A Report to the Calvert Corporation on the Thickness of Volcanic Ash and Overburden at the Calvert Volcanic Ash Mine, Kansas

Jon Smith, Anthony Layzell and Alan Peterson

Kansas Geological Survey Open-File Report 2019-6

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Introduction

The Kansas Geological Survey (KGS) was first contacted by Mr. Dean F. Kruse (deceased) of the Calvert Corporation in October of 2010 about a possible role for the KGS in helping address exploration issues associated with the Calvert volcanic ash mine located in Norton County, Kansas. The primary concerns for the Calvert Corporation are the variable subsurface thickness of the volcanic ash bed and the increasing thickness and removal costs of overburden in the westward path of current mining operations. To assist the Calvert Corporation with addressing this problem, the KGS was granted permission to drill a long, continuous core from the area of the ash mine by quarry operator Mr. Edward Fowler. In addition, the KGS also agreed to review the results of previous subsurface investigations as provided by Mr. Fowler.

Background

Following an initial visit by KGS geologists in 2011, a report was issued detailing direct observations of the Calvert Quarry and briefly summarized published research on the Calvert ash deposit (Smith and Ludvigson, 2011). Volcanic ash has been commercially mined in the vicinity of the active quarry (NW SW sec. 25, T. 2 S., R. 22 W) almost continuously since 1908 (Frye and Leonard, 1949). The ash is mined by open-pit method, screened in the pit, and transported by rail from Calvert, KS. Recent geochronological analyses of zircons collected from the quarry report a U-Pb age of ~11.7 Ma, suggesting the ash was likely derived from the Bruneau-Jarbidge Volcanic Field (12.7–10.5 Ma) of the Snake River volcanic province in southern Idaho (Smith et al., 2017).

Lenses of ash up to 17 ft. (~5 m) thick have been excavated from the Calvert mine in the past (Carey et al., 1952), though during the initial KGS site visit, the exposed layer in the active pit face appeared to be less than 5 ft. (1.5 m) thick. Smith and Ludvigson (2011) estimated that there was ~65 ft. (20 m) of overburden at its thickest point west of the current mine face. The

overburden consists primarily of interbedded clayey silt and fine- to medium-grained calcareous sand with multiple caliche layers at the top of the section.

Previous Investigations

Mr. Fowler provided the KGS with reports from two subsurface investigations conducted in the vicinity of the ash mine by private contractors. The earliest of these dates to December of 1982 and reports the thickness of overburden and ash, presumably from cuttings, in 30 boreholes throughout the property (Appendix A). The second investigation in July of 2010 drilled 7 boreholes immediately west of the current ash mine face and includes relatively detailed driller's logs noting generalized lithology and thickness of ash where encountered (Appendix A). Both of the previous investigations, in addition to the KGS core, were used to compile the ash bed and overburden thickness isopach maps and estimates of ash volume remaining that are included in this report.

Methods

Lithologic description of the core noted color, bedding features, mineralogy, and pedological and biological features such as nodules, fossil roots and burrows. Quantitative particle-size analyses of the cores at approximately 1 ft. intervals were conducted at the KGS Geoarchaeology and Paleo-environmental Research Laboratory using the standard pipette method (Soil Survey Staff, 1982) based on the Stokes Law of gravitational settling rates to determine texture on particle sizes less than 2000 μm; 2000–63 μm (total sand), 63–2 μm (total silt), and < 2 μm (total clay). Isopach contour maps and ash bed volume estimates were completed using the 3D Analyst Tools in ArcMap 10.2.2 for Desktop (ESRI, 2014).

KGS Core

In September of 2014, the KGS collected a 2.5-inch-diameter core, CQ-1, from the highest topographic position just west of the active quarry face. Approximately 99 ft. of core was retrieved with an approximately 70% rate of recovery (Fig. 1). In general, the lithologic characteristics of the CQ-1 core match well with driller logs from nearby boreholes in the 2010 subsurface investigation. Our more detailed logging indicates that the CQ-1 core can be divided into six sections based on stratigraphic differences in lithology and vertical trends in grain-size. Section 1, from 0 to 11 feet deep, is composed predominantly of silt and clay, likely representing upland wind-blown sediments of the late Quaternary loess-paleosol sequence in Kansas. Section 2, from 11 to 30 feet, is composed chiefly of carbonate cemented fine- to medium-grained sand,

with several 1- to 2-foot-thick layers of caliche dispersed throughout. Section 3, from 30 to 51 feet, is composed mostly of fine-sandy silt and clay that fines to predominantly clay at the base of this interval. Section 4, from 51 feet to approximately 66 feet, is dominantly carbonate cemented, fine- to medium-grained sand with some intervals of carbonate nodules in the upper portions of the section. Section 5, from approximately 66 to 82 feet, is volcanic ash. The ash contains such sedimentary structures as ripples and crossbedding, numerous small (1-2 inch diameter) to large (3-10 inch diameter) carbonate nodules, and burrows and plant root fossils preserved in fibrous carbonate. Section 6, from 82 feet to 99 feet, is composed of sandy silt and clay that coarsens to mostly carbonate cemented fine- to medium-grained sand with a 1- to 2-foot-thick caliche interval at approximately 90 feet deep.

Isopach Maps

The isopach maps (thickness maps) are based on the detailed logging of the CQ-1 core, in addition to the driller's logs of the previous 1982 and 2011 subsurface investigations provided to the KGS by Mr. Fowler. The reference point map (Fig. 2) details the position of all the driller's logs used to construct the isopach maps, along with reference numbers given in the older reports. It should be noted that although some of the borehole locations from the 1982 investigation (1, 2, 6, 7, and 20 for example, Fig. 2) have been quarried in the intervening 37 years, the overburden and ash bed thickness data from these logs were still used to construct the isopach maps.

Overburden Thickness

The locations of boreholes and the reported thicknesses of overburden ash bed in driller's logs are shown in Figure 3. These were used to construct the overburden thickness isopach map shown in Figure 4. The isopach map suggests that overburden thickness increases rapidly west of the active quarry face to approximately 66.5-feet-thick at the location of the CQ-1 core. Overburden is thinner south of the active quarry and south of the abandoned quarry to the east.

Ash Bed Thickness

The borehole locations and ash bed thicknesses (if encountered) in previous subsurface investigations are shown in Figure 5. These reference points were used to construct the ash bed thickness isopach map shown in Figure 6. In general, the isopach map suggests that the subsurface thickness of the ash increases to just over 15 feet to the west of the active quarry face. A similarly thick, though possibly smaller volume, ash deposit is suggested south of the inactive quarry to the east.

Ash Bed Volume Estimate

Using the ash bed thickness data in Figure 5 and the 3D Analyst Tools in ArcMap 10.2.2 (ESRI, 2014), we interpolated the thickness of the ash bed between reference points and calculated an estimated volume of ash remaining in the quarry area (Fig. 7). Our calculations suggest that approximately 126 million cubic feet (ft^3) or 4.7 million cubic yards (yd^3) of ash remains in the subsurface. Assuming the bulk density of Calvert Ash is similar to the 150 lbs/ft^3 or 2 $tons/yd^3$ reported as an average for volcanic glass (Wilson et al., 2012), we estimate that approximately 9.5 million US tons of volcanic ash remain buried in the subsurface.

Acknowledgements

The authors acknowledge and are grateful for support from the National Science Foundation Grant EAR-1023285. Special thanks to Dean F. Kruse and Ed Fowler for granting access to Calvert Quarry and the generous use of their time. We also thank Greg Ludvigson, Laura Murphy, Bridget Sanderson, Julie Tollefson, and the staffs of the KGS Exploration Services and KGS Geoarchaeology and Paleoenvironment Laboratory.

Disclaimer

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References

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Figures

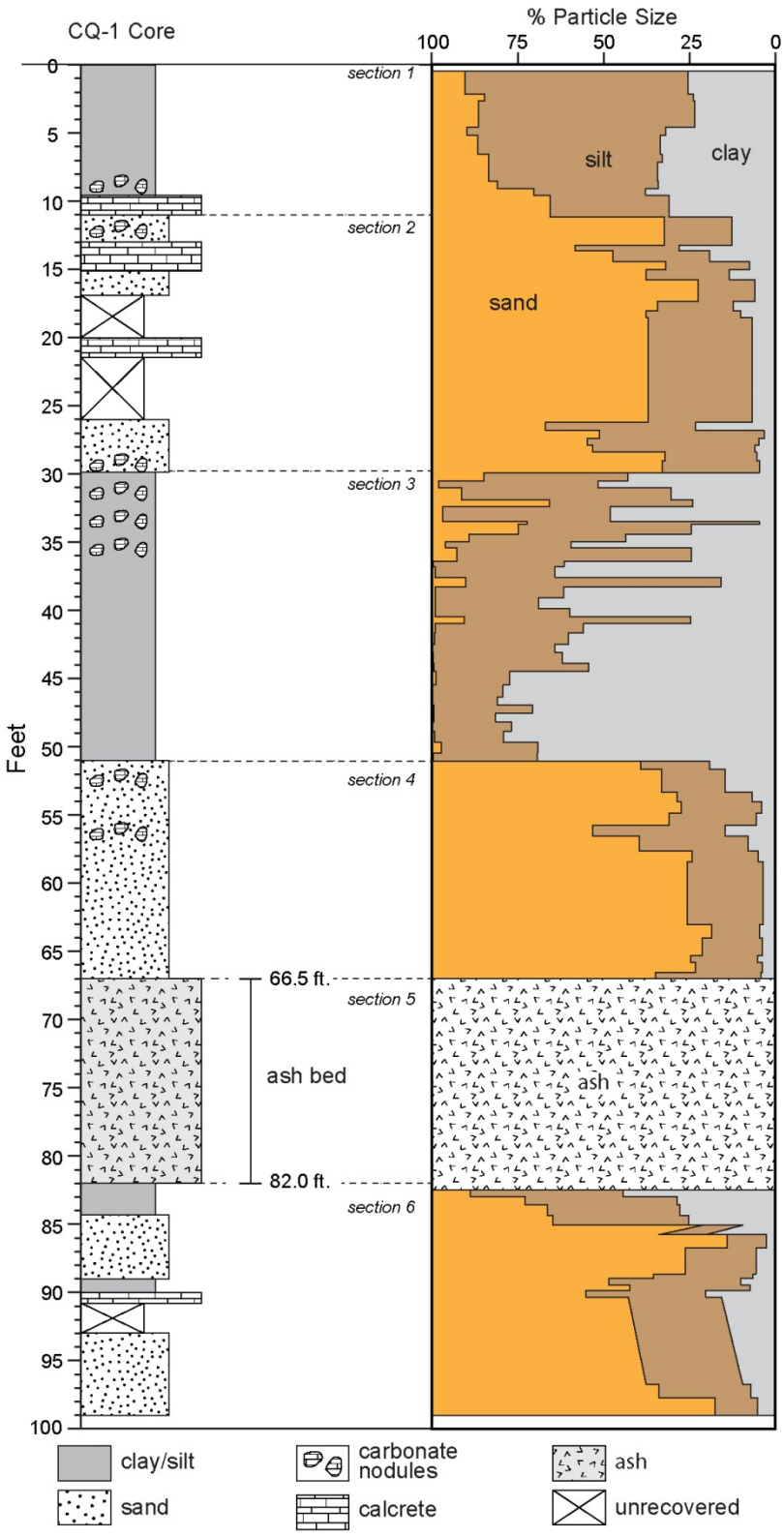


Figure 1. Drafted section and particle size analysis of CQ-1 core from Calvert Quarry, KS

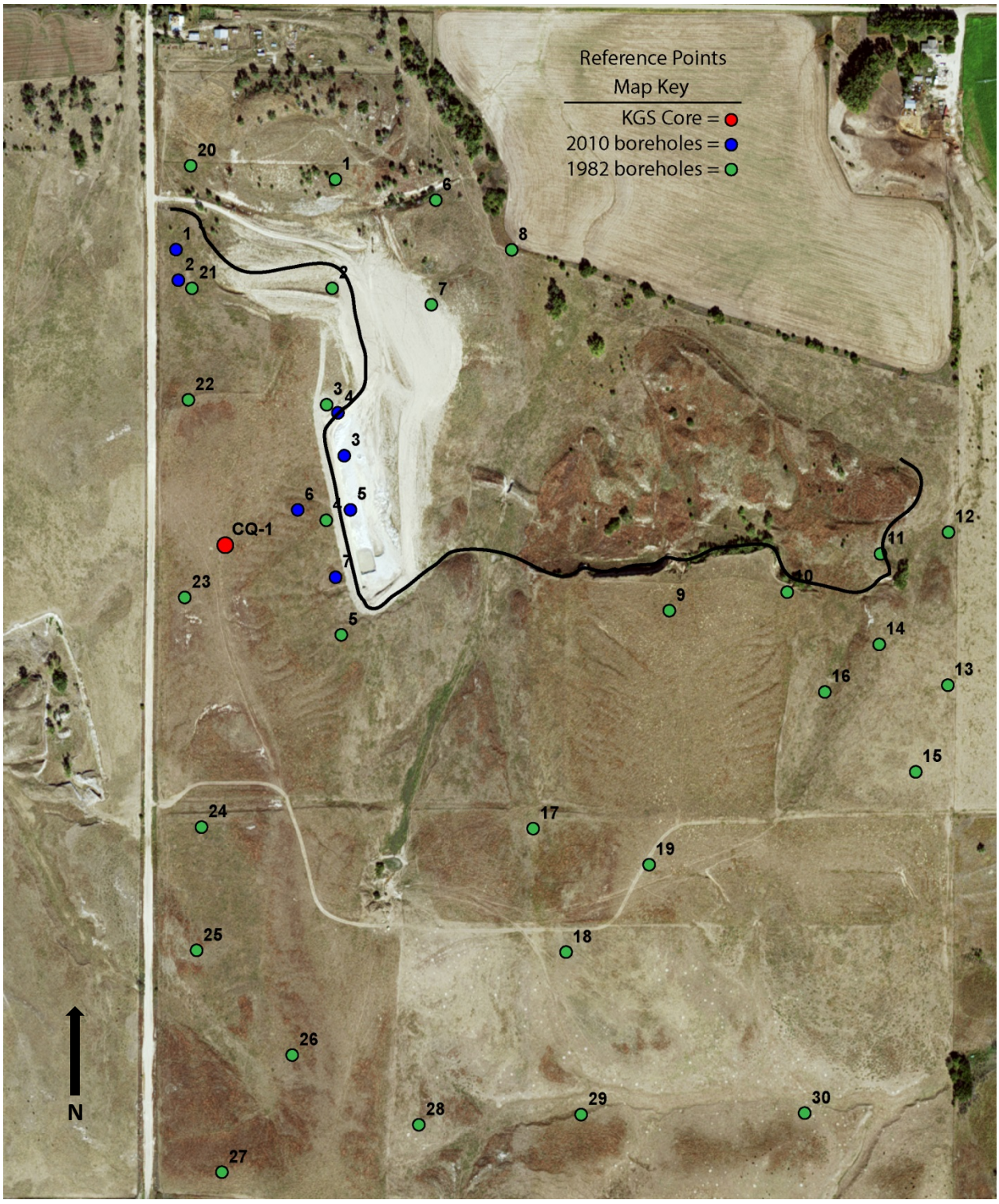


Figure 2. Location of CQ-1 (red) and all boreholes referenced in the 1982 and 2010 subsurface investigations (Appendix A) around Calvert Quarry from which the isopach maps were derived. Heavy black line represents the quarry face; areas north of this line have been mined.

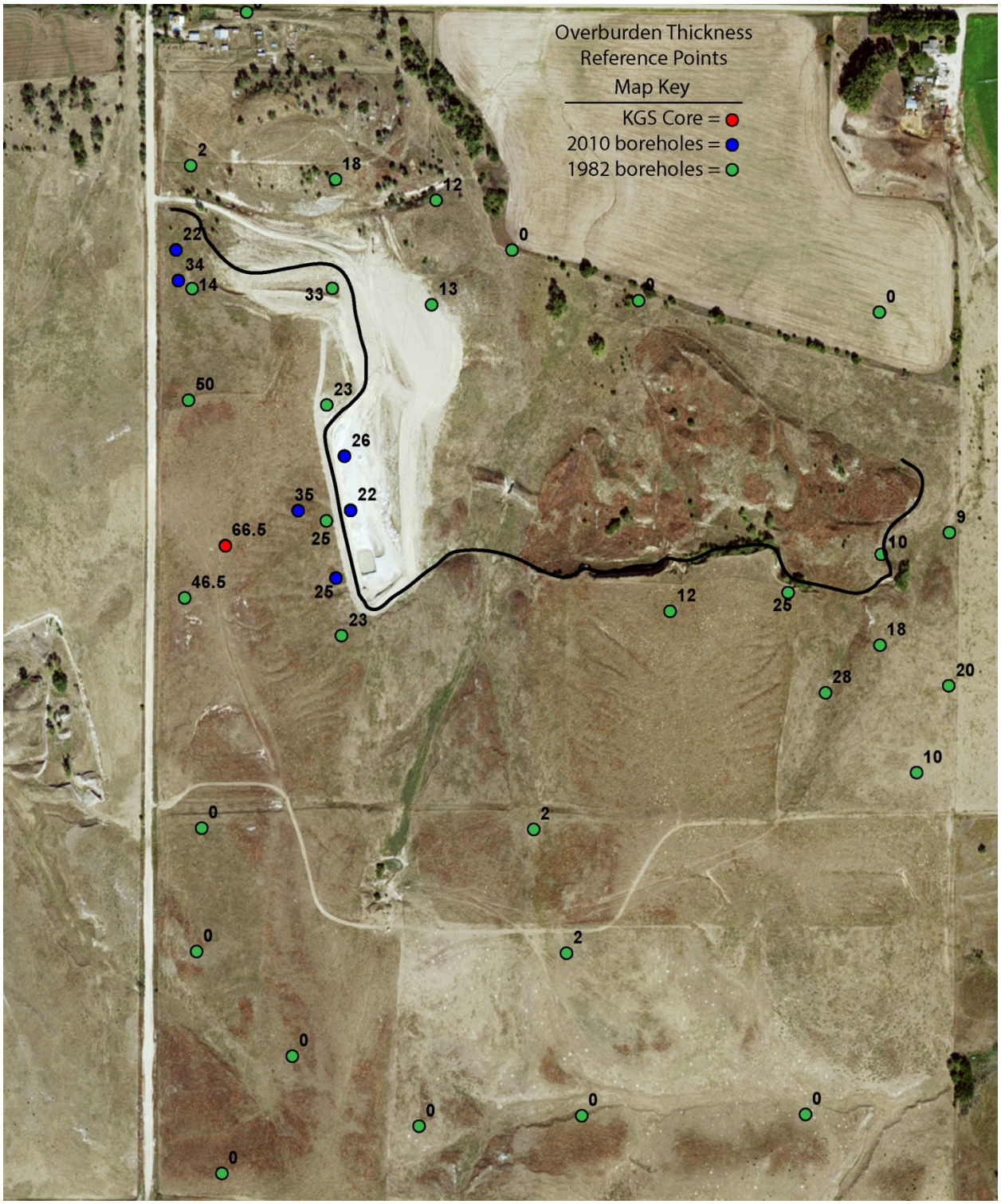


Figure 3. Locations of boreholes noting reported thicknesses of overburden above the ash bed used to construct Figure 4. Heavy black line represents the quarry face; areas north of this line have been mined.

Figure 4. Subsurface isopach map with 10-foot-contour intervals estimating thicknesses of overburden above the ash bed, generally west and south of the quarry face.

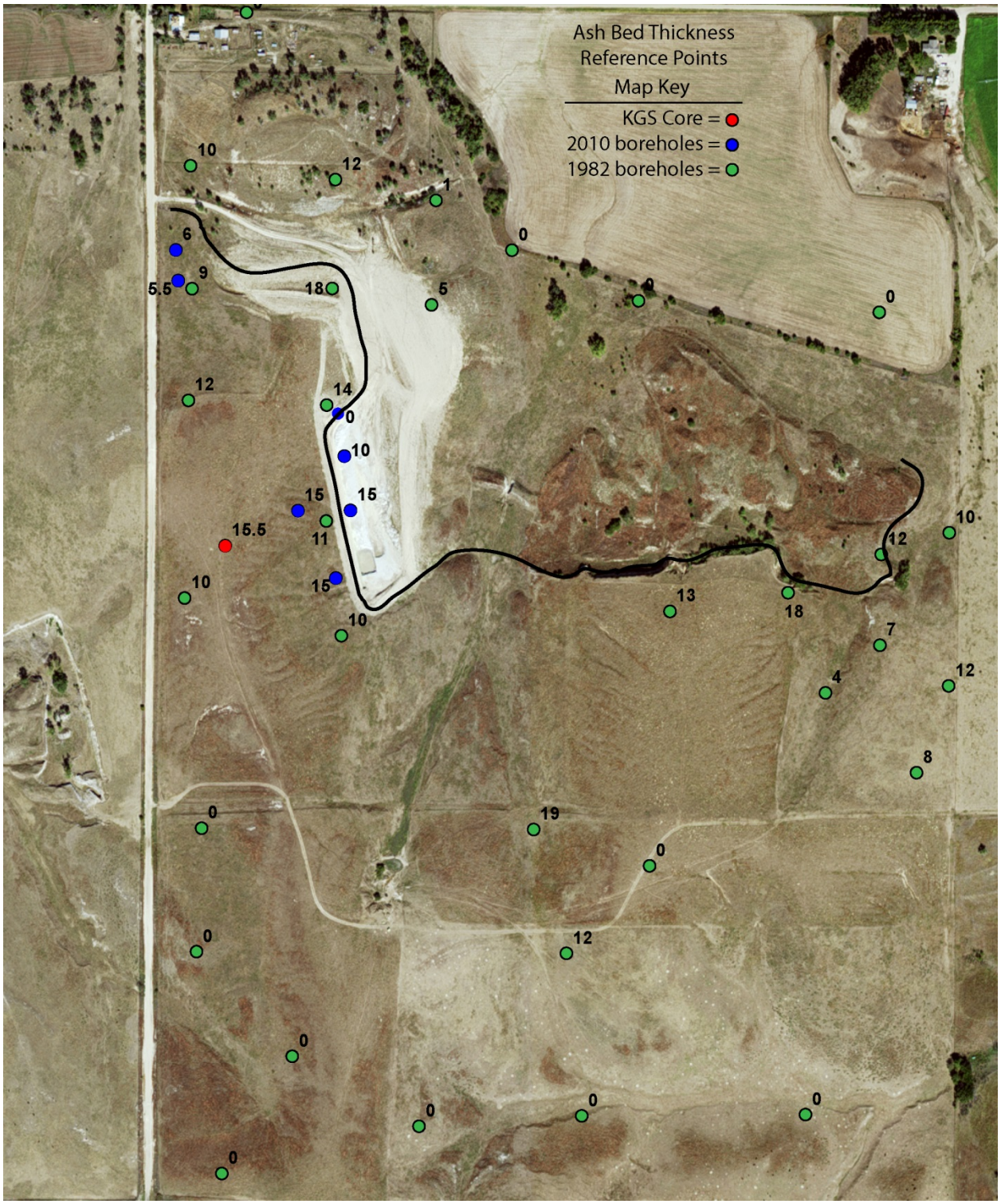


Figure 5. Locations of boreholes noting reported ash thicknesses used to construct Figure 6. Heavy black line represents the quarry face; areas north of this line have been mined.

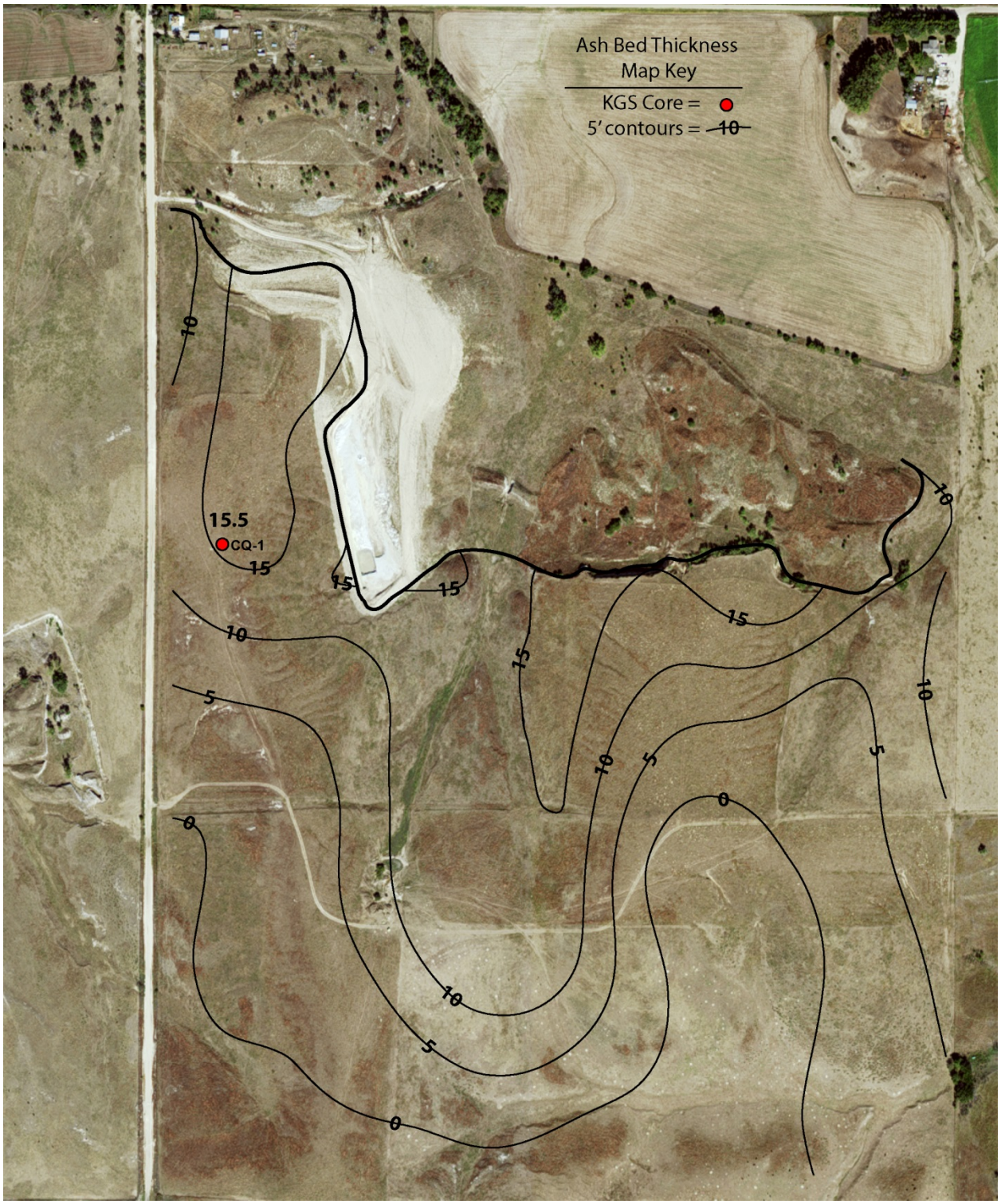


Figure 6. Subsurface isopach map with 5-foot-contour intervals estimating ash bed thicknesses, generally west and south of the quarry face.

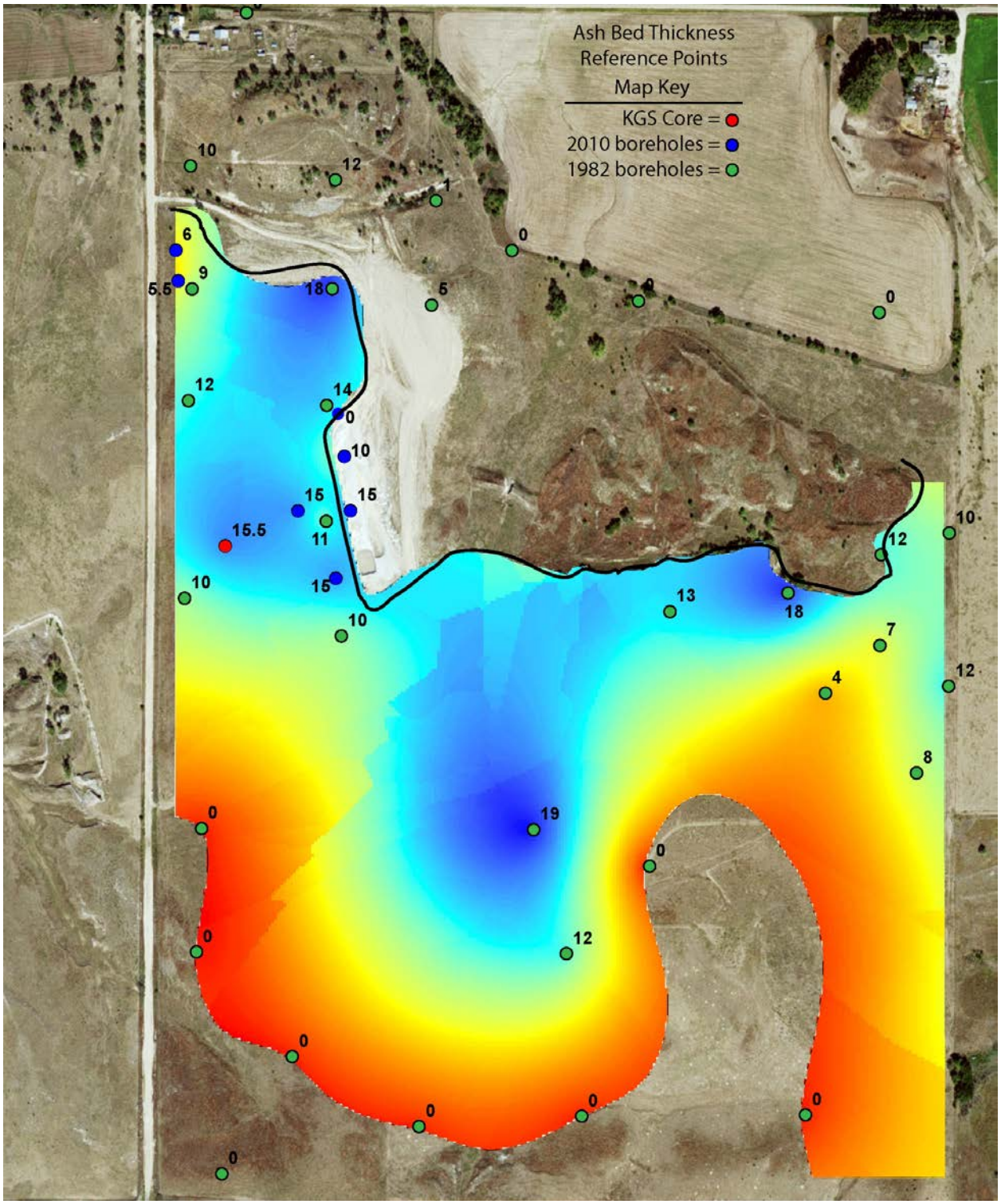


Figure 7. Interpolated ash bed thickness map, bluer areas indicate reported thickening of the ash, while redder areas indicate thinning, no color indicates no ash reported or already mined.

Appendix A: Previous Investigations

MATERIAL SURVEY REPORT

Location No. ..... Date 12-13-82

Material Silica County Norton

*Location SW 1/4 Sec. 25 Twp. 2 Range 22W

*Owner ..... Name ..... Address .....

Tenant ..... Name ..... Address .....

Nature of deposit (wet or dry) ..... Accessibility Good State Highway No. US 383 Miles .75 mile

45.36 .5 mile

% Rotten Stone (Ave.) ..... % Shale (Ave.) ..... % Other Deleterious Mat'ls (Ave.) .....

Max. Size Mat'l in Deposit ..... % Mat'l larger than 1" (Ave.) ..... Crushable? .....

Test Hole	Material at Bottom of Hole	Depth of Overburden	Depth of Material	Depth of Hole	PERCENT RETAINED 1½	¾	⅜	4	8	10	16	30	40	50	100	G. F.	Wash. Pass. 200	L. L. L.	P. I.
1	Sand	18	12	30															
2	"	33	18	51															
3	"	23	14	37															
4	"	25	11	36															
5	"	23	10	33															
6	"	1	12	13															
7	"	13	5	18															
8	"	9	Sand																
9	"	12	13	25	Brown Silica														
10	"	25	28	53	Brown Silica														
11	"	10	12	22															
12	"	9	10	19															
13	"	20	12	32															
14	"	18	7	25															
15	"	10	8	18	Brown Silica														
16	"	28	4	32	Brown Silica														

STONE CHARACTERISTICS

Lab. No.					
Sp. Gr. Sat.					
Sp. Gr. Dry					
% Absorption					
Los Angeles					
Soundness					

Remarks .....

SAND GRAVEL CHARACTERISTICS

Lab. No. .....

Sp. Gr. Saturated ..... % Absorption .....

Wt./Cu. Ft. .....

Color Test ..... Soundness .....

Str. Ratio–1 da. ..... 3 da. .....

% Wear (L.A.) ..... Grading .....

Remarks .....

Estimated quantity 201,000,000 cu. yd. 7,444,444 cu. yds.

* Show both if available.

NOTE: All depths should be given to the nearest foot.
All percents should be given to the nearest full percent.
Show stone characteristics for each sample from this location.

29016

Title K. D. Durell

Norton Co. Road Engineer

MATERIAL SURVEY REPORT

Page 2

Location No..... Date.....

Material..... County.....

*Location ..... Sec..... Twp..... Range.....

*Owner..... , ...
Name Address

Tenant..... , ...
Name Address

Nature of deposit (wet or dry)..... Accessibility..... State Highway No..... Miles.....

% Rotten Stone (Ave.)..... % Shale (Ave.)..... % Other Deleterious Mat'ls (Ave.).....

Max. Size Mat'l in Deposit..... % Mat'l larger than 1" (Ave.)..... Crushable?.....

Test Hole	Material at Bottom of Hole	Depth of Overburden	Depth of Material	Depth of Hole	PERCENT RETAINED											G. F.	Wash. Pass. 200	L. L. L.	P. I.
					1½	¾	⅜	4	8	10	16	30	40	50	100				
17	"	2	19	21															
18	"	2	12	14	Brown Silica Sand														
19	"	3	12	15															
20	"	2	10	12															
21	"	14	19	23															
22	"	1	12	13															
23	"	1	10	11															
24	"	5	33	38	Brown Silica Sand														
25	"	2	58	60	Brown Silica Sand														
26	"	12	48	60	Brown Silica Sand														
27	"	5	42	47	Brown Silica Sand														
28	"	4	31	35	Brown Silica Sand														
29	"	5	24	29	Brown Silica Sand														
30	"	5	45	50	Brown Silica Sand														

Stone Characteristics

Lab. No.....					
Sp. Gr. Sat....					
Sp. Gr. Dry...					
% Absorption					
Los Angeles...					
Soundness....					

Remarks.....

Sand Gravel Characteristics

Lab. No.....

Sp. Gr. Saturated..... % Absorption.....

Wt./Cu. Ft.....

Color Test..... Soundness.....

Str. Ratio–1 da..... 3 da.....

% Wear (L.A.)..... Grading.....

Remarks.....

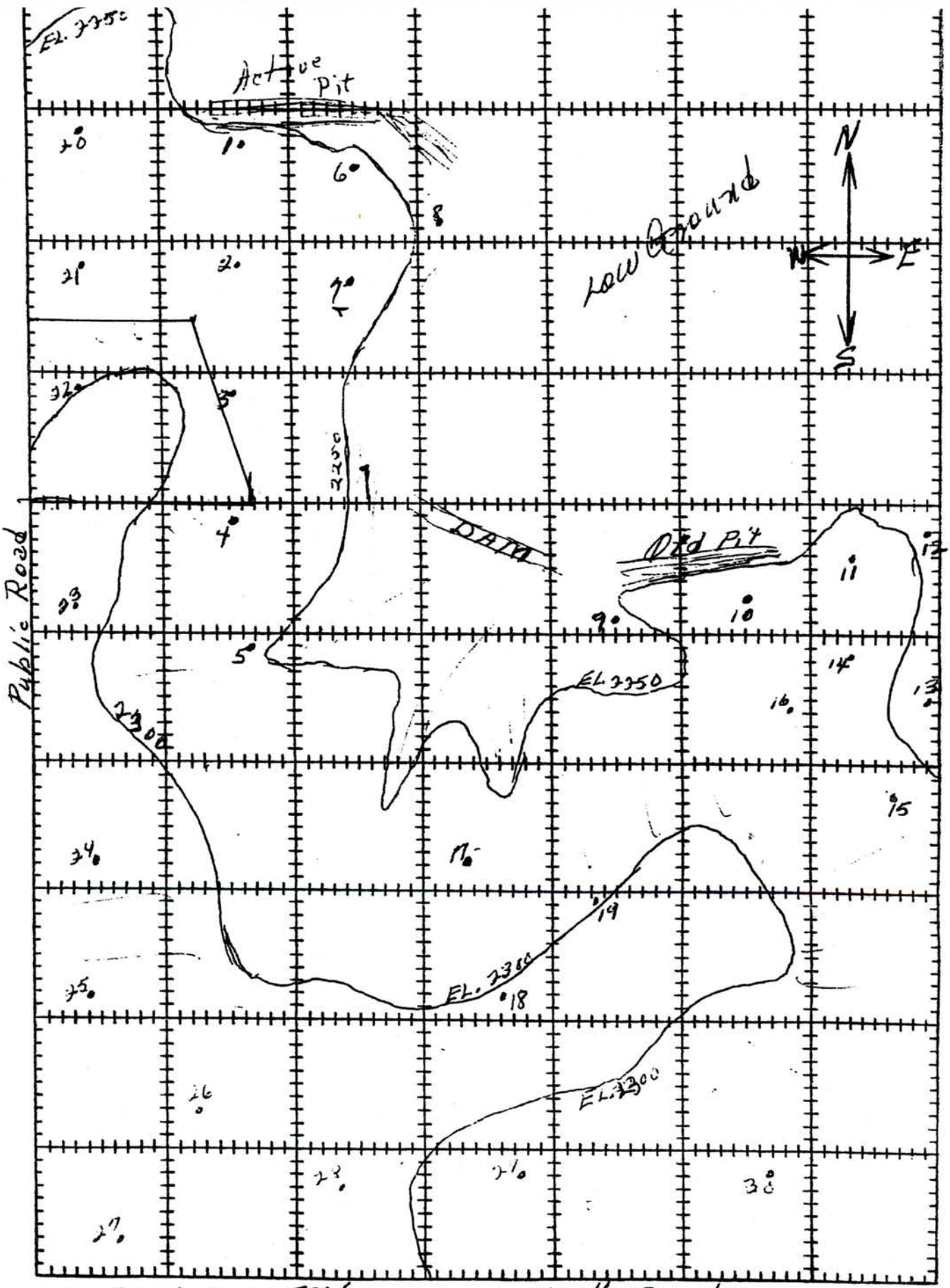
Estimated quantity.....

* Show both if available.

Note: All depths should be given to the nearest foot.
All percents should be given to the nearest full percent.
Show stone characteristics for each sample from this location.

Title.....

290M



Scale: Horizontal—1 Square = 500'
Vertical—1 Square = 500'

LOG OF BORING NO. 1

Job No. Calvert, ME Client

ENGINEER
DRILLER T. Hageman
HELPER
RIG NO. CME 75

SURFACE ELEV.
BORING STARTED 7-27-2010
BORING COMPLETED 7-27-2010
STATION
OFFSET

Sheet of
WEATHER Hot 100° Sunny
ST SIZE SS SIZE
CASING USED SIZE
HSA USED Flight Auger SIZE 6"

Sample No.	Depth or Elevation From	Depth or Elevation To	Sampling Method	PENETRATION RECORD Split Spoon Blows 6"	6"	6"	6" (2 Feet)	R Length Recovered in Inches	Qp Penetrometer Test in TSF	Sample Description
										Surface Level Dry Pasture
	0	5	AS							overburden - Mois. Brown silt
	5	10	AS							Overburden - Moist. Brown Silty-clay
	10	15	AS							overburden - Dry Silty-clay
	15	20	AS							overburden - Fine Sand w/ trace of Ash
	20	22	AS							overburden - Hard Rocky Material
	22	25	AS							White/Grey Powder - Ash
	25	28	AS							White/Grey Powder - Ash
	28	30	AS							Yellow Sand - Fine well graded
										Bottom of Boring 30'
										Ash = 22' to 28'

DRILL CREW CHECK LIST

WATER LEVEL OBSERVATIONS

WL: WS OR WD
WL: BCR ACR
WL: AB Hr. AB
WL: 24 Hr. AB
TOPSOIL THICKNESS
FILL THICKNESS

CAVE IN LEVEL:
While Drilling and Sampling
After Boring Completion

WATER LOSS:
At To
Percent Loss
At To
Percent Loss

BOULDERS OR OBSTRUCTIONS:
At To
At To

ARTESIAN PRESSURE:
Depth
Height of Soil Rise In Casing

ABBREVIATIONS
AB—After Boring
ACR—After Casing Removal
AS—Auger Sample
BCR—Before Casing Removal
DB—Diamond Bit
DCI—Dry Cave In
HA—Hand Auger
HS—Hollow Stem Auger
PA—Power Auger
SS—Split Spoon Sampler
ST—Thin Walled Sampler
RB—Rock Bit
WB—Wash Boring
WCI—Wet Cave In
WD—While Drilling
WL—Water Level
WS—While Sampling

[redacted]

LOG OF BORING NO. 2

Job No. Calvert, KS Client

ENGINEER
DRILLER T. Hagemann
HELPER
RIG NO. CME75

SURFACE ELEV.
BORING STARTED 7-27-10 9:55am
BORING COMPLETED 7-27-10 10:65am
STATION
OFFSET

Sheet of
WEATHER hot 100°
ST SIZE SS SIZE
CASING USED SIZE
HSA USED 6" Flight SIZE

Sample No.	Depth or Elevation From	Depth or Elevation To	Sampling Method	PENETRATION RECORD Split Spoon Blows 6"	6"	6"	6" (2 Feet)	R Length Recovered In Inches	Qp Penetrometer Test in TSF	Sample Description
										Hand Dry Texture
	0'	5	AS							overburden - Dry Silty Clay
	5	10	AS							overburden - Moist Silty clay
	10	15	AS							overburden - Brown moist Clay w/ Calcium
	15	20	AS							overburden - Moist - Clayey Sand
	20	25	AS							overburden - Moist - Clayey Sand
	25	30	AS							overburden - Bentonite Clay
	30	34	AS							overburden - Fine Sand
	34	40	AS							wht/grey - Ash
										turning to Yellow Sand @ 40'
										Bottom of Boring 40'
										Ash = 34' TO 39.5'

DRILL CREW CHECK LIST

WATER LEVEL OBSERVATIONS

WL: WS OR WD
WL: BCR ACR
WL: AB Hr. AB
WL: 24 Hr. AB
TOPSOIL THICKNESS
FILL THICKNESS

CAVE IN LEVEL:
While Drilling and Sampling
After Boring Completion

WATER LOSS:
At To
Percent Loss
At To
Percent Loss

BOULDERS OR OBSTRUCTIONS:
At To
At To

ARTESIAN PRESSURE:
Depth
Height of Soil Rise In Casing

ABBREVIATIONS
AB—After Boring
ACR—After Casing Removal
AS—Auger Sample
BCR—Before Casing Removal
DB—Diamond Bit
DCI—Dry Cave In
HA—Hand Auger
HS—Hollow Stem Auger
PA—Power Auger
SS—Split Spoon Sampler
ST—Thin Walled Sampler
RB—Rock Bit
WB—Wash Boring
WCI—Wet Cave In
WD—While Drilling
WL—Water Level
WS—While Sampling

[redacted]

LOG OF BORING NO. 3

Job No. Calvert, KS Client

ENGINEER
DRILLER T. Hagemann
HELPER
RIG NO. CME 75

SURFACE ELEV.
BORING STARTED 7-27-2010 11:05am
BORING COMPLETED 7-27-2010 11:45am
STATION
OFFSET

Sheet of
WEATHER Hot 100°
ST SIZE SS SIZE
CASING USED SIZE
HSA USED 6" Flight SIZE

Sample No.	Depth or Elevation From	Depth or Elevation To	Sampling Method	PENETRATION RECORD Split Spoon Blows 6"	6"	6"	6" (2 Feet)	R Length Recovered in Inches	Qp Penetrometer Test in TSF	Sample Description
										Hard, Dry Pasture
	0	5	AS							overburden - silty clay Dry
	5	10	AS							overburden - silty clay w/ some moisture
	10	15	AS							overburden - silty sandy clay -
	15	20	AS							overburden - Silty fine Sand.
	20	25	AS							overburden - fine Sand
	25	26	AS							overburden - fine Sand
	26	27	AS							Wht/Grey Ash Rock
	27	30	AS							Wht/Grey Ash
	30	31	AS							Wht/Grey Ash
	31	35	AS							Yellow Sand
										Bottom of Boring 35'
										Ash - 26 - 31

DRILL CREW CHECK LIST

WATER LEVEL OBSERVATIONS

WL: WS OR WD
WL: BCR ACR
WL: AB Hr. AB
WL: 24 Hr. AB

TOPSOIL THICKNESS
FILL THICKNESS

CAVE IN LEVEL:
While Drilling and Sampling
After Boring Completion

WATER LOSS:
At To
Percent Loss
At To
Percent Loss

BOULDERS OR OBSTRUCTIONS:
At To
At To

ARTESIAN PRESSURE:
Depth
Height of Soil Rise In Casing

ABBREVIATIONS
AB—After Boring
ACR—After Casing Removal
AS—Auger Sample
BCR—Before Casing Removal
DB—Diamond Bit
DCI—Dry Cave In
HA—Hand Auger
HS—Hollow Stem Auger
PA—Power Auger
SS—Split Spoon Sampler
ST—Thin Walled Sampler
RB—Rock Bit
WB—Wash Boring
WCI—Wet Cave In
WD—While Drilling
WL—Water Level
WS—While Sampling

[redacted]

LOG OF BORING NO. 4

Job No. Calvert, KS Client

ENGINEER
DRILLER T. Hagemann
HELPER
RIG NO. CME 75

SURFACE ELEV.
BORING STARTED 7-27-2010 11:45 am
BORING COMPLETED 7-27-2010 12:15 pm
STATION
OFFSET

Sheet of
WEATHER
ST SIZE SS SIZE
CASING USED SIZE
HSA USED SIZE

Sample No.	Depth or Elevation From	To	Sampling Method	PENETRATION RECORD Split Spoon Blows 6"	6"	6"	6" (2 Feet)	R Length Recovered In Inches	Qp Penetrometer Test in TSF	Sample Description
										Dry Hand Pasture Ground.
	0	5	AS							overburden - Silty clay
	5	10	AS							overburden - Silty Clay
	10	15	AS							overburden - Sandy Silty Clay
	15	20	AS							overburden - Fine Sand
	20	25	AS							overburden - Fine San
	25	30	AS							Yellow Sand
	30	35	AS							Yellow Sand
										Bottom of Boring = 35'
										* No Ash Found *

rm 130

DRILL CREW CHECK LIST

WATER LEVEL OBSERVATIONS

WL: _____ WS OR WD
WL: _____ BCR _____ ACR
WL: _____ AB _____ Hr. AB
WL: _____ 24 Hr. AB
TOPSOIL THICKNESS
FILL THICKNESS

CAVE IN LEVEL:
While Drilling and Sampling
After Boring Completion

WATER LOSS:
At _____ To _____
Percent Loss
At _____ To _____
Percent Loss

BOULDERS OR OBSTRUCTIONS:
At _____ To _____
At _____ To _____

ARTESIAN PRESSURE:
Depth
Height of Soil Rise In Casing

ABBREVIATIONS
AB—After Boring
ACR—After Casing Removal
AS—Auger Sample
BCR—Before Casing Removal
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HS—Hollow Stem Auger
PA—Power Auger
SS—Split Spoon Sampler
ST—Thin Walled Sampler
RB—Rock Bit
WB—Wash Boring
WCI—Wet Cave In
WD—While Drilling
WL—Water Level
WS—While Sampling

[redacted]

LOG OF BORING NO. 5

Job No. Calvert, KS Client

ENGINEER
DRILLER T. Hagemann
HELPER R. Patterson
RIG NO. CME 75

SURFACE ELEV.
BORING STARTED 7-27-2010 12:20 pm
BORING COMPLETED 7-27-2010 12:50 pm
STATION
OFFSET

Sheet of
WEATHER Hot 100°
ST SIZE SS SIZE
CASING USED SIZE
HSA USED SIZE

Sample No.	Depth or Elevation From	Depth or Elevation To	Sampling Method	PENETRATION RECORD Split Spoon Blows 6"	6"	6"	6" (2 Feet)	R Length Recovered in Inches	Qp Penetrometer Test in TSF	Sample Description
										Dry Hard Pasture
	0	5	AS							overburden - silty Brown clay
	5	10	AS							overburden - silty Brown clay
	10	15	AS							overburden - silty clay
	15	20	AS							overburden - Sand.
	20	22	AS							overburden - Rock @ 22'
	22	25	AS							wht/Grey Ash
	25	29	AS							wht/Grey Ash
	29	30	AS							Yellow Sand.
										Bottom of Boring = 30'
										Ash 22' to 29'

DRILL CREW CHECK LIST

WATER LEVEL OBSERVATIONS

WL: WS OR WD
WL: BCR ACR
WL: AB Hr. AB
WL: 24 Hr. AB
TOPSOIL THICKNESS
FILL THICKNESS

CAVE IN LEVEL:
While Drilling and Sampling
After Boring Completion

WATER LOSS:
At To
Percent Loss
At To
Percent Loss

BOULDERS OR OBSTRUCTIONS:
At To
At To

ARTESIAN PRESSURE:
Depth
Height of Soil Rise In Casing

ABBREVIATIONS
AB—After Boring
ACR—After Casing Removal
AS—Auger Sample
BCR—Before Casing Removal
DB—Diamond Bit
DCI—Dry Cave In
HA—Hand Auger
HS—Hollow Stem Auger
PA—Power Auger
SS—Split Spoon Sampler
ST—Thin Walled Sampler
RB—Rock Bit
WB—Wash Boring
WCI—Wet Cave In
WD—While Drilling
WL—Water Level
WS—While Sampling

[redacted]

LOG OF BORING NO. C6

Job No. Calvert, KS Client

ENGINEER
DRILLER T. Hagemann
HELPER R. Patterson
RIG NO. CME75

SURFACE ELEV.
BORING STARTED 7-27-2010 12:55pm
BORING COMPLETED 7-27-2010 1:30pm
STATION
OFFSET

Sheet of
WEATHER
ST SIZE SS SIZE
CASING USED SIZE
HSA USED 6" Flight SIZE

Sample No.	Depth or Elevation From	Depth or Elevation To	Sampling Method	PENETRATION RECORD Split Spoon Blows 6"	6"	6"	6" (2 Feet)	R Length Recovered In Inches	Qp Penetrometer Test in TSF	Sample Description
										Dry Hard Before.
	0	5	AS							overburden - Silty clay
	5	10	AS							overburden - Silty Sandy clay
	10	15	AS							overburden - silty - sandy clay
	15	20	AS							overburden - Brown clay
	20	25	AS							overburden - Brown clay
	25	30	AS							overburden - Sand
	30	35	AS							overburden - Sand
	35	40	AS							Wht/Grey Ash
										Bottom of Boring 40'
										Ash 35' to unknown

DRILL CREW CHECK LIST

WATER LEVEL OBSERVATIONS

WL: WS OR WD
WL: BCR ACR
WL: AB Hr. AB
WL: 24 Hr. AB
TOPSOIL THICKNESS
FILL THICKNESS

CAVE IN LEVEL:
While Drilling and Sampling
After Boring Completion

WATER LOSS:
At To
Percent Loss
At To
Percent Loss

BOULDERS OR OBSTRUCTIONS:
At To
At To

ARTESIAN PRESSURE:
Depth
Height of Soil Rise In Casing

ABBREVIATIONS
AB—After Boring
ACR—After Casing Removal
AS—Auger Sample
BCR—Before Casing Removal
DB—Diamond Bit
DCI—Dry Cave In
HA—Hand Auger
HS—Hollow Stem Auger
PA—Power Auger
SS—Split Spoon Sampler
ST—Thin Walled Sampler
RB—Rock Bit
WB—Wash Boring
WCI—Wet Cave In
WD—While Drilling
WL—Water Level
WS—While Sampling

[redacted]

orm 130

Boring #7

Calvert, KS

7-27-10 2:00 pm

7-27-10 2:15 pm

0 - 5	overBurden	Silty-clay
5 - 10	overBurden	Silty clay
10 - 15	overBurden	Silty sandy clay
15 - 20	overBurden	Silty - clay
20 - 25	overBurden	Sand
25 - 30'	wht/Grey Ash	
Turn Back	to sand @ 30'	

Bottom of Boring 30'

Ash 25' to 30'

25' overburden.

097-25-0-00-00-006.00-0

Disclaimer: This map is used for tax purposes and is not intended to be used for conveyances nor is it a legal survey.