

FOUNDATION || Engineering,
AND SOILS || Inc.

September 29, 1994
Commission No. 2449-01-01-02

N/S

Brittany Knolls Land L.L.C.
c/o Western States Consultants, Inc.
5555 DTC Parkway, Suite C-3009
Englewood, Colorado 80111

RE: Pavement Recommendations for a portion of Brittany Knolls
First Filing, Larimer County, Colorado

Gentlemen:

Enclosed are the results of our investigation and recommendations
for the roadways to be constructed in a portion of Brittany Knolls
First Filing, Fort Collins, Colorado. These recommendations are
based on software using the 1993 AASHTO "Guide for the Design of
Pavement Structures".

Test results conducted by Empire Laboratories in Fort Collins,
Colorado indicate an R-value of 12.9.

R-values of subgrade soils = 12.9 ($M_R = 8160$)
Design Life = 20 years
Standard Deviation = 0.44
Structural Coefficients
Asphalt (HBP) = 0.44
Aggregate Base Course (ABC) = 0.11

Westbourn Circle, Westbourn Court, and Courtney Circle
(DTN = 5, 18k ESAL = 36,500, psi = 2.0, Reliability Factor = 70%,
Design Structural Number = 1.89)

	<u>Option 1</u>	<u>Option 2</u>
HBP	3"	5"
ABC	6"	--
TOTALS	9"	5"

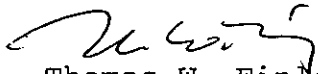
The top three (3) inches of the Hot Bituminous Pavement (HBP) shall
meet Grading C or CX or equivalent of CDOT Standards. The remaining
HBP shall meet Grading G of CDOT Standards. All Aggregate Base
Course (ABC) shall meet Class 5 or 6 of CDOT Standards and be
compacted to at least 95% or Standard Proctor. All select subbase
(SSB) shall meet Class 1 of CDOT Standards or equivalent. The

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Commission No.: 2449-01-01-02
Page 2

subgrade shall be stripped of vegetation and topsoil, scarified to a depth of six (6) inches, and recompactd to at least 95% or standard Proctor at plus or minus two percent ($\pm 2\%$) of optimum moisture content. Additional stabilization of the subgrade may be required. Stabilization techniques such as lime, fly ash, cement or fabric can be recommended at a later date, if needed.

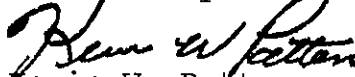
If you have any questions, please feel free to call.

Respectfully,

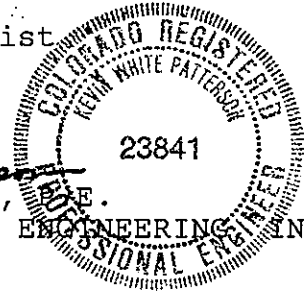


Thomas W. Finley,
Engineering Geologist

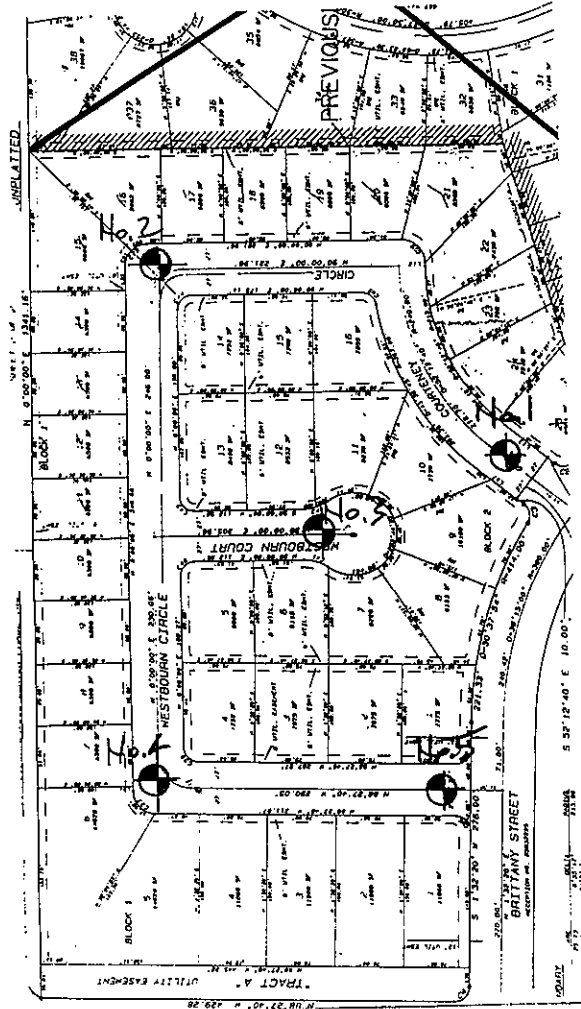
Reviewed by:



Kevin W. Patterson, P.E.
FOUNDATION & SOILS ENGINEERING, INC.



TWF/jlb

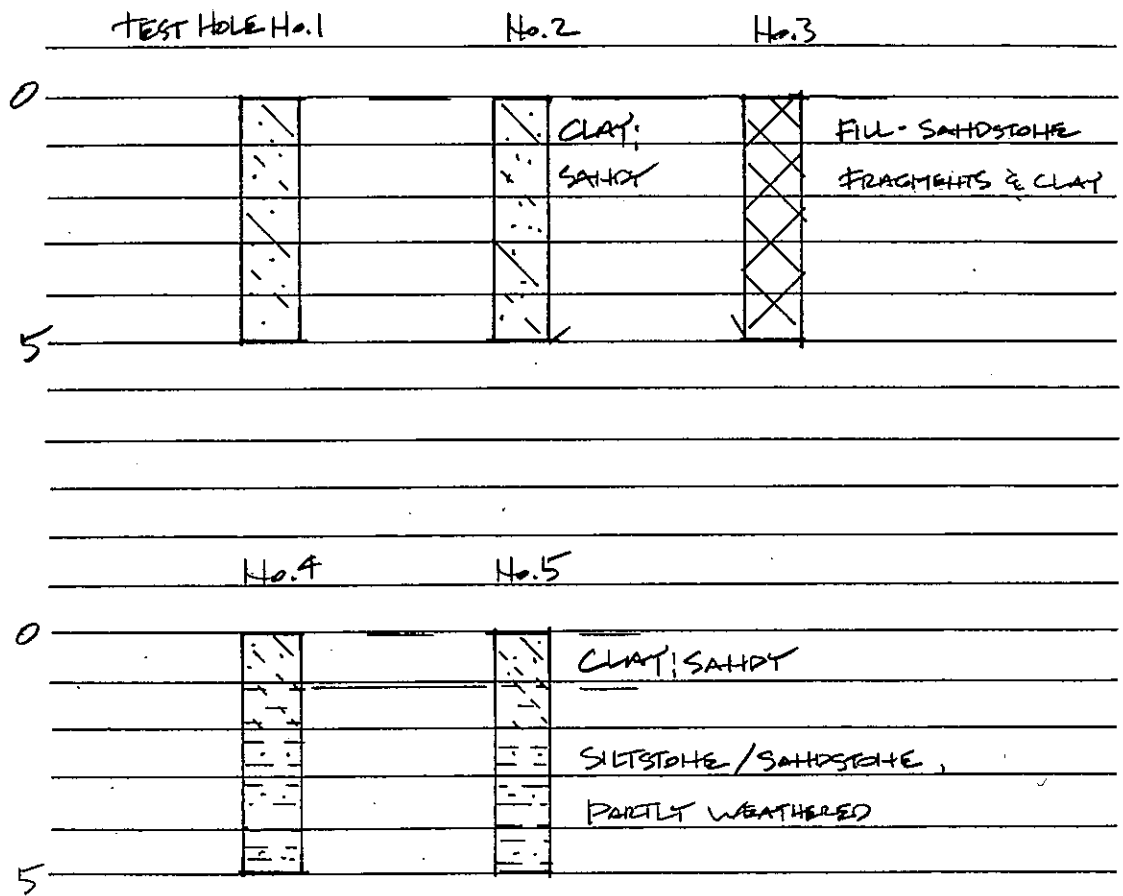


North
14200'

A PORTION OF BRITANNY KNOLLS,
FIRST FILING
LARIMER COUNTY, COLORADO

BORING LOCATION MAP

BORING LOGS



*Too sketchy
- Bed rock?*

Where is

FOUNDATION AND SOILS || Engineering, Inc.

October 28, 1994
Commission No. 2449-01-01-02A

Brittany Knolls Land L.L.C.
c/o Western States Consultants, Inc.
5555 DTC Parkway, Suite C-3009
Englewood, Colorado 80111

RE: Revised Pavement Recommendations for a portion of Brittany Knolls First Filing, Larimer County, Colorado

Gentlemen:

We have drilled five (5) test holes in the proposed roadways for the project referenced above. The purpose of this investigation is to determine to subsurface conditions and material characteristics in order to design the pavement sections. Supplemental information was obtained from our subsurface investigation report (#2250-06-01-01, dated October 20, 1994) for U.S. Homes to gain a better understanding of the soil, bedrock and groundwater conditions. Our investigation was conducted after a substantial amount of overlot grading had been conducted and during the installation of underground utilities.

Generally, the subsurface conditions consist of sandy clays in Test Hole Nos. 1 and 2, fill materials of sandstone and siltstone and clay at Test Hole No. 3 and sandy clays over siltstone and sandstone bedrock strata at Test Hole Nos. 4 and 5. The fill has been tested for compaction with passing results.

Test results indicate an R-value of 12.9 on the weathered sandstone/siltstone bedrock which appears to be the predominant and "worse-case" material under the roadways. We do not anticipate that perched water tables could form on the pavement subgrades due to the sandy and silty nature of the bedrock and the relatively shallow depths.

The following pavement recommendations are based on the City of Fort Collins - Design Criteria and Standards for Streets and software using the 1993 AASHTO "Guide for the Design of Pavement Structures."

- R-value of subgrade soils = 12.9 ($M_R = 8160$)
- Design Life = 20 years
- Standard Deviation = 0.44
- Structural Coefficients
 - Asphalt (HBP) = 0.44
 - Aggregate Base Course (ABC) = 0.11

October 28, 1994
Commission No.: 2449-01-01-02A
Page 2

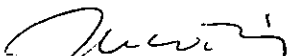
Westbourn Circle, Westbourn Court, and Courtney Circle
(DTN = 5, 18k ESAL = 36,500, Δ psi = 2.0, Reliability Factor = 70%,
Design Structural Number = 1.89)

	<u>Option 1</u>	<u>Option 2</u>
HBP	3"	5"
ABC	6"	--
TOTALS	9"	5"

The top three (3) inches of the Hot Bituminous Pavement (HBP) shall meet Grading C or CX or equivalent of CDOT Standards. The remaining HBP shall meet Grading G of CDOT Standards. All Aggregate Base Course (ABC) shall meet Class 5 or 6 of CDOT Standards and be compacted to at least 95% or Standard Proctor. All select subbase (SSB) shall meet Class 1 of CDOT Standards or equivalent. The subgrade shall be stripped of vegetation and topsoil, scarified to a depth of six (6) inches, and recompacted to at least 95% of standard Proctor at plus or minus two percent ($\pm 2\%$) of optimum moisture content. Additional stabilization of the subgrade may be required. Stabilization techniques such as lime, fly ash, cement or fabric can be recommended at a later date, if needed. We feel that a subdrain for the roadways is not necessary since a perched water table over the subgrade is not anticipated.

If you have any questions, please feel free to call.

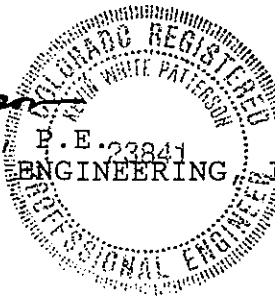
Respectfully,

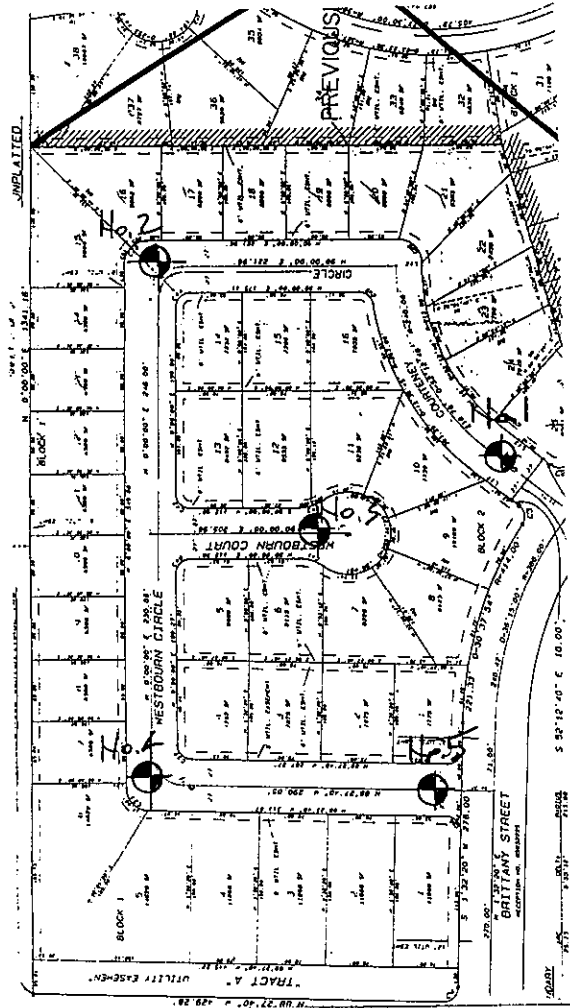

Thomas W. Finley,
Engineering Geologist

Reviewed by:


Kevin W. Patterson, P.E. 22841
FOUNDATION & SOILS ENGINEERING, INC.

TWF/jlb



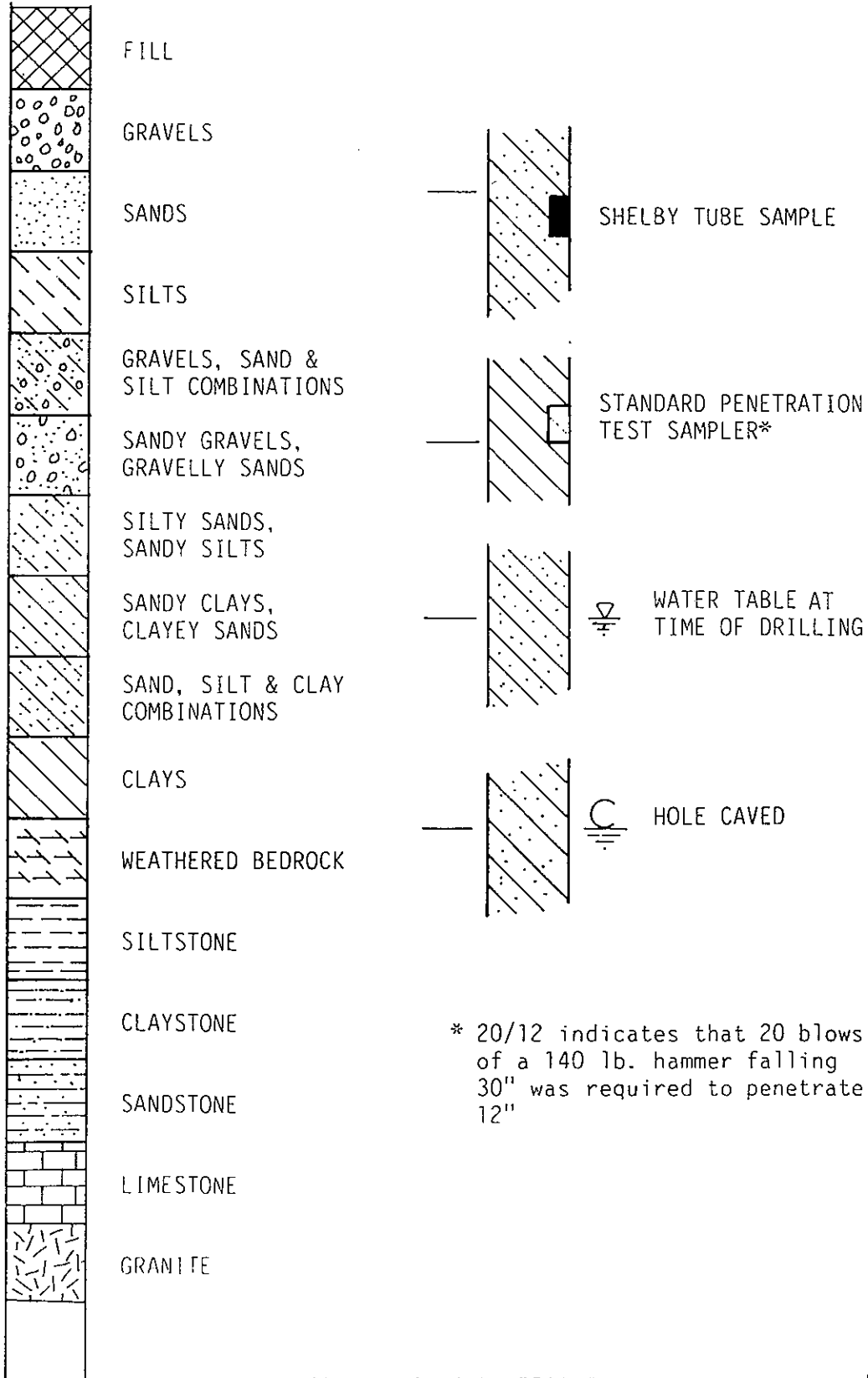


North
1/3200'

A PORTION OF BRITTANY HILLS,
FIRST FILING
LARAMIE COUNTY, COLORADO


BORING LOCATION MAP

LEGEND OF SOILS SYMBOLS



* 20/12 indicates that 20 blows of a 140 lb. hammer falling 30" was required to penetrate 12"

BORING LOGS

	TEST HOLE No. 1	No. 2	No. 3
0	CLAY; SANDY, SL. MOIST to MOIST, STIFF LT. BROWN	CLAY; SANDY, SL. MOIST to MOIST, STIFF LT. BROWN	 FILL - SANDSTONE FRAGMENTS & CLAY, SL. MOIST to MOIST, FIRM, OLIVE & BROWN
5	to BROWN	to BROWN	

	No. 4	No. 5
0	CLAY, SANDY SILTSTONE/ SANDSTONE, PARTLY WEATHERED,	CLAY, SANDY SILTSTONE / SANDSTONE, PARTLY WEATHERED, SL. MOIST, FIRM to HARD
5	SL. MOIST, FIRM to HARD, LT. OLIVE	LT. OLIVE

DRILLED 9/27/94

RESISTANCE R-VALUE AND EXPANSION PRESSURE OF COMPACTED SOIL

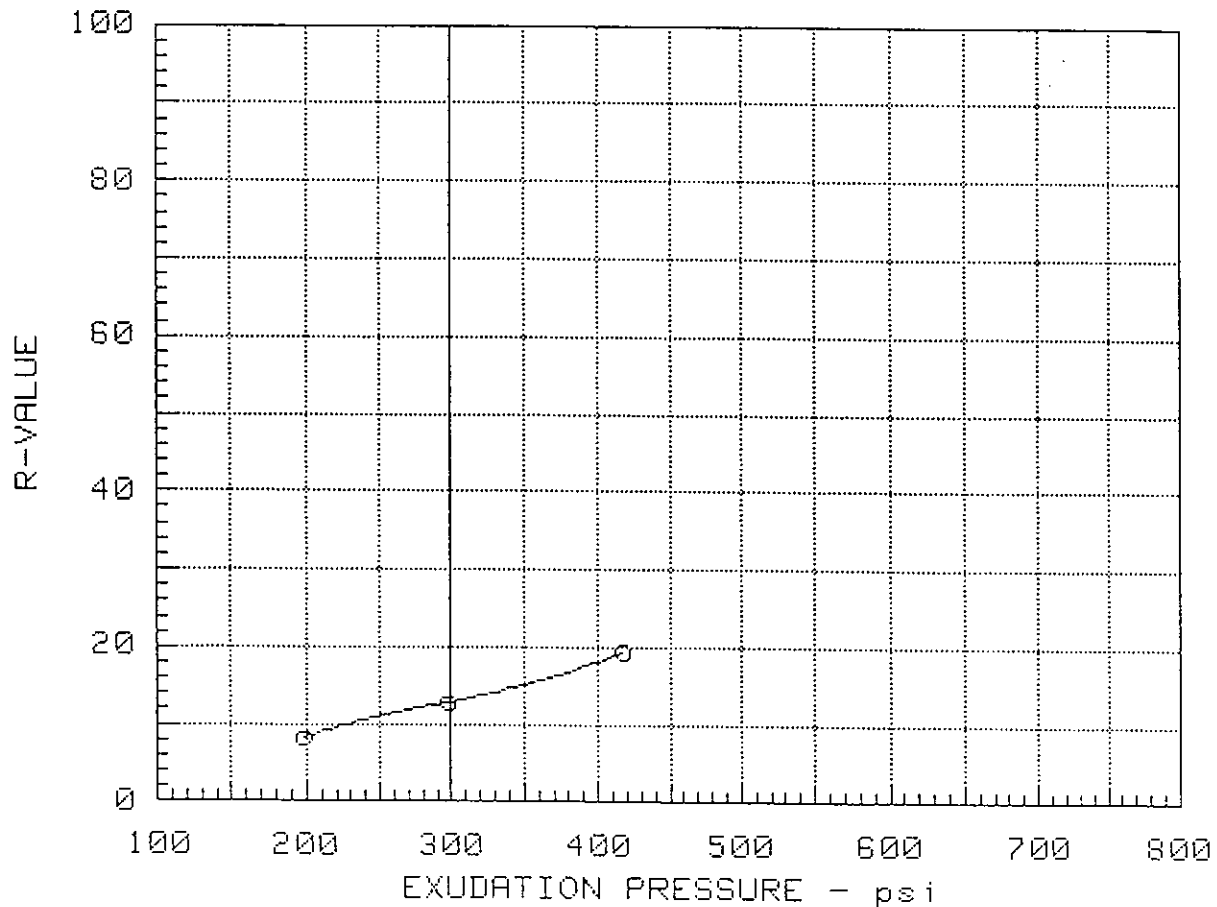
ASTM - D 2844

CLIENT: FOUNDATION ENGINEERING - CONSULTING ENGINEERS LTD.
PROJECT: FOUNDATION ENGINEERING PROJECT NO. 2449-01
LOCATION OF SAMPLE: WEATHERED SANDSTONE/SILTSTONE BEDROCK

SAMPLE DATA

TEST SPECIMEN	1	2	3
COMPACTION PRESSURE - PSI	140	200	280
DENSITY - PCF	110.6	113.5	116.1
MOISTURE - %	18.5	17.3	16.1
EXPANSION PRESSURE - PSI	0.18	0.67	1.88
HORIZONTAL PRESSURE @ 160 psi	142	133	122
SAMPLE HEIGHT - in.	2.56	2.50	2.53
EXUDATION PRESSURE - PSI	199	298	418
UNCORRECTED R-VALUE	8.0	12.9	19.5
CORRECTED R-VALUE	8.3	12.9	19.5

R-VALUE AT 300 PSI EXUDATION PRESSURE = 12.9



FOUNDATION ENGINEERING

SUMMARY OF LABORATORY TEST RESULTS

Sample Location		Natural Moisture Content (%)	Natural Dry Density (PCF)	Gradation		Percent Passing No. 200 Sieve	Atterberg Limits		Unconfined Compressive Strength * (PSF)	Standard Penetration Blows/Ft.	Soil or Bedrock Type
Hole	Depth (Feet)			Gravel (%)	Sand (%)		Liquid Limit	Plasticity Index			
1	1-3	14.0		8	24	68	33	20			Sandy clay
2	1-3	15.0									Sandy clay
3	1-3	13.5									Fill - sandstone & clay
4	1-3	9.6		2	19	79	35	22	R-value = 12.9		Weathered siltstone/sandstone
5	1-3										Weathered siltstone/sandstone
1	1-3			AASHTO Classification (Group Index) = A-6(11)							
4	1-3			AASHTO Classification (Group Index) = A-6(15)							

Date: September 29, 1994
 Commission No.: 2449-01-01-02

*Based on Pocket Penetrometer

FOUNDATION AND SOILS || **Engineering, Inc.**

Mike Herzog

November 3, 1994
Commission No. 2449-01-01-02B

Brittany Knolls Land L.L.C.
c/o Western States Consultants, Inc.
5555 DTC Parkway, Suite C-3009
Englewood, Colorado 80111

OK

RE: Revised Pavement Recommendations for a portion of Brittany Knolls First Filing, Larimer County, Colorado

Gentlemen:

As you know, we have made recommendations for the pavement for the roadway in our letters (2449-01-01-02, dated September 29, 1994 and 2449-01-01-02A, dated October 28, 1994). Our design was based on an R-value of 12.9. The City of Fort Collins Engineering Department disagreed with the test results and requested an additional R-value for comparison. The Engineering Department also requested a swell-consolidation test on the subgrade soils although expansion pressure tests were conducted for the R-value test. They also requested clarification of why a perched water table is not anticipated on the street subgrades.

This letter is to address these concerns and provide alternative recommendations so that the paving project may be completed in a timely manner. We have conducted two (2) swell-consolidation tests on the subgrade soils as requested by the City of Fort Collins. The swell tests indicate 0.2% to 0.3% swell at a 500 psf surcharge on both samples. We consider this to be insignificant swell. Therefore, no special procedures (other than controlling the moisture contents) need be taken during the paving preparation. We have arbitrarily used an R-value of 5, which is the lowest reportable R-value, for this revised design. Using an R-value of 5, we make the following revisions.

	<u>Option 1</u>	<u>Option 2</u>	<u>Option 3</u>
HBP	3"	4"	6"
ABC	12"	7"	--
TOTALS	15"	11"	6"

The City Engineers prefer to have roadbase underneath the pavement and not a full depth asphalt section. This is due to their perception that the soils on this site are highly expansive. Test data say otherwise. The roadbase would help the flexibility of the pavement structure should swelling of the subgrade occur. As discussed above, we feel that swelling will be minimal.


November 3, 1994
Commission No.: 2449-01-01-02B
Page 2

We feel that the formation of a perched water table on the subgrade is not anticipated. The reason for this is: 1) the bedrock is a siltstone/sandstone type and is not the impervious claystone-type bedrock where perched water tables are most often observed, and 2) most of the subgrade has been reworked during the installation of the sewer line, changing the structure of the materials and resulting in soil. We feel that these conditions are not conducive to the formation of a perched water table in shallow subgrade conditions.

We are providing this letter as an option so as to expedite the paving project. Your options are to either persuade the City of Fort Collins Engineers to accept the original pavement recommendations using the higher R-value of 12.9 (and conducting another R-value) or use these recommendations using the lower R-value of 5. It should be noted that the procedures used for design of the pavement structures were conducted in accordance with the City of Fort Collins Standards and CDOT Procedures.

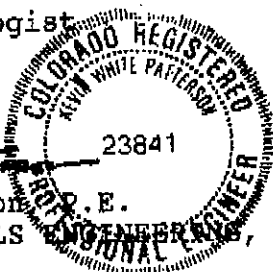
Refer to the previous pavement recommendations for material requirements and other recommendations. If you have any questions, please feel free to call.

Respectfully,


Thomas W. Finley,
Engineering Geologist

Reviewed by:

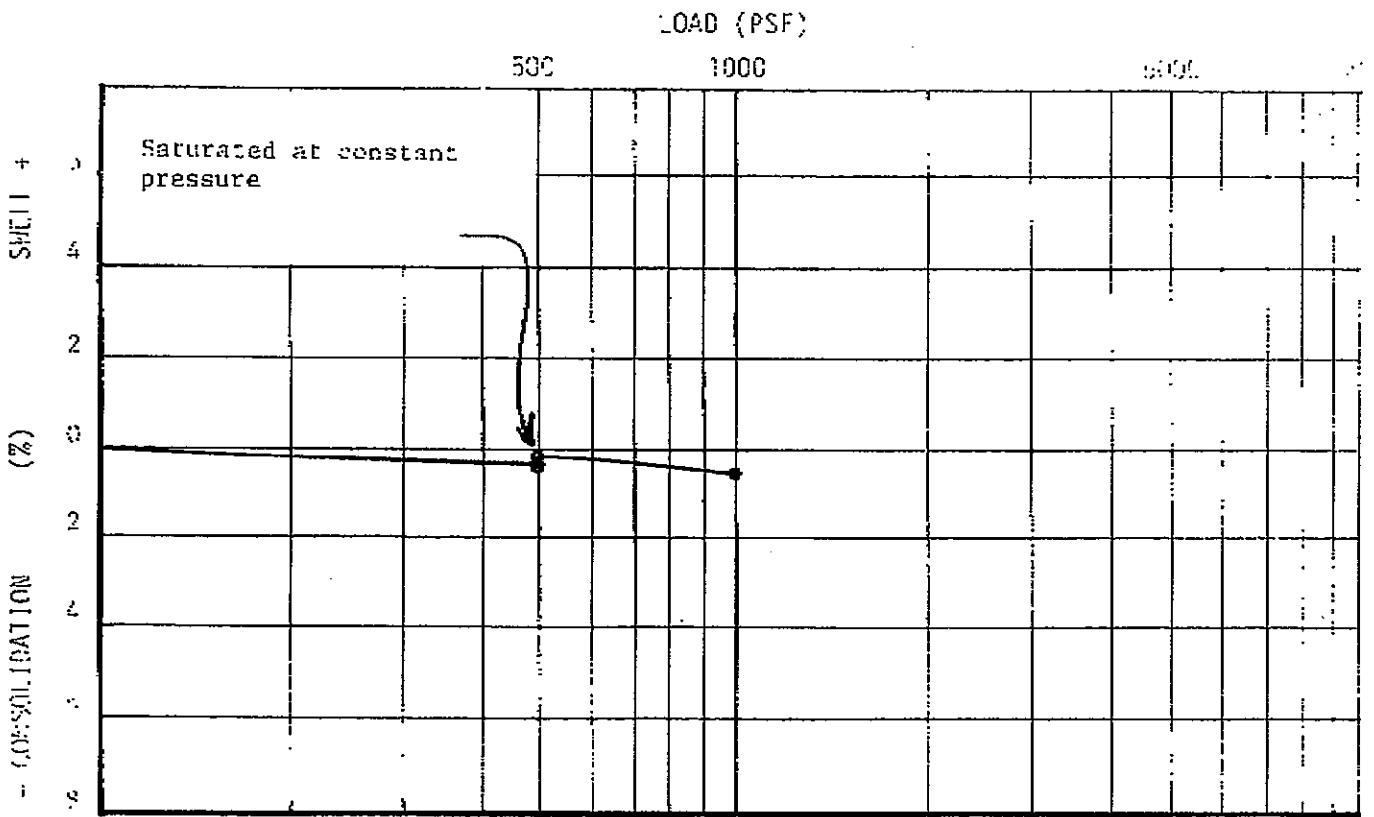

Kevin W. Patterson, P.E.
FOUNDATION & SOILS ENGINEERING, INC.



TWF\jlb

Date November 3, 1994
Commission File 2449-01-01-02B

SWELL-CONSOLIDATION



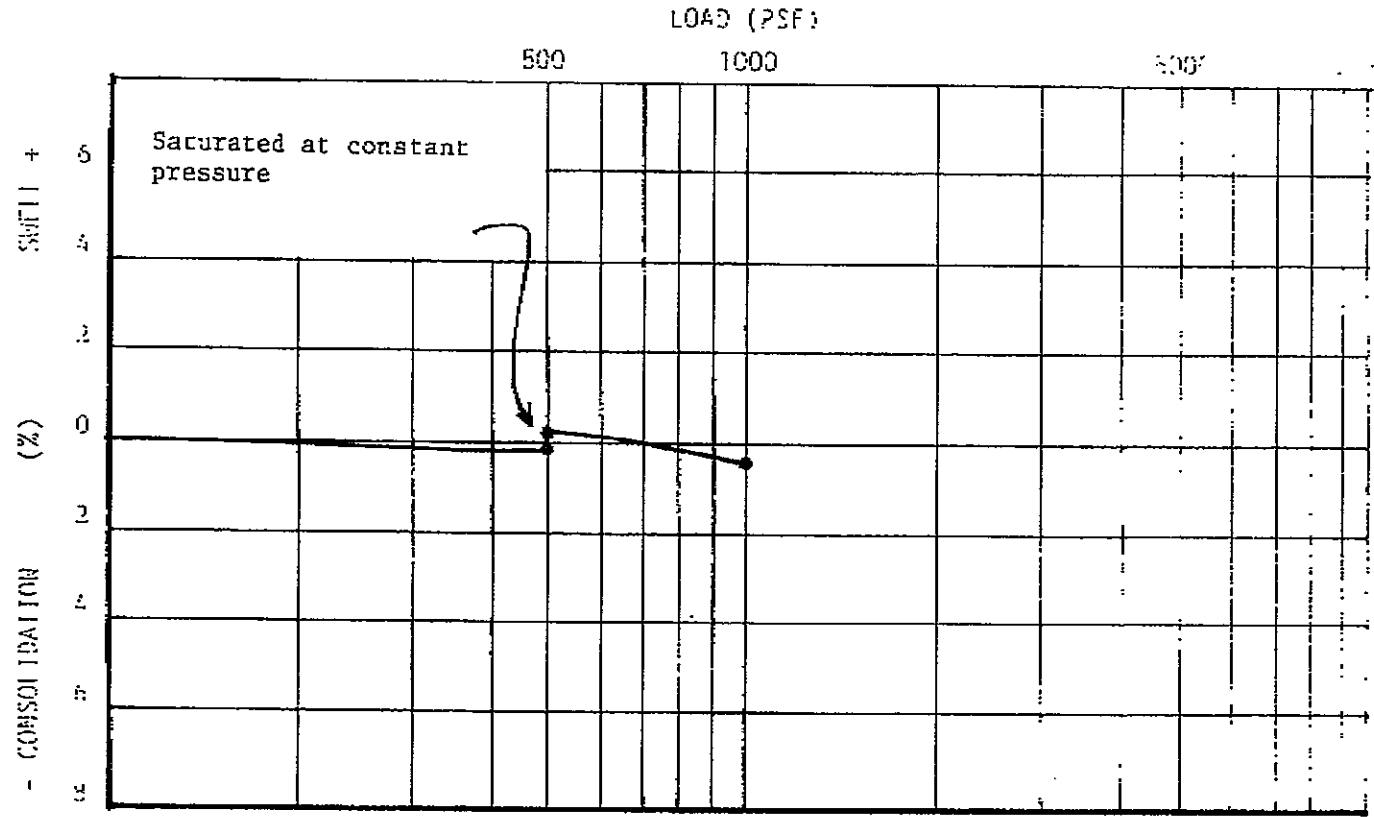
FOUNDATION ENGINEERING

111.1

SAMPLE OF BRICK-CLAY SLTSTONE FROM TEST HOLE NO. HEND COURTENAY
 AT DEPTH OF 5.6 FEET NATURAL MOISTURE CONTENT 15.3 NATURAL DR. POINT 111.6

November 3, 1994
Commission No. 2449-01-01-028

SWELL-CONSOLIDATION



SAMPLE OF BACKFILL SAND, CLAY & SILTSTONE FROM TEST HOLE NO. COURTNEY & WESTBOWELL
 DEPTH OF 5.6 FEET NATURAL MOISTURE CONTENT 15.2 NATURAL BR. DENS. 109.6

FOUNDATION ENGINEERING

2