Agenda Item 11

MEMORANDUM

TO: Programs, Projects and Operations Subcommittee

SUBJECT: California Bend Environmental Restoration Project – Access Road

DATE: January 15, 2009

FROM: Marlin J. Petermann, Martin Cleveland, and Jim Becic

The California Bend site is a 215 acre site that is adjacent to and north of Blair, NE, on a Missouri River West Bank Chute, (Exhibit A). The NRD cost shared on the restoration of this site with the Corps of Engineers and the project was considered complete in 2004 (Exhibit B). At this time, the District assumed responsibility for operation and maintenance of this site. Since that time a high diversity of flora has established and the site is being used by a variety of fish species, avian fauna and furbearers. In 2005, a Recreation Master Plan was developed with the City of Blair to eventually allow public access and low impact recreation (Exhibit C).

In May of 2007, a rain event occurred over-and-above the site that resulted in overland flooding and a quick, yet short lived, rise of the Missouri River. This excessive rain caused several serious erosion concerns along the access road through the site (Exhibits D, E and F).Some sloughing in this area is non consequential to the District, but the threat to the only access road to the upstream end of the project is the major concern.

The Corps of Engineers was consulted regarding the best method(s) of repair. They provided a recommended plan, but they were not able to provide funding assistance.

An Invitation for Bids was published, three bids were received and in May 2008 the Board awarded the Slope Repair/Road Restoration Project to Valley Corporation. The Bid amount was $57,675. Repair work commenced on May 19, 2008 and ceased on July 9, 2008. The slope failed during initial repair construction and the repair approach was then modified. The slope failed again after additional work was done. At the August 2008 Board meeting, Valley Corporation was approved for total payment of $186,240.74.

Thiele Geotech, Inc., a geotechnical engineering consultant was hired to evaluate the slope failure and recommend possible options. Attached are copies of the Thiele Geotechnical Exploration Report dated November 22, 2008 and an Addendum #1, dated January 19, 2009.

The soil below the failed slope is soft clay and silt (at least 20 ft. deep as per borings), which provides for a very poor base for any slope reconstruction and low factor of safety.

The options Thiele Geotech, Inc. provided were as follows:

1. Flatten the slope to 20H:1V. This option has a safety factor of 1.22, which is less than desired 1.5.
2. Leave the slope as is and monitor for changes. Minor grading would be required to smooth the grade change between roadway and failed area below.
3. Install driven steel H-piles to help anchor the slope.
4. Install rock trenches to reinforce the soil mass to improve its resistance to slope failure.

Thiele Geotech, Inc. did not provide cost estimates for above options. Options 1, 3 and 4 would require design by a Civil Engineering consultant and perhaps additional geotechnical exploration. It is the staff's opinion that total repair costs could be in the $250,000 range.

It is Management's plan to leave slope as is and monitor it for changes along with minor grading to allow good access and smooth the area with District equipment (Option 2). If the slope fails again in the future it is likely to occur along the same vertical slip-plane and not likely impact the adjacent landowner initially. Repair designs and construction bids could then be sought to address the situation more permanently.

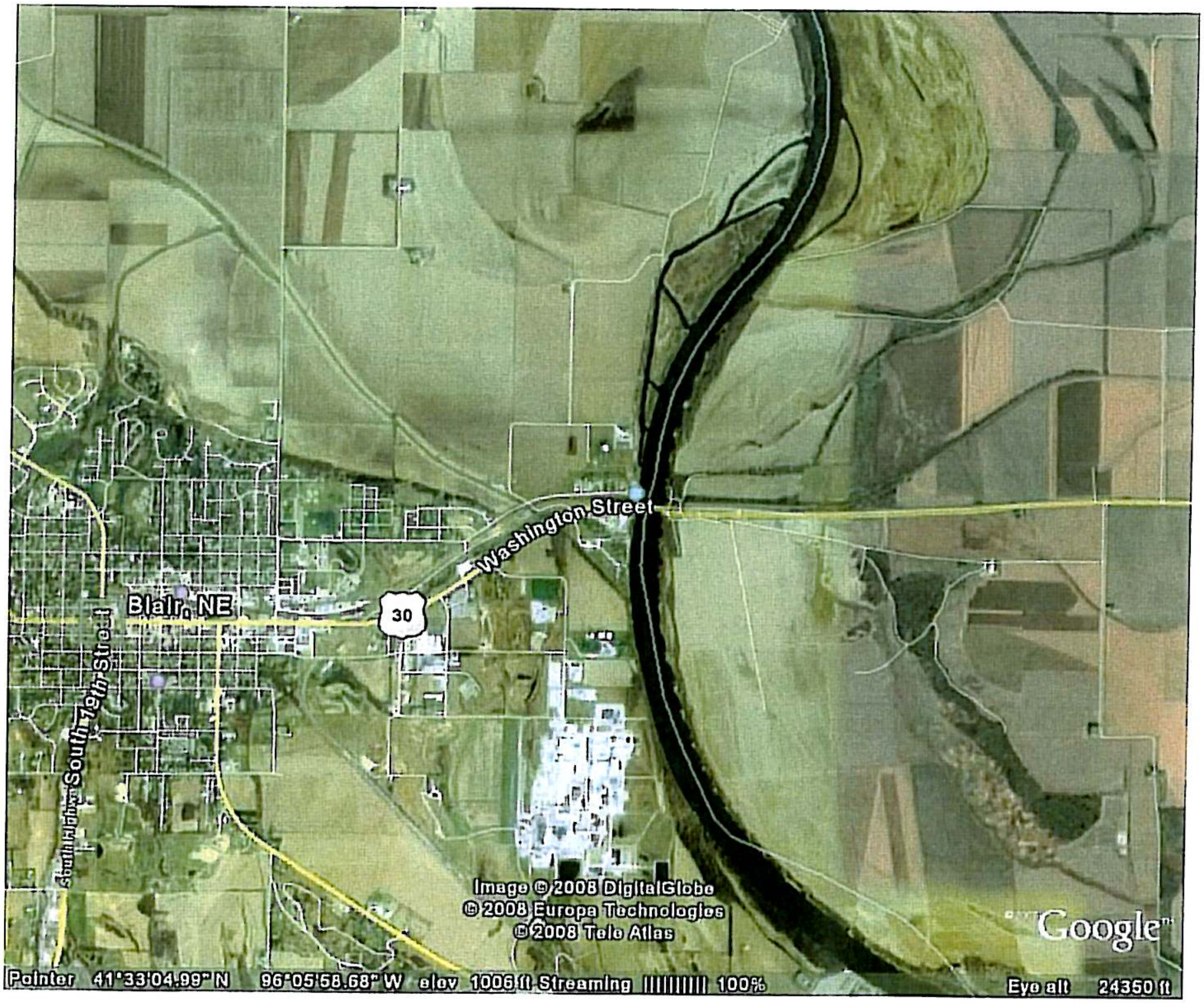
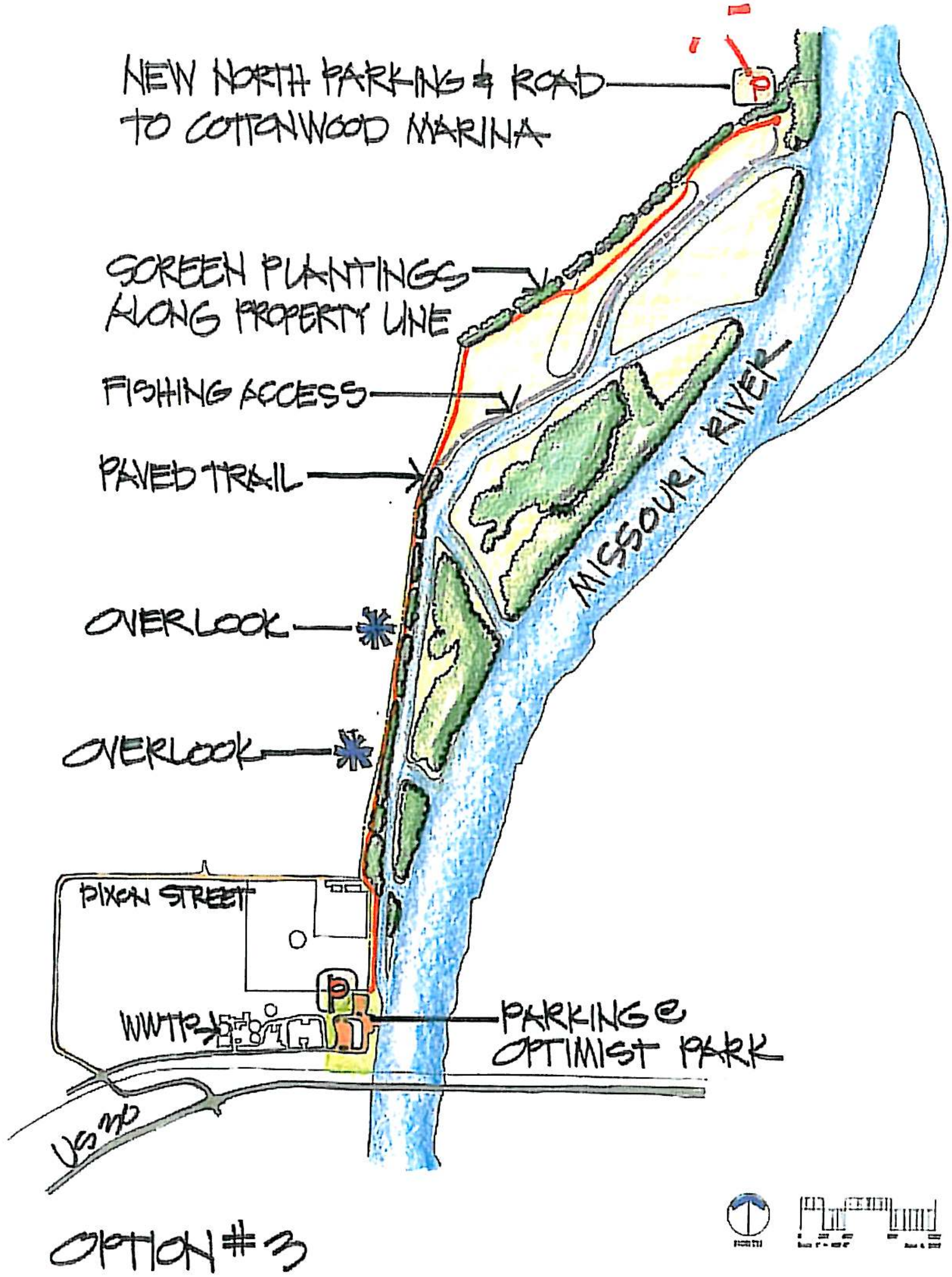


Exhibit A: California Bend - Site Location Map

Exhibit B: California Bend – Aerial

Exhibit C: California Bend – Recreation and Habitat Master Plan.



California Bend Recreation & Habitat Master Plan

City of Blair

Papio-Missouri River Natural Resources District

The Big Muddy Workshop Inc

Omaha, Nebraska

Exhibit D: California Bend – Road Washout Site Map.

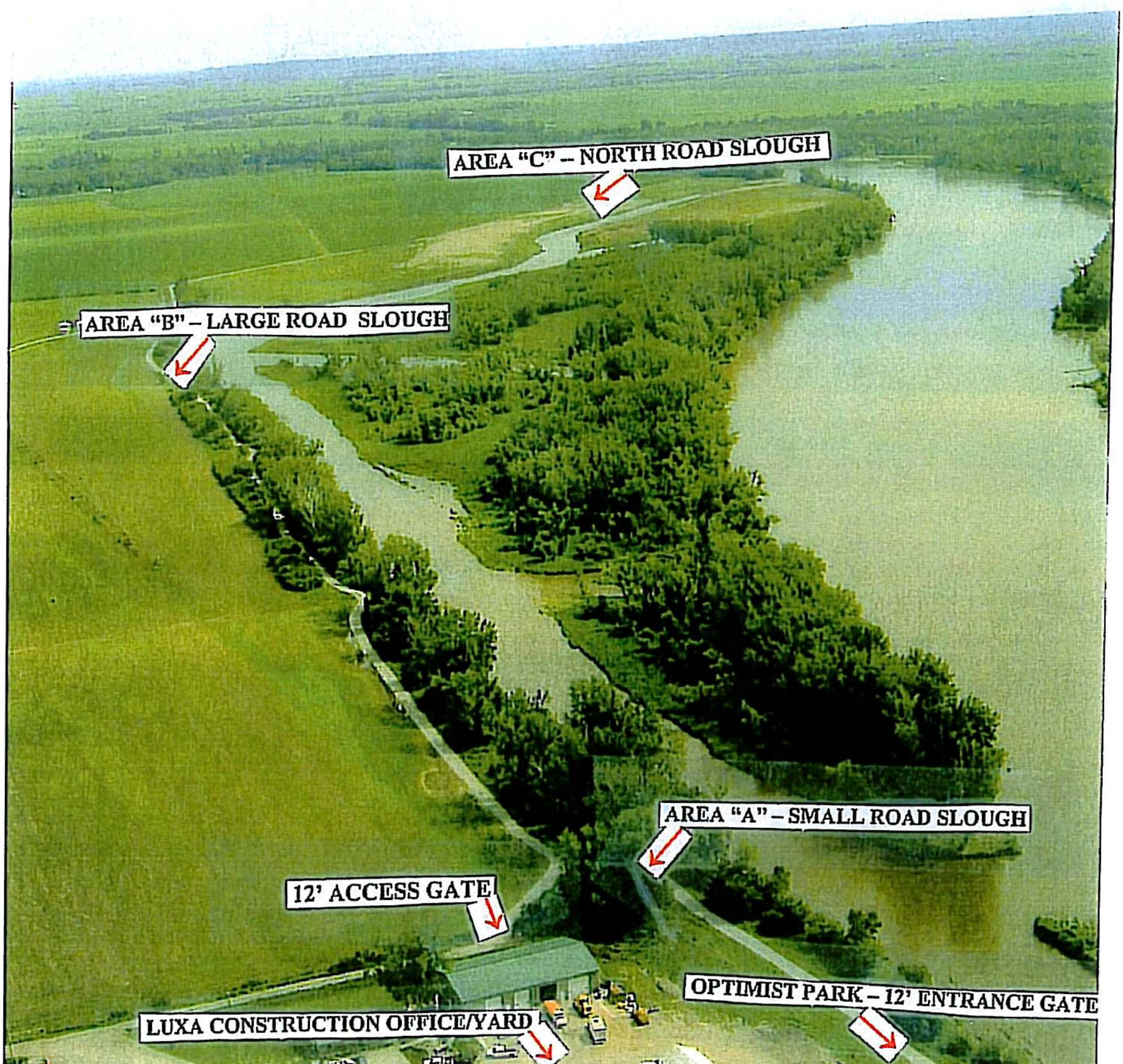


Exhibit E: California Bend – Area "A".

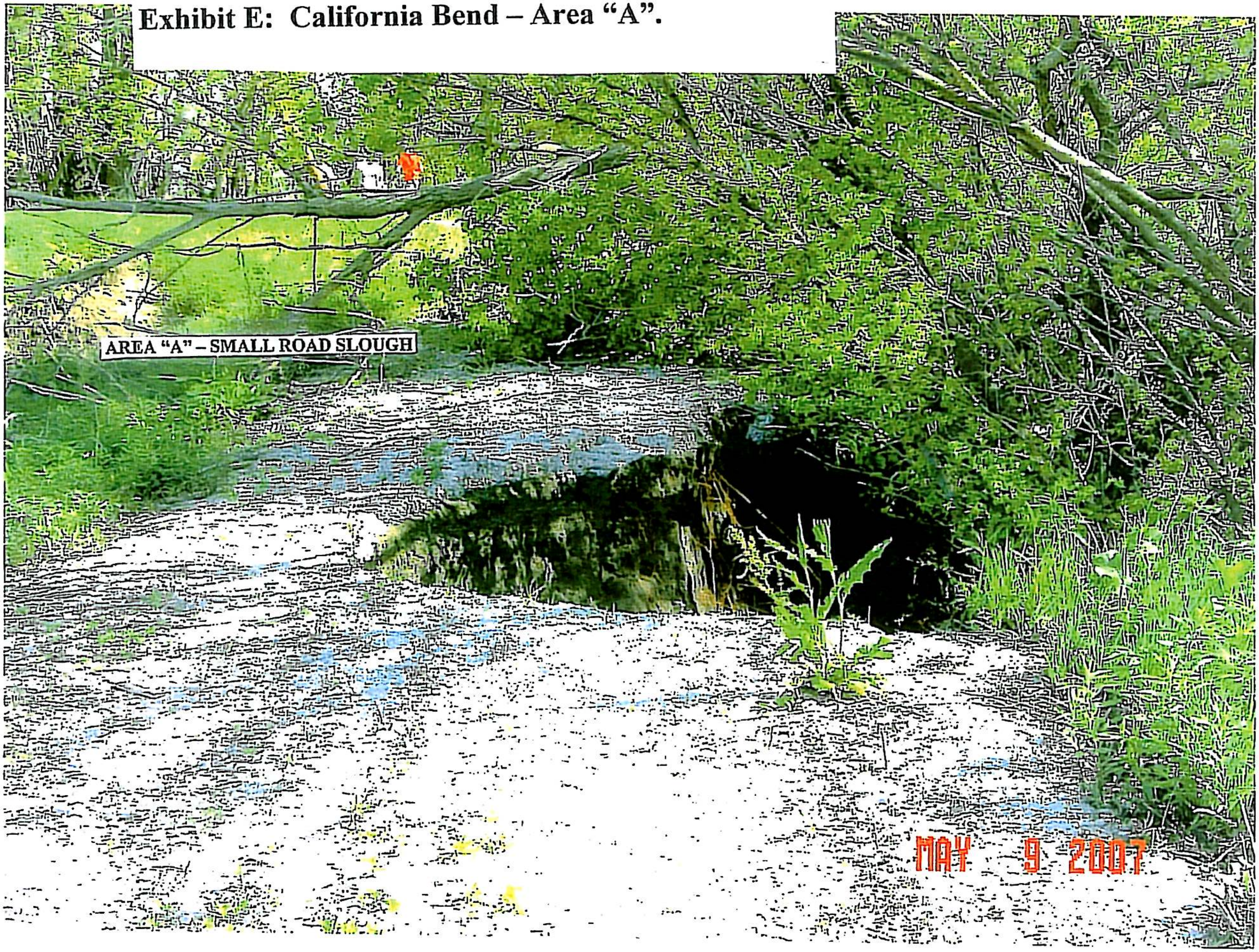
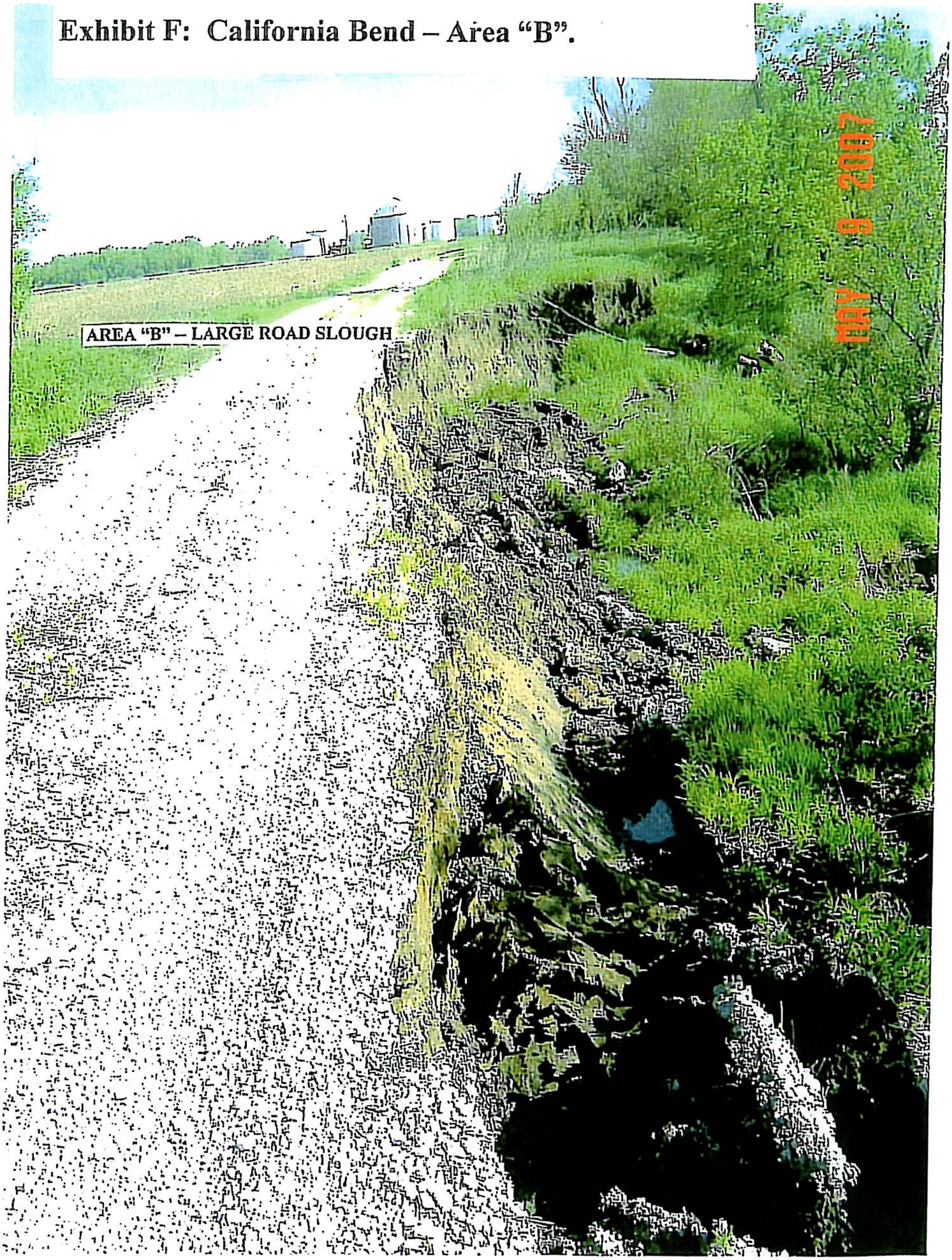


Exhibit F: California Bend – Area "B".



California Bend – Slough Area B – Sept. 2008

California Bend – Slough Area B – Sept. 2008

Thiele Geotech Inc

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January 19, 2009

Mr. Martin Cleveland, P.E.
Papio-Missouri River NRD
8901 South 154th Street
Omaha, Nebraska 68138-3621

RE: CALIFORNIA BEND SLOPE FAILURE, BLAIR, NEBRASKA
TG# 08475.00, ADDENDUM 1

Dear Mr. Cleveland:

This letter is Addendum 1 to the Geotechnical Exploration Report for this project, and should be included whenever the report is referenced. Several items which were discussed during a meeting on December 3, 2008, are documented and discussed further in this addendum. Discussion items include what effect flattening the slope would have on its stability, whether or not simply leaving the slope as it is would be a viable option, rock trench stabilization, and H-piles.

Additional slope stability analyses shows that flattening the slope would result in a minimal improvement of the safety factor. Flattening the slope to as flat as 20H:1V improves the safety factor to approximately 1.22. While this is still well below the desired safety factor of 1.5, it may be acceptable since the slope is in a non-critical, little-used area.

Consideration could be given to leaving the slope basically as it is. Based on limited movements since the last failure event in June 2008, the slope may have reached a stable equilibrium condition and can be monitored for any changes. Minor grading could be done to smooth the grade change between the roadway and the failed area below. This would help facilitate road use. More aggressive repairs could be done in the future if the area continues to degrade substantially.

The discussion about rock trenches included the following:

- Trenches to be constructed in conjunction with re-grading of the slope.
- New embankment fill to be compacted to at least 95 percent Standard Proctor.
- New fill to be benched into existing soil.
- Each trench should be at least 24 inches wide and filled with rip-rap rock.
- Trenches to be spaced 10' apart on center and installed perpendicular to the road.
- Trenches to extend to a depth of at least 30 feet below the roadway grade.
- Existing rock at the site (of the appropriate size) can be used to fill trenches below the water table.
- Do the work when the river water level is low.
- Keep the excavation work at least 3 feet above the ground water level.
- Trenches can be constructed in lifts as the fill is brought up.

Stabilization using steel H-piles was discussed, but was not considered practical due to the poor lateral support which would be provided by the soft soil conditions.

We are available for further discussion and development of any of these items. Please call if you have any questions.

Respectfully,
Thiele Geotech, Inc.

John A. Christiansen

John A. Christiansen, P.E.
Vice President

P:\08475.00\ADDENDUM I LETTER.DOCX

Thiele Geotech Inc

Geotechnical Exploration Report

California Bend Slope Failure

California Bend
Blair, Nebraska

Prepared for:
Papio-Missouri River NRD
8901 South 154th Street
Omaha, Nebraska 68138

November 22, 2008
TG Project No. 08475.00

PROFESSIONAL CIVIL ENGINEER
JOHN A. CHRISTIANSEN
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STATE OF NEBRASKA

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Geotechnical Exploration Report
California Bend Slope Failure

Table of Contents

INTRODUCTION

Thiele Geotech, Inc. has completed a geotechnical exploration study for the proposed slope repairs to be located at the California Bend channel at the Missouri River near Blair, Nebraska. The purpose of this study was to identify the general soil and ground water conditions underlying the site; to evaluate engineering properties of the existing soils; to provide earthwork and site preparation recommendations; to discuss results of our slope stability analysis; and to discuss causes of the failure and remedial measures.

This study included soil borings, laboratory testing, and engineering analysis. A series of 2 test borings was spaced across the project site at strategic locations. The field and laboratory data are presented in the Appendix, along with a description of investigative methods.

The drilling and testing performed for this study were conducted solely for geotechnical analysis. No analytical testing or environmental assessment has been conducted. Any statements or observations in this report regarding odors, discoloration, or suspicious conditions are strictly for the information of our client.

It should also be noted that this report was prepared for design purposes only, and may not be sufficient for a contractor in bid preparation. Prospective contractors should evaluate potential construction problems on the basis of their own knowledge and experience in the local area and on similar projects, taking into account their own intended construction methods and procedures.

This report is an instrument of service prepared for use by our client on this specific project. The report may be duplicated as necessary and distributed to those directly associated with this project, including members of the design team and prospective contractors. However, the technical approach and report format shall be considered proprietary and confidential, and this report may not be distributed in whole or in part to any third party not directly associated with this project. By using and relying on this report, all other parties agree to the same terms, conditions, and limitations to which the client has agreed.

PROJECT DESCRIPTION

We understand the project to consist of repairing a slope failure. This failure is located between the channel and the access road, approximately 4,000 feet north of Optimist Park. The failed area is approximately 250 feet long, and has dropped as much as 4 feet. Many cracks were observed at the ground surface in the failed area. These cracks paralleled the channel, and were up to 12 inches wide and 5 feet deep. This area failed in the spring of 2007, and was repaired in May and June 2008. It began failing again before the repairs were completed. The repairs included placing a rock revetment at the toe of the slope, and rebuilding the slope to a 2H:1V configuration. Four transverse rock filled trenches tied into the longitudinal trench and ran to the east. Rock for the revetment and the trenches was stockpiled at the top of the slope during repairs. Project documents indicate that the compaction requirement for the fill was a minimum of 90 percent Standard Proctor (ASTM D698). A longitudinal rock filled trench was constructed on the east edge of the road. An old railroad right of way exists on the west edge of the roadway.

SURFACE AND SUBSURFACE CONDITIONS

LOCAL GEOLOGY

The project site is located within the floodplain of the Missouri River. The Omaha/Council Bluffs area consists of a broad range of loess-covered hills that have been bisected by the valley of the Missouri River. Tributary streams and creeks such as the Mosquito, Indian, Honey, and Papillion, that flow into the Missouri River have also eroded and bisected the loess-covered hills, but to a lesser degree.

The surface geology of the Missouri River Basin is Pleistocene in age and consists of eolian (wind-blown) deposits of Peoria and Loveland loess. The loess formed in dune-shaped hills between major drainageways. The Peoria loess typically consists of silty lean clays that are stiff when dry but become softer with increasing moisture content. The Peoria often exhibits low unit weight and is collapse susceptible. The Loveland loess is an older deposit, and typically consists of lean clays. The Loveland generally exhibits higher unit weights and shear strengths than the Peoria.

The loess overlies Pleistocene glacial deposits of Kansan till. The till consists of lean to fat clays mixed with sand, gravel, and occasional cobbles. The glacial deposits are generally fairly deep, but are sometimes near the surface at lower elevations on steep slopes. Pennsylvanian limestone and shale form the bedrock unit below the glacial deposits. The depth to bedrock is normally great, and rock is rarely encountered in construction.

Along drainageways, alluvial and colluvial deposits are typically present. These soils were formed by erosion of the adjoining loess-mantled hills. Alluvial deposits are generally present along creeks and in major drainageways. The upper several feet of alluvium are usually stiffer due to the effects of desiccation. Colluvial soils are usually located at the base of steep slopes and in upland draws, and are formed by local creep and sloughing.

SOIL CONDITIONS

The soils encountered in the test borings generally consisted of man-placed fill over alluvium. The fill was found in the upper 3 to 5 feet of the borings, and was described as gray and grayish brown, very moist, firm to soft fat clay. Alluvium was found below the fill, and extended to the bottom of each boring. It was described as light gray to grayish brown, very moist to wet, firm to soft, fat clay, lean clay, and silt.

Ranges of engineering properties from laboratory tests on selected samples are presented in Table 1.

Table 1 - Laboratory Results

Soil Layer	Moisture Content (%)	Dry Unit Weight (pcf)	Unconfined Compressive Strength (tsf)	Classification *(LL/PI)*
Man-placed fill	25 to 34	83 to 99	--	CH (visual)
Alluvium	17 to 45	74 to 88	0.4 to 1.0	CH (100/74), CL (visual), ML (P200=95%)

GROUND WATER OBSERVATIONS

Ground water levels were observed in the borings as presented in Table 2. Note that ground water levels may fluctuate due to seasonal variations and other factors.

Table 2 - Water Level Observations

Boring Number	Water Level (ft. below grade)	
	During Drilling	Cave-in at end of Drilling
B-1	27.0	15.3
B-2	26.0	15.2

ANALYSIS AND RECOMMENDATIONS

GENERAL

Roughly the upper 20 feet of soil in each boring consists of fat clay and lean clay which is firm in consistency. Soil below 20 feet consists of soft clay and silt.

We modeled the soil layering and the pre-failure slope and ran a series of computerized slope stability analyses, using a STABL-based computer program. A slope of approximately 2H:1V with a height of 20 feet was used. Soil strengths and unit weights were estimated based on our laboratory test results. In our series of computer runs we varied the soil strength parameters to simulate the variability of field conditions. This model showed that the slope had safety factors of roughly at and just below 1 against global failure. Global failure is large scale failure of the slope, as opposed to surficial slumping. Failure occurs when the safety factor drops below 1.00. Commonly recommended safety factors for slopes are at least 1.3 for a short term condition, and at least 1.5 for a long term condition. Our modeling indicates that the existing soil conditions are not adequate to support the 2H:1V slope at this site, without some type of remediation.

It is desired to rebuild the slope in such a way that it does not fail again. Traditional methods to increase the stability of a slope include flattening the slope so it isn't as steep; placing a soil or rock buttress berm at the toe (base) of the slope; and reinforcing the slope with some type of anchor system such as driven steel H-piles, rock piers, or rock trenches. Dewatering is normally an important aspect in improving the stability of a slope, because it reduces the seepage pressure against the slope face, and can improve the engineering properties of the soil over time.

Flattening the slope to 3H:1V may be difficult given the configuration of the channel and adjacent roadway and field, and would only raise the safety factor marginally (approximately 0.2). Therefore it appears that by itself, flattening the slope may not be a solution. However, consideration could be given to flattening the slope in conjunction with other remedial measures.

A buttress berm of large rock was placed at the toe of the slope during the most recent repair. This apparently was not effective in stabilizing the slope since it began failing almost immediately. It appears that the failure zone for this most recent failure may have extended past the buttress berm toward the channel.

Installing driven steel H-piles would help anchor the slope, but would have to extend through the soft soils and into denser, harder deposits. No denser, harder deposits were identified within the depth of our borings, and additional drilling would be necessary to identify an appropriate bearing layer. Piles would likely need to be installed on a tightly-spaced grid (perhaps every 10' or less).

Stone trenches are sometimes used to reinforce a soil mass to improve its resistance to slope failure. They also act as a drainage trench for ground water, helping to lower water levels and reduce seepage pressures. A stone trench consists of a 2 to 3 foot wide trench, which is dug with a long-reach backhoe through the soft soil layer, deep enough to extend through the slip circle zone into underlying soils. The trench is typically lined with a filter geofabric, then filled with 6 to 8 inch diameter rip-rap rock. The rock is compacted with the bucket of the backhoe which is used to dig the trench. The rock typically extends to within 3 to 4 feet of the ground surface and is then capped with dirt. The trenches are placed perpendicular to the slope, and are spaced at intervals of roughly 10 feet apart. The use of stone trenches is limited by several factors including the reach of the backhoe equipment. On this site the trenches would need to extend to at least 30 feet below the roadway grade to reach below the slip circle zone. This means the trenches would have to extend 10 to 15 feet below the water table, which may be difficult to accomplish. It may be possible to install the trenches in lifts as the slope is rebuilt, which would minimize the depth of trench which is open at any given time.

This site appears to be difficult to stabilize due to the properties of the soil, the ground water elevation, and the physical location of the slope with respect to the surrounding channel and farmland. Thiele Geotech is available to discuss these options further and help evaluate which option has the most merit at this site.

We also ran an analysis where we modeled a stockpiled of rock at the top of the slope. The extra weight of the rock adds to the driving force, and reduces the safety factor. We therefore recommend that rock not be stockpiled at the top of the slope during future rebuilding of the slope.

For future rebuilding of the slope, we recommend compacting the embankment fill to a minimum of 95 percent of the maximum dry density (ASTM D698, Standard Proctor). Moisture content should be controlled to between -3 and +4 percent of optimum. The new fill should be benched into soil west of the failure area.

EARTHWORK AND EXCAVATIONS

Rubble and waste materials from site clearing and demolition should be removed from the site and lawfully disposed or recycled. Waste materials should not be buried on-site. Where trees are cleared, the stumps should be excavated and removed.

Topsoil and vegetation should be stripped to a depth of 4 to 6 inches in areas to be disturbed during grading, including borrow and fill areas. Surfaces to receive fill should be broken up and recompacted to allow new fill to bond to the existing soil. Slopes steeper than 5H:1V should be benched before placing fill.

The excavated site soils will generally be suitable for reuse as structural fill, although some moisture conditioning may be required. Borrow material should not contain an appreciable amount of roots, rock, or debris, and should not contain any foreign material with a dimension greater than 3 inches.

All fills should be placed and compacted as structural fill. Fill should be placed in thin lifts not to exceed 8 inches loose thickness. Structural fill should be compacted with a sheepsfoot type roller to a minimum of 95 percent of the maximum dry density (ASTM D698, Standard Proctor). Moisture content should be controlled to between -3 and +4 percent of optimum.

Quality control testing is an important part of any earthwork operation. It is recommended that a representative of the geotechnical engineer periodically monitor earthwork operations to verify proper compliance with these recommendations, including compaction levels.

OSHA's Construction Standards for Excavations require that the contractor's excavation activities follow certain worker safety procedures. These include a requirement that excavations over 4 feet deep be sloped back, shored, or shielded. The soils encountered in the test borings generally classify as type B and C soils according to the OSHA standard. The maximum allowable slope for an unbraced excavation in these soils is 1H:1V and 1.5H:1V, respectively, although other provisions and restrictions apply. Excavations over 20 feet deep require specific design by a licensed Professional Engineer. The contractor is solely responsible for site/excavation safety and compliance with OSHA regulations. The geotechnical engineer assumes no responsibility for site safety, and the above information is provided only for consideration by the designers.

OTHER RECOMMENDATIONS

During detailed design, additional issues may arise and possible conflicts may occur with our recommendations. Such issues and conflicts should be resolved through dialogue between the geotechnical engineer and designers. It is recommended that the geotechnical engineer review the final design, including the plans and specifications, to verify that our recommendations are properly interpreted and incorporated into the design.

If any changes are made in the design of the project, including the nature or location of proposed repairs on the site or significant elevation changes, the analysis and recommendations of this report shall not be considered valid unless the changes are reviewed. The analysis and recommendations of this report should not be applied to different projects on the same site or to similar projects on different sites.

The analysis and recommendations in this report are based upon borings at specific locations. The nature and extent of variation between boring locations is impossible to predict. Because of this, geotechnical recommendations are preliminary until they have been confirmed through observation of site excavation and earthwork preparation. If variations appear during subsequent exploration or during construction, we may reevaluate our recommendations and modify them, if appropriate. The geotechnical engineer should be retained during construction to observe compliance with the recommendations of this report and to provide quality control testing of earthwork construction. If these services are provided by others, including the contractor, the entity that provides construction phase observation and testing shares responsibility as the geotechnical engineer of record for implementing or modifying these recommendations.

Respectfully submitted,
Thiele Geotech, Inc.

Prepared by,

PROFESSIONAL CIVIL ENGINEER
JOHN A.
CHRISTIANSEN
E-7821
STATE OF NEBRASKA

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APPENDIX

Subsurface Exploration Methods

Legend of Terms

Boring Location Plan

Boring Logs

Soil Test Summary

SUBSURFACE EXPLORATION METHODS

The fieldwork for this study was conducted on October 3, 2008. The exploratory program consisted of 2 test borings drilled at the approximate locations shown on the Boring Location Plan. Boring locations were selected to provide the desired site coverage and were adjusted to accommodate access conditions. The boring locations were laid out by estimating angles and measuring with a cloth tape from existing site features. The boring locations should only be considered accurate to the degree implied by the methods used to define them.

Test borings were advanced using flight augers powered by a truck-mounted drill rig. Soil samples were obtained at selected depths as indicated on the boring logs. A 3-inch nominal diameter thin-walled sampler was hydraulically pushed to obtain undisturbed samples. Disturbed samples were obtained by driving a 2-inch nominal diameter split barrel sampler while conducting standard penetration tests (SPT).

The boring logs were prepared based on visual classification of the samples and drill cuttings, and by observation of the drilling characteristics of the subsurface formations. The logs have been supplemented and modified based on the laboratory test results and further examination of the recovered samples. The stratification lines on the boring logs represent the approximate boundary between soil types, but the insitu transition may be gradual.

Water level observations were made at the times stated on the boring logs. The borings were backfilled with drill cuttings at the completion of the fieldwork.

The field boring logs were reviewed to outline the depths, thicknesses, and extent of the soil strata. A laboratory testing program was then developed to further classify the basic soils and to evaluate the engineering properties for use in our analysis.

Laboratory tests to further classify the soils included visual classification, moisture content, dry unit weight, Atterberg limits, and fraction passing the #200 sieve. The shear strengths of cohesive samples were evaluated using the unconfined compression test.

The boring logs and related information in this report are indicators of subsurface conditions only at the specific locations and times noted. Subsurface conditions, including ground water levels, at other locations of the site may differ significantly from conditions that exist at the sampling locations. Also note that the passage of time may affect conditions at the sampling locations.

LEGEND OF TERMS

Soil Description Terms

Consistency - Fine Grained	Consistency - Coarse Grained	Moisture Conditions
Very Soft, Soft, Firm, Hard, Very Hard	Very Loose, Loose, Medium Dense, Dense, Very Dense	Dry, Slightly Moist, Moist Very Moist, Wet (Saturated)

Sample Identification

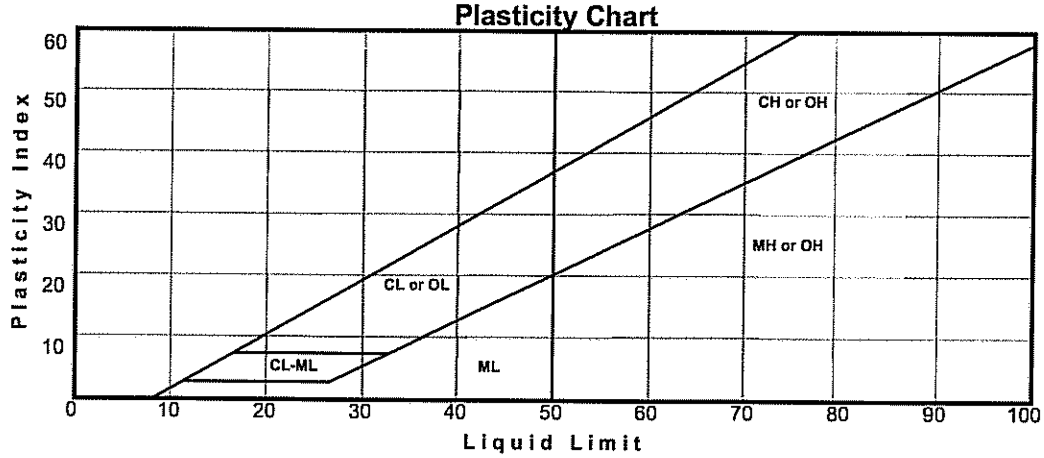
Sample Type	Sample Data	Laboratory Data
U -- Undisturbed (Shelby Tube)	No. -- Number	MC -- Moisture content
S -- Split barrel (disturbed)	SPT -- Standard penetration test	γ_d -- Dry unit weight
C -- Continuous sample	bpf -- blows per foot	q_u -- Unconfined compression
A -- Auger cuttings (disturbed)	Rec -- Recovery	LL/PI -- Liquid limit & plasticity index

Unified Soil Classification System

Peat	Pt	Highly organic soils	50% or more smaller than No. 200 sieve
Fat Clay	CH	Clay - Liquid Limit > 50 *	
Elastic Silt	MH	Silt - Liquid Limit > 50 *	
Lean Clay	CL	Clay - Liquid Limit < 50 *	
Silt	ML	Silt - Liquid Limit < 50 *	
Silty Clay	CL-ML	Silty Clay *	
Clayey Sand	SC	Sands with 12 to 50 percent smaller than No. 200 sieve *	More than 50% larger than No. 200 sieve and % sand > % Gravel
Silty Sand	SM		
Poorly-Graded Sand with Clay	SP-SC	Sands with 5 to 12 percent smaller than No. 200 Sieve *	
Poorly-Graded Sand with Silt	SP-SM		
Well-Graded Sand with Clay **	SW-SC		
Well-Graded Sand with Silt **	SW-SM		
Poorly-Graded Sand	SP	Sands with less than 5 percent smaller than No. 200 sieve *	
Well-Graded Sand **	SW		
Clayey Gravel	GC	Gravels with 12 to 50 percent smaller than No. 200 Sieve *	More than 50% larger than No. 200 sieve and % gravel > % sand
Silty Gravel	GM		
Poorly-Graded Gravel with Clay	GP-GC	Gravels with 5 to 12 percent smaller than No. 200 sieve *	
Poorly-Graded Gravel with Silt	GP-GM		
Well-Graded Gravel with Clay **	GW-GC		
Well-Graded Gravel with Silt **	GW-GM		
Poorly-Graded Gravel	GP	Gravels with less than 5 percent smaller than No. 200 sieve *	
Well-Graded Gravel **	GW		

* *See Plasticity Chart for definition of silts and clays*
** *See Criteria for Sands and Gravels for definition of well-graded*

Plasticity Chart

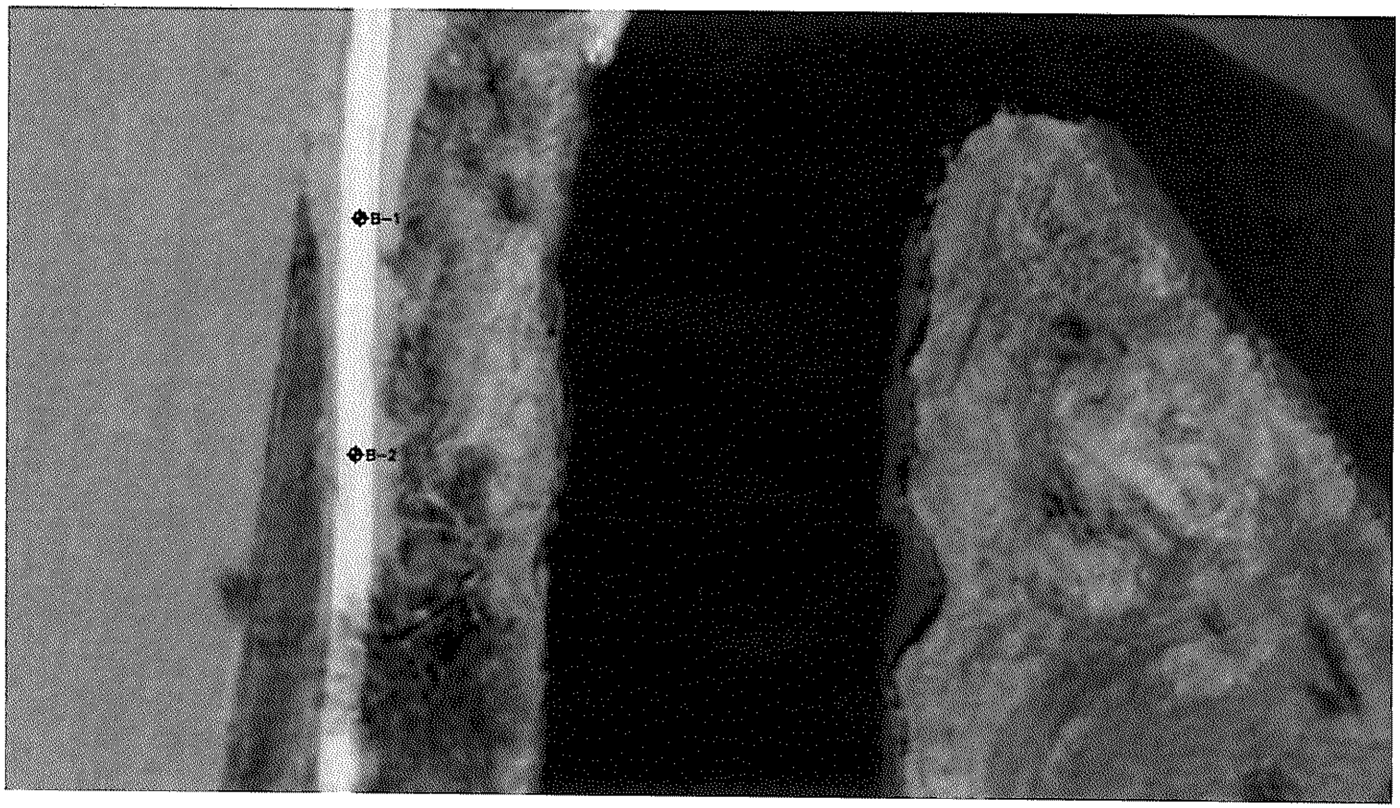


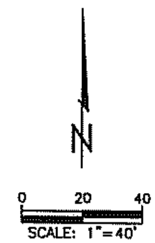
Criteria for Sands and Gravels

Boulders	Cobbles	Coarse Gravel	Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	FINES (silt or clay)
Sieve size 10"	3"	¾"	#4	#10	#40	#200	

Well-graded sands (SW) $C_u=D_{60}/D_{10}\geq 6$ and $C_c=(D_{30})^2/(D_{10} \times D_{60}) \leq 3$ and ≥ 1

Well-graded gravels (GW) $C_u=D_{60}/D_{10}\geq 4$ and $C_c=(D_{30})^2/(D_{10} \times D_{60}) \leq 3$ and ≥ 1





LEGEND

⊕ BORING LOCATION

Thiele Geotech Inc

PROJECT
CALIFORNIA BEND SLOPE FAILURE CALIFORNIA BEND BLAIR, NEBRASKA
JOB # 08475.00 DATE: 10/16/08

BORING LOCATION PLAN

Thiele Geotech Inc

BORING LOG

WATER LEVEL OBSERVATIONS		PROJECT	DRILLER	LOGGER	JOB NO.	DATE
During Drilling	27.0'	California Bend Slope Failure	Gappa	Kratz	08475.00	10/3/08
End of Drilling	20.0'	LOCATION	DRILLING METHOD		DRILL RIG	BORING NO.
Cave In	15.3'	California Bend, Blair, NE	3.25" HSA		CME 45B	B-1
		LOCATION OF BORING	TYPE OF SURFACE		ELEVATION	DEPTH
boring backfilled with cuttings		see Boring Location Plan	bare ground			40'

DEP (ft.)	COLOR	MOIST.	CONSIST.	SOIL TYPE	GEOLOGIC ORIGIN	REMARKS	NO. & TYPE	SPT (bpf)	REC (in.)	MC (%)	γ_d (pcf)	q_u (tsf)	LL/PI CLASS	DEP (ft.)
	gray	very moist	firm	fat clay	fill									
							U-1		12	34.2	83.4			
			soft											
5							U-2		5	24.6	89.6			5
	gray	very moist	firm	fat clay	alluvium	iron stains								
10							U-3		6	34.8	86.9			10
15							U-4		10	34.3	84.7	0.99	LL=100 PI=74 CH	15
20							U-5		11	37.7	82.8	0.80		20
		wet												
			soft											
25						very fine sandy silt layers	U-6		12	33.5	87.8	0.48		25

Thiele Geotech Inc

BORING LOG

WATER LEVEL OBSERVATIONS		PROJECT	DRILLER	LOGGER	JOB NO.	DATE
During Drilling	27.0'	California Bend Slope Failure	Gappa	Kratz	08475.00	10/3/08
End of Drilling	20.0'	LOCATION	DRILLING METHOD		DRILL RIG	BORING NO.
Cave In	15.3'	California Bend, Blair, NE	3.25" HSA		CME 45B	B-1(cont.)
		LOCATION OF BORING	TYPE OF SURFACE		ELEVATION	DEPTH
boring backfilled with cuttings		see Boring Location Plan	bare ground			40'

DEP (ft.)	COLOR	MOIST.	CONSIST.	SOIL TYPE	GEOLOGIC ORIGIN	REMARKS	NO. & TYPE	SPT (bpf)	REC (in.)	MC (%)	γd (pcf)	qu (tsf)	LL/PI CLASS	DEP (ft.)
	gray	wet	soft	fat clay	alluvium									
				lean clay		silty layers								
30							U-7		10	45.4	87.8	0.48		30
				silt										
35							U-8		4	16.7			P200 83.5% ML	35
40							S-9	7		33.4				40
						bottom of hole @ 40'								
45														45
50														50

Thiele Geotech Inc

BORING LOG

WATER LEVEL OBSERVATIONS		PROJECT	DRILLER	LOGGER	JOB NO.	DATE
During Drilling	26.0'	California Bend Slope Failure	Gappa	Kratz	08475.00	10/3/08
End of Drilling	21.0'	LOCATION	DRILLING METHOD		DRILL RIG	BORING NO.
Cave In	15.2'	California Bend, Blair, NE	3.25" HSA		CME 45B	B-2
		LOCATION OF BORING	TYPE OF SURFACE		ELEVATION	DEPTH
boring backfilled with cuttings		see Boring Location Plan	bare ground			40'

DEP (ft.)	COLOR	MOIST.	CONSIST.	SOIL TYPE	GEOLOGIC ORIGIN	REMARKS	NO. & TYPE	SPT (bpf)	REC (in.)	MC (%)	γ_d (pcf)	q_u (tsf)	LL/PI CLASS	DEP (ft.)
	VISUAL/MANUAL DESCRIPTION						SAMPLE DATA			LABORATORY DATA				
	grayish brown	very moist	firm	fat clay	fill									
							U-1		12	25.3	99.0			
	gray	very moist	firm	fat clay	alluvium	iron & carbon deposits								
5							U-2		8	33.8	85.7	0.90	LL=66 PI=44 CH	5
10							U-3		8	34.8	74.3	1.08		10
	light gray													
15							U-4		12	37.1	83.1	1.07		15
	gray													
20							U-5		11	36.8	84.9	0.90		20
		wet												
			soft	lean clay										
25							U-6		11	34.0	87.8	0.35		25

Thiele Geotech Inc

BORING LOG

WATER LEVEL OBSERVATIONS		PROJECT	DRILLER	LOGGER	JOB NO.	DATE
During Drilling	26.0'	California Bend Slope Failure	Gappa	Kratz	08475.00	10/3/08
End of Drilling	21.0'	LOCATION	DRILLING METHOD		DRILL RIG	BORING NO.
Cave In	15.2'	California Bend, Blair, NE	3.25" HSA		CME 45B	B-2(cont.)
		LOCATION OF BORING	TYPE OF SURFACE		ELEVATION	DEPTH
boring backfilled with cuttings		see Boring Location Plan	bare ground			40'

DEP (ft.)	VISUAL/MANUAL DESCRIPTION: COLOR	MOIST.	CONSIST.	SOIL TYPE	GEOLOGIC ORIGIN	REMARKS	SAMPLE DATA: NO. & TYPE	SPT (bpf)	REC (in.)	LABORATORY DATA: MC (%)	γd (pcf)	qu (tsf)	LL/PI CLASS	DEP (ft.)
	gray	wet	soft	lean clay	alluvium									
30	grayish brown			silt			S-7	3		39.0			P200 95.3% ML	30
35				fat clay			S-8	6		42.0				35
						layers of silt and fat clay								
40							S-9	4		26.9				40
						bottom of hole @ 40'								
45														45
50														50

Thiele Geotech Inc

SOIL TEST SUMMARY

Project: California Bend Slope Failure

Job No.: 08475.00

Location: California Bend, Blair, NE

Date: 10/9/2008

BORING NO.	SAMPLE NO.	SAMPLE DEPTH (ft.)	SAMPLE DIA. (in.)	MOISTURE CONTENT (%)	UNIT WEIGHT		VOID RATIO (e)	SAT. (%)	UNCONFINED COMPRESSION		SOIL CLASSIFICATION					REMARKS
					WET (pcf)	DRY (pcf)			q_u (tsf)	STRAIN (%)	ATTERBERG LIMITS LL	PL	PI	PASS #200 (%)		
B-1	U-1	0.5-2		34.2	112.0	83.4	1.019	91								
	U-2	3.5-5		34.6	120.6	89.6	0.880	100								
	U-3	8.5-10		34.8	117.1	86.9	0.940	100								
	U-4	13.5-15	2.85	34.3	113.7	84.7	0.990	94	0.99	11.7	100	26	74		CH	
	U-5	18.5-20	2.85	37.7	114.0	82.8	1.034	98	0.80	11.8						
	U-6	23.5-25	2.85	33.5	117.2	87.8	0.919	98	0.48	14.9						
	U-7	28.5-30	2.85	45.4	113.9	78.4	1.150	100	0.40	9.3						
	U-8	33.5-35		16.7										83.5	ML	
	S-9	48.5-40		33.4												
B-2	U-1	0.5-2		25.3	124.0	99.0	0.702	97								
	U-2	3.5-5	2.85	33.8	114.6	85.7	0.967	94	0.90	11.6	66	22	44		CH	
	U-3	8.5-10	2.85	34.8	100.2	74.3	1.268	74	1.08	13.5						
	U-4	13.5-15	2.85	37.1	113.9	83.1	1.028	97	1.07	6.3						
	U-5	18.5-20	2.85	36.8	116.1	84.9	0.984	100	0.90	14.7						
	U-6	23.5-25	2.85	34.0	117.7	87.8	0.918	100	0.35	15.0						
	S-7	28.5-30		39.0										95.3	ML	
	S-8	33.5-35		42.0												
	S-9	48.5-40		36.9												