

GEOTECHNICAL EVALUATION FOR
STREET PAVEMENT THICKNESS DESIGN
A PORTION OF FOUR SEASONS SUBDIVISION
FORT COLLINS, COLORADO

Ranch Builders, Inc.
1011 Arbor Avenue
Fort Collins, Colorado 80525

Attention: Mr. Dennis Lane

APPROVED

with Addendum / Pavement Design
BY: *Spike Kector* DATE: *8/18/99*



City of Fort Collins
Engineering Department

Job No. 534-95007
August 13, 1999

August 13, 1999

Ranch Builders, Inc.
1011 Arbor Avenue
Fort Collins, Colorado 80525

Attention: Mr. Dennis Lane

Job No. 534-95007

Subject: Geotechnical Evaluation for Street Pavement Thickness Design, a Portion of Wabash Street, Four Seasons Subdivision, Fort Collins, Colorado

Specifications: "Design and Construction Criteria, Standards and Specifications for Streets, Sidewalks, Alleys and Other Public Ways, City of Fort Collins, Colorado, City Engineering Office, July 1996.

Reference: "Proposed Four Seasons Condominiums Geotechnical Evaluation Northeast of Shields and Wabash Streets, Fort Collins, Colorado, By GTG Geotechnical Services, Dated January 6, 1997

Dear Mr. Lane:

In accordance with your request, we have performed a geotechnical evaluation to determine street pavement design criteria for the subject project. Our final asphalt thickness design report will be provided after City of Fort Collins releases traffic numbers for the proposed portion of Wabash Street. This investigation, and the resulting recommendations are based upon specifications referenced above.

Based upon the results of this investigation, the recommended subgrade for construction is detailed within this report. A detailed evaluation report is attached which includes the data generated during our geotechnical and laboratory investigations and the recommendations for pavement construction.

We are available to discuss the details of this report with you. We are also available for additional testing and observation during construction. Please call when further consultation or observations are required.

Sincerely,

PROFESSIONAL SERVICES INDUSTRIES



Derek Ulehla, P.E.
Department Manager

Copies: (2) Addressee
(4) Mr. Rick Richter, P.E. City of Fort Collins

Reviewed by,


K. Craig Vaughn, P.E.
Vice President



TABLE OF CONTENTS

LETTER OF TRANSMITTAL	Page i
GENERAL	1
FIELD INVESTIGATION	1
LABORATORY TESTING	1
SWELL POTENTIAL OF SUBGRADE SOILS	2
CONSTRUCTION RECOMMENDATIONS AND SPECIFICATIONS	2
DESIGN CONSULTATION AND CONSTRUCTION OBSERVATION	3
TEST REFERENCES	4
SITE LOCATION MAP	Figure 1
BORING LOCATION MAP	2
BORING LOGS, LEGEND AND NOTES	3
HVEEM STABILOMETER TEST RESULTS	4
SUMMARY OF LABORATORY TESTING	Table 1

GENERAL

This report presents the results of a geotechnical exploration performed to determine the street pavement thickness requirements for a portion of Wabash Street in Four Seasons Subdivision, Fort Collins, Colorado (see Figure 1).

The exploration was performed to determine street subgrade soil conditions, evaluate the engineering properties of the subgrade soils which will support the pavements, and, when approved, to provide recommended street pavement thickness criteria based on the soil conditions encountered. The conclusions and recommendations presented herein are based on data gathered during the site exploration, results of laboratory testing, and our experience with similar soil conditions. Data generated during the field exploration, laboratory testing, and the engineering analyses, are summarized on Figures 2 through 4, and Tables 1.

FIELD INVESTIGATION

Street subgrade soil conditions were explored by drilling a total of 3 borings at an approximate maximum spacing of 250 feet along the proposed street alignments. All of the borings were drilled to a depth of ten feet below subgrade elevation. The approximate locations of the borings are shown on Figure 2. Descriptions of the pavement subgrade soils encountered in the borings are shown on Figure 3, and are summarized on Table 1. Ground water was not encountered in the borings at the time of drilling to the maximum depth explored.

LABORATORY TESTING

The samples obtained during the field exploration were returned to our laboratory for subsequent testing to evaluate their engineering properties for pavement design. Laboratory testing was performed on each sample taken from the field and included:

1. Natural Moisture Content (ASTM D2216)
2. Grain Size Distribution (AASHTO T88), (ASTM D422)
3. Atterberg Limits (AASHTO T89 and T90), (ASTM D4318)
4. Classification, Description (AASHTO M145), (ASTM D2487),
(ASTM D2488)
5. Group Index Determination (AASHTO M145)
6. Hveem Stabilimeter Test (AASHTO T-190 and ASTM D2844)
7. Denver Swell/Consolidation

The results of the laboratory testing performed on each sample are summarized on Table 1.

The classification testing indicated that the subgrade materials on the subject portion of the site are comprised primarily of sandy clays, with some clayey sands. For purposes of this design, a sample of the A-6 soils was utilized for Hveem Stabilimeter Resistance Value (R-value) testing.

The Hveem Stabilimeter testing was performed in substantial accordance with AASHTO T-190 and ASTM D2844. The exudation pressure versus the corrected R-value curve, moisture content

and dry density data, and the design R-value at 300 psi exudation pressure is shown on Figure 4. The Hveem Stabilimeter results are summarized as follows:

Soil Type	R-Value (at 300 psi Exudation Pressure)
A-6	6

As a portion of the “Standard Method of Test for Resistance R-value on Expansion Pressure of Compacted Soils” (ASTM D2844), expansion pressures were measured on the samples. The samples were wetted and expansion pressure was allowed to develop for 16 to 24 hours. Minimal expansion pressures were measured for each sample.

SWELL POTENTIAL OF SUBGRADE SOILS

The subgrade soils are moderately plastic, having liquid limits varying from 34 to 43 and plasticity indices varying from 16 to 20. The percent swell varied from 1.9% to 4.7% as shown in the table below. Hence, in areas of moderately plastic soils measures to reduce the swell potential for expansive soils are required. Based upon Fort Collins specification referenced above and at the client’s request the two options are recommended to mitigate the swell potential of the subgrade soils under construction recommendations and specifications.

Soil Type	Liquid Limit	Plasticity Index	% Swell
A-6	34	14	+1.9
A-7	42	25	+4.7

CONSTRUCTION RECOMMENDATIONS AND SPECIFICATIONS

The soils requiring mitigation due to swell potential (classify as A-7-6) are located on the west end of proposed Wabash Street between South Shield Street (station 10+00) and Station 12+70. The remaining portion of the street in our opinion does not require any additional treatment before placement of pavement section.

In an effort to mitigate swell potential, two soil improvement options are proposed.

Option 1.

Overexcavation to a depth of two feet and scarify the third foot below the proposed asphalt section. The removed soils should be replaced with a type A-6 clayey soil and moisture conditioned and recompacted to 95% Standard Proctor maximum dry density at a moisture content within 0 to +4 percent of optimum moisture content. The proposed treatment area would be between South Shields Street (station 10+00) and approximately station 12+70. A field engineer from PSI should be on-site to verify the overexcavation location during construction.

Option 2.

In our opinion another suitable method of mitigating the swell potential of the clay soils on this site is to use fly ash stabilization. In our experience a 10% class C fly-ash has been used

effectively on similar clay soils. A full depth treatment of 18" should be used between South Shields Street (station 10+00) and approximately station 12+70. To provide a reasonable subgrade transition, the fly ash stabilized section should taper to zero thickness at station 14+25. A field engineer from PSI should be on-site to verify the stabilization location during construction.

Subgrade soils may presently have moisture contents, which are above or below optimum moisture content and may require the scarification and drying or moisture conditioning during subgrade preparation to bring the soils to suitable moisture content.

The final subgrade should be shaped to inhibit the accumulation of water below the pavement. Utility trench backfill compaction should meet the minimum compaction specifications outlined above.

DESIGN CONSULTATION AND CONSTRUCTION OBSERVATION

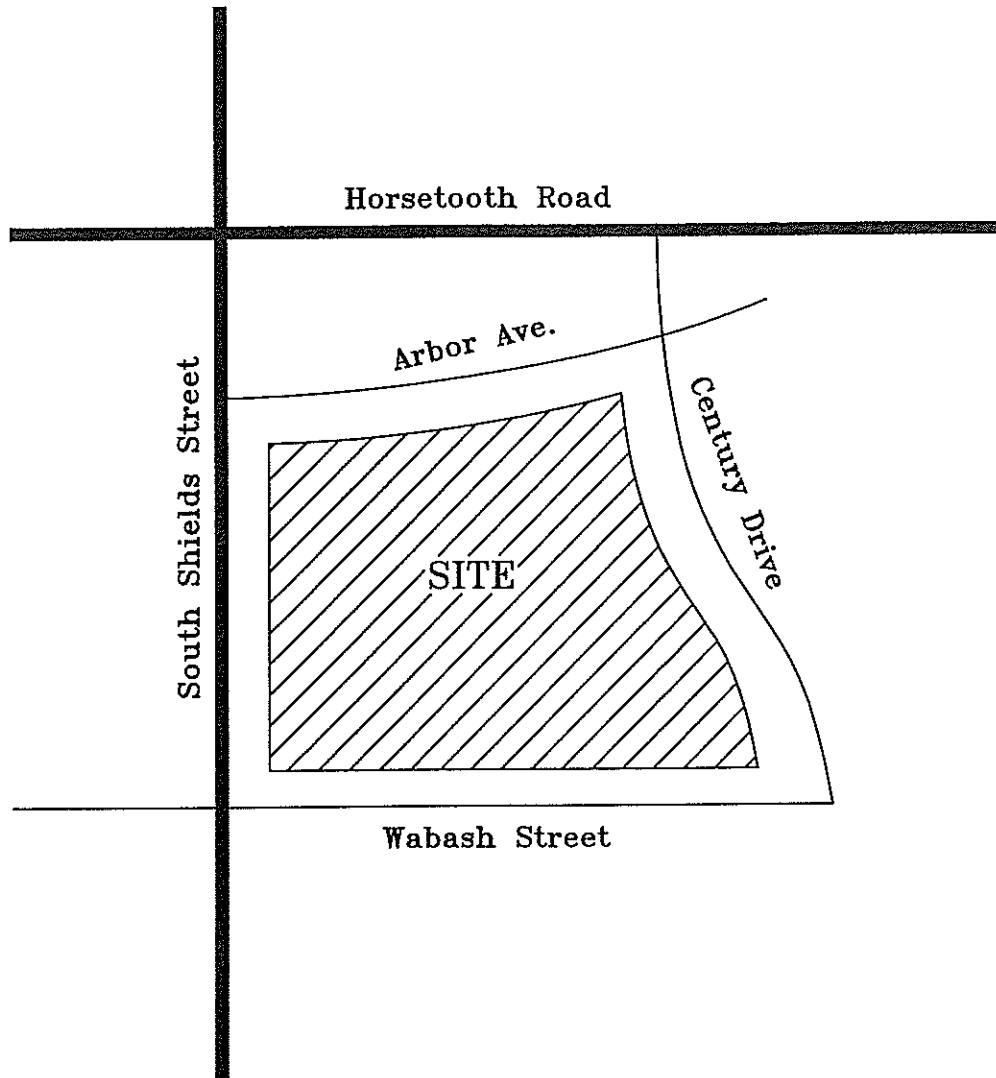
This report has been prepared for the exclusive use of Ranch Builders, Inc. for the purpose of designing the pavement thickness, and for preparing construction recommendations and specifications for the project. PSI has endeavored to perform geotechnical services for this project in a manner consistent with the level of skill ordinarily exercised by members of the local geotechnical engineering profession currently practicing in the same locality under similar conditions in the area of the project. No other warranty, express or implied, is made. In the event that any modifications are made in the plans for the proposed project, we should be contacted to review these changes and, if necessary, modify the conclusions of this report in writing.

It is recommended that PSI be provided with the opportunity for general review of final design and specifications in order to evaluate whether the construction recommendations outlined herein have been properly interpreted and implemented in the final construction. It is further recommended that PSI be retained to provide geotechnical and material engineering and testing services during pavement construction on the project. This is to provide observation of the construction with respect to the design specifications and/or recommendations and to enable design changes in the event that subsurface conditions differ from those anticipated prior the start of construction.

We are available to discuss the details of this report with you and to provide construction observation and testing services during actual construction of the project. Please call when further consultation, observation or testing is required.

TEST REFERENCES

- ASTM D422 "Particle-Size Analysis of Soils"
- ASTM D698 "Laboratory Compaction Characteristics of Soil Using Standard Effort (12,000 ft.-1bf-ft³ (600 kN-m/m³))"
- ASTM D1140 "Amount of Materials in Soils Finer than the No. 200 Sieve"
- ASTM D1452 "Soil Investigation and Sampling by Auger Borings"
- ASTM D1557 "Laboratory Compaction Characteristics for Soil Using Modified Effort (56,000 ft.-11f/ft³ (2,700 kN-m/m³))"
- ASTM D1559 "Test Method for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus"
- ASTM 2216 "Laboratory Determination of Water (Moisture) Content of Soil and Rock"
- ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)"
- ASTM D4318 "Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils"
- AASHTO M145 "The Classification of Soil and Soil Aggregate Mixtures for Highway Construction Purposes."
- ASTM D2844 "Resistance R-Value and Expansion Pressure of Compacted Soils"




SITE LOCATION MAP
NOT TO SCALE



FOUR SEASONS SUBDIVISION	
	JOB NO. 534-95007
	FIGURE NO. 1

SOUTH SHIELDS ST.

ST.

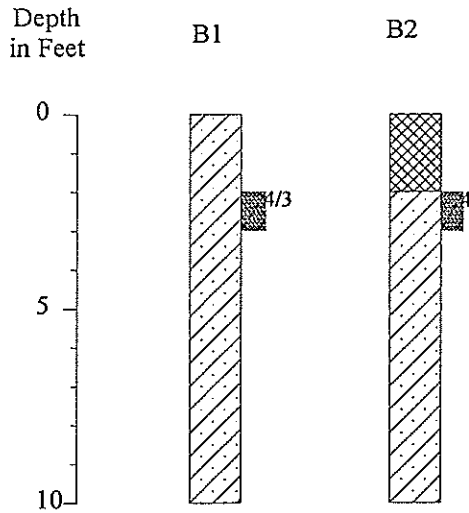
 Approximate location

FOUR SEASONS SUBDIVISION

si Information
To Build On
ing • Consulting • Testing

JOB NO. 534-95007

FIGURE NO. 2



ed on July 26, 1999, with 4-inch diameter



Spoon barrel sample; indicates that
 d hammer, falling 30 inches, were required to
 sampler 3 inches.

s represent the approximate boundary between
 ion may be gradual.

rings were approximately determined by pacing
 s or known structures. The location of the borings
 urate only to the degree implied by the method

ave been made in the borings at times and under
 report. This data has been reviewed and
 he text of this report. However, it must be noted
 vel of the ground water may occur due to variations
 nd other factors.

LEGEND

-  MAN PLACED FILL, Clay,
slightly moist to moist, brow
-  CLAY, sandy to very sandy,
moist, brown (CL) (A-7-6)

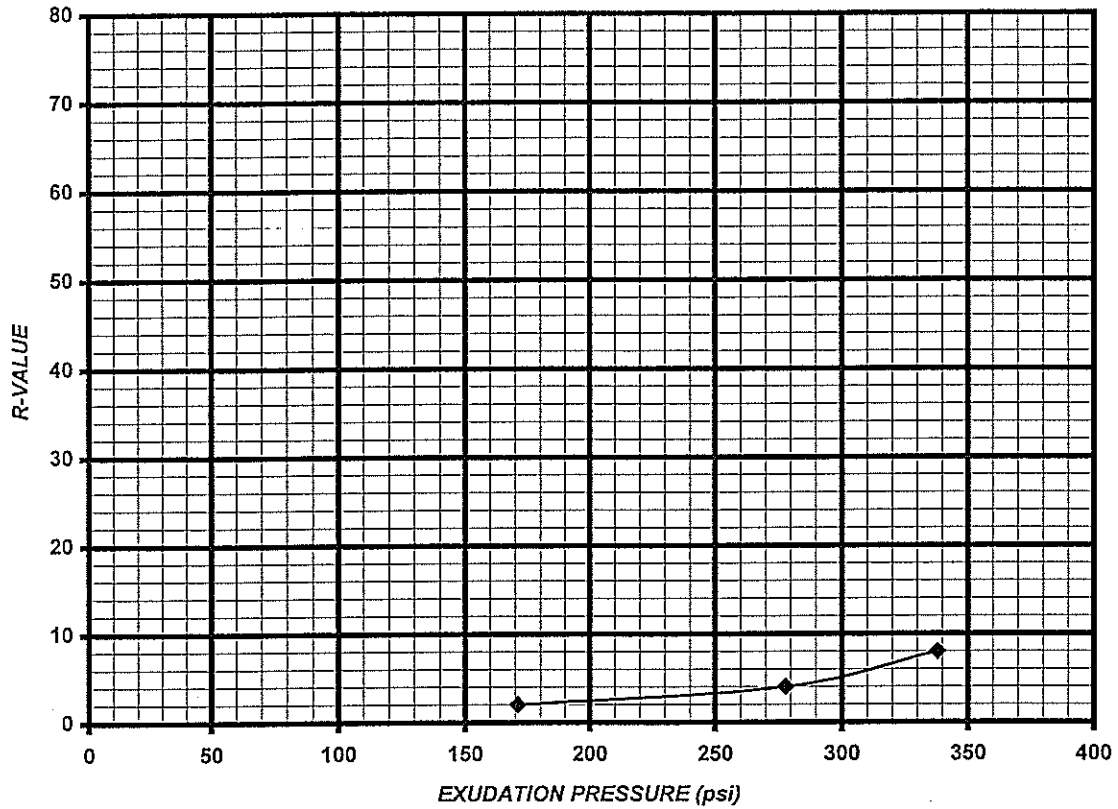
FOUR SEASONS SUBDIVISION

SI Information
 To Build On
 g • Consulting • Testing

JOB NO. 534-95007

FIGURE NO. 3

HVEEM STABILOMETER TEST RESULTS



Test Specimen	1	2	3
Moisture Content (%)	21.1%	19.2%	17.4%
Density (pcf)	97.1	106.3	108.1
Exudation Pressure (psi)	171	278	338
R-Value	2	4	8

Sample Description: CLAY, sandy

USCS Symbol: CL

AASHTO Classification: A-7-6

AASHTO Group Index: 11

Boring No: B-1

R-Value (300 psi): 6

SUMMARY OF LABORATORY TESTING

PROJECT: FOUR SEASONS SUBDIVISION
 LOCATION: FORT COLLINS, COLORADO
 SUBJECT: A PORTION OF WABASH STREET BETWEEN SOUTH SHIELDS STREET AND CENTURY DRIVE

JOB NO: 534-95007
 TABLE: 1

Boring Number	Depth Interval (feet)	Description	USCS Symbol	AASHTO		% Passing Each Sieve						ATTERBERG LIMITS			Natural Moisture Content (%)	R-Value	% Swell/ Consolidation
				Group Number	Group Index	3/8"	#4	#10	#40	#200	LL (%)	PI (%)	PL (%)				
B1	0-3	CLAY, sandy	CL	A-7-6	11	95	90	85	75	56	42	17	25	12.7	6	4.7	
	3-6	CLAY, sandy	CL	A-7-6	18	100	98	96	91	76	43	18	25				
	6-10	CLAY, sandy	CL	A-7-6	25	99	99	98	96	80	48	16	32				
B2	0-2	FILL, CLAY, sandy	CL	A-6	11	99	98	96	88	69	37	18	19	14.6			
	3-6	CLAY, sandy	CL	A-4	5	100	100	98	92	75	26	17	9				
B3	0-2	FILL, CLAY, sandy	SC	A-6	2	100	97	94	91	43	34	20	14			1.9	
	2-4	CLAY, sandy	SC	A-6	4	99	99	98	97	44	36	19	17	13.5			
B1/B2/B3	0-3	CLAY, sandy	CL	A-6	28	100	99	98	89	43	34	19	15	14.1			

