CITY OF DULUTH
Planning Division

411 W 1st St, Rm 208 * Duluth, Minnesota 55802-1197
Phone: 218/730.5580 Fax: 218/723-3559

STAFF REPORT

File Number	PL 14-034	**Contact**	Jenn Reed Moses, jmoses@duluthmn.gov		
Application Type	Shoreland Variance	**Planning Commission Date**	May 13, 2014		
Deadline for Action	**Application Date**	April 8, 2014	**60 Days**	June 7, 2014	
	Date Extension Letter Mailed	April 22, 2014	**120 Days**	August 6, 2014	
Location of Subject	1726 Piedmont Ave				
Applicant	Dennis Michaud	**Contact**	boman12120@yahoo.com		
Agent	Kate Kubiak, South St. Louis SWCD	**Contact**	218-723-4946; kate.kubiak@southstlouisswcd.org		
Legal Description	010-2880-00270				
Site Visit Date	N/A	**Sign Notice Date**	April 22, 2014		
Neighbor Letter Date	April 24, 2014	**Number of Letters Sent**	32		

Proposal

A variance to build a retaining wall and add fill in an area compromised by the June 2012 Flood. The retaining wall will help with slope stabilization. Retaining wall would be built so that the base of the rip-rap will be 25 feet from the stream, which is less than the required structure setback of 150 ft. Two 15-foot tall wall sections will be built with a bench in between.

	Current Zoning	Existing Land Use	Future Land Use Map Designation
Subject	R-1	Residential	Traditional Neighborhood/Preservation
North	R-1	Residential	Preservation
South	R-1	Residential	Traditional Neighborhood/ Preservation
East	R-1	Residential	Traditional Neighborhood/ Preservation
West	R-1	Residential	Traditional Neighborhood

Summary of Code Requirements (reference section with a brief description):

50-18.D - Structure setback for a coldwater river is 150 feet.

50-37.9.C. - General Variance Criteria (paraphrased here): Granting of variances of any kind is limited to situations where, due to characteristics of the applicant's property, enforcement of the ordinance would cause the landowner practical difficulties or undue hardship. The Planning Commission must find the following for a variance to be granted: a) That they are proposing to use the property in a reasonable manner, b) that the need for relief from the normal regulations is due to circumstances unique to the property and not caused by the landowner, c) that granting the variance will not alter the essential character of the area, d) that granting the variance is consistent with the intent of the UDC and the Comprehensive Plan.

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Comprehensive Plan Findings (Governing Principle and/or Policies) and Current History (if applicable):

Future Land Use - Traditional Neighborhood: Characterized by grid or connected street pattern, houses oriented with shorter dimension to the street and detached garages, some with alleys. Limited commercial, schools, churches, and home businesses.

Future Land Use - Preservation: Lands with substantial restrictions. High natural resource or scenic value, or severe development limitations. Primarily public lands but limited private use is anticipated subject to use and design controls.

Discussion (use numbered or bullet points; summarize and attach department, agency and citizen comments):

Staff finds that:

1.) This property was severely damaged during the June 2012 flood, with approximately 30 feet of the rear of the property sloughing into the ravine below. As a result, the garage is currently suspended over the collapsed bank.

2.) An analysis by Barr Engineering shows that installing a retaining wall provides the highest benefits to the property as well as to Miller Creek. The retaining wall will stabilize the garage and prevent further erosion into Miller Creek.

3.) This variance will not alter the essential character of the area, as the project will occur on the rear of the lot, in a location hidden from the road and neighbors.

4.) Variances to shoreland setbacks require mitigation. According to Kate Kubiak of the South St. Louis Soil and Water Conservation District, this project will itself mitigate the effects of stormwater runoff from the site by stabilizing the slope and preventing further erosion into Miller Creek. City staff is not requesting any additional landscaping or further mitigation.

5.) Use of the property as a single-family house and garage is reasonable in an R-1 district.

6.) Need for a variance is not caused by the landowner, but was caused by the June 2012 flood.

7.) No public, agency, or City comments were received.

8.) Per UDC Sec. 50-37.1.N, approved variances lapse if the project or activity authorized by the permit or variance is not begun within 1 year.

Staff Recommendation (include Planning Commission findings, i.e., recommend to approve):

Based on the above findings, Staff recommends that Planning Commission approve the variance to build a retaining wall 25' from the property line, subject to the following conditions:

1.) The project be limited to, constructed, and maintained according to the site plan submitted March 28, 2014.

2.) Any alterations to the approved plans that do not alter major elements of the plan may be approved by the Land Use Supervisor without further Planning Commission approval; however, no such administrative approval shall constitute a variance from the provisions of Chapter 50.

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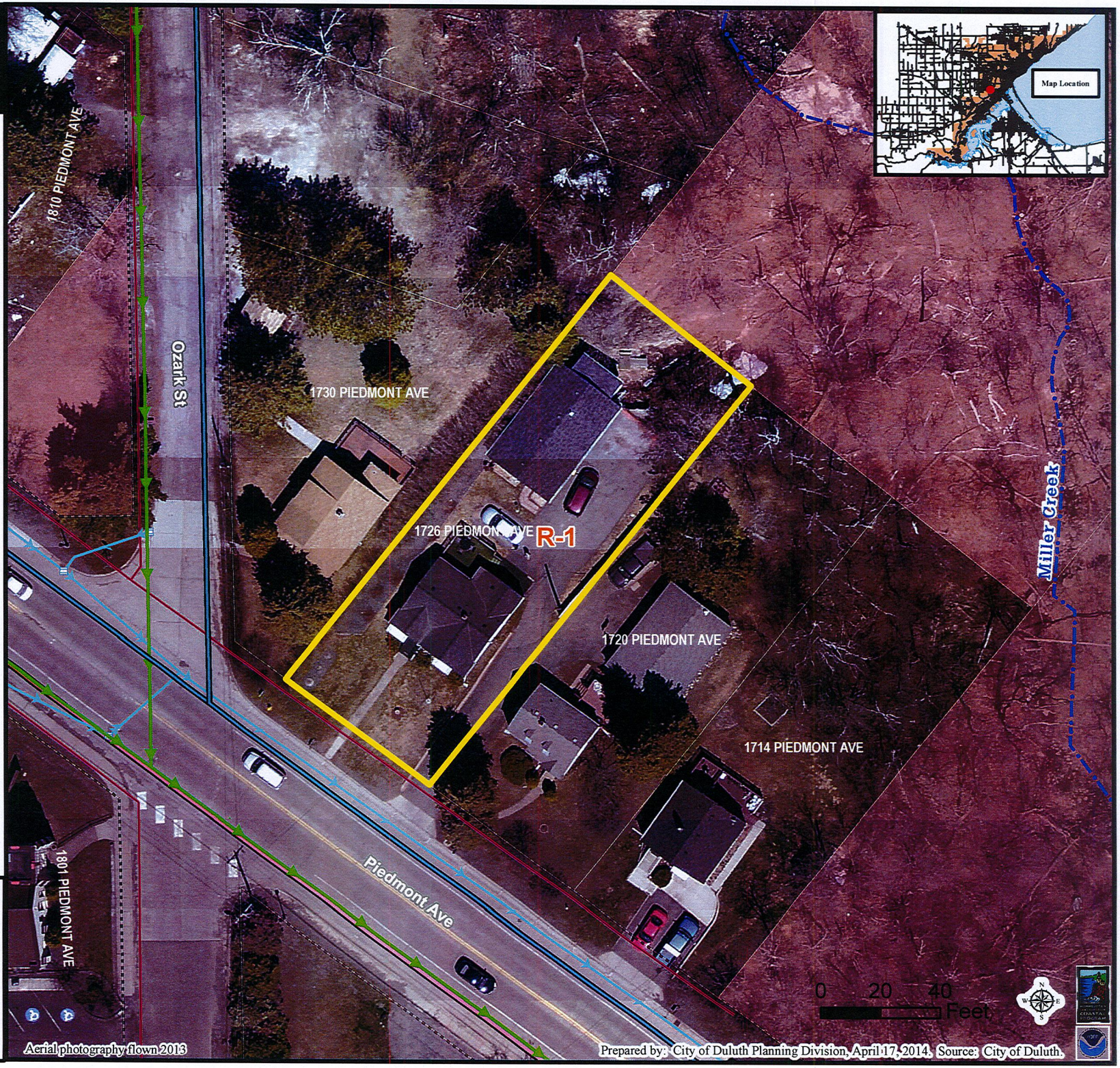
Attachments (aerial photo with zoning; future land use map; site plan; copies of correspondence)

City Planning

PL 14-034
1726 Piedmont Avenue



Legend

- Zoning Boundaries

Stream Type
- Trout Stream (GPS)
- Other Stream (GPS)

Water Distribution System
- 30 - 60" Water Pipe
- 16 - 24" Water Pipe
- 4 - 6" Water Pipe

Sanitary Sewer Collection System
- Sanitary Sewer Collector
- Sanitary Sewer Interceptor
- Sanitary Sewer Forced Main
- Storage Basin
- Pump Station (PS)

Gas Distribution Main
- 8" - 16" Gas Pipes
- 4" - 6" Gas Pipes
- 0" - 4" Gas Pipes

Storm Sewer Collection System
- Storm Sewer Pipe
- Storm Sewer Catch Basin
- Discharge_Points

Right-of-Way Type
- Road or Alley ROW
- Vacated ROW

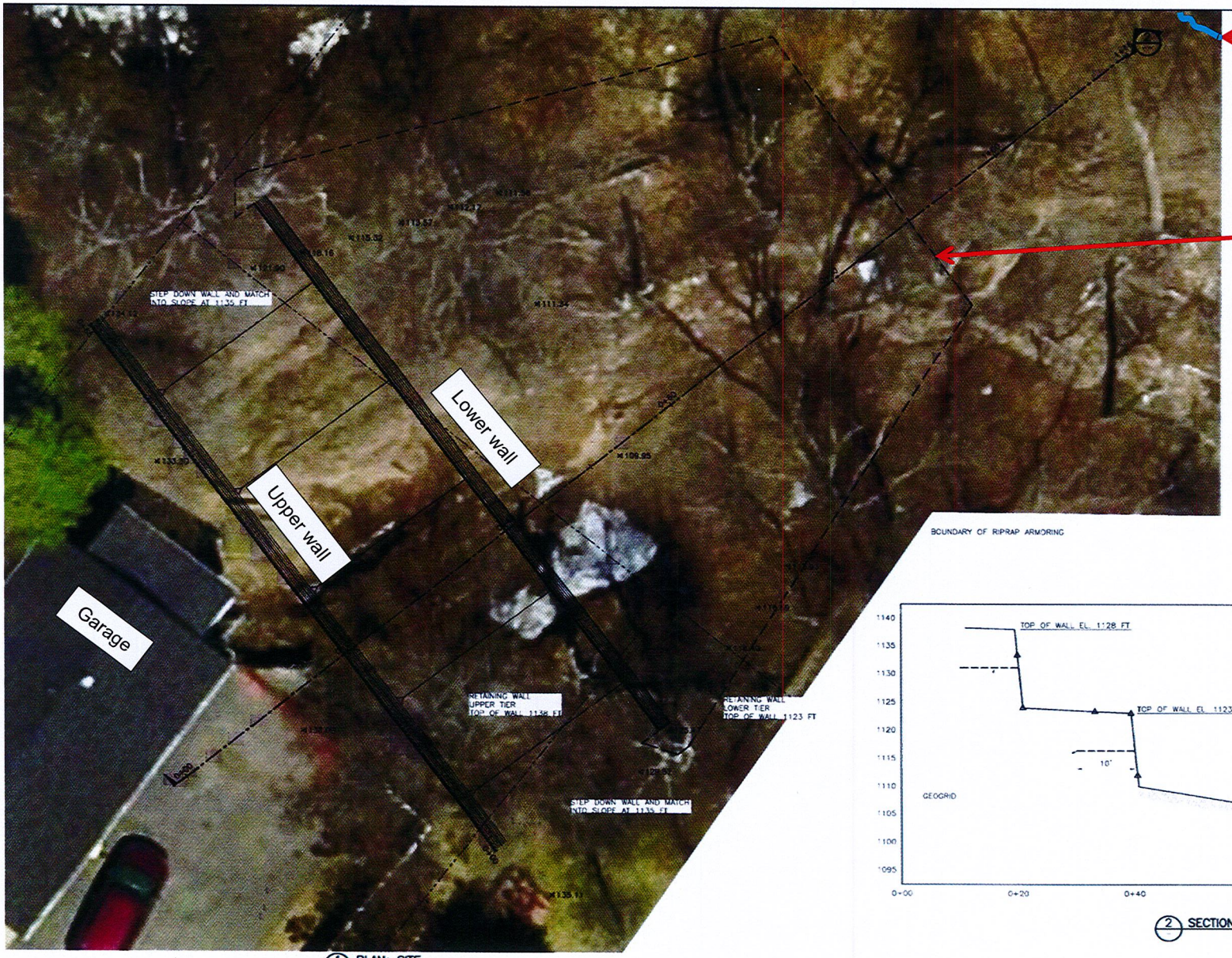
Easement Type
- Utility Easement
- Other Easement

Floodplain Type
- General Flood Plain
- Flood Way
- Flood Fringe

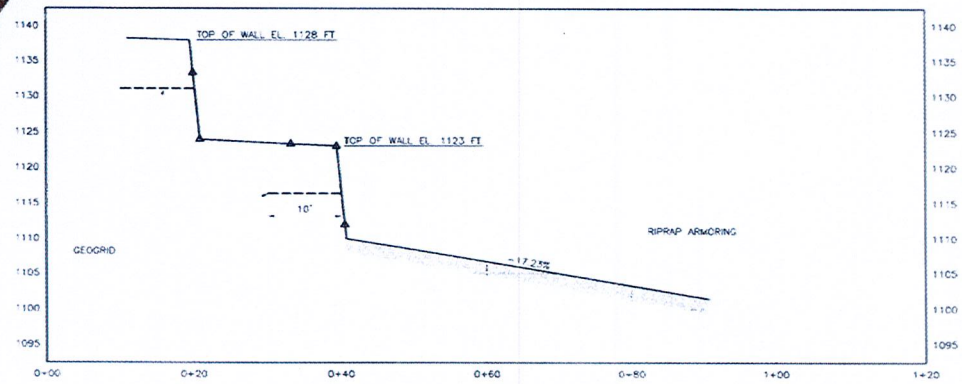
5-3

S-4


08/12/2012



1 PLAN: SITE



2 SECTION: SLOPE STABILIZATION

PRELIMINARY DRAFT 03/05/14

NO.	BY	CHK	APP.	DATE	REVISION DESCRIPTION

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.

SIGNATURE

PRINTED NAME

DATE REG. NO.

CLIENT
BID
CONSTRUCTION

RELEASED TO/FOR

A B C 0 1 2 3

DATE RELEASED

Corporate Headquarters: Minneapolis, Minnesota Ph: 1-800-632-2277

Project Office:
BARR ENGINEERING CO.
4700 WEST 77TH STREET
MINNEAPOLIS, MN.
55435-4803
Ph: 1-800-632-2277
Fax: (952) 832-2601
www.barr.com

Scale AS SHOWN
Date
Drawn
Checked
Designed
Approved

SLOPE STABILIZATION
1726 PIEDMONT AVENUE

PLAN AND SECTION

BARR PROJECT No.
CLIENT PROJECT No.
DWG. No.
REV. No

S-6

Dennis Michaud – 1726 Piedmont Ave., Duluth, MN
Variance Request Application submitted for May 13th, 2014 Planning Commission Meeting

Briefly describe the reasons for this request:

The Dennis Michaud property at 1726 Piedmont Avenue was severely damaged during the June 21st, 2012 flood. A large portion of the slope immediately behind the garage sloughed into the ravine (Miller Creek tributary) about 150 feet below. The neighboring property to the SE at 1720 Piedmont (Jim Winklesky) is also slightly affected. Mr. Michaud lost approximately 30 feet of his property off of the back (northeast) part of his lot, including the back of his garage, which is currently suspended over the collapsed bank (see attached photos). The City instructed Mr. Michaud to vacate the compromised garage due to the damages in June of 2013.

The South St. Louis Soil and Water Conservation District has funding available to help Mr. Michaud fix the damage as appropriated by the State of MN through the Board of Water and Soil Resources. BARR Engineering has completed a Slope Stability Evaluation (attached) of the damage and a Conceptual Retaining Wall Design (see attached) as requested by the South St. Louis SWCD for the purposes of this request. The Soil and Water Conservation District Board and Staff are supportive of the retaining wall option and are available to continue to assist Mr. Michaud and Mr. Winklesky with reviewing the wall design and supervising the installation of the wall to insure that Miller Creek is protected and that any potential erosion during construction is contained. The SWCD also believes that stabilizing this slope is the preferred alternative (vs a "no action" alternative) for the damage, as, left un-stabilized, the slope will continue to contribute sediment to Miller Creek as it erodes during heavy rain events. Leaving the slope un-stabilized will also jeopardize Mr. Michaud's and, possibly, Mr. Winklesky's ability to refinance or sell their homes. Stabilizing the slope with the proposed retaining wall(s) will not only protect this tributary of Miller Creek but will also allow Mr. Michaud to re-build his garage on stable ground to a point of being useable again. The SWCD staff does not forsee any negative impact to the neighborhood as the project will occur behind the Michaud and Winklesky lots in an area that is hidden from the road and neighbors. The SWCD believes that the project will have a positive impact on the neighborhood and on the City as a whole, as stabilizing this eroded slope will keep eroded sediment from impacting Miller Creek during future rain events. A professionally engineered wall is also aesthetically preferable to a large, eroding slump.

Approximately 46 cubic yards of soil would be excavated/cut from the site in order to install the walls and re-shape the slope. The preliminary design plan for the proposed wall indicates that the excavated soil will be re-used as backfill. As shown in the attached conceptual design, riprap armouring will be installed at the base of the walls to provide additional stability and to protect the walls. The base / lower boundary of the rip-rap armouring will be about 25 feet from the stream. The following criteria was used for the conceptual layout of the walls:

1. Two 15' (approx.) tall wall sections will be built with a bench between. Geogrid reinforcement for the walls was estimated at two-thirds the height of the walls.
2. The top of the uphill retaining wall is at elevation 1138 feet to match the driveway elevation.
3. The closest wall dimension from the corner of the garage is about 5 ft. The existing shed attached to the northeast end of the garage will have to be demolished in order to construct the wall. A safety fence will be required along the top of the upper wall.

Thank you for considering this request.

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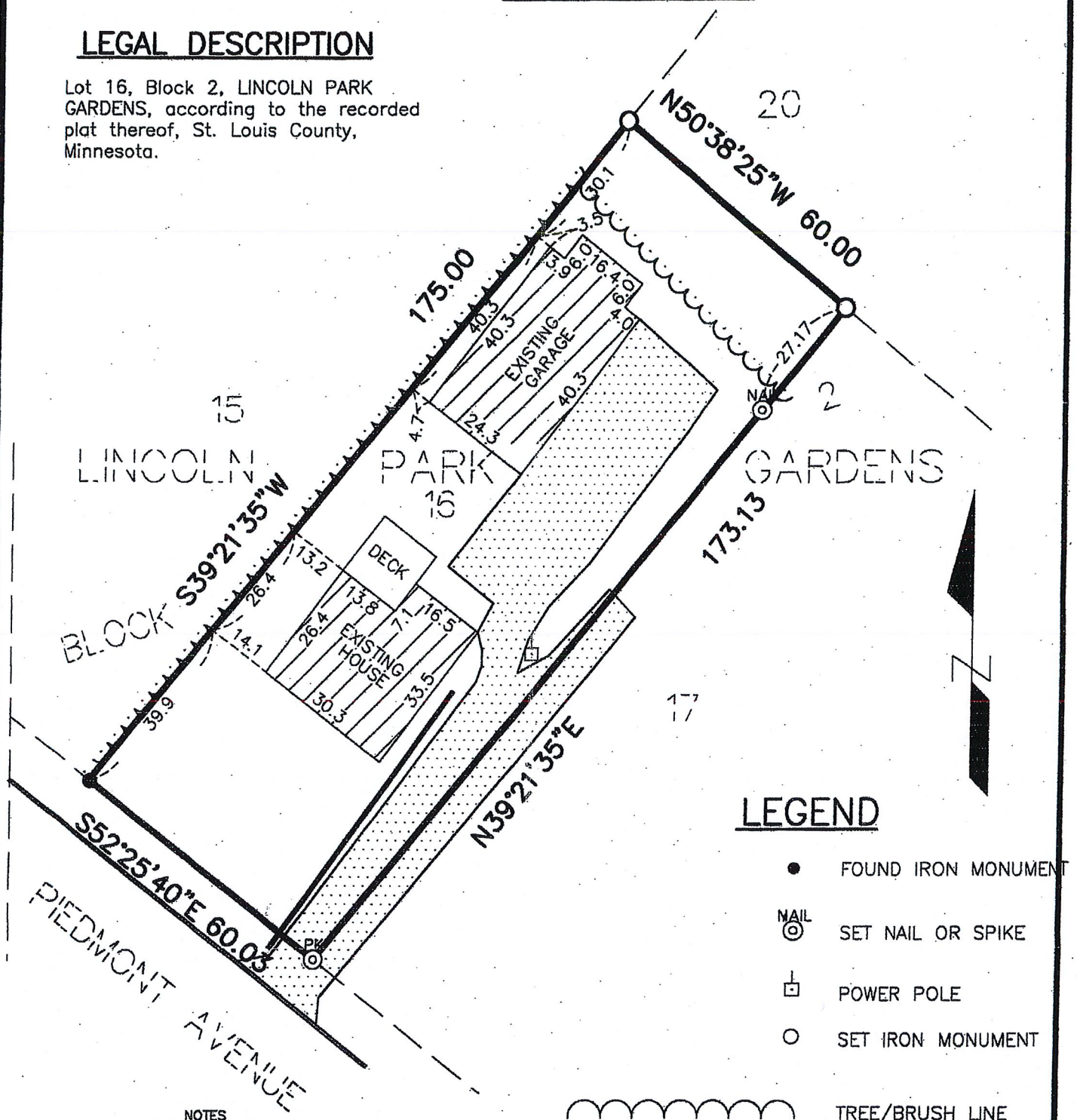
RECEIVED APR 0 8 2014

SURVEY FOR: DENNIS MICHAUD

LEGAL DESCRIPTION

Lot 16, Block 2, LINCOLN PARK GARDENS, according to the recorded plat thereof, St. Louis County, Minnesota.



LEGEND

- FOUND IRON MONUMENT
- NAIL — SET NAIL OR SPIKE
- POWER POLE
- SET IRON MONUMENT
- TREE/BRUSH LINE
- EXISTING BITUMINOUS

1 INCH = 30 FEET

NOTES

BEARINGS ARE BASED ON AN ASSUMED DATUM.

BUILDING DIMENSIONS SHOWN ARE FOR HORIZONTAL & VERTICAL PLACEMENT OF STRUCTURE ONLY. SEE ARCHITECTURAL PLAN FOR BUILDING & FOUNDATION DIMENSIONS.

THIS SURVEY HAS BEEN PREPARED WITHOUT BENEFIT OF A TITLE COMMITMENT OR TITLE OPINION. A TITLE SEARCH FOR RECORDED OR UNRECORDED EASEMENTS WHICH MAY BENEFIT OR ENCUMBER THIS PROPERTY HAS NOT BEEN COMPLETED BY ALTA SURVEY COMPANY, INC.

CLIENT
MICHAUD

SHEET # 1 | PROJ # 06-066

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly registered land surveyor under the laws of the State of Minnesota.

DATE 4/8/14 REGISTRATION NO. 14374

ALTA
SURVEY COMPANY, INC.
LAND SURVEYING, LAND DEVELOPMENT, LEGAL DESCRIPTIONS
4929 MATTERHORN DRIVE DULUTH, MN 55811
PHONE: (218) 727-5941 FAX: (218) 727-3798

resourceful. naturally.
engineering and environmental consultants

BARR

August 16, 2013

Mr. R.C. Boheim, District Manager
South St. Louis County Soil and Water Conservation District
215 North 1st Avenue East, Room 301
Duluth, Minnesota 55802

Re: Slope Stability Evaluation
1726 Piedmont Avenue
Duluth, MN 55811

Mr. Boheim,

Barr Engineering Co. (Barr) is pleased to submit this letter report regarding the results of our subsurface evaluation and field investigation for the above-referenced site. The purpose of our work was to obtain subsurface soil and groundwater conditions to evaluate the existing slope stability and to evaluate design alternatives with estimated costs. Our services were completed in general accordance with our proposal dated May 22, 2013.

Site and Description

The site is located on the northeast side of the property at 1726 Piedmont Avenue in the City of Duluth, St. Louis County, Minnesota as shown on Figure 1. The property is developed with a single-story wood-framed residential home near Piedmont Avenue, which also has a single-story garage located at the crest of the existing slope at the rear of the property. The garage is supported on a slab-on-grade foundation.

Visual Review

At the rear of the property behind the garage, a slope extends down to the base of a naturally carved valley created by erosion of an unnamed tributary to Miller Creek. A large portion of this slope immediately behind the garage has sloughed into the valley from the June flood of 2012 leaving the garage in a precarious and exposed condition. An approximately 4 to 5-foot vertical scarp exists at the top of the slope, which extends to the eastern side of the garage. A wood-framed shed, which is attached to the northeast side of the garage, has been completely undermined by the slope failure and is hanging perilously in the air and supported with wood shoring. A wooden ramp, which extended from the shed and provided access to the shed, was destroyed when portions of the slope failed. The rear of the property and slope are located between two ridges on the northern and southern property lines, creating a natural eddy during the 2012 floods. This eddy action caused extensive damage to the existing vegetation and undercut the base of the slope, which in turn caused the upper slope soils to topple, resulting in the current condition. Besides the obvious undermining of the shed and wooden ramp, damage to the garage from the slope failure was not obvious during the initial site visit in April 2013. However, during the subsurface investigation in June 2013, an approximately ¼-inch crack was observed within the foundation located about 15 feet from the slope crest, suggesting that settlement or movement of the garage is occurring. The

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existing concrete slab-on-grade and paved driveway are likely providing stability to the crest of the slope; without such support, the slope failure would likely have extend further west toward the home than its current location.

Subsurface Investigation

The geotechnical investigation consisted of a standard penetration test (SPT) boring advanced with a CME 55 truck-mounted drill rig using hollow-stem auger drilling methods. Soil sampling and classification was generally performed continuously to a depth of 22 feet and at 5-foot intervals thereafter to a final depth of 51.3 feet in accordance with ASTM D-1586. The test boring, identified as PA-1-13, was advanced within the existing driveway approximately 15 feet from the crest of the slope. Figure 2 depicts the boring location.

Bulk sampling and laboratory testing was also performed. The site investigation was conducted on June 20, 2013 under subcontract by Barr with equipment owned and operated by EPC Engineering & Testing (EPC) of Duluth, Minnesota. Barr directed and monitored the investigation. Laboratory testing which was requested by Barr was completed by EPC in July 2013.

A summary of the geotechnical investigations is below:

Test ID	Coordinates, NAD83		Surface Elevation [feet]
	Latitude	Longitude	
PA-1-13	46.775714	-92.147327	1,138

The soils encountered at the site are native glacial till varying from a sandy lean clay, silty sand with varying amounts of gravel, sandy lean clay with gravel, to poorly-graded sand with gravel. The glacial till extends beyond the depth of the boring, which was terminated at a depth of 51.3 feet below existing grade. The consistency of the sandy lean clay above a depth of about 4 feet was stiff to very stiff based on the recorded N-values. Below 4 feet, the relative density of the silty sand increased with depth from medium dense to very dense. The relative density and consistency of the remaining soil layers below a depth of 12 feet to the termination depth were generally very dense or hard. Groundwater was encountered at a depth of 32.4 feet immediately following drilling activities. The borehole was left open overnight in an attempt to measure a stabilized phreatic surface. Groundwater was measured at approximately 27.8 feet (Elevation 1110.2) approximately 24 hours following drilling; however, groundwater levels will fluctuate throughout the year with variations in precipitation, evaporation, and surface runoff. Furthermore, groundwater will likely seasonally perch above the relatively impermeable layers within the glacial till.

Field Testing

The in-situ density/consistency of the glacial till soils at the site precluded the use of thin-walled Shelby tube samples to evaluate strength properties of the soils, which is typically utilized when performing slope stability analysis. As such, field testing was utilized to evaluate the in-situ strength of the soils under various loading conditions without the need to obtain undisturbed samples for laboratory testing.

The Iowa Borehole Shear Test (BST) was performed adjacent to the existing boring at two depths, 7 feet and at 13.25 feet. The BST consists of inserting a shear head into a 3-inch diameter opening (made with the use of a California style split-barrel sampler), applying a normal stress, allowing the soils to

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consolidate for a period of time, and then pulling the shear head upward until shear failure of the sidewalls occurs. The test is repeated various times at each depth interval with increased normal stresses applied until an accurate plot of shear stress verses normal stress can be obtained.

Results of the BST indicate the drained friction angle for the glacial till, ranges from approximately 25.2 to 31.2 degrees. Because of the granular nature of the glacial till at the test location depths, and the tests being conducted in a drained condition, cohesion was not measured in the glacial till. These values were utilized in the slope stability calculations and evaluation.

Laboratory Testing

Laboratory compaction testing was performed on single bulk sample, acquired from within the native glacial till above a depth of 5 feet. The soil was classified as Sandy Clay (CL). The maximum dry density of the sample compacted with standard Proctor (ASTM D698) effort was found to be 130.4 pcf, with corresponding optimum moisture content of 8.1 percent, and if further described below:

Summary of Proctor Test Result

Sample ID	Sample Depth (feet)	Soil Type (USCS)	Maximum Dry Density - Modified Proctor (pcf)	Optimum Moisture Content (%)
PA-1-13	Composite 1 to 5 feet [1,137 to 1,133]	CL	130.4	8.1

This value (or percentage of) was used as an input parameter in our slope stability calculations.

Slope Stability Evaluation

Slope stability analyses were performed to evaluate the stability of the existing slope. A representative cross-section, taken from the results of the laser survey collected by Barr on June 24, 2013, was used to represent the overall slope condition and geometry. The cross-section used in the analysis is illustrated on Figure 3.

The stability of the slope was analyzed using SLOPE/W software, which is part of the GeoStudio 2007 suite or programs developed by Geo-Slope International of Calgary, Canada. The computer program uses two-dimensional limit-equilibrium methods to perform the analysis. The Morgenstern-Price method was used to compute the Factor of Safety against slope failure under normal loading conditions. For the analyses, groundwater was assumed to be at approximately elevation 1,110 feet based on the measured groundwater level within the test boring. Native glacial till was estimated to have a cohesion of 0 psf, a friction angle ranging between 25 and 31 degrees, and a total unit weight of 125 pounds per cubic foot (pcf). A uniform surcharge load of 120 psf was also modeled at the top of the slope to simulate the building load associated with the existing garage.

A factor of safety (FOS) equal to or greater than 1.5 against global slope failure under normal loads is considered adequate for long-term stability. Based on the method used for this analysis, the current slope has a FOS of just over 1.5 for global (large-scale) stability, but just over 1.0 for shallow sloughing failures

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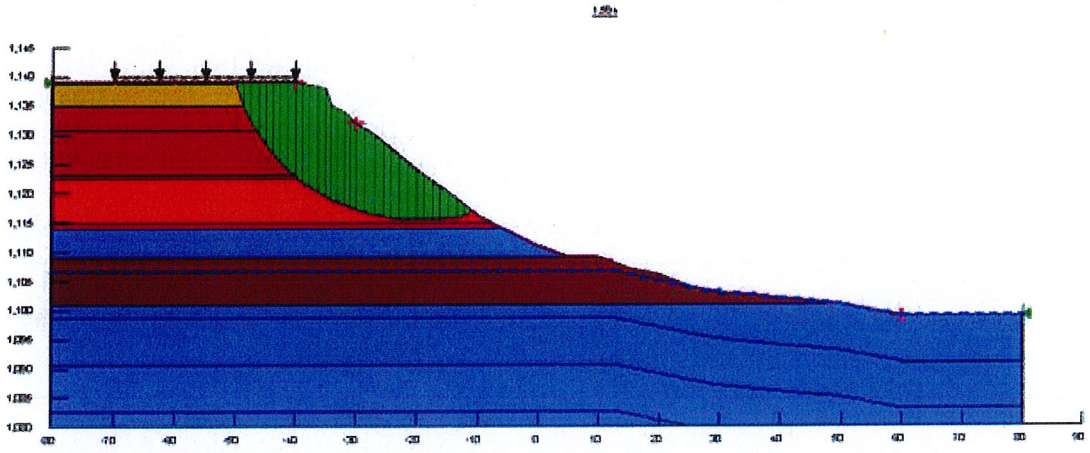
of near surface soils. However, the analysis is a "snapshot" in time and represents the geometry and soil conditions at the time of the subsurface investigation and survey. External forces are the greatest risk to long-term stability for this slope. Forces such as wind, rain, snow, drainage, and freezing temperatures are not easily modeled with available slope stability computer programs because the frequency and intensity can change dramatically over time. Additionally, the lack of surface vegetation, which tends to "knit" the soils together, will negatively impact the stability over the long-term. Near surface surficial sloughing will continue indefinitely because of the exposed nature of the slope. These surface sloughing failures cause an immediate threat to the safety of the existing garage.



Output from GeoStudio 2007 SLOPE/W

Recommendations

The near surface soils within the slope are in a state of failure with the current having a factor of safety just over 1.0 (incipient failure and expected). The existing garage structure (or portions of) and portions of the driveway are in imminent risk of toppling should additional slope movement occur. The relatively dense glacial till overburden soils provide moderate protection against a deep-seated global stability failure. Vegetation, specifically large diameter trees and their roots that extend into the overburden soils were toppled during the flood or as a result of the recent slope failures. This lack of substantial vegetation further de-stabilized the slope. Continued erosion associated with rain and surface drainage flow from the driveway and roof downspouts will continue to erode the slope indefinitely until a stable slope angle is achieved. We have provided the following alternatives with varying costs and benefits to address the current slope stability issue. The intent of these recommendations is to address long-term stability of the slope.

Option 1:

The slope could be left in its current state, recognizing that additional sloughing and erosion will occur. This erosion and sloughing will continue until the slope flattens to the soils angle of repose (a stable incline). Because of the granular nature of the glacial till and the relative density of the in-situ soils, this will likely occur at a slope of about 1.8H:1V to 2H:1V. Based on this stable slope

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geometry, approximately 20 to 30 additional feet of property at the crest of the slope would eventually slough into the creek. Because of this, the entire garage would likely have to be removed or will eventually topple into the ravine. Once the slope flattens out naturally and vegetation takes hold on the slope face, additional slope stability issues are negligible and would not threaten the safety of the existing residence. The timeframe of the slope erosion and sloughing depends on the amount of water allowed to flow over the face of the slope and cause erosion as well as seasonal effects such as wind, snow, and freezing temperatures. Additional flooding of the creek would also quicken the erosion process.

If salving the garage and driveway (or portions thereof) from the long-term effects of erosion and slope failures are deemed necessary and cost effective, the following two options are provided:

Option 2:
Place large diameter rip-rap along the face of the slope to increase long-term stability and provide additional means of erosion protection. This approach provides weight along the face of the slope to physically restrict further movement and increase the overall factor of safety while simultaneously adding an erosion resistant material to further limit mass wasting by overland flow and erosion of the toe by moving water caused erosion. Dual geotextile separation fabrics would be placed and secured to the slope prior to the rip-rap placement to provide erosion control during construction as well as to prevent migration of fine-grained soils within the slope through the rip-rap. The slope geometry may have to be flattened or terraced in order to allow equipment access and to place the separation fabric prior to the placement of rip-rap stones. Depending on the actual size of the rip-rap stones and final geometry of the slope, grouting of the rip-rap may be required. A drainage swale would also be constructed along the crest of the slope to channel surface flows to a specific area of the slope to minimize the amount of water flowing over the face of the slope. This option would require a portion of the existing garage to be demolished in order to achieve a recommended minimum 15 foot setback from the slope crest. Existing land loss associated with the observed slope failure would not be recovered. Permits from the City of Duluth and the Minnesota Department of Natural Resources (DNR) would be required to complete this work.

Option 3:
A gravity retaining wall could be installed to stabilize the slope and provide long-term erosion control protection. The toe of the slope (below the wall) would be armored with rip rap or a cable-stayed concrete erosion mat to provide scour protection should a similar flood event occur during the serviceable life of the armor system. The retaining wall would be constructed with the base of the wall at approximately elevation 1,110 feet and extend to the existing driveway grade at approximately elevation 1,138 feet. A mechanically stabilized earth (MSE) wall could be constructed, which would allow for a near vertical wall face and maximum land recovery (up to about 20 feet). This type of wall requires the use of geotextile or geogrid reinforcement installed horizontally behind the wall to provide pull out and overturning resistance, which increases the amount of earthwork associated with construction. An alternative would be to construct a gabion basket wall, which is strictly a gravity type retaining wall that utilizes the weight of the stones installed within the gabion baskets to provide overturning resistance. The gabion basket wall would be constructed with an overall slope no steeper than 1H:1V, or preferably in a series of 6 to 8 foot terraces. Based on our preliminary layout, about 10 feet (horizontal) of land could likely be reclaimed using the gabion basket wall. Depending on the final layout of the retaining wall, reinforcement lengths, and required property line setbacks, the entire garage could likely be saved with the retaining wall option. However, if additional damage occurs to the garage prior to construction, demolition of portions of the garage could be inevitable. Permits from the City of Duluth and DNR would be required to complete this work.

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Cost Estimates

For the options listed above, we have provided a preliminary conservative cost estimate. These costs are based on our experience with similar projects and a review of publicly available average construction rates/costs in the State of Minnesota. Actual costs would require development of plans and specifications and solicitation of contractors for construction bids.

Option 1: remove garage / buy-out
We estimate that the cost to demolish and remove the garage would be less than about $5,000; however, the loss of value to the property from the lack of a garage and usable property is likely on the order of $40,000 to $70,000.

Option 2: riprap - part of garage removed
The estimated cost to perform the engineering, permitting, and construction would range from $80,000 to $110,000. Additional long-term maintenance costs are not anticipated.

Option 3: retaining wall
The estimated cost to perform the engineering and install the retaining wall would range from $95,000 to $130,000 and will depend on which type of retaining wall is chosen. Long-term maintenance is not anticipated.

We trust this letter satisfies your needs at this time. If you have questions or require additional information please contact Rob at (218) 529-7165 (or at rolah@barr.com) or Travis Davidsavor at (218) 529-7108 (or tdavidsavor@barr.com).

Sincerely,

Robert W. Olah, P.E.
Senior Geotechnical Engineer
Minnesota Registration No. 50619

Travis A. Davidsavor, P.E.
Senior Geotechnical Engineer
Minnesota Registration No. 44914

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Figure 1 – Site Location Map

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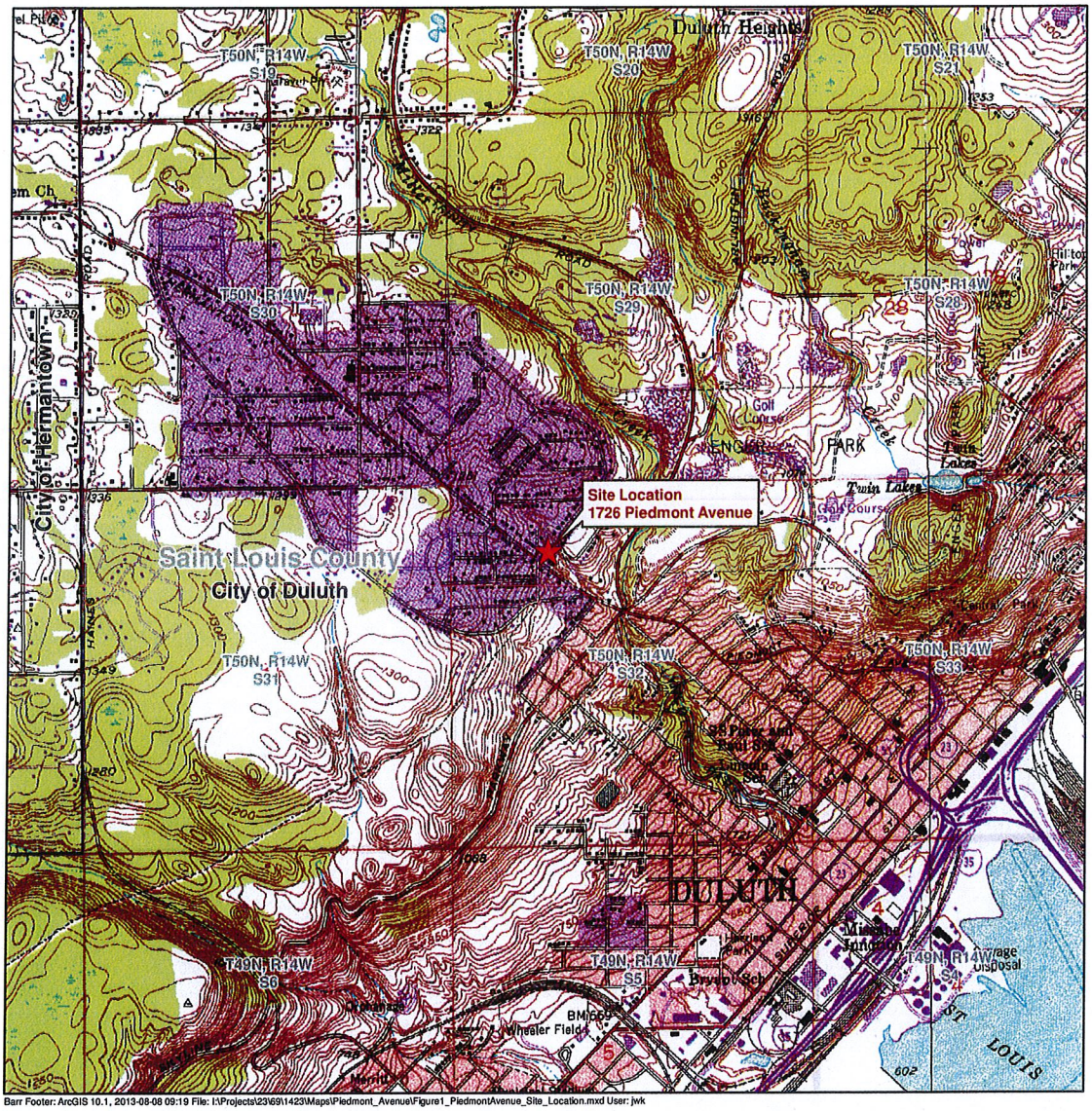

★ Site Location

N

0 2,000 4,000

Feet

1 Inch = 2,000 Feet

FIGURE 1

SITE LOCATION MAP

Geotechnical Investigation
1726 Piedmont Avenue
Duluth, Minnesota

BARR

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Figure 2 – Boring Location

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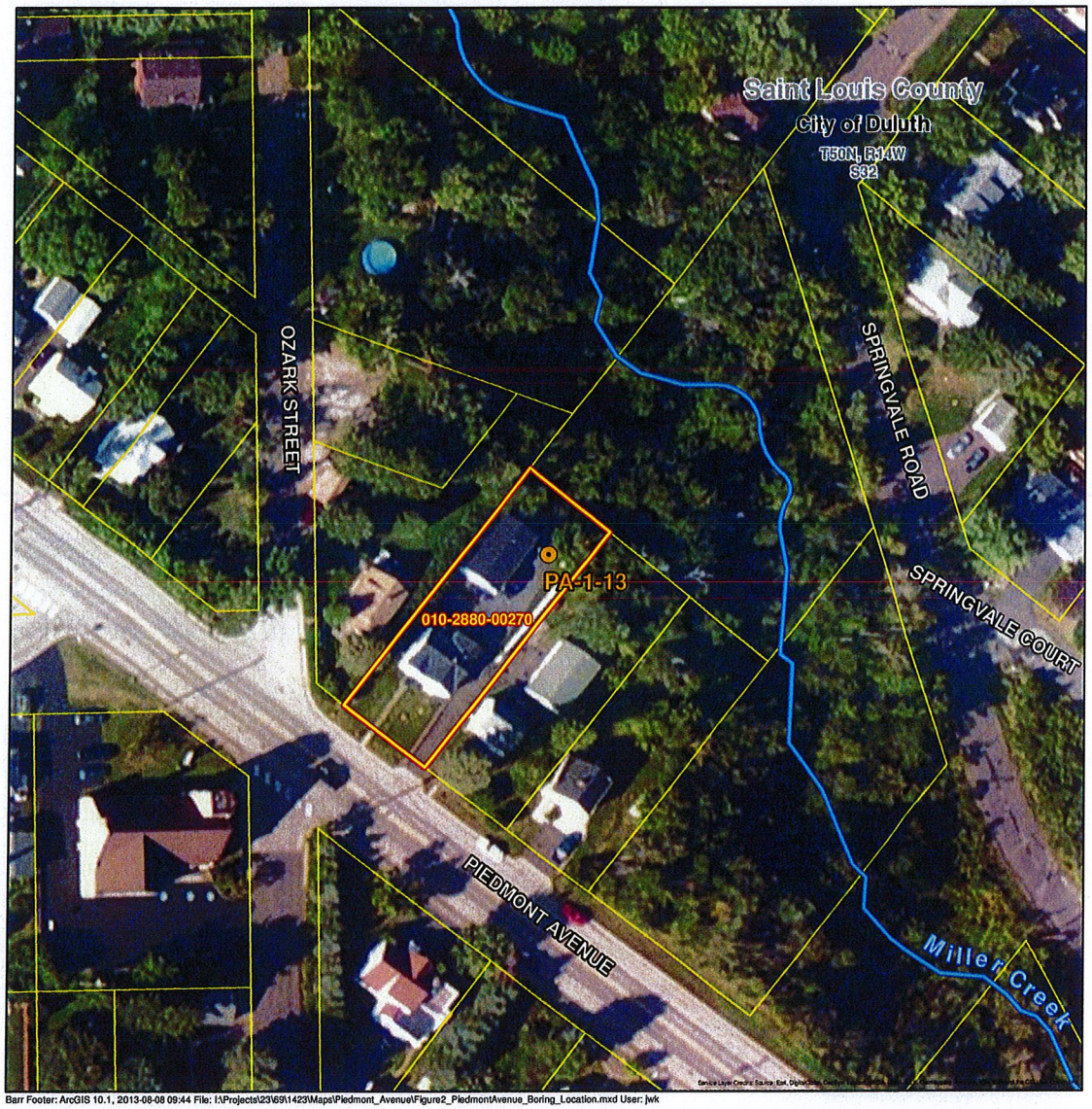

Boring Location

1726 Piedmont Avenue Parcel Boundary

Surrounding Parcels

Rivers and Streams

0 80 160

Feet

1 Inch = 80 Feet

ESRI World Imagery Circa August, 2011

Parcel data obtained from St. Louis County

FIGURE 2

BORING LOCATION

Geotechnical Investigation

1726 Piedmont Avenue

Duluth, Minnesota

BARR

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Figure 3 – Survey and Cross Sections

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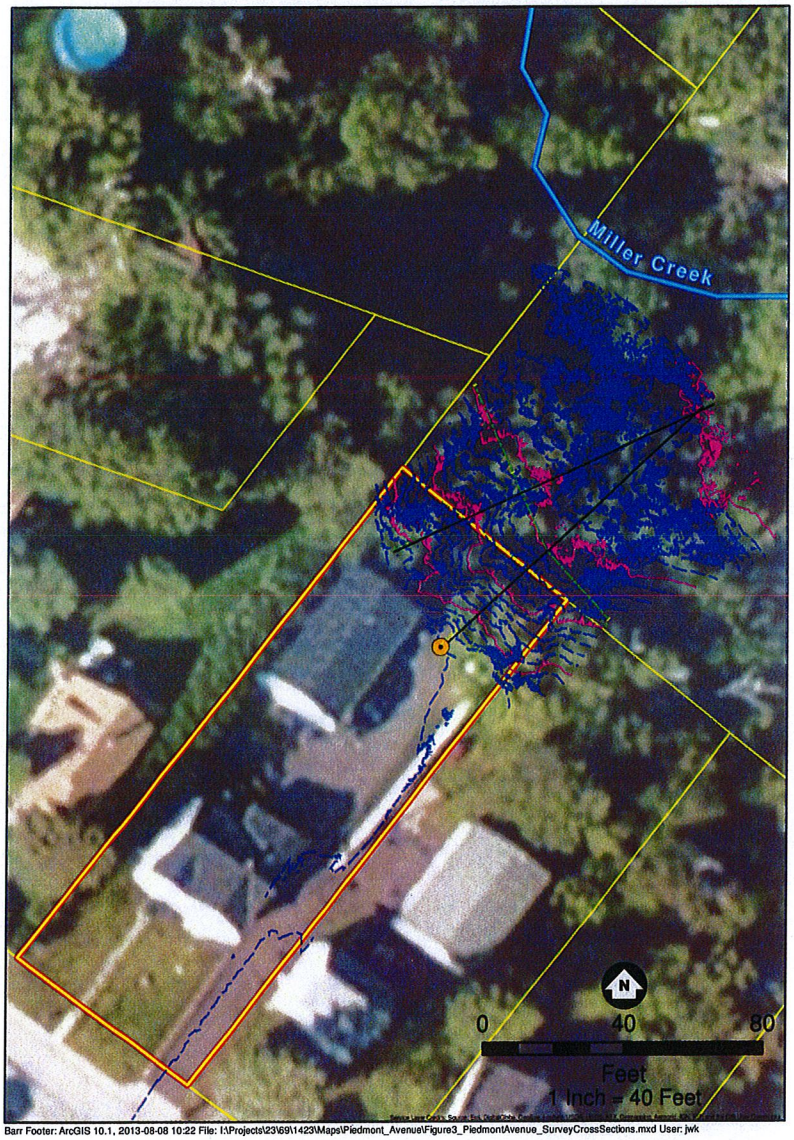

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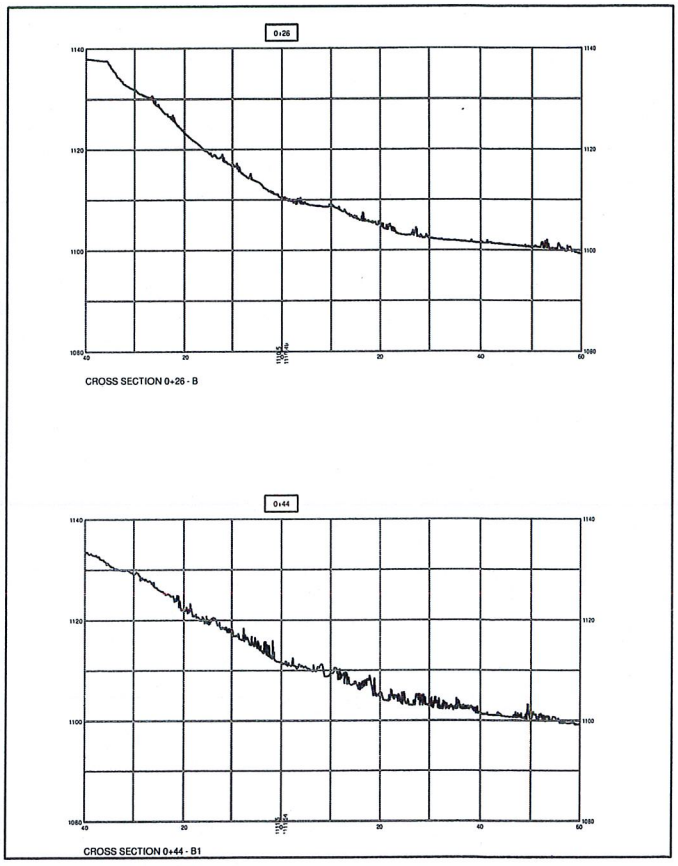

Boring Location

1726 Piedmont Avenue Parcel Boundary

Surrounding Parcels

Rivers and Streams

ESRI World Imagery Circa August, 2011
Parcel data obtained from St. Louis County

FIGURE 3

SURVEY AND CROSS SECTIONS
Geotechnical Investigation
1726 Piedmont Avenue
Duluth, Minnesota

BARR

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Attachment 1 – Test Boring Log

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Barr Engineering

LOG OF BORING PA-1-13

Sheet 1 of 2

Project: SSWCD - Slope Stability Evaluation | Location: 1726 Piedmont Avenue, Duluth, MN | Client: SSWCD

Barr Project Number: 23691423.01

Elevation, feet	Depth, feet	MATERIAL DESCRIPTION (ASTM D2488)	
		Surface Elev.:	
	0	ASPHALT.	0.2
		SILTY SAND WITH GRAVEL (SM): fine grained, reddish brown, dry.	0.4
		SANDY LEAN CLAY (CL): reddish brown, dry to moist.	
	5	SILTY SAND (SM): fine grained, reddish brown, dry to moist.	4.0
		8-9': fine to medium grained.	
	10	10-12': with lenses of silty clay.	
		12-16': with layers of poorly graded fine sand.	
	15	SILTY SAND WITH GRAVEL (SM): reddish brown, dry to moist.	16.0
	20		
	25	SANDY LEAN CLAY WITH GRAVEL (CL): reddish brown, moist.	25.0
	30	WELL GRADED SAND WITH GRAVEL (SW-SM): reddish brown, moist, with silt.	30.0

Continued Next Page

Graphic Log | Sample Type & Rec.

STANDARD PENETRATION TEST DATA — N in blows/ft ◎ (10, 20, 30, 40)

WATER CONTENT % — PL ⊢×⊣ LL (20, 40, 60)

SIEVE ANALYSIS — GRAVEL SAND SILT CLAY; FINES (20, 40, 60, 80)

Physical Properties	WC	γ	ϕ	Q_u	Q_p	Gs	RQD
	%	pcf	°	tsf	tsf		%
					1.5		
					1.5		

Completion Depth:	51.3
Date Boring Started:	6/20/13
Date Boring Completed:	6/20/13
Logged By:	RWO
Drilling Contractor:	EPC
Drilling Method:	HSA
Ground Surface Elevation:	

Remarks: 1726 Piedmont Avenue. Cobbles encountered during drilling between (hard drilling): 15-17', 23-24', 46-50'.

Weather: Scattered showers, mostly couldy, 50's

SAMPLE TYPES	WATER LEVELS		LEGEND	
Split Spoon	After Drilling	27.8	MC Moisture Content	Q_u Unconfined Compression
	At Time of Drilling	32.4	γ Dry Unit Weight	Q_p Hand Penetrometer UC
			ϕ Friction Angle	Gs Specific Gravity
				RQD Rock Quality Designation

The stratification lines represent approximate boundaries. The transition may be gradual.

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Barr Engineering

LOG OF BORING PA-1-13

Project: SSWCD - Slope Stability Evaluation | Location: 1726 Piedmont Avenue, Duluth, MN | Client: SSWCD

Barr Project Number: 23691423.01

Elevation, feet	Depth, feet	MATERIAL DESCRIPTION (ASTM D2488)	Graphic Log	Sample Type & Rec.	STANDARD PENETRATION TEST DATA (N in blows/ft ◎)	WATER CONTENT % (PL — LL)	SIEVE ANALYSIS (GRAVEL SAND SILT CLAY / FINES)	Physical Properties: WC %	γ pcf	ϕ °	Q_u tsf	Q_p tsf	Gs	RQD %
	35	PORLY GRADED SAND (SP): fine grained, reddish brown, wet, trace gravel. 33.0												
	40	SANDY LEAN CLAY WITH GRAVEL (CL): gray, wet. 38.0												
	45	SILTY SAND WITH GRAVEL (SM): fine grained, reddish brown, wet. 45.0												
	50	51.3												
	55													
	60													
	65													

Completion Depth: 51.3
Date Boring Started: 6/20/13
Date Boring Completed: 6/20/13
Logged By: RWO
Drilling Contractor: EPC
Drilling Method: HSA
Ground Surface Elevation:

Remarks: 1726 Piedmont Avenue. Cobbles encountered during drilling between (hard drilling): 15-17', 23-24', 46-50'.

Weather: Scattered showers, mostly couldy, 50's

SAMPLE TYPES	WATER LEVELS		LEGEND	
☒ Split Spoon	▽ After Drilling	27.8	MC Moisture Content	Q_u Unconfined Compression
	▼ At Time of Drilling	32.4	γ Dry Unit Weight	Q_p Hand Penetrometer UC
			ϕ Friction Angle	Gs Specific Gravity
				RQD Rock Quality Designation

The stratification lines represent approximate boundaries. The transition may be gradual.

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Attachment 2 – Field Test Data

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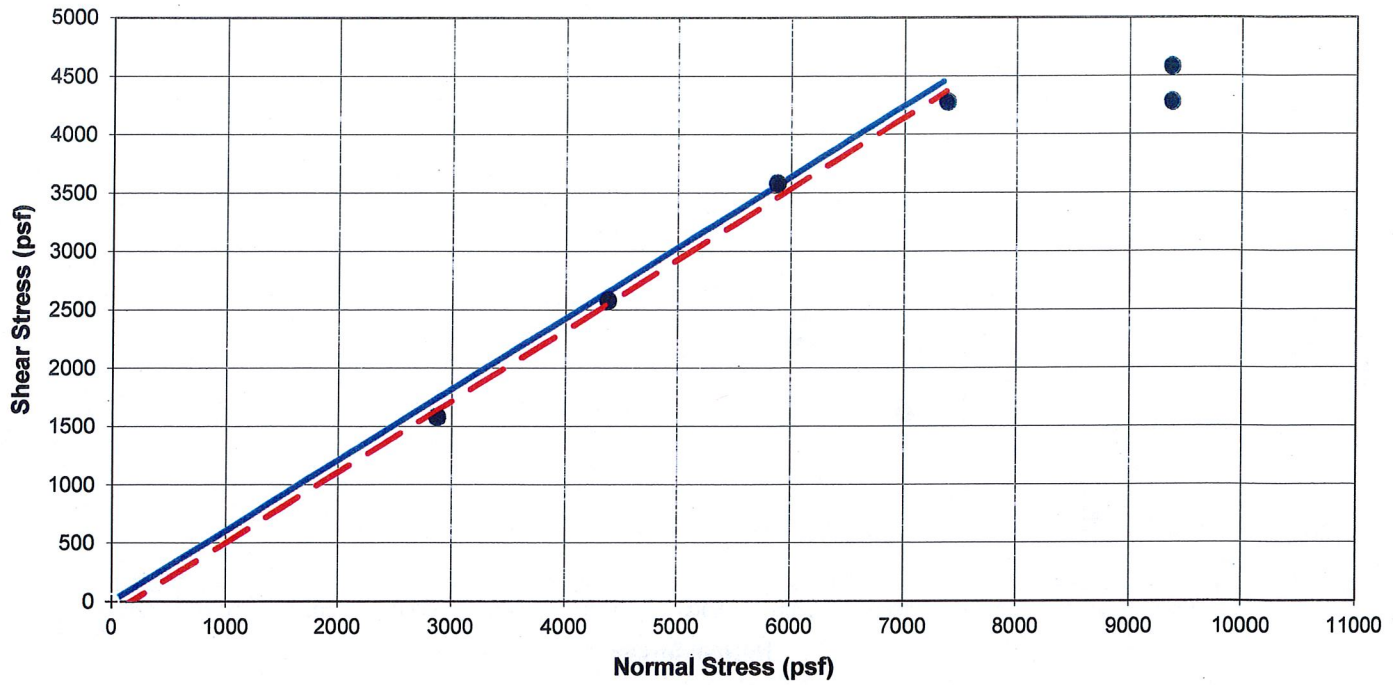
Iowa Borehole Shear Test Results

Boring PA-1-13 Test Depth: 7'

Project Name:	1736 Piedmont Avenue	**Date:** 6/21/2013		**Test By:** T Davidsavor and R Olah	
Project No.:	23/69-1423.01	**Test No.:** 1	**Rig:** EPC CME 750	**Crew:** JD, NEW	
		Base Plate Serial No: 163		**Depth to drilling mud:**	none
Boring No.:	PA-1-13 **Depth (ft):** 7	**Shear Head Serial No:** 163 Old		**Depth to groundwater:**	27.3
Shear Head Orientation: E-W	**Shear Head Plates:** Standard			**Depth to water in borehole:**	27.3
Soil Classification:	TILL: Dense Silty Sand				
Shear Gauge Correction: 19.01	Normal Gauge Correction: 125.86			Gage Factor: 1.00	
Normal Head Correction: 0	Shear Head Correction: 0		**Hole Prep Method:**	3" Split Spoon (California)	

Trial	1	2	3	4	5	6	7	8	9	10	11
Start Clock Time	14:00	14:15	14:30	14:55	15:10	15:20					
Consolidation Time (min)	0:08	0:08	0:05	0:05	0:05	0:05					
Test Time Start	14:08	14:23	14:35	15:00	15:15	15:25					
Test Time End	14:10	14:24	14:36	15:02	15:17	15:28					
Revolutions	200	98	105	140	200	241					
Normal Gauge	3000	4500	6000	7500	9500	9500					
Corrected Gage	3000	4500	6000	7500	9500	9500	0	0	0		
Normal Stress (psf)	**2874**	**4374**	**5874**	**7374**	**9374**	**9374**	**0**	**0**	**0**	**0**	**0**
Max Shear Stress	1800	2800	3800	4500	4800	4500					
Start Tare	200	200	200	200	200	200					
End Tare	200	200	200	200	200	200					
Net Gauge	1600	2600	3600	4300	4600	4300					
Shear Stress (psf)	**1581**	**2581**	**3581**	**4281**	**4581**	**4281**	**0**	**0**	**0**	**0**	**0**

Remarks:



Analysis Points	1	2	3	4	5	6	7	8	9	10	11
Enter yes to use, no to reject	yes	yes	yes	yes	no	no	no	no	no	no	no

Number of Points Used For Analysis: 4 **Stress Range** 2870 **to** 7370 psf

Iowa Borehole Shear Test Analyis Results

IBHST Friction Angle, ϕ : 31.2 Deg **IBHST Cohesion, c:** -100 psf **IBST Corr.:** 0.997

Unconfined Comp. Strength, q_u: 0 psf **Modified UC/IBST Cohesion:** 0 psf

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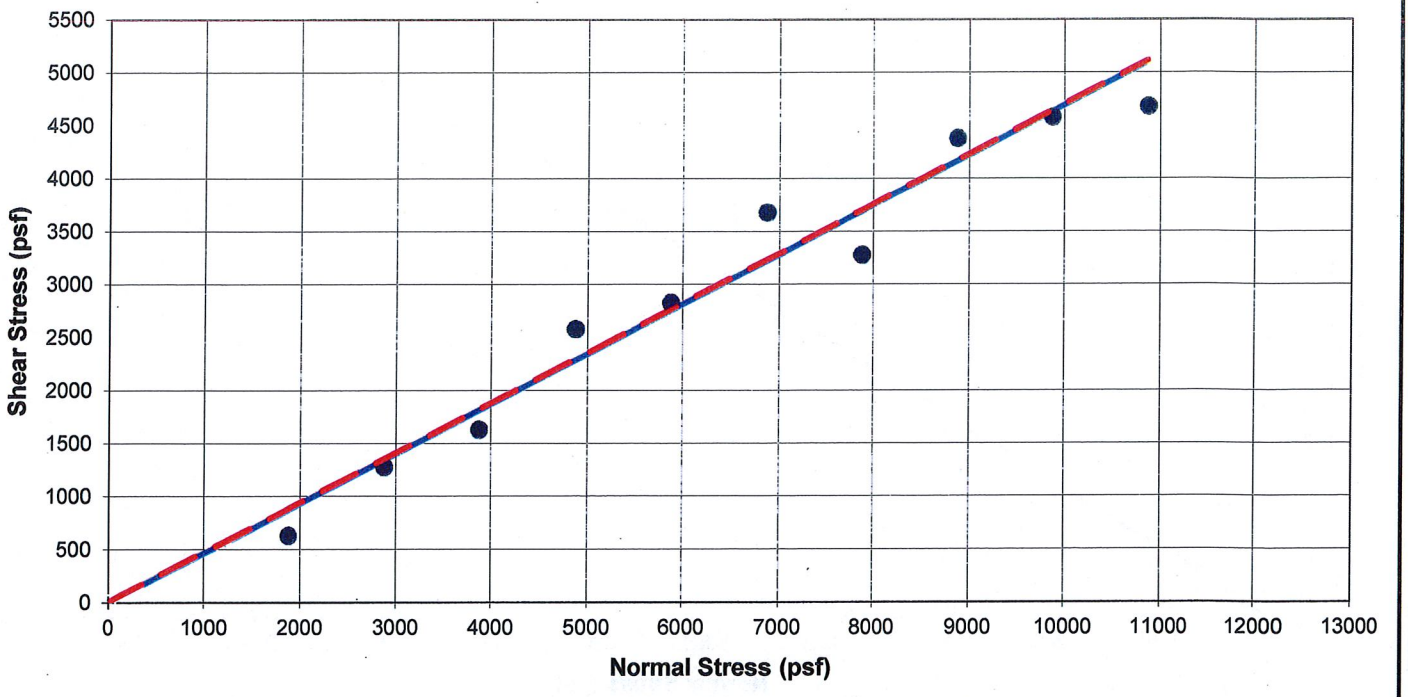
Iowa Borehole Shear Test Results

Boring PA-1-13 Test Depth: 13.25'

Project Name:	1736 Piedmont Avenue			**Date:** 6/21/2013			**Test By:** T Davidsavor and R Olah				
Project No.:	23/69-1423.01			**Test No.:** 2		**Rig:** EPC CME 750			**Crew:** JD, NEW		
				Base Plate Serial No: 163					**Depth to drilling mud:**	none	
Boring No.:	PA-1-13	**Depth (ft):**	13.25	**Shear Head Serial No:** 163 Old					**Depth to groundwater:**	27.3	
Shear Head Orientation: E-W		**Shear Head Plates:**		Standard					**Depth to water in borehole:**	27.3	
Soil Classification:	TILL: Dense Silty Sand										
Shear Gauge Correction: 19.01				Normal Gauge Correction: 125.86					Gage Factor: 1.00		
Normal Head Correction: 0				Shear Head Correction: 0					**Hole Prep Method:** 3" Split Spoon (California)		

Trial	1	2	3	4	5	6	7	8	9	10	11
Start Clock Time	16:25	16:40	16:33	16:36	16:39	16:48	16:50	16:53	16:55	16:48	
Consolidation Time (min)	0:02	0:02	0:02	0:02	0:02	0:02	0:02	0:02	0:02	0:02	
Test Time Start	16:27	16:42	16:35	16:38	16:41	16:50	16:52	16:55	16:57	16:50	
Test Time End	16:30	16:44	16:37	16:40	16:43	16:52	16:53	16:57	16:59	16:51	
Revolutions	270	136	200	191	217	190	89	135	210	100	
Normal Gauge	3000	5000	7000	9000	10000	11000	8000	6000	4000	2000	
Corrected Gage	3000	5000	7000	9000	10000	11000	8000	6000	4000	2000	
Normal Stress (psf)	**2874**	**4874**	**6874**	**8874**	**9874**	**10874**	**7874**	**5874**	**3874**	**1874**	**0**
Max Shear Stress	1500	2800	3900	4600	4800	4900	3500	3050	1850	850	
Start Tare	200	200	200	200	200	200	200	200	200	200	
End Tare	200	200	200	200	200	200	200	200	200	200	
Net Gauge	1300	2600	3700	4400	4600	4700	3300	2850	1650	650	
Shear Stress (psf)	**1281**	**2581**	**3681**	**4381**	**4581**	**4681**	**3281**	**2831**	**1631**	**631**	**0**

Remarks:



Analysis Points	1	2	3	4	5	6	7	8	9	10	11
Enter yes to use, no to reject	yes	yes	yes	yes	yes	yes	no	yes	yes	yes	no

Number of Points Used For Analysis: 9 **Stress Range** 1870 **to** 10870 psf

Iowa Borehole Shear Test Analyis Results

IBHST Friction Angle, ϕ : 25.2 Deg **IBHST Cohesion, c:** 0 psf **IBST Corr.:** 0.983

Unconfined Comp. Strength, q_u: 0 psf **Modified UC/IBST Cohesion:** 0 psf

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