Report of Geotechnical Exploration Program

Proposed Steel Grain Bins
Hawley, Minnesota
ZGE #11-033

For

Hawley Farmers Elevator

July 16, 2011

Zeltinger Geotechnical Engineering
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July 16, 2011

Hawley Farmers Elevator
Attn: Mr. Greg Nelson
P.O. Box 9
Hawley, Minnesota 56549

Subj: **Geotechnical Exploration Program**
Proposed Steel Bins
Hawley, Minnesota
ZGE #11-033

Dear Mr. Nelson:

Attached is our report covering the geotechnical exploration program that we conducted for the steel bin project at Hawley. An additional copy is being sent as noted below. This work was conducted according to our quotation #2011-132 dated April 5, 2011 and your signature of the same date.

The remaining soil samples will be retained in our office for a period of about 30 days. If you wish for us to hold them for a longer period of time, please notify us in writing.

We appreciate the opportunity to be of service to you on this project. If there are questions about the data or our recommendations, or if you need field geotechnical services during construction, please contact me at (701) 255-2371.

Very truly yours,

Joel A. Zeltinger

Joel A. Zeltinger, P.E.
Geotechnical Consultant

JAZ\jaz

PC: Gateway Building Systems
Attn: Mr. Nick Kloos

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Hawley, Minnesota
ZGE #11-033

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GEOTECHNICAL EXPLORATION PROGRAM
PROPOSED STEEL GRAIN BINS
HAWLEY, MINNESOTA
ZGE #11-033

1 INTRODUCTION

1.1 Authorization

This geotechnical exploration program was conducted in accordance with our quotation #2011-132 dated April 5, 2011 and the signature of Mr. Greg Nelson of the Hawley Farmers Elevator on the same date.

1.2 Scope of Services

The authorized scope of services included soil borings, laboratory testing and an engineering report.

As will be discussed later in the report, two steel grain bins will be constructed. Previous exploration was performed for two steel grain bins in 2006. Only the northern most bin was constructed at that time and the southern most bin will be constructed in 2011, along with one additional bin. Therefore, the northern most bin to be constructed in 2011 had borings drilled for it in 2006 and only the south bin required additional borings.

The authorization included drilling one boring to a depth of 40 feet between the two new 2011 grain bins and two borings to 20 feet along the perimeter of the south bin. All of the sampling was performed according to SPT (standard penetration test) procedures. Undisturbed 3-inch diameter thin-walled Shelby tubes were obtained of some of the softer clays that were encountered.

Laboratory tests authorized included moisture content, dry density, Atterberg limits (liquid & plastic limits) and unconfined compression testing.

The engineering report was to include the results of the field and laboratory testing as well as engineering recommendations regarding:

a. Foundation types and depths

b. Allowable bearing capacity and estimation of potential settlement for the proposed foundation system

c. Compaction requirements for controlled, compacted fill

d. Potential construction difficulties

e. Potential expansive or compressible soils

f. Effects of the new construction on existing structures

g. Loading and monitoring of the new bins

A determination of whether environmental contamination is present on the site was not included in the scope of services.

2 ENGINEERING REVIEW

2.1 Project Data

If the project information presented below is not correct or has been changed, it is necessary that the correct project data be presented to us for further review.

The project will include two new steel grain bins. The bins will be about 72 feet in diameter with an eave height of about 70 feet. They will be Brock bins supported by normal inverted "T" footings. It was indicated to us the footings were proportioned for a net allowable soil bearing capacity of 5000 psf.

The project was located on the south side of the steel bin that was constructed in 2006. The 2006 bin was constructed on the west side of a bunker system, and on the east side of County Highway 31 south of Hawley. Borings for two bins were performed in 2006; however, only the northern most bin was constructed at that time. Two bins are being constructed in 2011. Therefore, borings for the new south bin were authorized.

2.2 General Overview

Based on our review of the test boring data, it appears that the site should provide excellent support for the proposed steel bins. Some site preparation will be required to remove surficial fill and soft soils and replace them with controlled, compacted fill. An excavation depth on the order of 6.5 feet is anticipated. Some areas may encounter soft soil to greater depths.

2.3 Site Preparation

As mentioned, some site preparation will be required for the site to support the steel bins. We recommend excavating the existing fill and soft natural soils and replacing them with controlled, compacted fill. About 6.5 feet of excavation depth is anticipated; however, there could be some deeper excavations required, especially in the southwestern portion of the site due to some softer clays that were encountered in that area.

We recommend using a lateral excavation oversize of ½ foot for each 1 foot of fill required below the bottom of the foundations. The oversize should be measured from the bottom and outside edge of the new footings. Furthermore, the backslope should be flattened sufficiently to provide safe excavation slopes.

New fill should consist of pit-run sand or sand with gravel. It should be properly mixed and moisture conditioned. The fill should have 100 percent passing the 3-inch sieve and it should be classified as SP, SP-SM or SM according to the Unified Soil Classification System. However, if the fill will be re-excavated for tunnels, boot pits etc., to depths greater than about 3 feet, it would be advisable to use sand that has some binder to minimize problems with caving. These soils would be classified as SM or SC soils according to the USCS. In any event, OSHA requirements for safe excavation slopes must be carefully followed.

All new granular fill for steel bins should be compacted to at least 98 percent of the standard Proctor density (ASTM D 698) below footing elevation. Maximum loose lift thicknesses of 12 inches should be used. A heavy self propelled vibratory sheeps foot compactor should be used to compact the sand.

2.4 Foundation Recommendations

With the recommended site preparation, it is our opinion that the soils can support the desired load of 5000 psf while providing a theoretical safety factor of about 2.0 with respect to an overturn or punching shear failure. Our calculations suggest that total settlements should be less than 2 inches and differential settlements should be less than 1 inch.

In our opinion, the inverted "T" footings can be supported at shallow depths without detrimental frost action. It is our further opinion that the pit-run material can be assigned a

subgrade modulus of 250 pci (pounds per cubic inch). A reduced modulus of 100 pci should be used for the natural clayey soils.

2.5 Below Grade Considerations

Below grade tunnel and dump pit walls will be subjected to at-rest lateral earth pressures, as well as earth pressures due to the surcharge of floor slabs, foundation elements or other structures. To calculate lateral earth pressures, we recommend using an at-rest lateral earth pressure equivalent to that generated by a fluid having a total unit weight of 50 pounds per cubic foot (pcf) for the sand backfill.

To calculate lateral loads due to the surcharge imposed by the floor or foundations, we recommend using an at-rest earth pressure coefficient of 0.4 for sand backfill adjacent to the tunnel or dump pit. For deeper pits where very little sand backfill is placed next to these structures, we recommend using an at-rest earth pressure coefficient of 0.5 for the natural clays. Walls should be properly braced during construction and until they can be permanently restrained.

2.6 Methods of Analyses

The allowable foundation loading for the sandy lean clay glacial till was arrived at using the Terzaghi-Meyerhof bearing capacity equation with the cohesion determined from the unconfined compression test and estimated using the standard penetration resistance ("N" values). The bearing capacity of the natural sands was determined using the pressuremeter method of analysis. The limit pressure used in the pressuremeter equations was estimated using empirical correlations with the "N" values.

Settlements were estimated using empirical correlations between the "N" value and the pressuremeter modulus, with consideration given to soil type. The pressuremeter modulus

is determined with in-situ pressuremeter testing. The pressuremeter method of analysis was then used.

The equivalent passive and active pressures were calculated using estimated unit weights for the granular soils and unit weights from the laboratory testing for the clays. Estimated angles of internal friction were based on our experience and correlations with the Atterberg limits.

2.7 Foundation Backfill and Surface Drainage

We recommend that exterior foundation backfill consist of cohesive, non-expansive soil, such as lean clay with a liquid limit of 40 or less. If sand is used, we recommend that a clay cap at least 12 inches thick be provided along the exterior of the structure to divert surface water away from the foundation system. The perimeter grade should be sloped away from the structures for positive drainage. The existing clays can be reused. However, the clays may have to be moisture conditioned (either wetted or dried) to attain the desired compaction.

We recommend that exterior backfill around the structure be compacted to at least 92 percent of the standard Proctor density. Any perimeter backfill that will support driveways or other structures should be compacted to at least 95 percent of the standard Proctor density.

2.8 Settlement Monitoring

We recommend that settlement points be established around the foundation systems before the silos are filled. The contractor or a local surveyor should then tie the settlement points to a permanent benchmark far from the new construction.

Settlement monitoring should then be made as filling progresses. This is especially important for the initial filling. The settlement data should be forwarded to us for review.

3 CONSTRUCTION OBSERVATION AND TESTING

The recommendations contained in this report have been made based on the subsurface conditions found at the boring locations. It is possible that there are soil conditions on site that were not represented by those borings. Consequently, on-site observation during construction is considered integral to the successful implementation of the recommendations. We believe that qualified field personnel need to be on site at the following times to observe the site conditions and effectiveness of the construction. We recommend that the testing be performed by the geotechnical engineer as the owners representative during construction.

3.1 Excavation Observations

We recommend that the Geotechnical Engineer, or his representative, observe all excavations prior to the placement of engineered fill and/or concrete. He would also be available for additional consultation and recommendations if necessary.

3.2 Placement of Fill

We recommend that a representative number of compaction tests be taken during placement of engineered fill. The tests should be performed to determine if the required compaction was achieved. As a general guideline, tests should be taken for each 2,000 square feet embankment fill, every 75 to 100 feet in trench fill, and for each 2 foot thickness of fill. The actual number of tests should be left to the discretion of the geotechnical engineer.

4 EXPLORATION LIMITATIONS

The recommendations contained in this report represent our professional opinions. These opinions were arrived at according to currently accepted engineering practices at this time and location. Other than this, no warranty is intended or implied.

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of Minnesota

Joel A. Zeltinger

Date 7/16/2011 Registration No. 16280

JOEL A. ZELTINGER

APPENDIX A - FIELD EXPLORATION PROGRAM

A.1 Exploration Scope
A.2 Surface Observations
A.3 Subsurface Conditions
A.4 Water Levels
A.5 Soil Sampling
A.6 Soil Classification Procedure

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Location Maps
Soil Profile Drawing
Boring Logs
Symbols & Descriptive Terminology on Boring Logs
Soil Classification Chart

A FIELD EXPLORATION PROGRAM

A.1 Exploration Scope

Borings were drilled for the north bin in 2006. Two 20-foot and 1-40 foot additional borings were drilled for the south bin as part of this exploration program. The borings were drilled on April 7, 2011 at locations as shown on the attached site plan.

The surface elevations were referenced to the top of the truck scale northwest of the site. The top of the scale was assumed to be at an elevation of 100.0 feet. The elevations for the existing bin and the northern most bin to be constructed at this time were referenced to the top of the railroad tracks directly east of the proposed site. The top of the railroad tracks for those borings was also assumed to be at an elevation of 100.0 feet.

A.2 Surface Observations

The site consisted of a fairly level area with grade elevations at the test boring locations ranging from about 97 to 98 feet, as referenced to the scale slab. The existing bin was on the north side of the site and the existing scale was northwest of the existing bin, as mentioned. Railroad tracks were located east of the site and the truck drive was on the west side of the site.

A.3 Subsurface Conditions

The subsurface conditions encountered at each test location are illustrated by means of the attached boring logs. We wish to point out that the subsurface conditions at other times and locations at the site may differ from those found at our test boring locations. If different conditions are encountered during construction, it is necessary that you contact us so that our

recommendations can be reviewed. The test boring logs also show the possible geologic origin of the materials encountered.

The soil borings for the southern most 2006 bin, which will now be the northern most 2011 bin, encountered 2 to 3 feet of surficial fill consisting mostly of brown, dark brown and black sandy lean clay. Natural grayish brown and mottled to gray sandy lean clays were then encountered to the depth of the two 31-foot borings and to 30 feet in the 51-foot boring. Medium grained brown sand was then encountered to the depth of the 51-foot boring. Based on the "N" values (standard penetration resistance) the sandy lean clays were firm to soft in consistency and the sand was in a loose to medium dense condition. Groundwater was encountered at a shallow depth of about 4.5 feet at that time.

The 2011 borings encountered 2 to 3 feet of surficial fill from the construction of the existing facility and then sandy lean clay with a trace of gravel. The fill consisted of sandy lean clay as well and was brown, dark brown and black in color. The natural soils were grayish brown and mottled in color. There were some sand layers in the sandy lean clay as well. Boring 2011-3 encountered medium grained brown sand below a depth of 23 feet and Boring 2011-2 encountered a layer of clayey sand from 9 to 12 feet.

Based on the standard penetration resistance ("N" values), the clays were mostly firm to hard in consistency. However, there was a zone of soft clay encountered from 2 to 4 feet at Borings 2011-1 and 2011-3 and from 4 to 6.5 feet at Boring 2011-2.

A.4 Water Levels

Groundwater measurements were made in the borings. This information is shown on the bottom of the attached boring logs. Groundwater was measured as high as 4.5 feet in 2006. The 2011 borings encountered groundwater as high as 13.5; however, it appeared that the

water level could be higher and it did not have sufficient time to stabilize during the exploration program. We would anticipate a groundwater level based on the condition of the samples to be on the order of 4 to 8 feet.

Groundwater levels should be expected to fluctuate seasonally and yearly from the groundwater readings noted in the borings. The time of year that the borings were drilled and the history of precipitation prior to drilling should be known when using the groundwater to extrapolate water levels at other points in time.

A.5 Soil Sampling

Soil sampling was done according to the procedures described by ASTM D1586. Using this procedure, a 2 inch O.D. split barrel sampler is driven into the soil by a 140-lb weight falling 30 inches. After an initial set of 6 inches, the number of blows required to drive the sampler an additional 12 inches is known as penetration resistance or "N" value. The "N" value is an index of the relative density of cohesionless soils and the consistency of cohesive soils.

We are retaining representative samples of the soil obtained during our field operations for one month. We will then discard them unless we are notified further as to their disposition.

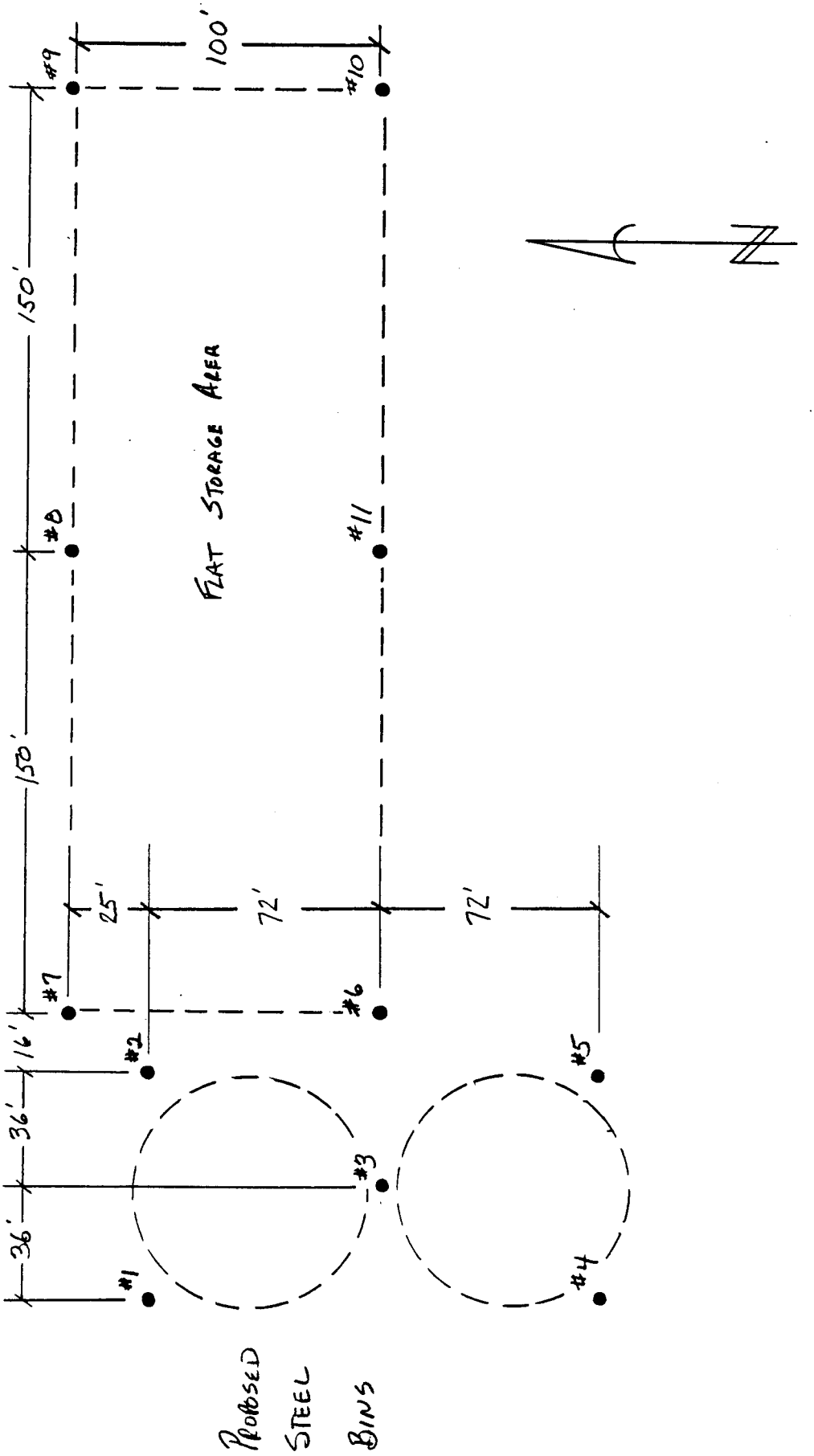
A.6 Soil Classification Procedure

As the samples were obtained in the field they were visually and manually classified by the crew chief according to ASTM D 2488. Representative portions of all samples were then sealed and returned to the laboratory for further examination and for verification of the field classification. In addition, selected samples were then submitted to a program of laboratory tests. Logs of the borings indicating the depth and identification of the various strata, the "N"

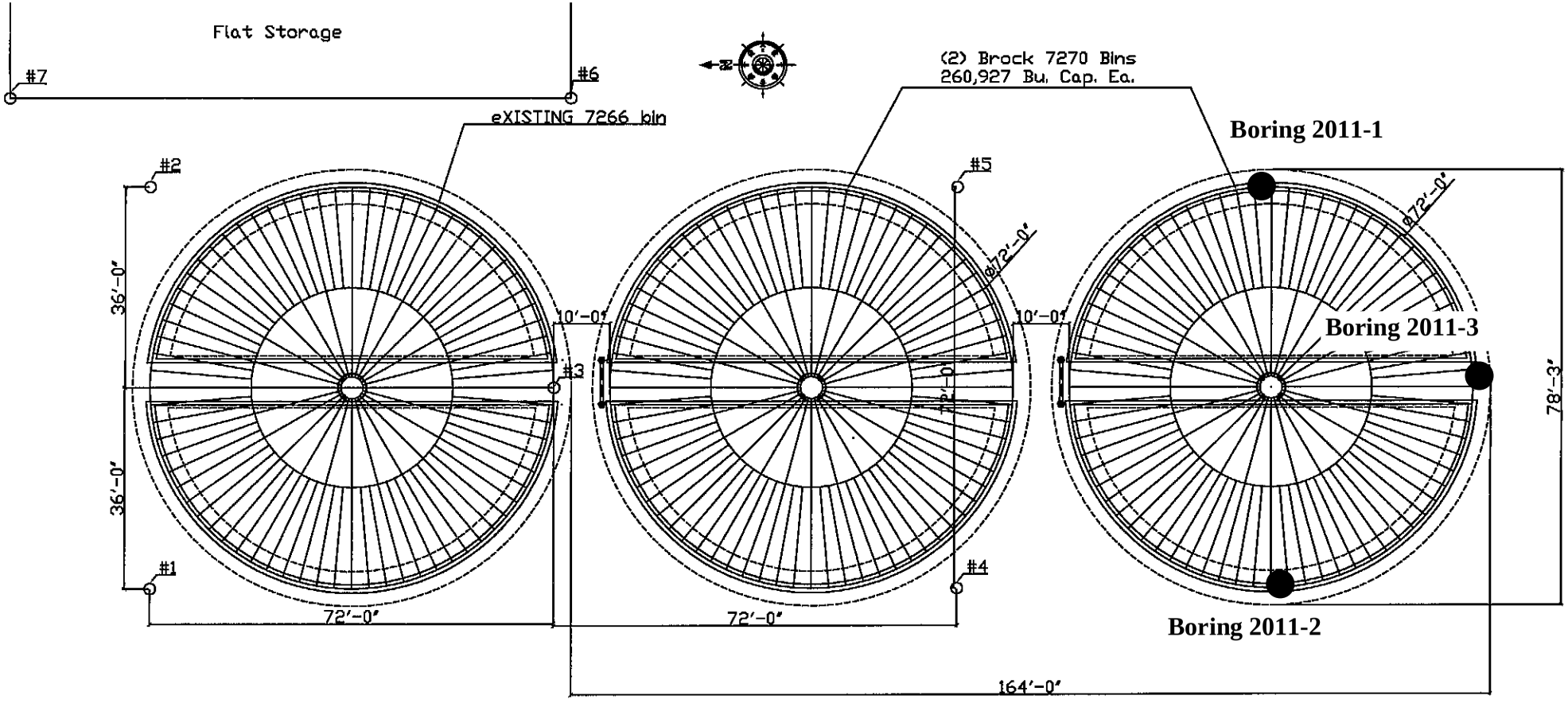
value, the laboratory test data, water level information and pertinent information regarding the method of maintaining and advancing the drill holes are also attached. Charts illustrating the soil classification procedures, the descriptive terminology and symbols used on the boring logs are also attached.


Two New Bins to go
South of Existing Bin
North
Yeovil St
Co Hwy 31
© 2011 Google
©2010 Google
Imagery Date: 10/2/2010
46°52'18.78" N 96°19'13.28" W elev 1160 ft
Eye alt 2065 ft

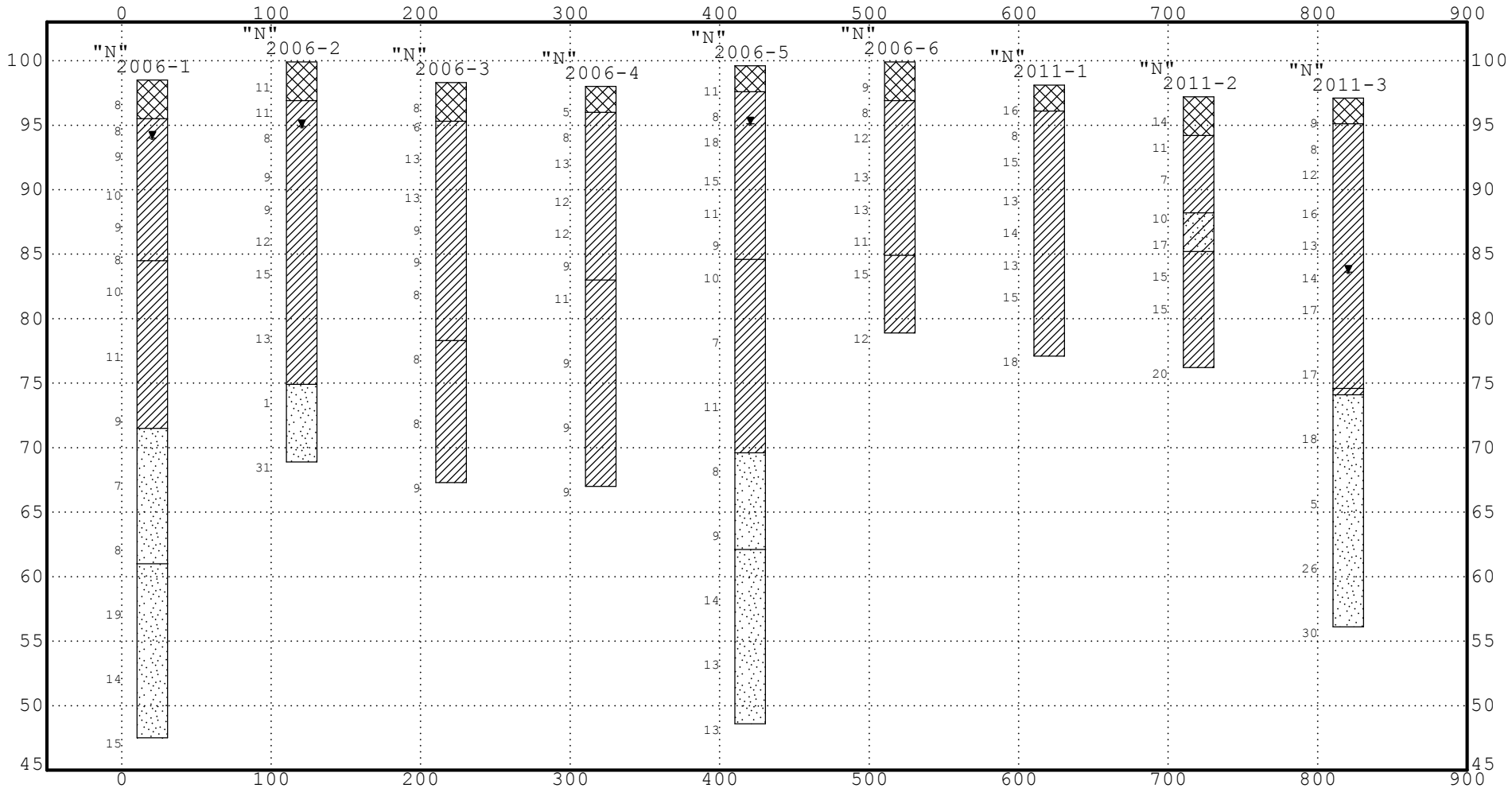
06-58	BORING LOCATIONS	JOEL ZELTINGER	STEEL BINS & FLAT STORAGE, HAWLEY, MN	07/14/0



Borings #1 through #5 were drilled in 2006.



Bins are 72' in diameter



Boring	North	East	Elev.	Depth
2006-1	100.0	100.0	98.5	51.0
2006-2	100.0	200.0	99.9	31.0
2006-3	100.0	300.0	98.3	31.0
2006-4	100.0	400.0	98.0	31.0
2006-5	100.0	500.0	99.6	51.0
2006-6	100.0	600.0	99.9	21.0
2011-1	100.0	700.0	98.1	21.0
2011-2	100.0	800.0	97.2	21.0
2011-3	100.0	900.0	97.1	41.0

COORDINATES ARE ASSUMED
DISTANCES:
Beginning -50.0
Ending 900.0
VIEWING ANGLES (degrees):
Horizontal 0.0
Vertical 0.0

Position	North	East
Left, Front	100.00	50.00
Right, Front	100.00	1000.00
Left, Back	100.00	50.00
Right, Back	100.00	1000.00

SOIL PROFILE DIAGRAM

Steel Grain Bin

Hawley, Minnesota (hawley steel bin)

PROJECT #	DATE	PLATE
ZGE #11-033	Jul 11	1

LOG OF TEST BORING

JOB NO. **ZGE #11-033** VERTICAL SCALE **1" = 5'** BORING NO. **2006-1**

PROJECT **Steel Grain Bin, Hawley, Minnesota (hawley steel bin)**

DEPTH IN FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 98.5)	GEOLOGIC ORIGIN	N or CR	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS W	D	LL	PL	QU or Pq
	FILL, mostly SANDY LEAN CLAY, brown, dark brown & black mixed, some organics	Fill	8		1	SB					
3.0	**SANDY LEAN CLAY**, grayish brown, mottled, a trace of gravel, firm (CL)	Glacial Till	8		2	SB					
			9	▼	3	SB					
			10		4	SB					
			9		5	SB					
14.0			8		6	SB					
	SANDY LEAN CLAY, brownish gray, mottled, firm (CL)		10		7	SB					
			11		8	SB					
27.0			9		9	SB					
	SAND, medium to coarse grained, a trace of gravel, gray, waterbearing, loose to medium dense (SP)	Coarse Alluvium	7		10	SB					
			8		11	SB					
37.5	**Continued on Next Page**										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
6-2	**1106**	**51'**	**50'**	**--**		**18'**
6-3	**1315**	**51'**	**None**	**20'**		**4.5'**

START **6-2-06** COMPLETE **6-2-06 @ 1116**

METHOD **3.25" I.D. HSA 0' to 49.5'**

CREW CHIEF **Tokar (IDS)**

ZELTINGER GEOTECHNICAL ENGINEERING, P.C.

LOG OF TEST BORING

JOB NO. ZGE #11-033 VERTICAL SCALE 1" = 5' BORING NO. 2006-1 CONTINUED Z

PROJECT Steel Grain Bin, Hawley, Minnesota (hawley steel bin)

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N or CR	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS W	D	LL	PL	QU or Pq
	Sand continued	Coarse Alluvium continued	19		12	SB					
			14		13	SB					
			15		14	SB					
51.0	End of Boring										

LOG OF TEST BORING

JOB NO. **ZGE #11-033** VERTICAL SCALE **1" = 5'** BORING NO. **2006-2**

PROJECT **Steel Grain Bin, Hawley, Minnesota (hawley steel bin)**

DEPTH IN FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 99.9)	GEOLOGIC ORIGIN	N or CR	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS W	D	LL	PL	QU or Pq
	FILL, mostly SANDY LEAN CLAY, brown, dark brown & black mixed, organic	Fill	11		1	SB					
3.0	**SANDY LEAN CLAY**, a trace of gravel, grayish brown, mottled, soft to firm, gypsum crystals (CL)	Glacial Till	11		2	SB					
			8	▼	3	SB					
			9		4	SB					
			9		5	SB					
			12		6	SB					
			15		7	SB					
			13		8	SB					
25.0	**SAND**, medium grained, brown, waterbearing, very loose to dense (SP)	Coarse Alluvium	1		9	SB					
			31		10	SB					
31.0	End of Boring										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
6-3	**1310**	**31'**	**None**	**19'**		**5'**

START **6-2-06** COMPLETE **6-2-06 @ 1231**

METHOD **3.25" I.D. HSA 0' to 29.5'**

CREW CHIEF **Tokar (IDS)**

ZELTINGER GEOTECHNICAL ENGINEERING, P.C.

LOG OF TEST BORING

JOB NO. **ZGE #11-033** VERTICAL SCALE **1" = 5'** BORING NO. **2006-3**

PROJECT **Steel Grain Bin, Hawley, Minnesota (hawley steel bin)**

DEPTH IN FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 98.3)	GEOLOGIC ORIGIN	N or CR	WL	SAMPLE NO.	SAMPLE TYPE	LAB W	LAB D	LAB LL	LAB PL	LAB QU or Pq
	FILL, mostly SANDY LEAN CLAY, brown, dark brown & black mixed	Fill	8		1	SB					
			6		2	SB					
3.0	**SANDY LEAN CLAY**, a trace of gravel, grayish brown, mottled, firm to soft (CL)	Glacial Till			3	3T					
			13		4	SB					
			13		5	SB					
					6	3T	24	102	48	19	6683
	Note: 3T sample taken at 2' to 4', 9' to 11' and 14' to 16' from secondary boring.		9		7	SB					
			9		8	SB					
					9	3T	22	104			5383
			8		10	SB					
20.0	**SANDY LEAN CLAY**, a trace of gravel, gray, soft to firm (CL)		8		11	SB			38	16	
			8		12	SB					
31.0	End of Boring		9		13	SB					
	* None Measurable										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
6-2	**1327**	**31'**	**None**	**--**		***NM**

START **6-2-06** COMPLETE **6-2-06 @ 1325**

METHOD **3.25" I.D. HSA 0' to 29.5'**

CREW CHIEF **Tokar (IDS)**

ZELTINGER GEOTECHNICAL ENGINEERING, P.C.

LOG OF TEST BORING

JOB NO. **ZGE #11-033** VERTICAL SCALE **1" = 5'** BORING NO. **2006-4**

PROJECT **Steel Grain Bin, Hawley, Minnesota (hawley steel bin)**

DEPTH IN FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 98.0)	GEOLOGIC ORIGIN	N or CR	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS W	D	LL	PL	QU or Pq
	FILL, mostly SANDY LEAN CLAY, brown, dark brown & black mixed	Fill	5		1	SB					
2.0	**SANDY LEAN CLAY**, a trace of gravel, grayish brown, mottled, soft to firm (CL)	Glacial Till	8		2	SB					
			13		3	SB					
			12		4	SB					
			12		5	SB					
			9		6	SB					
15.0	**SANDY LEAN CLAY**, a trace of gravel, gray, firm (CL)		11		7	SB					
			9		8	SB					
			9		9	SB					
31.0	End of Boring		9		10	SB					
	* None Measurable										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
6-2	**1429**	**51'**	**30'**	**--**		***NM**

START **6-2-06** COMPLETE **6-2-06 @ 1425**

METHOD **3.25" I.D. HSA 0' to 29.5'**

CREW CHIEF **Tokar (IDS)**

ZELTINGER GEOTECHNICAL ENGINEERING, P.C.

LOG OF TEST BORING

JOB NO. ZGE #11-033 VERTICAL SCALE 1" = 5' BORING NO. 2006-5

PROJECT Steel Grain Bin, Hawley, Minnesota (hawley steel bin)

DEPTH IN FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 99.6)	GEOLOGIC ORIGIN	N or CR	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS W	D	LL	PL	QU or Pq
	FILL, mostly SANDY LEAN CLAY, brown, dark brown & black mixed, organic	Fill	11		1	SB					
2.0	**SANDY LEAN CLAY**, a trace of gravel, grayish brown, mottled, soft to firm, lense of sand at 5' (CL)	Glacial Till	8	▼	2	SB					
			18		3	SB					
			15		4	SB					
			11		5	SB					
			9		6	SB					
15.0	**SANDY LEAN CLAY**, a trace of gravel, gray, soft to firm (CL)		10		7	SB					
			7		8	SB					
			11		9	SB					
30.0	**SAND**, medium grained, brown, waterbearing, loose (SP)	Coarse Alluvium	8		10	SB					
			9		11	SB					
37.5	**Continued on Next Page**										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
6-3	1858	51'	None	25'		4.5'

START 6-2-06 COMPLETE 6-2-06 @ 1716

METHOD 3.25" I.D. HSA 0' to 49.5'

CREW CHIEF Tokar (IDS)

ZELTINGER GEOTECHNICAL ENGINEERING, P.C.

LOG OF TEST BORING

JOB NO. ZGE #11-033 VERTICAL SCALE 1" = 5' BORING NO. 2006-5 CONTINUED Z

PROJECT Steel Grain Bin, Hawley, Minnesota (hawley steel bin)

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N or CR	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS W	D	LL	PL	QU or Pq
	Sand continued	Coarse Alluvium continued	14		12	SB					
			13		13	SB					
			13		14	SB					
51.0	End of Boring										

LOG OF TEST BORING

JOB NO. **ZGE #11-033** VERTICAL SCALE **1" = 5'** BORING NO. **2006-6**

PROJECT **Steel Grain Bin, Hawley, Minnesota (hawley steel bin)**

DEPTH IN FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 99.9)	GEOLOGIC ORIGIN	N or CR	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS W	D	LL	PL	QU or Pq
	FILL, mostly SANDY LEAN CLAY, brown, dark brown & black mixed, organic	Fill	9		1	SB					
3.0	**SANDY LEAN CLAY**, a trace of gravel, grayish brown, mottled, soft to firm (CL)	Glacial Till	8		2	SB					
			12		3	SB					
			13		4	SB					
			13		5	SB					
			11		6	SB					
15.0	**SANDY LEAN CLAY**, a trace of gravel, gray, firm (CL)		15		7	SB					
21.0	* None Measurable End of Boring		12		8	SB					

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
6-3	**1954**	**21'**	**20'**	**--**		***NM**

START **6-3-06** COMPLETE **6-3-06 @ 1953**

METHOD **3.25" I.D. HSA 0' to 19.5'**

CREW CHIEF **Tokar (IDS)**

ZELTINGER GEOTECHNICAL ENGINEERING, P.C.

LOG OF TEST BORING

JOB NO. ZGE #11-033 VERTICAL SCALE 1" = 3' BORING NO. 2011-1

PROJECT Steel Grain Bin, Hawley, Minnesota (hawley steel bin)

DEPTH IN FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 98.1)	GEOLOGIC ORIGIN	N or CR	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS W	D	LL	PL	QU or Pq
	FILL, mostly SANDY LEAN CLAY, brown, dark brown & black mixed	Fill	16		1	SB					
2.0	**SANDY LEAN CLAY**, a trace of gravel, grayish brown, soft to hard (CL)	Glacial Till	8		2	SB					
			15		3	SB					
			13		4	SB					
			14		5	SB					
			13		6	SB					
			15		7	SB					
	* None Measurable										
			18		8	SB					
21.0	End of Boring										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
4-7	1515	19.5'	None	21'		*NM

START 4-7-11 COMPLETE 4-7-11 @ 1515

METHOD 3.25" I.D. HSA 0' to 19.5'

CREW CHIEF Anderson (IDS)

ZELTINGER GEOTECHNICAL ENGINEERING, P.C.

LOG OF TEST BORING

JOB NO. **ZGE #11-033** VERTICAL SCALE **1" = 3'** BORING NO. **2011-2**

PROJECT **Steel Grain Bin, Hawley, Minnesota (hawley steel bin)**

DEPTH IN FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 97.2)	GEOLOGIC ORIGIN	N or CR	WL	SAMPLE NO.	SAMPLE TYPE	LAB TESTS W	D	LL	PL	QU or Pq
	FILL, mostly SANDY LEAN CLAY, brown, dark brown & black mixed	Fill	14		1	SB					
3.0	**SANDY LEAN CLAY**, a trace of gravel, grayish brown, mottled, soft to firm, sand lenses (CL)	Glacial Till	11		2	SB					
					3	3T	19	107			
			7		4	SB					
	Note: 3T samples taken at 4' to 6' and 7' to 9' from secondary boring.				5	3T	20	108	29	14	1439
			10		6	SB					
9.0	**CLAYEY SAND**, grayish brown, mottled, hard, sand lenses (SC)		17		7	SB					
12.0	**SANDY LEAN CLAY**, a trace of gravel, grayish brown, mottled, firm to hard (CL)		15		8	SB					
			15		9	SB					
	* None Measurable										
			20		10	SB					
21.0	End of Boring										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
4-7	**1620**	**19'**	**None**	**21'**		***NM**

START **4-7-11** COMPLETE **4-7-11 @ 1620**

METHOD **3.25" I.D. HSA 0' to 19.5'**

CREW CHIEF **Anderson (IDS)**

ZELTINGER GEOTECHNICAL ENGINEERING, P.C.

LOG OF TEST BORING

JOB NO. ZGE #11-033 VERTICAL SCALE 1" = 3' BORING NO. 2011-3

PROJECT Steel Grain Bin, Hawley, Minnesota (hawley steel bin)

DEPTH IN FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION 97.1)	GEOLOGIC ORIGIN	N or CR	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS W	D	LL	PL	QU or Pq
	FILL, mostly SANDY LEAN CLAY, brown, dark brown & black mixed	Fill	9		1	SB					
2.0	**SANDY LEAN CLAY**, a trace of gravel, grayish brown, mottled, soft to hard	Glacial Till	8		2	SB					
			12		3	SB					
			16		4	SB					
			13		5	SB					
			14	▼	6	SB					
			17		7	SB					
			17		8	SB					
	Continued on Next Page										
22.5											

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
4-7	1140	26'	24.5'	--		22'
4-7	1153	31'	29.5'	--		13.5'

START 4-7-11 COMPLETE 4-7-11 @ 1400

METHOD 3.25" I.D. HSA 0' to 39.5'

CREW CHIEF Anderson (IDS)

ZELTINGER GEOTECHNICAL ENGINEERING, P.C.

LOG OF TEST BORING

JOB NO. ZGE #11-033 VERTICAL SCALE 1" = 3' BORING NO. 2011-3 CONTINUED Z

PROJECT Steel Grain Bin, Hawley, Minnesota (hawley steel bin)

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N or CR	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS W	D	LL	PL	QU or Pq
23.0	**Continued on Next Page**										
	SAND, medium grained, brown, waterbearing, medium dense (SP)	Coarse Alluvium	18		9	SB					
			5		10	SB					
			26		11	SB					
			30		12	SB					
41.0	End of Boring										

SYMBOLS AND DESCRIPTIVE TERMINOLOGY ON TEST BORING LOG

SYMBOLS FOR DRILLING AND SAMPLING

Symbol	Description
HSA	3 1/4" I.D. hollow stem auger
_FA	4", 6" or 10" diameter flight auger
_HA	2", 4" or 6" hand auger
_DC	2 1/2", 4", 5" or 6" steel drive casing
_RC	Size A, B or N rotary casing
PD	Pipe drill or cleanout tube
CS	Continuous split barrel sampling
DM	Drilling mud
JW	Jetting water
SB	2" O.D. split barrel sampling
_L	2 1/2" or 3 1/2" O.D. SB liner sample
_T	2" or 3" thin walled tube sample
3TP	3" thin walled tube using pitcher sampler
_TO	2" or 3" thin walled tube using Osterberg sampler
W	Wash sample
B	Bag sample
P	Test pit sample
_Q	BQ, NQ, or PQ wireline system
_X	AX, BX, or NX double tube barrel
N	Standard penetration test, blows per foot
CR	Core recovery, percent
WL	Water level
?	Water level
NMR	No measurement recorded, primarily due to presence of drilling or coring fluid

SYMBOLS FOR LABORATORY TESTS

Symbol	Description
W	Water content
D	Dry density - pounds per cubic foot
LL	Liquid limit - ASTM** D 4318
PL	Plastic limit - ASTM D 4318
	--- Inserts in Last Column (Qu or RQD) ---
Qu	Unconfined compressive strength, psf - ASTM D 2166
Pq	Penetrometer reading, tsf
Ts	Torvane reading, tsf
G	Specific gravity
SL	Shrinkage limits - ASTM D 427
OC	Organic content - Combustion method
SP	Swell pressure, tsf
PS	Percent swell under pressure
FS	Free swell, percent
SS	Shrink swell, percent
pH	Hydrogen ion content - Meter Method
SC	Sulfate content, parts/million or mg/l
CC	Chloride content, parts/million or mg/l
C*	One dimensional consolidation - ASTM D 2435
Qc*	Triaxial compression
D.S.*	Direct shear - ASTM D 3080
K*	Coefficient of permeability, cm/sec
DH*	Double hydrometer - ASTM D 4221
MA*	Particle size analysis - ASTM D 422
R	Laboratory electrical resistivity, ohm-cm - ASTM G 57
E*	Pressuremeter deformation modulus, tsf
PM*	Pressuremeter test
VS*	Field vane shear - ASTM D 2573
IR*	Infiltrometer test - ASTM D 3385
RQD	Rock quality designation, percent
*	Results shown on attached data sheet or graph
**	ASTM designates American Society for Testing and Materials

DESCRIPTIONS OF N-VALUES VS. SOIL PROPERTIES

N Value	Density	N Value	Consistency
0 - 4	Very loose	0 - 4	Very soft
5 - 10	Loose	5 - 8	Soft
11 - 30	Medium dense	9 - 15	Firm
31 - 50	Dense	16 - 30	Hard
Over 50	Very dense	Over 30	Very hard

DESCRIPTIONS OF SOIL CONDITIONS

Condition	Description
Lamination	Up to 1/2" thick stratum
Layer	1/2" to 6" thick stratum
Dry	Powdery, no noticeable water
Moist	Below saturation
Wet	Saturated, above liquid limit
Waterbearing	Pervious soil below water
Varved	Alternating laminations of any combinations of clay, silt and fine grained sand

DESCRIPTIONS OF GRAVEL PROPORTIONS IN SOILS

Soil Type	Description	Range, %
Coarse grained soils	A little gravel	2 - 14
Coarse grained soils	With gravel	15 - 49
Fine grained soils:		
71-85% passing #200 sieve	A little gravel	2 - 7
71-85% passing #200 sieve	With gravel	8 - 29
70% passing #200 sieve	A little gravel	2 - 14
70% passing #200 sieve	With gravel	15 - 24
70% passing #200 sieve	Gravelly	16 - 49

DESCRIPTIONS OF PARTICLE SIZES

Material Type	Size
Boulders	Over 12"
Cobbles	3" - 12"
Coarse gravel	3/4" - 3"
Fine gravel	#4 sieve - 3/4"
Coarse sand	#4 - #10 sieve
Medium sand	#10 - #40 sieve
Fine sand	#40 - #200 sieve
Silt	100% passing #200 sieve and > 0.002mm
Clay	100% passing #200 sieve and < 0.002mm

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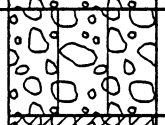
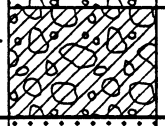
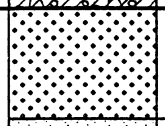
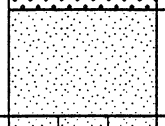
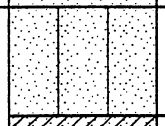
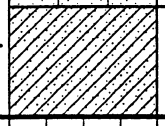
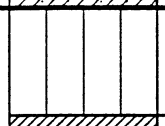
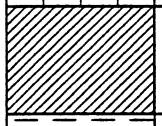
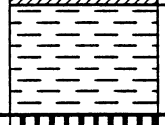
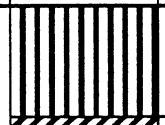
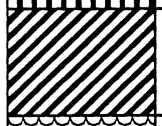
SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS — MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS — MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS — MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS — MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

APPENDIX B - LABORATORY TEST PROGRAM

B.1 Testing Scope
B.2 Index Properties
B.3 Strength Testing

Attachments to Appendix B
Unconfined Compression Test Results

B LABORATORY TEST RESULTS

B.1 Testing Scope

The scope of services included a laboratory test program to characterize the soil index properties. The index properties included Atterberg limits (liquid and plastic limits) moisture content and dry density. Strength testing consisted of unconfined compression (QU) testing. The results can be noted on the boring logs across from their sample locations and/or on attached data sheets.

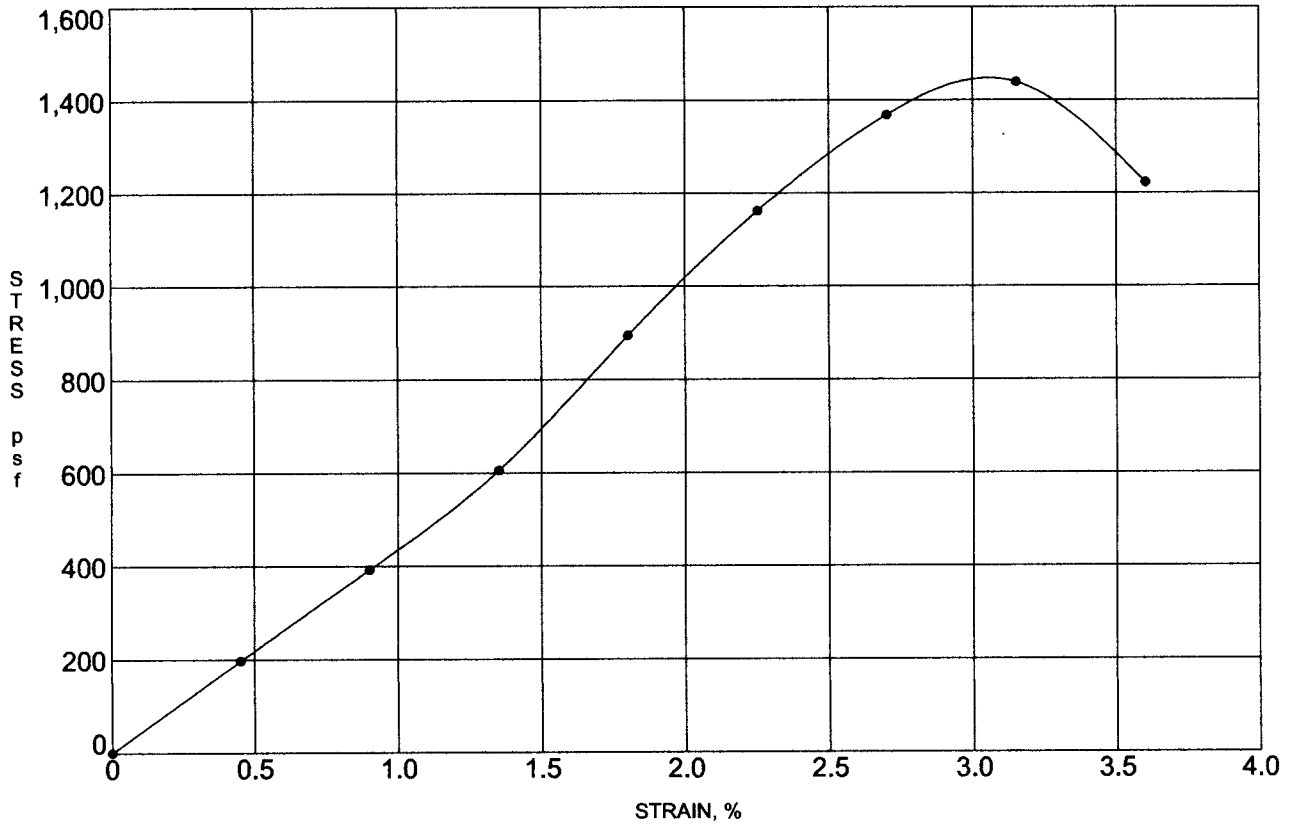
B.2 Index Properties

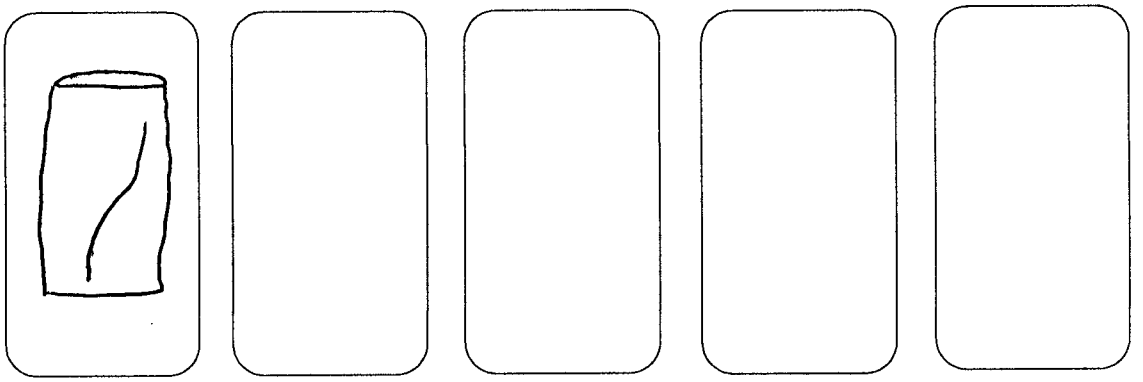
Testing and classification of soils was performed according to the Unified Soil Classification System as described in ASTM D 2487. Index property tests were performed to aid in soil classification.

Atterberg limits were performed according to ASTM D 4318. Moisture content was determined according to ASTM D 4959 and D 4643. The dry density was determined using direct measurement procedures.

B.3 Strength Testing

The strength testing consisted of a unconfined compression (QU) tests. The QU tests were conducted in accordance with ASTM D 2166.





Test 1 **Test 2** **Test 3** **Test 4** **Test 5**

	Test	Specimen	Classification	QU (psf)	DD	MC%
●	1	**2011-27.0'**	**Sandy Lean Clay (CL)**	**1439**	**108**	**20**
	2					
	3					
	4					
	5					
	6					

PROJECT **Steel Grain Bin, Hawley, Minnesota (hawley steel bin)** JOB NO. **ZGE #11-033**
DATE **7/16/11**

UNCONFINED COMPRESSION TEST

Zeltinger Geotechnical Engineering
Bismarck, ND 58503