INVITATION TO BID #2018-07
Feyrer Park Paving Project
ADDENDUM NUMBER 4
March 1, 2018

On January 30, 2018, Clackamas County ("County") published Invitation to Bid #2018-07 ("BID") and amended with Amendment #1 on February 14, 2018, and Amendment #2 on February 15, 2018, and Amendment #3 on February 26, 2018. The County has found that it is in its interest to amend the BID through the issuance of this Addendum #4. Except as expressly amended below, all other terms and conditions of the original BID and subsequent Addenda shall remain unchanged.

1. **Remove and replace the bid schedule with the attached bid schedule, titled Feyrer Park Paving Package, Addendum #4, dated spring 2018. (Note bid item #102 and #103 units of measure have been altered.)**

2. **Add the following to the Project Information, Plans, Specifications and Drawings:**

   The Scope further includes the following Plans, Specifications, and Drawings:
   - Pavement Design Report – S. Ona Way, Molalla Oregon, dated December 7, 2017

Attachments: Bid Schedule, Feyrer Park Paving Package, Spring 2018, Addendum #4.
Pavement Design Report- S. Ona Way, Molalla Oregon, dated December 7, 2017.

End of Addendum #4

FEYRER PARK PAVING PACKAGE						
Item #	Spec #	Item Description	**Unit**	**Quantity**	**Unit Price**	**Amount**
TEMPORARY FEATURES AND APPURTENANCES FOR PAVING PACKAGE						
10	00210	MOBILIZATION	LS	1		
20	00290	POLLUTION CONTROL PLAN	LS	1		
TEMPORARY FEATURES AND APPURTENANCES FOR PAVING PACKAGE-SUBTOTAL						

Worksite #1 - **Feyrer Park Road (BCM to ECM)**						
Item #	Spec #	Item Description	**Unit**	**Quantity**	**Unit Price**	**Amount**
TEMPORARY FEATURES AND APPURTENANCES						
101	00225	TEMPORARY WORK ZONE TRAFFIC CONTROL, COMPLETE	LS	1		
102	00225	TEMPORARY FLEXIBLE PAVEMENT MARKERS	EACH	10060		
103	00225	TEMPORARY STRIPING	FOOT	9260		
TEMPORARY FEATURES AND APPURTENANCES-SUBTOTAL						
ROADWORK						
104	00310	ASPHALT PAVEMENT SAW CUTTING	FOOT	500		
ROADWORK-SUBTOTAL						
DRAINAGE AND SEWERS						
105	480	DRAINAGE CURBS, STANDARD	FOOT	150		
DRAINAGE AND SEWERS - SUBTOTAL						
BASES						
106	00620	COLD PLANE PAVEMENT REMOVAL, 0 - 4 INCH DEPTH	SQYD	4505		
107	00620	COLD PLANE PAVEMENT REMOVAL, 4 INCH DEEP	SQYD	2790		
108	00641	SHOULDER ROCK IN PLACE	TON	4140		
109	00641	4"-0 AGGREGATE BASE	TON	350		
BASE - SUBTOTAL						
WEARING SURFACES						
110	00745	LEVEL 3, 1/2 INCH ACP	TON	7045		
111	00749	EXTRA FOR ASPHALT APPROACHES	EACH	12		
WEARING SURFACES - SUBTOTAL						

Worksite #1 **- Feyrer Park Road (BCM to ECM)**

Item #	Spec #	Item Description	Unit	Quantity	Unit Price	Amount
PERMANENT TRAFFIC CONTROL						
112	00855	BI-DIRECTIONAL YELLOW TYPE 1AR MARKERS, RECESSED	EACH	292		
113	00866	HI-BUILD PAINT, 25 MIL, SPRAYED	FOOT	45600		
114	00867	PAVEMENT BAR, TYPE B-HS	SQFT	70		
PERMANENT TRAFFIC CONTROL-SUBTOTAL						
WORKSITE #1 - FEYRER PARK ROAD PAVING PROJECT (BCM TO ECM) TOTAL						

Worksite #2 **- Mathias Road Paving Project (BCM to ECM)**

Item #	Spec #	Item Description	Unit	Quantity	Unit Price	Amount
TEMPORARY FEATURES AND APPURTENANCES						
201	00225	TEMPORARY WORK ZONE TRAFFIC CONTROL, COMPLETE	LS	1		
202	00225	TEMPORARY FLEXIBLE PAVEMENT MARKERS	EACH	800		
TEMPORARY FEATURES AND APPURTENANCES-SUBTOTAL						
ROADWORK						
203	00310	ASPHALT PAVEMENT SAW CUTTING	FOOT	75		
ROADWORK-SUBTOTAL						
DRAINAGE AND SEWERS						
204	480	DRAINAGE CURBS, STANDARD	FOOT	150		
DRAINAGE AND SEWERS - SUBTOTAL						
BASES						
205	00620	COLD PLANE PAVEMENT REMOVAL, 0 - 4 INCH DEPTH	SQYD	1630		
206	00641	SHOULDER ROCK IN PLACE	TON	1180		
BASE - SUBTOTAL						
WEARING SURFACES						
207	00745	LEVEL 3, 1/2 INCH ACP	TON	2250		
208	00749	EXTRA FOR ASPHALT APPROACHES	EACH	20		
WEARING SURFACES - SUBTOTAL						

Worksite #2 **- Mathias Road Paving Project (BCM to ECM)**

Item #	Spec #	Item Description	Unit	Quantity	Unit Price	Amount
PERMANENT TRAFFIC CONTROL						
209	00855	BI-DIRECTIONAL YELLOW TYPE 1AR MARKERS, RECESSED	EACH	105		
210	00866	HI-BUILD PAINT, 25 MIL, SPRAYED	FOOT	4105		
211	00867	PAVEMENT BAR, TYPE B-HS	SQFT	15		
PERMANENT TRAFFIC CONTROL-SUBTOTAL						
WORKSITE #2 - MATHIAS ROAD PAVING PROJECT (BCM TO ECM) TOTAL						

Worksite #3 **- Molalla Avenue (BCM to Wilhoit)**

Item #	Spec #	Item Description	Unit	Quantity	Unit Price	Amount
TEMPORARY FEATURES AND APPURTENANCES						
301	00225	TEMPORARY WORK ZONE TRAFFIC CONTROL, COMPLETE	LS	1		
302	00225	TEMPORARY FLEXIBLE PAVEMENT MARKERS	EACH	6164		
TEMPORARY FEATURES AND APPURTENANCES-SUBTOTAL						
ROADWORK						
303	00310	ASPHALT PAVEMENT SAW CUTTING	FOOT	91		
ROADWORK-SUBTOTAL						
DRAINAGE AND SEWERS						
304	480	DRAINAGE CURBS, STANDARD	FOOT	150		
DRAINAGE AND SEWERS - SUBTOTAL						
BASES						
305	00620	COLD PLANE PAVEMENT REMOVAL, 0 - 4 INCH DEPTH	SQYD	3015		
306	00641	SHOULDER ROCK IN PLACE	TON	1500		
BASES - SUBTOTAL						
WEARING SURFACES						
307	00745	LEVEL 2, 1/2 INCH ACP	TON	2855		
308	00749	EXTRA FOR ASPHALT APPROACHES	EACH	28		
WEARING SURFACES - SUBTOTAL						

Worksite #3 - **Molalla Avenue (BCM to Wilhoit)**						
PERMANENT TRAFFIC CONTROL						
309	00855	BI-DIRECTIONAL YELLOW TYPE 1AR MARKERS, RECESSED	EACH	120		
310	00866	HI-BUILD PAINT, 25 MIL, SPRAYED	FOOT	16100		
311	00867	PAVEMENT BAR, TYPE B-HS	SQFT	32		
PERMANENT TRAFFIC CONTROL-SUBTOTAL						
WORKSITE #3 - MOLALLA AVENUE (WILHOIT TO ECM) TOTAL						

Worksite #4 - **Ona Way (HWY 211 to ECM)**						
Item #	Spec #	Item Description	**Unit**	**Quantity**	**Unit Price**	**Amount**
TEMPORARY FEATURES AND APPURTENANCES						
401	00225	TEMPORARY WORK ZONE TRAFFIC CONTROL, COMPLETE	LS	1		
402	00225	TEMPORARY FLEXIBLE PAVEMENT MARKERS	EACH	2420		
403	00280	COMPOST FILTER BERM	FOOT	7120		
404	00280	INLET PROTECTION	EA	1		
TEMPORARY FEATURES AND APPURTENANCES-SUBTOTAL						
ROADWORK						
405	00310	ASPHALT PAVEMENT SAW CUTTING	FOOT	78		
ROADWORK-SUBTOTAL						
DRAINAGE AND SEWERS						
406	480	DRAINAGE CURBS, STANDARD	FOOT	150		
DRAINAGE AND SEWERS - SUBTOTAL						
BASES						
407	00641	SHOULDER ROCK IN PLACE	TON	1340		
408	00644	FDR/CTB: TREATED BASE/SOIL, 12-INCHES THICK	SQYD	9170		
409	00644	PORTLAND CEMENT (8% NOMINAL)	TON	450		
410	00644	EXCESSIVE MATERIAL REMOVAL/DISPOSAL-AS NEEDED/DIRECTED BY ENGINEER	CY	120		
411	00644	SUPPLEMENTARY AGGREGATE (BASE AGGREGATE)	TON	100		
BASES - SUBTOTAL						

Worksite #4 **- Ona Way (HWY 211 to ECM)**						
WEARING SURFACES						
412	00710	SINGLE APPLICATION EMULSIFIED ASPHALT SURFACE TREATMENT	SQYD	9170		
413	00745	LEVEL 3, 1/2 INCH ACP	TON	2400		
414	00749	EXTRA FOR ASPHALT APPROACHES	EACH	37		
WEARING SURFACES - SUBTOTAL						
PERMANENT TRAFFIC CONTROL						
415	00867	PAVEMENT BAR, TYPE B-HS / SQFT	SQFT	15		
PERMANENT TRAFFIC CONTROL-SUBTOTAL						
WORKSITE #4 - ONA WAY (HWY 211 TO ECM) TOTAL						

WORKSITE TOTALS
TEMPORARY FEATURES AND APPURTENANCES FOR PAVING PACKAGE TOTAL
WORKSITE #1 - FEYRER PARK ROAD (BCM TO ECM) TOTAL
WORKSITE #2 - MATHIAS ROAD PAVING (BCM TO ECM) TOTAL
WORKSITE #3 - MOLALLA AVE (BCM TO WILHOIT) TOTAL
WORKSITE #4 - ONA WAY (HWY 211 TO ECM) TOTAL

PAVING PACKAGE TOTAL

Total Price _____ Dollars and

_____ Cents

Name of Firm _____

Name (Print) _____

Signature _____

Date

Pavement Design Report

S Ona Way
Molalla, Oregon

Prepared by

GRI

Oregon & Washington

December 7, 2017

Providing geotechnical, pavement, and environmental consulting services since 1984

EXECUTIVE SUMMARY

Project Scope

GRI completed a pavement evaluation for the planned S Ona Way Improvement Project. S Ona Way is a two-lane, two-way, asphalt concrete (AC) surfaced roadway that has roughly 200 ft of curb and gutter. The project extends approximately 4,028 ft, and the limits are from the Woodburn-Estacada Highway (OR Hwy 211) south to the end of the roadway near a grouping of residential driveways. This evaluation was conducted in order to develop design recommendations for rehabilitation of the existing pavement and/or reconstruction (as applicable) and to review Clackamas County specifications for full-depth reclamation (FDR) with portland cement (Oregon Department of Transportation Special Provisions [ODOT SP] Section 00644) and single application emulsified asphalt surface treatment (ODOT SP Section 00710).

This report summarizes our findings and pavement design recommendations. Our design recommendations for the project are based on field and laboratory testing, which included pavement boring explorations, falling weight deflectometer (FWD) testing, and soil-cement laboratory testing. The pavement design analysis was accomplished in general accordance with the 1993 American Association of State Highway and Transportation Officials (AASHTO) Guide for Design of Pavement Structures (AASHTO Guide) and the ODOT Pavement Design Guide.

Existing Conditions

As discussed later, the existing pavement on S Ona Way is in poor condition and exhibits widespread medium- to high-severity fatigue cracking (i.e., load-associated distress that is a precursor to pavement failure), utility patches, and potholes.

Pavement Design Recommendations

Based upon the poor condition of the roadway, rehabilitation of the pavement does not appear to be viable and reconstruction is, in our opinion, necessary. In addition, the pavement borings indicate that there is a minimal aggregate base thickness and therefore, partial-depth reconstruction (i.e., new construction above the existing aggregate base) does not appear to be feasible. Therefore, our analysis approach was based on the assumption that full-depth reconstruction is necessary, and we developed the following two asphalt concrete pavement (ACP) reconstruction design alternatives for a 20-year design period.

Reconstruction

<u>Aggregate Stabilization with Geotextile</u>

- 4-in.-thick Level 2, 1/2-in. size Dense ACP (two lifts)
- 16-in.-thick, 1- or 3/4-in.-minus size Aggregate Base
- Subgrade Geotextile

<u>Full-Depth Reclamation with Cement Treatment</u>

- 4-in.-thick Level 2, 1/2-in. size Dense ACP (two lifts)
- 12-in.-thick, In-Place Cement Treated Base

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PROJECT DESCRIPTION

GRI conducted a pavement evaluation in order to develop pavement rehabilitation design recommendations for S Ona Way in Molalla, Oregon. The project limits are shown on the Vicinity Map, Figure 1, and the location of our boring explorations are shown on the Site Map, Figure 2. The project limits are from the Woodburn-Estacada Highway (OR Hwy 211) south to the end of the roadway near a grouping of residential driveways. Between the project limits, S Ona Way is a two-lane, two-way asphalt concrete (AC)-surfaced street in a residential area.

PAVEMENT DESIGN APPROACH

Pavement design analysis was accomplished in accordance with the 1993 American Association of State Highway and Transportation Officials (AASHTO) Guide for Design of Pavement Structures (AASHTO Guide) and the Oregon Department of Transportation (ODOT) Pavement Design Guide.

For our reconstruction analysis, we first evaluated whether partial-depth reconstruction is feasible. Partial-depth reconstruction is only feasible when the existing aggregate base (AB) can be utilized as a platform for placing the new AC section. Based on our field investigation, there is not sufficient thickness of existing AB to support construction traffic, therefore full-depth reconstruction or reclamation is necessary. A structural design life of 20 years was used to develop recommendations for reconstruction.

PAVEMENT SURFACE CONDITIONS

An experienced engineer from GRI conducted a visual survey of the pavement between the project limits in August 2017. The survey was conducted in order to identify the severity and extent of load-associated distress and patching. The existing pavement between the project limits exhibit extensive medium- to high-severity fatigue cracking (i.e., load associated distress that is a precursor to pavement failure), utility patches, and potholes. Our observations indicate that a majority of the pavement will require full-depth repair. When the quantity of full-depth repairs/dig outs exceeds 20 to 30%, it is commonly accepted that patching followed by an overlay is less cost effective than conventional reconstruction. Furthermore, reconstruction using full-depth reclamation (FDR) is typically less expensive than conventional reconstruction methods (Caltrans, 2013 & PCA, 2017).

SUBSURFACE CONDITIONS

General

GRI completed boring explorations and falling weight deflectometer (FWD) testing along the existing roadway alignment between the project limits. The locations of the boring explorations are shown on Figure 2. Additional information about the explorations and FWD testing is provided below and in Appendices A and B, respectively.

Core and Boring Explorations

Subsurface materials and conditions at the site were investigated on September 6, 2017, with four borings, designated B-1 through B-4, which were advanced to depths between 3.5 and 5 ft.

The field and laboratory testing program completed for this project is described in Appendix A. Logs of the borings are provided on Figures 1A through 4A. Photographs of the pavement cores are also provided in Appendix A on Figures 5A and 6A. The terms and symbols used to describe the soils encountered in the borings are defined in Table 1A and the attached legend.

Falling Weight Deflectometer (FWD) Testing

GRI conducted nondestructive FWD deflection testing using our KUAB 2m Model 150 FWD, which fully complies with ASTM D4694. Testing was completed on S Ona Way on September 6, 2017, at 100-ft intervals between the project limits. The testing was done within the outer wheel paths of both the southbound and northbound lanes. The FWD testing was performed in order to estimate the in-situ modulus of the subgrade and pavement layers from backcalculation analysis, as described later herein. The pavement surface deflections in mil units (1 mil = 0.001 in.) were normalized to a 9,000-lb (9-kip) FWD load and are shown in Table 1B of Appendix B. Additionally, Figure 1B shows the 9-kip normalized deflections.

Soils

The U.S. Department of Agriculture (USDA) Web Soil Survey map (based on the Soil Survey of Clackamas County) indicates the predominant near-surface soil in the project area consists of the Sawtell soil series (Soil Survey Staff, 2017). In typical profile, the Sawtell series consists of clayey silt to a depth of approximately 2.5 ft and gravely clayey silt to a depth of 5 ft. The soil survey data generally agree with the results of our boring explorations.

For the purpose of discussion, the materials observed in the borings have been grouped into the following categories based on their physical characteristics and engineering properties. Listed as they were encountered from the ground surface downward, the units are as follows:

1. **PAVEMENT**
2. **Crushed Rock BASE COURSE**
3. **Clayey SILT**
4. **Sandy SILT and SILT**
5. **Gravelly, Silty CLAY and Silty GRAVEL**

The following paragraphs provide a detailed description of the pavement and soil units.

1. PAVEMENT. We encountered dense-graded AC at each of the boring explorations. As shown on the boring logs, 2.5 in., 4 in., 2.75 in., and 2.75 in. of AC were measured in borings B-1 through B-4, respectively. All borings were taken in locations of fatigue cracking that extends full depth through the pavement.

2. Crushed Rock BASE COURSE. Crushed rock was encountered beneath the AC surfacing in borings B-1, B-2, and B-4. There was an approximate 3-in., 5-in., and 2-in.-thick layer of AB beneath the AC at B-1, B-2, and B-4 respectively.

3. Clayey SILT. Clayey silt was encountered at various depths directly beneath the crushed rock base course in borings B-1 and B-2. The clayey silt layer extends a depth1.5 and 2.3 ft beneath the AC, at borings B-1 and B-2, respectively. The material is generally soft to medium stiff and gray to brown in color. The moisture content of the clayey silt at the time of our exploration ranged from 18 to 21% at the time of our investigation.

4. Sandy SILT and SILT. A layer of silt to sandy silt was observed beneath the AC layer in boring B-3 and beneath the crushed rock base course in boring B-4. At boring B-3, the thickness of the sandy silt is 1.7 ft, and at boring B-4, the thickness of the sandy silt is about 3.4ft. The silt layer in borings B-3 and B-4 ranged in thickness from 3 to 1.5 ft. at a depth of 2 to 3.5 ft. respectively. The sandy silt is generally medium stiff and brown to rust in color. The silt is generally soft to medium stiff and light brown in color. The moisture

content of the sandy silt ranged from 13 to 17% at the time of our investigation. Borings B-3 and B-4 were terminated in the silt at a depth of 5 ft.

5. Gravely, Silty CLAY and silty GRAVEL. Gravely, silty clay with some fine to coarse-grained sand was encountered at a depth of 2 ft in boring B-1 and at 3 ft in B-2. The material is generally medium stiff and brown mottled rust and black in color. Boring BA layer of silty gravel was encountered beneath the gravelly, silty clay in boring B-1 at a depth of 3 ft. The silty gravel is dense to very dense and subrounded. Boring B-1 was terminated in the silty gravel at a depth of 3.5 ft, and boring B-2 was terminated in the gravelly silty clay at a depth of 4 ft.

DESIGN DOCUMENTATION – ANALYSIS RESULTS

Traffic Loading Analysis

Estimates of the cumulative 18-kip Equivalent Single Axle Load (ESAL) repetitions (traffic loading) were developed for a 20-year design period. The traffic loading estimate is based on traffic data obtained from classified tube counts conducted on S Ona Way on August 2, 2017, by Clackamas County. The counts were conducted in both the northbound and southbound lane. We used the load equivalency factors (LEFs) given in the ODOT Pavement Design Guide to convert the truck volume into ESALs. Based on the analysis, the 20-year design loading estimate is approximately 74,200 ESALs. The traffic loading estimate is summarized in Table 1C in Appendix C.

Backcalculation Analysis

Backcalculation analysis was accomplished using the PAVBACK backcalculation analysis program, which is an iterative elastic layered analysis procedure. Deflections are calculated using the Boussinesq-Odemark equivalent-thickness procedure (Ullidtz, 1998). PAVBACK solutions have been validated by comparing calculated and measured values of asphalt tensile strain and subgrade compressive strain/stress using data from tests on instrumented pavement (test data published in Ullidtz, 2000) where the calculated values were based on the moduli backcalculated by PAVBACK from the deflections measured on the instrumented pavement. The calculated strains and stress were found to agree nearly exactly with the measured values (within $\pm$ 10% of the measured values).

The backcalculated subgrade modulus values for each of the FWD test locations are shown in Table 2C in Appendix C. The AC moduli have been normalized to 68ºF temperature and 10-Hz loading rate conditions. Tensile strain at the base of the lowest bound layer and subgrade principal stress were computed for a 9,000-lb FWD load based on the normalized AC modulus and take into account the stress sensitivity, if any, of the subgrade soil.

Pavement Design Analysis and Recommendations

The pavement design analysis for the roadway pavement was accomplished in accordance with the 1993 AASHTO *Guide for Design of Pavement Structures*.

Reconstruction

The design calculations for reconstruction are shown in Appendix C for the 20-year design period. A design subgrade resilient modulus for reconstruction was based on the backcalculation analysis results from FWD tests conducted on the existing pavement. Based on the data, the design subgrade modulus value of 2,600 psi was used for the project.

The reconstruction analysis results are based on the AASHTO input parameters given in Table 1.

Table 1: AASHTO DESIGN PARAMETERS FOR FLEXIBLE PAVEMENT

Parameter	Design Value
Design Period:	20 years
Traffic Loading Case, ESALs:	74,200
Design Reliability Level:	80%
Initial Serviceability:	4.2
Terminal Serviceability:	2.5
Standard Deviation:	0.5
Subgrade Modulus, psi:	2,600
Asphalt Concrete Layer Coefficient:	0.42
Aggregate Base Resilient Modulus/Layer Coefficient:	20,000 psi/0.10
Cement Treated Material Layer Coefficient:	0.13

Based on the boring exploration, partial-depth reconstruction is not feasible because there is not sufficient thickness of the existing AB to support construction traffic. Therefore, we developed two full-depth reconstruction alternatives, aggregate stabilization over a geotextile or full depth reclamation (FDR) with cement treatment.

The pavement design recommendations are described below. Supporting computations are provided in Tables 3C and 4C in Appendix C.

Reconstruction

Aggregate Stabilization with Geotextile

- 4-in.-thick Level 2, 1/2-in. size Dense ACP (two lifts)
- 16-in.-thick, 1- or 3/4-in.-minus size Aggregate Base
- Subgrade Geotextile

Full-Depth Reclamation with Cement Treatment

- 4-in.-thick Level 2, 1/2-in. size Dense ACP (two lifts)
- 12-in.-thick, In-Place Cement Treated Base

CEMENT TREATED MATERIAL EVALUATION

GRI performed a laboratory investigation in order to evaluate the necessary portland cement content needed for in-place cement stabilization of the pulverized pavement on S Ona Way. As presented above, the pavement reconstruction with FDR consists of 4 in. if AC over 12 in. of in-place cement treated material.

During the field investigation, we collected samples of the asphalt concrete, aggregate base, and subgrade material at each of the boring explorations. We combined the exploration materials to develop two composite samples, fine-grained and coarse-grained, for laboratory testing. The composite samples were a combination of AC, aggregate base, and subgrade material that varied from silty clay to gravelly silty clay. Based on an assumed pulverization and treatment depth of 12 in., we combined the materials at a ratio of 2.75 in. of AC to 2 in. of aggregate base to 7.25 in. subgrade, by dry weight (based on typical in-place densities). We simulated pulverization of the AC by heating the material in the oven and breaking it apart.

Laboratory Testing

We performed the soil-cement mix design on the combined in general accordance with the Portland Cement Association (PCA) design procedures *Soil-Cement Laboratory Handbook*, except that acceptance criteria was based on compressive strength test results rather than freeze-thaw tests. Based on the PCA guidelines, a cement content of 10% (by dry weight of soil) was selected for the soil-cement moisture-density test. The moisture-density (compaction) test was performed in accordance with ASTM D558 *Moisture-Density Relations of Soil-Cement Mixtures*. The test yielded an optimum moisture content and maximum dry density of 12.7% and 119 pcf, respectively. The PCA handbook indicates that the optimum moisture content is insensitive to changes in the cement content, so long as the selected cement content is near (within a few percentage points of) the cement content used for the moisture-density test.

Two soil-cement compressive strength specimens (Proctor-size specimens) were molded at 8% cement content by dry weight for the coarse-grained material and two soil-cement compressive strength specimens were molded at 8 and 10% cement content by dry weight for the fine-grained material (a total of 6 specimens). The specimens were compacted in accordance with the procedures of ASTM D558 at target moisture contents corresponding to the optimum moisture content of 12.7%. The specimens were cured at 100% humidity for 7 days, then soaked in water for at least 4r hours and tested for compressive strength in accordance with ASTM D1633 *Compressive Strength of Molded Soil-Cement Cylinders*. The average 7-day compressive strength test results are shown graphically on Chart 1, below.

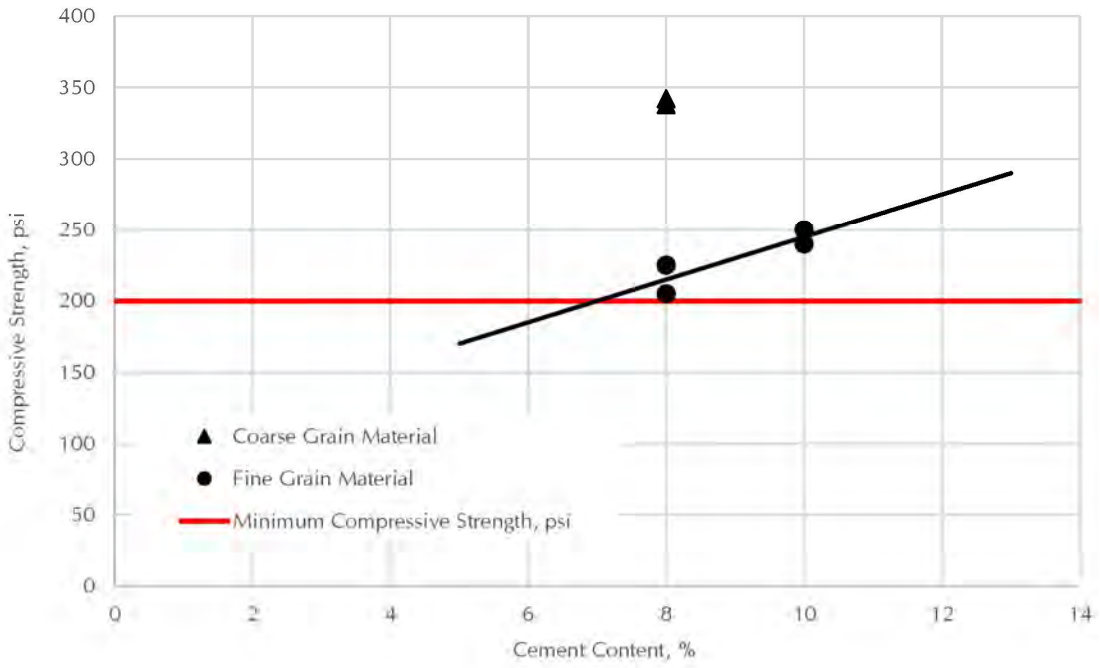

Chart 1: CEMENT-TREATED MATERIAL LABORATORY TEST RESULTS

Recommendations

The design pavement section for the project was based on a minimum of 12 in. of cement-treated material with a minimum unconfined compressive strength of 200 psi. Based on the compressive strength test data shown in Figure 1, the results indicate that a cement treatment rate of 8% provides the required strength to improve the pulverized pavement to the minimum design strength of 200 psi. To be consistent with the laboratory values, a minimum four-day curing period following cement amendment is recommended prior to placement of the asphalt concrete. The cement-amended stabilization should be placed and compacted to a minimum of 95% of the ASTM D558 maximum density and within 2% of the soil-cement optimum moisture content. It should be noted that on occasion, cement treated material has the potential to cause reflective cracking. Although reflective cracking maybe unsightly, it should not affect the serviceability or structural capacity of the treated base.

CONSTRUCTION CONSIDERATIONS

Recommendations for Materials and Construction

Standard Specifications. Construction materials and procedures should comply with the applicable sections of the 2018 ODOT/American Public Works Association (APWA) Oregon Standard Specifications for Construction (OSSC) with the modifications or supplements given below.

References to specification sections preceded by ODOT SP refer to the latest ODOT Special Provisions for the designated specification section, including any associated special provisions.

Asphalt Concrete. Asphalt concrete should comply with the requirements of ODOT SP Section 00744. A PG 64-22 grade asphalt cement is recommended for all pavement lifts.

Place the asphalt concrete section using a minimum lift thickness of 2 in. and a maximum lift thickness of 3 in.

Aggregate Base. Aggregate base should comply with the requirements of ODOT SP Section 00641, 1 in.-0 in. or 3/4 in.-0 in., except that it should contain no more than 5% passing the No. 200 sieve based on a wet-sieve test.

Subgrade Geotextile. ODOT SP Section 00350, Level B Certification.

FDR with Cement. ODOT SP Section 00644, which is not a Standard Specification. See recommended specification modifications in Appendix D. During pulverization of the AC, AB, and subgrade materials, if significant amount of rocks exceeding 3 in. in diameter are encountered, reconstruction with AC over AB section is recommended in lieu of FDR with cement.

Single Application Emulsified Asphalt Surface Treatment. ODOT SP Section 00710. See recommended specification modifications in Appendix D.

Other Construction Considerations

The pavement sections provided above for reconstruction are based on the assumption pavement construction will be accomplished during warm, dry conditions and all workmanship and materials will conform to the applicable specifications. An experienced geotechnical engineer should evaluate the exposed subgrade conditions during construction. During periods of wet weather or when wet-ground

conditions exist, it will likely be necessary to increase the thickness of the aggregate base in order to support construction equipment and protect the potentially moisture-sensitive subgrade soils from disturbance. Soft subgrade or unsuitable materials will likely require additional thickness of aggregate base in order to support construction traffic and should be evaluated by an experienced geotechnical engineer.

Traffic should not be allowed on the new pavement before all lifts of the AC base course have been placed, and if the road is opened to traffic, no more than 14 days should pass prior to placing the wearing course.

Prior to placing AC and after complete curing (if applicable), the aggregate base or cement treated material base should be proof rolled with a loaded dump truck. If unsuitable conditions are observed during proof rolling, the area should be overexcavated using hoe-type equipment equipped with a smooth-edge bucket and stabilized using the recommendations given below for subgrade stabilization. For extremely soft conditions, additional thickness of aggregate base backfill may be required.

Subgrade Stabilization

- 12-in.-thick, 1½-in. or 2-in.-minus size Aggregate Base Backfill
- Subgrade Geotextile
- On undisturbed subgrade

DESIGN REVIEW AND CONSTRUCTION SERVICES

We welcome the opportunity to review and discuss construction plans and specifications for this project as they are being developed. In addition, GRI should review all pavement-related portions of the plans and specifications to evaluate whether they are in conformance with the recommendations provided in our report. To observe compliance with the intent of our recommendations, the design concepts, and the plans and specifications, we are of the opinion all construction operations dealing with earthwork and pavements should be observed by a GRI representative. Our construction-phase services will allow for timely design changes if site conditions are encountered that are different from those described in this report. If we do not have the opportunity to confirm our interpretations, assumptions, and analyses during construction, we cannot be responsible for the application of our recommendations to subsurface and pavement conditions different from those described in this report.

LIMITATIONS

This pavement design report has been prepared for use by the project team and should not be relied upon by any other entity without the written permission of an authorized representative. The scope is limited to the specific project and location described herein, and our description of the project represents our understanding of the significant aspects of the project relevant to the design and construction of the pavements at the time of publication. In the event any changes in the design and location of the improvements as outlined in this report are planned, we should be given the opportunity to review the changes and modify or reaffirm the conclusions and recommendations of this report in writing.

The conclusions and recommendations submitted in this report are based on the data obtained from our field and laboratory investigation at the locations indicated on Figure 2 and other sources of information discussed in this report. In the performance of subsurface investigations, specific information is obtained at specific locations at specific times. However, it is acknowledged that variations in pavement or soil conditions may exist between explorations. This report does not reflect any variations that may occur between these

explorations. The nature and extent of variation may not become evident until construction. If, during construction, subsurface conditions are found that are different from those encountered in the explorations, we should be advised at once so that we can observe and review these conditions and revise our recommendations where necessary.

Please contact the undersigned if you have any questions regarding this report or any other geotechnical considerations associated with this project.

Submitted for GRI,

Renews 06/2019

Michael J. Maloney, PE
Principal

Lindsi A. Hammond, PE
Senior Engineer

This document has been submitted electronically.

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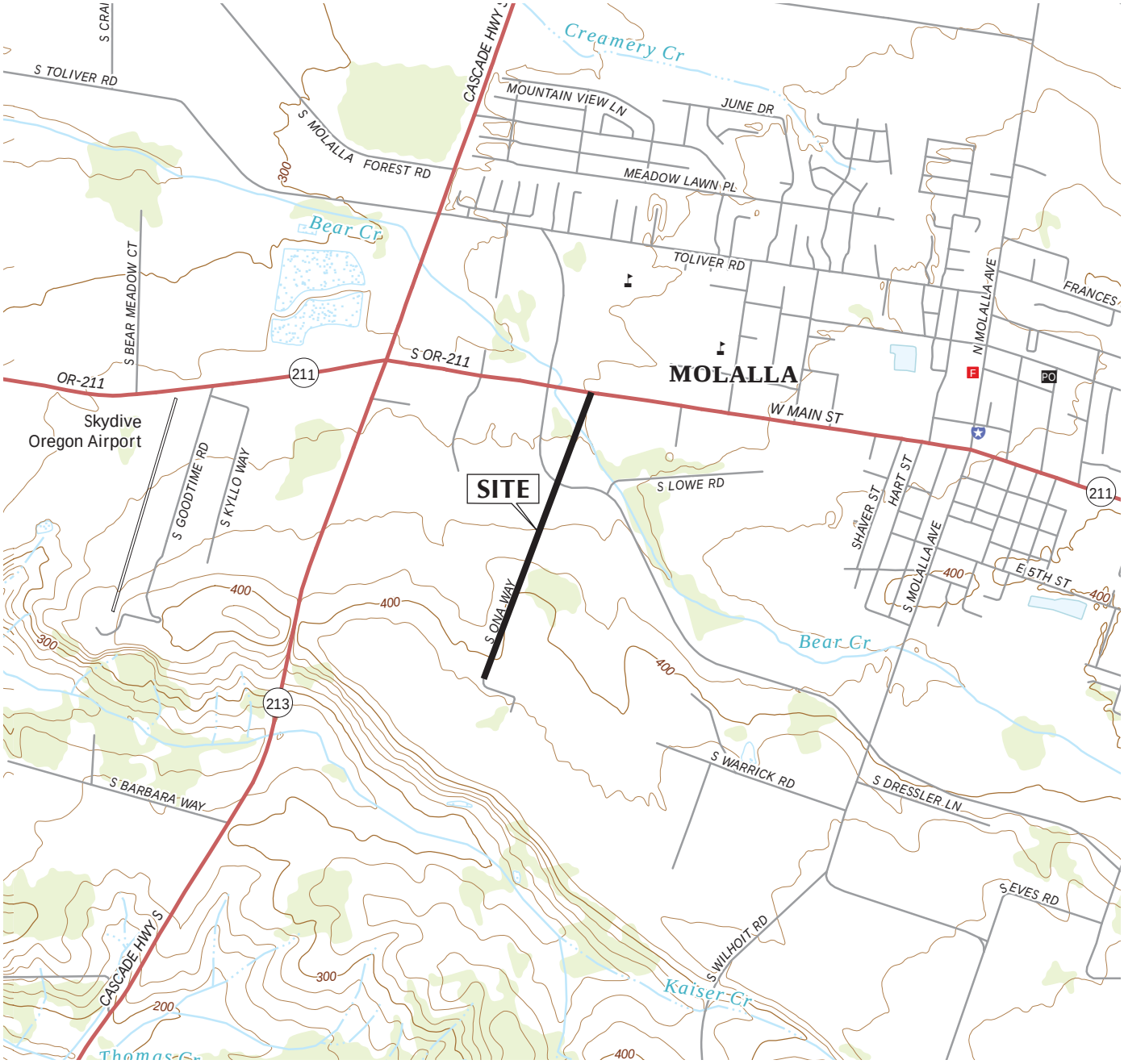


USGS TOPOGRAPHIC MAP
MOLALLA, OREG. (2014)

North

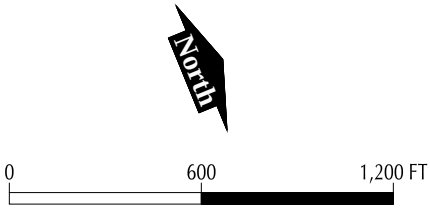
0 1/2 1 MILE

GRI

CLACKAMAS COUNTY
S ONA WAY

VICINITY MAP

DEC. 2017 JOB NO. 6024 FIG. 1



BORING COMPLETED BY GRI
(SEPTEMBER 6, 2017)

SITE MAP FROM GOOGLE EARTH PRO, DATED MAY 22, 2017

GRI

CLACKAMAS COUNTY
S ONA WAY

SITE MAP

DEC. 2017 JOB NO. 6024 FIG. 2

APPENDIX A

Field Explorations and Laboratory Testing

APPENDIX A

FIELD EXPLORATIONS AND LABORATORY TESTING

FIELD EXPLORATIONS

General

Subsurface conditions and materials at the site were investigated on September 6, 2017, with four borings, designated B-1 through B-4. The locations of the explorations are shown on the Site Map, Figure 2. The field exploration and laboratory programs completed for this project are described below.

Borings

Borings B-1 through B-4 were advanced to depths of 3.5 to 5 ft at the locations shown on Figure 2. The borings were drilled using solid-stem auger drilling techniques with a Dandy Digger 25-30T rig provided and operated by Custom Hole Drilling, Inc., of Molalla, Oregon. The field exploration work was coordinated and documented by an experienced geotechnical engineer from GRI, who maintained a detailed log of the materials and conditions disclosed during the course of the work.

Disturbed samples were obtained from the borings at about1-ft intervals of depth. The soil samples obtained were carefully examined in the field, and representative portions were saved in sample bags for further examination and physical testing in our laboratory.

Logs of the borings are provided on Figures 1A through 4A. Each log presents a descriptive summary of the various types of material encountered and notes the depth where the materials and/or characteristics of the materials change. To the right of the descriptive summary, the numbers and types of samples taken during the drilling operation are indicated. Farther to the right, are the natural moisture contents. The terms and symbols used to describe the soils are defined in Table 1A and the attached legend.

LABORATORY TESTING

General

All samples obtained from the field exploration program were brought to our laboratory for examination and testing. The physical characteristics were noted, and the field classifications were modified where necessary. The laboratory program included determinations of natural moisture contents.

Natural Moisture Content

Natural moisture content determinations were made in conformance with ASTM D2216. The results are presented on the Boring Logs, Figures 1A through 4A, and are summarized in Table 2A.

Table 1A: GUIDELINES FOR CLASSIFICATION OF SOIL

Description of Relative Density for Granular Soil

Relative Density	Standard Penetration Resistance (N-values), blows per ft
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	over 50

Description of Consistency for Fine-Grained (Cohesive) Soils

Consistency	Standard Penetration Resistance (N-values), blows per ft	Torvane or Undrained Shear Strength, tsf
Very Soft	0 - 2	less than 0.125
Soft	2 - 4	0.125 - 0.25
Medium Stiff	4 - 8	0.25 - 0.50
Stiff	8 - 15	0.50 - 1.0
Very Stiff	15 - 30	1.0 - 2.0
Hard	over 30	over 2.0

Grain-Size Classification	Modifier for Subclassification		
Boulders: >12 in.		Primary Constituent SAND or GRAVEL	Primary Constituent SILT or CLAY
Cobbles: 3 - 12 in.	Adjective	Percentage of Other Material (by weight)	
Gravel: 1/4 - 3/4 in. (fine); 3/4 - 3 in. (coarse)	trace:	5 - 15 (sand, gravel)	5 - 15 (sand, gravel)
	some:	15 - 30 (sand, gravel)	15 - 30 (sand, gravel)
	sandy, gravelly:	30 - 50 (sand, gravel)	30 - 50 (sand, gravel)
Sand: No. 200 - No. 40 sieve (fine); No. 40 - No. 10 sieve (medium); No. 10 - No. 4 sieve (coarse)	trace:	<5 (silt, clay)	*Relationship of clay and silt determined by plasticity index test*
	some:	5 - 12 (silt, clay)	
	silty, clayey:	12 - 50 (silt, clay)	
Silt/Clay: pass No. 200 sieve			

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Table 2A

SUMMARY OF LABORATORY RESULTS

Sample Information						Atterberg Limits			
Location	Sample	Depth, ft	Elevation, ft	Moisture Content, %	Dry Unit Weight, pcf	Liquid Limit, %	Plasticity Index, %	Fines Content, %	Soil Type
B-1	S-3	0.5	--	18	--	--	--	--	Clayey SILT
B-2	S-3	0.8	--	21	--	--	--	--	Clayey SILT
B-3	S-2	0.3	--	13	--	--	--	--	Sandy SILT
B-4	S-3	0.4	--	17	--	--	--	--	Sandy SILT

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BORING AND TEST PIT LOG LEGEND

SOIL SYMBOLS

Symbol	Typical Description
	LANDSCAPE MATERIALS
	FILL
	GRAVEL; clean to some silt, clay, and sand
	Sandy GRAVEL; clean to some silt and clay
	Silty GRAVEL; up to some clay and sand
	Clayey GRAVEL; up to some silt and sand
	SAND; clean to some silt, clay, and gravel
	Gravelly SAND; clean to some silt and clay
	Silty SAND; up to some clay and gravel
	Clayey SAND; up to some silt and gravel
	SILT; up to some clay, sand, and gravel
	Gravelly SILT; up to some clay and sand
	Sandy SILT; up to some clay and gravel
	Clayey SILT; up to some sand and gravel
	CLAY; up to some silt, sand, and gravel
	Gravelly CLAY; up to some silt and sand
	Sandy CLAY; up to some silt and gravel
	Silty CLAY; up to some sand and gravel
	PEAT

BEDROCK SYMBOLS

Symbol	Typical Description
	BASALT
	MUDSTONE
	SILTSTONE
	SANDSTONE

SURFACE MATERIAL SYMBOLS

Symbol	Typical Description
	Asphalt concrete PAVEMENT
	Portland cement concrete PAVEMENT
	Crushed rock BASE COURSE

SAMPLER SYMBOLS

Symbol	Sampler Description
	2.0-in. O.D. split-spoon sampler and Standard Penetration Test with recovery (ASTM D1586)
	Shelby tube sampler with recovery (ASTM D1587)
	3.0-in. O.D. split-spoon sampler with recovery (ASTM D3550)
	Grab Sample
	Rock core sample interval
	Sonic core sample interval
	Geoprobe sample interval

INSTALLATION SYMBOLS

Symbol	Symbol Description
	Flush-mount monument set in concrete
	Concrete, well casing shown where applicable
	Bentonite seal, well casing shown where applicable
	Filter pack, machine-slotted well casing shown where applicable
	Grout, vibrating-wire transducer cable shown where applicable
P	Vibrating-wire pressure transducer
	1-in.-diameter solid PVC
	1-in.-diameter hand-slotted PVC
	Grout, inclinometer casing shown where applicable

FIELD MEASUREMENTS

Symbol	Typical Description
	Groundwater level during drilling and date measured
	Groundwater level after drilling and date measured
	Rock core recovery (%)
	Rock quality designation (RQD, %)

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL **Surface Elevation:** Not Available	DEPTH, FT	SAMPLE NO.	SAMPLE TYPE	MOISTURE CONTENT, % FINES CONTENT, % LIQUID LIMIT, % PLASTIC LIMIT, % (0 – 50 – 100)	COMMENTS AND ADDITIONAL TESTS
		Asphalt concrete PAVEMENT (2.5 in.) over crushed rock BASE COURSE (3 in.)		S-1			
				S-2			
		Clayey SILT, trace to some fine- to coarse-grained sand, gray, soft to medium stiff	0.5				
1				S-3		●	
		---brown to gray below 1.5 ft					
2		Gravelly silty CLAY, some fine- to coarse-grained sand, brown mottled rust and black, medium stiff, subrounded to rounded	2.0	S-4			
3		Silty GRAVEL, some fine- to coarse-grained sand, dense to very dense, subrounded	3.0	S-5			Driller notes increased resistance below 3 ft
		(9/6/2017) Practical refusal at 3.5 ft Groundwater not encountered	3.5				
4							
5							
6							
7							

0 – 0.5 – 1.0 ◆ TORVANE SHEAR STRENGTH, TSF

Logged By: B. Cook	**Excavated by:** Custom Hole Drilling, Inc.	**Equipment:** Dandy Digger 25-30T
Date Started: 9/6/17	**Coordinates:** Not Available	**Note:** See Legend for Explanation of Symbols

GRI PAVEMENT LOG (LAT/LONG)-NO ELEV GRI DATA TEMPLATE.GDT 10/18/17

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BORING B-1

DEC. 2017 JOB NO. 6024 FIG. 1A

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL **Surface Elevation:** Not Available	DEPTH, FT	SAMPLE NO.	SAMPLE TYPE	MOISTURE CONTENT, % FINES CONTENT, % LIQUID LIMIT, % PLASTIC LIMIT, % (0 – 50 – 100)	COMMENTS AND ADDITIONAL TESTS
		Asphalt concrete PAVEMENT (4 in.) over crushed rock BASE COURSE (5 in.)		S-1			
				S-2			
		Clayey SILT, trace to some fine- to coarse-grained sand, gray, soft to medium stiff ---brown to rust below 1.1 ft	0.7	S-3		●	
1							
2				S-4			
3		Gravelly silty CLAY, some fine- to coarse-grained sand, brown mottled rust, black, and gray, medium stiff, subrounded to rounded	3.0	S-5			
4		(9/6/2017) Practical refusal at 4 ft Groundwater not encountered	4.0				
5							
6							
7							

TORVANE SHEAR STRENGTH, TSF (0 – 0.5 – 1.0)

Logged By: B. Cook	**Excavated by:** Custom Hole Drilling, Inc.	**Equipment:** Dandy Digger 25-30T
Date Started: 9/6/17	**Coordinates:** Not Available	**Note:** See Legend for Explanation of Symbols

GRI PAVEMENT LOG (LAT/LONG)-NO ELEV GRI DATA TEMPLATE.GDT 10/18/17

GRI

BORING B-2

DEC. 2017 JOB NO. 6024 FIG. 2A

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL **Surface Elevation:** Not Available	DEPTH, FT	SAMPLE NO.	SAMPLE TYPE	MOISTURE CONTENT, % FINES CONTENT, % LIQUID LIMIT, % PLASTIC LIMIT, % (0 – 50 – 100)	COMMENTS AND ADDITIONAL TESTS
		Asphalt concrete PAVEMENT (2.75 in.)		S-1			
		Sandy SILT, some subrounded gravel, brown to rust, medium stiff, fine- to coarse-grained sand	0.3	S-2		●	Petroleum odor detected in sample S-2
1							
2		SILT, some clay, trace to some fine- to coarse-grained sand, light brown, soft to medium stiff	2.0	S-3			
3		---some clay to clayey, trace sand below 3 ft		S-4			
4		---light brown mottled rust below 4 ft ---rust mottled light brown below 4.5 ft		S-5			
5		(9/6/2017) Groundwater not encountered	5.0				
6							
7							

◆ TORVANE SHEAR STRENGTH, TSF (0 – 0.5 – 1.0)

Logged By: B. Cook	**Excavated by:** Custom Hole Drilling, Inc.	**Equipment:** Dandy Digger 25-30T
Date Started: 9/6/17	**Coordinates:** Not Available	**Note:** See Legend for Explanation of Symbols

GRI PAVEMENT LOG (LAT/LONG)-NO ELEV GRI DATA TEMPLATE.GDT 10/18/17

GRI

BORING B-3

DEC. 2017 JOB NO. 6024 FIG. 3A

DEPTH, FT	GRAPHIC LOG	CLASSIFICATION OF MATERIAL **Surface Elevation:** Not Available	DEPTH, FT	SAMPLE NO.	SAMPLE TYPE	● MOISTURE CONTENT, % □ FINES CONTENT, % LIQUID LIMIT, % PLASTIC LIMIT, % 0 50 100	COMMENTS AND ADDITIONAL TESTS
		Asphalt concrete PAVEMENT (2.75 in.) over crushed rock BASE COURSE (2 in.)		S-1			
				S-2			
		Sandy clayey SILT, some subrounded gravel, brown to rust, medium stiff, fine- to coarse-grained sand	0.4				
1				S-3		●	
2		---trace to some gravel below 2 ft		S-4			
3							
		SILT, some fine- to coarse-grained sand, trace to some clay, light brown to brown, soft to medium stiff	3.5				
4				S-5			
5		(9/6/2017) Groundwater not encountered	5.0				
6							
7							

0 0.5 1.0

◆ TORVANE SHEAR STRENGTH, TSF

Logged By: B. Cook	**Excavated by:** Custom Hole Drilling, Inc.	**Equipment:** Dandy Digger 25-30T
Date Started: 9/6/17	**Coordinates:** Not Available	**Note:** See Legend for Explanation of Symbols

GRI PAVEMENT LOG (LAT/LONG)-NO ELEV GRI DATA TEMPLATE.GDT 10/18/17

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BORING B-4

DEC. 2017 JOB NO. 6024 FIG. 4A

BORING B-1 (PHOTOGRAPH TAKEN 9/6/17)

BORING B-2 (PHOTOGRAPH TAKEN 9/6/17)

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PAVEMENT PHOTOGRAPHS

DEC. 2017 JOB NO. 6024 FIG. 5A

BORING B-3 (PHOTOGRAPH TAKEN 9/6/17)

BORING B-4 (PHOTOGRAPH TAKEN 9/6/17)

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PAVEMENT PHOTOGRAPHS

DEC. 2017 JOB NO. 6024 FIG. 6A

APPENDIX B

FWD Deflection Data

Table 1B: FWD NORMALIZED DEFLECTION TEST DATA

Test Section:	S Ona Way
Start Point:	OR Hwy 211
Test Date:	9/6/2017
Test File:	6024 S Ona Way.fwd
Load Plate Radius, in:	5.91
Sensor Distance, in:	0 8 12 18 24 36 48 60 72

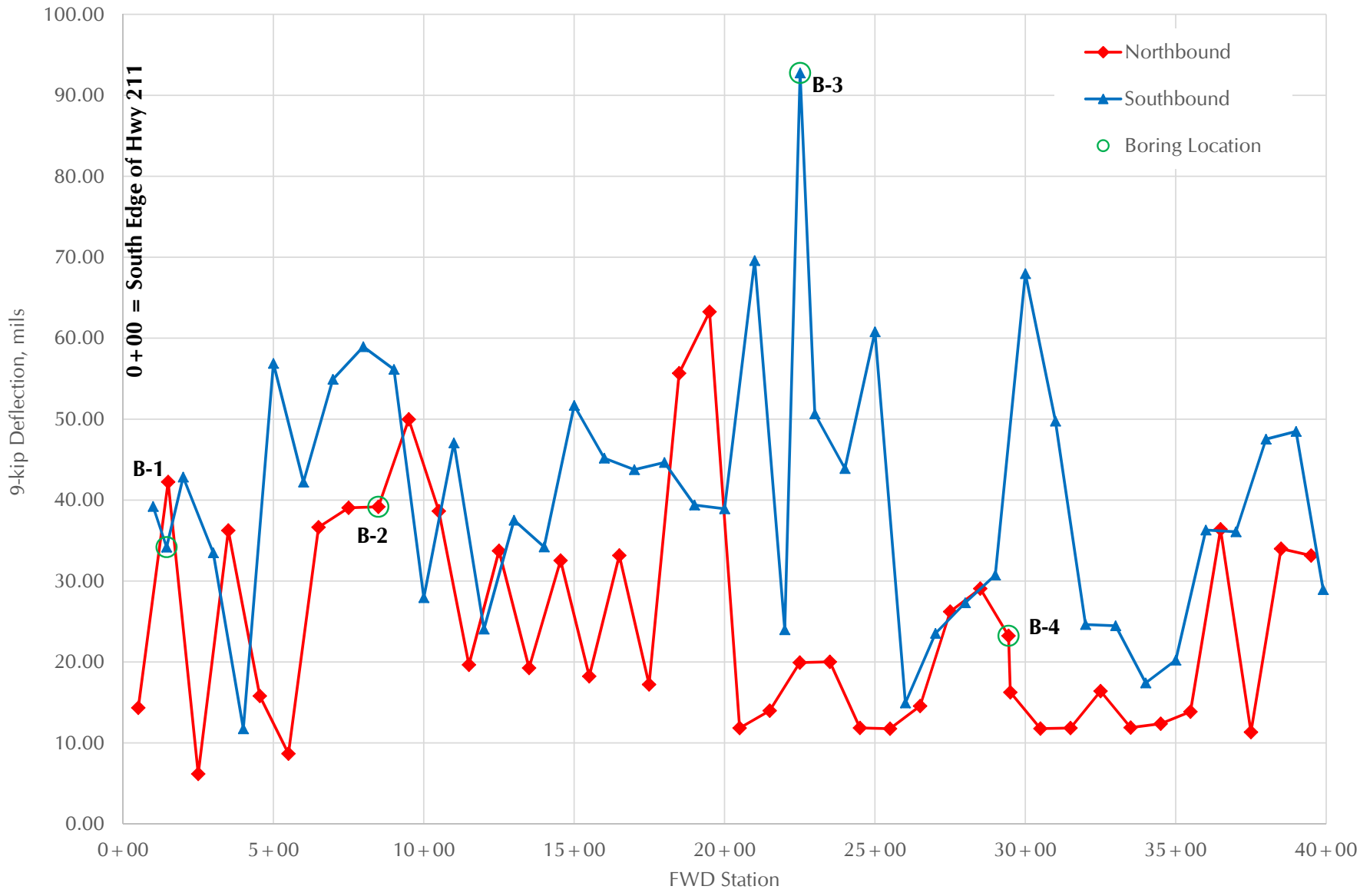
Deflections Normalized to 9000 lbf Basis

Test No.	Test Station	Test Line	D 0, mils	D 1, mils	D 2, mils	D 3, mils	D 4, mils	D 5, mils	D 6, mils	D 7, mils	D 8, mils	Surface Temp., °F	BELLS3 Mid-depth AC Temp., °F	68 °F Temp. Adj. D0, mils	Time	Surface Modulus, Ksi	Comments
1	1+00	SB	43.57	30.92	19.20	8.94	4.04	0.89	0.52	0.43	0.38	80	77	39.21	12:06:09	17	Start SB
2	1+45	SB	38.84	25.22	15.56	5.91	2.41	0.47	0.32	0.36	0.32	80	77	34.18	12:07:48	19	Boring B-1
3	2+00	SB	45.58	27.82	16.57	7.55	4.84	2.44	1.39	0.87	0.62	79	76	42.85	12:08:57	16	
4	3+00	SB	35.25	22.59	13.97	7.98	4.96	2.60	1.59	1.04	0.73	79	76	33.49	12:09:51	21	
5	4+00	SB	12.77	8.73	5.87	3.73	2.46	1.07	0.54	0.35	0.27	78	76	11.75	12:10:42	57	
6	5+00	SB	60.51	32.23	12.93	5.41	3.12	1.42	0.93	0.69	0.52	76	74	56.88	12:11:37	12	
7	6+00	SB	45.89	32.11	21.36	9.91	4.52	1.25	0.84	0.66	0.54	78	76	42.22	12:12:54	16	
8	6+98	SB	60.35	42.40	28.18	13.46	5.99	0.83	0.26	0.23	0.25	79	76	54.92	12:14:02	12	
9	7+99	SB	66.22	46.26	30.14	14.40	6.34	0.64	0.30	0.37	0.49	79	77	58.94	12:15:14	11	
10	9+01	SB	62.38	42.60	27.85	12.90	5.75	0.90	0.52	0.63	0.58	79	77	56.14	12:16:39	12	
11	10+00	SB	30.05	21.15	15.57	9.51	5.77	1.93	0.82	0.56	0.49	79	77	27.95	12:17:33	24	
12	11+00	SB	50.06	33.47	24.02	12.92	6.56	1.70	0.76	0.56	0.46	77	75	47.06	12:18:29	15	
13	12+00	SB	25.60	17.37	12.14	7.65	5.16	2.79	1.76	1.17	0.82	79	77	24.06	12:19:24	28	
14	13+00	SB	39.91	27.02	17.98	9.68	5.74	2.54	1.49	0.98	0.74	80	77	37.52	12:20:21	18	
15	14+00	SB	36.40	27.90	21.07	12.87	8.07	2.86	1.29	0.75	0.58	79	77	34.22	12:21:17	20	
16	15+00	SB	54.99	42.15	30.73	17.43	9.02	2.47	1.26	1.00	0.92	80	77	51.69	12:22:55	13	
17	16+00	SB	48.06	33.21	21.19	10.79	5.38	2.04	1.31	0.96	0.76	78	76	45.18	12:23:50	15	
18	17+00	SB	47.05	32.49	22.32	11.42	6.25	2.05	1.19	0.86	0.70	80	77	43.76	12:24:43	15	
19	18+00	SB	47.00	33.60	22.92	13.12	6.92	2.56	1.42	1.01	0.83	78	76	44.65	12:25:50	15	
20	19+00	SB	41.46	30.70	22.72	13.63	7.83	2.65	1.20	0.78	0.61	78	76	39.39	12:26:45	18	
21	20+00	SB	41.41	32.16	24.13	14.08	8.20	3.03	1.55	0.97	0.78	79	77	38.93	12:27:42	18	
22	21+00	SB	73.24	50.76	34.66	19.08	9.64	3.02	2.07	1.55	1.34	78	76	69.58	12:28:37	10	
23	22+00	SB	24.72	18.29	14.01	9.96	7.70	5.16	3.77	2.82	2.22	77	75	23.98	12:29:50	29	
24	22+51	SB	96.63	46.80	24.22	10.85	6.61	4.16	2.86	2.06	1.61	79	77	92.76	12:31:10	8	Boring B-3
25	23+00	SB	52.76	38.62	28.50	16.76	11.82	5.84	3.60	2.48	1.96	81	78	50.65	12:32:23	14	
26	24+00	SB	46.70	31.24	19.40	10.21	6.43	2.98	1.89	1.45	1.23	80	77	43.90	12:33:19	16	
27	25+00	SB	65.37	44.24	25.93	10.74	5.59	1.78	0.98	0.80	0.73	80	77	60.79	12:34:20	11	
28	26+01	SB	16.24	10.75	7.41	4.92	3.33	1.73	1.08	0.74	0.62	81	78	14.94	12:35:17	45	
29	27+01	SB	25.04	17.13	12.17	8.33	6.16	4.04	2.84	2.11	1.65	82	79	23.54	12:36:15	29	
30	28+00	SB	28.46	20.15	15.29	11.38	8.29	5.05	3.62	2.81	2.25	81	78	27.32	12:37:12	26	
31	29+00	SB	32.37	19.34	11.47	6.45	4.31	2.72	2.03	1.54	1.29	77	75	30.75	12:38:09	22	
32	30+00	SB	71.56	47.17	29.27	16.65	10.41	4.55	2.67	1.90	1.60	80	78	67.98	12:39:02	10	
33	31+00	SB	54.68	34.03	21.40	11.05	6.33	2.67	1.68	1.26	1.00	84	81	49.76	12:40:00	13	
34	32+00	SB	26.76	15.43	8.62	5.17	3.92	2.67	2.00	1.52	1.28	83	80	24.62	12:40:54	27	
35	33+00	SB	25.77	16.41	11.41	7.16	5.07	3.11	2.36	1.84	1.47	79	77	24.48	12:41:50	28	
36	34+00	SB	18.15	11.70	8.31	5.96	4.84	3.48	2.42	1.64	1.34	77	75	17.42	12:42:43	40	
37	35+00	SB	21.52	13.95	9.32	5.95	4.14	2.47	1.73	1.37	1.15	78	76	20.23	12:43:38	34	
38	36+00	SB	38.62	27.53	20.49	12.86	8.42	3.78	2.36	1.74	1.38	83	80	36.30	12:44:33	19	
39	37+00	SB	38.38	23.88	15.67	10.22	7.00	3.46	2.12	1.56	1.29	82	79	36.08	12:45:29	19	
40	38+00	SB	51.11	33.90	21.98	11.10	6.09	2.29	1.44	1.05	0.86	81	78	47.53	12:46:29	14	
41	39+00	SB	51.04	33.35	22.72	13.37	8.65	3.84	2.22	1.45	1.08	79	77	48.49	12:47:34	14	
42	39+90	SB	31.12	21.91	15.14	8.92	5.55	2.70	1.70	1.23	0.96	82	79	28.94	12:49:29	23	Final SB Test Turn around started. Turn around done.
43	39+50	NB	36.03	26.06	18.98	11.62	7.02	2.66	1.51	1.03	0.82	83	80	33.15	12:52:51	20	Start NB Testing
44	38+50	NB	36.17	22.41	14.61	8.38	5.20	2.75	1.95	1.43	1.13	79	77	34.00	12:54:02	20	
45	37+50	NB	12.06	8.69	6.03	4.30	3.19	1.99	1.39	1.06	0.88	78	76	11.34	12:54:54	60	
46	36+49	NB	38.70	27.69	18.95	10.67	6.96	3.30	2.16	1.63	1.31	82	79	36.38	12:55:58	19	
47	35+49	NB	14.74	9.16	6.37	4.35	3.42	2.45	1.82	1.40	1.21	78	76	13.86	12:56:59	49	
48	34+50	NB	13.16	9.28	6.85	4.51	3.33	2.13	1.52	1.16	0.91	78	76	12.37	12:57:58	55	

Table 1B: FWD NORMALIZED DEFLECTION TEST DATA

Deflections Normalized to 9000 lbf Basis

Test No.	Test Station	Test Line	D 0, mils	D 1, mils	D 2, mils	D 3, mils	D 4, mils	D 5, mils	D 6, mils	D 7, mils	D 8, mils	Surface Temp., °F	BELLS3 Mid-depth AC Temp., °F	68 °F Temp. Adj. D0, mils	Time	Surface Modulus, Ksi	Comments
49	33+50	NB	12.53	9.68	8.00	6.16	4.84	2.78	2.06	1.55	1.21	77	76	11.90	12:58:48	58	
50	32+50	NB	17.63	12.04	9.13	6.37	4.80	3.00	2.16	1.78	1.38	83	80	16.40	12:59:51	41	
51	31+50	NB	13.31	8.96	6.37	4.29	3.24	2.04	1.46	1.12	0.93	86	82	11.85	13:00:49	55	
52	30+50	NB	12.93	7.87	5.56	4.02	3.09	2.14	1.61	1.26	1.02	83	80	11.77	13:01:39	56	
53	29+50	NB	17.30	11.95	9.18	6.14	4.48	2.76	1.84	1.44	1.20	79	77	16.26	13:02:39	42	
54	29+44	NB	24.46	16.21	11.86	7.97	5.65	3.22	2.24	1.72	1.39	79	77	23.24	13:03:26	30	Boring B-4
55	28+50	NB	29.96	22.25	18.28	13.76	10.20	5.55	3.79	2.67	2.06	77	76	29.06	13:04:27	24	
56	27+50	NB	27.90	19.12	13.73	9.08	6.38	3.82	2.72	2.11	1.68	82	79	26.23	13:05:27	26	
57	26+50	NB	15.49	11.41	9.36	7.63	6.46	4.02	3.24	2.53	2.02	81	79	14.56	13:06:21	47	
58	25+50	NB	12.92	8.79	6.27	4.23	2.93	1.43	0.89	0.65	0.51	80	78	11.76	13:07:13	56	
59	24+50	NB	13.03	8.50	6.19	3.97	2.64	1.64	1.17	0.86	0.71	81	79	11.86	13:08:13	56	
60	23+50	NB	21.08	13.11	9.51	7.11	5.53	3.62	2.77	2.17	1.81	80	78	20.03	13:09:07	34	
61	22+50	NB	20.98	14.97	12.16	9.49	7.89	5.12	3.19	2.22	1.80	84	81	19.93	13:10:03	35	
62	21+50	NB	15.04	9.91	7.47	5.32	3.78	2.21	1.64	1.40	1.16	80	78	13.99	13:10:54	48	
63	20+50	NB	12.87	8.52	6.04	4.08	2.93	1.60	1.16	0.92	0.76	79	77	11.84	13:11:50	56	
64	19+50	NB	70.29	48.06	33.12	15.97	8.12	2.14	1.14	0.91	0.79	85	82	63.26	13:12:46	10	
65	18+49	NB	62.55	42.13	28.09	13.36	7.01	2.16	1.42	1.14	0.91	86	83	55.67	13:13:43	12	
66	17+49	NB	18.72	12.74	9.76	7.00	5.21	2.71	1.51	0.94	0.73	83	80	17.22	13:14:46	39	
67	16+50	NB	38.11	26.33	17.90	9.26	5.19	2.00	1.15	0.78	0.59	89	85	33.16	13:15:46	19	
68	15+50	NB	20.04	13.76	9.21	5.84	3.89	2.23	1.47	1.06	0.80	83	80	18.24	13:16:43	36	
69	14+55	NB	35.37	26.54	19.71	13.09	8.32	3.74	1.76	0.97	0.71	87	83	32.54	13:17:49	21	
70	13+50	NB	21.64	15.30	11.31	7.53	5.27	2.74	1.70	1.17	0.88	89	85	19.26	13:18:40	34	
71	12+50	NB	35.89	27.44	21.47	14.96	10.71	5.65	3.17	1.87	1.29	89	85	33.74	13:19:33	20	
72	11+50	NB	21.60	15.70	12.16	8.31	5.83	2.74	1.44	0.85	0.68	85	82	19.66	13:20:27	34	
73	10+50	NB	42.46	31.85	23.62	14.74	8.08	2.10	0.89	0.66	0.56	82	80	38.64	13:21:18	17	
74	9+50	NB	54.91	41.13	30.43	19.27	12.22	3.92	1.39	0.79	0.75	89	85	49.97	13:22:15	13	
75	8+49	NB	44.51	31.70	23.46	14.37	8.67	2.73	1.22	0.91	0.79	88	84	39.17	13:23:50	16	Boring B-2
76	7+50	NB	44.89	32.83	22.84	12.30	6.72	2.07	0.97	0.65	0.53	90	86	39.05	13:25:00	16	
77	6+50	NB	41.18	29.89	21.55	12.40	7.40	2.60	1.30	0.85	0.64	89	85	36.65	13:26:01	18	
78	5+50	NB	9.63	6.36	4.77	3.42	2.53	1.41	0.93	0.64	0.41	81	79	8.67	13:27:06	76	
79	4+55	NB	17.57	13.20	9.79	6.74	4.69	2.10	1.14	0.69	0.50	83	81	15.81	13:28:21	41	
80	3+50	NB	39.83	27.87	19.88	12.15	7.88	3.41	1.78	0.99	0.66	88	84	36.25	13:29:24	18	
81	2+50	NB	7.09	5.15	4.06	3.10	2.49	1.74	1.31	1.00	0.76	88	84	6.17	13:30:32	103	
82	1+50	NB	52.81	32.08	19.09	6.14	2.71	0.70	0.53	0.51	0.43	89	85	42.25	13:31:30	14	
83	0+51	NB	18.15	10.54	5.45	3.21	1.79	0.79	0.67	0.55	0.42	91	87	14.34	13:32:31	40	Final NB Test. On repair patch



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9-KIP NORMALIZED DEFLECTIONS

DEC. 2017 JOB NO. 6024 FIG. 1B

APPENDIX C

Traffic and Pavement Design Calculations

Table 1C: SUMMARY OF TRAFFIC LOADING ANALYSIS - S ONA WAY

Road:	S Ona Way
Direction:	Southbound
Lane:	Travel
Date of Count:	8/2/2017
Duration, hrs:	24
Lane Factor:	1

Duration	Vehicle Class 1	2	3	4	5	6	7	8	9	10	11	12	13	Total 1-Way 24-hr ESAL's	1-way ESAL Repetitions with 1% Annual Growth Rate 20-yrs
24-hour Count Total	1	139	33	0	18	2.25	0	0	0	1	0	0	0		
ODOT Flexible Pavement 1-way ESAL Factor	0	0	0	246	104	284	757	253	466	561	603	546	1037		
24 hour ESAL's (flexible factor)	0.0	0.0	0.0	0.0	5.1	1.8	0.0	0.0	0.0	1.5	0.0	0.0	0.0	8.3	67,070

Road:	S Ona Way
Direction:	Northbound
Lane:	Travel
Date of Count:	8/2/2017
Duration, hrs:	24
Lane Factor:	1

Duration	Vehicle Class 1	2	3	4	5	6	7	8	9	10	11	12	13	Total 1-Way 24-hr ESAL's	1-way ESAL Repetitions with 1% Annual Growth Rate 20-yrs
24-hour Count Total	0	147	33.75	0	20	2.75	0	0	0	1	0	0	0		
ODOT Flexible Pavement 1-way ESAL Factor	0	0	0	246	104	284	757	253	466	561	603	546	1037		
24 hour ESAL's (flexible factor)	0.0	0.0	0.0	0.0	5.6	2.1	0.0	0.0	0.0	1.5	0.0	0.0	0.0	9.2	74,204

Recommended 20-Year Design Traffic Loading:	74,200	ESAL's

Note: FHWA Classified Traffic Counts were Conducted by Clackamas County

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Table 2C: S ONA WAY - BACKCALCULATION ANALYSIS RESULTS

Based on FWD Testing Conducted: 9/6/17
Distance Reference: 0+00 South Edge of Hwy 211

Overlay Analysis Parameters:

Design Life, yrs:	20	Design Reliability, %	80	Initial Serviceability:	4.20
Traffic Loading, ESAL Repetitions:	74,200	Standard Deviation	0.5	Terminal Serviceability:	2.50

				Structural Characteristics				
Test No.	**Test Station**	**Direction**	**Unit**	**D0, mils**	**Asphalt Concrete (AC) Thickness, in.**	**Aggregate Base (AB) Thickness, in.**	**Subgrade M_r at 6 psi deviator stress, psi**	**SNeff of Existing Pavement Above SG**
1	1+00	SB	1	43.57	3.00	2.50	5,670	0.91
2	1+45	SB	1	38.84	2.50	3.00	6,683	0.84
3	2+00	SB	1	45.58	3.00	2.50	7,838	0.97
4	3+00	SB	1	35.25	3.00	2.50	9,502	1.09
5	4+00	SB	1	12.77	3.00	2.50	17,856	2.11
6	5+00	SB	High RSME	60.51	3.00	2.50	9,318	0.67
7	6+00	SB	1	45.89	3.00	2.50	2,766	1.42
8	6+98	SB	1	60.35	3.00	2.50	2,994	0.95
9	7+99	SB	1	66.22	3.00	2.50	2,533	0.96
10	9+01	SB	1	62.38	3.00	2.50	3,267	0.90
11	10+00	SB	1	30.05	3.00	2.50	8,607	1.16
12	11+00	SB	High RSME	50.06	3.00	2.50	8,006	0.58
13	12+00	SB	1	25.60	3.00	2.50	10,504	1.55
14	13+00	SB	1	39.91	3.00	2.50	5,848	1.29
15	14+00	SB	1	36.40	3.00	2.50	1,984	1.97
16	15+00	SB	1	54.99	3.00	2.50	1,334	1.55
17	16+00	SB	1	48.06	3.00	2.50	4,291	1.21
18	17+00	SB	1	47.05	3.00	2.50	2,800	1.53
19	18+00	SB	1	47.00	3.00	2.50	3,191	1.42
20	19+00	SB	1	41.46	3.00	2.50	2,158	1.72
21	20+00	SB	1	41.41	3.00	2.50	3,095	1.52
22	21+00	SB	1	73.24	3.00	2.50	1,577	1.31
23	22+00	SB	1	24.72	3.00	2.50	8,236	2.08
24	22+51	SB	1	96.63	2.75	0.00	5,211	0.62
25	23+00	SB	1	52.76	3.00	2.50	5,673	1.02

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Table 2C: S ONA WAY - BACKCALCULATION ANALYSIS RESULTS

				Structural Characteristics				
Test No.	Test Station	Direction	Unit	D0, mils	Asphalt Concrete (AC) Thickness, in.	Aggregate Base (AB) Thickness, in.	Subgrade M_r at 6 psi deviator stress, psi	SNeff of Existing Pavement Above SG
26	24+00	SB	1	46.70	3.00	2.50	7,419	0.95
27	25+00	SB	1	65.37	3.00	2.50	3,032	1.13
28	26+01	SB	1	16.24	3.00	2.50	14,881	2.19
29	27+01	SB	1	25.04	3.00	2.50	15,352	1.13
30	28+00	SB	1	28.46	3.00	2.50	9,080	1.79
31	29+00	SB	1	32.37	3.00	2.50	13,618	0.87
32	30+00	SB	1	71.56	3.00	2.50	3,114	0.00
33	31+00	SB	1	54.68	3.00	2.50	4,650	1.23
34	32+00	SB	1	26.76	3.00	2.50	19,713	0.74
35	33+00	SB	1	25.77	3.00	2.50	15,288	1.06
36	34+00	SB	High RSME	18.15	3.00	2.50	6,018	3.38
37	35+00	SB	1	21.52	3.00	2.50	17,708	1.14
38	36+00	SB	1	38.62	3.00	2.50	4,018	1.76
39	37+00	SB	1	38.38	3.00	2.50	6,524	1.43
40	38+00	SB	1	51.11	3.00	2.50	3,841	1.31
41	39+00	SB	1	51.04	3.00	2.50	3,832	0.00
42	39+90	SB	1	31.12	3.00	2.50	7,552	1.45
43	39+50	NB	1	36.03	3.00	2.50	3,348	1.84
44	38+50	NB	1	36.17	3.00	2.50	8,846	1.23
45	37+50	NB	1	12.06	3.00	2.50	22,825	2.16
46	36+49	NB	1	38.70	3.00	2.50	8,124	1.10
47	35+49	NB	1	14.74	3.00	2.50	22,178	2.18
48	34+50	NB	1	13.16	3.00	2.50	23,720	1.77
49	33+50	NB	1	12.53	3.00	2.50	13,208	2.71
50	32+50	NB	1	17.63	3.00	2.50	17,481	1.71
51	31+50	NB	1	13.31	3.00	2.50	26,329	1.84
52	30+50	NB	1	12.93	3.00	2.50	24,198	2.49
53	29+50	NB	1	17.30	3.00	2.50	12,987	2.22
54	29+44	NB	1	24.46	2.75	2.00	11,094	1.74
55	28+50	NB	1	29.96	3.00	0.00	5,428	1.96
56	27+50	NB	1	27.90	3.00	2.50	11,727	1.32
57	26+50	NB	1	15.49	3.00	2.50	12,718	2.66
58	25+50	NB	1	12.92	3.00	2.50	14,505	2.53
59	24+50	NB	1	13.03	3.00	2.50	22,554	1.96

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Table 2C: S ONA WAY - BACKCALCULATION ANALYSIS RESULTS

				Structural Characteristics				
Test No.	Test Station	Direction	Unit	D0, mils	Asphalt Concrete (AC) Thickness, in.	Aggregate Base (AB) Thickness, in.	Subgrade M_r at 6 psi deviator stress, psi	SNeff of Existing Pavement Above SG
60	23+50	NB	1	21.08	3.00	2.50	17,357	1.90
61	22+50	NB	1	20.98	3.00	2.50	4,927	3.00
62	21+50	NB	1	15.04	3.00	2.50	17,799	2.24
63	20+50	NB	1	12.87	3.00	2.50	19,339	2.36
64	19+50	NB	1	70.29	3.00	2.50	1,369	1.47
65	18+49	NB	1	62.55	3.00	2.50	2,153	1.45
66	17+49	NB	1	18.72	3.00	2.50	4,987	2.89
67	16+50	NB	1	38.11	3.00	2.50	4,772	1.62
68	15+50	NB	1	20.04	3.00	2.50	15,659	1.46
69	14+55	NB	1	35.37	3.00	2.50	1,717	2.40
70	13+50	NB	1	21.64	3.00	2.50	9,269	2.22
71	12+50	NB	1	35.89	3.00	2.50	1,639	2.45
72	11+50	NB	1	21.60	3.00	2.50	3,556	2.77
73	10+50	NB	1	42.46	3.00	2.50	1,945	1.73
74	9+50	NB	Outlier	54.91	3.00	2.50	537	2.18
75	8+49	NB	1	44.51	4.00	5.00	1,985	1.92
76	7+50	NB	1	44.89	3.00	2.50	3,028	1.66
77	6+50	NB	1	41.18	3.00	2.50	3,319	1.73
78	5+50	NB	1	9.63	3.00	2.50	23,765	2.78
79	4+55	NB	1	17.57	3.00	2.50	14,870	1.60
80	3+50	NB	1	39.83	3.00	2.50	2,000	2.26
81	2+50	NB	High RSME	7.09	3.00	2.50	15,754	4.85
82	1+50	NB	High RSME	52.81	3.00	2.50	7,308	0.68
83	0+51	NB	1	18.15	3.00	2.50	18,117	2.12

Design Subgrade Resilient Modulus for Reconstruction

Structural Unit #	Lane	Average AC Thickness (inch)	Average AB Thickness (inch)	SNeff of Existing Pavement Above SG	Average Subgrade Modulus, psi	Std Dev Subgrade Modulus, psi	15th Percentile Subgrade Modulus, psi	Design Subgrade Modulus, psi
1	Both	3.00	2.47	1.63	9,196	7,044	2,626	2,600

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Table 3C: PAVEMENT DESIGN WORKSHEET FOR CONSTRUCTION WITH SUBGRADE STABILIZATION WITH GEOTEXTILE

Project Segment: S Ona Way
Design Alternative 1: Geotextile Reinforced Working Platform

AASHTO Design Parameters & Input Values:		**Notes**
Design Period, Yrs:	20	
Cumulative ESAL Repetitions:	74,200	
Design Reliability:	80	
Overall Standard Deviation, S_o:	0.5	
Initial Serviceability, P_o:	4.2	
Terminal Serviceability, P_t:	2.5	
Effective Subgrade M_r, psi:	2,600	
Aggregate Base Backfill Modulus, psi:	7,763	per Dorman and Metcalf Procedure
Aggregate Base Modulus, psi:	20,000	per ODOT Pavement Design Guide
Asphalt Concrete (AC) Layer Coefficient:	0.42	per AASHTO Guide
Aggregate Base (AB) Layer Coefficient:	0.10	per AASHTO Guide
AB Drainage Coefficient:	1.0	
Minimum AB thickness on geotextile for support of construction, in.:	16.0	per Giroud & Han procedure
SN required above subgrade:	3.20	
SN required above AB:	1.43	

Denotes user data field

Denotes calculated field

Pavement Section

Layer Description	Thickness, in.	Layer Coeff.	SN	SN Subtotals	Notes
Level 2, 1/2-inch ACP	2.00	0.42	0.84		PG 64-22
Level 2, 1/2-inch ACP	2.00	0.42	0.84	1.68	>1.43 required above AB - OK
3/4"-0 Aggregate Base Backfill	16.00	0.10	1.60	3.28	>3.20 required above subgrade - OK
Geotextile	NA				
Total Depth	20.00				

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Table 4C: PAVEMENT DESIGN WORKSHEET FOR FULL DEPTH RECONSTRUCTION WITH CEMENT

Project Segment: S Ona Way
Design Alternative 2: Full Depth Reclimation with Cement

AASHTO Design Parameters & Input Values:		Notes
Design Period, Yrs:	20	
Cumulative ESAL Repetitions:	74,200	
Design Reliability:	80	
Overall Standard Deviation, S_o:	0.5	
Initial Serviceability, P_o:	4.2	
Terminal Serviceability, P_t:	2.5	
Effective Subgrade M_r, psi:	2,600	
Aggregate Base Modulus, psi:	20,000	
Asphalt Concrete (AC) Layer Coefficient:	0.42	per AASHTO Guide
Aggregate Base (AB) Layer Coefficient:	0.10	per AASHTO Guide
Cement Treated Material (CTM) Layer Coefficient:	0.13	per AASHTO Guide
AB Drainage Coefficient:	1.0	
SN required above subgrade:	3.20	

Denotes user data field

Denotes calculated field

Pavement Section

Layer Description	Thickness, in.	Layer Coeff.	SN	SN Subtotals	Notes
Level 2, 1/2-inch ACP	2.00	0.42	0.84		PG 64-22
Level 2, 1/2-inch ACP	2.00	0.42	0.84		
Cement Treated Layer	12.00	0.13	1.56	3.24	>3.20 required above subgrade - OK
Total Depth	16.00				

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APPENDIX D

ODOT Special Provisions:
ODOT Section 00644 - FDR with portland cement
ODOT Section 00710 - Single application emulsified asphalt surface treatment

SECTION 00644 – FULL DEPTH RECLAMATION WITH PORTLAND CEMENT (FDR)

Section 00644, which is not a Standard Specification, is included in this Project by Special Provision.

Description

00644.00 - Scope - This work, full depth reclamation (FDR) with cement, consists of pulverizing and mixing existing in-place asphalt pavement and base course material with portland cement, soil, water, and if specified, supplementary base aggregate to produce a dense and hard cement treated base. The mixture shall be proportioned, mixed, placed, graded, compacted, and cured in accordance with the specifications, and shall conform to the lines, grades, thicknesses on the plans.

00644.01 – Definitions

Maximum Density - Maximum dry density as established by AASHTO T-134.

Optimum Moisture - Moisture content of compacted cement treated material corresponding to the maximum density as established by the above described test methods.

Field Density - Dry density of in-place materials as measured by nuclear densometer in accordance with ASTM D 2922.

Field Moisture Content - Moisture content of in-place cement treated materials as measured by nuclear gage in accordance with ASTM D 3017.

Degree of Compaction and Percent Compaction - Ratio of field density to maximum density, expressed as a percentage.

Materials

00644.10 – Mixed Material – The pulverized mixture of existing asphalt pavement, existing underlying material, supplementary aggregate, and cement. The mixed material shall not contain roots, topsoil, or any other material deleterious to its reaction with the cement. The gradation/particle distribution of the processed mixture shall be 100% passing a 3-inch sieve, at least 95% passing a 2-inch sieve, and 85% passing a 1.5-inch sieve. The moisture content of the processed mixture material shall be within 2 percent of the optimum moisture content at the start of compaction.

00644.11 – Mix Design - Portland cement shall be applied at the rate determined by the Engineer in percent of the dry weight of the material based upon the treatment depth in order to achieve a seven day strength between 200psi and 400psi.

00644.12 – Supplementary Aggregate - If supplementary aggregate is specified, supplement aggregate shall meet dense-graded base aggregate specified in Sections 00641 and 02630.10.

00644.13 – Portland cement - shall meet the requirements of AASHTO M 85 and Section 02010.

00644.14 – Water - The water shall meet the requirements of Section 00340 and shall be free from substances deleterious to the hardening of cement treated material.

00644.15 – Curing Seal - The cure seal shall be a chip seal. The emulsified asphalt shall be either CRS-1 or CRS-2, as designated, and conform to the requirements of Section 00710. The cover aggregate shall conform to the requirements of Section 00710 and shall be ¼" - #10 size.

Equipment

00644.20 – Road Reclaimer/Soil Stabilizer – shall be a self-propelled, traveling single-shaft or multiple-shaft drum mixer capable of cutting through existing bituminous concrete pavement and mixing to a minimum depth of up to 12-inches with one pass. The road reclaimer/soil stabilizer cutting and mixing drum shall be capable of adjustment to conform to the slopes of the existing pavement. Cutting drums shall have both automatic and manual depth control capabilities at each corner. The road reclaimer/soil stabilizer's cutting drum(s) shall have variable rotating speeds to ensure the capability of dealing with different material types and thicknesses. The road reclaimer/soil stabilizer shall have a rear door of the mixing pulverization chamber or other device that will strike off the reclaimed material in a generally smooth and level shape in preparation of the initial compaction.

The road reclaimer/soil stabilizer shall have independent and interlocking systems for water and must include a digital electronic controller system, pumping system, and spray bar system. The road reclaimer/soil stabilizer shall also have a working water system capable of bringing the mixture to optimum moisture content. The road reclaimer/soil stabilizer shall be capable of pulverizing and mixing existing pavement and road base in place.

Equipment such as road planers or cold milling machines designed to mill or shred existing bituminous concrete, rather than crush or fracture it, shall not be allowed. Agricultural disks or motor graders are not acceptable mixing equipment.

00644.21 – Water Storage Equipment – The water storage equipment shall not leak and shall attach to the road reclaimer/soil stabilizer with a tow bar and hose.

00644.22 – Cement Spreader – spreading of portland cement shall be done with a spreader truck designed to spread dry particulate such as portland cement to insure uniform distribution across the width of the spread. The cement spreading equipment shall be in good working condition and shall be equipped with a metering device and travel speed indicator capable of accurately metering and uniformly spreading the required amount of portland cement on the grade. Spreading by blade or pneumatically pressurized pipe spreader will not be permitted.

00644.23 – Tamping Foot Roller – shall be a self-propelled and reversible and capable of an adjustable frequency and amplitude up to 15 tons of force in vibratory mode. The tamping foot roller shall have a minimum drum width of 84-inches with a minimum of 112 tamping feet that are a minimum of 3-inches high, and a minimum of 17-square inches per foot.

00644.24 – Grading Equipment – shall be a motor grader with a minimum of a 2-foot-high by 12-foot-wide mold board. The motor grader shall have cross slope indicators.

00644.24 – Vibratory Roller – shall be a self-propelled and reversible and capable of an adjustable frequency and amplitude up to 15 tons of force in vibratory mode. The vibratory steel drum roller shall have a minimum single drum width of 84 inches.

Labor

00644.30 – Quality Control Personnel – provide technicians having CDT technical certifications.
Construction

Construction

00644.39 – Job Conditions – Do not perform cement treated base work during or in any of the following conditions: periods of rain, on frozen soil, when air temperatures are below 40ºF or if air temperatures lower than 40ºF are anticipated during the cure period. Do not apply cement during windy conditions.

00644.40 – Preparation – Prior to the commencement of reclamation process, all utility and drainage features shall be relocated as necessary or marked and necessary care taken to avoid damaging any existing utilities and/or drainage features.

Methods, equipment, tools, and any machinery to be used during construction shall be approved by the engineer prior to the start of the project. The contractor shall schedule an on-site Full-Depth Reclamation pre-construction conference.

Prior to the actual reclaiming of the roadway, inlets, catch basins, and ditches need to be protected to prevent reclaimed subbase material, silt, or runoff from entering existing drainage features/systems. Sufficient surface drainage must be provided for each stage of construction so that ponding does not occur on the reclaimed subbase course prior to placement of bituminous asphalt concrete. The Contractor shall maintain all frames, grates, covers, metal inlets, valve boxes and other like structures that are designated to remain in the final work and shall provide for the safe flow of traffic around such structures. Any such structures damaged during the work shall be repaired at the expense of the Contractor.

In areas where the vertical or horizontal geometry of the proposed roadway is different from that of the existing, the roadway shall be reclaimed in-place and the reclaimed material subbase placed in windrows or stockpiled while any filling or excavation is performed. If windowing or stockpiling is to be stored adjacent to the shoulder, clear and dispose of the weeds, grass, and debris from the storage area. When the proposed subgrade elevation is achieved, the reclaimed subbase material will be placed back onto the roadway in lifts no greater than 6 inches thick before being compacted.

Reshaping using the reclaimed subbase material should be minimized in order to insure that the roadway has a uniform thickness of reclaimed subbase throughout. Unless otherwise specified, when reshaping of the roadway is required, it should be performed utilizing additional subbase or processed aggregate base, The reclaimed subbase material shall be compacted prior to the placement of any additional granular material used (subbase or processed aggregate base). Subsequent to the compaction of the reclaimed subbase material, any reshaped material or additional material placed on the roadway should not exceed 6 inches thick before being compacted.

The reclaimed subbase material shall be compacted to the requirements above prior to the placement of traffic on the roadway.

A motor grader shall be used for shaping, fine grading, finishing the surface of the reclaimed material or any other granular materials placed to form the surface prior to paving.

Any surface irregularities which develop during or after the above described work shall be corrected until it is brought to a firm and uniform surface satisfactory to the Engineer.

00644.41 – **Mixing and Placing Sequence** – FDR construction occurs in three stages. Stage one pulverizes the existing roadway and shaping the roadway to compacted base grades (minus cement volume). Stage two incorporates, mixes, the cement into the prepared compacted roadway to final base grades. Stage three cures the newly constructed roadway with a chip seal treatment per the specifications and Section 00710.

00644.42 – **Pulverizing** – Before cement is applied, initial pulverization shall be to the full mixing depth and all pulverized material shall pass a 2-inch sieve.

Do not pulverize more material than can be mixed with cement and compacted in one day.

Do not leave a wedge where the pulverizing drum cuts into the existing material. The first cut width must use the full width of the pulverizing drum. Subsequent cuts shall overlap at least 4 inches. Do not leave gap of unpulverized material between cuts. If an overlap of more than 4 inches occurs, immediately adjust. If an overlap is less than 4 inches, immediately back up and pulverize the deviation along the correct cut line.

Mark the existing pavement where the center of the pulverizing drum stops. Start the following cut on this alignment at least 2 feet behind the mark.

The surface of the pulverized material shall then be brought to the uniform grades and cross sections, adjusting the grade and crown of the roadway to utilize all available materials wherever possible or as shown on the plans for the final FDR grades (minus cement volume) and then compacted to specifications prior to adding cement. The grade of the material shall be set to allow for placement of the specified thickness of asphalt concrete surfacing to produce a finished surface at the designated height above any existing pavement surfaces.

If the Engineer determines excess pulverized material is generated, these excessive pulverized material shall be disposed of at an approved dump site. Excessive pulverized material located throughout the project shall be removed at the direction of the Engineer prior to addition of cement.

The County makes no representation as the type and size of the material that may be encountered in the existing roadway. If unstable subgrade or rocks greater than 3 inches in the roadway section are encountered, notify the Engineer immediately. The Engineer will determine the extent of the problem and the corrective measures to be taken.

00644.43 – **Spreading of Stabilization Materials** – Chemical stabilization material under this contract shall be cement. A mechanical cement spreader is required. Apply the cement at the spread rate required to achieve the specified percent cement content based on the dry weight of the material in the full depth of the base. The applied percent content of cement shall be within minus 1 percentage point of the specified content. The cement shall be applied uniformly over the full roadway surface width in a manner to minimize dust and is satisfactory to the Engineer. Do not

spread cement more than 30 minutes before mixing. Do not apply dry cement in windy conditions that will result in dust outside the work area.

Mechanical stabilization material is supplementary aggregate. Supplementary aggregate will only be used on the project if called out for in the plans and/or bid item list. Spread supplementary aggregate in compliance with the mix design and/or direction of the Engineer. Spread supplementary aggregate over the full roadway width. Do not spread supplementary aggregate before pulverizing the existing roadway.

00644.44 – **Mixing** – Complete all mixing, compaction, and finishing within 2 hours from the time the cement is spread. If this work is not completed within this time period, the cement treated material shall be re-pulverized and re-treated with cement at the expense of the Contractor.

Add water during mixing operations as necessary to raise the moisture content of the cement treated mixture to within 0 to plus 2 percentage points of optimum moisture content. Maintain this moisture content until mixing is completed.

Mixing shall begin as soon as possible after the cement has been spread and shall continue until a homogeneous mixture is obtained. Mixing shall continue until the mixture is uniform in color, free of streaks or pockets of cement, meets the gradation requirements, and the required moisture content throughout. The entire operation of cement spreading, water application, and mixing shall result in a uniform pulverized asphalt, soil, cement, and water mixture for the full design depth and width of the roadway. Any processed material that has not been compacted and finished shall not be left undisturbed for longer than 30 minutes.

Do not leave a wedge where the mixing drum cuts into the existing material. The first cut width must use the full width of the mixing drum. Subsequent cuts shall overlap at least 4 inches. Do not leave gap of unmixed material between cuts. If an overlap of more than 4 inches occurs, immediately adjust. If an overlap is less than 4 inches, immediately back up and mix the deviation along the correct cut line.

Mark where the center of the mixing drum stops. Start the following cut on this alignment at least 2 feet behind the mark.

Special attention shall be given to ensure that the material next to all joints is thoroughly mixed with cement, moistened and compacted to the specified depth.

Longitudinal and transverse joints adjacent to partially hardened cement treated subgrade shall be formed by cutting back with the mixer into the previously constructed work. The amount of overlap shall be sufficient to cut back into dense material.

Longitudinal and transverse joints adjacent to hardened cement shall be formed by cutting back into the work to form a straight vertical face. When completed, the face of the joint must be free of loose and shattered material.

Special attention shall be taken around utility structures, survey monument boxes, and next to curbs to ensure that the material is thoroughly pulverized, mixed with cement, moistened and compacted to specified depth. Material that is inaccessible to the mixer shall be bladed or shoveled into the pulverized and mixing process after which it shall be returned to its original position.

Before compacting, remove solids larger than 3 inches in any dimension.

00644.45 – Compaction – The tamping foot roller shall be used immediately behind the road stabilizer as breakdown roller and before the motor grader begins shaping. The vibratory roller shall be used behind the motor grader. Special attention shall be taken around utility structures and next to curbs to ensure the material is compacted to the specified depth. Vibratory plate compactors shall be used to achieve compaction of the mixture in areas that are inaccessible to the rollers.

Immediately after pulverizing and mixing, compact the mixture to the minimum relative compaction. Do not allow more than 2 hours to between the final mixing of the pulverized material with the cement and completion of compaction.

If needed during grading and final compaction, add water to maintain optimum moisture content.

The processed material shall be uniformly compacted to a minimum of 98% of maximum density based on the moving average of five consecutive tests with no individual test below 96%. Field density of compacted material can be determined by nuclear method in the direct transmission mode (ASTM D 2922, AASHTO T310), sand cone method (ASTM D 1556, ASSHTO T 191), or rubber balloon method (ASTM D 2167). Optimum moisture and maximum density determined prior to start of construction and also in the field during construction by moisture-density test (ASTM D 558 or AASHTO T 134).

At the start of compaction, the moisture content shall be within 2 percent of the specified optimum moisture. No section shall be left undisturbed for longer than 30 minutes during compaction operations. All compaction operations shall be completed within 2 hours from start of mixing.

The final in-place full-depth reclamation mixture shall be able to pass a full loaded 10-yard dump truck proof-roll test. The contract shall provide everything required to perform the proof-roll test at no cost to the agency.

00644.46 – Finishing – As compaction nears completion, the surface of the newly constructed base shall be shaped to the lines and grades shown in the plans. When directed by the Engineer, the finished FDR surface shall be tested by the Contractor with a 12-foot straight edge at no cost to the Agency. The finished FDR surface shall not vary more than ½ inch from the lower edge of a 12-foot straight edge laid in directions parallel and perpendicular to the centerline of the roadway.

If required by the Engineer, the surface shall be lightly scarified or broom dragged to remove imprints left by equipment or to prevent compaction planes, cracks, ridges, indentations, segregation, raveling, or loose material. All finishing operations shall be completed within 4 hours from the start of mixing.

If the Engineer believes the thickness of the FDR base is deficient, the Engineer will request cores be taken before the asphalt is placed. If a core indicates the FDR base thickness is less than the specified thickness by ½ inch, additional cores in the vicinity of the non-compliant core will be taken to determine the extent of the deficient thickness. Once the extent of the deficient thickness is known to the Engineer, the correct measure will determined by the Engineer.

00344.51 – Control of Line and Grade – The Contractor is responsible for establishing line and grade control for the cement treated base construction. Line and grade shall be set to provide the designated base section and to meet the designated grades, lines and cross-sections. The finished surface of the FDR base shall be within plus or minus 0.04 foot of the designated grade.

00644.47 – Curing – Finished portions of the FDR base that are traveled on by equipment used in constructing an adjoining section shall be protected in such a manner as to prevent equipment from marring or damaging completed work. Immediately after completion of final finish grading and compaction and while the FDR base is still moist, the surface shall be cured by application of a bituminous sealing membrane. The cure seal shall be placed no later than 8 hours after compaction has been completed.

For this project the cure seal shall be a chip seal applied in accordance with Section 00710. The FDR base shall be allowed to cure for 7 days before placing asphalt concrete surface course, unless approved by Engineer. The FDR base surface shall be dense, free of all loose and extraneous materials, and shall contain sufficient moisture to prevent excessive penetration of the bituminous material.

The curing seal may be omitted if within 2 hours after the start of mixing the initial lift of asphalt concrete is placed over the cement treated base. Vibratory rollers will not be permitted in the compaction of any lift of material placed over the cement treated base during the time period from 2 hours to 96 hours after the start of mixing of the cement treated base.

Contractor assumes all material cost to keep the FDR base moist during curing until base course asphalt cement pavement is applied. Lack if compliance with the curing requirements will be cause for rejection of the FDR material.

00644.48 – Traffic During Curing Period – Completed portions of the FDR base can be opened to low-speed local traffic and construction, provided the curing material is sufficiently stable to withstand marring, permanent deformation, and pick-up of the FDR base and curing material. Heavy traffic shall not be allowed to drive over the FDR base until the base course of asphalt concrete pavement has been applied.

Cure seal shall be placed a minimum of 2 hours in advance of opening the work to traffic. Construction truck traffic shall be detoured and the roadway signed “Local Delivery Only” during the 7-day cure period or as approved by the County. The signage for curing shall be incidental to the temporary traffic control.

00644.49 – Quality Assurance – Density tests shall be conducted on average of one location per 5,000 square feet of surface area. At each location, conduct two density tests at right angles to one another and average the two results to determine the density for that location.

Verify the cement spread rate by measurement of pan samples of the amount of cement applied to the surface. Check cement spread rate at least once per day and at the start of any change in cement spread rate. Verify the uniformity and depth of mixing by digging test holes through the mixture on average of one test per 5,000 square feet of surface area.

00644.52 – Maintenance – The Contractor shall maintain the FDR base in good condition until all work is completed and accepted. Such maintenance shall be done by the contractor at his own expense

Maintenance shall include immediate repairs of any defects that may occur. If necessary to replace any processed material, the replacement shall be for the full depth, with vertical cuts, using either cement-treated material. No skin patches shall be permitted.

Measurement

00644.80 Measurement - Quantities of cement treated soil or cement treated base will be measured on the area basis, by the square yard, measured along the lines and grades of the area actually treated.

(a) Portland cement will be measured and paid for on a dry weight/ton basis, to the nearest 0.01 ton. Payment will not be made for the quantity of portland cement that exceeds the specified mixture rate by more than 1 percentage point when the total cement quantity is averaged over the total project area. Materials will be accepted at the net weight shown by the manufacturer, subject to periodic verification and approval. Provide a certificate with each shipment together with a certified copy of the weight of each delivery. Measurement of stabilizing material will not include any which is lost, displaced, use in reworking, used in restoration work or used contrary to direction.

(b) Water for mixing will not be measured and will be considered incidental.

(c) Application and water for continuous water for dust control for the 7-day cure time will not be measured and will be considered incidental.

(e) Excessive material will be measured by the loose cubic yard volume in the hauling vehicle and payment will be by the unit price found in the schedule of prices. This material shall only go to an approved dump site and disposal is the responsibility of the Contractor.

(f) Supplementary aggregate will be measured on the per ton basis.

Payment

00644.90 Payment - The accepted quantities of cement treated soil or cement treated base materials will be paid for at the Contract unit price, per unit of measurement, for the following items:

Pay Item Unit of Measurement
(a) Treated soil/base, 12 inches Thick .....Square Yard
(c) Portland Cement .....Ton
(d) Excessive Material Removal/ Disposal.....Cubic Yard
(e) Supplementary Aggregate .....Ton

In item (a), the depth of the treated soil or base will be inserted in the blank.

Payment will be payment in full for furnishing and placing all materials, and for furnishing all equipment, labor, and incidentals necessary to complete the work as specified.

No separate or additional payment will be made for:

- pulverization existing roadway materials
- protection of utilities or monuments
- draining water from the subgrade
- subgrade stabilization work
- smoothing the subgrade in preparation for staking
- blading, shaping and compacting the grade, including roadbed materials, to final line, grade and cross section
- curing seal or water for cure application
- maintenance of in-place FDR base

Application and materials for watering for the 7 day cure time is considered incidental and no measurement or payment will be made.

END SECTION

SECTION 00710 - SINGLE APPLICATION EMULSIFIED ASPHALT SURFACE TREATMENT

Comply with Section 00710 of the Standard Specifications modified as follows:

00710.00 Scope – replace the subsection with the following:

This Work consists of applying a CRS-1 or CRS-2 Non-Polymer-Modified Emulsified Asphalt and Single Size Medium graded Aggregate.

00710.11 Emulsified Asphalt - Add the following paragraph to this subsection:

Provide Non-Polymer-Modified emulsified asphalt for this Project.

END SECTION