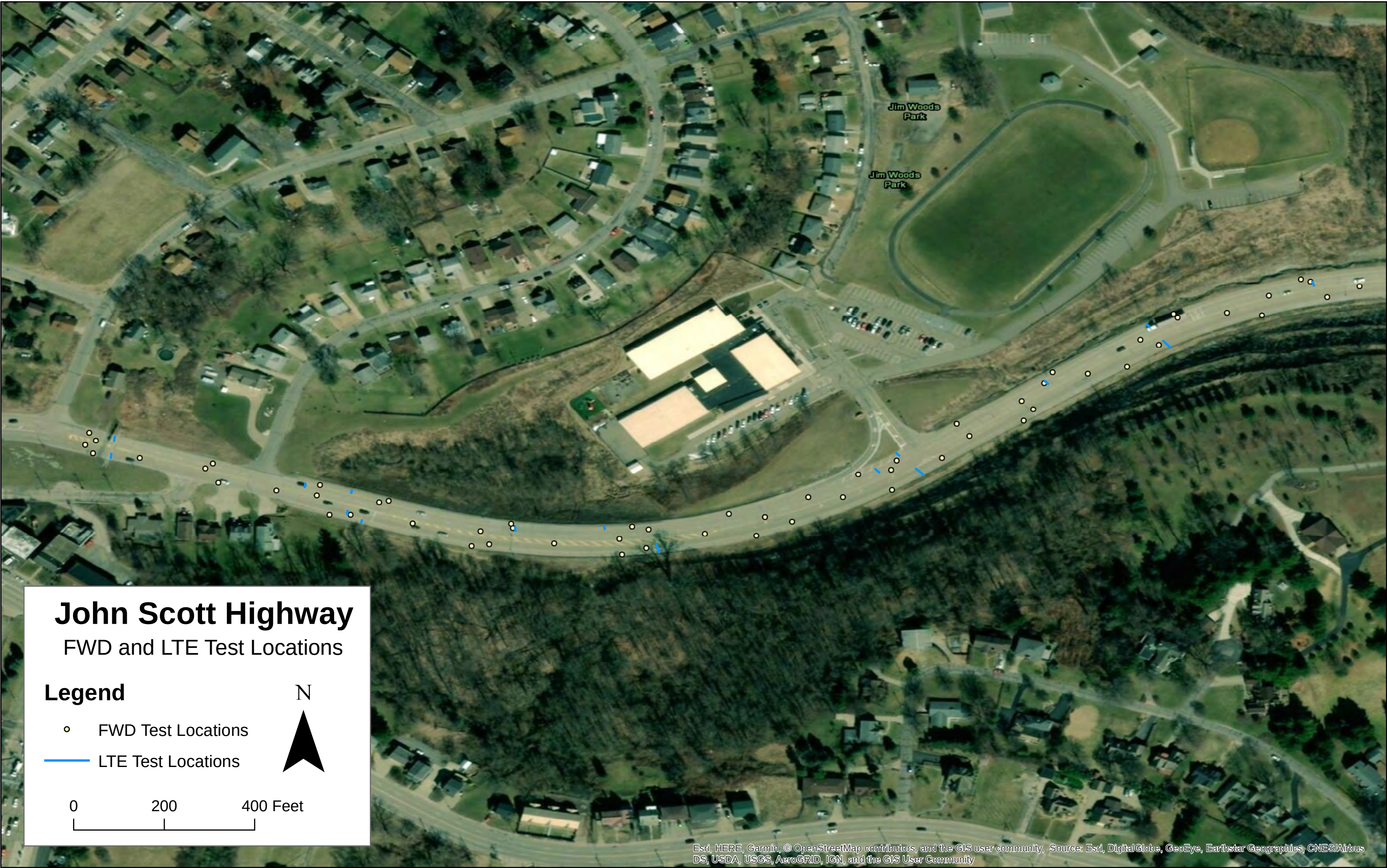


Figure C-1



John Scott Highway

FWD and LTE Test Locations

Legend

- FWD Test Locations
- LTE Test Locations

N



0 200 400 Feet

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Figure C-2



Figure C-3

APPENDIX D

Listing of Normalized FWD Raw Data &
Results of Back-calculated Elastic Moduli of
Pavement Layers

Table D1. Listing of Normalized FWD Data collected fom John Scott Highway pavement at 11:07 am on 3/20/2019

Location: John Scott Highway Eastbound Passing Lane
Start: Kingston Ave

Direction: EB
End: SR 22 on Ramp

Chainage (feet)	Drop No.	Stress (psi)	Load (lbs.)	Deflections, mils.									Temp. deg, F		GPS Data	
				D1 (0")	D2 (8")	D3 (12")	D4 (-12")	D5 (18")	D6 (24")	D7 (36")	D8 (48")	D9 (60")	Surface	Air	Latitude	Longitude
7	1	88.4	10,000	8.68	8.44	8.14	8.05	7.83	7.33	6.29	5.20	4.21	65.3	56.0	40.378314	-80.667711
7	2	88.4	10,000	8.66	8.43	8.14	8.02	7.82	7.32	6.25	5.18	4.19	65.3	56.0	40.378314	-80.667711
7	3	88.4	10,000	8.63	8.39	8.09	7.99	7.80	7.30	6.24	5.17	4.16	65.3	56.0	40.378314	-80.667711
105	1	88.4	10,000	10.93	10.88	10.64	9.71	10.47	9.96	8.84	7.65	6.53	64.6	56.0	40.378236	-80.667381
105	2	88.4	10,000	11.01	10.92	10.70	9.75	10.55	10.01	8.90	7.71	6.58	64.6	56.0	40.378236	-80.667381
105	3	88.4	10,000	11.12	11.03	10.81	9.84	10.64	10.11	8.97	7.79	6.65	64.6	56.0	40.378236	-80.667381
349	1	88.4	10,000	4.51	4.41	4.26	3.86	4.10	3.81	3.22	2.65	2.12	65.6	56.0	40.378039	-80.666553
349	2	88.4	10,000	4.53	4.42	4.26	3.88	4.10	3.82	3.22	2.66	2.12	65.6	56.0	40.378039	-80.666553
349	3	88.4	10,000	4.50	4.38	4.24	3.84	4.07	3.79	3.20	2.64	2.11	65.6	56.0	40.378039	-80.666553
595	1	88.4	10,000	3.95	3.69	3.46	3.46	3.18	2.83	2.23	1.69	1.31	64.3	56.0	40.377839	-80.665728
595	2	88.4	10,000	3.96	3.70	3.48	3.46	3.19	2.85	2.22	1.69	1.32	64.3	56.0	40.377839	-80.665728
595	3	88.4	10,000	3.97	3.71	3.49	3.47	3.20	2.85	2.24	1.69	1.32	64.3	56.0	40.377839	-80.665728
839	1	88.4	10,000	6.51	6.13	5.82	5.84	5.50	4.99	3.99	3.05	2.22	62.6	56.0	40.377717	-80.664869
839	2	88.4	10,000	6.47	6.11	5.81	5.82	5.48	4.97	3.99	3.04	2.19	62.6	56.0	40.377717	-80.664869
839	3	88.4	10,000	6.50	6.13	5.83	5.86	5.49	4.98	3.99	3.04	2.19	62.6	56.0	40.377717	-80.664869
1,096	1	88.4	10,000	8.44	8.33	8.16	7.41	8.04	7.69	6.97	6.22	5.47	58.7	56.0	40.377775	-80.663956
1,096	2	88.4	10,000	8.45	8.36	8.19	7.44	8.05	7.71	6.99	6.24	5.50	58.7	56.0	40.377775	-80.663956
1,096	3	88.4	10,000	8.42	8.33	8.16	7.41	8.03	7.70	6.98	6.24	5.48	58.7	56.0	40.377775	-80.663956
1,345	1	88.4	10,000	8.61	8.34	8.07	7.76	7.82	7.35	6.37	5.40	4.47	62.0	56.0	40.377997	-80.663119
1,345	2	88.4	10,000	8.62	8.34	8.07	7.77	7.81	7.34	6.35	5.38	4.45	62.0	56.0	40.377997	-80.663119
1,345	3	88.4	10,000	8.55	8.27	8.01	7.70	7.76	7.29	6.29	5.33	4.40	62.0	56.0	40.377997	-80.663119
1,600	1	88.4	10,000	7.00	6.79	6.53	6.01	6.30	5.86	5.01	4.22	3.50	60.6	56.0	40.378369	-80.662353
1,600	2	88.4	10,000	6.95	6.73	6.49	5.96	6.26	5.82	4.99	4.22	3.50	60.6	56.0	40.378369	-80.662353
1,600	3	88.4	10,000	6.97	6.74	6.51	5.98	6.28	5.84	5.00	4.23	3.49	60.6	56.0	40.378369	-80.662353
1,845	1	88.4	10,000	5.29	4.94	4.68	4.57	4.38	3.94	3.09	2.30	1.64	62.0	56.0	40.378747	-80.661636
1,845	2	88.4	10,000	5.24	4.91	4.65	4.52	4.34	3.90	3.06	2.28	1.62	62.0	56.0	40.378747	-80.661636
1,845	3	88.4	10,000	5.25	4.91	4.65	4.55	4.33	3.91	3.06	2.28	1.62	62.0	56.0	40.378747	-80.661636
2,122	1	88.4	10,000	11.77	11.44	11.01	10.74	10.55	9.73	8.19	6.62	5.20	64.9	56.0	40.379117	-80.660792
2,122	2	88.4	10,000	11.75	11.43	11.01	10.74	10.53	9.72	8.18	6.62	5.21	64.9	56.0	40.379117	-80.660792
2,122	3	88.4	10,000	11.80	11.48	11.05	10.78	10.59	9.77	8.22	6.66	5.23	64.9	56.0	40.379117	-80.660792
2,356	1	88.4	10,000	8.08	7.71	7.36	7.38	7.04	6.47	5.31	4.18	3.19	66.9	56.0	40.379275	-80.659989
2,356	2	88.4	10,000	8.01	7.66	7.31	7.34	6.98	6.41	5.29	4.16	3.17	66.9	56.0	40.379275	-80.659989
2,356	3	88.4	10,000	8.06	7.69	7.35	7.36	7.02	6.44	5.29	4.17	3.17	66.9	56.0	40.379275	-80.659989
2,619	1	88.4	10,000	11.67	11.27	10.87	10.92	10.47	9.76	8.25	6.72	5.32	66.6	56.0	40.379278	-80.659056
2,619	2	88.4	10,000	11.55	11.15	10.77	10.82	10.37	9.68	8.19	6.66	5.26	66.6	56.0	40.379278	-80.659056
2,619	3	88.4	10,000	11.64	11.25	10.86	10.92	10.45	9.75	8.25	6.71	5.30	66.6	56.0	40.379278	-80.659056

Table D1. Listing of Normalized FWD Data collected fom John Scott Highway pavement at 11:07 am on 3/20/2019

Location: John Scott Highway Eastbound Passing Lane
Start: Kingston Ave

Direction: EB
End: SR 22 on Ramp

Chainage (feet)	Drop No.	Stress (psi)	Load (lbs.)	Deflections, mils.									Temp. deg, F		GPS Data	
				D1 (0")	D2 (8")	D3 (12")	D4 (-12")	D5 (18")	D6 (24")	D7 (36")	D8 (48")	D9 (60")	Surface	Air	Latitude	Longitude
2,850	1	88.4	10,000	12.94	12.77	12.48	11.89	12.27	11.71	10.41	8.97	7.47	65.9	56.0	40.379131	-80.658267
2,850	2	88.4	10,000	12.91	12.74	12.46	11.84	12.26	11.69	10.41	8.96	7.48	65.9	56.0	40.379131	-80.658267
2,850	3	88.4	10,000	12.96	12.79	12.51	11.88	12.31	11.73	10.45	9.01	7.52	65.9	56.0	40.379131	-80.658267
3,103	1	88.4	10,000	5.76	5.48	5.22	5.07	4.95	4.49	3.65	2.84	2.12	63.9	56.0	40.378928	-80.657411
3,103	2	88.4	10,000	5.71	5.43	5.17	5.02	4.90	4.46	3.61	2.82	2.11	63.9	56.0	40.378928	-80.657411
3,103	3	88.4	10,000	5.75	5.48	5.21	5.07	4.94	4.50	3.65	2.84	2.13	63.9	56.0	40.378928	-80.657411
3,364	1	88.4	10,000	4.29	4.15	4.00	3.71	3.83	3.56	3.02	2.49	2.02	64.6	56.0	40.378728	-80.656522
3,364	2	88.4	10,000	4.21	4.08	3.94	3.65	3.77	3.50	2.97	2.46	1.99	64.6	56.0	40.378728	-80.656522
3,364	3	88.4	10,000	4.22	4.08	3.92	3.64	3.76	3.50	2.97	2.44	1.99	64.6	56.0	40.378728	-80.656522
3,601	1	88.4	10,000	3.46	3.23	3.05	2.94	2.84	2.56	2.00	1.51	1.12	63.6	56.0	40.378617	-80.655683
3,601	2	88.4	10,000	3.42	3.19	3.02	2.90	2.81	2.52	1.98	1.50	1.10	63.6	56.0	40.378617	-80.655683
3,601	3	88.4	10,000	3.44	3.20	3.03	2.91	2.81	2.53	1.99	1.50	1.11	63.6	56.0	40.378617	-80.655683
3,886	1	88.4	10,000	4.82	4.63	4.36	4.31	4.06	3.66	2.92	2.29	1.82	63.0	56.0	40.378683	-80.654669
3,886	2	88.4	10,000	4.84	4.63	4.36	4.31	4.06	3.67	2.92	2.31	1.84	63.0	56.0	40.378683	-80.654669
3,886	3	88.4	10,000	4.84	4.64	4.37	4.33	4.06	3.67	2.93	2.32	1.84	63.0	56.0	40.378683	-80.654669
4,109	1	88.4	10,000	11.68	11.38	11.08	11.25	10.92	10.26	8.50	6.85	5.53	58.3	56.0	40.378894	-80.653931
4,109	2	88.4	10,000	11.83	11.52	11.22	11.40	11.05	10.37	8.58	6.92	5.57	58.3	56.0	40.378894	-80.653931
4,109	3	88.4	10,000	11.80	11.49	11.20	11.38	11.03	10.34	8.56	6.90	5.56	58.3	56.0	40.378894	-80.653931
4,359	1	88.4	10,000	5.04	4.74	4.49	4.45	4.18	3.78	3.04	2.37	1.86	52.1	56.0	40.379278	-80.653186
4,359	2	88.4	10,000	5.04	4.72	4.48	4.45	4.17	3.77	3.02	2.37	1.83	52.1	56.0	40.379278	-80.653186
4,359	3	88.4	10,000	5.08	4.78	4.53	4.51	4.21	3.82	3.06	2.38	1.85	52.1	56.0	40.379278	-80.653186
4,569	1	88.4	10,000	9.30	9.29	9.17	8.11	9.13	8.85	8.19	7.46	6.74	59.0	56.0	40.379706	-80.652681
4,569	2	88.4	10,000	9.26	9.24	9.13	8.07	9.09	8.81	8.14	7.42	6.70	59.0	56.0	40.379706	-80.652681
4,569	3	88.4	10,000	9.29	9.29	9.17	8.10	9.11	8.84	8.17	7.45	6.72	59.0	56.0	40.379706	-80.652681

Data in Yellow was not used in Backcalcuation of layer Moduli

Table D2. Listing of Backcalculated Moduli of pavement layers, John Scott Highway pavement (compiled on 3/20/2019)

Location: John Scott Highway Eastbound Passing Lane						Direction: EB						
Start: Kingston Ave						End: SR 22 on Ramp						
Test No.	Chainage (feet)	Drop	Layer Thickness, in.			Backcalculated E, ksi.			RMS (%)	Concrete Temp °F	Latitude	Longitude
			H1	H2	H3	E1	E2	E3				
1	7	3	8.5	5.5	0.0	2,491.130	45.671	13.331	0.2	65.3	40.378314	-80.667711
2	105	3	8.5	5.5	0.0	2,969.493	42.594	8.102	0.2	64.6	40.378236	-80.667381
3	349	3	8.5	5.5	0.0	5,583.739	82.539	19.859	0.1	65.6	40.378039	-80.666553
4	595	3	8.5	5.5	0.0	4,939.937	74.498	22.021	0.1	64.3	40.377839	-80.665728
5	839	3	8.5	5.5	0.0	3,000.000	55.000	13.786	0.1	62.6	40.377717	-80.664869
6	1,096	3	8.5	5.5	0.0	4,709.637	81.594	9.628	0.1	58.7	40.377775	-80.663956
7	1,345	3	8.5	5.5	0.0	3,105.692	42.350	12.454	0.1	62.0	40.377997	-80.663119
8	1,600	3	8.5	5.5	0.0	3,383.016	46.132	16.294	0.1	60.6	40.378369	-80.662353
9	1,845	3	8.5	5.5	0.0	3,629.433	48.270	17.800	0.1	62.0	40.378747	-80.661636
10	2,122	3	8.5	5.5	0.0	1,642.167	36.797	10.214	0.3	64.9	40.379117	-80.660792
11	2,356	3	8.5	5.5	0.0	2,079.017	36.383	16.913	0.2	66.9	40.379275	-80.659989
12	2,619	3	8.5	5.5	0.0	1,871.115	29.626	10.088	0.3	66.6	40.379278	-80.659056
13	2,850	3	8.5	5.5	0.0	2,617.556	31.509	7.019	0.3	65.9	40.379131	-80.658267
14	3,103	3	8.5	5.5	0.0	4,002.075	44.439	14.817	0.1	63.9	40.378928	-80.657411
15	3,364	3	8.5	5.5	0.0	5,150.999	65.185	28.500	0.1	64.6	40.378728	-80.656522
16	3,601	3	8.5	5.5	0.0	5,273.494	97.192	27.760	0.1	63.6	40.378617	-80.655683
17	3,886	3	8.5	5.5	0.0	3,990.504	76.817	19.202	0.1	63.0	40.378683	-80.654669
18	4,109	3	8.5	5.5	0.0	1,771.470	29.525	9.842	0.4	58.3	40.378894	-80.653931
19	4,359	3	8.5	5.5	0.0	4,002.075	66.384	17.687	0.1	52.1	40.379278	-80.653186
20	4,569	3	8.5	5.5	0.0	5,911.112	82.259	7.338	0.1	59.0	40.379706	-80.652681
					Average	3606.183	55.738	15.133				
					Min	1642.167	29.525	7.019				
					Max	5911.112	97.192	28.500				
					Std Dev	1298.232	20.281	6.078				

Table D3. Listing of Normalized FWD Data collected fom John Scott Highway pavement at 10:16 am on 3/20/2019

Location: John Scott Highway Eastbound Driving Lane
Start: Kingston Ave

Direction: EB
End: SR 22 on Ramp

Chainage (feet)	Drop No.	Stress (psi)	Load (lbs.)	Deflections, mils.									Temp. deg, F		GPS Data	
				D1 (0")	D2 (8")	D3 (12")	D4 (-12")	D5 (18")	D6 (24")	D7 (36")	D8 (48")	D9 (60")	Surface	Air	Latitude	Longitude
22	1	88.4	10,000	7.58	6.94	6.52	6.78	6.04	5.42	4.32	3.22	2.36	57.3	50.4	40.378264	-80.667664
22	2	88.4	10,000	7.65	6.99	6.57	6.84	6.08	5.48	4.35	3.26	2.39	57.3	50.4	40.378264	-80.667664
22	3	88.4	10,000	7.66	7.01	6.58	6.85	6.08	5.49	4.35	3.26	2.38	57.3	50.4	40.378264	-80.667664
249	1	88.4	10,000	5.50	5.26	5.08	4.86	4.89	4.57	2.89	0.78	0.65	55.7	50.4	40.378086	-80.666906
249	2	88.4	10,000	5.52	5.29	5.09	4.89	4.89	4.59	2.87	0.78	0.64	55.7	50.4	40.378086	-80.666906
249	3	88.4	10,000	5.51	5.28	5.08	4.87	4.89	4.58	2.90	0.78	0.64	55.7	50.4	40.378086	-80.666906
486	1	88.4	10,000	4.73	4.47	4.25	4.06	4.00	3.66	3.02	2.47	0.84	55.0	50.4	40.377892	-80.666103
486	2	88.4	10,000	4.74	4.47	4.27	4.08	4.01	3.68	3.04	2.49	0.87	55.0	50.4	40.377892	-80.666103
486	3	88.4	10,000	4.74	4.47	4.26	4.08	4.01	3.68	3.04	2.47	0.87	55.0	50.4	40.377892	-80.666103
728	1	88.4	10,000	4.82	4.51	4.27	4.20	4.00	3.62	2.91	2.27	1.77	56.0	50.4	40.377711	-80.665264
728	2	88.4	10,000	4.84	4.52	4.29	4.21	4.01	3.63	2.92	2.27	1.77	56.0	50.4	40.377711	-80.665264
728	3	88.4	10,000	4.83	4.52	4.29	4.21	4.01	3.63	2.91	2.28	1.76	56.0	50.4	40.377711	-80.665264
995	1	88.4	10,000	5.18	4.90	4.65	4.67	4.29	3.85	3.04	2.32	1.76	55.4	50.4	40.377689	-80.664311
995	2	88.4	10,000	5.26	4.96	4.69	4.74	4.34	3.90	3.07	2.34	1.78	55.4	50.4	40.377689	-80.664311
995	3	88.4	10,000	5.24	4.96	4.69	4.72	4.33	3.88	3.07	2.34	1.77	55.4	50.4	40.377689	-80.664311
1,250	1	88.4	10,000	4.67	4.22	3.91	4.31	3.52	3.03	2.19	1.46	0.87	50.1	50.4	40.377850	-80.663428
1,250	2	88.4	10,000	4.61	4.17	3.86	4.25	3.47	2.99	2.15	1.44	0.86	50.1	50.4	40.377850	-80.663428
1,250	3	88.4	10,000	4.60	4.16	3.85	4.24	3.46	2.98	2.15	1.43	0.86	50.1	50.4	40.377850	-80.663428
1,543	1	88.4	10,000	5.49	5.01	4.64	5.26	4.17	3.58	2.60	1.80	1.21	49.8	50.4	40.378236	-80.662519
1,543	2	88.4	10,000	5.38	4.92	4.57	5.17	4.08	3.52	2.54	1.76	1.18	49.8	50.4	40.378236	-80.662519
1,543	3	88.4	10,000	5.40	4.94	4.58	5.18	4.10	3.53	2.57	1.78	1.18	49.8	50.4	40.378236	-80.662519
1,730	1	88.4	10,000	2.99	2.75	2.58	2.57	2.37	2.08	1.56	1.06	0.69	50.4	50.4	40.378531	-80.661967
1,730	2	88.4	10,000	2.97	2.74	2.57	2.55	2.35	2.07	1.54	1.05	0.67	50.4	50.4	40.378531	-80.661967
1,730	3	88.4	10,000	2.97	2.74	2.56	2.56	2.35	2.07	1.54	1.05	0.67	50.4	50.4	40.378531	-80.661967
1,986	1	88.4	10,000	4.21	3.95	3.70	3.69	3.37	2.95	2.20	1.53	1.03	57.0	50.4	40.378922	-80.661206
1,986	2	88.4	10,000	4.23	3.94	3.69	3.70	3.36	2.95	2.19	1.52	1.03	57.0	50.4	40.378922	-80.661206
1,986	3	88.4	10,000	4.25	3.96	3.71	3.72	3.38	2.96	2.20	1.52	1.02	57.0	50.4	40.378922	-80.661206
2,294	1	88.4	10,000	4.68	4.46	4.20	4.23	3.88	3.45	2.69	2.02	1.47	58.0	50.4	40.379211	-80.660186
2,294	2	88.4	10,000	4.70	4.46	4.21	4.25	3.89	3.46	2.71	2.02	1.47	58.0	50.4	40.379211	-80.660186
2,294	3	88.4	10,000	4.70	4.47	4.22	4.26	3.90	3.47	2.71	2.01	1.48	58.0	50.4	40.379211	-80.660186
2,512	1	88.4	10,000	4.03	3.77	3.53	3.70	3.21	2.82	2.13	1.52	1.09	57.0	50.4	40.379261	-80.659425
2,512	2	88.4	10,000	4.01	3.75	3.51	3.66	3.18	2.79	2.11	1.51	1.08	57.0	50.4	40.379261	-80.659425
2,512	3	88.4	10,000	4.06	3.78	3.52	3.70	3.21	2.82	2.11	1.51	1.08	57.0	50.4	40.379261	-80.659425
2,773	1	88.4	10,000	4.72	4.35	4.07	4.13	3.76	3.30	2.47	1.73	1.12	59.0	50.4	40.379144	-80.658511
2,773	2	88.4	10,000	4.70	4.33	4.06	4.12	3.75	3.28	2.46	1.72	1.12	59.0	50.4	40.379144	-80.658511
2,773	3	88.4	10,000	4.70	4.31	4.05	4.09	3.73	3.27	2.45	1.72	1.12	59.0	50.4	40.379144	-80.658511

Table D3. Listing of Normalized FWD Data collected fom John Scott Highway pavement at 10:16 am on 3/20/2019

Location: John Scott Highway Eastbound Driving Lane
Start: Kingston Ave

Direction: EB
End: SR 22 on Ramp

Chainage (feet)	Drop No.	Stress (psi)	Load (lbs.)	Deflections, mils.									Temp. deg, F		GPS Data	
				D1 (0")	D2 (8")	D3 (12")	D4 (-12")	D5 (18")	D6 (24")	D7 (36")	D8 (48")	D9 (60")	Surface	Air	Latitude	Longitude
3,001	1	88.4	10,000	4.91	4.53	4.23	4.36	3.80	3.28	2.36	1.53	0.95	57.7	50.4	40.378961	-80.657733
3,001	2	88.4	10,000	4.87	4.50	4.19	4.33	3.76	3.25	2.32	1.52	0.95	57.7	50.4	40.378961	-80.657733
3,001	3	88.4	10,000	4.82	4.46	4.14	4.28	3.72	3.21	2.31	1.50	0.93	57.7	50.4	40.378961	-80.657733
3,271	1	88.4	10,000	4.97	4.62	4.37	4.33	4.08	3.66	2.87	2.14	1.58	56.4	50.4	40.378750	-80.656800
3,271	2	88.4	10,000	4.96	4.62	4.36	4.33	4.07	3.67	2.86	2.14	1.57	56.4	50.4	40.378750	-80.656800
3,271	3	88.4	10,000	4.97	4.63	4.36	4.32	4.08	3.66	2.86	2.13	1.57	56.4	50.4	40.378750	-80.656800
3,547	1	88.4	10,000	6.66	6.40	6.16	5.85	5.93	5.51	4.72	3.97	3.30	56.7	50.4	40.378583	-80.655844
3,547	2	88.4	10,000	6.70	6.42	6.20	5.87	5.95	5.54	4.73	3.98	3.31	56.7	50.4	40.378583	-80.655844
3,547	3	88.4	10,000	6.71	6.45	6.20	5.89	5.97	5.55	4.76	4.00	3.31	56.7	50.4	40.378583	-80.655844
3,764	1	88.4	10,000	4.05	3.69	3.45	3.53	3.15	2.77	2.12	1.57	1.16	54.7	50.4	40.378589	-80.655075
3,764	2	88.4	10,000	4.04	3.68	3.44	3.54	3.14	2.75	2.12	1.57	1.16	54.7	50.4	40.378589	-80.655075
3,764	3	88.4	10,000	4.02	3.67	3.42	3.51	3.12	2.75	2.11	1.57	1.15	54.7	50.4	40.378589	-80.655075
3,991	1	88.4	10,000	4.09	3.69	3.38	3.61	2.98	2.53	1.75	1.10	0.65	54.4	50.4	40.378731	-80.654292
3,991	2	88.4	10,000	4.12	3.70	3.39	3.61	2.98	2.52	1.75	1.11	0.64	54.4	50.4	40.378731	-80.654292
3,991	3	88.4	10,000	4.06	3.65	3.35	3.58	2.94	2.49	1.72	1.09	0.64	54.4	50.4	40.378731	-80.654292
4,260	1	88.4	10,000	4.30	4.02	3.77	3.80	3.48	3.09	2.39	1.77	1.31	44.8	50.4	40.379075	-80.653456
4,260	2	88.4	10,000	4.27	3.99	3.74	3.78	3.45	3.06	2.36	1.74	1.29	44.8	50.4	40.379075	-80.653456
4,260	3	88.4	10,000	4.28	3.99	3.75	3.79	3.45	3.07	2.35	1.74	1.30	44.8	50.4	40.379075	-80.653456
4,503	1	88.4	10,000	4.12	3.84	3.63	3.62	3.36	3.04	2.48	2.07	0.79	44.5	50.4	40.379517	-80.652822
4,503	2	88.4	10,000	4.14	3.84	3.62	3.62	3.35	3.03	2.47	2.04	0.79	44.5	50.4	40.379517	-80.652822
4,503	3	88.4	10,000	4.14	3.85	3.62	3.63	3.35	3.02	2.47	2.04	0.79	44.5	50.4	40.379517	-80.652822
4,716	1	88.4	10,000	5.03	4.77	4.54	4.36	4.25	3.83	3.04	2.30	1.69	43.5	50.4	40.379978	-80.652361
4,716	2	88.4	10,000	5.01	4.75	4.52	4.34	4.21	3.81	3.01	2.28	1.67	43.5	50.4	40.379978	-80.652361
4,716	3	88.4	10,000	5.02	4.76	4.54	4.36	4.23	3.81	3.02	2.29	1.68	43.5	50.4	40.379978	-80.652361

Data in Yellow was not used in Backcalcuation of layer Moduli

Table D4. Listing of Backcalculated Moduli of pavement layers, John Scott Highway pavement (compiled on 3/20/2019)

Location: John Scott Highway Eastbound Driving Lane

Direction: EB

Start: Kingston Ave

End: SR 22 on Ramp

Test No.	Chainage (feet)	Drop	Layer Thickness, in.			Backcalculated E, ksi.			RMS (%)	Concrete Temp °F	Latitude	Longitude
			H1	H2	H3	E1	E2	E3				
1	22	3	8.4	5.8	0.0	2,212.954	45.079	13.663	0.2	57.3	40.378264	-80.667664
2	249	3	8.4	5.8	0.0	2,910.897	32.477	12.652	0.8	55.7	40.378086	-80.666906
3	486	3	8.4	5.8	0.0	4,831.530	53.906	15.992	0.5	55.0	40.377892	-80.666103
4	728	3	8.4	5.8	0.0	4,392.300	69.545	18.442	0.0	56.0	40.377711	-80.665264
5	995	3	8.4	5.8	0.0	3,721.317	53.080	17.905	0.1	55.4	40.377689	-80.664311
6	1,250	3	8.4	5.8	0.0	3,226.163	72.290	17.902	0.1	50.1	40.377850	-80.663428
7	1,543	3	8.4	5.8	0.0	2,705.577	36.988	18.978	0.1	49.8	40.378236	-80.662519
8	1,730	3	8.4	5.8	0.0	5,327.305	88.788	30.925	0.1	50.4	40.378531	-80.661967
9	1,986	3	8.4	5.8	0.0	4,392.300	65.885	17.562	0.1	57.0	40.378922	-80.661206
10	2,294	3	8.4	5.8	0.0	4,192.650	77.040	16.659	0.0	58.0	40.379211	-80.660186
11	2,512	3	8.4	5.8	0.0	4,402.283	73.371	19.853	0.1	57.0	40.379261	-80.659425
12	2,773	3	8.4	5.8	0.0	3,601.305	61.792	18.594	0.1	59.0	40.379144	-80.658511
13	3,001	3	8.4	5.8	0.0	3,142.446	60.812	17.008	0.1	57.7	40.378961	-80.657733
14	3,271	3	8.4	5.8	0.0	4,102.752	52.111	17.545	0.1	56.4	40.378750	-80.656800
15	3,547	3	8.4	5.8	0.0	3,539.817	68.141	16.706	0.1	56.7	40.378583	-80.655844
16	3,764	3	8.4	5.8	0.0	4,508.723	84.945	21.405	0.1	54.7	40.378589	-80.655075
17	3,991	3	8.4	5.8	0.0	3,726.218	58.688	19.276	0.1	54.4	40.378731	-80.654292
18	4,260	3	8.4	5.8	0.0	4,292.913	66.373	20.849	0.1	44.8	40.379075	-80.653456
19	4,503	3	8.4	5.8	0.0	4,611.915	69.878	19.725	0.3	44.5	40.379517	-80.652822
20	4,716	3	8.4	5.8	0.0	3,993.000	54.450	18.290	0.1	43.5	40.379978	-80.652361
					Average	3891.718	62.282	18.496				
					Min	2212.954	32.477	12.652				
					Max	5327.305	88.788	30.925				
					Std Dev	753.918	14.126	3.520				

Table D5. Listing of Normalized FWD Data collected fom John Scott Highway pavement at 9:18 am on 3/20/2019

Location: John Scott Highway Eastbound Shoulder
Start: Kingston Ave

Direction: EB
End: SR 22 on Ramp

Chainage (feet)	Drop No.	Stress (psi)	Load (lbs.)	Deflections, mils.									Temp. deg, F		GPS Data	
				D1 (0")	D2 (8")	D3 (12")	D4 (-12")	D5 (18")	D6 (24")	D7 (36")	D8 (48")	D9 (60")	Surface	Air	Latitude	Longitude
454	1	88.4	10,000	7.35	6.63	6.15	6.92	5.60	4.91	3.70	2.67	1.80	47.8	39.2	40.377892	-80.666231
454	2	88.4	10,000	7.42	6.69	6.22	7.00	5.65	4.95	3.73	2.70	1.81	47.8	39.2	40.377892	-80.666231
454	3	88.4	10,000	7.37	6.67	6.19	6.95	5.63	4.92	3.72	2.69	1.80	47.8	39.2	40.377892	-80.666231
705	1	88.4	10,000	10.70	9.13	8.25	11.94	7.14	5.96	4.07	2.63	1.66	46.1	39.2	40.377700	-80.665369
705	2	88.4	10,000	10.42	8.89	8.02	11.58	6.95	5.80	3.97	2.59	1.62	46.1	39.2	40.377700	-80.665369
705	3	88.4	10,000	10.42	8.90	8.04	11.53	6.96	5.80	3.98	2.60	1.64	46.1	39.2	40.377700	-80.665369
964	1	88.4	10,000	7.18	6.74	6.35	6.92	5.84	5.19	3.95	2.86	1.93	46.5	39.2	40.377650	-80.664458
964	2	88.4	10,000	7.04	6.61	6.23	6.73	5.72	5.08	3.87	2.80	1.90	46.5	39.2	40.377650	-80.664458
964	3	88.4	10,000	7.08	6.64	6.25	6.74	5.75	5.13	3.88	2.82	1.91	46.5	39.2	40.377650	-80.664458
1,195	1	88.4	10,000	5.64	5.21	4.89	4.90	4.49	3.90	2.86	1.90	1.16	42.5	39.2	40.377764	-80.663644
1,195	2	88.4	10,000	5.57	5.14	4.82	4.83	4.42	3.85	2.82	1.88	1.12	42.5	39.2	40.377764	-80.663644
1,195	3	88.4	10,000	5.59	5.16	4.83	4.85	4.43	3.86	2.82	1.89	1.14	42.5	39.2	40.377764	-80.663644
1,447	1	88.4	10,000	7.44	7.05	6.69	6.57	6.29	5.65	4.45	3.28	2.27	43.5	39.2	40.378042	-80.662822
1,447	2	88.4	10,000	7.47	7.10	6.75	6.59	6.34	5.69	4.47	3.32	2.29	43.5	39.2	40.378042	-80.662822
1,447	3	88.4	10,000	7.53	7.15	6.80	6.64	6.39	5.75	4.51	3.36	2.32	43.5	39.2	40.378042	-80.662822
1,718	1	88.4	10,000	9.20	8.59	8.06	8.49	7.46	6.58	4.89	3.33	1.99	41.5	39.2	40.378461	-80.662025
1,718	2	88.4	10,000	9.06	8.47	7.96	8.23	7.37	6.52	4.85	3.33	1.99	41.5	39.2	40.378461	-80.662025
1,718	3	88.4	10,000	9.01	8.43	7.92	8.15	7.34	6.50	4.84	3.33	1.99	41.5	39.2	40.378461	-80.662025
1,930	1	88.4	10,000	7.47	7.20	6.94	6.66	6.68	6.18	5.18	4.20	3.32	46.1	39.2	40.378789	-80.661397
1,930	2	88.4	10,000	7.67	7.39	7.13	6.83	6.86	6.37	5.35	4.36	3.45	46.1	39.2	40.378789	-80.661397
1,930	3	88.4	10,000	7.85	7.56	7.29	6.99	7.03	6.52	5.49	4.48	3.55	46.1	39.2	40.378789	-80.661397
2,190	1	88.4	10,000	5.52	5.15	4.82	4.68	4.45	3.93	2.92	2.05	1.34	49.4	39.2	40.379100	-80.660581
2,190	2	88.4	10,000	5.58	5.21	4.89	4.74	4.52	4.00	2.99	2.11	1.38	49.4	39.2	40.379100	-80.660581
2,190	3	88.4	10,000	5.64	5.27	4.95	4.80	4.57	4.05	3.03	2.13	1.41	49.4	39.2	40.379100	-80.660581
2,458	1	88.4	10,000	3.93	3.59	3.32	3.27	2.95	2.49	1.66	1.01	0.53	52.4	39.2	40.379231	-80.659636
2,458	2	88.4	10,000	3.88	3.53	3.26	3.21	2.90	2.43	1.63	0.99	0.52	52.4	39.2	40.379231	-80.659636
2,458	3	88.4	10,000	3.86	3.52	3.25	3.18	2.89	2.43	1.62	0.99	0.52	52.4	39.2	40.379231	-80.659636
2,699	1	88.4	10,000	4.26	3.90	3.65	3.70	3.26	2.84	2.10	1.46	1.02	50.1	39.2	40.379167	-80.658783
2,699	2	88.4	10,000	4.24	3.88	3.63	3.69	3.25	2.82	2.08	1.46	1.01	50.1	39.2	40.379167	-80.658783
2,699	3	88.4	10,000	4.23	3.87	3.63	3.69	3.25	2.81	2.07	1.45	1.01	50.1	39.2	40.379167	-80.658783
2,980	1	88.4	10,000	15.05	14.55	14.06	13.24	13.53	12.61	10.60	8.68	7.14	46.8	39.2	40.378956	-80.657822
2,980	2	88.4	10,000	15.58	15.08	14.57	13.74	14.05	13.13	11.04	9.07	7.48	46.8	39.2	40.378956	-80.657822
2,980	3	88.4	10,000	15.80	15.29	14.78	13.96	14.26	13.34	11.23	9.25	7.65	46.8	39.2	40.378956	-80.657822
3,224	1	88.4	10,000	6.87	6.50	6.14	5.96	5.74	5.17	4.12	3.18	2.45	49.8	39.2	40.378764	-80.656986
3,224	2	88.4	10,000	6.89	6.52	6.16	5.97	5.77	5.20	4.14	3.21	2.47	49.8	39.2	40.378764	-80.656986
3,224	3	88.4	10,000	6.95	6.56	6.21	6.02	5.81	5.25	4.19	3.24	2.49	49.8	39.2	40.378764	-80.656986

Table D5. Listing of Normalized FWD Data collected fom John Scott Highway pavement at 9:18 am on 3/20/2019

Location: John Scott Highway Eastbound Shoulder

Direction: EB

Start: Kingston Ave

End: SR 22 on Ramp

Chainage (feet)	Drop No.	Stress (psi)	Load (lbs.)	Deflections, mils.									Temp. deg, F		GPS Data	
				D1 (0")	D2 (8")	D3 (12")	D4 (-12")	D5 (18")	D6 (24")	D7 (36")	D8 (48")	D9 (60")	Surface	Air	Latitude	Longitude
3,464	1	88.4	10,000	7.55	7.46	6.96	6.56	6.59	5.99	4.84	3.77	2.84	48.1	39.2	40.378592	-80.656164
3,464	2	88.4	10,000	7.66	7.58	7.08	6.65	6.71	6.10	4.93	3.85	2.91	48.1	39.2	40.378592	-80.656164
3,464	3	88.4	10,000	7.78	7.68	7.19	6.75	6.82	6.21	5.03	3.94	2.98	48.1	39.2	40.378592	-80.656164
3,734	1	88.4	10,000	6.08	5.57	5.11	5.07	4.51	3.78	2.57	1.61	1.06	47.8	39.2	40.378550	-80.655206
3,734	2	88.4	10,000	5.99	5.48	5.02	4.98	4.42	3.71	2.49	1.56	1.03	47.8	39.2	40.378550	-80.655206
3,734	3	88.4	10,000	5.95	5.45	4.99	4.95	4.39	3.68	2.48	1.56	1.01	47.8	39.2	40.378550	-80.655206
3,949	1	88.4	10,000	6.18	5.58	5.06	5.12	4.41	3.63	2.31	1.45	0.94	41.9	39.2	40.378658	-80.654456
3,949	2	88.4	10,000	6.19	5.59	5.08	5.12	4.41	3.63	2.29	1.46	0.94	41.9	39.2	40.378658	-80.654456
3,949	3	88.4	10,000	6.19	5.59	5.08	5.11	4.41	3.62	2.29	1.45	0.94	41.9	39.2	40.378658	-80.654456
4,203	1	88.4	10,000	7.02	6.46	6.06	6.46	5.53	4.88	3.71	2.69	1.91	39.6	39.2	40.378947	-80.653639
4,203	2	88.4	10,000	6.96	6.41	6.01	6.42	5.48	4.83	3.67	2.65	1.89	39.6	39.2	40.378947	-80.653639
4,203	3	88.4	10,000	6.97	6.42	6.00	6.42	5.50	4.84	3.68	2.66	1.89	39.6	39.2	40.378947	-80.653639
4,474	1	88.4	10,000	9.20	8.69	8.31	8.52	7.89	7.18	5.82	4.56	3.50	40.5	39.2	40.379419	-80.652889
4,474	2	88.4	10,000	9.50	8.99	8.60	8.75	8.18	7.47	6.11	4.83	3.72	40.5	39.2	40.379419	-80.652889
4,474	3	88.4	10,000	9.67	9.16	8.77	8.90	8.37	7.65	6.26	4.98	3.85	40.5	39.2	40.379419	-80.652889
4,686	1	88.4	10,000	4.92	4.44	4.14	4.60	3.75	3.26	2.44	1.75	1.21	40.2	39.2	40.379867	-80.652411
4,686	2	88.4	10,000	4.83	4.36	4.06	4.49	3.68	3.21	2.39	1.72	1.19	40.2	39.2	40.379867	-80.652411
4,686	3	88.4	10,000	4.84	4.35	4.06	4.48	3.68	3.21	2.39	1.72	1.19	40.2	39.2	40.379867	-80.652411

Data in Yellow was not used in Backcalcuation of layer Moduli

Table D6. Listing of Backcalculated Moduli of pavement layers, John Scott Highway pavement (compiled on 3/20/2019)

Location: John Scott Highway Eastbound Shoulder
Start: Kingston Ave

Direction: EB
End: SR 22 on Ramp

Test No.	Chainage (feet)	Drop	Layer Thickness, in.			Backcalculated E, ksi.			RMS (%)	Concrete Temp °F	Latitude	Longitude
			H1	H2	H3	E1	E2	E3				
1	454	3	8.2	6.5	0.0	2,237.796	52.467	11.767	0.2	47.80	40.377892	-80.666231
2	705	3	8.2	6.5	0.0	1,020.882	57.793	8.523	0.3	46.10	40.377700	-80.665369
3	964	3	8.2	6.5	0.0	2,578.807	54.966	11.419	0.1	46.50	40.377650	-80.664458
4	1,195	3	8.2	6.5	0.0	3,263.145	54.966	12.959	0.2	42.50	40.377764	-80.663644
5	1,447	3	8.2	6.5	0.0	2,706.136	54.863	10.514	0.2	43.50	40.378042	-80.662822
6	1,718	3	8.2	6.5	0.0	1,944.054	45.000	8.071	0.3	41.50	40.378461	-80.662025
7	1,930	3	8.2	6.5	0.0	2,711.693	47.056	15.294	0.2	46.10	40.378789	-80.661397
8	2,190	3	8.2	6.5	0.0	3,423.510	53.591	13.600	0.1	49.40	40.379100	-80.660581
9	2,458	3	8.2	6.5	0.0	5,481.037	45.000	14.327	0.1	52.40	40.379231	-80.659636
10	2,699	3	8.2	6.5	0.0	4,030.244	48.048	22.272	0.1	50.10	40.379167	-80.658783
11	2,980	3	8.2	6.5	0.0	1,240.004	42.525	7.259	0.3	46.80	40.378956	-80.657822
12	3,224	3	8.2	6.5	0.0	2,390.293	39.994	18.959	0.1	49.80	40.378764	-80.656986
13	3,464	3	8.2	6.5	0.0	2,659.025	47.278	11.970	0.2	48.10	40.378592	-80.656164
14	3,734	3	8.2	6.5	0.0	2,496.167	46.125	13.197	0.1	47.80	40.378550	-80.655206
15	3,949	3	8.2	6.5	0.0	2,017.676	48.992	13.743	0.1	41.90	40.378658	-80.654456
16	4,203	3	8.2	6.5	0.0	2,486.228	42.778	13.513	0.1	39.60	40.378947	-80.653639
17	4,474	3	8.2	6.5	0.0	2,091.031	43.057	10.638	0.2	40.50	40.379419	-80.652889
18	4,686	3	8.2	6.5	0.0	3,561.027	49.638	19.788	0.1	40.20	40.379867	-80.652411
					Average	2685.486	48.563	13.212				
					Min	1020.882	39.994	7.259				
					Max	5481.037	57.793	22.272				
					Stnd Dev	995.940	5.044	3.867				

Table D7. Listing of Normalized FWD Data collected fom John Scott Highway pavement at 11:30 am on 3/20/2019

Location: John Scott Highway Westbound Passing Lane
Start: SR 22 on Ramp

Direction: WB
End: Kingston Ave

Chainage (feet)	Drop No.	Stress (psi)	Load (lbs.)	Deflections, mils.									Temp. deg, F		GPS Data	
				D1 (0")	D2 (8")	D3 (12")	D4 (-12")	D5 (18")	D6 (24")	D7 (36")	D8 (48")	D9 (60")	Surface	Air	Latitude	Longitude
23	1	88.4	10,000	4.90	4.27	3.91	4.54	3.46	2.98	2.23	1.60	1.17	57.7	59.0	40.380136	-80.652414
23	2	88.4	10,000	4.80	4.20	3.83	4.46	3.40	2.95	2.18	1.58	1.15	57.7	59.0	40.380136	-80.652414
23	3	88.4	10,000	4.82	4.22	3.85	4.47	3.41	2.94	2.20	1.59	1.16	57.7	59.0	40.380136	-80.652414
108	1	88.4	10,000	5.41	5.16	4.92	4.93	4.59	4.16	3.35	2.56	2.01	53.4	59.0	40.379939	-80.652544
108	2	88.4	10,000	5.42	5.17	4.93	4.94	4.61	4.18	3.34	2.57	1.96	53.4	59.0	40.379939	-80.652544
108	3	88.4	10,000	5.45	5.18	4.95	4.95	4.62	4.19	3.36	2.58	1.97	53.4	59.0	40.379939	-80.652544
347	1	88.4	10,000	3.86	3.64	3.44	3.32	3.18	2.86	2.28	1.73	1.29	57.7	59.0	40.379422	-80.653050
347	2	88.4	10,000	3.85	3.63	3.43	3.31	3.16	2.86	2.28	1.72	1.28	57.7	59.0	40.379422	-80.653050
347	3	88.4	10,000	3.83	3.60	3.41	3.31	3.14	2.84	2.25	1.71	1.28	57.7	59.0	40.379422	-80.653050
585	1	88.4	10,000	5.14	4.83	4.56	4.62	4.23	3.79	2.99	2.20	1.54	57.3	59.0	40.379022	-80.653711
585	2	88.4	10,000	5.04	4.74	4.48	4.56	4.16	3.73	2.95	2.18	1.52	57.3	59.0	40.379022	-80.653711
585	3	88.4	10,000	5.06	4.77	4.50	4.55	4.18	3.75	2.94	2.19	1.53	57.3	59.0	40.379022	-80.653711
843	1	88.4	10,000	9.91	9.77	9.54	9.00	9.36	8.93	7.99	6.98	6.05	60.6	59.0	40.378742	-80.654547
843	2	88.4	10,000	9.94	9.79	9.57	9.04	9.38	8.94	8.01	7.01	6.05	60.6	59.0	40.378742	-80.654547
843	3	88.4	10,000	9.89	9.73	9.53	9.00	9.34	8.91	7.96	6.96	6.03	60.6	59.0	40.378742	-80.654547
1,108	1	88.4	10,000	4.63	4.27	4.00	4.31	3.65	3.22	2.43	1.71	1.17	62.6	59.0	40.378644	-80.655467
1,108	2	88.4	10,000	4.65	4.27	4.00	4.32	3.67	3.24	2.45	1.72	1.19	62.6	59.0	40.378644	-80.655467
1,108	3	88.4	10,000	4.64	4.29	4.02	4.33	3.66	3.23	2.45	1.72	1.18	62.6	59.0	40.378644	-80.655467
1,347	1	88.4	10,000	4.49	4.20	4.01	3.96	3.75	3.40	2.75	2.04	1.60	63.0	59.0	40.378717	-80.656294
1,347	2	88.4	10,000	4.25	4.01	3.83	3.78	3.59	3.26	2.63	1.96	1.47	63.0	59.0	40.378717	-80.656294
1,347	3	88.4	10,000	4.39	4.16	3.97	3.91	3.72	3.39	2.73	2.03	1.55	63.0	59.0	40.378717	-80.656294
1,620	1	88.4	10,000	9.40	8.89	8.51	8.96	8.05	7.28	6.10	4.86	3.67	63.9	59.0	40.378922	-80.657206
1,620	2	88.4	10,000	9.37	8.84	8.46	8.91	8.00	7.36	6.03	4.74	3.53	63.9	59.0	40.378922	-80.657206
1,620	3	88.4	10,000	9.38	8.84	8.45	8.92	8.00	7.36	6.05	4.73	3.51	63.9	59.0	40.378922	-80.657206
1,868	1	88.4	10,000	10.74	10.08	9.59	10.46	9.00	8.15	6.45	4.70	3.22	63.6	59.0	40.379114	-80.658044
1,868	2	88.4	10,000	10.78	10.13	9.64	10.52	9.04	8.17	6.48	4.73	3.19	63.6	59.0	40.379114	-80.658044
1,868	3	88.4	10,000	10.75	10.10	9.61	10.49	9.02	8.15	6.46	4.71	3.18	63.6	59.0	40.379114	-80.658044
2,114	1	88.4	10,000	12.92	12.54	12.12	12.28	11.71	10.92	9.15	7.13	5.15	64.9	59.0	40.379286	-80.658867
2,114	2	88.4	10,000	12.85	12.47	12.07	12.23	11.64	10.86	9.10	7.06	5.13	64.9	59.0	40.379286	-80.658867
2,114	3	88.4	10,000	12.88	12.51	12.10	12.26	11.67	10.88	9.11	7.06	5.13	64.9	59.0	40.379286	-80.658867
2,369	1	88.4	10,000	9.14	8.40	7.95	8.65	7.33	6.49	4.88	3.23	1.82	64.3	59.0	40.379325	-80.659764
2,369	2	88.4	10,000	9.26	8.53	8.05	8.79	7.44	6.59	4.94	3.28	1.87	64.3	59.0	40.379325	-80.659764
2,369	3	88.4	10,000	9.22	8.49	8.02	8.74	7.40	6.55	4.93	3.26	1.85	64.3	59.0	40.379325	-80.659764
2,597	1	88.4	10,000	14.28	14.16	13.92	13.10	13.72	13.13	11.84	10.30	8.97	64.3	59.0	40.379219	-80.660539
2,597	2	88.4	10,000	14.26	14.15	13.91	13.10	13.70	13.12	11.83	10.28	8.84	64.3	59.0	40.379219	-80.660539
2,597	3	88.4	10,000	14.22	14.11	13.87	13.05	13.66	13.08	11.79	10.27	8.82	64.3	59.0	40.379219	-80.660539

Table D7. Listing of Normalized FWD Data collected fom John Scott Highway pavement at 11:30 am on 3/20/2019

Location: John Scott Highway Westbound Passing Lane
Start: SR 22 on Ramp

Direction: WB
End: Kingston Ave

Chainage (feet)	Drop No.	Stress (psi)	Load (lbs.)	Deflections, mils.									Temp. deg, F		GPS Data	
				D1 (0")	D2 (8")	D3 (12")	D4 (-12")	D5 (18")	D6 (24")	D7 (36")	D8 (48")	D9 (60")	Surface	Air	Latitude	Longitude
2,840	1	88.4	10,000	9.02	8.90	8.69	7.97	8.49	8.03	7.05	5.98	4.84	64.9	59.0	40.378953	-80.661317
2,840	2	88.4	10,000	8.94	8.81	8.62	7.90	8.41	7.96	6.97	5.95	4.96	64.9	59.0	40.378953	-80.661317
2,840	3	88.4	10,000	8.96	8.84	8.65	7.92	8.44	8.00	7.00	5.97	4.90	64.9	59.0	40.378953	-80.661317
3,090	1	88.4	10,000	10.28	9.81	9.39	9.71	8.91	8.16	6.66	5.07	3.58	64.3	59.0	40.378581	-80.662036
3,090	2	88.4	10,000	10.22	9.74	9.33	9.64	8.83	8.10	6.60	5.03	3.54	64.3	59.0	40.378581	-80.662036
3,090	3	88.4	10,000	10.26	9.78	9.36	9.69	8.88	8.12	6.62	5.05	3.56	64.3	59.0	40.378581	-80.662036
3,361	1	88.4	10,000	11.40	10.86	10.41	10.52	9.94	9.13	7.54	5.91	4.43	62.0	59.0	40.378164	-80.662828
3,361	2	88.4	10,000	11.38	10.84	10.40	10.50	9.91	9.11	7.52	5.89	4.40	62.0	59.0	40.378164	-80.662828
3,361	3	88.4	10,000	11.30	10.77	10.32	10.44	9.85	9.05	7.48	5.84	4.37	62.0	59.0	40.378164	-80.662828
3,602	1	88.4	10,000	7.24	7.03	6.76	6.46	6.47	6.00	5.06	4.16	3.34	63.0	59.0	40.377878	-80.663592
3,602	2	88.4	10,000	7.21	7.00	6.73	6.45	6.44	5.98	5.05	4.16	3.32	63.0	59.0	40.377878	-80.663592
3,602	3	88.4	10,000	7.22	7.00	6.73	6.45	6.46	6.00	5.06	4.17	3.35	63.0	59.0	40.377878	-80.663592
3,859	1	88.4	10,000	5.10	4.75	4.47	4.57	4.09	3.64	2.82	2.05	1.43	63.9	59.0	40.377744	-80.664475
3,859	2	88.4	10,000	5.07	4.73	4.45	4.56	4.08	3.62	2.80	2.04	1.44	63.9	59.0	40.377744	-80.664475
3,859	3	88.4	10,000	5.09	4.74	4.46	4.58	4.10	3.63	2.80	2.05	1.44	63.9	59.0	40.377744	-80.664475
4,095	1	88.4	10,000	10.24	9.84	9.43	9.51	8.94	8.19	6.65	5.02	3.30	66.2	59.0	40.377792	-80.665317
4,095	2	88.4	10,000	10.05	9.65	9.24	9.33	8.77	8.03	6.52	4.89	3.30	66.2	59.0	40.377792	-80.665317
4,095	3	88.4	10,000	10.05	9.64	9.24	9.33	8.77	8.03	6.51	4.88	3.32	66.2	59.0	40.377792	-80.665317
4,390	1	88.4	10,000	5.35	5.14	4.93	4.61	4.74	4.38	3.70	3.03	2.43	67.2	59.0	40.378008	-80.666308
4,390	2	88.4	10,000	5.36	5.14	4.95	4.61	4.74	4.40	3.72	3.05	2.44	67.2	59.0	40.378008	-80.666308
4,390	3	88.4	10,000	5.32	5.12	4.92	4.59	4.70	4.36	3.68	3.02	2.42	67.2	59.0	40.378008	-80.666308
4,595	1	88.4	10,000	6.49	6.21	5.98	5.96	5.72	5.30	4.47	3.63	2.91	67.6	59.0	40.378172	-80.666983
4,595	2	88.4	10,000	6.54	6.27	6.04	6.01	5.76	5.34	4.50	3.65	2.92	67.6	59.0	40.378172	-80.666983
4,595	3	88.4	10,000	6.52	6.24	6.00	5.98	5.74	5.31	4.47	3.64	2.90	67.6	59.0	40.378172	-80.666983
4,793	1	88.4	10,000	6.04	5.81	5.60	5.33	5.31	4.90	4.03	3.12	2.33	67.2	59.0	40.378342	-80.667647
4,793	2	88.4	10,000	6.07	5.82	5.63	5.35	5.33	4.90	4.04	3.13	2.34	67.2	59.0	40.378342	-80.667647
4,793	3	88.4	10,000	6.09	5.86	5.64	5.37	5.35	4.92	4.06	3.14	2.35	67.2	59.0	40.378342	-80.667647

Data in Yellow was not used in Backcalcuation of layer Moduli

Table D8. Listing of Backcalculated Moduli of pavement layers, John Scott Highway pavement (compiled on 3/20/2019)

Location: John Scott Highway Westbound Passing Lane
Start: SR 22 on Ramp

Direction: WB
End: Kingston Ave

Test No.	Chainage (feet)	Drop	Layer Thickness, in.			Backcalculated E, ksi.			RMS (%)	Concrete Temp °F	Latitude	Longitude
			H1	H2	H3	E1	E2	E3				
1	23	3	8.3	6.1	0.0	2,821.500	54.574	24.290	0.2	57.70	40.380136	-80.652414
2	108	3	8.3	6.1	0.0	4,237.261	40.371	16.392	0.1	53.40	40.379939	-80.652544
3	347	3	8.3	6.1	0.0	5,362.386	39.488	28.028	0.1	57.70	40.379422	-80.653050
4	585	3	8.3	6.1	0.0	4,051.696	52.242	16.894	0.1	57.30	40.379022	-80.653711
5	843	3	8.3	6.1	0.0	3,748.097	44.550	8.961	0.1	60.60	40.378742	-80.654547
6	1,108	3	8.3	6.1	0.0	4,198.821	41.681	18.323	0.1	62.60	40.378644	-80.655467
7	1,347	3	8.3	6.1	0.0	4,968.957	34.747	23.899	0.1	63.00	40.378717	-80.656294
8	1,620	3	8.3	6.1	0.0	2,121.811	44.550	10.627	0.2	63.90	40.378922	-80.657206
9	1,868	3	8.3	6.1	0.0	1,765.293	49.613	6.908	0.3	63.60	40.379114	-80.658044
10	2,114	3	8.3	6.1	0.0	1,733.769	36.906	6.568	0.5	64.90	40.379286	-80.658867
11	2,369	3	8.3	6.1	0.0	2,016.644	52.500	6.849	0.3	64.30	40.379325	-80.659764
12	2,597	3	8.3	6.1	0.0	2,516.293	46.132	5.987	0.3	64.30	40.379219	-80.660539
13	2,840	3	8.3	6.1	0.0	3,543.740	45.328	10.701	0.2	64.90	40.378953	-80.661317
14	3,090	3	8.3	6.1	0.0	1,947.197	38.494	8.964	0.3	64.30	40.378581	-80.662036
15	3,361	3	8.3	6.1	0.0	1,931.313	40.500	7.733	0.2	62.00	40.378164	-80.662828
16	3,602	3	8.3	6.1	0.0	2,999.029	48.263	16.506	0.1	63.00	40.377878	-80.663592
17	3,859	3	8.3	6.1	0.0	3,602.016	60.500	17.450	0.1	63.90	40.377744	-80.664475
18	4,095	3	8.3	6.1	0.0	1,836.961	54.450	8.832	0.4	66.20	40.377792	-80.665317
19	4,390	3	8.3	6.1	0.0	4,552.963	36.605	23.043	0.1	67.20	40.378008	-80.666308
20	4,595	3	8.3	6.1	0.0	3,490.717	36.605	19.024	0.1	67.60	40.378172	-80.666983
21	4,793	3	8.3	6.1	0.0	3,888.752	38.956	15.057	0.1	67.20	40.378342	-80.667647
					Average	3206.439	44.622	14.335				
					Min	1733.769	34.747	5.987				
					Max	5362.386	60.500	28.028				
					Stnd Dev	1113.379	7.017	6.609				

Table D9. Listing of Normalized FWD Data collected fom John Scott Highway pavement at 10:42 am on 3/20/2019

Location: John Scott Highway Westbound Driving Lane
Start: SR 22 on Ramp

Direction: WB
End: Kingston Ave

Chainage (feet)	Drop No.	Stress (psi)	Load (lbs.)	Deflections, mils.									Temp. deg, F		GPS Data	
				D1 (0")	D2 (8")	D3 (12")	D4 (-12")	D5 (18")	D6 (24")	D7 (36")	D8 (48")	D9 (60")	Surface	Air	Latitude	Longitude
26	1	88.4	10,000	4.24	4.01	3.79	3.76	3.53	3.18	2.55	1.96	1.52	46.5	51.0	40.380122	-80.652464
26	2	88.4	10,000	4.24	4.01	3.80	3.77	3.52	3.17	2.55	1.95	1.52	46.5	51.0	40.380122	-80.652464
26	3	88.4	10,000	4.20	3.98	3.77	3.75	3.51	3.15	2.52	1.94	1.51	46.5	51.0	40.380122	-80.652464
258	1	88.4	10,000	3.20	2.92	2.70	2.82	2.45	2.14	1.60	1.15	0.84	46.5	51.0	40.379603	-80.652917
258	2	88.4	10,000	3.19	2.89	2.70	2.80	2.43	2.12	1.59	1.16	0.83	46.5	51.0	40.379603	-80.652917
258	3	88.4	10,000	3.18	2.89	2.69	2.80	2.44	2.13	1.59	1.14	0.83	46.5	51.0	40.379603	-80.652917
517	1	88.4	10,000	4.39	4.21	4.06	3.81	3.87	3.59	3.15	2.78	2.48	46.5	51.0	40.379131	-80.653575
517	2	88.4	10,000	4.39	4.21	4.06	3.81	3.85	3.59	3.15	2.77	2.44	46.5	51.0	40.379131	-80.653575
517	3	88.4	10,000	4.39	4.20	4.05	3.80	3.85	3.57	3.14	2.75	2.45	46.5	51.0	40.379131	-80.653575
738	1	88.4	10,000	4.35	3.99	3.72	3.92	3.39	2.98	2.27	1.66	1.23	53.4	51.0	40.378853	-80.654256
738	2	88.4	10,000	4.33	3.97	3.70	3.90	3.36	2.96	2.27	1.65	1.22	53.4	51.0	40.378853	-80.654256
738	3	88.4	10,000	4.37	3.99	3.73	3.93	3.39	2.98	2.28	1.66	1.22	53.4	51.0	40.378853	-80.654256
985	1	88.4	10,000	4.30	3.96	3.73	3.77	3.42	3.03	2.29	1.61	1.07	56.4	51.0	40.378697	-80.655108
985	2	88.4	10,000	4.26	3.94	3.72	3.76	3.40	3.01	2.28	1.61	1.06	56.4	51.0	40.378697	-80.655108
985	3	88.4	10,000	4.25	3.94	3.70	3.75	3.38	3.00	2.27	1.61	1.06	56.4	51.0	40.378697	-80.655108
1,244	1	88.4	10,000	6.16	5.94	5.72	5.37	5.44	5.00	4.15	3.31	2.55	56.0	51.0	40.378711	-80.656017
1,244	2	88.4	10,000	6.14	5.92	5.71	5.36	5.42	5.00	4.14	3.29	2.53	56.0	51.0	40.378711	-80.656017
1,244	3	88.4	10,000	6.14	5.93	5.70	5.37	5.42	4.98	4.15	3.29	2.54	56.0	51.0	40.378711	-80.656017
1,511	1	88.4	10,000	3.99	3.88	3.78	3.26	3.66	3.45	3.04	2.69	2.40	58.7	51.0	40.378889	-80.656917
1,511	2	88.4	10,000	3.95	3.85	3.73	3.23	3.62	3.42	3.01	2.66	2.35	58.7	51.0	40.378889	-80.656917
1,511	3	88.4	10,000	3.94	3.83	3.72	3.21	3.62	3.40	3.00	2.66	2.33	58.7	51.0	40.378889	-80.656917
1,733	1	88.4	10,000	6.12	5.86	5.64	5.30	5.37	4.95	4.13	3.35	2.66	58.0	51.0	40.379061	-80.657658
1,733	2	88.4	10,000	6.06	5.82	5.60	5.27	5.34	4.91	4.10	3.31	2.64	58.0	51.0	40.379061	-80.657658
1,733	3	88.4	10,000	6.04	5.79	5.58	5.25	5.31	4.88	4.07	3.30	2.63	58.0	51.0	40.379061	-80.657658
2,034	1	88.4	10,000	4.81	4.59	4.37	4.16	4.11	3.75	3.03	2.37	1.79	58.3	51.0	40.379289	-80.658675
2,034	2	88.4	10,000	4.83	4.59	4.38	4.17	4.11	3.75	3.04	2.38	1.80	58.3	51.0	40.379289	-80.658675
2,034	3	88.4	10,000	4.80	4.57	4.36	4.14	4.10	3.74	3.03	2.35	1.78	58.3	51.0	40.379289	-80.658675
2,254	1	88.4	10,000	4.16	3.85	3.63	3.58	3.32	2.94	2.26	1.63	1.17	59.7	51.0	40.379367	-80.659428
2,254	2	88.4	10,000	4.11	3.82	3.59	3.55	3.29	2.91	2.23	1.62	1.14	59.7	51.0	40.379367	-80.659428
2,254	3	88.4	10,000	4.14	3.84	3.60	3.58	3.31	2.93	2.24	1.63	1.16	59.7	51.0	40.379367	-80.659428
2,501	1	88.4	10,000	8.48	8.15	7.86	7.66	7.51	6.91	5.71	4.47	3.35	60.6	51.0	40.379306	-80.660286
2,501	2	88.4	10,000	8.54	8.20	7.90	7.70	7.54	6.96	5.74	4.48	3.35	60.6	51.0	40.379306	-80.660286
2,501	3	88.4	10,000	8.43	8.10	7.80	7.62	7.45	6.87	5.68	4.44	3.31	60.6	51.0	40.379306	-80.660286
2,744	1	88.4	10,000	7.19	7.01	6.78	6.31	6.52	6.06	5.10	4.13	3.24	60.3	51.0	40.379086	-80.661092
2,744	2	88.4	10,000	7.17	6.98	6.75	6.30	6.49	6.03	5.06	4.12	3.21	60.3	51.0	40.379086	-80.661092
2,744	3	88.4	10,000	7.12	6.94	6.70	6.26	6.44	5.99	5.03	4.08	3.19	60.3	51.0	40.379086	-80.661092

Table D9. Listing of Normalized FWD Data collected fom John Scott Highway pavement at 10:42 am on 3/20/2019

Location: John Scott Highway Westbound Driving Lane
Start: SR 22 on Ramp

Direction: WB
End: Kingston Ave

Chainage (feet)	Drop No.	Stress (psi)	Load (lbs.)	Deflections, mils.									Temp. deg, F		GPS Data	
				D1 (0")	D2 (8")	D3 (12")	D4 (-12")	D5 (18")	D6 (24")	D7 (36")	D8 (48")	D9 (60")	Surface	Air	Latitude	Longitude
3,015	1	88.4	10,000	7.45	7.14	6.86	6.54	6.60	6.12	5.17	4.25	3.39	58.0	51.0	40.378689	-80.661900
3,015	2	88.4	10,000	7.45	7.13	6.86	6.54	6.60	6.12	5.17	4.25	3.38	58.0	51.0	40.378689	-80.661900
3,015	3	88.4	10,000	7.41	7.08	6.81	6.50	6.55	6.08	5.13	4.22	3.35	58.0	51.0	40.378689	-80.661900
3,323	1	88.4	10,000	8.02	7.17	6.67	7.90	6.03	5.32	4.09	3.08	2.27	57.7	51.0	40.378219	-80.662794
3,323	2	88.4	10,000	7.90	7.08	6.58	7.80	5.96	5.25	4.03	3.03	2.24	57.7	51.0	40.378219	-80.662794
3,323	3	88.4	10,000	7.91	7.08	6.56	7.80	5.96	5.25	4.03	3.04	2.25	57.7	51.0	40.378219	-80.662794
3,496	1	88.4	10,000	7.41	7.33	7.15	6.28	6.98	6.59	5.72	4.82	3.88	59.7	51.0	40.377997	-80.663331
3,496	2	88.4	10,000	7.34	7.26	7.08	6.22	6.91	6.52	5.66	4.76	3.85	59.7	51.0	40.377997	-80.663331
3,496	3	88.4	10,000	7.29	7.22	7.04	6.18	6.87	6.47	5.62	4.73	3.81	59.7	51.0	40.377997	-80.663331
3,780	1	88.4	10,000	5.50	5.26	5.01	4.77	4.73	4.32	3.49	2.70	2.04	59.3	51.0	40.377803	-80.664297
3,780	2	88.4	10,000	5.41	5.17	4.94	4.71	4.66	4.24	3.44	2.65	2.00	59.3	51.0	40.377803	-80.664297
3,780	3	88.4	10,000	5.43	5.19	4.95	4.72	4.67	4.26	3.43	2.65	2.00	59.3	51.0	40.377803	-80.664297
4,014	1	88.4	10,000	4.75	4.30	3.98	4.22	3.59	3.16	2.42	1.82	1.36	62.0	51.0	40.377811	-80.665119
4,014	2	88.4	10,000	4.76	4.31	4.01	4.24	3.61	3.18	2.45	1.82	1.35	62.0	51.0	40.377811	-80.665119
4,014	3	88.4	10,000	4.76	4.32	4.00	4.23	3.61	3.18	2.45	1.82	1.38	62.0	51.0	40.377811	-80.665119
4,250	1	88.4	10,000	4.65	4.45	4.23	4.03	3.97	3.62	2.93	2.29	1.74	61.6	51.0	40.377967	-80.665931
4,250	2	88.4	10,000	4.65	4.46	4.25	4.05	3.98	3.63	2.94	2.29	1.76	61.6	51.0	40.377967	-80.665931
4,250	3	88.4	10,000	4.62	4.42	4.23	4.03	3.96	3.61	2.92	2.27	1.74	61.6	51.0	40.377967	-80.665931
4,554	1	88.4	10,000	5.97	5.85	5.70	5.19	5.53	5.24	4.58	3.87	3.24	62.6	51.0	40.378203	-80.666939
4,554	2	88.4	10,000	5.98	5.85	5.70	5.20	5.53	5.22	4.57	3.87	3.20	62.6	51.0	40.378203	-80.666939
4,554	3	88.4	10,000	5.96	5.84	5.70	5.20	5.54	5.23	4.56	3.87	3.20	62.6	51.0	40.378203	-80.666939
4,779	1	88.4	10,000	7.22	6.90	6.63	6.60	6.34	5.92	5.09	4.30	3.62	63.9	51.0	40.378389	-80.667686
4,779	2	88.4	10,000	7.28	6.96	6.70	6.65	6.39	5.98	5.15	4.34	3.66	63.9	51.0	40.378389	-80.667686
4,779	3	88.4	10,000	7.26	6.92	6.66	6.61	6.36	5.95	5.12	4.32	3.63	63.9	51.0	40.378389	-80.667686

Data in Yellow was not used in Backcalcuation of layer Moduli

Table D10. Listing of Backcalculated Moduli of pavement layers, John Scott Highway pavement (compiled on 3/20/2019)

Location: John Scott Highway Westbound Driving Lane

Direction: WB

Start: SR 22 on Ramp

End: Kingston Ave

Test No.	Chainage (feet)	Drop	Layer Thickness, in.			Backcalculated E, ksi.			RMS (%)	Concrete Temp °F	Latitude	Longitude
			H1	H2	H3	E1	E2	E3				
1	26	3	8.0	5.9	0.0	5,377.753	74.250	22.700	0.0	46.50	40.380122	-80.652464
2	258	3	8.0	5.9	0.0	5,846.151	99.872	28.778	0.0	46.50	40.379603	-80.652917
3	517	3	8.0	5.9	0.0	7,162.266	119.371	23.856	0.1	46.50	40.379131	-80.653575
4	738	3	8.0	5.9	0.0	4,337.396	89.685	20.066	0.1	53.40	40.378853	-80.654256
5	985	3	8.0	5.9	0.0	4,769.626	70.460	19.577	0.1	56.40	40.378697	-80.655108
6	1,244	3	8.0	5.9	0.0	3,813.769	68.214	16.079	0.1	56.00	40.378711	-80.656017
7	1,511	3	8.0	5.9	0.0	9,239.841	138.995	24.063	0.0	58.70	40.378889	-80.656917
8	1,733	3	8.0	5.9	0.0	4,195.146	62.013	16.908	0.1	58.00	40.379061	-80.657658
9	2,034	3	8.0	5.9	0.0	5,326.762	65.720	17.797	0.1	58.30	40.379289	-80.658675
10	2,254	3	8.0	5.9	0.0	4,831.530	88.578	20.406	0.1	59.70	40.379367	-80.659428
11	2,501	3	8.0	5.9	0.0	2,193.075	52.250	15.593	0.3	60.60	40.379306	-80.660286
12	2,744	3	8.0	5.9	0.0	3,450.769	38.500	16.913	0.2	60.30	40.379086	-80.661092
13	3,015	3	8.0	5.9	0.0	3,300.000	42.525	16.500	0.2	58.00	40.378689	-80.661900
14	3,323	3	8.0	5.9	0.0	2,214.338	36.906	14.388	0.2	57.70	40.378219	-80.662794
15	3,496	3	8.0	5.9	0.0	4,002.075	55.125	14.250	0.2	59.70	40.377997	-80.663331
16	3,780	3	8.0	5.9	0.0	4,401.595	60.339	17.050	0.1	59.30	40.377803	-80.664297
17	4,014	3	8.0	5.9	0.0	4,175.430	72.428	18.583	0.1	62.00	40.377811	-80.665119
18	4,250	3	8.0	5.9	0.0	5,087.663	72.976	20.541	0.0	61.60	40.377967	-80.665931
19	4,554	3	8.0	5.9	0.0	5,158.179	79.757	17.038	0.1	62.60	40.378203	-80.666939
20	4,779	3	8.0	5.9	0.0	3,909.709	42.557	15.886	0.1	63.90	40.378389	-80.667686
					Average	4639.654	71.526	18.849				
					Min	2193.075	36.906	14.250				
					Max	9239.841	138.995	28.778				
					Stnd Dev	1545.634	25.705	3.618				

Table D11. Listing of Normalized FWD Data collected fom John Scott Highway pavement at 9:48 am on 3/20/2019

Location: John Scott Highway Westbound Shoulder
Start: SR 22 on Ramp

Direction: WB
End: Kingston Ave

Chainage (feet)	Drop No.	Stress (psi)	Load (lbs.)	Deflections, mils.									Temp. deg, F		GPS Data	
				D1 (0")	D2 (8")	D3 (12")	D4 (-12")	D5 (18")	D6 (24")	D7 (36")	D8 (48")	D9 (60")	Surface	Air	Latitude	Longitude
26	1	88.4	10,000	17.00	16.64	16.19	15.63	15.79	14.85	12.84	11.00	9.58	37.2	39.2	40.380128	-80.652511
26	2	88.4	10,000	16.98	16.61	16.17	15.61	15.77	14.84	12.83	11.01	9.66	37.2	39.2	40.380128	-80.652511
26	3	88.4	10,000	17.28	16.89	16.45	15.90	16.05	15.10	13.07	11.22	9.85	37.2	39.2	40.380128	-80.652511
199	1	88.4	10,000	3.86	3.62	3.40	3.30	3.13	2.77	2.14	1.68	1.34	39.2	39.2	40.379728	-80.652833
199	2	88.4	10,000	3.84	3.58	3.37	3.29	3.10	2.74	2.13	1.67	1.32	39.2	39.2	40.379728	-80.652833
199	3	88.4	10,000	3.81	3.57	3.36	3.26	3.08	2.73	2.12	1.65	1.32	39.2	39.2	40.379728	-80.652833
468	1	88.4	10,000	18.17	17.61	16.98	17.90	16.27	15.14	12.90	10.89	9.41	39.9	39.2	40.379211	-80.653500
468	2	88.4	10,000	18.65	18.14	17.48	18.38	16.76	15.60	13.39	11.35	9.78	39.9	39.2	40.379211	-80.653500
468	3	88.4	10,000	19.00	18.45	17.81	18.74	17.09	15.92	13.67	11.63	10.06	39.9	39.2	40.379211	-80.653500
713	1	88.4	10,000	4.73	4.40	4.14	3.93	3.75	3.40	3.01	2.83	0.56	43.2	39.2	40.378889	-80.654250
713	2	88.4	10,000	4.51	4.15	3.91	3.72	3.52	3.15	2.72	2.48	0.53	43.2	39.2	40.378889	-80.654250
713	3	88.4	10,000	4.45	4.11	3.85	3.67	3.46	3.09	2.63	2.37	0.53	43.2	39.2	40.378889	-80.654250
955	1	88.4	10,000	3.37	3.01	2.71	3.08	2.33	1.93	1.30	0.88	0.47	46.8	39.2	40.378725	-80.655067
955	2	88.4	10,000	3.19	2.83	2.55	2.88	2.20	1.81	1.23	0.83	0.55	46.8	39.2	40.378725	-80.655067
955	3	88.4	10,000	3.17	2.81	2.54	2.86	2.18	1.80	1.20	0.83	0.53	46.8	39.2	40.378725	-80.655067
1,250	1	88.4	10,000	5.12	4.84	4.56	4.33	4.16	3.66	2.70	1.96	1.36	51.4	39.2	40.378747	-80.656100
1,250	2	88.4	10,000	5.08	4.82	4.54	4.32	4.15	3.64	2.71	1.95	1.37	51.4	39.2	40.378747	-80.656100
1,250	3	88.4	10,000	5.07	4.82	4.54	4.32	4.14	3.63	2.70	1.95	1.36	51.4	39.2	40.378747	-80.656100
1,489	1	88.4	10,000	6.91	6.37	6.04	6.39	5.59	4.96	3.81	2.81	2.00	50.8	39.2	40.378917	-80.656917
1,489	2	88.4	10,000	7.14	6.60	6.24	6.62	5.79	5.14	3.95	2.91	2.07	50.8	39.2	40.378917	-80.656917
1,489	3	88.4	10,000	7.34	6.79	6.43	6.82	5.97	5.30	4.06	3.00	2.12	50.8	39.2	40.378917	-80.656917
1,731	1	88.4	10,000	6.73	6.05	5.58	6.53	4.94	4.19	2.94	1.90	1.19	52.4	39.2	40.379108	-80.657744
1,731	2	88.4	10,000	6.54	5.87	5.39	6.32	4.77	4.05	4.72	1.83	1.12	52.4	39.2	40.379108	-80.657744
1,731	3	88.4	10,000	6.50	5.83	5.36	6.27	4.73	4.02	2.81	1.81	1.11	52.4	39.2	40.379108	-80.657744
1,952	1	88.4	10,000	5.62	5.26	4.94	4.85	4.58	4.06	3.12	2.28	1.56	53.1	39.2	40.379272	-80.658483
1,952	2	88.4	10,000	5.61	5.24	4.94	4.82	4.57	4.06	3.11	2.27	1.58	53.1	39.2	40.379272	-80.658483
1,952	3	88.4	10,000	5.64	5.28	4.96	4.85	4.59	4.08	3.14	2.30	1.58	53.1	39.2	40.379272	-80.658483
2,185	1	88.4	10,000	5.27	4.80	4.52	4.55	4.18	3.68	2.75	1.86	1.18	54.7	39.2	40.379389	-80.659289
2,185	2	88.4	10,000	5.20	4.75	4.48	4.51	4.15	3.65	2.71	1.84	1.20	54.7	39.2	40.379389	-80.659289
2,185	3	88.4	10,000	5.24	4.78	4.52	4.54	4.17	3.67	2.74	1.86	1.22	54.7	39.2	40.379389	-80.659289
2,489	1	88.4	10,000	8.60	7.96	7.48	8.07	6.87	6.05	4.58	3.21	2.06	53.4	39.2	40.379319	-80.660344
2,489	2	88.4	10,000	8.64	7.99	7.51	8.08	6.89	6.08	4.59	3.22	2.06	53.4	39.2	40.379319	-80.660344
2,489	3	88.4	10,000	8.76	8.10	7.61	8.21	6.99	6.15	4.64	3.26	2.08	53.4	39.2	40.379319	-80.660344
2,721	1	88.4	10,000	6.40	5.97	5.64	5.60	5.20	4.63	3.58	2.60	1.77	53.1	39.2	40.379108	-80.661117
2,721	2	88.4	10,000	6.35	5.93	5.60	5.56	5.16	4.58	3.55	2.58	1.79	53.1	39.2	40.379108	-80.661117
2,721	3	88.4	10,000	6.35	5.94	5.62	5.57	5.17	4.60	3.55	2.60	1.79	53.1	39.2	40.379108	-80.661117

Table D11. Listing of Normalized FWD Data collected fom John Scott Highway pavement at 9:48 am on 3/20/2019

Location: John Scott Highway Westbound Shoulder
Start: SR 22 on Ramp

Direction: WB
End: Kingston Ave

Chainage (feet)	Drop No.	Stress (psi)	Load (lbs.)	Deflections, mils.									Temp. deg, F		GPS Data	
				D1 (0")	D2 (8")	D3 (12")	D4 (-12")	D5 (18")	D6 (24")	D7 (36")	D8 (48")	D9 (60")	Surface	Air	Latitude	Longitude
2,969	1	88.4	10,000	6.34	5.97	5.62	5.51	5.21	4.66	3.56	2.54	1.57	51.4	39.2	40.378756	-80.661850
2,969	2	88.4	10,000	6.31	5.93	5.60	5.49	5.20	4.65	3.55	2.53	1.57	51.4	39.2	40.378756	-80.661850
2,969	3	88.4	10,000	6.29	5.94	5.61	5.50	5.20	4.65	3.56	2.53	1.58	51.4	39.2	40.378756	-80.661850
3,171	1	88.4	10,000	12.59	12.02	11.58	12.00	11.10	10.32	8.75	7.24	5.91	51.4	39.2	40.378442	-80.662431
3,171	2	88.4	10,000	12.80	12.20	11.75	12.22	11.27	10.46	8.87	7.33	5.92	51.4	39.2	40.378442	-80.662431
3,171	3	88.4	10,000	12.91	12.30	11.84	12.35	11.36	10.56	8.94	7.39	5.98	51.4	39.2	40.378442	-80.662431
3,372	1	88.4	10,000	12.30	11.54	10.88	11.57	10.09	9.07	7.18	5.62	4.35	50.8	39.2	40.378136	-80.663028
3,372	2	88.4	10,000	12.76	11.98	11.29	12.07	10.49	9.42	7.48	5.84	4.50	50.8	39.2	40.378136	-80.663028
3,372	3	88.4	10,000	13.06	12.27	11.56	12.39	10.74	9.66	7.68	6.02	4.63	50.8	39.2	40.378136	-80.663028
3,614	1	88.4	10,000	8.83	8.25	7.79	7.84	7.22	6.43	5.01	3.73	2.69	54.4	39.2	40.377897	-80.663811
3,614	2	88.4	10,000	8.74	8.17	7.72	7.77	7.14	6.37	4.95	3.70	2.68	54.4	39.2	40.377897	-80.663811
3,614	3	88.4	10,000	8.75	8.19	7.73	7.79	7.16	6.39	4.97	3.71	2.68	54.4	39.2	40.377897	-80.663811
3,782	1	88.4	10,000	10.17	9.70	9.28	9.24	8.74	7.94	6.43	4.96	3.75	53.1	39.2	40.377819	-80.664397
3,782	2	88.4	10,000	10.30	9.82	9.40	9.37	8.85	8.06	6.51	5.05	3.76	53.1	39.2	40.377819	-80.664397
3,782	3	88.4	10,000	10.31	9.83	9.41	9.37	8.89	8.08	6.54	5.06	3.77	53.1	39.2	40.377819	-80.664397
3,987	1	88.4	10,000	5.12	4.71	4.41	4.53	3.96	3.43	2.46	1.65	1.08	55.4	39.2	40.377836	-80.665131
3,987	2	88.4	10,000	5.18	4.77	4.46	4.59	4.01	3.47	2.51	1.68	1.06	55.4	39.2	40.377836	-80.665131
3,987	3	88.4	10,000	5.18	4.80	4.48	4.61	4.03	3.49	2.53	1.67	1.05	55.4	39.2	40.377836	-80.665131
4,204	1	88.4	10,000	9.70	9.07	8.63	9.09	8.09	7.38	6.06	4.84	3.81	56.4	39.2	40.377975	-80.665872
4,204	2	88.4	10,000	9.75	9.12	8.67	9.15	8.13	7.41	6.07	4.85	3.80	56.4	39.2	40.377975	-80.665872
4,204	3	88.4	10,000	9.74	9.09	8.65	9.14	8.11	7.38	6.06	4.82	3.79	56.4	39.2	40.377975	-80.665872
4,325	1	88.4	10,000	10.65	9.34	8.47	11.41	7.39	6.20	4.22	2.62	1.86	55.0	39.2	40.378072	-80.666289
4,325	2	88.4	10,000	10.42	9.12	8.26	11.11	7.19	6.03	4.04	2.46	1.68	55.0	39.2	40.378072	-80.666289
4,325	3	88.4	10,000	10.45	9.14	8.30	11.13	7.20	6.03	4.04	2.43	1.60	55.0	39.2	40.378072	-80.666289

Data in Yellow was not used in Backcalcuation of layer Moduli

Table D12. Listing of Backcalculated Moduli of pavement layers, John Scott Highway pavement (compiled on 3/20/2019)

Location: John Scott Highway Westbound Shoulder
Start: SR 22 on Ramp

Direction: WB
End: Kingston Ave

Test No.	Chainage (feet)	Drop	Layer Thickness, in.			Backcalculated E, ksi.			RMS (%)	Concrete Temp °F	Latitude	Longitude
			H1	H2	H3	E1	E2	E3				
1	26	3	8.2	6.0	0.0	1,792.241	25.028	5.755	0.2	37.20	40.380128	-80.652511
2	199	3	8.2	6.0	0.0	4,780.991	90.778	26.828	0.1	39.20	40.379728	-80.652833
3	468	3	8.2	6.0	0.0	1,456.277	18.319	5.739	0.1	39.90	40.379211	-80.653500
4	713	3	8.2	6.0	0.0	4,192.650	69.878	19.042	0.6	43.20	40.378889	-80.654250
5	955	3	8.2	6.0	0.0	4,831.530	102.369	23.128	0.1	46.80	40.378725	-80.655067
6	1,250	3	8.2	6.0	0.0	3,539.250	58.250	16.906	0.1	51.40	40.378747	-80.656100
7	1,489	3	8.2	6.0	0.0	2,324.691	49.109	13.426	0.1	50.80	40.378917	-80.656917
8	1,731	3	8.2	6.0	0.0	2,187.000	44.550	13.906	0.2	52.40	40.379108	-80.657744
9	1,952	3	8.2	6.0	0.0	3,465.000	63.669	14.542	0.1	53.10	40.379272	-80.658483
10	2,185	3	8.2	6.0	0.0	3,432.392	44.522	17.384	0.1	54.70	40.379389	-80.659289
11	2,489	3	8.2	6.0	0.0	1,905.353	35.241	10.651	0.2	53.40	40.379319	-80.660344
12	2,721	3	8.2	6.0	0.0	2,700.000	47.025	15.984	0.1	53.10	40.379108	-80.661117
13	2,969	3	8.2	6.0	0.0	2,827.912	46.907	14.591	0.2	51.40	40.378756	-80.661850
14	3,171	3	8.2	6.0	0.0	1,806.383	30.106	9.192	0.2	51.40	40.378442	-80.662431
15	3,372	3	8.2	6.0	0.0	1,133.387	19.834	12.057	0.2	50.80	40.378136	-80.663028
16	3,614	3	8.2	6.0	0.0	1,470.987	23.672	19.715	0.3	54.40	40.377897	-80.663811
17	3,782	3	8.2	6.0	0.0	1,642.167	27.369	13.870	0.3	53.10	40.377819	-80.664397
18	3,987	3	8.2	6.0	0.0	2,970.000	44.550	18.831	0.2	55.40	40.377836	-80.665131
19	4,204	3	8.2	6.0	0.0	1,761.939	30.109	14.895	0.2	56.40	40.377975	-80.665872
20	4,325	3	8.2	6.0	0.0	1,363.146	23.741	8.114	0.3	55.00	40.378072	-80.666289
					Average	2579.165	44.751	14.728				
					Min	1133.387	18.319	5.739				
					Max	4831.530	102.369	26.828				
					Stnd Dev	1110.877	22.421	5.260				

APPENDIX E

FWD Load Transfer Efficiency Evaluation

Table E1. Listing of LTE data collected fom John Scott Highway pavement at 12:54 pm on 3/20/2019

Location: John Scott Highway Eastbound Driving Lane

Direction: EB

Start: Kingston Ave

End: SR 22 on Ramp

Distance	Deflections, mils.		LTE (3/1)	Latitude	Longitude
	Sensor 1 (0")	Sensor 3 (12")			
61	21.98	21.20	96%	40.378242	-80.667558
482	10.00	8.92	89%	40.377903	-80.666125
1,021	9.86	8.20	83%	40.377697	-80.664250
1,501	9.02	7.31	81%	40.378167	-80.662669
2,010	8.12	6.03	74%	40.378944	-80.661164
2,525	6.68	5.59	84%	40.379261	-80.659425
3,025	12.15	11.64	96%	40.378950	-80.657664
3,509	10.89	9.67	89%	40.378600	-80.656000
4,015	8.28	7.59	92%	40.378756	-80.654228
4,361	8.75	7.74	88%	40.379244	-80.653183

Table E2. Listing of LTE data collected fom John Scott Highway pavement at 12:06 pm on 3/20/2019

Location: John Scott Highway Eastbound Shoulder

Direction: EB

Start: Kingston Ave

End: SR 22 on Ramp

Distance	Deflections, mils.		LTE (3/1)	Latitude	Longitude
	Sensor 1 (0")	Sensor 3 (12")			
509	26.78	7.02	26%	40.377847	-80.666036
1,022	25.72	8.33	32%	40.377672	-80.664236
1,508	18.53	10.65	57%	40.378139	-80.662642
2,014	24.04	15.80	66%	40.378919	-80.661142
2,502	9.34	7.90	85%	40.379233	-80.659478
2,998	23.83	20.56	86%	40.378942	-80.657758
3,507	13.73	12.29	90%	40.378575	-80.656000
3,991	9.10	7.53	83%	40.378433	-80.654303
4,506	14.85	6.85	46%	40.379492	-80.652808
4,749	18.92	9.53	50%	40.380014	-80.652281

Table E3. Listing of LTE data collected fom John Scott Highway pavement at 12:32 pm on 3/20/2019

Location: John Scott Highway Westbound Driving Lane

Direction: WB

Start: SR 22 on Ramp

End: Kingston Ave

Distance	Deflections, mils.		LTE (3/1)	Latitude	Longitude
	Sensor 1 (0")	Sensor 3 (12")			
22	10.20	8.17	80%	40.380142	-80.652461
512	11.63	10.64	91%	40.379144	-80.653561
1,009	8.91	8.78	99%	40.378689	-80.655178
1,513	5.69	4.84	85%	40.378889	-80.656914
1,981	7.19	6.23	87%	40.379244	-80.658467
2,496	7.98	6.90	86%	40.379314	-80.660261
3,010	8.04	7.10	88%	40.378703	-80.661881
3,361	13.09	11.93	91%	40.378161	-80.662900
4,005	7.46	6.58	88%	40.377803	-80.665092
4,378	6.72	5.64	84%	40.378072	-80.666369
4,726	12.25	11.16	91%	40.378356	-80.667522

Table E4. Listing of LTE data collected fom John Scott Highway pavement at 1:15 pm on 3/20/2019

Location: John Scott Highway Westbound Shoulder

Direction: WB

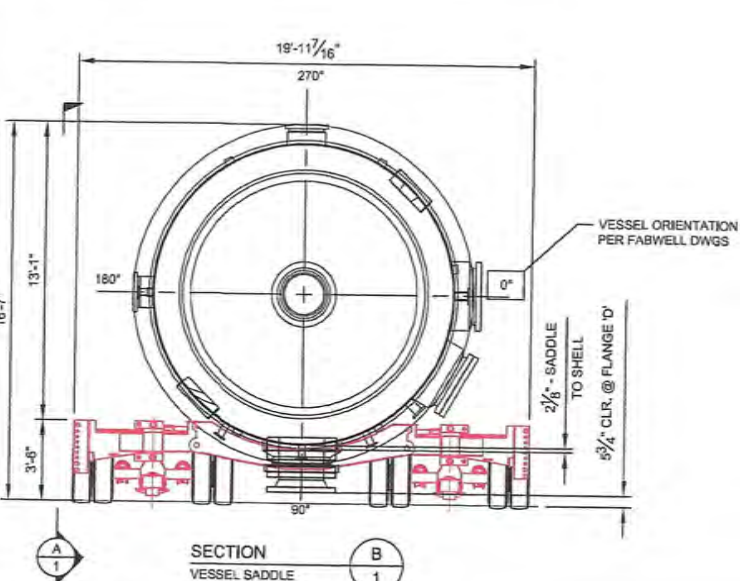
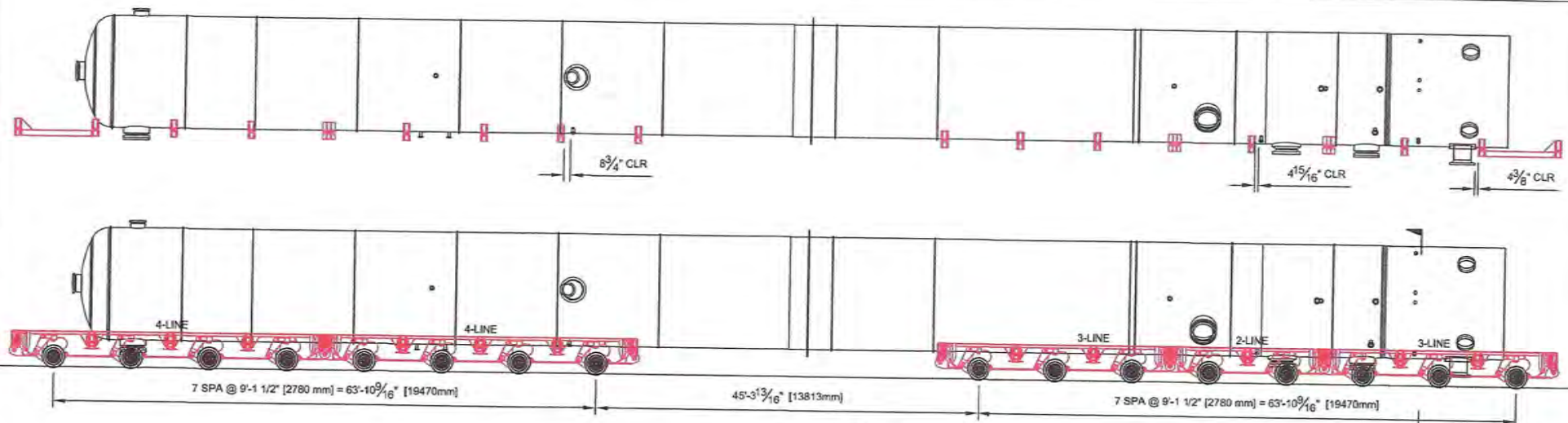
Start: SR 22 on Ramp

End: Kingston Ave

Distance	Deflections, mils.		LTE (3/1)	Latitude	Longitude
	Sensor 1 (0")	Sensor 3 (12")			
40	44.51	10.55	24%	40.380083	-80.652539
244	8.32	7.27	87%	40.379628	-80.652928
757	7.54	6.38	85%	40.378844	-80.654394
1,271	9.25	8.36	90%	40.378753	-80.656175
1,783	16.84	11.63	69%	40.379142	-80.657914
2,246	12.68	9.51	75%	40.379394	-80.659508
2,764	20.31	15.20	75%	40.379050	-80.661267
3,282	23.74	14.55	61%	40.378261	-80.662781
3,817	19.26	16.49	86%	40.377814	-80.664561
4,261	22.54	6.16	27%	40.378028	-80.666092

APPENDIX F

Transportation Configuration

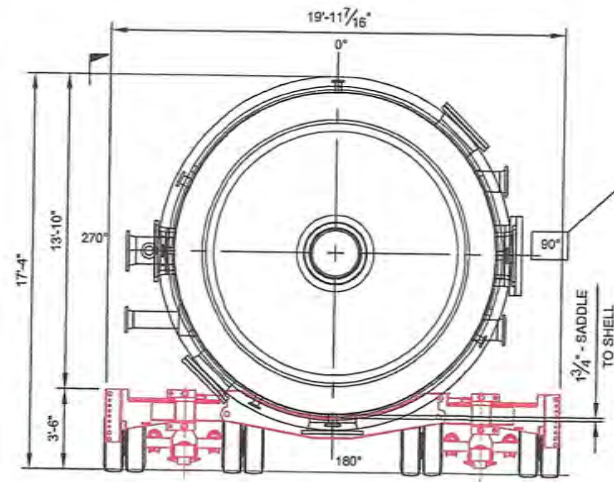
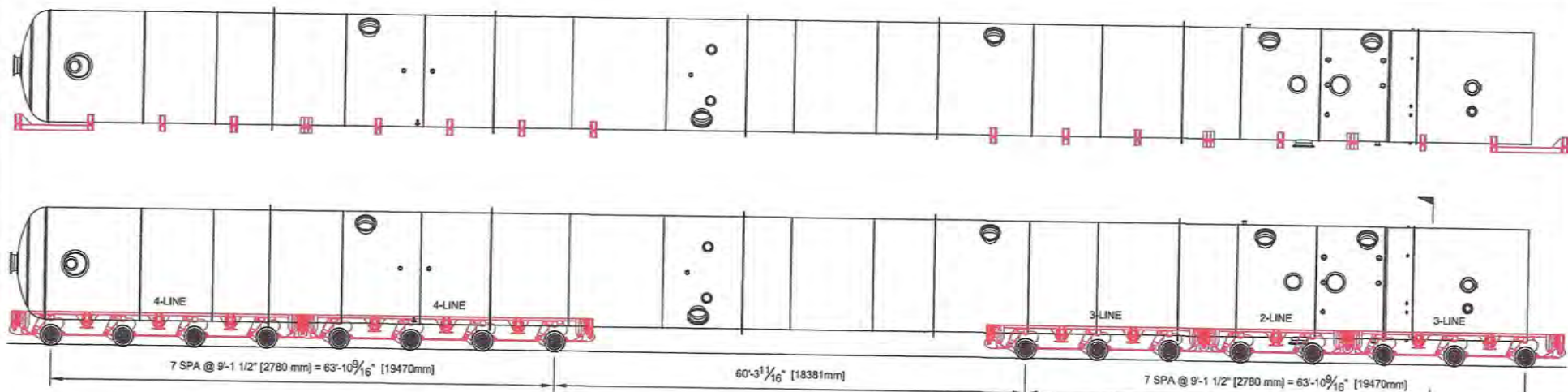


ELEVATION A
1

PRELIMINARY

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TRANSPORTATION CONFIGURATION VESSEL ORIENTATION AND SUPPORT 156" I.D. DEBUTANIZER (5620) ON SCHEUERLE HIGHWAY GIANT TRAILER				JOB NO. CCG01-19-08		DRAWING NO. P1		SHEET NO. 1 of 1		REV. NO. B	
B	REVISED RIDE HEIGHT TO 42"	JTC	3/25/19	-	-	SCALE:	NTS	BY	DATE	APPROVED	
A	PRELIMINARY - PROPOSAL DRAWING	JTC	3/25/19	-	-						
REV	DESCRIPTION	BY	DATE	DATE	DATE						
		DRAWN									



SECTION
VESSEL SADDLE

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CUSTOMER INFO

REV	DESCRIPTION	BY	DATE	BY	DATE	SCALE	JOB NO.	DRAWING NO.	SHEET NO.	REV. NO.
B	REVISED RIDE HEIGHT TO 42"	JTC	3/25/19	-	-	NTS	CCG01-19-08		P2	1 of 1
A	PRELIMINARY - PROPOSAL DRAWING	JTC	3/25/19	-	-					B

TRANSPORTATION CONFIGURATION
VESSEL ORIENTATION AND SUPPORT
168" I.D. DEBUTANIZER (5621)
ON SCHEUERLE HIGHWAY GIANT TRAILER

PRELIMINARY

Appendix B

Geotechnical Report



**PAVEMENT INVESTIGATION
JOHN SCOTT HIGHWAY
JEFFERSON COUNTY
STEUBENVILLE, OHIO**

Prepared For:

**Mr. Brian Hughes, P.E.
Project Engineer
MS Consultants, Inc.
333 East Federal Street
Youngstown, Ohio 44503-1821**

Prepared by:

**ACA ENGINEERING, INC.
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**ACA Project No. Y20030x10
June 15, 2020**

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APPENDIX C	Test Boring and Test Core Location Plan
APPENDIX D	Test Boring, Test Core Logs, Subsurface Profile, and Subsurface Graphs
APPENDIX E	Laboratory Testing
APPENDIX F	Test Core Photographs



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Geotechnical & Environmental Engineering, Materials Testing & Inspection

June 17, 2020

Mr. Brian Hughes, P.E.
Project Engineer
MS Consultant, Inc.
333 East Federal Street
Youngstown, Ohio 44503-1821

Re: Pavement Investigation
John Scott Highway
Steubenville, Ohio
ACA Project No. Y20030x10

Dear Mr. Hughes,

Thank you for choosing ACA Engineering, Inc. as your geotechnical engineering firm for the John Scott Highway pavement investigation. Per your authorization, ACA has completed the pavement investigation for the above referenced project. The results and findings of the investigation are discussed in the report.

If you have any questions about the report, please contact our office. ACA would be pleased to assist during design and construction by providing geotechnical, inspection, and testing services.

Sincerely,

ACA Engineering, Inc.


Michael Suchar
Michael Suchar, P.E.
Director of Engineering

Nicolas Chammas

Nicolas Chammas
Vice President



George Chammas, E.I.
Geotechnical/Materials Engineer

1.0 INTRODUCTION

1.1 Authority

This report has been prepared in accordance with the objective and scope of investigation outlined by ACA Engineering, Inc. (ACA) in its technical proposal, which was presented to Mr. Brian Hughes, P.E., Project Manager, MS Consultants, Inc., on April 22, 2020, for review and approval. Authorization to proceed was provided by email from Mr. Hughes on May 20th, 2020.

1.2 Scope of Geotechnical Investigation and Pavement Evaluation

To achieve the above objective, the investigation program consisted of the following tasks:

- Prepare and perform an exploration program to delineate and characterize the subsurface materials by drilling test borings and measuring the existing pavement thickness.
- Engineering involvement during all phases of the investigation and analysis of all data required.
- Provide inspection during the drilling of test borings to supervise the drilling operation and log test borings and cores.
- Formulate and perform a laboratory test program on soils and to determine parameters needed for subsequent design and analyses.
- Prepare a report that documents the data and analyses performed as well as presents the discussion and evaluation of the existing pavement conditions.

2.0 FIELD EXPLORATION PROGRAM

Subsurface conditions were evaluated by an exploration program consisting of six (6) pavement test cores for pavement thickness and type, and six (6) test borings for subsurface conditions. The concrete test cores were retrieved utilizing a portable electrical coring machine with a four (4.0) inch diameter thin-walled diamond bit.

2.1 Soil Sampling

Each of the test borings was drilled and sampled in general accordance with ASTM Standards to a depth of five and one-half (5.5) feet below the existing pavement surface. The soil sampling program consisted of obtaining continuous split spoon samples. The continuous spoon samples were obtained by conducting Standard Penetration Test (SPT) by driving a 2-inch O.D. Split Spoon Sampler (ASTM D-1586). The sampler was driven 18 inches into the soil with blows from a 140-pound hammer falling 30 inches, and the number of blows required to drive the sampler for each 6-inch interval was

recorded. The cumulative number of blows for the last two 6-inch intervals (blows/foot) is termed as Standard Penetration Resistance, which can be correlated with relative density of granular soils or consistence of fine-grained soils and, in turn, their shear strength and compressibility characteristics.

2.2 Groundwater/Trapped Water Readings

Water seepage/trapped water was encountered in test borings B-2, B-4, and B-5 at depths ranging from two and one-half (2.5) feet to four (4.0) feet below the pavement. It should be noted, in test boring B-5 the water seepage was encountered just beneath the subbase layer. The groundwater levels at the site may fluctuate in response to precipitation, run-off volumes and during the flooding periods.

3.0 LABORATORY TESTING PROGRAM

All soil samples were subjected to visual-manual soil classification. In addition, moisture content, Atterberg limits, and grain size analysis were performed on select split spoon samples in general accordance with applicable ASTM and ODOT standards to determine the in-place characteristics of the existing soils. A summary of the test results has been included in the table below, while the full report can be found in appendix E.

<i>Lab Testing Summary</i>								
Test Boring No.	Depth (ft)	Natural Moisture (%)	Liquid Limit	Plasticity Index	Passing #200 Sieve (%)	Classification (USCS, AASHTO)	CBR	Resilient Modulus M_R (psi)
B-1	1.0-2.5	14.2	36	16	55.9	CL,A-6(6)	2.5	3,000
B-3	1.0-2.5	11.7	26	10	45.7	SC,A-4(1)	4.0	4,800
B-6	1.0-2.5	11.5	33	15	36.4	GC, A-6(1)	4.0	4,800

- NP= Non-Plastic Soil
- The above CBR values were calculated using a factor of safety of 3.

4.0 GENERAL SITE CONDITION

4.1 Project Location

The location of the site is on John Scott Highway off State Route 22 in Steubenville, Jefferson County, Ohio. For site location, see U.S.G.S. Topographic Map in Appendix A.

4.2 Surface Conditions

Most of the existing concrete pavement throughout the area is in fair to good overall condition with localized distresses along the right wheel path, centerline of the lanes, and perpendicular to the lanes running from one edge

of the pavement to the other. In addition, a stream was present adjacent to the road flowing from the West to the East.

4.3 Soil Conditions

According to the U.S.D.A. Soil Survey of Jefferson County, Ohio the soils in the project area are derived from residuum, colluvium over residuum, residuum from siltstone and sandstone, and clayey residuum weathered from limestone and shale. The colluvium is derived from a mixture of residual and transported soil moving downslope under the influence of gravity. The residuum deposits are soil derived from the weathering of rock exposed at the earth's surface. In addition, outcrops were observed with signs of blasting and drilling. For more information, refer to the U.S.D.A soil survey map in Appendix B.

5.0 PAVEMENT AND SUBSURFACE PROFILE

5.1 Reinforced Concrete

A total of six (6) test cores (C-1 through C-6) were taken to determine the pavement thickness and type. The thickness of the reinforced concrete ranged from approximately seven and three quarters (7.75) inches in C-5 to eight and one-quarter (8.25) inches in the rest of the test cores. The average thickness of the concrete is approximately 8.2 inches.

5.2 Aggregate Subbase

Subbase was encountered in all the test borings drilled on site. The thickness of the subbase ranged from approximately three (3.0) inches in test boring B-5 to ten (10) inches in test boring B-4. The subbase consisted of well graded limestone/slag sand and sand with limestone fragments.

5.3 Subgrade Soil

Six (6) test borings were drilled through the soil beneath the existing pavement. Fill materials were encountered in all the test borings and extended to varying depths. The fill material consisted of silty sandy clay, silty clay, clayey sand, and clayey gravel. Beneath the fill materials, weathered rock and bedrock were encountered. The weathered rock consisted of shale. The weathered rock was severely weathered and very weak to week. The bedrock consisted of sandstone and limestone. The sandstone and limestone were severely weathered to highly weathered and weak to moderately strong. It appears the fill materials contain residuum and possible boulders from blasting operations.

5.4 Groundwater/Trapped Water

Water seepage/trapped water was encountered in test borings B-2, B-4, and B-5 at depths ranging from two and one-half (2.5) feet to four (4.0) feet below the pavement. In test boring B-5, the water seepage was encountered just beneath the subbase layer. However, groundwater level at the site might fluctuate in response to precipitation, run-off volumes and during the flooding periods.

6.0 RECOMMENDATIONS AND ANALYSIS

The analysis and recommendations presented in this report are based on the subsurface conditions disclosed by the site reconnaissance, field exploration, laboratory testing, and office research programs. Due to the large distances between the test borings performed, the possibility exists that conditions other than those revealed during our investigation may be present at the site. If substantial variations in the site conditions do exist or are revealed during construction operations, the recommendations given in this section may either become invalid or need to be modified.

6.1 Existing Pavement Condition

The existing concrete pavement at John Scott Highway appears to be in fair to good overall condition, however there are localized areas of the pavement showing distress. The cracking throughout the existing pavement appears to be a result of longitudinal cracking, transverse (thermal) cracking, faulting, and spalling of joints. Longitudinal cracking is load associated cracks from repetitive wheel loading applied over the life of the pavement. Transverse (thermal) cracking is non load associated and occurs when temperature of the surface drops to create a shrinkage stress that exceeds the tensile strength of the concrete mixture. The faulting is a distress in which the pavement settles slightly towards the direction of traffic. The spalling of joints is the breaking and chipping of the slab edges within transverse/longitudinal joints. It appears both the load and non-load cracking are a result of the age of the pavement, inadequate subbase in localized areas, and underlying undocumented fill materials. Typically, a rigid pavement requires an aggregate base with sufficient size stone such as ODOT #304. In addition, it appears that the concrete has experienced thermal cracking during freeze thaw cycles which is resulting in the non-load associated distresses. The fill materials on site are derived from primarily residuum and from what appears to be blasting operations. Possible boulders were encountered in the fill materials which can result in voids beneath the pavement. During the site visit, it appears the outcrop has visible signs of drilling and blasting. The fill materials can contain pockets of less compacted materials which can consolidate under their own weight.

The test cores indicate that the existing pavement consisted of reinforced concrete. The reinforced concrete was in good condition and did not have any cracks. In addition, the test core from B-2/C-2 was tested for compressive strength which resulted in a corrected unit load of 8,552 pounds per square inch (psi).

A stream was present adjacent to the pavement flowing from the West to the East. The stream provides proper drainage to not allow water to percolate through or beneath the pavement. The existing topography allows water to slope away from the pavement; however, water seepage was still encountered in some test borings. The most significant amount of water seepage encountered was in test boring B-2.

6.2 Pavement Analysis

Based on the test cores, the pavement profile consisted of a reinforced concrete pavement and subbase material. Three (3) pavement analyses were performed based on existing conditions using the thicknesses from the test cores, and structural coefficients from the ODOT pavement design manual. The following tables summarize the results:

<i>Best Case Scenario (TB-4/C-4)</i>			
Material	Actual Thickness (in.)	ODOT Structural Coefficient	Structural Number
Reinforced Concrete	8.25	0.27	2.23
Subbase	10.00	0.11	1.10
Total SN			3.3

<i>Worst Case Scenario (TB-5/C-5)</i>			
Material	Actual Thickness (in.)	ODOT Structural Coefficient	Structural Number
Reinforced Concrete	7.75	0.27	2.09
Subbase	3.00	0.11	0.33
Total SN			2.4

<i>Average Thicknesses</i>			
Material	Actual Thickness (in.)	ODOT Structural Coefficient	Structural Number
Reinforced Concrete	8.16	0.27	2.20
Subbase	7.66	0.11	0.84
Total SN			3.0

Based on the above analyses, the existing pavement section varied throughout the length of the investigated road. No minimum structural number or traffic data were available at the time of the investigation. However, a pavement analysis and/or design can be conducted by the design engineer to determine the minimum structural number required for the pavement section. It should be noted, the three (3) analyses performed are based on existing pavement conditions and thicknesses.

6.3 Pavement Support

As mentioned before, the existing pavement appears to be in fair to good condition. Deterioration is due to the age of the pavement, inadequate subbase in localized areas, and undocumented fill materials. A pavement design/analysis should be performed to determine if the existing pavement buildup is acceptable. In addition, ongoing maintenance of the road will be required. Based on the laboratory testing and the ODOT pavement design manual, an average CBR value of 3.5 and resilient modulus of 4,200 pounds per square inch (psi) should be utilized for pavement design. It should be noted that if poor drainage or other deleterious conditions develop, the recommended design parameters may become invalid.

6.4 High Plasticity Soils

Based on the laboratory testing, no high plasticity soils were encountered beneath the existing pavement. The soils had a liquid limit below 40 and plasticity index below 20. The moisture contents of these soils were relatively low, but this could be affected by rainfall, groundwater/water seepage, and seasonal changes.

6.5 Drainage Considerations

The streams along the side of the road are allowing water to be drained away from the pavement. The city will have to maintain the existing drainage to further extend the pavements life. The areas where drainage was not present will need to be monitored.

7.0 GENERAL CONSIDERATIONS

Our services were provided in general accordance with the standards for such professional services during the term of our agreement. Plan and specification review, and monitoring and testing during construction, are an extension of these professional services although they may not have been specifically addressed by the original agreement and are subject to the same standard of care. These extended services should be provided by ACA Engineering, Inc. to maintain continuity of the original intent of the test cores and test borings process and to reduce the possibility of conflicting interpretations or misinterpretations of the data presented in this report.

ACA Engineering, Inc. accepts no responsibility for used or interpretations of the data by the client, contractors, or other design professionals for any purpose whatsoever except as expressly described in this report or unless otherwise stated in writing, and then only for the stated purpose.

The analyses presented herein are based upon data obtained from test cores and test borings conditions at the randomly selected locations and is based on the engineering judgment of ACA and could be interpreted differently by others.

In the performance of coring, and test borings specific information is obtained at specific locations at specific times. However, it should be recognized that variations might exist between cores and test borings locations.

If you require additional information or clarification of the existing pavements, please contact our office.

APPENDICES

APPENDIX A

U.S.G.S. Topographic Map

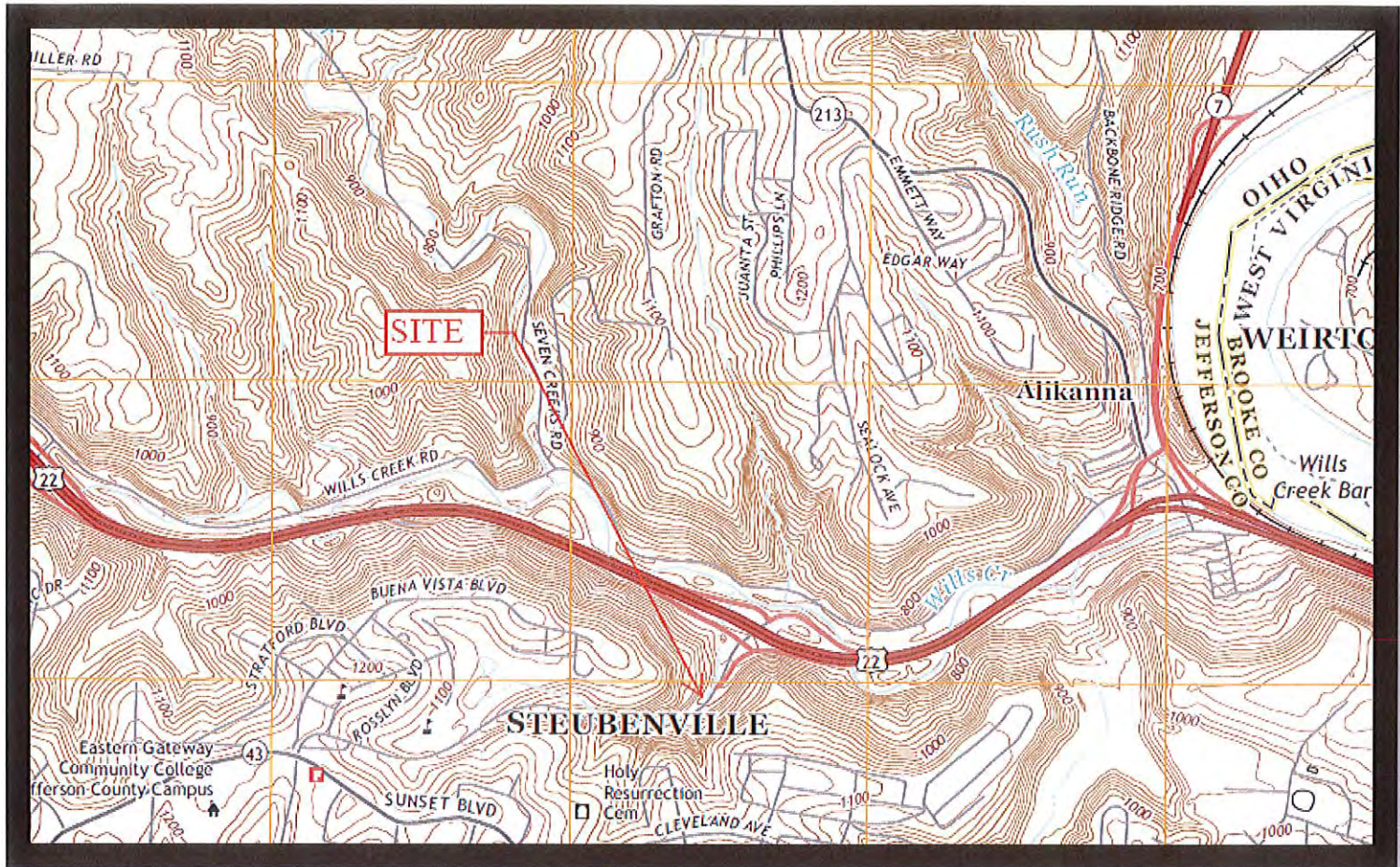
U.S.G.S. TOPOGRAPHIC MAP

Source:

U.S.G.S. Knoxville Quadrangle
Ohio-West Virginia
7.5 Minute Series (Topographic)
Scale 1:24,000

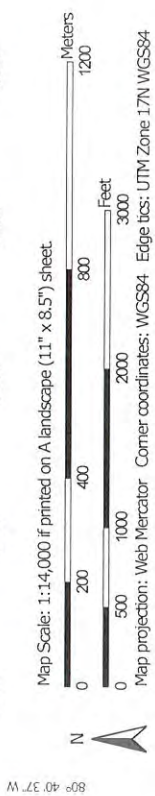
Project:

John Scott Highway Pavement
Evaluation
Steubenville, Ohio



APPENDIX B

U.S.D.A. Soil Survey Map & Symbols



MAP LEGEND

 Area of Interest (AOI)	 Area of Interest (AOI)
 Soils	 Spoil Area
 Soil Map Unit Polygons	 Stony Spot
 Soil Map Unit Lines	 Very Stony Spot
 Soil Map Unit Points	 Wet Spot
 Special Point Features	 Other
 Blowout	 Special Line Features
 Borrow Pit	 Water Features
 Clay Spot	 Streams and Canals
 Closed Depression	 Transportation
 Gravel Pit	 Rails
 Gravelly Spot	 Interstate Highways
 Landfill	 US Routes
 Lava Flow	 Major Roads
 Marsh or swamp	 Local Roads
 Mine or Quarry	 Background
 Miscellaneous Water	 Aerial Photography
 Perennial Water	
 Rock Outcrop	
 Saline Spot	
 Sandy Spot	
 Severely Eroded Spot	
 Sinkhole	
 Slide or Slip	
 Sodic Spot	

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

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

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

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

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

Soil Survey Area: Jefferson County, Ohio
Survey Area Data: Version 18, Sep 16, 2019

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

Date(s) aerial images were photographed: May 23, 2014—Mar 7, 2017

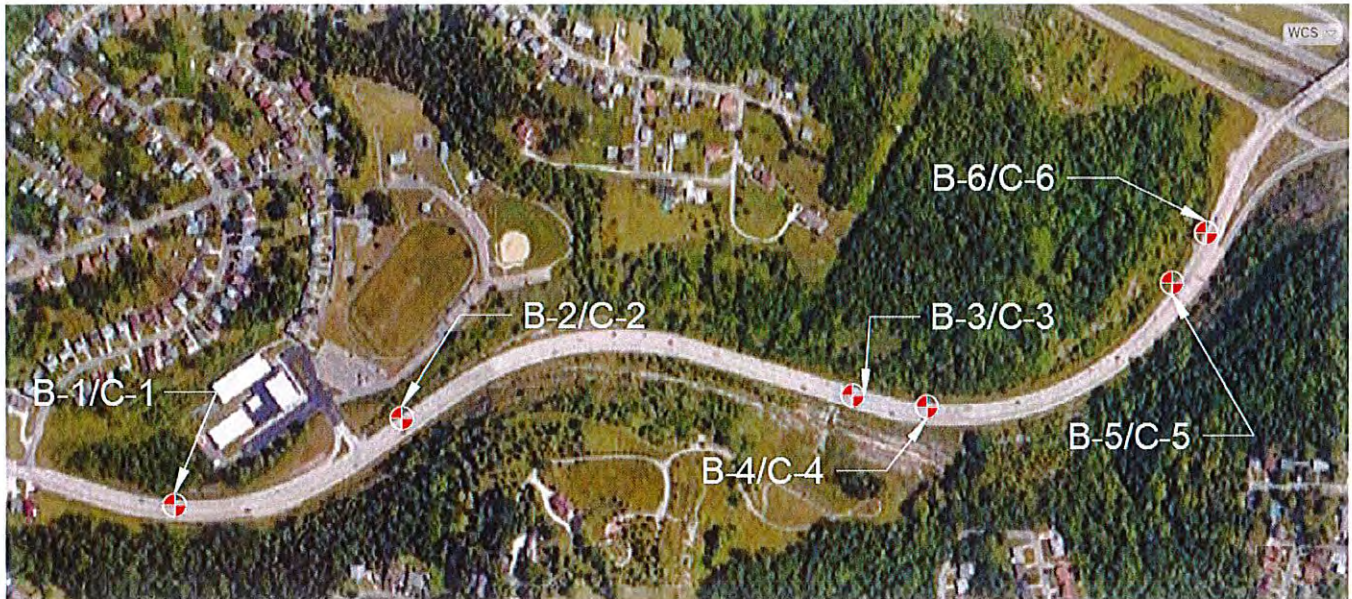
The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
Bhv1B	Bethesda silt loam, 0 to 8 percent slopes, reclaimed	0.2	0.0%
Bhv1F	Bethesda silt loam, 25 to 70 percent slopes, reclaimed	1.1	0.2%
BmE	Berks-Guernsey complex, 25 to 40 percent slopes	50.4	7.1%
CkD	Clarksburg silt loam, 15 to 25 percent slopes	13.2	1.9%
CnB	Coshocton silt loam, 1 to 7 percent slopes	0.1	0.0%
GoC	Gilpin-Coshocton silt loams, 8 to 15 percent slopes	4.6	0.6%
GpC	Gilpin-Lowell silt loams, 8 to 15 percent slopes	1.4	0.2%
GpD	Gilpin-Lowell silt loams, 15 to 25 percent slopes	70.4	9.9%
HgE	Hazleton-Westmoreland complex, 25 to 40 percent slopes	8.2	1.2%
Mwc3B	Morristown silty clay loam, 0 to 8 percent slopes, reclaimed	6.1	0.9%
Mwc3D	Morristown silty clay loam, 8 to 25 percent slopes, reclaimed	3.6	0.5%
Mwc3F	Morristown silty clay loam, 25 to 70 percent slopes, reclaimed	4.4	0.6%
RcB	Richland silt loam, 1 to 7 percent slopes	30.8	4.3%
UtC	Urban land-Gilpin-Lowell complex, 8 to 15 percent slopes	117.2	16.4%
UtD	Urban land-Gilpin-Lowell complex, 15 to 25 percent slopes	184.6	25.9%
WuF	Westmoreland-Lowell complex, 40 to 70 percent slopes	217.4	30.5%
Totals for Area of Interest		713.5	100.0%

APPENDIX C

Test Boring and Test Core Location Plan



Test Bores Location

Project: John Scott Highway Pavement Evaluation

Project No: Y20030x10

Location: Steubenville, Ohio

* Test boring map shows approximate locations.

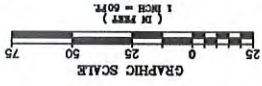
ACA ENGINEERING, INC.
741 McClurg Road, Suite A
Boardman, OH 44512
P: (330) 729-1222
F: (330) 729-9222
info@acaohio.com

GPR VOID MAP
 JOHN SCOTT HIGHWAY
 FROM KINGSTON AVE TO SR 22 ON RAMP
 JEFFERSON COUNTY
 STATE OF OHIO

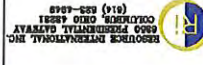


- LEGEND**
- LARGE VOIDS
 - SMALL VOIDS
 - PATCHES

Figure B-2



GPR VOID MAP
 JOHN SCOTT HIGHWAY
 FROM KINGSTON AVE
 TO SR 22 ON RAMP
 JEFFERSON COUNTY
 STATE OF OHIO



DRAWN BY:	DTF	DATE:	3-29-2019
CHECKED BY:	CAY	DRAWING NO.:	2
JOB NO.:	W-19-025	SHEET:	1 OF 1

GPR VOID MAP
 JOHN SCOTT HIGHWAY
 FROM KINGSTON AVE TO SR 22 ON RAMP
 JEFFERSON COUNTY
 STATE OF OHIO

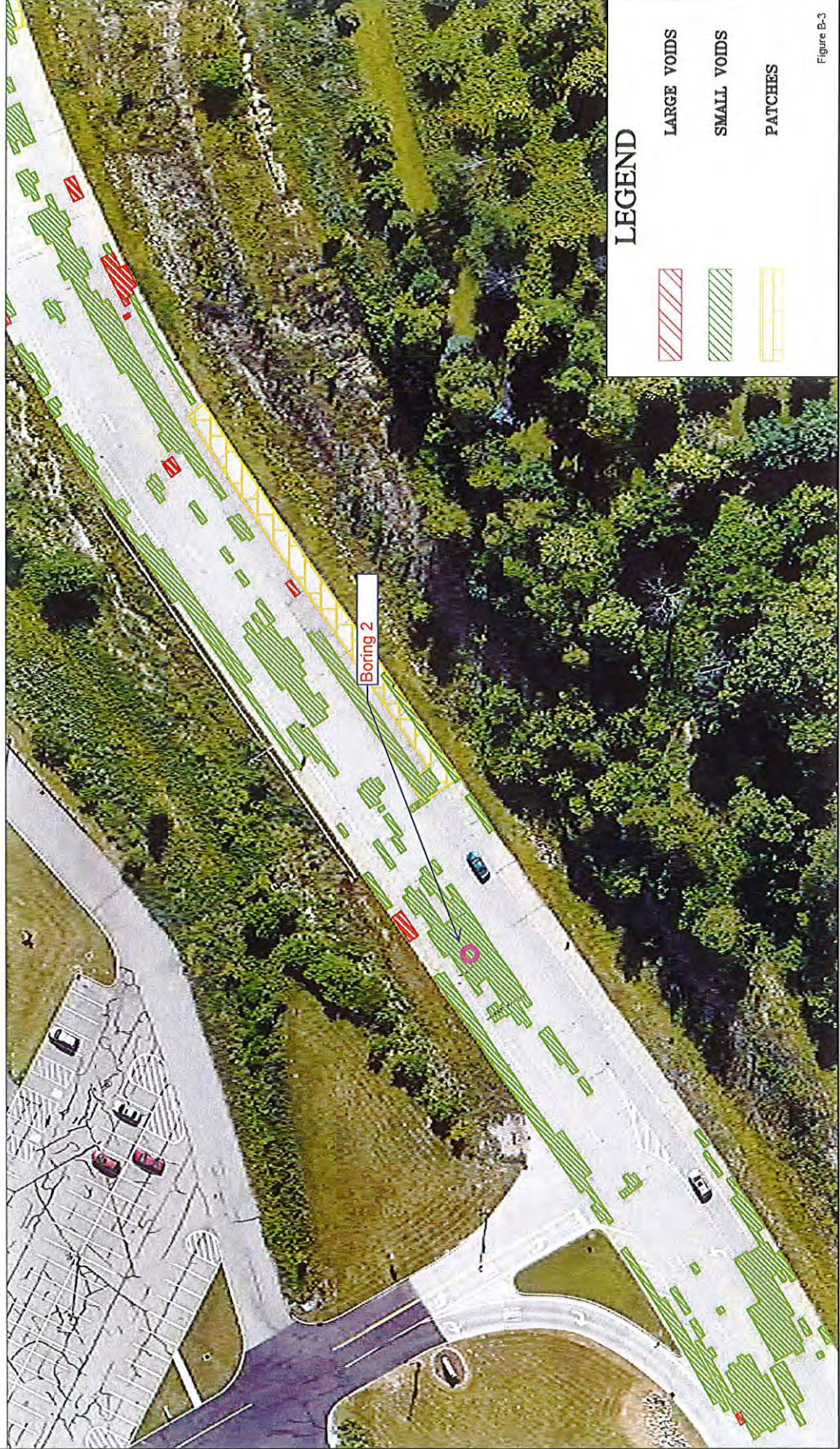
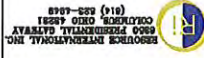


Figure B-3

B3

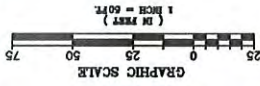


GPR VOID MAP
 JOHN SCOTT HIGHWAY
 FROM KINGSTON AVE
 TO SR 22 ON RAMP
 JEFFERSON COUNTY
 STATE OF OHIO

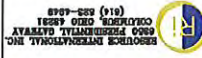


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JOB NO.	W-19-025	SHEET	1 OF 1

GPR VOID MAP
 JOHN SCOTT HIGHWAY
 FROM KINGSTON AVE TO SR 22 ON RAMP
 JEFFERSON COUNTY
 STATE OF OHIO



GPR VOID MAP
 JOHN SCOTT HIGHWAY
 FROM KINGSTON AVE
 TO SR 22 ON RAMP
 JEFFERSON COUNTY
 STATE OF OHIO



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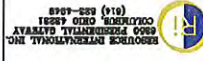
- LARGE VOIDS
- SMALL VOIDS
- PATCHES

Figure B-4

GPR VOID MAP JOHN SCOTT HIGHWAY FROM KINGSTON AVE TO SR 22 ON RAMP JEFFERSON COUNTY STATE OF OHIO



GPR VOID MAP
 JOHN SCOTT HIGHWAY
 FROM KINGSTON AVE
 TO SR 22 ON RAMP
 JEFFERSON COUNTY
 STATE OF OHIO



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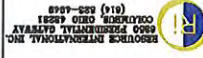
LEGEND

- LARGE VOIDS
- SMALL VOIDS
- PATCHES

GPR VOID MAP
 JOHN SCOTT HIGHWAY
 FROM KINGSTON AVE TO SR 22 ON RAMP
 JEFFERSON COUNTY
 STATE OF OHIO



GPR VOID MAP
 JOHN SCOTT HIGHWAY
 FROM KINGSTON AVE
 TO SR 22 ON RAMP
 JEFFERSON COUNTY
 STATE OF OHIO



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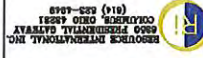
LEGEND

-  LARGE VOIDS
-  SMALL VOIDS
-  PATCHES

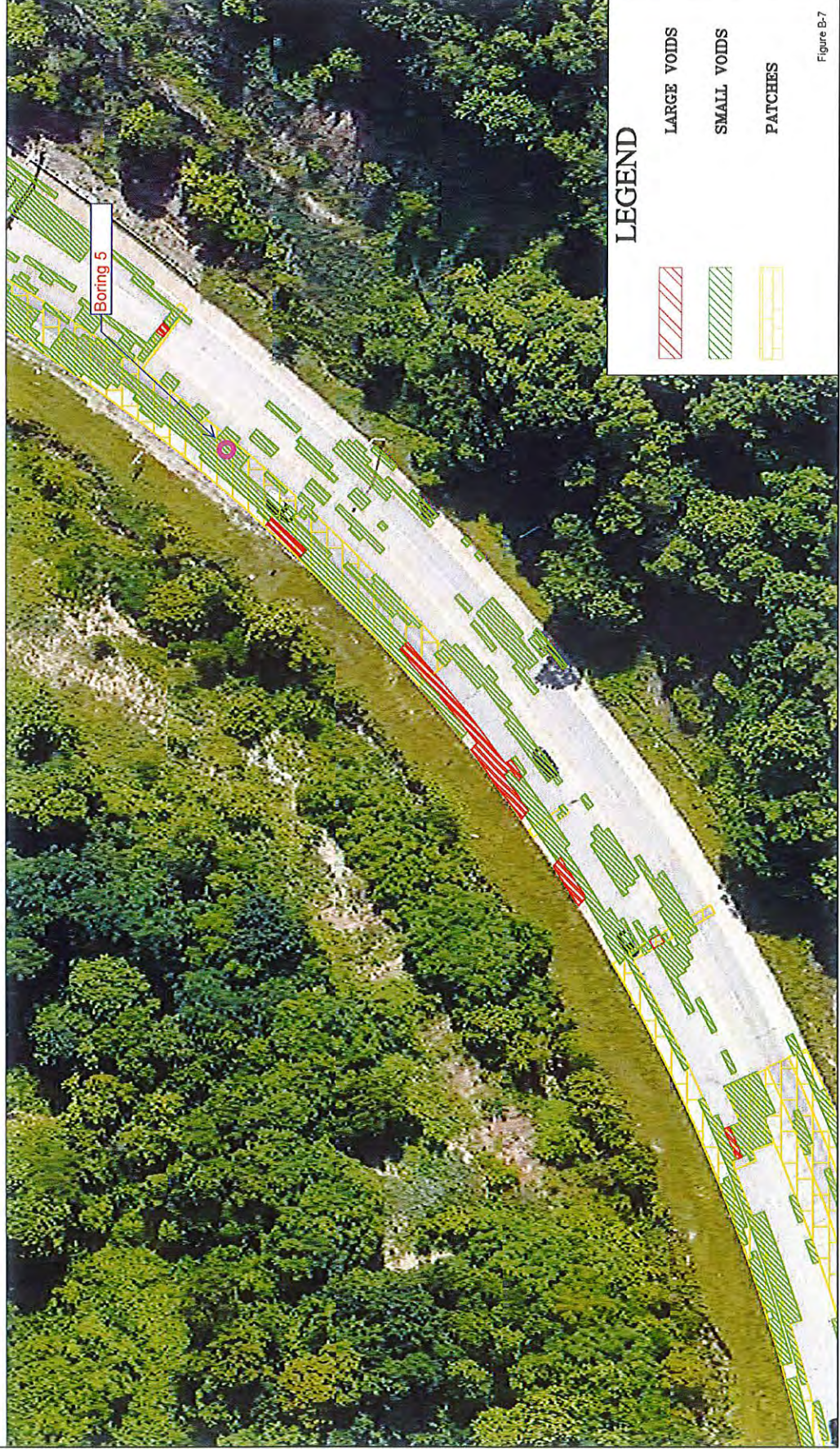
GPR VOID MAP
 JOHN SCOTT HIGHWAY
 FROM KINGSTON AVE TO SR 22 ON RAMP
 JEFFERSON COUNTY
 STATE OF OHIO



GPR VOID MAP
 JOHN SCOTT HIGHWAY
 FROM KINGSTON AVE
 TO SR 22 ON RAMP
 JEFFERSON COUNTY
 STATE OF OHIO



JOB NO.: W-19-023	SHEET: 1 OF 1
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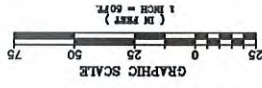


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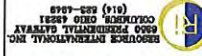
- LARGE VOIDS
- SMALL VOIDS
- PATCHES

Figure B-7

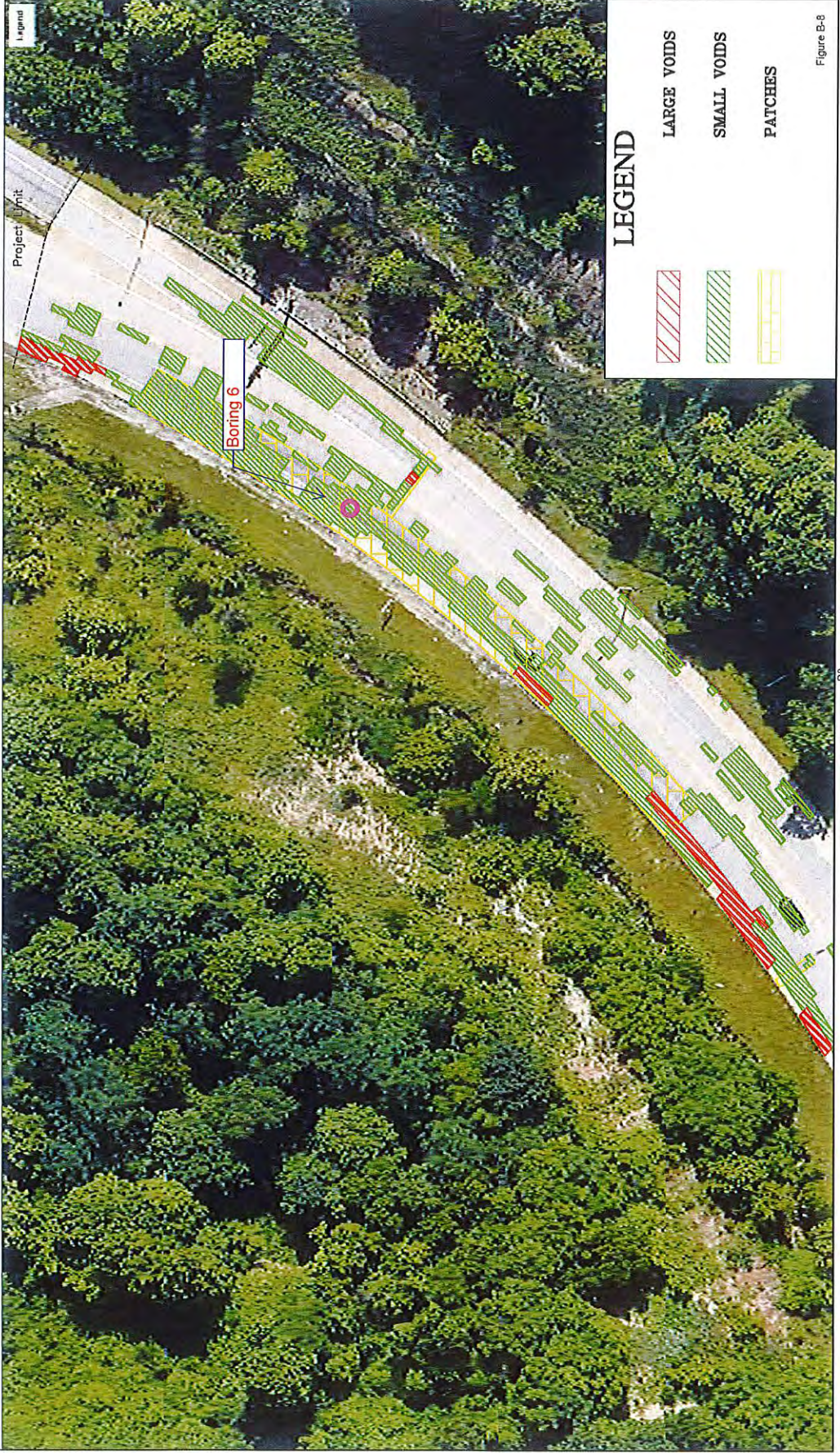
GPR VOID MAP
 JOHN SCOTT HIGHWAY
 FROM KINGSTON AVE TO SR 22 ON RAMP
 JEFFERSON COUNTY
 STATE OF OHIO



GPR VOID MAP
 JOHN SCOTT HIGHWAY
 FROM KINGSTON AVE
 TO SR 22 ON RAMP
 JEFFERSON COUNTY
 STATE OF OHIO



DATE:	J-29-2019	DRAWN BY:	DTF
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JOB NO.:	W-19-025	SHEET:	1 OF 1



APPENDIX D

Test Boring Logs, Test Core Logs, Subsurface Profile, and Subsurface
Graphs

Project No.: Y20030x10

John Scott Highway Pavement
Project: Evaluation

Client: MS Consultants, Inc.

Location: Steubenville, Ohio



Borehole #: B-1/C-1

Elevation: N/A

Engineer/Geologist: G. Chammas

SUBSURFACE PROFILE				SAMPLE					Shear Strength blows/ft	Water Level	Remarks
Depth	Symbol	Description	Depth/Elev.	Number	Type	Sample Depth (ft)	Blows/ft	N60 Value			
0		Ground Surface	0						20 40 60		
		Reinforced Concrete 8.25"	0.7								
		Well Graded Limestone/Slag Sand with Silt. 9"	1.4				8				
2		Very stiff to hard, brown, damp, Silty Sandy CLAY with little shale fragments. (FILL)		S-1	SS	1.0-2.5	4	16			Recovery= 18"
							7				
				S-2	SS	2.5-4.0	12	39			Recovery= 18"
4		Very stiff, gray, moist, Silty CLAY with shale fragments. (FILL)					15				
				S-3	SS	4.0-5.5	9	26			Recovery= 18"
			5.5				9				
6		End of test boring at 5.50'									
8											
10											
12											

Drilled By: Ohio TestBor

Drill Method: Hollow Stem Auger, ER=87.4%

Drill Date: 06-08-2020

Hole Size: 5.50"

Weather: Clear

Sheet: 1 of 1

Project No.: Y20030x10

John Scott Highway Pavement
Project: Evaluation

Client: MS Consultants, Inc.

Location: Steubenville, Ohio



Borehole #: B-2/C-2

Elevation: N/A

Engineer/Geologist: G. Chammas

SUBSURFACE PROFILE				SAMPLE					Shear Strength blows/ft	Water Level	Remarks
Depth	Symbol	Description	Depth/Elev.	Number	Type	Sample Depth (ft)	Blows/ft	N60 Value			
0		Ground Surface	0						20 40 60		
		Reinforced Concrete 8.25"	0.7								
		Well Graded Limestone/Slag Sand with Silt. 8"	1.4				3				
2		Very stiff, brown and gray, damp, Silty CLAY with sandstone, shale, and coal fragments. (FILL)		S-1	SS	1.0-2.5	6	22			Recovery= 18"
							9				
							7				
				S-2	SS	2.5-4.0	8	19			Recovery= 14"
4		Hard, brown and gray, moist to wet, Silty CLAY with shale fragments. (FILL)					5				
		Water seepage at 4.0'					6				
				S-3	SS	4.0-5.5	8	64			Recovery= 18"
			5.5				36				
6		End of test boring at 5.50'									
8											
10											
12											

Drilled By: Ohio TestBor

Drill Method: Hollow Stem Auger, ER=87.4%

Drill Date: 06-08-2020

Hole Size: 5.50"

Weather: Clear

Sheet: 1 of 1

Project No.: Y20030x10

John Scott Highway Pavement
Project: Evaluation

Client: MS Consultants, Inc.

Location: Steubenville, Ohio



Borehole #: B-3/C-3

Elevation: N/A

Engineer/Geologist: G. Chammas

SUBSURFACE PROFILE				SAMPLE					Shear Strength blows/ft	Water Level	Remarks
Depth	Symbol	Description	Depth/Elev.	Number	Type	Sample Depth (ft)	Blows/ft	N60 Value			
0		Ground Surface	0						20 40 60		
		Reinforced Concrete 8.25"	0.7								
		Well Graded Limestone/Slag Sand with Silt. 8"	1.3								
2		Medium Dense, brown, red, and gray, moist, Clayey SAND with with some shale and sandstone fragments. (FILL)	2.5	S-1	SS	1.0-2.5	9 6 11	25			Recovery= 18"
		SANDSTONE, gray, severely to highly weathered, slightly strong to moderately strong, trace coal fragments.		S-2	SS	2.5-3.4	9 50/5"	73			Recovery= 16"
4			4.7	S-3	SS	4.0-4.3	50/3"	73			Recovery=8"
		End of test boring at 4.7' Auger refusal at 4.7'									
6											
8											
10											
12											

Drilled By: Ohio TestBor

Drill Method: Hollow Stem Auger, ER=87.4%

Drill Date: 06-08-2020

Hole Size: 5.50"

Weather: Clear

Sheet: 1 of 1

Project No.: Y20030x10

John Scott Highway Pavement
Project: Evaluation

Client: MS Consultants, Inc.

Location: Steubenville, Ohio



Borehole #: B-4/C-4

Elevation: N/A

Engineer/Geologist: G. Chammas

SUBSURFACE PROFILE				SAMPLE					Shear Strength blows/ft	Water Level	Remarks
Depth	Symbol	Description	Depth/Elev.	Number	Type	Sample Depth (ft)	Blows/ft	N60 Value			
0		Ground Surface	0						20 40 60		
		Reinforced Concrete 8.25"	0.7								
		Well Graded Limestone/Slag Sand with Silt. 10"	1.5				9				
2		Medium stiff, brown and gray, moist, Silty CLAY with little sand. (FILL)		S-1	SS	1.0-2.5	2	6			Recovery= 12"
		Medium dense to dense, gray, moist, Clayey SAND with sandstone and coal fragments. (FILL)					2				
		Water seepage at 2.5' 4" layer of brown sandstone.		S-2	SS	2.5-4.0	4				
4		SHALE, brown and gray, severely weathered, weak.	4.0				8	23			Recovery= 18"
							10				
				S-3	SS	4.0-5.5	16	42			Recovery= 18"
			5.5				13				
6		End of test boring at 5.5'									
8											
10											
12											

Drilled By: Ohio TestBor

Drill Method: Hollow Stem Auger, ER=87.4%

Drill Date: 06-08-2020

Hole Size: 5.50"

Weather: Clear

Sheet: 1 of 1

Project No.: Y20030x10

John Scott Highway Pavement
Project: Evaluation

Client: MS Consultants, Inc.

Location: Steubenville, Ohio



Borehole #: B-5/C-5

Elevation: N/A

Engineer/Geologist: G. Chammas

SUBSURFACE PROFILE				SAMPLE					Shear Strength blows/ft	Water Level	Remarks
Depth	Symbol	Description	Depth/Elev.	Number	Type	Sample Depth (ft)	Blows/ft	N60 Value			
0		Ground Surface	0						20 40 60		
		Reinforced Concrete 7.75"									
			0.6								
		Sand and limestone fragments	0.9								
		3"									
2		Hard, brown, damp, Sandy Silty CLAY with shale fragments. (FILL) Seepage beneath subbase layer.		S-1	SS	1.0-2.5	3 5	36			Recovery= 18"
		LIMESTONE, gray, highly weathered, moderately strong.					20 14				
		Possible boulder at 2.0'. Pocket of dark brown sand at 3.0'.		S-2	SS	2.5-4.0	50/6"	73			Recovery= 12"
4		SHALE, gray, severely weathered, very weak.	4.0								
				S-3	SS	4.0-5.5	15 27	64			Recovery= 18"
			5.5				17				
6		End of test boring at 5.5'									
8											
10											
12											

Drilled By: Ohio TestBor

Drill Method: Hollow Stem Auger, ER=87.4%

Drill Date: 06-08-2020

Hole Size: 5.50"

Weather: Clear

Sheet: 1 of 1

Project No.: Y20030x10

John Scott Highway Pavement
Project: Evaluation

Client: MS Consultants, Inc.

Location: Steubenville, Ohio



Borehole #: B-6/C-6

Elevation: N/A

Engineer/Geologist: G. Chammas

SUBSURFACE PROFILE				SAMPLE					Shear Strength blows/ft	Water Level	Remarks
Depth	Symbol	Description	Depth/Elev.	Number	Type	Sample Depth (ft)	Blows/ft	N60 Value			
0		Ground Surface	0						20 40 60		
		Reinforced Concrete 8.25"	0.7								
		Sand and Limestone fragments 8"	1.4				5				
2		Medium Dense, brown, moist, Clayey GRAVEL with some sand. (FILL)		S-1	SS	1.0-2.5	6	17			Recovery= 16"
		SHALE, gray, severely weathered, very weak.		S-2	SS	2.5-4.0	15	39			Recovery= 18"
4		Dense, brown, damp, Clayey SAND with sandstone fragments. (FILL)	4.5				4				
		SANDSTONE, brown, severely weathered, weak.	5.5	S-3	SS	4.0-5.5	7	44			Recovery= 14"
6		End of test boring at 5.5'					23				
8											
10											
12											

Drilled By: Ohio TestBor

Drill Method: Hollow Stem Auger, ER=87.4%

Drill Date: 06-08-2020

Hole Size: 5.50"

Weather: Clear

Sheet: 1 of 1

KEY TO SYMBOLS

Symbol Description

Strata symbols



Paving



Sand



Fill



Sandstone



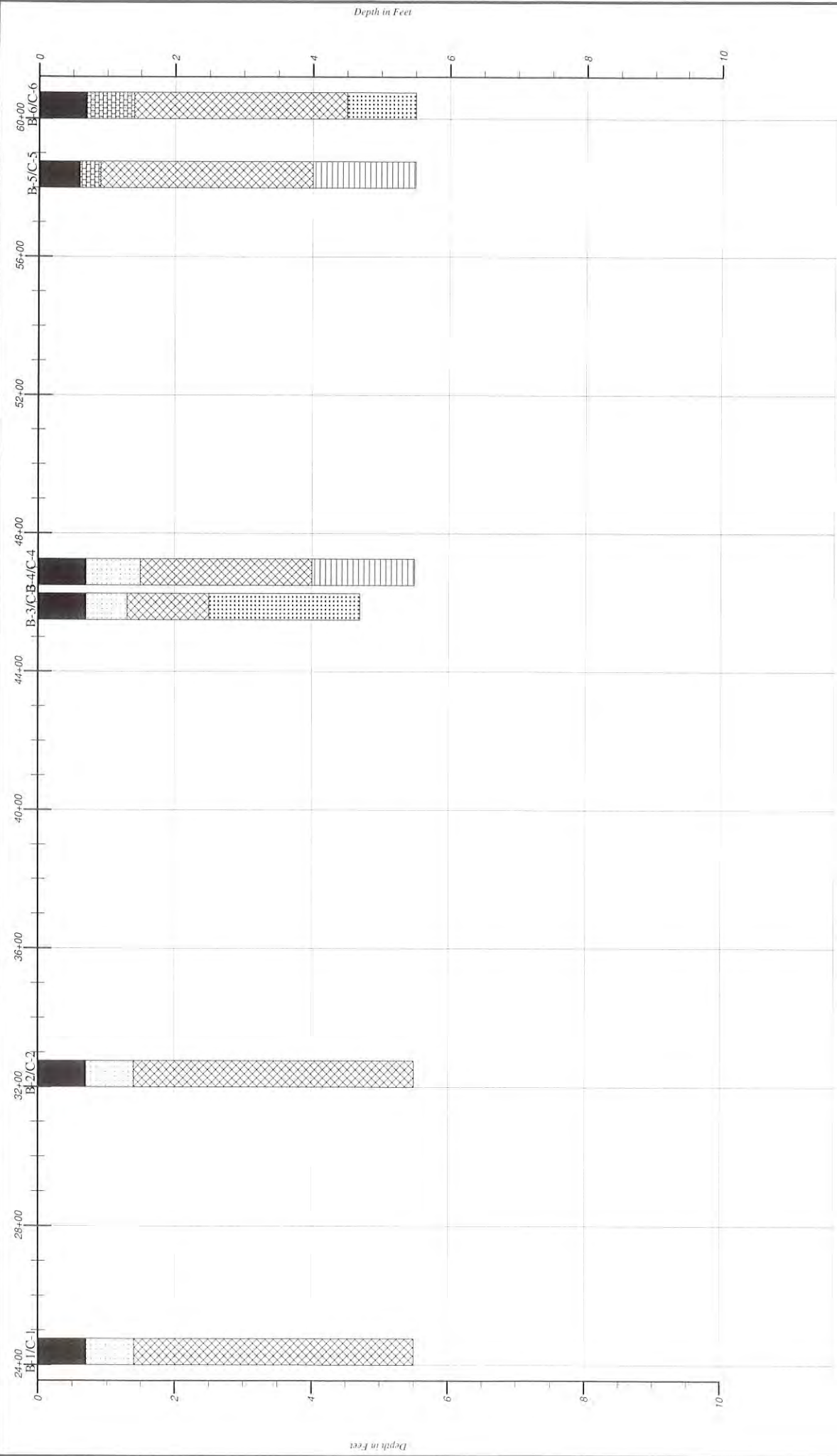
Shale



Description not given for:
"LS"

Notes:

1. The units for all hand penetrometer (H) readings is tons per square foot.
2. LL= Liquid Limit (%)
3. PI= Plasticity Index (%)
4. Qu= Unconfined Compressive Strength (pounds per square foot)
5. All elevations are approximate and were obtained from Google Earth. Actual elevations shall be checked and verified by the Engineer.
6. All stations are approximate and were obtained from on site stations marked on the concrete. Actual stations shall be checked and verified by the Engineer.
7. The subsurface profile is approximate elevations and stations.



ACA Engineering, Inc.
GENERALIZED SOIL PROFILE
DRAWN BY/APPROVED BY
GC/MS

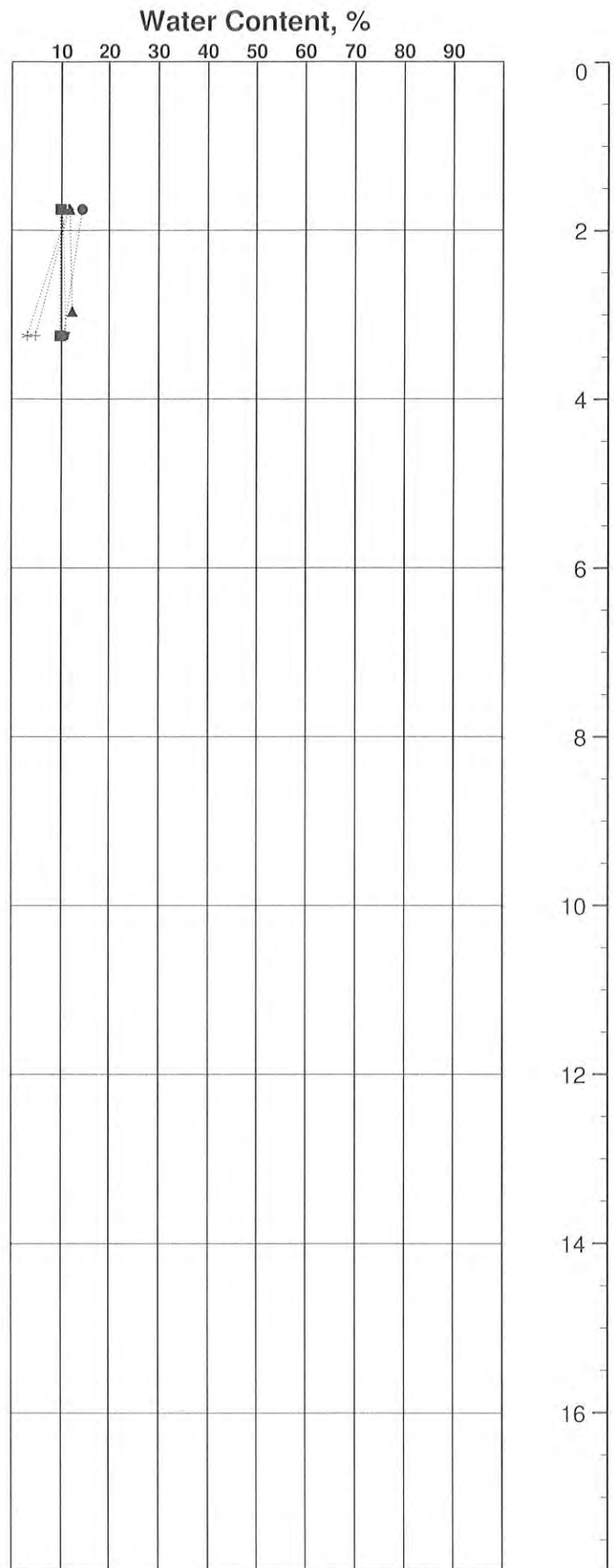
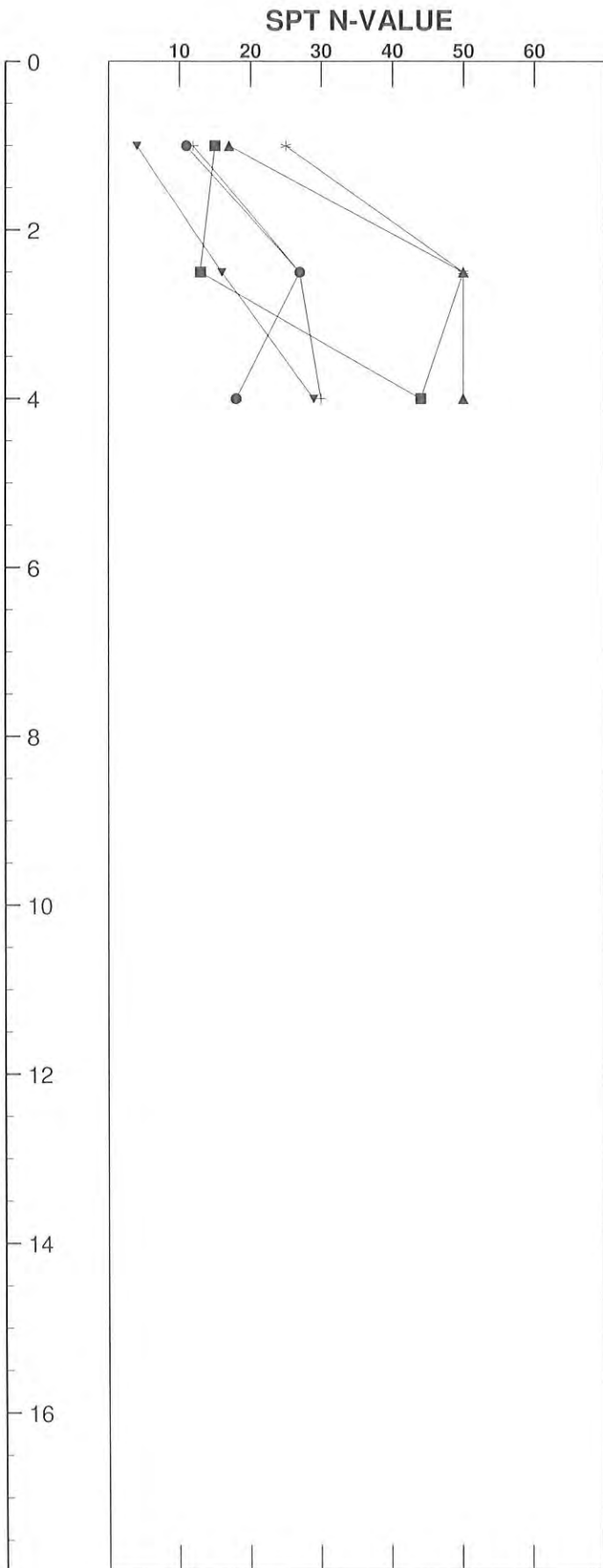
DATE DRAWN
6/17/2020

HORIZONTAL SCALE: 1"=100' (approx.)
VERTICAL SCALE: 1"=2'

John Scott Highway Pavement Evaluation

PROJECT NO. Y20030x10

FIGURE NUMBER
1



Key to Borings

- | | | |
|-----------|-----------|-----------|
| ● B-1/C-1 | ▲ B-3/C-3 | * B-5/C-5 |
| ■ B-2/C-2 | ▼ B-4/C-4 | + B-6/C-6 |

SOIL CLASSIFICATION CHART - ASTM D2487

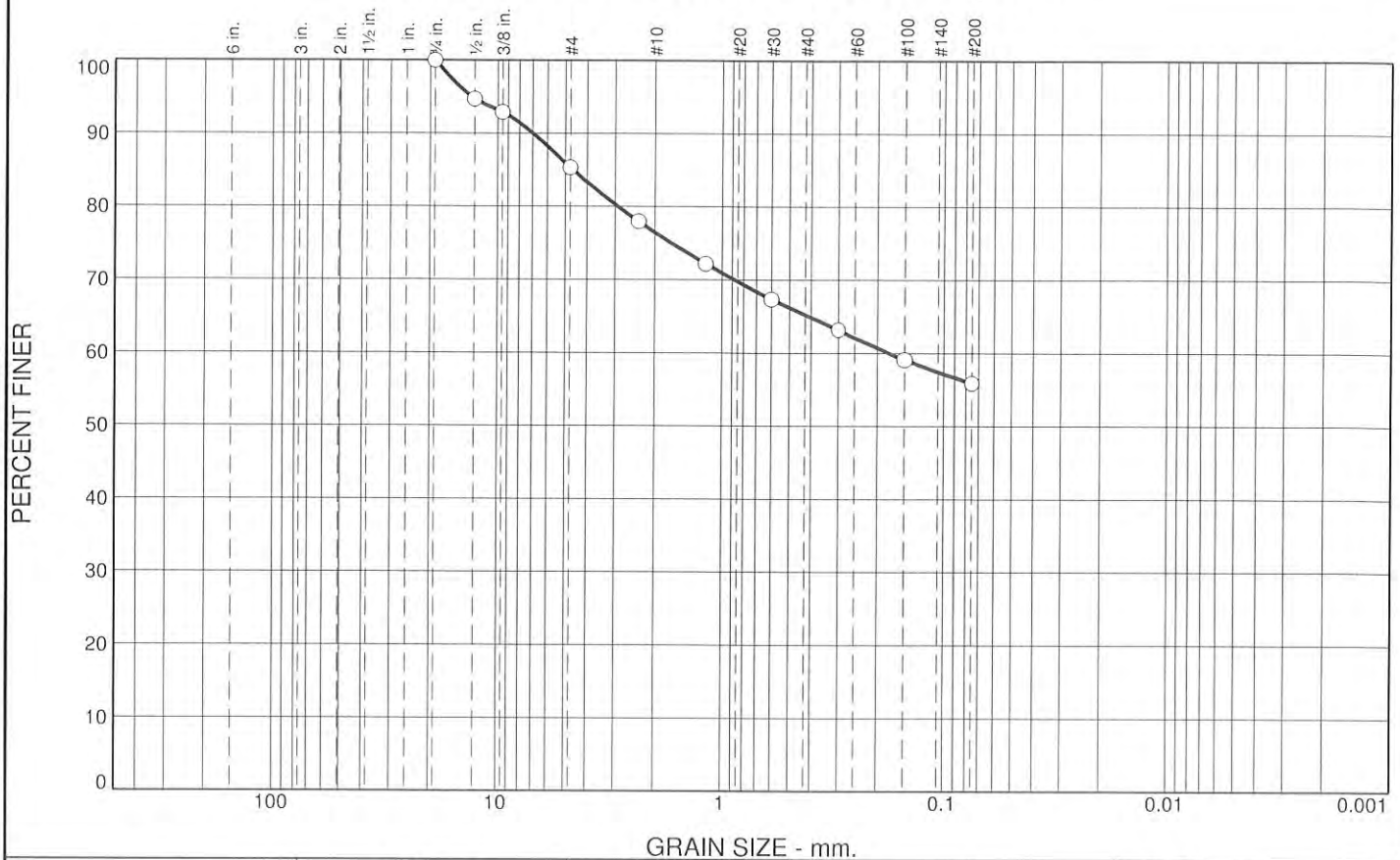
MAJOR DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE-GRAINED SOILS More than 50% retained on the No. 200 sieve	GRAVEL More than 50% of coarse fraction retained on No. 4 sieve	CLEAN GRAVELS	GW	Well graded gravel.
		Less than 5% fines	GP	Poorly graded gravel.
		GRAVELS WITH FINES	GM	Silty gravel.
		More than 12% fines	GC	Clayey gravel.
	SANDS 50% or more of coarse fraction passes No. 4 sieve	CLEAN SANDS	SW	Well graded sand.
		Less than 5% fines	SP	Poorly graded sand.
		SAND WITH FINES	SM	Silty sand.
		More than 12% fines	SC	Clayey sand.
FINE-GRAINED SOILS 50% or more passes the No. 200 sieve	SILTS AND CLAYS Liquid Limit < 50	Inorganic	ML	Silt.
			CL	Lean clay.
		Organic	OL	Organic silt and organic clay of low plasticity.
	SILTS AND CLAYS Liquid Limit > 50	Inorganic	MH	Elastic silt.
			CH	Fat clay.
		Organic	OH	Organic silt and organic clay of high plasticity.
HIGHLY ORGANIC SOILS		Primarily organic matter, dark in color, and organic odor.	PT	Peat.

<u>COMPONENT</u>		<u>SIZE</u>	<u>TERMS</u>	<u>RANGE</u>								
BOULDERS		Larger than 12"	Trace	0 - 10%								
COBBLES		12" to 3"	Little	10 - 20%								
GRAVEL	COARSE	3" to 3/4"	Some	20 - 35%								
	FINE	3/4" to 4.75MM (3/4" to #4 sieve)	And	35 - 50%								
SAND	COARSE	4.75MM to 2.0MM (#4 to #10 sieve)	<u>Criteria for Describing Moisture Condition</u> <table><tr><th>Description</th><th>Criteria</th></tr><tr><td>Dry</td><td>Absence of moisture, dusty, dry to the touch</td></tr><tr><td>Moist</td><td>Damp but no visible water</td></tr><tr><td>Wet</td><td>Visible free water, usually soil is below water table</td></tr></table>		Description	Criteria	Dry	Absence of moisture, dusty, dry to the touch	Moist	Damp but no visible water	Wet	Visible free water, usually soil is below water table
	Description	Criteria										
	Dry	Absence of moisture, dusty, dry to the touch										
Moist	Damp but no visible water											
Wet	Visible free water, usually soil is below water table											
MEDIUM	2.0MM to 0.425MM (#10 to #40 sieve)											
FINE	0.425MM to 0.075 MM (#40 to #200 sieve)											
SILT (inorganic silt) (rock flour)		0.075MM to 0.005MM (#200 to 0.005MM) Material passing the #200 (75-µm) U.S. standard sieve that is not plastic or very slightly plastic and that exhibits little or no strength when air-dry.										
CLAY (clay soil)		Smaller than 0.005MM Fine-grained soil or the fine-grained portion of soil that can be made to exhibit plasticity (putty-like properties) within a range of water contents, and that exhibits considerable strength when air-dry.										

APPENDIX E

Laboratory Testing

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	14.6	8.9	11.2	9.4	55.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
1/2"	94.7		
3/8"	92.9		
#4	85.4		
#8	78.0		
#16	72.2		
#30	67.4		
#50	63.2		
#100	59.1		
#200	55.9		

* (no specification provided)

<u>Soil Description</u>		
Brown Silty Sandy Clay with little shale fragments .		
<u>Atterberg Limits</u>		
PL= 20	LL= 36	PI= 16
<u>Coefficients</u>		
D ₉₀ = 6.9597	D ₈₅ = 4.6064	D ₆₀ = 0.1752
D ₅₀ =	D ₃₀ =	D ₁₅ =
D ₁₀ =	C _u =	C _c =
<u>Classification</u>		
USCS= CL	AASHTO= A-6(6)	
<u>Remarks</u>		
Date sampled: 06-08-2020		
F.M.=1.82		

Location: Steubenville, Ohio
Sample Number: B-1

Depth: 1.0-2.5

Date: 06-15-2020



Client: MS Consultants, Inc.
Project: John Scott Highway Pavement Evaluation

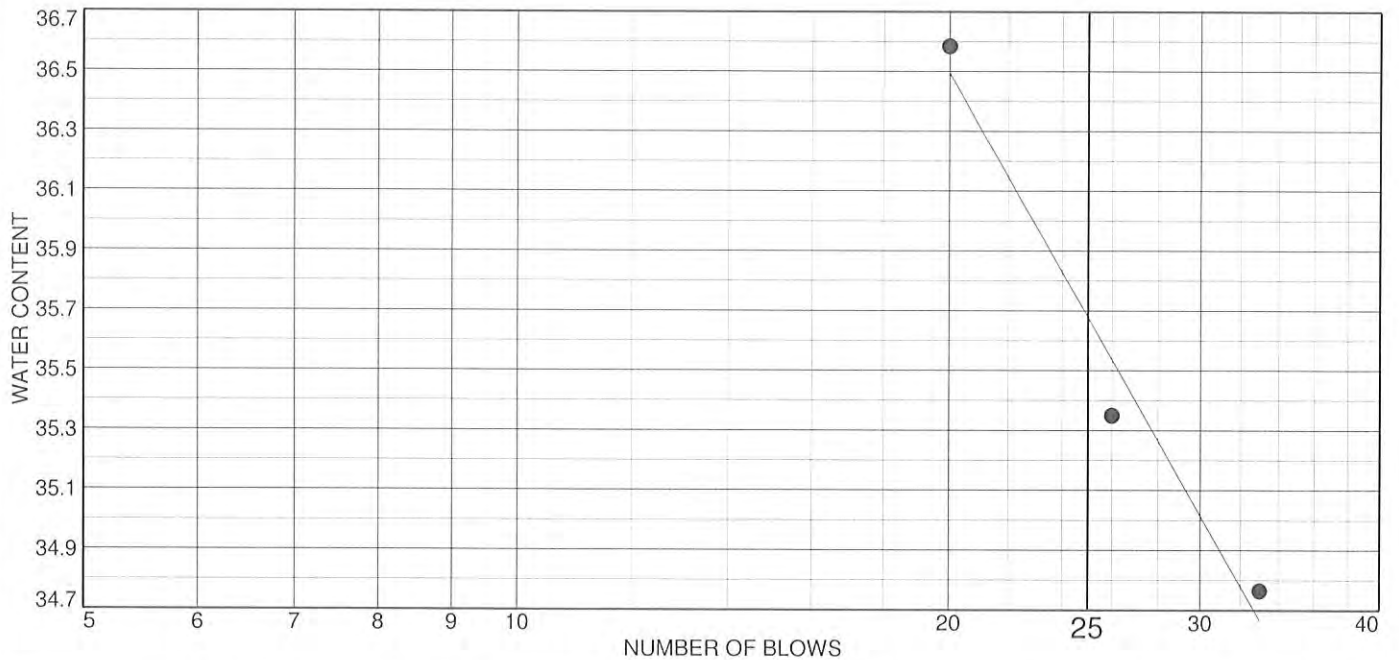
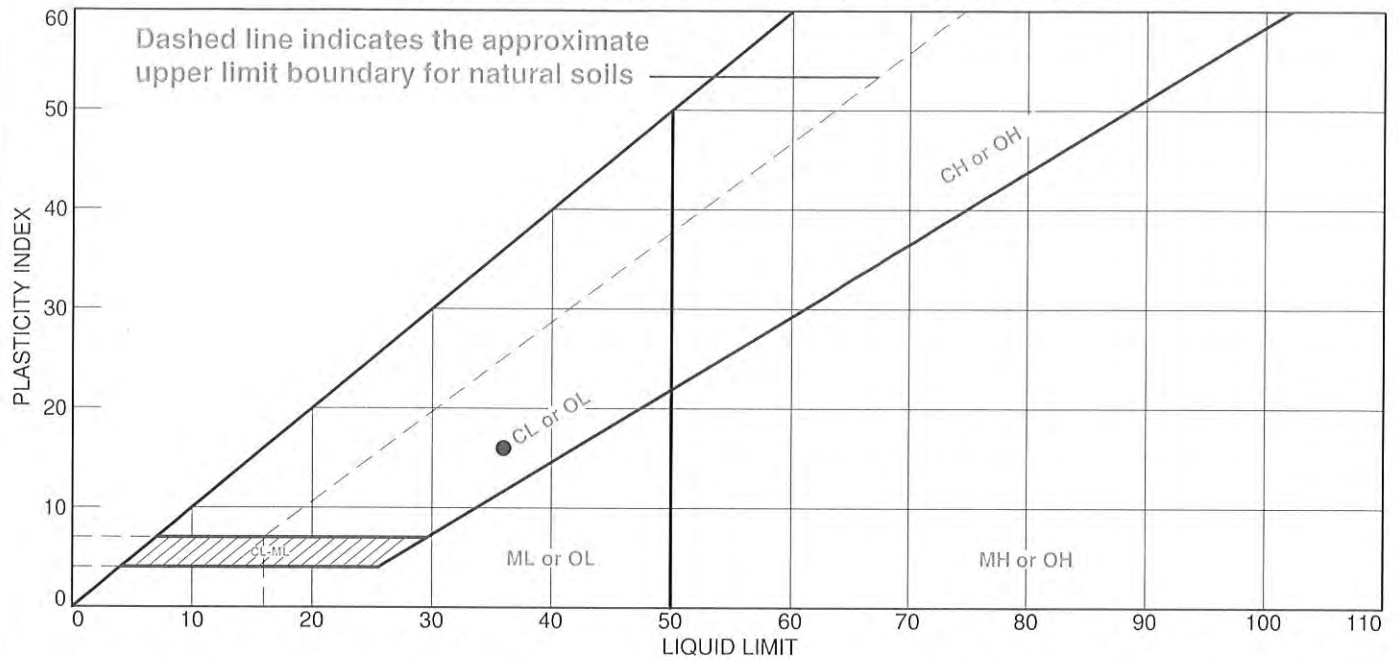
Project No: Y20030x10

Figure SA-B1-01

Tested By: K. Weeks

Checked By: N. Chammas

LIQUID AND PLASTIC LIMITS TEST REPORT



MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
• Brown Silty Sandy Clay with little shale fragments .	36	20	16	65.3	55.9	CL

Project No. Y20030x10 **Client:** MS Consultants, Inc.

Project: John Scott Highway Pavement Evaluation

Location: Steubenville, Ohio

Sample Number: B-1 **Depth:** 1.0-2.5



Remarks:

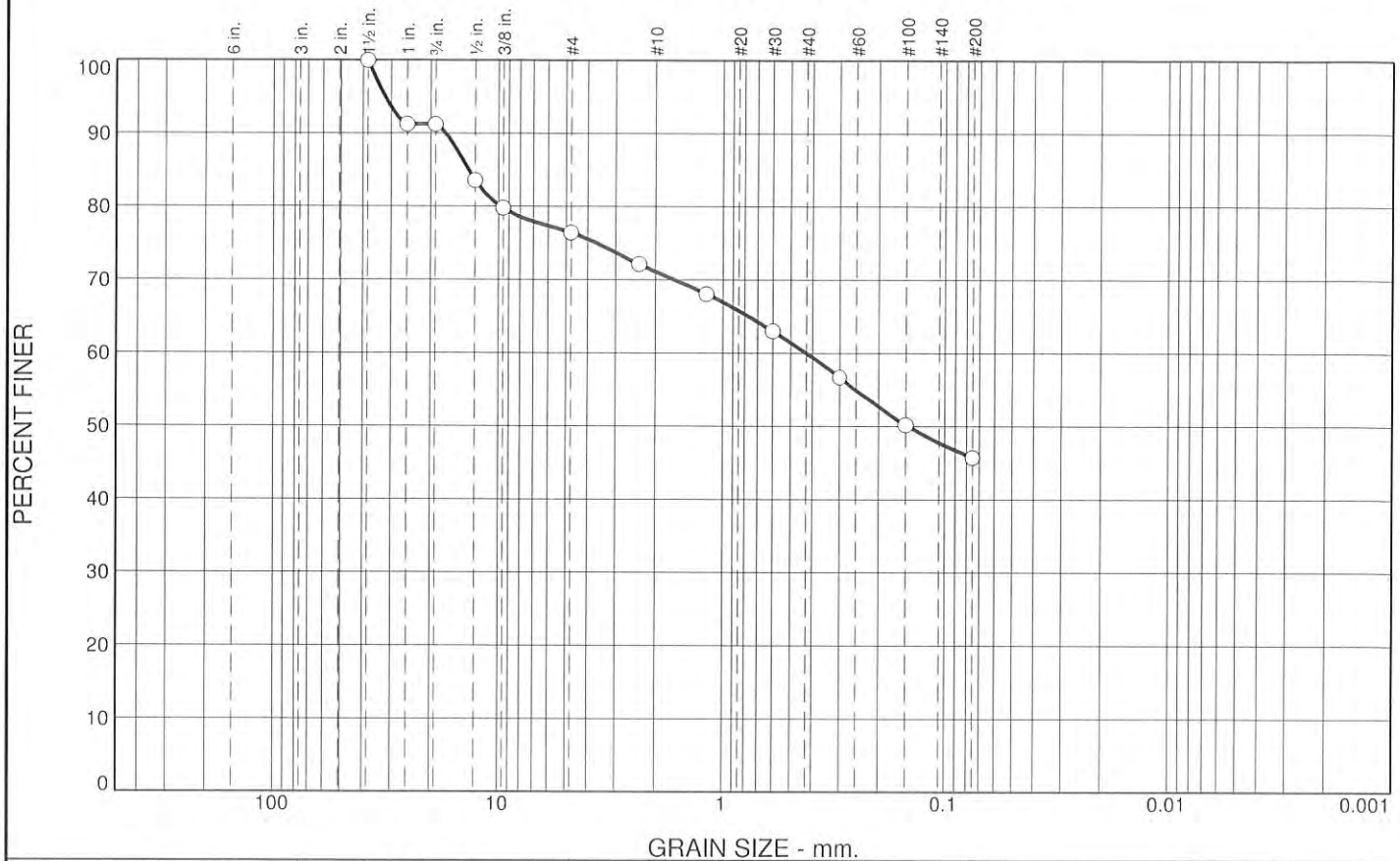
• Date sampled: 06-08-2020

Figure ATT-B1-01

Tested By: K. Weeks

Checked By: N. Chammas

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	8.8	14.7	5.4	11.1	14.3	45.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5"	100.0		
1"	91.2		
3/4"	91.2		
1/2"	83.6		
3/8"	79.8		
#4	76.5		
#8	72.1		
#16	68.1		
#30	63.0		
#50	56.7		
#100	50.2		
#200	45.7		

* (no specification provided)

Soil Description

Brown, Red, and Gray Clayey Sand with some shale and sandstone fragments.

Atterberg Limits

PL= 16 LL= 26 PI= 10

Coefficients

D₉₀= 17.1476 D₈₅= 13.5719 D₆₀= 0.4249
D₅₀= 0.1456 D₃₀= C_u= D₁₅=
D₁₀= C_c=

Classification

USCS= SC AASHTO= A-4(1)

Remarks

Date sampled: 06-08-2020
F.M.=2.42

Location: Steubenville, Ohio
Sample Number: B-3

Depth: 1.0-2.5

Date: 06-15-2020



Client: MS Consultants, Inc.
Project: John Scott Highway Pavement Evaluation

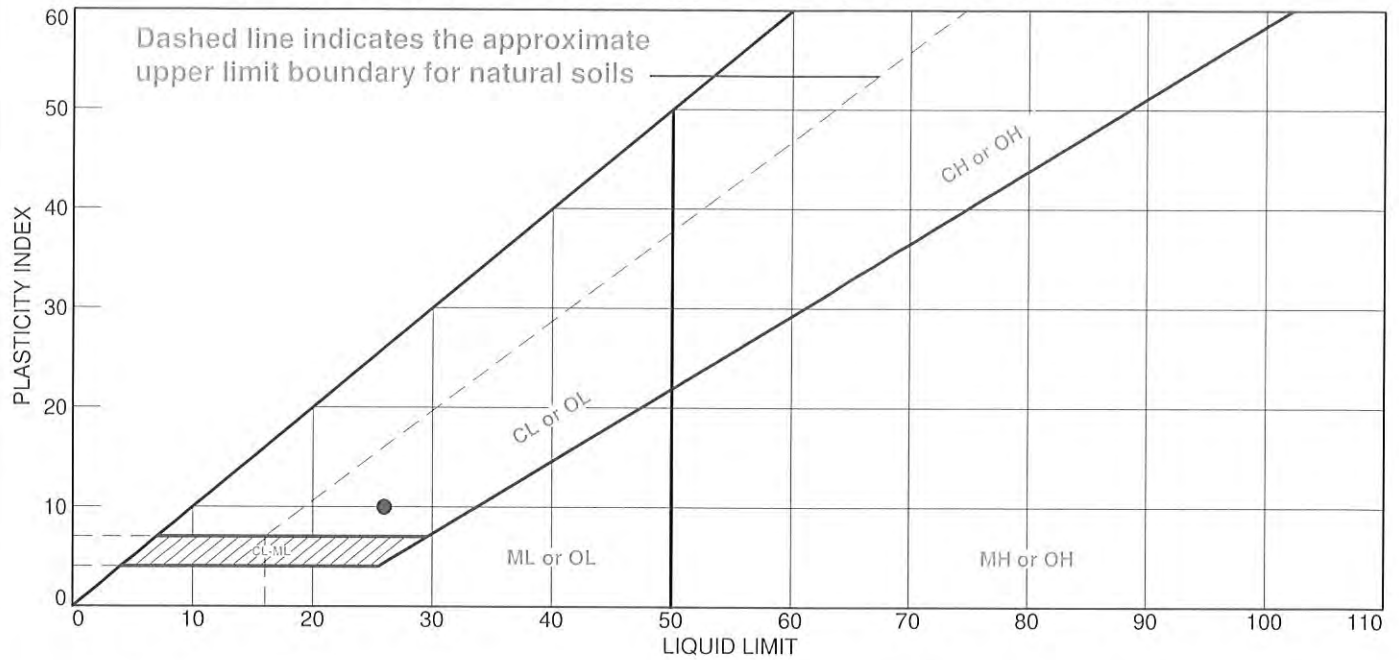
Project No: Y20030x10

Figure SA-B3-01

Tested By: K. Weeks

Checked By: N. Chammas

LIQUID AND PLASTIC LIMITS TEST REPORT



MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
● Brown, Red, and Gray Clayey Sand with some shale and sandstone fragments.	26	16	10	60.0	45.7	SC

Project No. Y20030x10 **Client:** MS Consultants, Inc.

Project: John Scott Highway Pavement Evaluation

Location: Steubenville, Ohio

Sample Number: B-3 **Depth:** 1.0-2.5



Remarks:

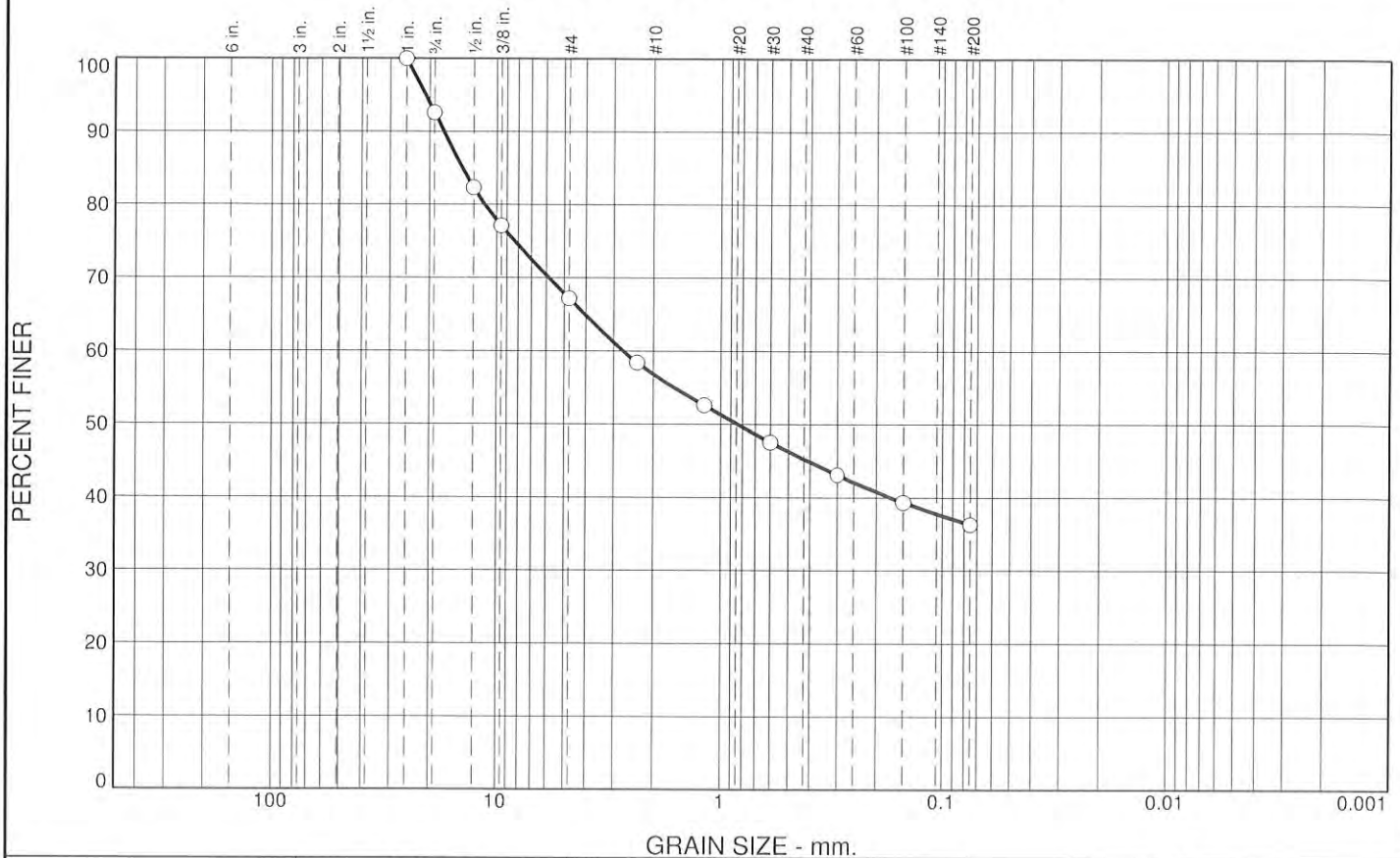
● Date sampled: 06-08-2020

Figure ATT-B3-01

Tested By: K. Weeks

Checked By: N. Chammas

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	7.4	25.4	10.4	11.5	8.9	36.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100.0		
3/4"	92.6		
1/2"	82.3		
3/8"	77.2		
#4	67.2		
#8	58.5		
#16	52.6		
#30	47.5		
#50	43.1		
#100	39.4		
#200	36.4		

* (no specification provided)

Soil Description
Brown Clayey Gravel with some sand.

Atterberg Limits
PL= 18 LL= 33 PI= 15

Coefficients
D₉₀= 17.2677 D₈₅= 14.2458 D₆₀= 2.7162
D₅₀= 0.8364 D₃₀= D₁₅=
D₁₀= C_u= C_c=

Classification
USCS= GC AASHTO= A-6(1)

Remarks
Date sampled: 06-08-2020
F.M.=3.22

Location: Steubenville, Ohio
Sample Number: B-6 **Depth:** 1.0-2.5

Date: 06-15-2020



Client: MS Consultants, Inc.
Project: John Scott Highway Pavement Evaluation

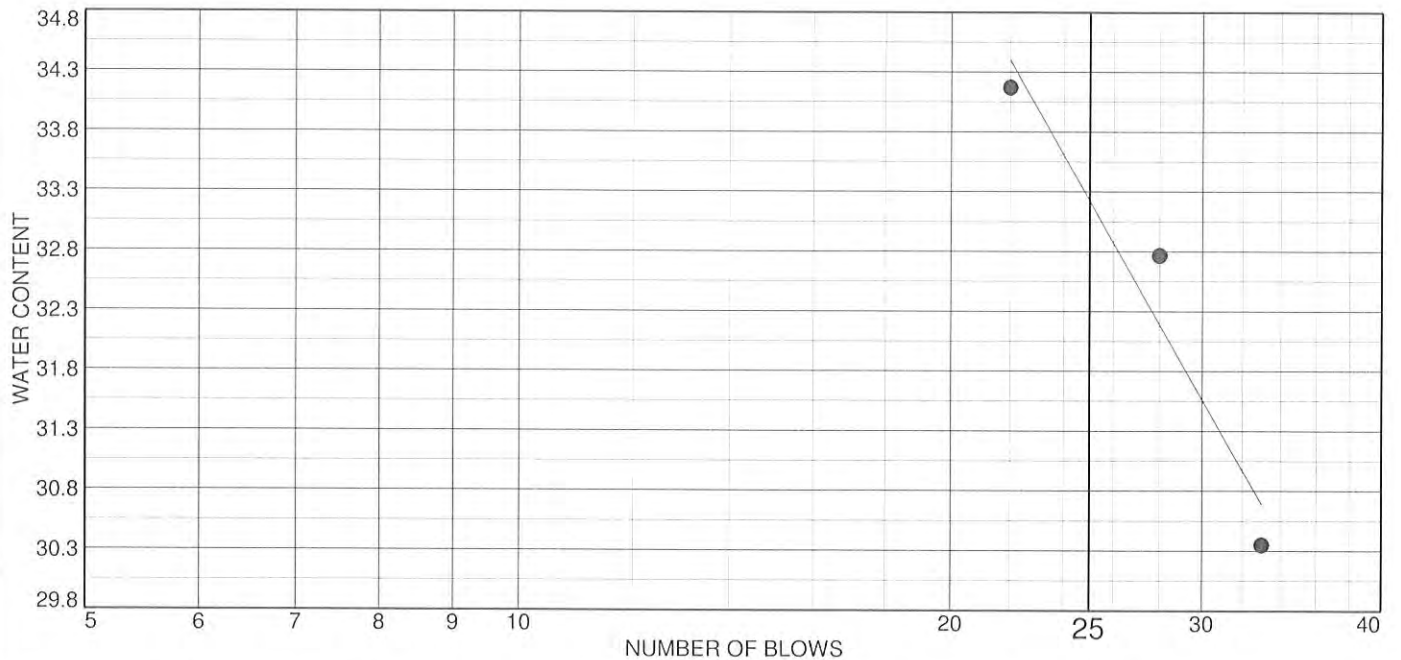
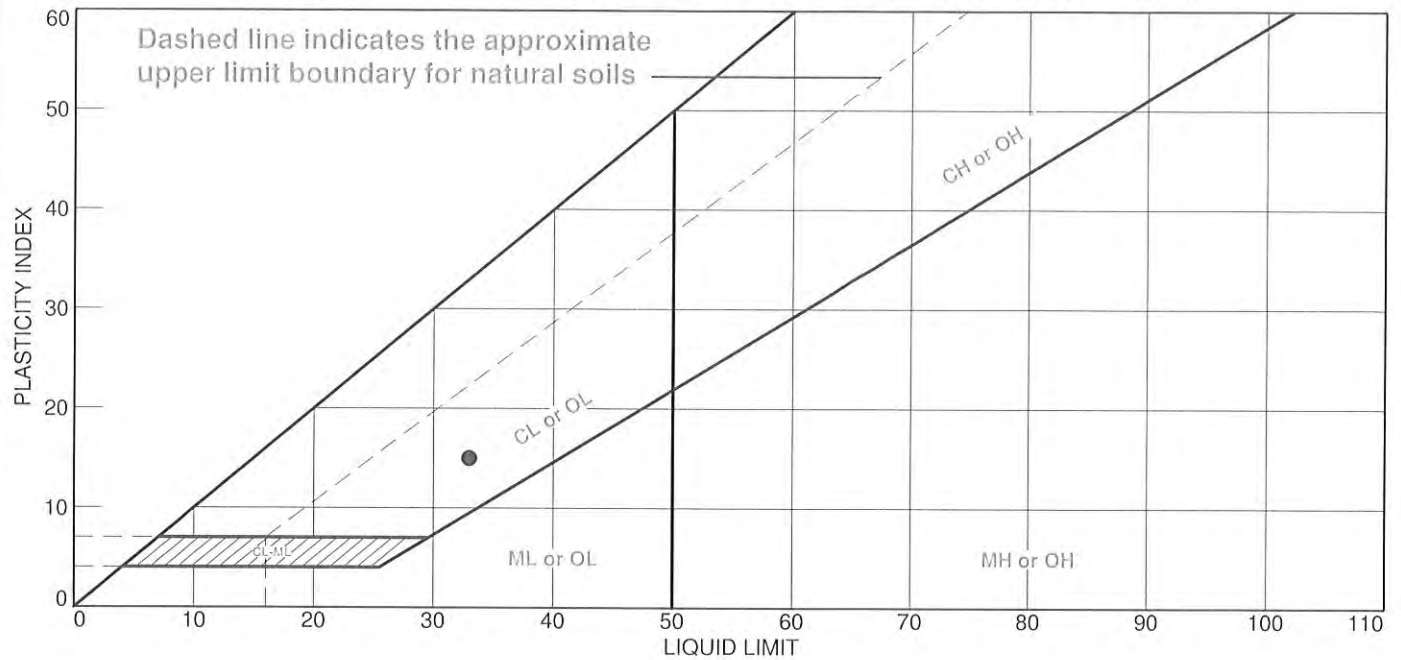
Project No: Y20030x10

Figure SA-B6-01

Tested By: K. Weeks

Checked By: N. Chammas

LIQUID AND PLASTIC LIMITS TEST REPORT



MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
• Brown Clayey Gravel with some sand.	33	18	15	45.3	36.4	GC

Project No. Y20030x10 **Client:** MS Consultants, Inc.

Project: John Scott Highway Pavement Evaluation

Location: Steubenville, Ohio

Sample Number: B-6 **Depth:** 1.0-2.5



Remarks:

• Sampled: 06-08-2020

Figure ATT-B6-01

Tested By: K. Weeks

Checked By: N. Chammas

APPENDIX F

Test Core Photographs

JOHN SCOTT HIGHWAY
PAVEMENT EVALUATION

C-1



JOHN SCOTT HIGHWAY
PAVEMENT EVALUATION

C-2



JOHN SCOTT HIGHWAY
PAVEMENT EVALUATION

C-3



JOHN SCOTT HIGHWAY
PAVEMENT EVALUATION

C-4



JOHN SCOTT HIGHWAY
PAVEMENT EVALUATION

C-5



JOHN SCOTT HIGHWAY
PAVEMENT EVALUATION

C-6



Appendix C

Pavement Designs



Pavement Design - Alum Creek Trail "Johnstown Road Widening"



ms consultants, inc.
 2221 Schrock Road
 Columbus, Ohio 43229
 Phone: (614) 898-7100 Fax: (614) 898-7570

Project: <u>John Scott Highway</u>	Date: <u>6/24/2020</u>	ms Proj. No.: <u>6842</u>
Location: <u>Steubenville Ohio</u>	Calc. By: <u>HRB</u>	PID No.: <u></u>

Flexible Pavement Design:

Note: Pavement design based on:

ODOT Pavement Design Manual, revised July 2016

Geotechnical Report prepared by: ACA Engineering - June 5, 2020

Design Data:

Number of Lanes	4	
Functional Classification	Urban Principal Arterial	▼
Opening Year ADT	12,575	
Design Year ADT	15,343	
24 Hour Truck % (%T ₂₄)	5.0%	
Design Period	20	Years
Opening Year	2020	
Subgrade CBR	3.5	
Length	0.85	Miles

Step 1 - Determine 18 Kip Equivalent Single Axle Loading (ESAL)

Calculate the mid design life ADT

Mid design life year = 2030
 14097

Directional Distribution (%D) (Figure 202-1)

50%

Lane Factor (%LF) (Figure 202-1)

95%

% B:C Ratio (Figure 202-1)

2 : 1

ESAL Conversion Factor for B Trucks (CF_B) (Figure 202-1)

1.04

ESAL Conversion Factor for C Trucks (CF_C) (Figure 202-1)

0.41

ESALs from B trucks: $ADT * \%T_{24} * \%D * \%LF * \%B * CF_B$
 232

ESALs from C trucks: $ADT * \%T_{24} * \%D * \%LF * \%C * CF_C$
 46

Total Daily ESALs 278 ESAL/day

Design Period ESALs 2,030,023

Use 2,030,023

Pavement Design - Alum Creek Trail "Johnstown Road Widening"



ms consultants, inc.
2221 Schrock Road
Columbus, Ohio 43229
Phone: (614) 898-7100 Fax: (614) 898-7570

Project:	John Scott Highway	Date:	6/24/2020	ms Proj. No.:	6842
Location:	Steubenville Ohio	Calc. By:	HRB	PID No.:	

Flexible Pavement Design:

Step 2 - Determine Subgrade Resilient Modulus (M_r)

CBR from Geotechnical Report = 4

M_r = 4800 psi

If CBR is not provided by Geotechnical Report, calculate the CBR using Figures 203-1 and 203-2.

From Geotechnical Report, obtain Percent Passing No. 200 Sieve and either Liquid Limit or Plasticity Index

Percent Passing No. 200 Sieve
Liquid Limit (LL)
Plasticity Index (PI)

From Figure 203-1, Partial group Index (GI) No.

From Figure 203.2, Determine CBR using Parial Group Index

CBR =

M_r = 0 psi

Step 3 - Determine the Design Structural Number (SN)

From Figure 402-2, Determine Match Line Number

Reliability (Figure 201-1)	90%
Overall Standard Deviation (Figure 201-1)	0.49
18-Kip Axle Loads	2,030,023
Subgrade Resilient Modulus	4,800

Match Line Number (Figure 402-2)	40
----------------------------------	----

From Figure 402-3, Determine Design Structural Number (SN)

Design Serviceability Loss (Figure 201-1)	2.0
---	-----

From Figure 402-3, the Structural Number (SN)	4.4
---	-----

Pavement Design - Alum Creek Trail "Johnstown Road Widening"



ms consultants, inc.
 2221 Schrock Road
 Columbus, Ohio 43229
 Phone: (614) 898-7100 Fax: (614) 898-7570

Project: <u>John Scott Highway</u>	Date: <u>6/24/2020</u>	ms Proj. No.: <u>6842</u>
Location: <u>Steubenville Ohio</u>	Calc. By: <u>HRB</u>	PID No.: <u></u>

Flexible Pavement Design:

Step 4 - Design Typical Section

Check for Heavy Traffic (see Proposal Note 416) by calculating opening day (2018) truck traffic
 ADTT 636



Using the layer coefficients found in Figure 401-1, build the typical section for the project.

Material	Thickness (inches)	Coefficient	SN
AC Surface Courses ▼	1.25	0.43	0.5375
Intermediate Courses ▼	1.75	0.43	0.7525
Asphalt Concrete Base Courses ▼	6.5	0.36	2.34
Aggregate Base ▼	6	0.14	0.84
▼			0
▼			0
▼			0
▼			0
▼			0
▼			0
▼			0
▼			0
▼			0
Total SN			4.47

SN of: 4.4 needed.

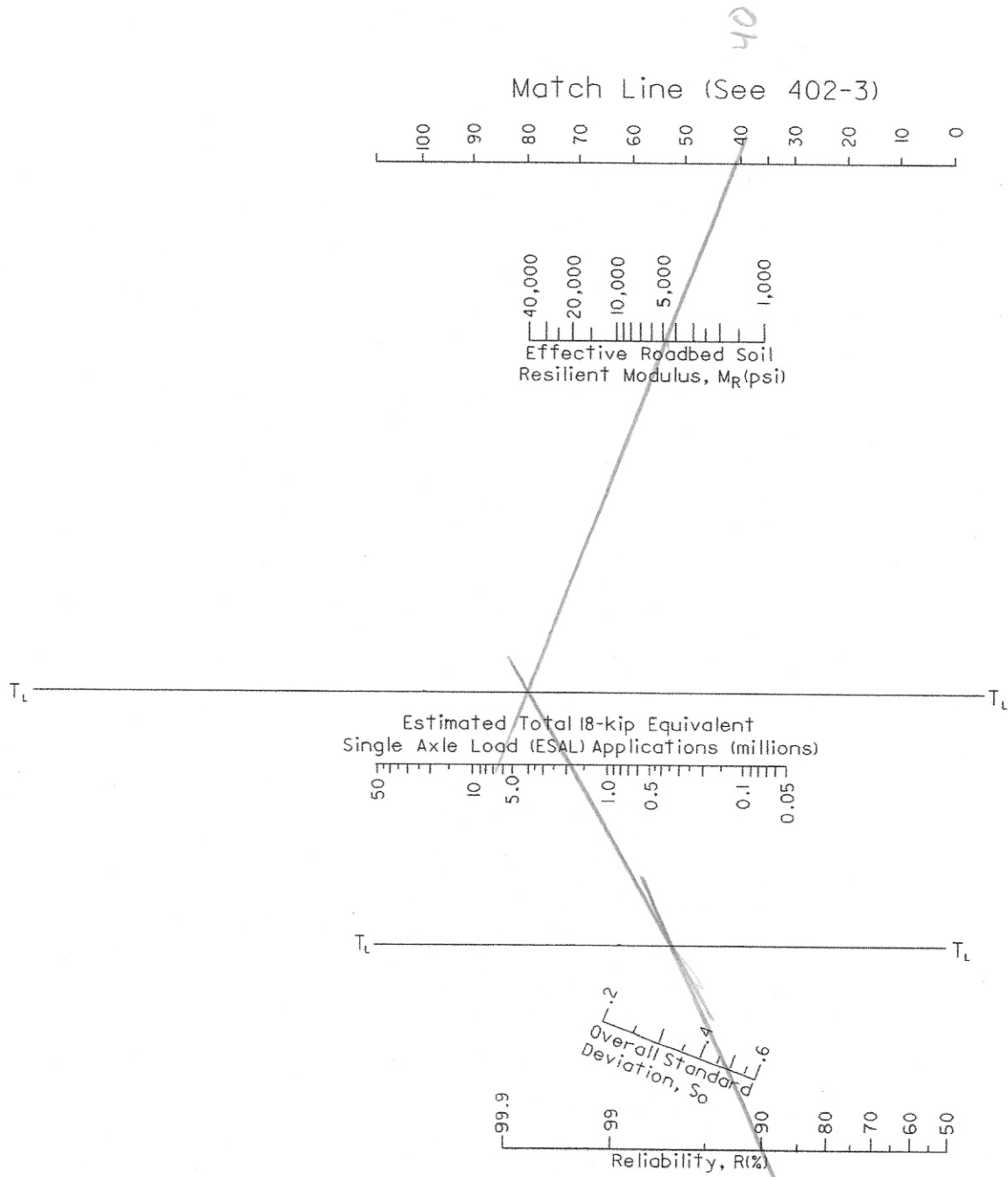
Check Left Thickness and Usage Guidelines listed in Section 406 and Figure 406-1.

Flexible Pavement Design Chart Segment 1

402-2

July 2008

Reference Section & Figure
402, 402-1(step 3)

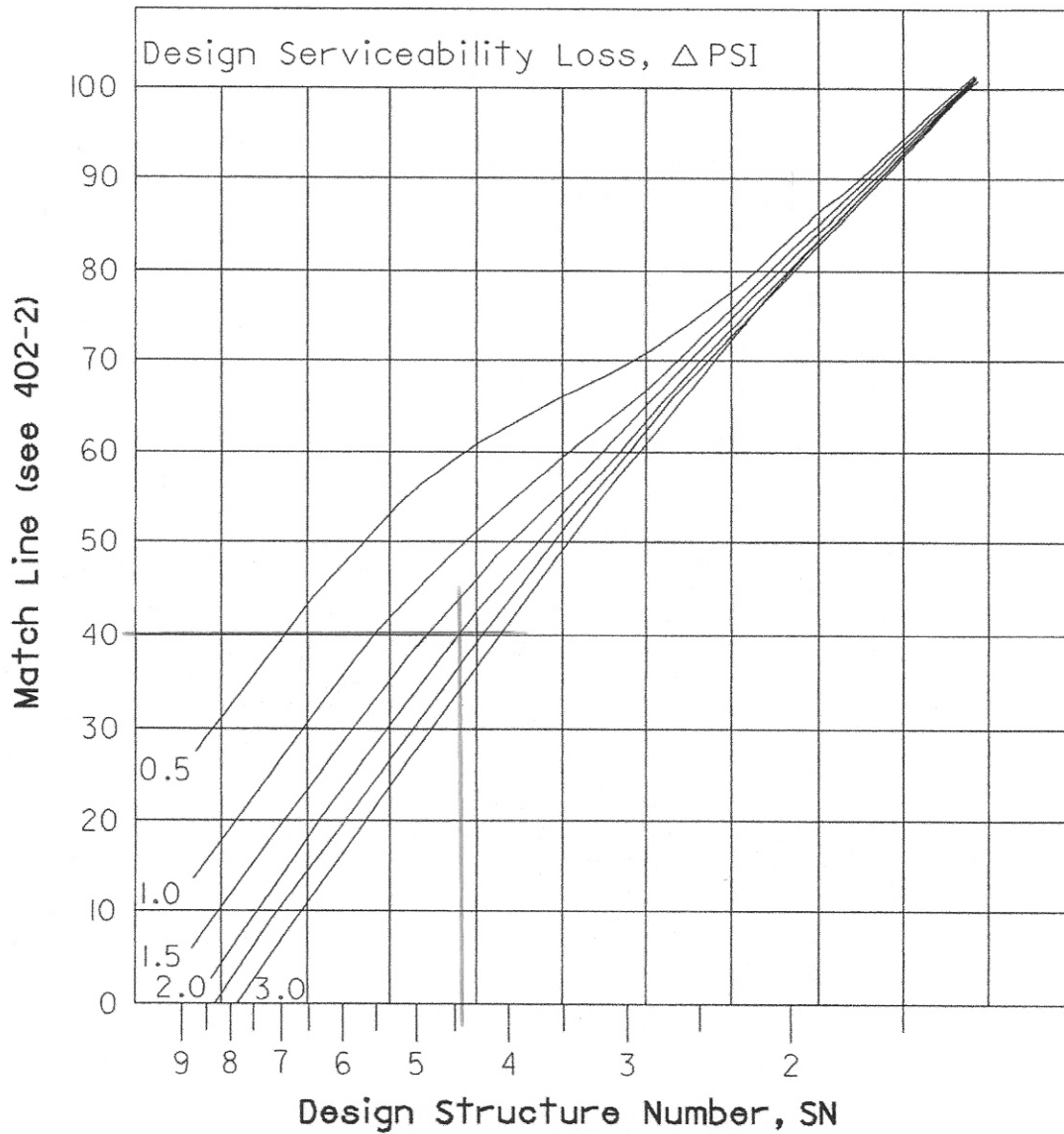


Flexible Pavement Design Chart Segment 2

402-3

July 2008

Reference Section & Figure
402, 402-1(step 3)



$SN = 4.4$



Pavement Design

ms consultants, inc.
 2221 Schrock Road
 Columbus, Ohio 43229
 Phone: (614) 898-7100 Fax: (614) 898-7570

Project:	John Scott Highway	Date:	6/24/2020	ms Proj. No.:	6842
Location:	Steubenville Ohio	Calc. By:	HRB	PID No.:	

Rigid Pavement Design:

Note: Pavement design based on:

ODOT Pavement Design Manual, revised July 2014

Geotechnical Report prepared by:

ACA Engineering - June 5, 2020

Design Data:

Number of Lanes	4	
Functional Classification	Urban Principal Arterial	Major Collector
Opening Year ADT	12,575	
Design Year ADT	15,343	
24 Hour Truck % (%T ₂₄)	5.0%	
Design Period	20	Years
Opening Year	2020	
Subgrade CBR	3.5	
Pavement Choice		
Design Subbase (D _{SB})		
Shoulders		
Project Length	0.85	Miles

Step 1 - Determine 18 Kip Equivalent Single Axle Loading (ESAL)

Calculate the mid design life ADT

Mid design life year = 2030
 14097

Directional Distribution (%D) (Figure 202-1)

50%

Lane Factor (%LF) (Figure 202-1)

95%

% B:C Ratio (Figure 202-1)

2 : 1

ESAL Conversion Factor for B Trucks (CF_B) (Figure 202-1)

1.64

ESAL Conversion Factor for C Trucks (CF_C) (Figure 202-1)

0.53

ESALs from B trucks: $ADT * \%T_{24} * \%D * \%LF * \%B * CF_B$
 366

ESALs from C trucks: $ADT * \%T_{24} * \%D * \%LF * \%C * CF_C$
 59

Total Daily ESALs 425 ESAL/day

Design Period ESALs 3,106,180

Use 3,106,180



Pavement Design

ms consultants, inc.
2221 Schrock Road
Columbus, Ohio 43229
Phone: (614) 898-7100 Fax: (614) 898-7570

Project: John Scott Highway
Location: Steubenville Ohio

Date: 6/24/2020
Calc. By: HRB

ms Proj. No.: 6842
PID No.:

Rigid Pavement Design:

Step 2 - Determine Subgrade Resilient Modulus (M_r)

CBR from Geotechnical Report = 4

M_r = 4800 psi

If CBR is not provided by Geotechnical Report, calculate the CBR using Figures 203-1 and 203-2.

From Geotechnical Report, obtain Percent Passing No. 200 Sieve and either Liquid Limit or Plasticity Index

Percent Passing No. 200 Sieve
Liquid Limit (LL)
Plasticity Index (PI)

From Figure 203-1, Partial group Index (GI) No.

From Figure 203.2, Determine CBR using Partial Group Index

CBR = 4

M_r = 4800 psi

Step 3 - Determine the Composite Modulus of subgrade Reaction (K_c) using Figure 301-2

From Figure 301-2

Using the figure and the following information, solve for the modulus of Subgrade Reaction (K_c)

Subbase thickness (D_{sb}) 6 inches
Subbase Elastic Modulus (E_{sb}) 30,000 Figure 301-1
Subgrade Resilient Modulus (M_r) 4800 psi

From Figure 301-2, Composite Modulus of Subgrade Reaction (K_c) 300 pci

Step 4 - Determine the Effective Modulus of Subgrade Reaction (k) using 301-3

From Figure 301-3

Using the figure and the following information, solve for the Effective Modulus of Subgrade Reaction (k).

Composite Modulus of Subgrade Reaction (K_c) 300 pci
Loss of Support (Figure 301-1) 1
Effective Modulus of Subgrade Reaction(k) 101 pci



Pavement Design

ms consultants, inc.
2221 Schrock Road
Columbus, Ohio 43229
Phone: (614) 898-7100 Fax: (614) 898-7570

Project:	John Scott Highway	Date:	6/24/2020	ms Proj. No.:	6842
Location:	Steubenville Ohio	Calc. By:	HRB	PID No.:	

Rigid Pavement Design:

Step 5 - Determine the thickness of the concrete slab using Figures 302-2 and 302-3

Figure 302-2 is used to solve for the match line number using the following information

Effective Modulus of Subgrade (k)	101	pci			
Concrete Elastic Modulus (Ec)	5,000,000	psi			
Concrete Modulus of Rupture (S'c)	700	psi			
Load Transfer Coefficient (J)	3.2		Edged?	N	(Y for yes, N for no)
Drainage Coefficient (Dc)	1				
Match Line (see Figure 302-3)	65				

Figure 302-3 is then used to solve for the Design Slab Thickness (D) using the following information

Design Serviceability Loss (psi)	1.7	psi
Reliability	90%	
Overall Standard Deviation	0.39	
18-Kip Equivalent Single Axle Load	3,106,180	
Design Slab Thickness	8.1	inches

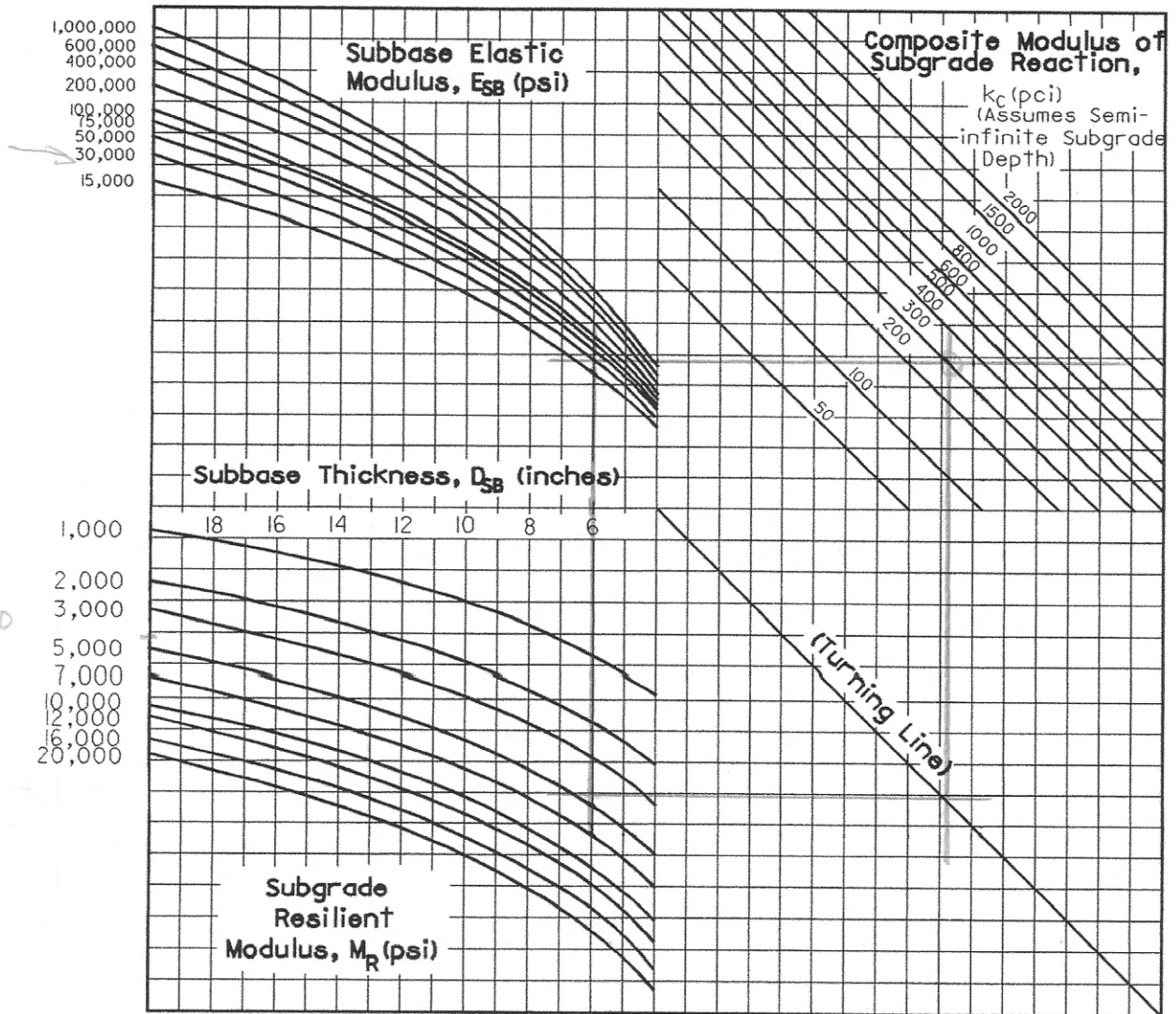
The composite section of 6 inch concrete and 6 inch asphalt will exceed the structural requirement needed

Composite Modulus of Subgrade Reaction (k_c)

301-2

July 2008

Reference Section & Figure
301.4, 302-1 (step 3)

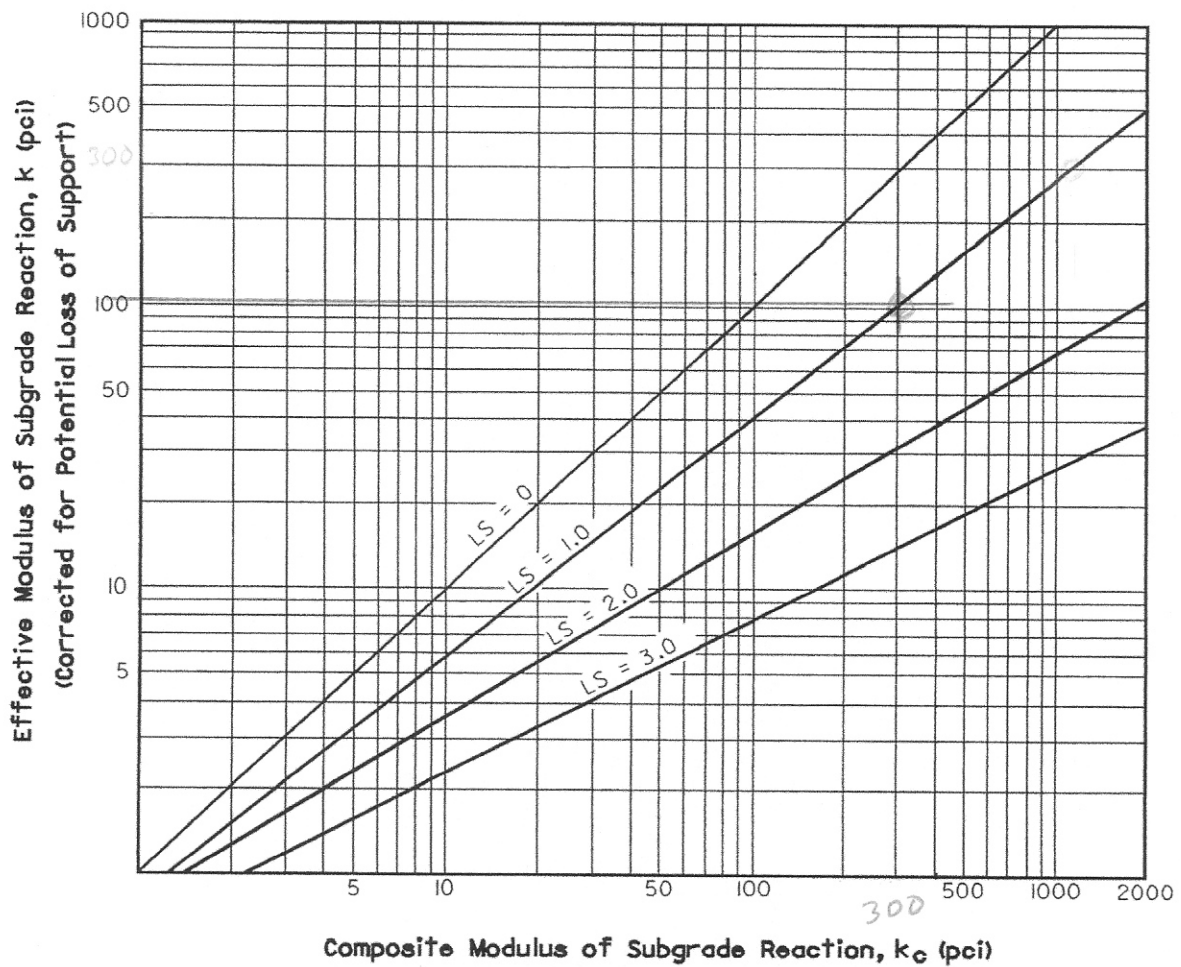


Effective Modulus of Subgrade Reaction (k)

301-3

July 2008

Reference Section & Figure
301.6, 302-1 (step 4)

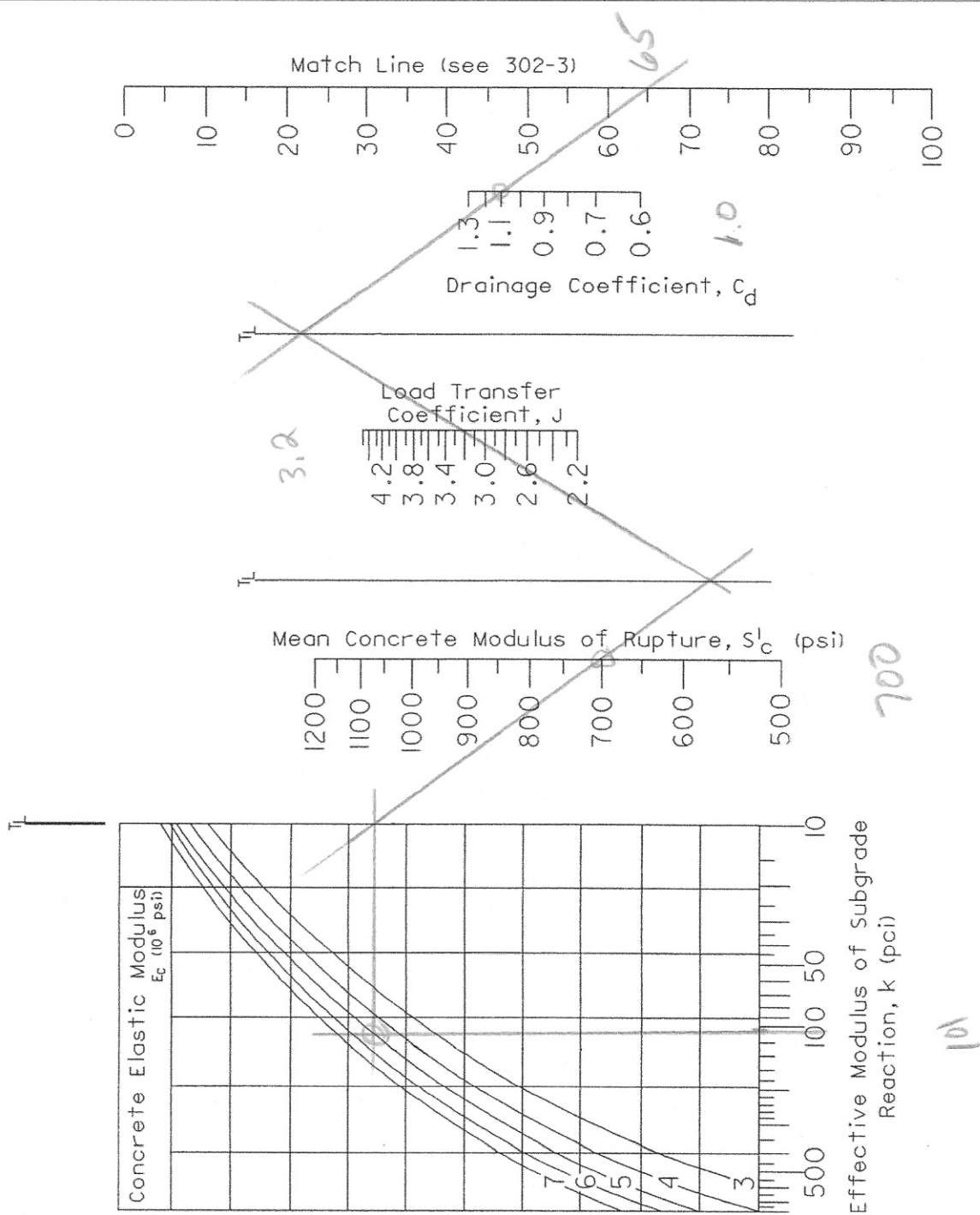


Rigid Pavement Design Chart Segment 1

302-2

July 2008

Reference Section & Figure
302, 302-1 (step 5)

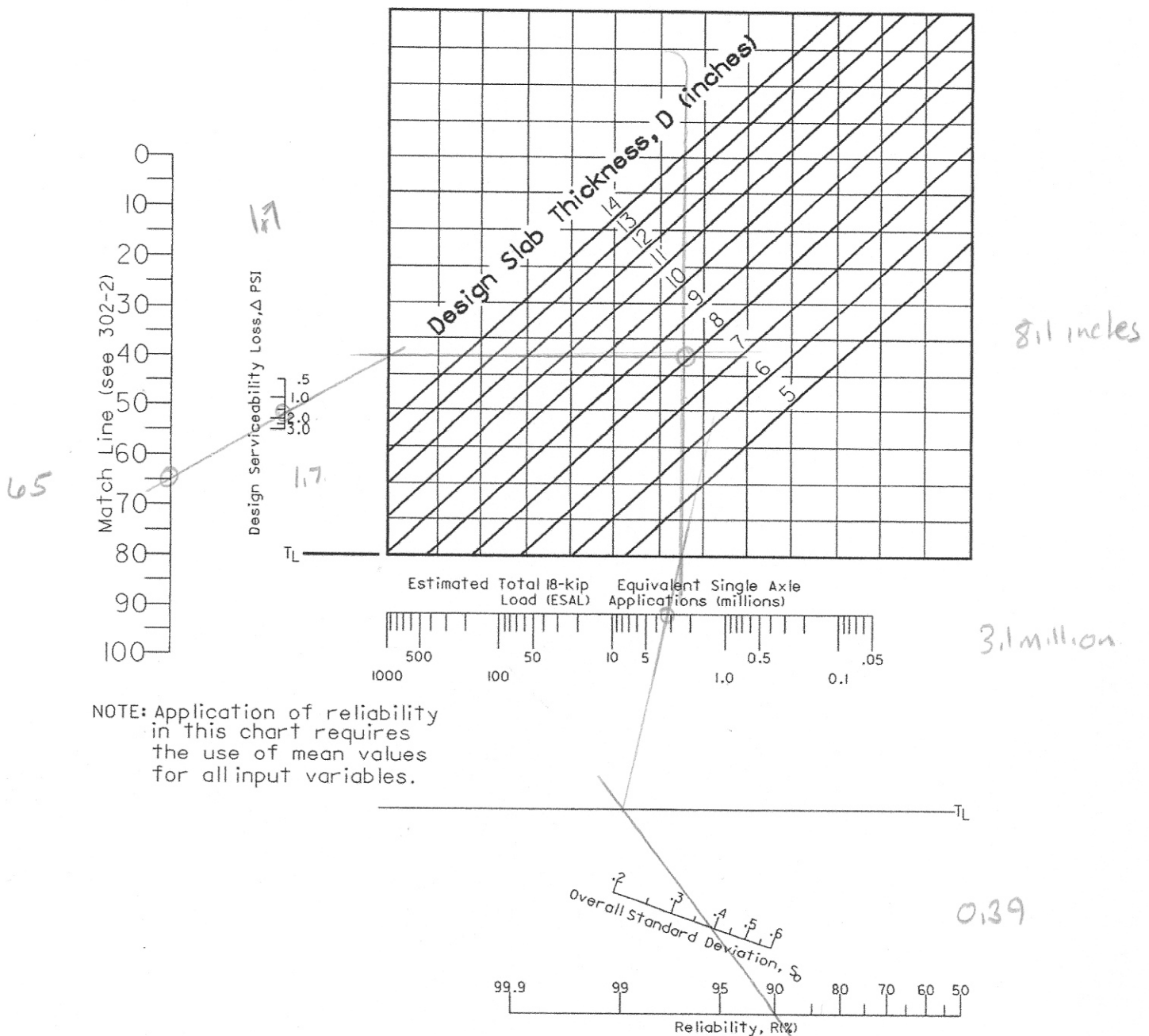


Rigid Pavement Design Chart Segment 2

302-3

July 2008

Reference Section & Figure
302, 302-1 (step 5)



Pavement Design - Alum Creek Trail "Johnstown Road Widening"



ms consultants, inc.
 2221 Schrock Road
 Columbus, Ohio 43229
 Phone: (614) 898-7100 Fax: (614) 898-7570

Project: <u>John Scott Highway</u>	Date: <u>6/24/2020</u>	ms Proj. No.: <u>6842</u>
Location: <u>Steubenville Ohio</u>	Calc. By: <u>HRB</u>	PID No.: <u></u>

Flexible Pavement Design:

Note: Pavement design based on:

ODOT Pavement Design Manual, revised July 2016

Geotechnical Report prepared by: ACA Engineering - June 5, 2020

Design Data:

Number of Lanes	4	
Functional Classification	Urban Principal Arterial	▼
Opening Year ADT	12,575	
Design Year ADT	15,343	
24 Hour Truck % (%T ₂₄)	5.0%	
Design Period	20	Years
Opening Year	2020	
Subgrade CBR	3.5	
Length	0.85	Miles

Step 1 - Determine 18 Kip Equivalent Single Axle Loading (ESAL)

Calculate the mid design life ADT

Mid design life year = 2030
 14097

Directional Distribution (%D) (Figure 202-1)

Lane Factor (%LF) (Figure 202-1)

% B:C Ratio (Figure 202-1)

ESAL Conversion Factor for B Trucks (CF_B) (Figure 202-1)

ESAL Conversion Factor for C Trucks (CF_C) (Figure 202-1)

50%

95%

2 : 1

1.04

0.41

ESALs from B trucks: $ADT * \%T_{24} * \%D * \%LF * \%B * CF_B$
 232

ESALs from C trucks: $ADT * \%T_{24} * \%D * \%LF * \%C * CF_C$
 46

Total Daily ESALs 278 ESAL/day

Design Period ESALs 2,030,023

Use 2,030,023

Pavement Design - Alum Creek Trail "Johnstown Road Widening"



ms consultants, inc.
2221 Schrock Road
Columbus, Ohio 43229
Phone: (614) 898-7100 Fax: (614) 898-7570

Project:	John Scott Highway	Date:	6/24/2020	ms Proj. No.:	6842
Location:	Steubenville Ohio	Calc. By:	HRB	PID No.:	

Flexible Pavement Design:

Step 2 - Determine Subgrade Resilient Modulus (M_r)

CBR from Geotechnical Report = 4

M_r = 4800 psi

If CBR is not provided by Geotechnical Report, calculate the CBR using Figures 203-1 and 203-2.

From Geotechnical Report, obtain Percent Passing No. 200 Sieve and either Liquid Limit or Plasticity Index

Percent Passing No. 200 Sieve
Liquid Limit (LL)
Plasticity Index (PI)

From Figure 203-1, Partial group Index (GI) No.

From Figure 203.2, Determine CBR using Parial Group Index

CBR =

M_r = 0 psi

Step 3 - Determine the Design Structural Number (SN)

From Figure 402-2, Determine Match Line Number

Reliability (Figure 201-1)	90%
Overall Standard Deviation (Figure 201-1)	0.49
18-Kip Axle Loads	2,030,023
Subgrade Resilient Modulus	4,800

Match Line Number (Figure 402-2)	40
----------------------------------	----

From Figure 402-3, Determine Design Structural Number (SN)

Design Serviceability Loss (Figure 201-1)	2.0
---	-----

From Figure 402-3, the Structural Number (SN)	4.4
---	-----

Pavement Design - Alum Creek Trail "Johnstown Road Widening"



ms consultants, inc.
 2221 Schrock Road
 Columbus, Ohio 43229
 Phone: (614) 898-7100 Fax: (614) 898-7570

Project: <u>John Scott Highway</u>	Date: <u>6/24/2020</u>	ms Proj. No.: <u>6842</u>
Location: <u>Steubenville Ohio</u>	Calc. By: <u>HRB</u>	PID No.: <u></u>

Flexible Pavement Design:

Step 4 - Design Typical Section

Check for Heavy Traffic (see Proposal Note 416) by calculating opening day (2018) truck traffic
 ADTT 636



Using the layer coefficients found in Figure 401-1, build the typical section for the project.

Material	Thickness (inches)	Coefficient	SN
AC Surface Courses ▼	1.25	0.43	0.5375
Intermediate Courses ▼	3	0.43	1.29
Intermediate Courses ▼	1	0.43	0.43
Cracked & Sealed Plain Concrete ▼	8	0.27	2.16
▼			0
▼			0
▼			0
▼			0
▼			0
▼			0
▼			0
▼			0
▼			0
Total SN			4.4175

SN of: 4.4 needed.

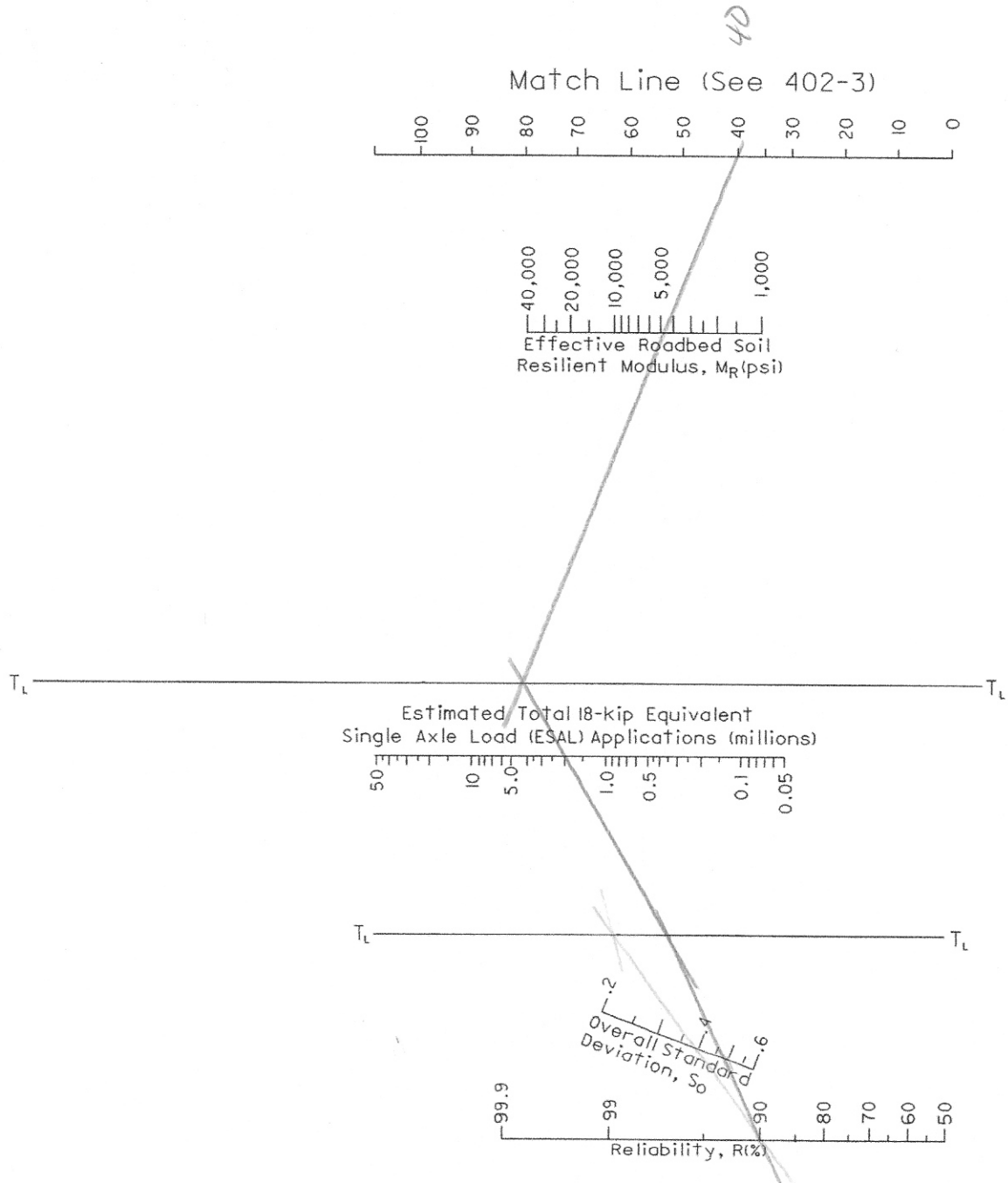
Check Left Thickness and Usage Guidelines listed in Section 406 and Figure 406-1.

Flexible Pavement Design Chart Segment 1

402-2

July 2008

Reference Section & Figure
402, 402-1(step 3)

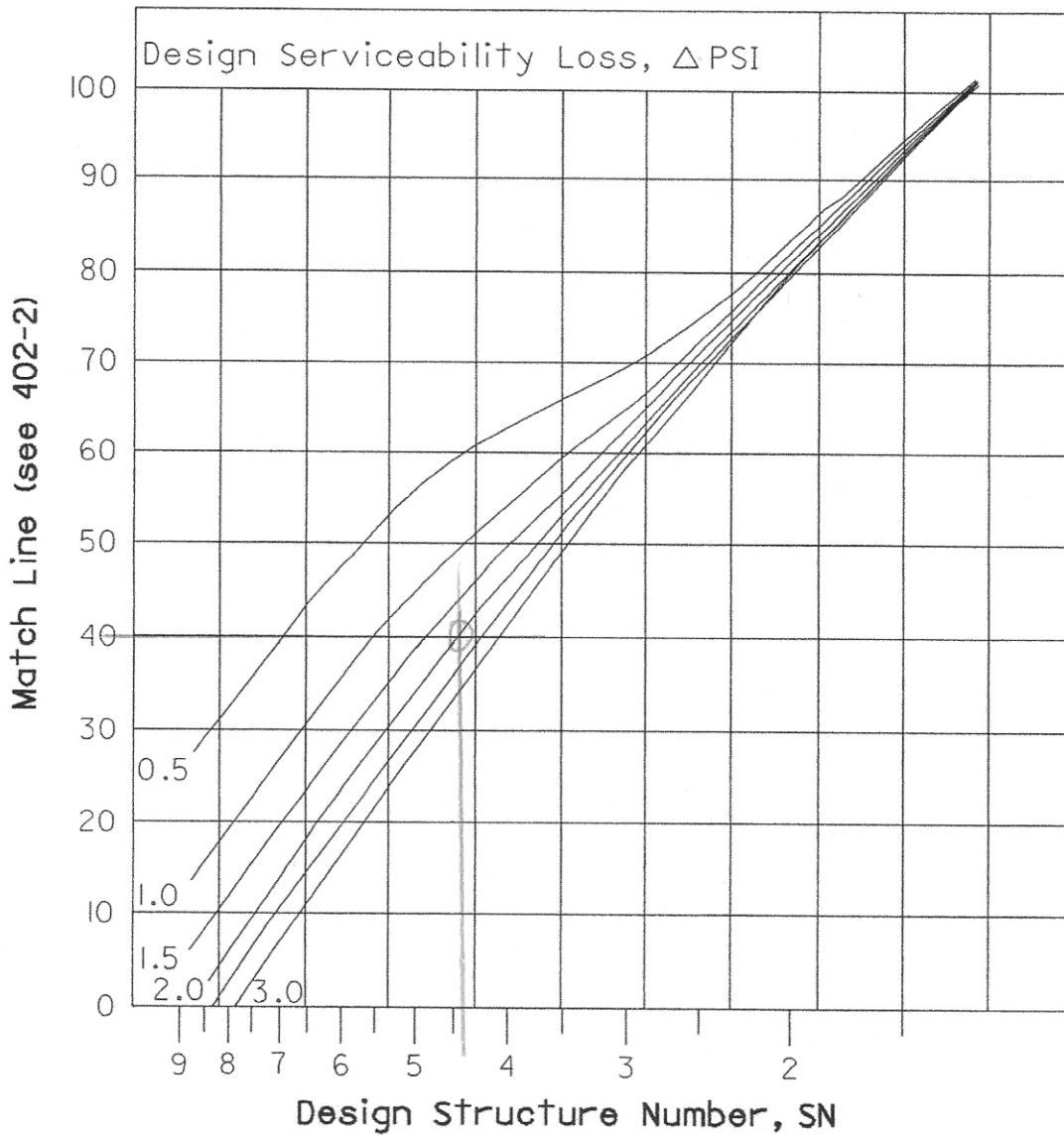


Flexible Pavement Design Chart Segment 2

402-3

July 2008

Reference Section & Figure
402, 402-1(step 3)



SN 4.4

Appendix D

URETEK
Proposal



PROPOSAL FOR SERVICES

Prepared for:

Heath Brendinger

MS Consultants, Inc - Columbus, OH

City of Steubenville - Roadway - 20/06

Prepared by:

Joe Kindler

Project Manager

URETEK USA, Inc.

(614) 561-6440

jkindler@uretekusa.com

www.uretekusa.com

Proposal date:

July 17, 2020



Heath,

URETEK USA, Inc. is pleased to present this proposal for our safe, non-intrusive, and long-lasting polymer repair solutions. URETEK pioneered and refined the polymer ground injection technology in use today. We have 30 years in the business and over 100,000 (and counting) successful projects to date.

Scope of Work:

URETEK USA will use the URETEK Deep Injection (UDI) process and our URETEK 486 STAR polymer to stabilize the soils under the slabs. Injections will continue after stabilization if lift is required.

URETEK USA will perform the following operations:

1. Profile the roadway panels.
2. Drill injection holes on 4' centers and install injection tubes.
3. Inject the highly expansive, high strength, lightweight, water-resistant URETEK 486 STAR polymer through the tubes and into the soils beneath the base to fill the voids & stabilize the soils. Injection will continue until 1mm of movement is detected at the surface of the roadway confirming adequate soil stabilization. Since this polymer is water-resistant, it can be injected into wet soil conditions without compromising the integrity of the polymer.
4. Drill out the top 2" of grout injection holes and fill with a non-shrink cementitious grout.
5. Perform final profile of all lanes of the roadway for warranty purposes.

This work shall consist of soil densification to strengthen base and sub-base soils under flexible asphalt, concrete, or composite pavement, by furnishing and injecting expansive polyurethane material into the foundation soils beneath the pavement through holes or injection tubes inserted into drilled holes at locations and depths, as shown on the plans or as directed by the Engineer, while monitoring for movement at the surface. If necessary, injection of material shall continue as needed to lift the pavement to grade.

This problem can be addressed by utilizing the URETEK Deep Injection® (UDI) or the URETEK Method® process in conjunction with our URETEK 486 STAR® hydro-insensitive polymer.

Construction Details:

URETEK will perform the following operations:

- If required, Dynamic Cone Penetrometer (DCP) tests at locations chosen by the URETEK Supervisor will be executed. DCP tests will be used to confirm existing subgrade and/or foundation soil conditions, to locate voids, and to assist in determining or confirming injection depth(s). This plan will include depths, spacing, and pattern for all injections. If testing shows additional injection levels are needed, the URETEK Project Manager will get approval from the client prior to proceeding.

- Pavement Profile will be taken every 10 ft. in a longitudinal direction on edges and center of work area. Profile spots will be taken before and after injections and documented for review. During the procedure for void fill and/or pavement lifting, injections will be monitored by laser level, dial indicator, and/or string line.
- For UDI, holes will be vertically drilled to a depth sufficient to penetrate below the pavement and into the subgrade. Injection tubes will be inserted to the required depth(s) determined by the DCP test results. The holes shall be sufficiently spaced to fill voids and realign the pavement.
- Production units will have mounted proportion pumps capable of maintaining proper polyurethane component material temperature, material pressure and proper mixing of component materials.
- Certified and calibrated Flow Meters will read injected material amounts of components ("A" + "B").

Proposed Cost:

URETEK 486 STAR (LB)
397,710 LB @ \$5.75/LB = \$2,286,832.50

Mobilization (Each)
1 Each @ \$3,500.00/Each = \$3,500.00

Total Estimate: \$2,290,332.50

We highly recommend performing a pilot project to better estimate quantities.

Changes to Scope of Work:

All change orders must be approved in writing and signed on behalf of URETEK and the project site representative.

Items not Included in Quote:

Traffic Control, Bonding/Bond Participation, Joint/Crack Sealing

Payment Terms:

If agreement is by the pound, client will only pay for product installed. Payment terms are net 30 unless the contract states differently.

Warranty:

URETEK will provide a two-year unconditional warranty against settlement of more than 1/2" of the injected areas. In the unlikely event that movement of more than 1/2" in the injected areas occurs, URETEK will return to inject the affected area to lift to proper grade at no charge to the owner. If traffic control is not included in this proposal, URETEK would require that any traffic control required to perform the warranty work be provided by the owner.

Any bonded project shall only provide a one-year warranty from date of substantial completion. This shall not impact the URETEK two-year unconditional warranty described above.

This warranty shall be null if:

The only exception to the warranty is if the DCP tests reveal problems deeper than the approved injection plan and the client chooses not to address those problems at the time of this project.

Indemnification & Hold Harmless:

To the fullest extent permitted by law, the Subcontractor shall indemnify and hold harmless the Contractor, the Contractor's other subcontractors, the Architect, the Owner and their agents, consultants and employees (the Indemnities) from all claims for bodily injury and property damage other than to the Work itself that may arise from the performance of the Subcontract Work, including reasonable attorneys' fees, costs and expenses, that arise from the performance of the Work, but only to the extent caused by the negligent acts or omissions of the Subcontractor, the Subcontractor's Sub Subcontractors or anyone employed directly or indirectly by any of them or by anyone for whose acts any of them may be liable. This indemnity includes if the Subcontractor or any of its agents, employees, suppliers, or lower-tier Subcontractors utilize any machinery, equipment, tools, scaffolding, hoists, lifts or similar items owned, leased, or under the control of the Contractor. The Subcontractor shall be entitled to reimbursement of any defense cost paid above Subcontractor's percentage of liability for the underlying claim to the extent attributable to the negligent acts or omissions of the Indemnities.

Schedule:

Schedule will be discussed between URETEK and client after all paperwork has been approved by both sides. Operations can accommodate day or night/weekday and/or weekend work depending on the client's schedule. Traffic can be returned to the project area 15 minutes after our last injection.

Merit Shop Contractor:

URETEK USA, Inc. is a merit shop contractor and all services provided by this proposal will be on a merit shop basis. All reference to labor agreement of any kind, or alluded to, in a principle contract or a sub-contract, are set aside, and not part of this proposal.

Appendix E

Probable
Construciton
Cost
Estimates



John Scott Highway - Replacement Option - Concrete					
Roadway					
Item	Description	Grand Total	Unit	Unit Cost	Total
203	EXCAVATION	800	CY	\$19.00	\$15,200.00
203	EMBANKMENT	500	CY	\$20.50	\$10,250.00
202	PAVEMENT REMOVED	39200	SY	\$8.50	\$333,200.00
202	GUARDRAIL REMOVED	1650	FT	\$2.00	\$3,300.00
606	GUARDRAIL, MGS	1650	FT	\$17.00	\$28,050.00
606	ANCHOR ASSEMBLY, TYPE E	8	EACH	\$2,100.00	\$16,800.00
Roadway Subtotal					\$406,800.00

Erosion Control					
Item	Description	Grand Total	Unit	Unit Cost	Total
832	EROSION CONTROL	1	LUMP	\$35,000.00	\$35,000.00
832	SEEDING AND MULCHING	4600	SY	\$2.00	\$9,200.00
832	STORM WATER POLLUTION PREVENTION PLAN	1	LUMP	\$3,000.00	\$3,000.00
832	STORM WATER POLLUTION PREVENTION INSPECTIONS	1	LUMP	\$5,000.00	\$5,000.00
832	STORM WATER POLLUTION PREVENTION INSPECTION SC	1	LUMP	\$2,500.00	\$2,500.00
Erosion Control Subtotal					\$54,700.00

Drainage					
Item	Description	Grand Total	Unit	Unit Cost	Total
605	4" UNDERDRAINS	11000	FT	\$8.00	\$88,000.00
	DRAINAGE CONTINGENCY	1	LUMP	\$50,000.00	\$50,000.00
Drainage Subtotal					\$138,000.00

Pavement					
Item	Description	Grand Total	Unit	Unit Cost	Total
452	8" NON-REINFORCED CONCRETE PAVEMENT	39200	SY	\$54.00	\$2,116,800.00
304	6" AGGREGATE BASE	6520	CY	\$50.00	\$326,000.00
Pavement Subtotal					\$2,442,800.00

Maintenance of Traffic					
Item	Description	Grand Total	Unit	Unit Cost	Total
614	MAINTENANCE OF TRAFFIC	1	LUMP	\$150,000.00	\$150,000.00
Maintenance of Traffic Subtotal					\$150,000.00

Traffic Control - Signing and Pavement Marking					
Item	Description	Grand Total	Unit	Unit Cost	Total
646	EDGE LINE	2	MI	\$5,000.00	\$10,000.00
646	LANE LINE	2	MI	\$3,000.00	\$6,000.00
646	CENTER LINE	2	MI	\$6,000.00	\$12,000.00
632	SIGNING	1	LUMP	\$75,000.00	\$75,000.00
Traffic Control - Signing and Pavement Marking Subtotal					\$103,000.00

Miscellaneous					
Item	Description	Grand Total	Unit	Unit Cost	Total
614	Maintaining Traffic	1	Lump	\$85,000.00	\$85,000.00
623	Construction Layout Stakes	1	Lump	\$60,000.00	\$60,000.00
619	Field Office	18	Month	\$2,000.00	\$36,000.00
624	Mobilization	1	Lump	\$100,000.00	\$120,000.00
Miscellaneous Subtotal					\$301,000.00

Project Summary - ODOT	Subtotal
Roadway	\$406,800.00
Erosion Control	\$54,700.00
Drainage	\$138,000.00
Pavement	\$2,442,800.00
Maintenance of Traffic	\$150,000.00
Traffic Control - Signing and Pavement Marking	\$103,000.00
Miscellaneous	\$301,000.00
Total	\$3,596,300.00

25% Contingency	\$899,075.00
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Project Total	\$4,495,375.00
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John Scott Highway - Replacement Option - Asphalt

Roadway					
Item	Description	Grand Total	Unit	Unit Cost	Total
203	EXCAVATION	800	CY	\$19.00	\$15,200.00
203	EMBANKMENT	500	CY	\$20.50	\$10,250.00
202	PAVEMENT REMOVED	39200	SY	\$8.50	\$333,200.00
202	GUARDRAIL REMOVED	1650	FT	\$2.00	\$3,300.00
606	GUARDRAIL, MGS	1650	FT	\$17.00	\$28,050.00
606	ANCHOR ASSEMBLY, TYPE E	8	EACH	\$2,100.00	\$16,800.00
Roadway Subtotal					\$406,800.00

Erosion Control					
Item	Description	Grand Total	Unit	Unit Cost	Total
832	EROSION CONTROL	1	LUMP	\$35,000.00	\$35,000.00
832	SEEDING AND MULCHING	4600	SY	\$2.00	\$9,200.00
832	STORM WATER POLLUTION PREVENTION PLAN	1	LUMP	\$3,000.00	\$3,000.00
832	STORM WATER POLLUTION PREVENTION INSPECTIONS	1	LUMP	\$5,000.00	\$5,000.00
832	STORM WATER POLLUTION PREVENTION INSPECTION SC	1	LUMP	\$2,500.00	\$2,500.00
Erosion Control Subtotal					\$54,700.00

Drainage					
Item	Description	Grand Total	Unit	Unit Cost	Total
605	4" UNDERDRAINS	11000	FT	\$8.00	\$88,000.00
	DRAINAGE CONTINGENCY	1	LUMP	\$50,000.00	\$50,000.00
Drainage Subtotal					\$138,000.00

Pavement					
Item	Description	Grand Total	Unit	Unit Cost	Total
441	1.5" ASPHALT CONCRETE SURFACE COURSE	1650	CY	\$150.00	\$247,500.00
441	1.75" ASPHALT CONCRETE INTERMEDIATE COURSE	1925	CY	\$135.00	\$259,875.00
304	6" AGGREGATE BASE	6550	CY	\$50.00	\$327,500.00
302	6" ASPHALT CONCRETE BASE COURSE	6550	CY	\$115.00	\$753,250.00
Pavement Subtotal					\$1,588,125.00

Maintenance of Traffic					
Item	Description	Grand Total	Unit	Unit Cost	Total
614	MAINTENANCE OF TRAFFIC	1	LUMP	\$150,000.00	\$150,000.00
Maintenance of Traffic Subtotal					\$150,000.00

Traffic Control - Signing and Pavement Marking					
Item	Description	Grand Total	Unit	Unit Cost	Total
642	EDGE LINE	2	MI	\$5,000.00	\$10,000.00
642	LANE LINE	2	MI	\$3,000.00	\$6,000.00
642	CENTER LINE	2	MI	\$6,000.00	\$12,000.00
632	SIGNING	1	LUMP	\$75,000.00	\$75,000.00
Traffic Control - Signing and Pavement Marking Subtotal					\$103,000.00

Miscellaneous					
Item	Description	Grand Total	Unit	Unit Cost	Total
614	Maintaining Traffic	1	Lump	\$55,000.00	\$55,000.00
623	Construction Layout Stakes	1	Lump	\$60,000.00	\$60,000.00
619	Field Office	18	Month	\$2,000.00	\$36,000.00
624	Mobilization	1	Lump	\$100,000.00	\$100,000.00
Miscellaneous Subtotal					\$251,000.00

Project Summary - ODOT	Subtotal
Roadway	\$406,800.00
Erosion Control	\$54,700.00
Drainage	\$138,000.00
Pavement	\$1,588,125.00
Maintenance of Traffic	\$150,000.00
Traffic Control - Signing and Pavement Marking	\$103,000.00
Miscellaneous	\$251,000.00
Total	\$2,691,625.00

25% Contingency	\$672,906.25
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Project Total	\$3,364,531.25
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John Scott Highway - Rehabilitation Option 2 (Crack and seat with Asphalt Overlay)					
Roadway					
Item	Description	Grand Total	Unit	Unit Cost	Total
321	CRACKING AND SEATING NON-REINFORCED CONCRETE PAVEMENT	39200	SY	\$8.00	\$313,600.00
203	EMBANKMENT	500	CY	\$20.50	\$10,250.00
202	GUARDRAIL REMOVED	1650	FT	\$2.00	\$3,300.00
606	GUARDRAIL, MGS	1650	FT	\$17.00	\$28,050.00
606	ANCHOR ASSEMBLY, TYPE E	8	EACH	\$2,100.00	\$16,800.00
SPECIAL	REINFORCED PAVEMENT FABRIC	39200	SY	\$4.50	\$176,400.00
Roadway Subtotal					\$548,400.00

Erosion Control					
Item	Description	Grand Total	Unit	Unit Cost	Total
832	EROSION CONTROL	1	LUMP	\$20,000.00	\$20,000.00
832	SEEDING AND MULCHING	4600	SY	\$2.00	\$9,200.00
832	STORM WATER POLLUTION PREVENTION PLAN	1	LUMP	\$3,000.00	\$3,000.00
832	STORM WATER POLLUTION PREVENTION INSPECTIONS	1	LUMP	\$5,000.00	\$5,000.00
832	STORM WATER POLLUTION PREVENTION INSPECTION SOFTWARE	1	LUMP	\$2,500.00	\$2,500.00
Erosion Control Subtotal					\$39,700.00

Drainage					
Item	Description	Grand Total	Unit	Unit Cost	Total
	DRAINAGE CONTINGENCY	1	LUMP	\$50,000.00	\$50,000.00
Drainage Subtotal					\$50,000.00

Pavement					
Item	Description	Grand Total	Unit	Unit Cost	Total
441	1.25" ASPHALT CONCRETE SURFACE COURSE	1375	CY	\$150.00	\$206,250.00
441	3.0" ASPHALT CONCRETE INTERMEDIATE COURSE, TYPE II	3300	CY	\$135.00	\$445,500.00
441	1.0" ASPHALT CONCRETE INTERMEDIATE COURSE, TYPE I (SCRATCH)	1100	CY	\$135.00	\$148,500.00
Pavement Subtotal					\$800,250.00

Maintenance of Traffic					
Item	Description	Grand Total	Unit	Unit Cost	Total
614	MAINTENANCE OF TRAFFIC	1	LUMP	\$60,000.00	\$60,000.00
Maintenance of Traffic Subtotal					\$60,000.00

Traffic Control - Signing and Pavement Marking					
Item	Description	Grand Total	Unit	Unit Cost	Total
642	EDGE LINE	2	MI	\$5,000.00	\$10,000.00
642	LANE LINE	2	MI	\$3,000.00	\$6,000.00
642	CENTER LINE	2	MI	\$6,000.00	\$12,000.00
632	SIGNING	1	LUMP	\$75,000.00	\$75,000.00
Traffic Control - Signing and Pavement Marking Subtotal					\$103,000.00

Miscellaneous					
Item	Description	Grand Total	Unit	Unit Cost	Total
614	Maintaining Traffic	1	Lump	\$40,000.00	\$50,000.00
623	Construction Layout Stakes	1	Lump	\$60,000.00	\$60,000.00
619	Field Office	18	Month	\$2,000.00	\$36,000.00
624	Mobilization	1	Lump	\$75,000.00	\$65,000.00
Miscellaneous Subtotal					\$211,000.00

Project Summary - ODOT	Subtotal
Roadway	\$548,400.00
Erosion Control	\$39,700.00
Drainage	\$50,000.00
Pavement	\$800,250.00
Maintenance of Traffic	\$60,000.00
Traffic Control - Signing and Pavement Marking	\$103,000.00
Miscellaneous	\$211,000.00
Total	\$1,812,350.00

25% Contingency	\$453,087.50
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Project Total	\$2,265,437.50
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John Scott Highway - Rehabilitation Option 2 (Epoxy Injection with asphalt overlay)					
Roadway					
Item	Description	Grand Total	Unit	Unit Cost	Total
202	URETECH DEEP INJECTION	1	LUMP	\$2,290,332.50	\$2,290,332.50
203	EMBANKMENT	500	CY	\$20.50	\$10,250.00
202	GUARDRAIL REMOVED	1650	FT	\$2.00	\$3,300.00
606	GUARDRAIL, MGS	1650	FT	\$17.00	\$28,050.00
606	ANCHOR ASSEMBLY, TYPE E	8	EACH	\$2,100.00	\$16,800.00
SPECIAL	REINFORCED PAVEMENT FABRIC	39200	SY	\$4.50	\$176,400.00
Roadway Subtotal					\$2,525,132.50

Erosion Control					
Item	Description	Grand Total	Unit	Unit Cost	Total
832	EROSION CONTROL	1	LUMP	\$20,000.00	\$20,000.00
832	SEEDING AND MULCHING	4600	SY	\$2.00	\$9,200.00
832	STORM WATER POLLUTION PREVENTION PLAN	1	LUMP	\$3,000.00	\$3,000.00
832	STORM WATER POLLUTION PREVENTION INSPECTIONS	1	LUMP	\$5,000.00	\$5,000.00
832	STORM WATER POLLUTION PREVENTION INSPECTION SO	1	LUMP	\$2,500.00	\$2,500.00
Erosion Control Subtotal					\$39,700.00

Drainage					
Item	Description	Grand Total	Unit	Unit Cost	Total
	DRAINAGE CONTINGENCY	1	LUMP	\$50,000.00	\$50,000.00
Drainage Subtotal					\$50,000.00

Pavement					
Item	Description	Grand Total	Unit	Unit Cost	Total
441	1.5" ASPHALT CONCRETE SURFACE COURSE	1650	CY	\$150.00	\$247,500.00
441	1.5" ASPHALT CONCRETE INTERMEDIATE COURSE	1650	CY	\$135.00	\$222,750.00
Pavement Subtotal					\$470,250.00

Maintenance of Traffic					
Item	Description	Grand Total	Unit	Unit Cost	Total
614	MAINTENANCE OF TRAFFIC	1	LUMP	\$60,000.00	\$60,000.00
Maintenance of Traffic Subtotal					\$60,000.00

Traffic Control - Signing and Pavement Marking					
Item	Description	Grand Total	Unit	Unit Cost	Total
642	EDGE LINE	2	MI	\$5,000.00	\$10,000.00
642	LANE LINE	2	MI	\$3,000.00	\$6,000.00
642	CENTER LINE	2	MI	\$6,000.00	\$12,000.00
632	SIGNING	1	LUMP	\$75,000.00	\$75,000.00
Traffic Control - Signing and Pavement Marking Subtotal					\$103,000.00

Miscellaneous					
Item	Description	Grand Total	Unit	Unit Cost	Total
614	Maintaining Traffic	1	Lump	\$82,000.00	\$83,000.00
623	Construction Layout Stakes	1	Lump	\$60,000.00	\$60,000.00
619	Field Office	18	Month	\$2,000.00	\$36,000.00
624	Mobilization	1	Lump	\$75,000.00	\$115,000.00
Miscellaneous Subtotal					\$294,000.00

Project Summary - ODOT	Subtotal
Roadway	\$2,525,132.50
Erosion Control	\$39,700.00
Drainage	\$50,000.00
Pavement	\$470,250.00
Maintenance of Traffic	\$60,000.00
Traffic Control - Signing and Pavement Marking	\$103,000.00
Miscellaneous	\$294,000.00
Total	\$3,542,082.50

25% Contingency	\$885,520.63
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Project Total	\$4,427,603.13
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Appendix F

ODOT 1991 CMS Item 310 Specification

as adjusted for changes, errors, and deviations in excess of allowable tolerances will be the method of measurement.

305.03 Basis of Payment. The accepted quantities of concrete base will be paid for at the contract unit price per square yard which price and payment shall be full compensation for furnishing and placing all materials; provided, however, that for base found deficient in thickness only the reduced price stipulated in 451.16 shall be paid.

No additional payment over the unit contract bid price will be made for any base which has an average thickness in excess of that shown on the plans.

Payment will be made under:

Item	Unit	Description
305	Square yard	Concrete base

ITEM 310 SUBBASE

310.01 Description

310.02 Materials

310.03 Construction Methods

310.04 Method of Measurement

310.05 Basis of Payment

310.01 Description. This work shall consist of furnishing, placing and compacting subbase, including furnishing and incorporating water required for compaction, in reasonably close conformity with the lines, grades and cross sections shown on the plans or established by the Engineer.

Type I subbase shall meet one of the gradations listed in 310.02 at the time of incorporation into the work. Type II subbase shall meet grading A, 310.02, after all operations of placing and compaction have been completed.

310.02 Materials. Materials furnished under this item shall be gravel, crushed slag, crushed stone, sand, granulated slag, a mixture of crushed and granulated slags, or other types of suitable materials meeting the requirements of this item and having the approval of the Director. The sodium sulfate soundness loss for all aggregates except sandstone shall not exceed 15 percent. However, where the major portion of the unsound material in a coarse aggregate acquires a mud-like condition when tested for soundness, the maximum loss shall be five percent for all uses.

In addition, open-hearth and basic-oxygen furnace slag shall conform to stockpiling and aging requirements of 703.01.

Total Percent Passing		
Sieve	Grading A	Grading B
2 1/2 inch	100	100
1 inch	70-100	70-100
No. 4	25-100	25-100
No. 40	5-50	10-50
No. 200	0-10	5-15

Broken salvaged road metal (salvaged pavements and bases which are non-agglomerating when compacted), and granulated slag may be used for either Type I or Type II. For Type I, unless otherwise specified, these materials shall meet the following requirements.

Broken salvaged road metal shall have a reasonable size distribution with 100 percent passing a 3-inch square sieve and not more than 15 percent passing a No. 200 sieve.

Granulated slag shall conform to 703.08.

The fraction of these materials passing a No. 40 sieve shall have a liquid limit not greater than 30 and a plasticity index not greater than 6.

Material containing free water shall not be placed upon the subgrade.

Where material from an untested and/or undeveloped source is furnished, the Contractor shall submit to the Director at least ten days in advance of delivery of such material to the work, a report of exploration including a plan showing the location of the source, the depth of overburden to be removed and the area and depth to which the source is to be operated. The report shall include test data, satisfactory to the Director, which show that the source is capable of furnishing material meeting the requirements of these specifications, in sufficient quantity for the work. After the report and test data have been reviewed and the roadside source inspected, the Director may conditionally authorize the Contractor to furnish material from the source provided samples selected from the material produced for delivery to the work and from material delivered conforms to the requirements of these specifications. In addition, the Director may require that the material be stockpiled in quantities of at least

100 cubic yards for sampling and testing prior to delivery to the work.

310.03 Construction Methods. The subbase material shall be spread upon the subgrade after the prescribed subgrade and subbase drainage has been placed except that for portland cement concrete pavements, shallow pipe underdrains need not be placed prior to placing subbase material, providing adequate surface drainage of the subgrade is maintained during construction.

The subbase shall be constructed in layers not to exceed 6 inches compacted depth, except that for variable depth subbase used under concrete pavement or in the shoulder adjacent to concrete pavement, the material may be placed in single course thickness of not more than 8 inches compacted depth. The moisture content shall be as determined by the Engineer to obtain the desired compaction. Subbase material which does not contain sufficient moisture to compact in accordance with this section shall be sprinkled with water as directed by the Engineer. The water shall not be applied in a manner that will soften the subgrade. Water shall be applied when ordered by the Engineer.

At the beginning of the work the Contractor shall build a test section for the purpose of the Engineer determining density requirements for the material to be placed. With the moisture content of the material near optimum, the compaction of the test section shall be continued with approved compaction equipment, consisting of rollers alone or vibratory equipment and rollers, until there is no appreciable increase in density as determined by test. Approved compaction equipment shall consist of rollers alone, vibratory equipment and rollers, or vibratory equipment alone only where subbase material is of such a nature that it will not support rollers. For the remainder of the work the subbase course shall be compacted until the density is at least 98 percent of the weight in the test section. During the construction of the project, if there is an appreciable change in grading of the material or a change of source of material, a new test section shall be built in order to establish a new weight for the density requirement.

In areas where normal production rollers cannot be used, the compaction requirement shall be in accordance with 203.12.

Compaction of the subbase course shall immediately follow the spreading operation.

The finished surface of this course shall have sufficient stability to support loaded construction equipment used in construction of this and the subsequent course without rutting or deflection in excess of the surface tolerance permitted herein. When material

falling within a grading permitted by this specification is used and surface stability cannot be obtained, a sufficient quantity of crushed angular material shall be added to secure the stated stability.

The finished surface for the subbase shall conform to the plan requirements within the tolerances set forth under 203.06, except that when this item is used as a subbase for 451, 452 or 453 pavement, the variation shall not exceed $\frac{1}{4}$ inch.

Any irregularities or depressions that develop in the finished surface of the subbase under rolling shall be corrected by loosening the surface and adding or removing material until the surface presents a smooth regular appearance.

310.04 Method of Measurement. The quantity measured shall be the number of cubic yards, computed from plan lines, of subbase material compacted in place.

310.05 Basis of Payment. Payment for accepted quantities, complete in place, will be made at contract price for:

Item	Unit	Description
310	Cubic yard	Subbase