

Terracon

CONSULTANTS SE, INC.

1609 OakRidge Drive, Suite 101
Ft. Collins, Colorado 80525
(303) 226-5611

Gerald R. Olson, PE.
James A. Cunningham, PE.
C. Fred Schoell, PE.
Lester L. Litton, PE.

August 21, 1991

Land Development Services
309 West Harmony Road, Unit "B"
Ft. Collins, CO 80526

ATTN: Mr. Dennis Donovan

RE: Pavement Section/Subgrade
Evaluation
South Shields Street
Ft. Collins, Colorado
Job No. 12915031

Mr. Donovan:

Attached with this letter are results of the pavement section evaluation you requested for South Shields Street adjacent to the Clarendon Hills development.

As requested, pavement section evaluations were performed at Stations 42+00, 36+00 and 30+00. Those evaluations were completed in the east (northbound) lane of South Shields Street. At those locations, asphalt cores were obtained using a 3-inch nominal diameter diamond bit core barrel. Below the asphalt pavement, the borings were advanced using a rotary drill rig equipped with continuous flight augers. As requested, one sample was obtained from the subgrade material encountered in each boring at a depth of approximately 1 foot below the base and/or subbase. The subgrade samples were obtained using thin-walled tube sampling procedures. For that sampling, pitrun aggregate (which was encountered below the road base material) was defined as subbase.

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Geotechnical, Environmental and Materials Engineers

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As requested, moisture content, Atterberg limits and washed sieve analysis tests were completed on each of the recovered subgrade samples. Those soils were also observed in the laboratory by an engineer and classified in accordance with the attached General Notes and the Unified Soil Classification System. A brief description of the Unified Classification System is included with this letter.


A brief summary describing the materials encountered in the test borings and providing results of the laboratory testing is attached. The stratification boundaries shown on the attached summary represent the approximate locations of changes in material types; in-situ, the transition of materials may be gradual and indistinct.

We have not been asked to interpret the attached data nor to make design and/or construction recommendations based on this information and cannot assume liability for interpretation of this data by others.

We appreciate the opportunity to provide services to you on this project. If you have any questions concerning this report, or if we can be of further service to you in any other way, please do not hesitate to contact us.

Very truly yours,

TERRACON CONSULTANTS SE, INC.


Lester L. Litton, P.E.
Colorado No. 23957

LLL/dmf

TERRACON CONSULTANTS SE, INC.

Project: South Shields Street
(Clarendon Hills 4th Addition)
Fort Collins, Colorado

Job No: 12915031
Date: August 1991

SUMMARY OF PAVEMENT/SUBGRADE CORES

<u>Boring</u>	<u>Location</u>	<u>Depth</u>	<u>Layer Thickness</u>	<u>Material Description</u>	<u>Moisture Content (%)</u>	<u>Minus 200 (%)</u>	<u>Atterberg Limits (%)</u>		
							<u>LL</u>	<u>PL</u>	<u>PI</u>
B-1	STA 42+00 East Lane	0 - 2 11/16"	2 11/16"	Asphalt Pavement	25.7	91.5	62	40	22
		2 11/16" - 9"	6"	Aggregate Base					
		9" - 27"	18"	Pitrun Aggregate					
		27" - 39"	12"	Dark Brown Silty Sand					
		39" - 51"	12"	Brown Fat Clay					
B-2	STA 36+00 East Lane	0" - 2 1/2"	2 8/16"	Asphalt Pavement	16.6	57.0	23	18	5
		2 1/2 - 9"	6"	Aggregate Base					
		9" - 21"	12"	Pitrun Aggregate					
		21" - 39"	18"	Dark Brown Silty Sand					
		39" - 51"	12"	Brown Sandy Lean Clay					
B-3	STA 30+00 East Lane	0" - 3"	3"	Asphalt Pavement	11.0	62.8	33	20	13
		3" - 9"	6"	Aggregate Base					
		9" - 33"	24"	Pitrun Aggregate					
		33" - 51"	18"	Dark Brown Silty Sand					
		51" - 63"	12"	Brown Siltstone/Sandstone					

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UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests^A

Soil Classification

			Soil Classification		
			Group Symbol	Group Name ^B	
Coarse-Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines ^C	$Cu \geq 4$ and $1 \leq Cc \leq 3^E$	GW	Well-graded gravel ^F
			$Cu < 4$ and/or $1 > Cc > 3^E$	GP	Poorly graded gravel ^F
		Gravels with Fines More than 12% fines ^C	Fines classify as ML or MH	GM	Silty gravel ^{F, G, H}
			Fines classify as CL or CH	GC	Clayey gravel ^{F, G, H}
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines ^E	$Cu \geq 6$ and $1 \leq Cc \leq 3^E$	SW	Well-graded sand ^I
			$Cu < 6$ and/or $1 > Cc > 3^E$	SP	Poorly graded sand ^I
		Sands with Fines More than 12% fines ^D	Fines classify as ML or MH	SM	Silty sand ^{G, H, I}
			Fines classify as CL or CH	SC	Clayey sand ^{G, H, I}
Fine-Grained Soils 50% or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	inorganic	$PI > 7$ and plots on or above "A" line ^J	CL	Lean clay ^{K, L, M}
			$PI < 4$ or plots below "A" line ^J	ML	Silt ^{K, L, M}
		organic	$\frac{\text{Liquid limit — oven dried}}{\text{Liquid limit — not dried}} < 0.75$	OL	Organic clay ^{K, L, M, N} Organic silt ^{K, L, M, O}
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line	CH	Fat clay ^{K, L, M}
			PI plots below "A" line	MH	Elastic silt ^{K, L, M}
		organic	$\frac{\text{Liquid limit — oven dried}}{\text{Liquid limit — not dried}} < 0.75$	OH	Organic clay ^{K, L, M, P} Organic silt ^{K, L, M, O}
Highly organic soils	Primarily organic matter, dark in color, and organic odor		PT	Peat	

^ABased on the material passing the 3-in. (75-mm) sieve.

^BIf field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

^CGravels with 5 to 12% fines require dual symbols:

GW-GM well-graded gravel with silt
 GW-GC well-graded gravel with clay
 GP-GM poorly graded gravel with silt
 GP-GC poorly graded gravel with clay

^DSands with 5 to 12% fines require dual symbols:

SW-SM well-graded sand with silt
 SW-SC well-graded sand with clay
 SP-SM poorly graded sand with silt
 SP-SC poorly graded sand with clay

$${}^E C_u = D_{60}/D_{10} \quad C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$$

^FIf soil contains $\geq 15\%$ sand, add "with sand" to group name.

^GIf fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

^HIf fines are organic, add "with organic fines" to group name.

^IIf soil contains $\geq 15\%$ gravel, add "with gravel" to group name.

^JIf Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

^KIf soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel", whichever is predominant.

^LIf soil contains $\geq 30\%$ plus No. 200 predominantly sand, add "sandy" to group name.

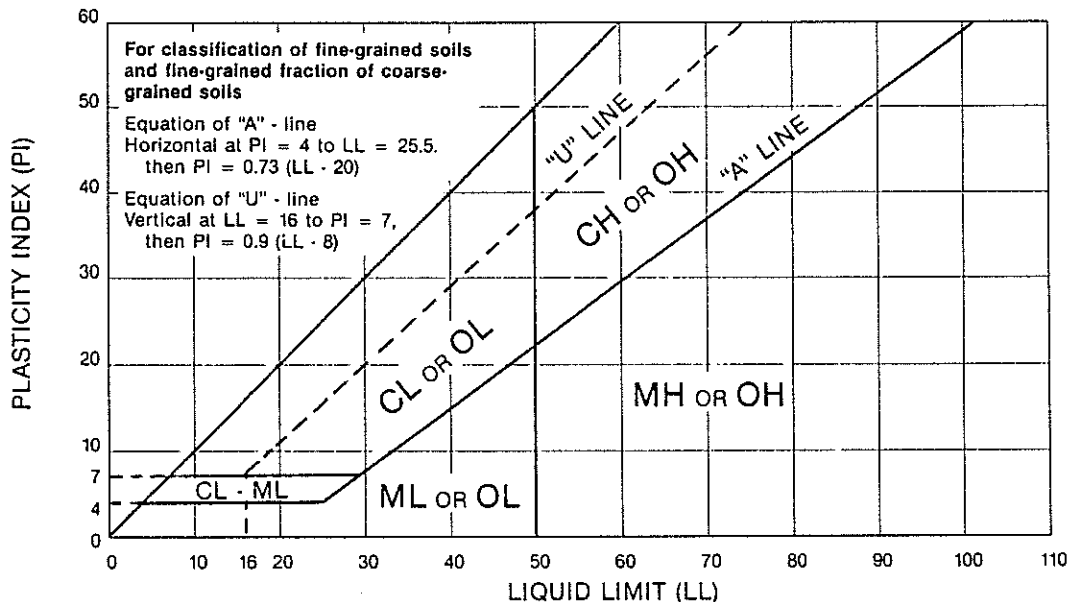
^MIf soil contains $\geq 30\%$ plus No. 200, predominantly gravel, add "gravelly" to group name.

^N $PI \geq 4$ and plots on or above "A" line.

^O $PI < 4$ or plots below "A" line.

^P PI plots on or above "A" line.

^Q PI plots below "A" line.



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Larry K. Davidson, P.E.

June 7, 1991

Land Development Services
4924 South Shields
Ft. Collins, CO 80526

ATTN: Mr. Dennis Donovan

RE: Pavement Section Evaluation
South Shields Street
(Clarendon Hills)
Ft. Collins, Colorado
Job No. 12915031

Mr. Donovan:

Enclosed, herewith, are the results of the structural pavement section evaluation you requested for the referenced project. We understand this project involves the widening and paving of South Shields Street adjacent to the Clarendon Hills Subdivision in Ft. Collins, Colorado. That development is located south of Harmony Road and east of South Shields. The project includes construction of under-road drainage structures. Minor cuts and fills of 10 to 15 feet are currently being placed to develop the pavement subgrades.

Terracon personnel obtained a representative sample of stockpiled site materials being used for fill in the roadway section. The Hveem stabilometer R-value of a remolded sample of those materials was determined in the laboratory to provide a basis for the pavement design. An R-value of 11.0 was established for the remolded sample and was used in the pavement evaluation.

The 1986 "AASHTO Guide for Design of Pavement Structures" was used to help evaluate alternative pavement sections. An average 18-kip equivalent daily axle load (EDAL) of 145 was provided by the City of Ft. Collins for use in the pavement design. A resilient modulus of 7100 psi was used for the design based on the AASHTO recommended

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correlation. A design reliability of 90 percent was assigned to the arterial street with standard deviations of 0.44 and 0.34 used for flexible and rigid pavement designs, respectively. A serviceability loss due to traffic of 2.0 was used for both designs. The rigid concrete pavement was assumed to be non-reinforced with a modulus of rupture of 650 psi.

Based on the above-outlined design parameters, a rigid concrete pavement thickness of 8.5 inches and flexible pavement weighted structure number of 3.46 were calculated for the roadway. Alternative sections to meet the flexible pavement structural number would include: 8 inches of full-depth asphaltic concrete; 4 inches of asphaltic concrete overlying 14 1/2 inches of high-quality aggregate base course or; 4 inches of asphaltic concrete underlain by 8 inches of high-quality aggregate base course and 8 inches of lesser quality subbase material. Other alternatives could be used to meet the pavement structural number requirements and we would be pleased to evaluate those alternatives, at your request.

Portland cement concrete used for the pavement design should consist of high-quality, ready mix concrete with a minimum compressive strength of 3,500 psi. The pavement concrete should be air entrained. The recommended pavement section is based on a non-reinforced concrete with good surface drainages.

Asphalt for use in the roadway should consist of high-quality hot-bituminous pavement consistent with City of Ft. Collins standards for SC Type 1 or SC Type 2 asphaltic concrete. High-quality aggregate base should consist of either Class 5 or Class 6 base as defined by City of Ft. Collins criteria and the underlying subbase aggregate should be Class 1 material as defined by the city standards.

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The analysis and recommendations presented in this report are based upon the information obtained from the laboratory testing and any other data discussed in this report. It is recommended that the geotechnical engineer be retained to review the plans and specifications so that comments can be made regarding the interpretation and implementation of our geotechnical recommendations in the design and specifications.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No other warranty, expressed or implied, is made. In the event that any changes in the nature, design or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and the conclusions of this report modified or verified in writing by the geotechnical engineer.

We appreciate the opportunity to be of service to you on this project. If you have any questions or require any additional information, please do not hesitate to contact us.

Very truly yours,

TERRACON CONSULTANTS SE, INC.



Lester L. Litton, P.E.
Colorado No. 23957



Craig K. Denny, P.E.

LLL/dmf