Location Restrictions Demonstration Report
Bottom Ash Settling Area

Tecumseh Energy Center

Prepared for: Westar Energy
Tecumseh Energy Center
Tecumseh, Kansas

Prepared by:
APTIM Environmental & Infrastructure, Inc.

October 2018

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1.0 INTRODUCTION AND PURPOSE

The Disposal of Coal Combustion Residuals (CCR) from Electric Utilities Final Rule (CCR Rule) 40 CFR §257.60 through §257.64 requires owner/operators of existing CCR surface impoundments to make demonstrations in the event a unit is located in certain areas. The purpose of this report is to demonstrate whether the Bottom Ash Settling Area (Unit) at Westar Energy's (Westar) Tecumseh Energy Center (TEC) is located in any of those areas, and if so, to make certain demonstrations per the CCR Rule that will permit continued CCR disposal/management operations.

The Unit, which is an existing CCR surface impoundment, is located at TEC in Tecumseh, Kansas, as indicated in **Figure 1**.

APTIM Environmental & Infrastructure, Inc. (APTIM) has reviewed available historical reports provided in **Section 7.0** as well as undertaken a site visit in May 2018 to develop this report. This report provides the demonstrations necessary to document CCR Rule requirements outlined in 40 CFR §257.60 through §257.64 to determine if the Unit is located in an area:

- with a base that is constructed no less than 5 feet above the upper limit of the uppermost aquifer (40 CFR §257.60);
- in wetlands (40 CFR §257.61);
- within 200 feet of the outermost damage zone of a fault which has been displaced in Holocene time (40 CFR §257.62);
- within a seismic impact zone (40 CFR §257.63); and
- in an unstable area (40 CFR §257.64).

The applicable CCR Rule requirement for each of the above is listed in the respective section in italics followed by an explanation of the review and determinations completed by APTIM.

2.0 PLACEMENT ABOVE UPPERMOST AQUIFER (§257.60)

§257.60 (a) New CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must be constructed with a base that is located no less than 1.52 meters (five feet) above the upper limit of the uppermost aquifer, or must demonstrate that there will not be an intermittent, recurring, or sustained hydraulic connection between any portion of the base of the CCR unit and the uppermost aquifer due to normal fluctuations in groundwater elevations (including the seasonal high water table). The owner or operator must demonstrate by the dates specified in paragraph (c) of this section that the CCR unit meets the minimum requirements for placement above the uppermost aquifer.

APTIM compared the location of the Unit to the location of the upper limit of the uppermost aquifer by reviewing the site geology as characterized by Haley & Aldrich in the CCR Groundwater Monitoring Network Description (Haley & Aldrich, 2017) and Golder Associates, Inc. in the Safety Factor Assessment for the Stability of the Bottom Ash Staging Area (Golder Associates, 2016). As described in the reports, the generalized geology underlying the Unit includes the following, from the surface down:

1. Glacial Deposits/Overburden (uppermost aquifer)
2. Shale and limestone (bedrock, aquitard)

The Unit is underlain by clay, sand and gravel (approximately 19 to 36 feet) and a shale and limestone bedrock (Haley & Aldrich, 2016). The geology is based on the borings drilled along the Unit berm in 2016 by Haley & Aldrich and the 2009 and 2010 borings conducted by Golder Associates, Inc. The geology is overall consistent across the Unit. Based on the boring results and the definition of aquifer in §257.53, the uppermost aquifer is located in the Glacial Deposits/Overburden, which extend to an estimated depth of 842 ft MSL.

There are no available drawings or construction records from the original construction of the Unit. However, it is understood that the east end of the Unit was incised into the sloping topography and above-grade berms were constructed of silty clay around the north, west, and south slopes (Westar, 2016). The base of Unit is conservatively estimated at 865 ft. mean sea level (MSL) (Golder Associates, 2016). The 2016 through 2018 groundwater elevations demonstrate that a portion of the base of the Unit has, at a minimum, 4 feet of separation from the uppermost aquifer during the seasonal high groundwater level, and greater than 5 feet separation during the remaining periods (Haley & Aldrich, 2018). The documentation presented in **Appendix A** demonstrates that the 865 ft MSL base of the Unit is above the uppermost fluctuation of the groundwater elevations. It is the opinion of APTIM that the base of the Unit being above the level of normal fluctuations in groundwater elevation demonstrates that there will not be an intermittent, recurring, or sustained hydraulic connection between the base of the Unit and the uppermost aquifer. This information demonstrates the Unit is in compliance with the requirements of §257.60.

3.0 WETLANDS (§257.61)

§257.61 (a) New CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must not be located in wetlands, as defined in §232.2 of

this chapter, unless the owner or operator demonstrates by the dates specified in paragraph (c) of this section that the CCR unit meets the requirements of paragraphs (a)(1) through (5) of this section."

A Certified Wetland Delineator visited the Unit on August 22, 2018 to determine if any area within the boundary of the Unit is potentially located in an existing wetland area, as defined in 40 CFR §232.2. Details of the area inspected are presented in **Figure 2**. Based on the conclusions during the site visit and wetland inspection, APTIM determined that the Unit is not located within an existing wetland area. Consequently, no additional demonstration is necessary.

4.0 FAULT AREAS (§257.62)

§257.62 (a) New CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must not be located within 60 meters (200 feet) of the outermost damage zone of a fault that has had displacement in Holocene time unless the owner or operator demonstrates by the dates specified in paragraph (c) of this section that an alternative setback distance of less than 60 meters (200 feet) will prevent damage to the structural integrity of the CCR unit.

APTIM compared the location of the Unit to the location of faults from the Holocene time, as shown in the United States Geologic Survey (USGS) Quaternary Fault and Fold Database for the United States. The nearest fault area is indicated on **Figure 3**. Based on this review, APTIM determined the Unit is not located within 200 feet of the outermost damage zone of a fault that has had displacement in the Holocene time. Consequently, no additional demonstration is necessary.

5.0 SEISMIC IMPACT ZONE (§257.63)

§257.63 (a) New CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must not be located in seismic impact zones unless the owner or operator demonstrates by the dates specified in paragraph (c) of this section that all structural components including liners, leachate collection and removal systems, and surface water control systems, are designed to resist the maximum horizontal acceleration in lithified earth material for the site.

APTIM compared the location of the Unit to the location of seismic impact zones, as defined in §257.53, using the USGS map "Two Percent Probability of Exceedance in 50 Years Map of Peak Ground Acceleration" shown in **Figure 4**. The location of the Unit in relation to the nearest seismic impact zones (i.e. in areas of at least 0.1g) is shown on the Figure in light blue. Based on this review, APTIM determined the Unit is not located within a seismic impact zone. Consequently, no additional demonstration is necessary.

6.0 UNSTABLE AREAS (§257.64)

§257.64 (a) An existing or new CCR landfill, existing or new CCR surface impoundment, or any lateral expansion of a CCR unit must not be located in an unstable area unless the owner or operator demonstrates by the dates specified in paragraph (d) of this section that recognized and generally accepted good engineering practices have been incorporated into the design of the CCR unit to ensure that the integrity of the structural components of the CCR unit will not be disrupted.

APTIM evaluated the location of the Unit for the presence of on-site or local unstable areas as defined in §257.53. Evaluations of the conditions listed in §257.64(b)(1) through (3) were evaluated and are discussed below. Based on this review, APTIM determined the Unit is not located within an unstable area as defined in §257.53. Consequently, no additional demonstration is necessary.

257.64 (b) The owner or operator must consider all of the following factors, at a minimum, when determining whether an area is unstable:

6.1 Unstable Factors Considered: Differential Settling (§257.64(b)(1))

On-site or local soil conditions that may result in significant differential settling;

APTIM has visited the Unit and evaluated site-specific reports detailing the conditions of the on-site and local soils for conditions that could result in significant differential settling. The Unit is located on a clay, sand and gravel that is approximately 19 to 36 feet thick (Haley & Aldrich, 2016). It was reported by Haley & Aldrich that the foundation was found to be stable for the Unit (Haley & Aldrich, 2016). No significant differential settlement has been recorded in the 40 years since the construction of the Unit. Based on this information and a review of the available geotechnical data for the Unit (Golder Associates, 2016), which shows dense, cohesive soils were used in the construction of the Unit, APTIM's professional opinion is that the Unit will not experience significant differential settlement and is not located within an area that may result in significant differential settling. Pertinent documents and sections of documents reviewed are provided in **Appendix B.1**.

6.2 Unstable Factors Considered: Geologic/Geomorphologic Features (§257.64(b)(2))

On-site or local geologic or geomorphologic features; and

APTIM visited the Unit in May 2018 in addition to evaluating the most recent USGS Topographic Map; and reviewing site-specific reports characterizing the site geology (Golder Associates, 2016 and Haley & Aldrich, 2016), and structural stability (Haley & Aldrich, 2016) for the presence of on-site or local geologic and geomorphologic features such as karst terrain, steep slopes, and sinkholes. The Unit is underlain by clay, sand and gravel (approximately 19 to 36 feet) and a shale and limestone bedrock. The groundwater flow is predominantly towards the Northwest, with the uppermost aquifer characteristics consisting of clay, sand and gravel (approximately 9 to 11 feet) (Haley & Aldrich, 2016). A review of the terrain at or near the Unit indicated no steep slopes, terrain features, or other local geologic or geomorphologic features that could feasibly result in an unstable condition. The visit and references indicated that the Unit is not underlain by near-surface or significant amounts of limestone and there are no known near surface karst terrain or sinkholes in the area, nor is this area of Kansas known to have near-surface karst terrain or sinkholes. Based on a review of this information and the site visit, APTIM has concluded that there are no steep slopes, terrain features, or other local geologic or geomorphologic features that could feasibly result in an unstable condition. Pertinent documents and sections of documents reviewed are provided in **Appendix B.2**.

6.3 Unstable Factors Considered: Human-made Features or Events (§257.64(b)(3))

On-site or local human-made features or events (both surface and subsurface).

APTIM visited the Unit in May 2018 as well as evaluated published data and site-specific reports for the presence of on-site or local human-made features or events (both surface and subsurface), including surface and subsurface mining, extensive oil and gas extractions, and sources of rapid groundwater drawdown that could feasibly impact the Unit. Documents and websites reviewed include:

- Kansas Geological Survey, Water Wells Interactive Map
- Kansas Geological Survey, Oil and Gas Wells and Fields Interactive Map
- Kansas Geological Survey, Industrial Minerals – Shawnee County
- Haley & Aldrich (2016), CCR Groundwater Monitoring Network Description for the Tecumseh Energy Center.

While there are records of oil and gas drilling and coal mining in eastern Shawnee County, there are no known records of any surface or subsurface mining, oil and gas extractions and/or groundwater drawdowns near to the Unit. APTIM concludes that, absent these features and events (both surface and subsurface), there will not be an unstable condition at the Unit due to human-made activities. Pertinent documents and sections of documents reviewed are provided in **Appendix B.3**, and indicate the location of the Unit in relation to the known on-site or local human-made features or events (both surface and subsurface).

7.0 REFERENCES

Golder Associates, Inc. (2016), Safety Factor Assessment for Stability of the Bottom Ash Staging Area.

Haley & Aldrich (2018), 2017 Annual Groundwater Monitoring and Corrective Action Report for the Bottom Ash Settling Area.

Haley & Aldrich (2016), CCR Groundwater Monitoring Network Description for the Tecumseh Energy Center.

Haley & Aldrich (2016), Initial Periodic Structural Stability Assessment Area 1 Pond Tecumseh Energy Center.

U.S. Environmental Protection Agency (2015), Hazardous Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities, Federal Register Volume 80, No. 74 40 CFR Parts 257 and 261, April 17, 2015.

Westar Energy (2016), Tecumseh Energy Center Bottom Ash Settling Area, History of Construction.

8.0 QUALIFIED PROFESSIONAL ENGINEER CERTIFICATION (§§257.60(b), 257.61(b), 257.62(b), 257.63(b), 257.64(c))

The undersigned registered professional engineer is familiar with the requirements of the CCR Rule and has visited and examined the Unit and/or has supervised examination of the Unit and development of this report by appropriately qualified personnel. I hereby certify based on a review of available information and observations, that this report meets the requirements of paragraphs §§257.60(a), 257.61(a), 257.62(a), 257.63(a) and 257.64(a).

Name of Professional Engineer: Richard Southorn, P.E., P.G.

Company: APTIM

PE Registration State: Kansas

PE Registration Number: 25201

Professional Engineer Seal:

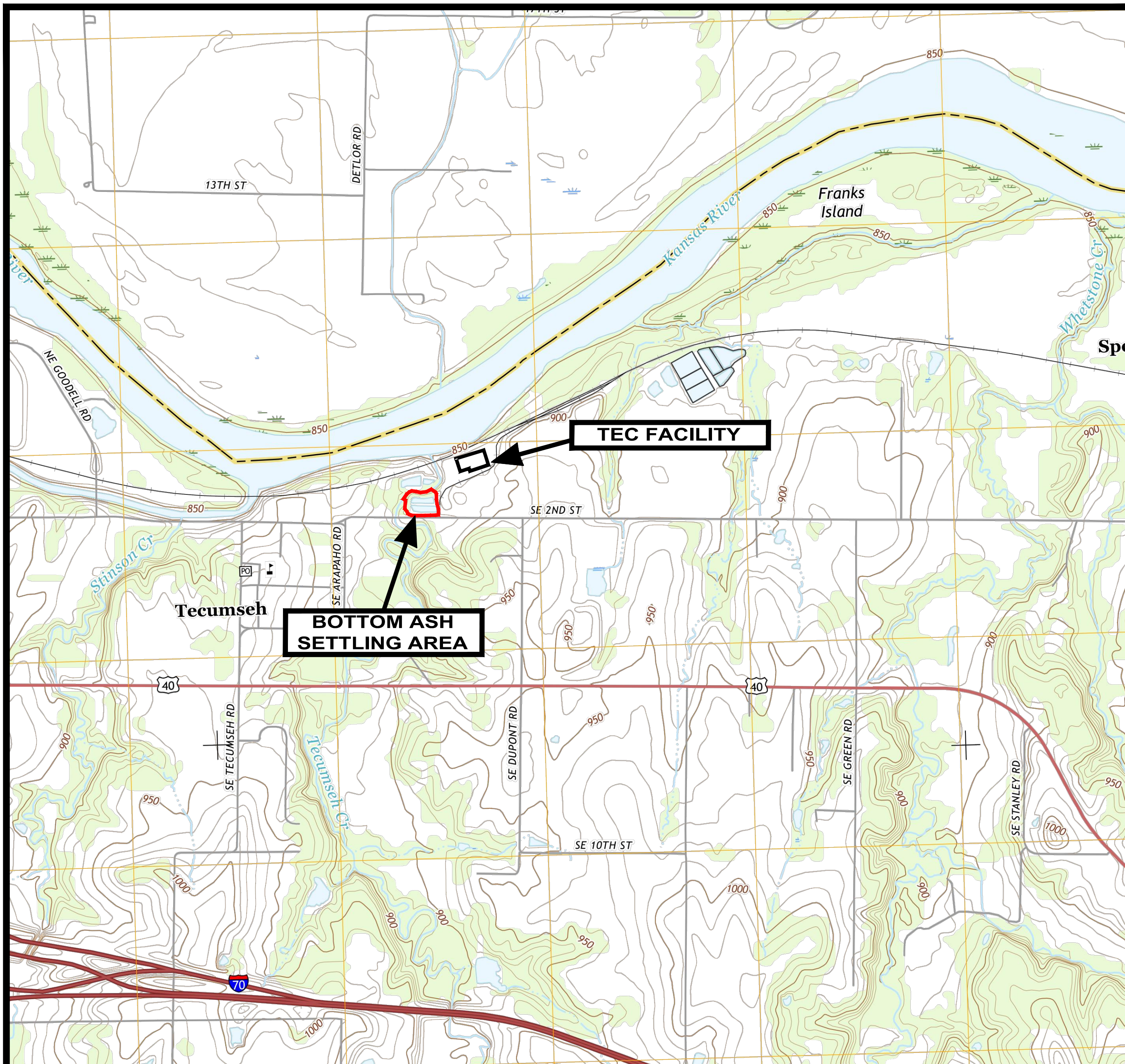
RICHARD DAVID SOUTHORN
LICENSED
25201
KANSAS
PROFESSIONAL ENGINEER

10/15/2018

Richard Southorn

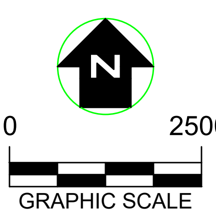
Digitally signed by Richard Southorn
Date: 2018.10.15 11:25:53 -05'00'

FIGURES



LEGEND

APPROXIMATE CCR UNIT BOUNDARY



NOTES

1. AERIAL TOPO OBTAINED FROM USGS 7.5-MINUTE SERIES, GRANTVILLE QUADRANGLE, KANSAS, 2014.
2. ALL BOUNDARIES ARE APPROXIMATE

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FIGURE 1
SITE LOCATION MAP

APPROVED BY: RDS	PROJ. NO.: 631236415	DATE: OCT. 2018

N

0 100'

GRAPHIC SCALE

LEGEND

AREAS FOUND NOT TO INCLUDE WETLANDS BASED ON INSPECTION

NOTES

1. GOOGLE EARTH IMAGE DATED AUGUST 2017.
2. ALL BOUNDARY LOCATIONS ARE APPROXIMATE.
3. FOR CLARITY, NOT ALL SITE FEATURES MAY BE SHOWN.

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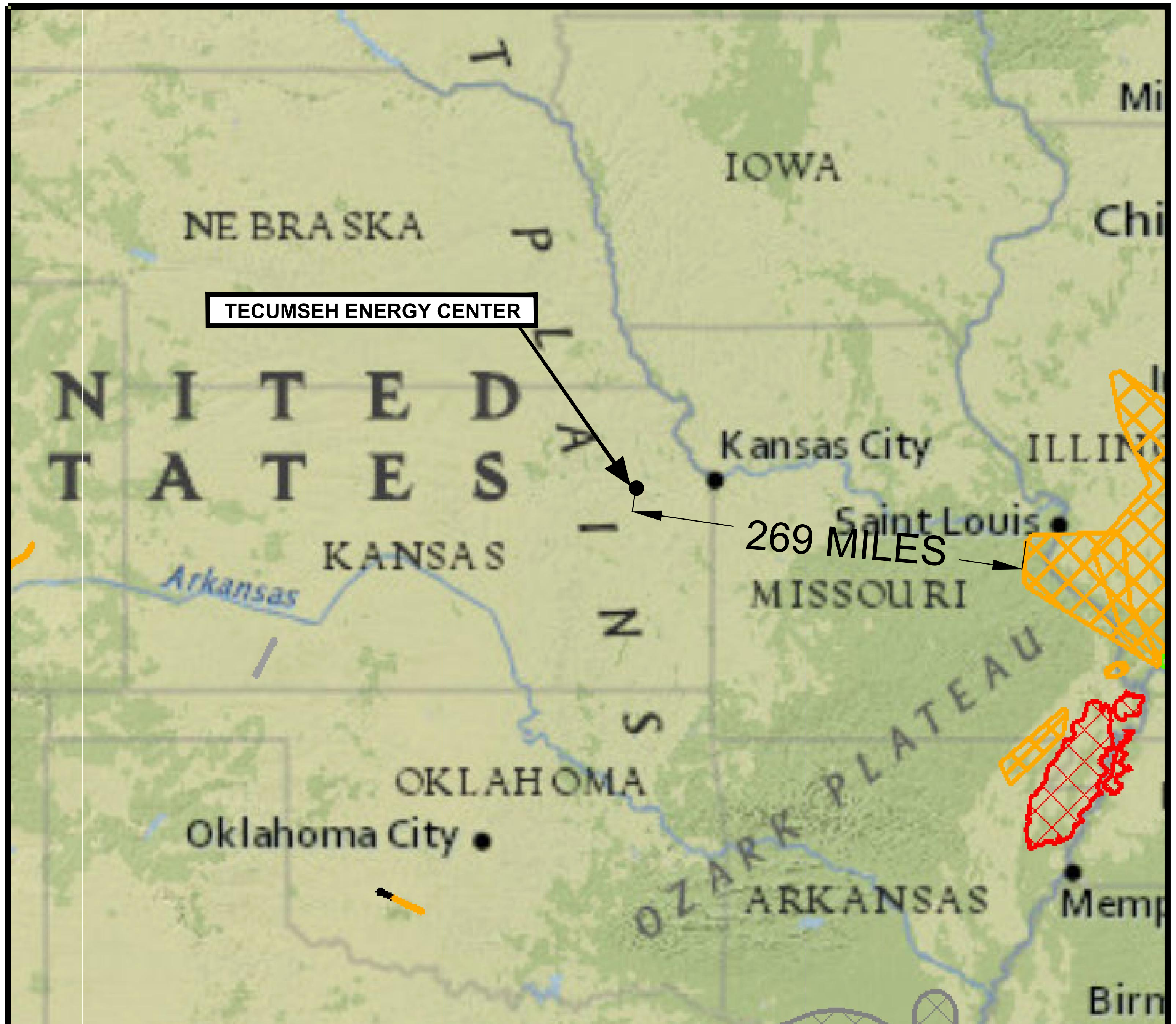
FIGURE 2
MAP OF WETLANDS INSPECTION AREA

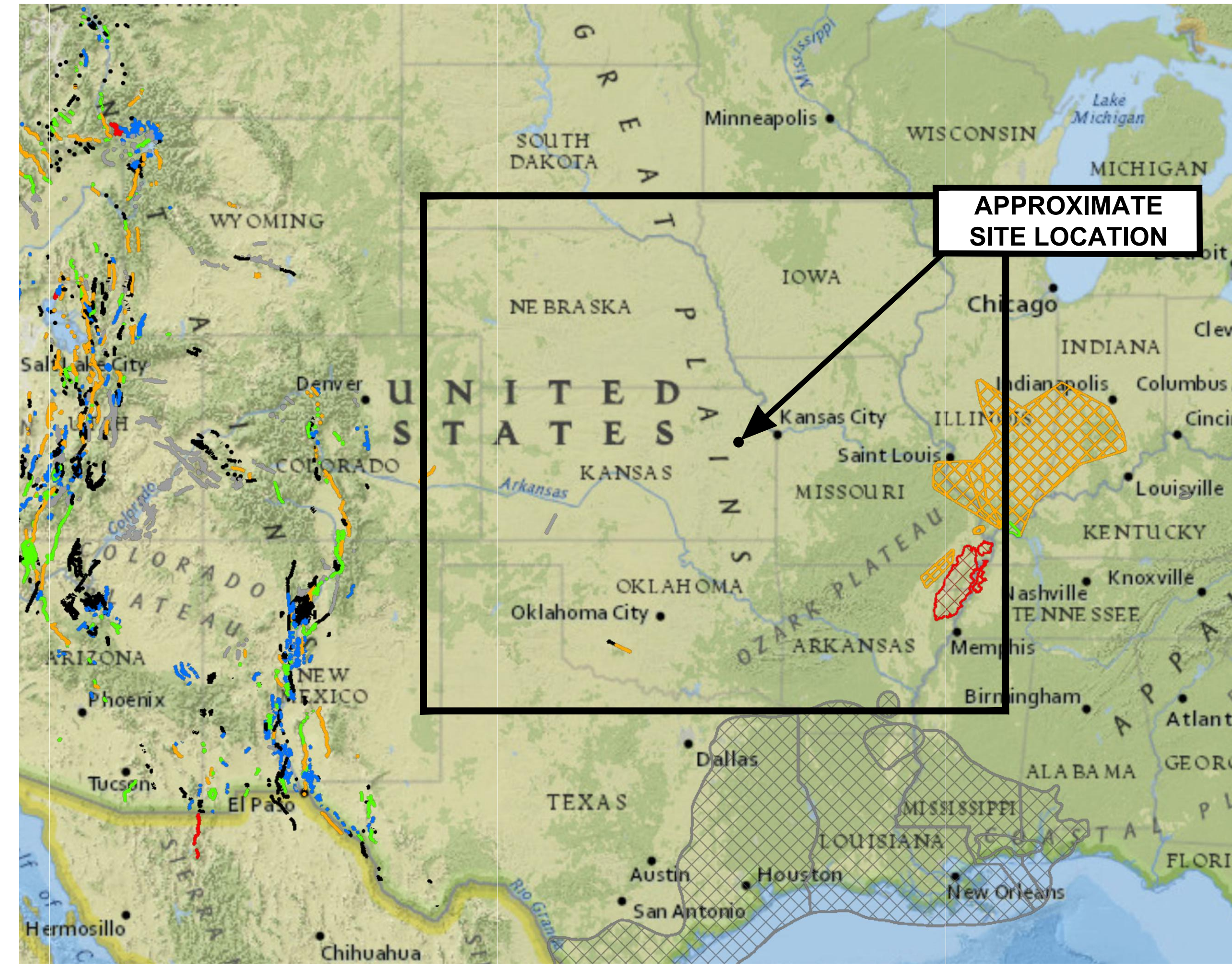
DRAWN BY: ORC	APPROVED BY: RDS	PROJ. NO.: 631236415	DATE: OCTOBER 2018

T:\AutoCAD Projects\Westar Energy\Tecumseh\Surface Impoundment\Location Analyses\FIGURE 2 - WETLANDS.dwg, 10/15/2018 8:30:29 AM, _AutoCAD PDF (General Documentation).pc3

USGS QUATERNARY FAULTS AND FOLDS DATABASE



0 100 MILES
GRAPHIC SCALE



0 250 MILES
GRAPHIC SCALE

Quaternary Faults

- historical (<150 years), well constrained location
- historical (<150 years), moderately constrained location
- historical (<150 years), inferred location
- latest Quaternary (<15,000 years), well constrained location
- latest Quaternary (<15,000 years), moderately constrained location

Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

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NOTES

1. SOURCE: UNITED STATES GEOLOGIC SERVICE (USGS) U.S. QUATERNARY FAULTS AND FOLDS DATABASE, 2014.

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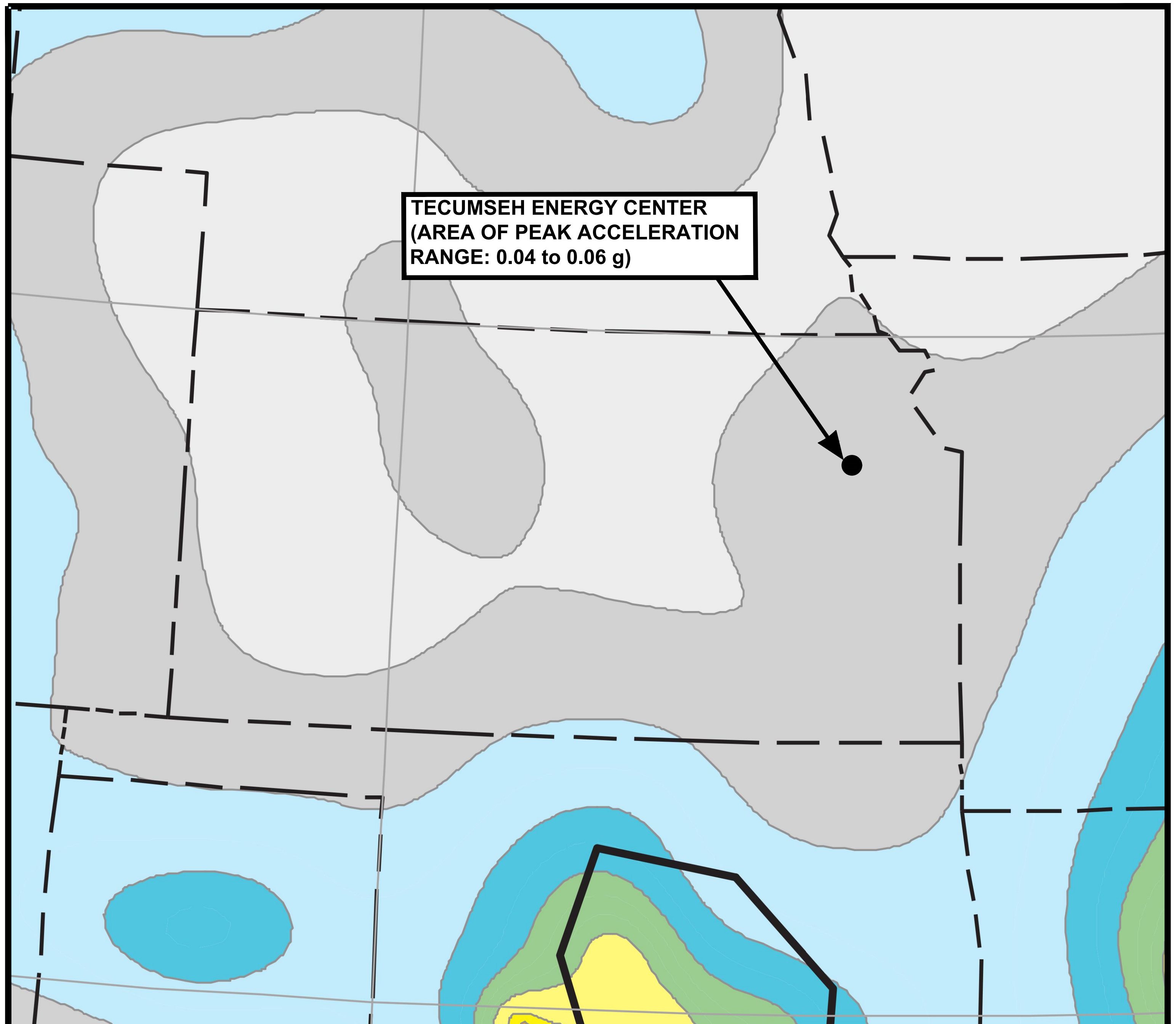
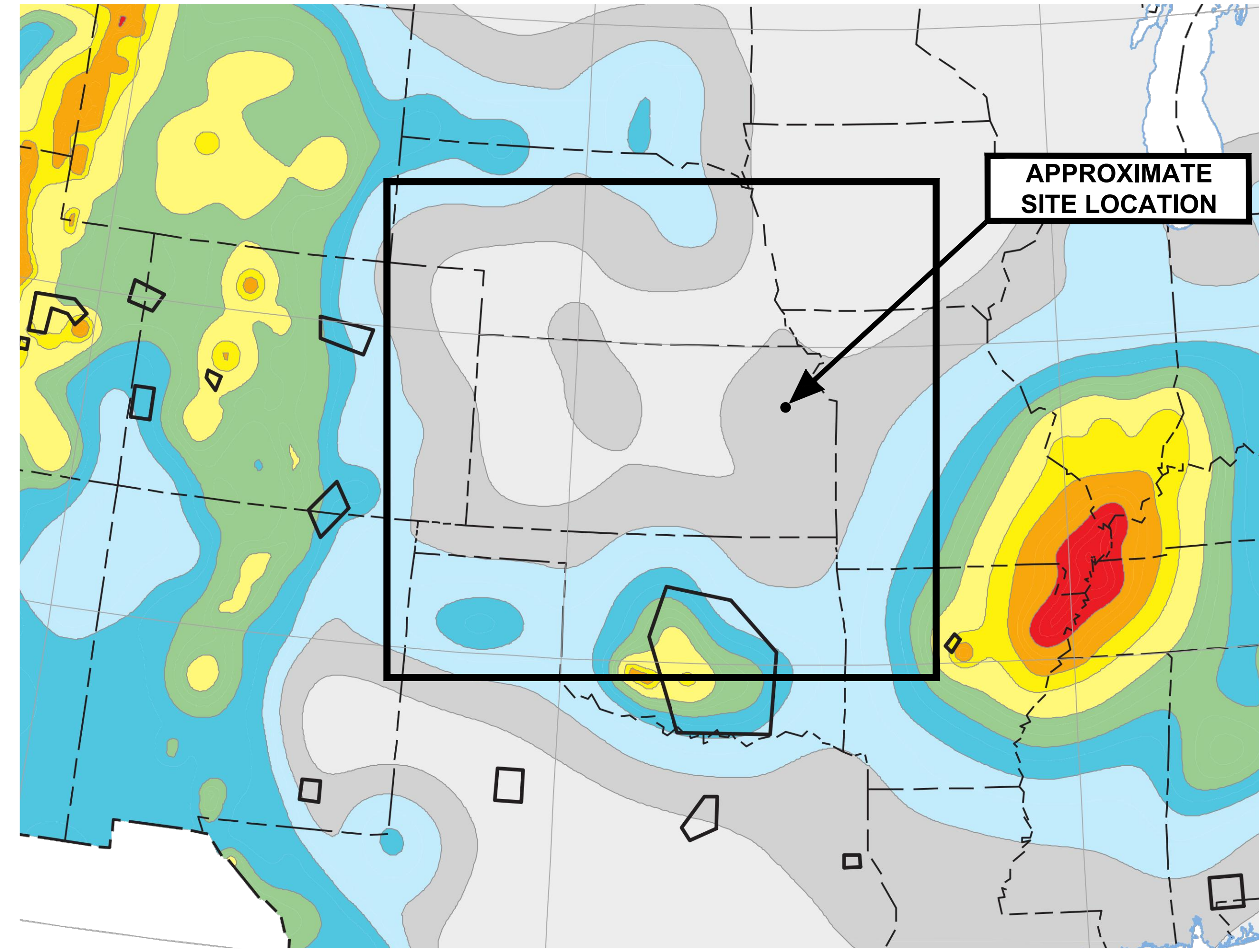
FIGURE 3
MAP OF FAULT AREAS

DRAWN BY:	APPROVED BY:	PROJ. NO.:	DATE:
ORC	RDS	631236415	OCTOBER 2018

TWO-PERCENT PROBABILITY OF EXCEEDANCE IN 50 YEARS MAP OF PEAK GROUND ACCELERATION



0 75 MILES
GRAPHIC SCALE



0 200 MILES
GRAPHIC SCALE

N

EXPLANATION

Peak acceleration, expressed as a fraction of standard gravity (g)

0.8
0.4
0.3
0.2
0.14
0.1
0.06
0.04
0.02
0

NOTES

1. SOURCE: UNITED STATES GEOLOGIC SERVICE (USGS) WEBSITE, 2014.
2. AREAS WITH SUSPECTED NONTECTONIC EARTHQUAKES ARE NOT INCLUDED.

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FIGURE 4
MAP OF HORIZONTAL ACCELERATION

DRAWN BY: ORC	APPROVED BY: RDS	PROJ. NO.: 63123640	DATE: OCTOBER 2018

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APPENDIX A

Aquifer Hydraulic Connection Demonstration

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TABLE I
SUMMARY OF GROUNDWATER ELEVATIONS
Westar Tecumseh Energy Center
Bottom Ash Settling Area
Tecumseh, Kansas

Location		Measure Point Elevation (TOC)	Sample Date	Depth to Water (btoc)	Groundwater Elevation (ft AMSL)
Up Gradient	MW-7	878.28	8/30/2016	21.75	856.53
			9/20/2016	20.47	857.81
			11/1/2016	21.93	856.35
			12/13/2016	22.68	855.6
			2/7/2017	23.16	855.12
			4/6/2017	16.01	862.27
			5/24/2017	21.32	856.96
			6/27/2017	21.70	856.58
			3/9/2018	23.44	854.84
			6/11/2018	23.45	854.83
Down Gradient	MW-8	888.01	8/31/2016	33.24	854.77
			9/21/2016	30.96	857.05
			11/2/2016	32.64	855.37
			12/14/2016	33.71	854.3
			2/7/2017	34.39	853.62
			4/6/2017	29.63	858.38
			5/24/2017	32.54	855.47
			6/27/2017	32.65	855.36
			3/9/2018	29.11	858.90
			6/11/2018	26.53	861.48
	MW-9	886.98	8/31/2016	33.83	853.15
			9/21/2016	34.71	852.27
			11/2/2016	35.49	851.49
			12/16/2016	35.92	851.06
			2/7/2017	36.00	850.98
			4/6/2017	33.03	853.95
			5/24/2017	35.06	851.92
			6/27/2017	35.42	851.56
			3/9/2018	33.58	853.40
			6/11/2018	33.56	853.42
	MW-10	887.08	8/30/2016	33.96	853.12
			9/21/2016	32.67	854.41
			11/2/2016	33.65	853.43
			12/14/2016	34.06	853.02
			2/7/2017	34.09	852.99
			4/6/2017	31.63	855.45
			5/24/2017	32.86	854.22
			6/27/2017	33.50	853.58
			3/9/2018	33.75	853.33
			6/11/2018	33.65	853.43

3.0 SLOPE STABILITY EVALUATION

3.1 Minimum Required Factors of Safety

Under 40 CFR 257.73(e)(1), the computed minimum factors of safety for slope stability of the bottom ash staging area are required to meet or exceed the following minimum factors of safety:

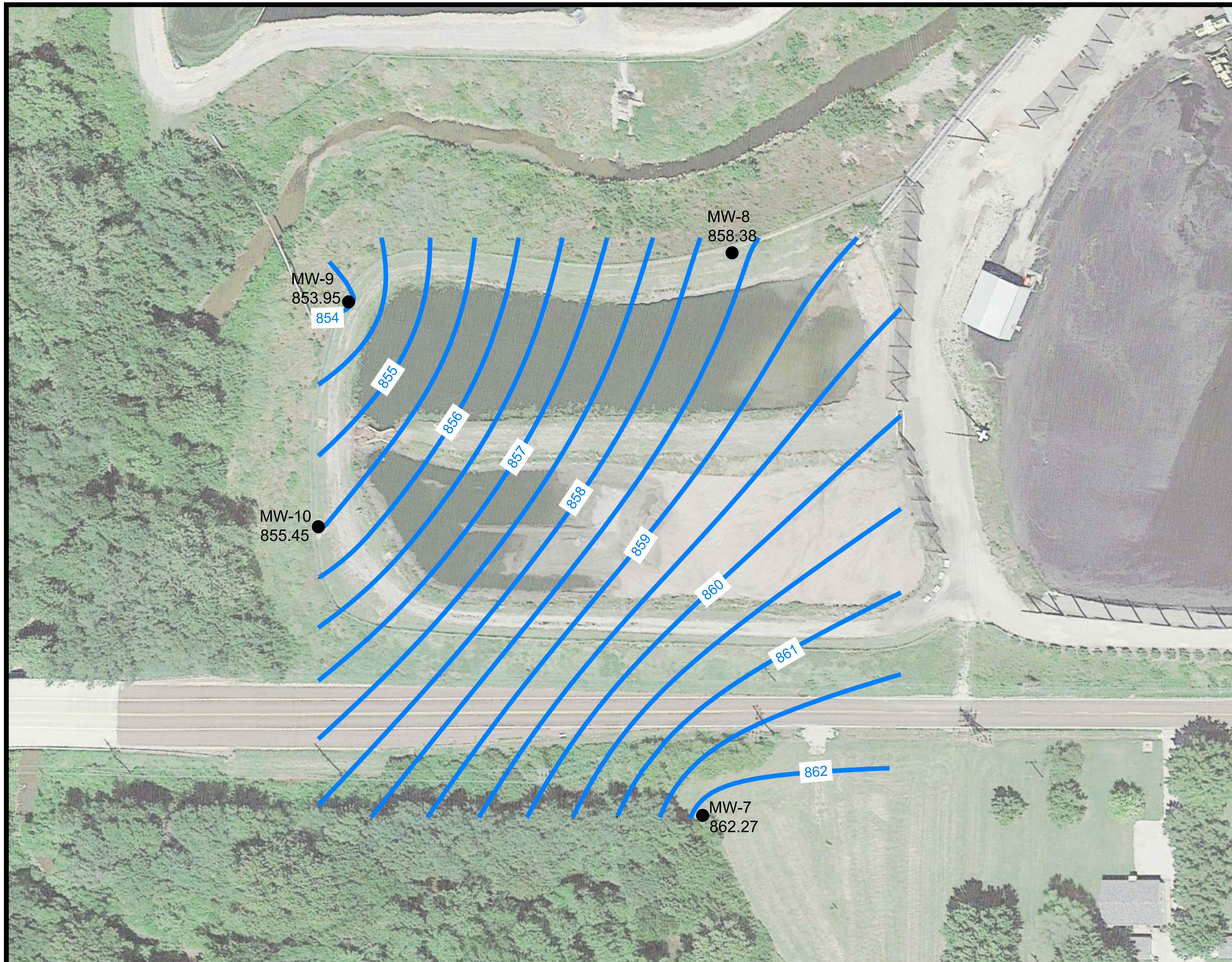
- 1.50 for static loading under the long-term, maximum storage pool condition
- 1.40 for static loading under the maximum surcharge pool condition
- 1.00 for seismic loading under the seismic event with a two-percent probability of being exceeded in 50 years based on seismic hazard maps published by the United States Geological Survey (USGS), as stated in 40 CFR 257.53
- 1.20 for liquefaction factor of safety, if the berms are constructed of soils that are susceptible to liquefaction

As described in Section 2.0, the berm around the bottom ash staging area consists primarily of CL soil. Based on laboratory geotechnical testing summarized in Appendix C, the liquid limit of soil samples collected at TEC ranged from 42 to 50. The plasticity index of soil samples collected at TEC ranged from 24 to 33. The moisture contents of soil samples collected at TEC were approximately half of the liquid limit. Soil materials having these characteristics are not susceptible to liquefaction (Bray et al. 2004). Therefore, the requirement to compute the liquefaction factor of safety does not apply to the bottom ash staging area at TEC.

3.2 Cross Section

Golder identified the critical cross section for slope stability through the berm surrounding the bottom ash staging area. The location of the critical cross section is shown in Figure 1. Golder selected the steepest portion of the berm as the critical cross section, since we observed subsurface conditions to be fairly consistent across the bottom ash staging area. The location of the critical cross section is through the berm north of the bottom ash staging area, which has an overall downstream slope as steep as 1.73 horizontal to 1 vertical based on survey information from the reshaping and revegetation work in 2010. Riprap placed at the toe of the downstream slope in this location as part of the reshaping and revegetation work in 2010 is represented in the cross section (refer to Appendix A). For purposes of the slope stability evaluation, we assumed that the bottom ash staging area was filled with bottom ash to an elevation of 880 feet above mean sea level (approximately 5 feet below the berm crest). We assumed the depth of the surface impoundment to be approximately 20 feet (i.e., bottom elevation of approximately 865 feet above mean sea level) based on site observations and conservatively assumed an upstream berm slope of 0.5 horizontal to 1 vertical. Tecumseh Creek on the north and west sides of the facility has a bottom elevation of approximately 846 feet above mean sea level. The base of the cross section is at an elevation of 842 feet above mean sea level, which corresponds with the top of the underlying shale layer (Haley & Aldrich 2016).

Golder Associates



N

0 75'

GRAPHIC SCALE

LEGEND

861 — APPROXIMATE GROUNDWATER ELEVATIONS (FT MSL) FOR 04-2017

● APPROXIMATE MONITORING WELL LOCATION

NOTES

1. GOOGLE EARTH IMAGE DATED AUGUST 2017.
2. ALL PIEZOMETRIC LINES AND MONITORING WELL LOCATIONS ARE APPROXIMATE.
3. FOR CLARITY, NOT ALL SITE FEATURES MAY BE SHOWN.
4. BASE ASSUMED TO BE AT 865 FT. MSL (GOLDER ASSOCIATES, 2016).

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BOTTOM ASH SETTLING AREA
APRIL 2017 GROUNDWATER ELEVATION CONTOUR MAP

DRAWN BY: ORC	APPROVED BY: RDS	PROJ. NO.: 631236415	DATE: OCTOBER 2018

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APPENDIX B

Unstable Areas

APPENDIX B.1

Differential Settling

Table 2 – Hydrogeologic Characterization Data for the Ash Settling Ponds CCR Management Unit

Unsaturated Material Overlaying Uppermost Aquifer Characteristics	
Lithology	clay, sand, and gravel
Unit Thickness	19 to 36 feet[a]
Hydraulic Conductivity	N/A[b]
Uppermost Aquifer Characteristics	
Lithology	clay, sand, and gravel
Aquifer Thickness	9 to 11 feet[a]
Groundwater Gradient	0.006 feet/feet
Hydraulic Conductivity	$1.6x10^{-3}$ cm/sec[c]
Groundwater Flow Rate	202.36 feet/year
Groundwater Flow Direction	northwest[a]
Estimated Effective Porosity	0.05
Confining Unit Below the Uppermost Aquifer Characteristics	
Lithology	shale
Unit Thickness	>10 feet[d]
Hydraulic Conductivity	$1x10^{-6}$ cm/sec[c]
Estimated Effective Porosity	<0.01

NOTES:
[a] = Data based on April 2016 groundwater elevation data
[b] = Saturation is required to calculate hydraulic conductivity
[c] = Hydraulic conductivity value from Haley & Aldrich, 2016
[d] = Estimated thickness based on boring logs, Haley & Aldrich, 2016

Ash Landfill No. 322 Groundwater Monitoring System

The groundwater monitoring system at Ash Landfill No. 322 was designed to monitor the saturated glacial till formation that constitutes the uppermost aquifer beneath this CCR unit. The monitoring system includes one up gradient monitoring well and three down gradient monitoring wells. The up gradient monitoring well (MW-4) is sited at a location that is representative of background groundwater quality. The down gradient monitoring wells (MW-1, MW-5, and MW-6) are sited based on site-specific conditions at locations that are representative of groundwater flowing beneath Ash Landfill No 322. One cross gradient well (MW-2) exists at the Ash Landfill No. 322 that will be used to monitor groundwater elevation only for the purpose of supplementing groundwater elevation data collected at the up gradient and down gradient wells to establish groundwater flow direction at each sampling event. Based on available groundwater elevation data, the groundwater flow direction beneath Ash Landfill No. 322 is consistently toward the northeast, as shown on Figure 2. The monitoring wells are placed to detect migration of CCR impacted groundwater in the uppermost aquifer on the northern and

6. Localized sloughing in a 5-ft x 5-ft area of the south downstream slope caused by erosion in the bottom of the unlined drainage ditch on the north side of SE 2nd Street.

Haley & Aldrich recommends the following actions:

1. Place and compact fill as needed to raise the grade in the low spot on the crest at the southwest corner of the south pond.

2. Backfill animal burrows with a compacted sand and gravel mix.

3. Regularly manage vegetation on slopes to maintain allowable vegetative growth height.

4. Seed and re-establish vegetation in the dead patches on the south and west downstream slopes.

5. Fill ruts and erosion channels on the west and south downstream slopes.

6. Evaluate need for armoring the bottom of drainage ditch between SE 2nd Street and the south downstream toe of slope in the vicinity of the slough to prevent continued deepening of the channel and resulting sloughing of the downstream slope.

7. Regularly monitor banks of Tecumseh Creek at toe of north downstream slope for signs of instability.

8. Monitor the area of mature trees downstream of the west berm for uprooting, signs of decay, or other conditions that could potentially impact the Area 1 Pond.

Structural Stability Assessment

In accordance with 40 CFR §257.73(d), the owner or operator of a CCR surface impoundment must conduct initial and periodic structural stability assessments to determine whether the design, construction, operation, and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering practices.

Haley & Aldrich reviewed the information provided to us and inspected the Area 1 Pond as described above. Based on our review of the information and observations during our inspection, we have concluded the following in accordance with 40 CFR §257.73(d):

1. §257.73(d)(1)(i) – Stable Foundations and Abutments:

   Based on test borings performed by Golder Associates and information contained in their December 2009 report (Reference 1), it appears the foundation soils below the Area 1 Pond consist of stiff silty clay. Based on our review of the available information and observations during our inspection, the foundation soils were judged to provide a stable foundation for the surface impoundment.

2. §257.73(d)(1)(ii) – Adequate Slope Protection:

   The north and west downstream slopes are generally well protected against surface erosion by the heavy erosion control blankets placed during 2010 and 2012 construction activities and the

EVALUATION OF BOTTOM ASH STAGING AREA SLOPE STABILITY
WESTAR ENERGY - TECUMSEH ENERGY CENTER
SUMMARY OF LABORATORY GEOTECHNICAL TEST RESULTS

Borehole	Sample	Depth	USCS Classification	Dry Unit Weight	Moisture Content	Liquid Limit	Plasticity Limit	Plasticity Index	Effective Friction Angle	Effective Cohesion
TEC-3	2	13-15'	CH	100 pcf	24%	50	17	33		
TEC-4	2	13-15'	CL	102 pcf	23%	42	18	24	29 deg	180 psf
TEC-5	1	3-5'	CL	104 pcf	22%	48	18	30		
P-1	1	33-35'	CL			44	17	27		

APPENDIX B.2

Geologic/Geomorphologic Features Documentation

2.0 SUBSURFACE INVESTIGATION

Three boreholes, TEC-3, TEC-4, and TEC-5, were completed on October 27, 2009, at the locations shown in Figure 1 to support a slope stability evaluation of the bottom ash staging area. The borehole locations were designated by Golder and Westar in areas where site topography indicated a downstream berm slope height of 12 feet or more, generally around the south, west, and north sides of the bottom ash staging area. The boreholes were drilled between the center and the downstream edge of the berm crest and were advanced with a truck-mounted Central Mine Equipment Company (CME) drill rig using 6-inch-diameter hollow-stem continuous-flight augers. Relatively undisturbed soil samples were collected from each borehole using 2-inch-diameter thin-walled tube samplers (Shelby tubes). Soil strata were visually classified by a geotechnical engineer from Golder in accordance with the Unified Soil Classification System (USCS). Berm stratigraphy was fairly consistent between the boreholes and generally consisted of gravel road surfacing underlain primarily by low-plasticity clay (CL), with some high-plasticity clay (CH)[2], to the completed borehole depths. The berm crest around the bottom ash staging area is at an approximate elevation of 885 feet above mean sea level, and the borehole depths ranged from 15 to 25 feet. Groundwater was not observed in any of the three boreholes. Borehole logs with field and laboratory soil classifications are provided in Appendix B.

Two additional boreholes, P-1 and P-2, were completed on March 23, 2010, at the locations shown in Figure 1. Piezometers were installed in these boreholes to better define piezometric levels in the steepest portions of the berm on the north side of the bottom ash staging area. The boreholes were drilled 16 to 22 feet from the upstream edge of the berm crest and were advanced with a truck-mounted CME drill rig using 6-inch-diameter hollow-stem continuous-flight augers. A relatively undisturbed soil sample was collected from P-2 using a 2-inch-diameter thin-walled tube sampler (Shelby tube). Soil strata were visually classified by a geotechnical engineer from Golder in accordance with the USCS. Berm stratigraphy was fairly consistent between the boreholes and generally consisted of gravel road surfacing underlain by CL to the completed borehole depths. The borehole depth was approximately 40 feet for both P-1 and P-2. Borehole logs with field soil classifications are provided in Appendix B.

The piezometers consisted of polyvinyl chloride (PVC) pipe, with the lowest 10 feet slotted to allow measurement of piezometric levels. The annular space around the slotted PVC pipe was backfilled with granular material to create a filter pack. A bentonite seal approximately 10 feet in height was placed in the annular space above the filter pack. The remaining annular space was filled with cuttings, and a concrete pad was installed at the ground surface. A lockable well cap was installed on each piezometer. The piezometers were registered with the Kansas Department of Health and Environment. Groundwater elevations in the piezometers were recorded on August 30, 2010, approximately five months after

[2] A single soil sample classified as CH by laboratory geotechnical testing. The test results were on the borderline between CL and CH (liquid limit equal to 50), and the specimen was designated as CH in accordance with the USCS.

installation of the piezometers. At that time, the groundwater level was measured at an elevation of 859 feet above mean sea level in both P-1 and P-2. The piezometers were subsequently abandoned.

In 2016, additional subsurface investigation was conducted by others in the vicinity of the bottom ash staging area (Haley & Aldrich 2016). The findings of this work are generally consistent with those from the subsurface investigation conducted by Golder in 2009 and 2010. Based on a review of the findings, berm stratigraphy was fairly consistent between boreholes and generally consisted of CL and CH[3]. The groundwater elevation measured in a piezometer installed in the berm on the north side of the bottom ash staging area as part of the 2016 subsurface investigation was 853.6 feet above mean sea level approximately one month after piezometer installation.

[3] Classification was likely limited to field methods. Haley & Aldrich (2016) does not indicate that laboratory geotechnical testing was conducted as part of the subsurface investigation.

Table 2 – Hydrogeologic Characterization Data for the Ash Settling Ponds CCR Management Unit

Unsaturated Material Overlaying Uppermost Aquifer Characteristics	
Lithology	clay, sand, and gravel
Unit Thickness	19 to 36 feet[a]
Hydraulic Conductivity	N/A[b]
Uppermost Aquifer Characteristics	
Lithology	clay, sand, and gravel
Aquifer Thickness	9 to 11 feet[a]
Groundwater Gradient	0.006 feet/feet
Hydraulic Conductivity	$1.6\text{x}10^{-3}$ cm/sec[c]
Groundwater Flow Rate	202.36 feet/year
Groundwater Flow Direction	northwest[a]
Estimated Effective Porosity	0.05
Confining Unit Below the Uppermost Aquifer Characteristics	
Lithology	shale
Unit Thickness	>10 feet[d]
Hydraulic Conductivity	$1\text{x}10^{-6}$ cm/sec[c]
Estimated Effective Porosity	<0.01

NOTES:
[a] = Data based on April 2016 groundwater elevation data
[b] = Saturation is required to calculate hydraulic conductivity
[c] = Hydraulic conductivity value from Haley & Aldrich, 2016
[d] = Estimated thickness based on boring logs, Haley & Aldrich, 2016

Ash Landfill No. 322 Groundwater Monitoring System

The groundwater monitoring system at Ash Landfill No. 322 was designed to monitor the saturated glacial till formation that constitutes the uppermost aquifer beneath this CCR unit. The monitoring system includes one up gradient monitoring well and three down gradient monitoring wells. The up gradient monitoring well (MW-4) is sited at a location that is representative of background groundwater quality. The down gradient monitoring wells (MW-1, MW-5, and MW-6) are sited based on site-specific conditions at locations that are representative of groundwater flowing beneath Ash Landfill No 322. One cross gradient well (MW-2) exists at the Ash Landfill No. 322 that will be used to monitor groundwater elevation only for the purpose of supplementing groundwater elevation data collected at the up gradient and down gradient wells to establish groundwater flow direction at each sampling event. Based on available groundwater elevation data, the groundwater flow direction beneath Ash Landfill No. 322 is consistently toward the northeast, as shown on Figure 2. The monitoring wells are placed to detect migration of CCR impacted groundwater in the uppermost aquifer on the northern and

2. Inspection

2.1 VISUAL INSPECTION

On 7 October 2015, Haley & Aldrich conducted a visual inspection of the Area 1 Pond impoundment. The inspection was performed by Mark D. Brownstein, P.E. and Andy Lucas, EIT of Haley & Aldrich. In attendance for at least a portion of the inspection were the following Westar personnel: Jared Morrison, Stone Junod, Brandon Griffin, and Kirk Wiscomb. In addition, Sam Sunderraj of Kansas Department of Health and Environment was present for the inspection.

The following paragraphs describe the conditions observed on the north, west, and south berms during the inspection. Photographs taken during the inspection are included in Appendix A. A copy of the Inspection Checklist is included Appendix B.

2.1.1 General Findings

2.1.1.1 Area 1 Pond Upstream Slopes

At the time of the inspection, the north pond had been drained and the full height of the slope was visible. The south pond was filled with water with approximately 3 ft of the slope visible above the water surface (pond level at approximately El. 882). See Photos 1 through 4.

The upstream slopes are steep, ranging from nearly vertical to about 1H:1V. No slope protection is provided and there is little to no vegetation on the slopes. Despite having no protection, the slope appeared to be reasonably stable but exhibited some erosion from runoff (Photos 8 and 9).

2.1.1.2 Area 1 Pond Crest

The berm crests are generally 18 to 25 ft in width and are gravel surfaced, providing access to service vehicles around the ponds. The surface is hard and being capable of supporting vehicle traffic without significant rutting (Photos 5 and 6).

The crest alignment appeared generally level, however, a low spot exists at the southwest corner of the south pond. At this location, the crest was also sloped toward the upstream slope, resulting in some erosion of the slope caused by runoff (Photos 7 and 8).

Several rodent burrows were observed along the downstream edge of the crest, primarily along the north berm at the fence line located on the downstream edge of the crest. The burrows were typically on the order of 2 inches in diameter. A somewhat larger burrow hole, approximately 3 inches in diameter, was observed at the downstream edge of the west berm crest (Photo 19). Two dead moles were observed on the crest of the west berm.

The crest exhibited no signs of surface cracking, significant rutting, sinkholes, or depressions other than noted above.

APPENDIX B.3

Human-made Features or Events Documentation

APTIM

Geology of Eastern Shawnee County

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Geology of Eastern Shawnee County, Kansas, and Vicinity

by William D. Johnson, Jr., and W. L. Adkison

Originally published in 1967 as U.S. Geological Survey Bulletin 1215-A, prepared in cooperation with the State Geological Survey of Kansas as a part of a U.S. Department of the Interior program for the development of the Missouri River basin.

This is, in general, the original text as published in 1967. The information has not been updated. Volume B, Geology of Western Shawnee County, Kansas, and Vicinity, is also online.

Abstract

The eastern Shawnee County and vicinity study area, encompassing about 355 square miles of northeastern Kansas, was mapped as part of a study of Upper Pennsylvanian rocks. The area includes eastern Shawnee County and parts of southeastern Jackson, southwestern Jefferson, and westernmost Douglas Counties. Topographic coverage is provided by the Elmont, Grantville, Meriden, Richland, Topeka, and Wakarusa 7 1/2-minute quadrangles and the northernmost parts of the Carbondale and Overbrook quadrangles.

The unexposed sedimentary rocks in the area range in age from Late Cambrian to Late Pennsylvanian and are as much as 2,700 feet thick. Biotite granite of the Precambrian basement complex has been penetrated in two wells.

Exposed sedimentary rocks in the area are about 725 feet thick and are in the Shawnee and Wabaunsee Groups, of Late Pennsylvanian (Virgil) age. Relatively thick shale formations of claystone, siltstone, and sandstone and alternating thinner limestone formations record a cyclic pattern of deposition. The shale formations were deposited largely under nonmarine conditions. The limestone units were deposited largely under marine conditions ranging from beach or extremely shallow water to deeper, fairly quiet water of normal salinity. The claystone and siltstone in the limestone formations were deposited in estuarine, shallow lagoonal, and normal-marine environments. The widespread Nodaway coal bed of the Howard Limestone was deposited during subaerial conditions. Local channels have eroded several formations, particularly the Topeka and Howard Limestones.

Scattered deposits of chert gravel of pre-Kansan age occur in the area but are too small to map. Kansan glacial drift, consisting mainly of unstratified and unsorted clay till, covers most of the area. Thick deposits of stratified glacial outwash occur along the Kansas and Wakarusa Rivers.

Alluvial material of Quaternary age fills the Kansas and Wakarusa River valleys and the valleys of the larger creeks. In the Kansas River valley, extensive deposits correlated with the Newman terrace of Wisconsin age occupy much of the valley floor, and a broad band of Recent alluvium borders the river In the Wakarusa River valley the alluvial fill is also correlated with the Newman terrace, but small terrace remnants, questionably correlated with the Buck Creek terrace of Illinoian age, locally occur along the valley sides.

The mapped area is in the western part of the Forest City basin. Outcropping rocks in the area strike about N. 20°-30° E. and dip northwest, generally 20-40 feet to the mile. The regional dip is interrupted by minor folds, a few of which have almost 20 feet of closure.

No oil or gas in commercial quantities has been discovered in the area, but in several test wells slight oil stains have been found in rocks in the part of the Hunton Formation that is of Devonian age and in the Simpson Group, of Middle Ordovician age. Coal was formerly mined from the Nodaway coal bed of the Howard Limestone at many localities, particularly around Topeka, but the mines are no longer in operation. Limestone and river sand and gravel are being quarried commercially.

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Geology of Eastern Shawnee County

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Economic Geology

Oil and Gas

Eighteen wells have been drilled for oil or gas in eastern Shawnee County and vicinity, but no shows of oil or gas have been reported (Jewett, 1954, p. 336). The well locations are shown on the geologic map (pl. 1). Oil in adjacent Wabaunsee County, which is also in the Forest City basin, has been found primarily on small anticlinal structures (Smith and Anders, 1951; Hilpman, 1958; Goebel and others, 1962); the oil is mainly from porous zones in carbonate rocks of the Viola Limestone (Middle and Upper Ordovician) and the Hunton Formation (Silurian and Devonian). In a few wells oil has been obtained from sandstone in the Simpson Group (Middle Ordovician) and from limestone in the Kansas City Group (Upper Pennsylvanian). In the abandoned McLouth gas and oil field in Jefferson County, about 18 miles east of the mapped area, gas and oil were obtained from sandstone in the Cherokee Group (Middle Pennsylvanian) and from limestone and dolomite of Mississippian age (Lee and Payne, 1944).

The rocks that yield oil or gas in various fields adjacent to Shawnee County are in the subsurface of the mapped area. Zones of pinhole porosity are present in both the Viola Limestone and the Hunton rocks in the Murchison Federal Land Bank 1 well in the SE cor. sec. 28, T. 10 S., R. 15 E., and in the J. J. Lynn Warner 1 well in the center of the SE NW sec. 5, T. 13 S., R. 17 E., (pl. 2). Very slight oil stains occur in the upper few feet of the Hunton and in Simpson rocks in the J. J. Lynn Warner 1 well and in Simpson rocks in the Murchison Federal Land Bank 1 well.

Several small anticlinal folds with less than 20 feet of closure are reflected by the structure contours drawn at an interval of 20 feet on the base of the Topeka Limestone, but no detailed information is available about the relation of these folds to the structure of older rocks at depth. Zones of porosity and oil staining in the Viola Limestone and in rocks of the Hunton and Simpson suggest the possibility that stratigraphic traps may be present in these rocks.

Coal

Thin beds of coal occur locally in rocks of the Shawnee and Wabaunsee Groups in eastern Shawnee County and vicinity, but only the Nodaway coal bed, at the base of the Howard Limestone, is of sufficient thickness to have been mined for domestic and commercial uses. Schoewe (1946) described the coal resources of the Wabaunsee Group in detail; most data presented herein are from that publication. Previously, Whitla (1940) had described the coal resources of all post-Cherokee rocks in Kansas.

The Nodaway coal bed in the mapped area ranges in thickness from 0.2 to 1.5 feet and is bituminous in rank, banded, shiny, brittle, and moderately hard. Analyses of coal from 10 mines in adjacent Osage County and nearby parts of Jefferson County show an average of 10.2 percent moisture, 35.7 percent volatile matter, 43.5 percent fixed carbon, 10 percent ash, 7.6 percent sulfur, 11,093 Btu per pound as received, and 13,843 Btu per pound on a moisture-matter-free basis (Schoewe, 1946, table 3).

The Nodaway was mined at 25 known mines in Shawnee County; 3 were strip mines, 5 were shaft mines, and the rest were small drift mines (Schoewe, 1946, p. 129). Coal was mined at Topeka by the early settlers; but by 1908 most mining in the county had ceased, and no mining activity was reported after 1927. The mines were located in four areas: west of Meriden, along Muddy Creek near State Route 4; north of Topeka, along a tributary of Halfday Creek in secs. 2 and 12, T. 11 S., R. 15 E.; on the west edge of Topeka, near Gage Park and the State Hospital; and in the southwestern part of Topeka, along Shunganunga Creek in the S2 sec. 10, in the SW sec. 13, and along South Branch Shunganunga Creek in the NE sec. 26, T. 12 S., R. 15 E.

Schoewe (1946, p. 133) reported that the total amount of coal produced in Shawnee County probably exceeded 80,000 tons, most of which was from the Nodaway. He estimated that the proved reserves of coal in the Nodaway are approximately 10,290,000 tons. The Nodaway is of little economic value now because of the thinness of the coal, the amount of overburden, and the position of the bed under part of the city of Topeka.

Limestone

Limestone quarried in the eastern part of Shawnee County and adjacent parts of Jefferson County is used primarily as concrete aggregate and road metal, although in 1959 some was quarried for riprap material for the new channel of Soldier Creek around North Topeka.

The Ervine Creek Limestone Member of the Deer Creek Limestone and the Burlingame and Wakarusa Limestone Members of the Bern Limestone are the principal beds quarried in the mapped area. Rock from the Hartford and Curzon Limestone Members of the Topeka Limestone is quarried immediately east of Forbes Air Force Base. Quarrying of the Bern Limestone centers around the town of Elmont. The Burlingame Limestone Member is the principal source in these quarries, but the Wakarusa is also taken where it is not deeply weathered. Quarries in the Ervine Creek Limestone Member are located east of Topeka along Tecumseh and Stinson Creeks, in the Wakarusa River valley about 2 miles east of Wakarusa, and about 2 miles northeast of Grantville. Where quarried, the Ervine Creek is 14-18 feet thick, the Hartford and Curzon Limestone Members of the Topeka are 6.2 and 10.4 feet thick, respectively, and the Burlingame is 5-10 feet thick. Chemical analyses of rock from these and from two other limestone members are given in table 2.

Table 2--Chemical analyses of selected limestones in eastern Shawnee County and adjacent parts of Douglas County, Kansas. [In percent by weight; Tr. = trace; Adapted from Runnels and Schleicher, 1956; $CaCO_3$, $MgCO_3$ and $CaCO_3$
equivalent are all calculated; L.O.I. is net loss of weight on ignition from 105° to 1000° C; Al_2O_3 includes MnO, ZrO_2, V_2O_5, and TiO_2 when present; Total iron expressed as Fe_2O_3; S omitted from computing total because it is included in L.O.I.; Total does not include amounts shown for $CaCO_3$, $MgCO_3$ or $CaCO_3$.]

Formation	Member	Sample locality Section	Township	Range	County	Thickness (ft.)	Lab. No.	$CaCO_3$	$MgCO_3$	$CaCO_3$ equivalent	CaO	MgO	L.O.I.	SiO_2	Al_2O_3	Fe_2O_3	K_2O	Na_2O	SO
Bern Limestone	Burlingame Limestone	NE NW 26	10 S.	15 E.	Shawnee	4.5	53210	87.86	1.86	90.34	49.29	0.89	39.75	4.71	1.47	2.91			Tr
Topeka Limestone	Curzon Limestone	C 16	11 S.	16 E.	Shawnee	4.0	49454	85.19	3.33	88.82	47.91	1.59	39.08	9.04	0.87	1.93			0
Topeka Limestone	Curzon Limestone	SE SW 11	12 S.	17 E.	Douglas	3.0	54369	91.38	0.61	92.04	51.27	0.79	40.50	4.66	1.62	1.15			Tr
Topeka Limestone		SW SW 4	13 S.	16 E.	Shawnee	13.0	53211	76.44	7.32	85.86	43.03	3.50	37.78	10.12	2.06	2.64	0.25	0.12	0.1

	Curzon and Hartford Limestones																		
Topeka Limestone	Hartford Limestone	C 16	11 S.	16 e.	Shawnee	3.0	49445	83.60	4.58	88.61	47.05	2.19	38.99	5.40	1.51	5.53			0.1
Deer Creek	Ervine Creek Limestone	SE 14	11 S.	16 E.	Shawnee	10.0	49455	93.56	1.07	93.93	52.53	0.51	41.33	4.08	0.87	1.37			0
Deer Creek	Ervine Creek Limestone	SE NW 4	12 S.	17 E.	Shawnee	6.9	53213	92.83	1.36	93.25	52.05	0.65	41.03	3.54	0.87	1.65			0
Deer Creek	Ervine Creek Limestone	SE SE 10	13 S.	16 E.	Shawnee	8.8	53214	91.08	2.72	94.48	51.15	1.30	41.57	3.63	0.93	1.15			0.1
Deer Creek	Ozawkie Limestone	SE (?) 36	11 S.	17 E.	Douglas		50554	95.07		95.18	53.27		41.88	2.11	0.71	0.89			0
Lecompton Limestone	Spring Branch Limestone	NE NW 36	11 S.	17 E.	Douglas	6.8	53216	73.94	12.41	90.91	41.63	5.93	40.00	6.29	1.55	4.22			0.1

No dimension stone is produced in this area, but several limestone members have been quarried along their outcrops for local use as building stone. Near Topeka, rock from the Hartford Limestone Member of the Topeka has been used in construction of houses, barns, and small bridges. This limestone is difficult to saw because of its hardness, but it can be hand dressed without difficulty (Riser, 1960, p. 110). Near Richland, rock from beds in the Lecompton Limestone is locally used for building stone. Small amounts of stone have also been quarried for local use from the Maple Hill and Tarkio Limestone Members of the Zeandale Limestone and from the Reading Limestone Member of the Emporia Limestone.

Sand and Gravel

All sand and gravel currently (1961) produced commercially in Shawnee County is from the alluvium along the Kansas River. Most of the sand is used for building, for paving, and as fill, although small amounts are used as engine and blast sand. The building industry utilizes most of the gravel, but some is used in paving and as fill.

Deposits of glacial sand and gravel of Kansan age have been quarried at several localities in the mapped area, especially south of the Kansas River. A fairly large amount of material was dug from a morainal deposit along the south side of Shunganunga Creek in the SW SW sec. 10, T. 12 S., R. 15 E.; also, a large pit was formerly operated in the SW SW sec. 24, T. 13 S., R. 16 E. Because these deposits are poorly sorted and contain cemented zones, the pits were probably difficult to operate. Material from both pits was probaibly used mainly as road metal. North of the Kansas River small deposits, mainly of chert gravel, were quarried in the SW NW sec. 7, T. 11 S., R. 16 E. and in the SW NE sec. 18, T. 11 S., R. 17 E. Small deposits of glacial sand and gravel, such as that in the creekbank in the W2 NW sec. 15, T. 10 S., R. 17 E., probably supplied the needs of local residents.

Clay

Claystone immediately beneath the Nodaway coal bed of the Howard Limestone was formerly dug from a pit on the west side of Topeka in the SE NE sec. 27, T. 11 S., R. 15 E., for the manufacture of brick. Digging operations ceased at this pit in the 1930's, and no clay or shale is currently being dug in Shawnee County for ceramic use. Claystone was dug from the Calhoun Shale along the east side of Deer Creek in the SW sec. 3, T. 12 S., R. 16 E., for several years (around 1950) and was blended with clay from the Dakota Formation (Lower Cretaceous) of central Kansas for the manufacture of small pottery objects.

A sample from near the middle of the Calhoun Shale in the center of the N2 SW sec. 15, T. 11 S., R. 16 E., produced a light weight aggregate with a density of 48.5 pounds per cubic foot (Plummer and Hladik, 1951, p. 60). If this sample was representative, the clayey parts of the Calhoun Shale probably are usable for the production of lightweight aggregate.

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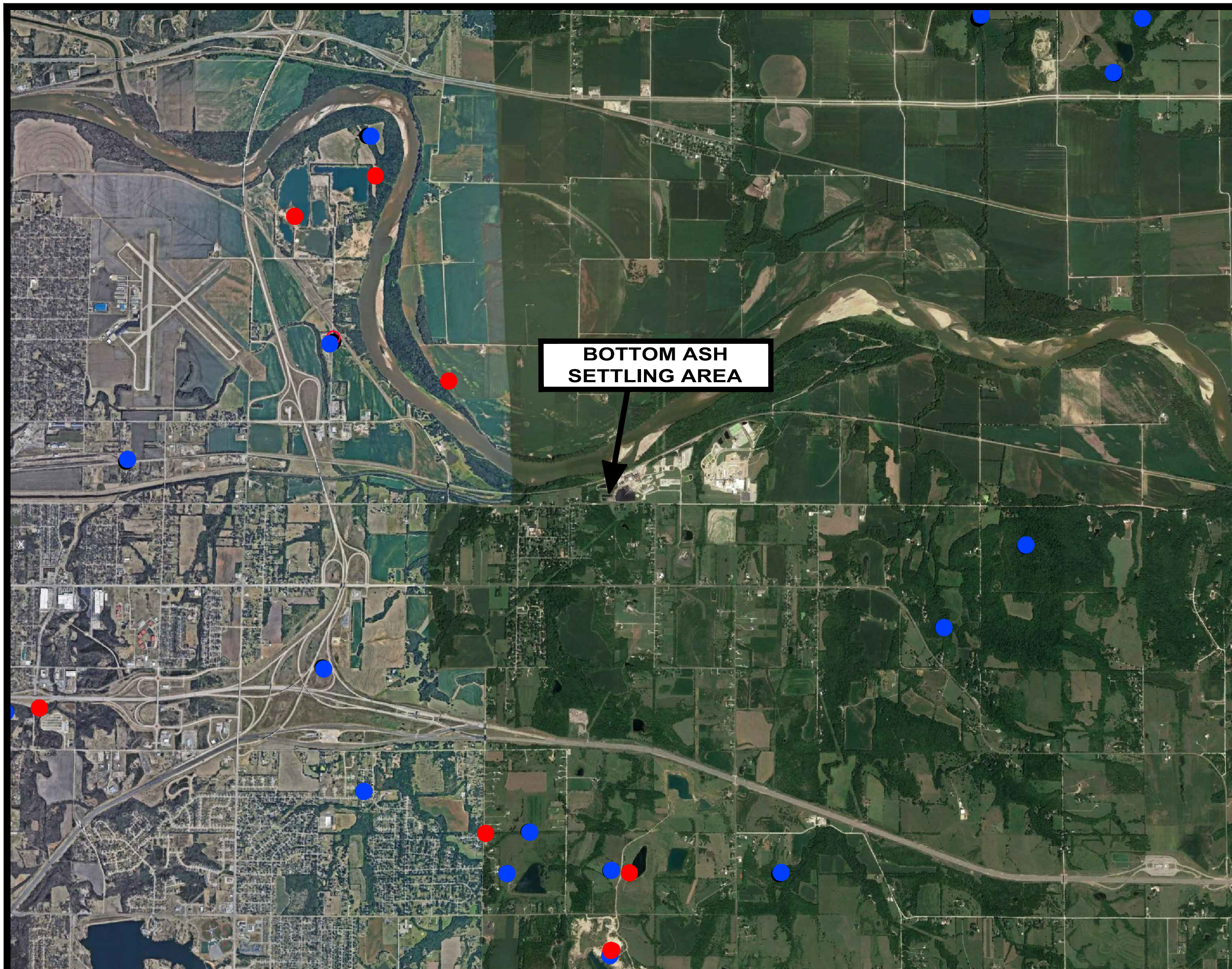

0 1 MILE

GRAPHIC SCALE

LEGEND

- ● ACTIVE
- ● ABANDONED

NOTES

1. AERIAL PHOTO FROM GOOGLE EARTH, AUGUST 2017.
2. QUARRY LOCATIONS ARE APPROXIMATE.
3. FOR CLARITY, NOT ALL SITE FEATURES MAY BE SHOWN.

APTIM Environmental & Infrastructure, Inc.

WESTAR ENERGY
5636 SE 2nd ST., TECUMSEH, KS

QUARRIES NEAR BOTTOM ASH SETTLING AREA

DRAWN BY: ORC	APPROVED BY: RDS	PROJ. NO.: 631236340	DATE: OCTOBER 2018

Kansas Geological Survey | Geology | Industrial Mineral Producers

Industrial Minerals--Shawnee County; Both Active and Abandoned Quarries

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163 records returned. **You may also choose to save this data to a file.**
Show Active Quarries || Show Abandoned Quarries || **Both Active and Abandoned Quarries Shown**

Building Limestone

Company	Type	Location
Native Stone Company 9120 Sw 10th Street Topeka, Ks 66615 785-478-9359	Surface Active	T11S, R14E, Sec. 36, NENE Long: -95.80005, Lat: 39.05585

Coal

Company	Type	Location
Name Unknown	Abandoned	T10S, R16E, Sec. 10, NE Long: -95.61271, Lat: 39.19813
	Abandoned	T11S, R15E, Sec. 11, Long: -95.71516, Lat: 39.10924
	Abandoned	T11S, R15E, Sec. 12, Long: -95.69647, Lat: 39.10933
	Abandoned	T12S, R15E, Sec. 13, Long: -95.69672, Lat: 39.00786

Limestone

Company	Type	Location
Concrete Materails	Abandoned	T12S, R17E, Sec. 7, SW Long: -95.57152, Lat: 39.01887
J.H. & J. Rock Co.	Abandoned	T10S, R15E, Sec. 10, SE Long: -95.72448, Lat: 39.19117

Shawnee Limestone Co.	Abandoned	T11S, R14E, Sec. 35, N2 Long: -95.82565, Lat: 39.05409
Native Stone Company 7820 Southwest 10th Street Topeka, Kansas 66615 913-478-9359	Surface Active	T11S, R14E, Sec. 36, NE Long: -95.80237, Lat: 39.05402
	Surface Active	T12S, R14E, Sec. 2, NWNE Long: -95.82328, Lat: 39.04144
H.C.Luttjohann	Abandoned	T11S, R15E, Sec. 31, SW Long: -95.79324, Lat: 39.04683
Martin Marietta	Abandoned	T12S, R17E, Sec. 18, NW Long: -95.57156, Lat: 39.0116
	Abandoned	T13S, R16E, Sec. 20, SE Long: -95.65494, Lat: 38.90265
Martin Marietta Aggr.	Abandoned	T12S, R17E, Sec. 22, SW Long: -95.51463, Lat: 38.98955
	Abandoned	T12S, R17E, Sec. 27, NE Long: -95.50529, Lat: 38.98226
	Abandoned	T13S, R17E, Sec. 7, SE Long: -95.56142, Lat: 38.9314
Concrete Mateials	Abandoned	T10S, R15E, Sec. 26, NW Long: -95.71468, Lat: 39.1548
(Miller Clarkson)	Abandoned	T11S, R17E, Sec. 33, SE Long: -95.52427, Lat: 39.04778
H.C. Luttjohann	Abandoned	T12S, R14E, Sec. 3, NE Long: -95.83958, Lat: 39.03976
Anderson Oxandale	Abandoned	T12S, R16E, Sec. 11, NE Long: -95.59976, Lat: 39.02604
F.E. Fritts	Abandoned	T12S, R16E, Sec. 22, NE Long: -95.6188, Lat: 38.99702
Hamm, N.R., Quarry, Inc	Abandoned	T10S, R15E, Sec. 11, NE Long: -95.70557, Lat: 39.19835

	Abandoned	T10S, R15E, Sec. 15, NE Long: -95.72446, Lat: 39.18388
	Abandoned	T12S, R13E, Sec. 2, ALL Long: -95.93723, Lat: 39.03696
	Abandoned	T13S, R16E, Sec. 13, SE Long: -95.58083, Lat: 38.91699
Martin Marietta Aggregates 1303 W 42nd Street Topeka, Kansas 66609 913-267-5230	Surface Active	T10S, R15E, Sec. 11, W2SE Long: -95.70796, Lat: 39.19109
	Abandoned	T10S, R15E, Sec. 11, NW Long: -95.71506, Lat: 39.19842
	Surface Abandoned	T10S, R15E, Sec. 11, NW Long: -95.71506, Lat: 39.19842
	Surface Active	T12S, R16E, Sec. 12, Long: -95.58574, Lat: 39.02245
	Surface Active	T12S, R17E, Sec. 7, SW Long: -95.57152, Lat: 39.01887
	Surface Active	T12S, R17E, Sec. 7, SW Long: -95.57152, Lat: 39.01887
	Surface Active	T12S, R17E, Sec. 7, SW Long: -95.57152, Lat: 39.01887
	Surface Active	T12S, R17E, Sec. 18, NW Long: -95.57156, Lat: 39.0116
	Surface Active	T12S, R17E, Sec. 18, NW Long: -95.57156, Lat: 39.0116
	Surface Active	T12S, R17E, Sec. 18, NW Long: -95.57156, Lat: 39.0116
	Surface Active	T12S, R17E, Sec. 18, NW Long: -95.57156, Lat: 39.0116
	Surface Active	T12S, R17E, Sec. 22, SESW Long: -95.5123, Lat: 38.98772
	Surface Active	T12S, R17E, Sec. 27, Long: -95.5099, Lat: 38.97864
	Active	T13S, R14E, Sec. 17, Long: -95.88197, Lat: 38.92091
	Abandoned	T13S, R16E, Sec. 20, SESE Long: -95.65263, Lat: 38.90082
	Surface Abandoned	T13S, R16E, Sec. 20, SESE Long: -95.65263, Lat: 38.90082
	Surface Active	T13S, R17E, Sec. 7, SE Long: -95.56142, Lat: 38.9314
Shawnee County 3137 S. E. 29th Street	Surface	T12S, R17E, Sec. 22, SE Long: -95.50537, Lat: 38.98951
	Surface	

Topeka, Kansas 66605 913-266-0192		T12S, R17E, Sec. 27, NE Long: -95.50529, Lat: 38.98226
N.R.Hamm	Abandoned	T10S, R15E, Sec. 11, NE Long: -95.70557, Lat: 39.19835
	Abandoned	T10S, R15E, Sec. 13, SW Long: -95.69615, Lat: 39.17651
	Abandoned	T10S, R15E, Sec. 15, NE Long: -95.72446, Lat: 39.18388
	Abandoned	T11S, R15E, Sec. 8, SE Long: -95.76659, Lat: 39.10516
	Abandoned	T12S, R13E, Sec. 2, Long: -95.93723, Lat: 39.03696
	Abandoned	T12S, R13E, Sec. 23, SW Long: -95.94193, Lat: 38.98995
	Abandoned	T12S, R13E, Sec. 26, Long: -95.93733, Lat: 38.97898
	Abandoned	T12S, R14E, Sec. 4, SE Long: -95.85813, Lat: 39.03271
	Abandoned	T12S, R16E, Sec. 4, SE Long: -95.63692, Lat: 39.03333
	Abandoned	T12S, R17E, Sec. 8, SW Long: -95.55228, Lat: 39.01881
	Abandoned	T13S, R16E, Sec. 13, SE Long: -95.58083, Lat: 38.91699
	Abandoned	T10S, R13W, Sec. 13, NE Long: -98.71753, Lat: 39.18771
G.W.Baker	Abandoned	T10S, R15E, Sec. 29, SE Long: -95.76104, Lat: 39.1476
	Abandoned	T13S, R16E, Sec. 4, SW Long: -95.64639, Lat: 38.94625
Name Unknown	Abandoned	T10S, R15E, Sec. 32, NE Long: -95.76109, Lat: 39.14033
	Abandoned	T10S, R16E, Sec. 2, Long: -95.5987, Lat: 39.20899
	Abandoned	T11S, R14E, Sec. 29, NW Long: -95.88565, Lat: 39.06912
	Abandoned	T11S, R15E, Sec. 2, NW Long: -95.71956, Lat: 39.12621
	Abandoned	T11S, R15E, Sec. 31, SE Long: -95.78432, Lat: 39.04697
	Abandoned	T12S, R14E, Sec. 11, NE Long: -95.82098, Lat: 39.02529

	Abandoned	T12S, R14E, Sec. 18, SW Long: -95.90475, Lat: 39.00404
	Abandoned	T12S, R15E, Sec. 7, NW Long: -95.79346, Lat: 39.02511
	Abandoned	T12S, R15E, Sec. 31, S2 Long: -95.78931, Lat: 38.95982
	Abandoned	T12S, R16E, Sec. 15, E2 Long: -95.61874, Lat: 39.0079
	Abandoned	T12S, R16E, Sec. 22, SE Long: -95.6188, Lat: 38.98975
	Abandoned	T12S, R16E, Sec. 26, NW Long: -95.60944, Lat: 38.98247
	Abandoned	T12S, R16E, Sec. 27, NW Long: -95.62807, Lat: 38.98251
	Abandoned	T12S, R16E, Sec. 27, NE Long: -95.61877, Lat: 38.98249
	Abandoned	T12S, R17E, Sec. 20, NW Long: -95.55196, Lat: 38.99702
	Abandoned	T12S, R17E, Sec. 30, SE Long: -95.56136, Lat: 38.97522
	Abandoned	T13S, R16E, Sec. 9, SE Long: -95.63683, Lat: 38.93171
	Abandoned	T13S, R16E, Sec. 15, NW Long: -95.62739, Lat: 38.9244
	Abandoned	T13S, R16E, Sec. 24, NE Long: -95.58073, Lat: 38.90972
	Abandoned	T13S, R16E, Sec. 31, SWNW Long: -95.68451, Lat: 38.87905
	Abandoned	T13S, R16E, Sec. 31, NW Long: -95.68221, Lat: 38.88085
(O.F.Griffen)	Abandoned	T11S, R16E, Sec. 16, NW Long: -95.64542, Lat: 39.09882
Concrete Matrials	Abandoned	T12S, R16E, Sec. 2, Long: -95.60416, Lat: 39.03702
N.R. Hamm Quarries, Inc. P. O. Box 17 One Perry Plaza Perry, Ks 66073-0017 785-597-5111	Surface Active	T10S, R15E, Sec. 11, NE Long: -95.70557, Lat: 39.19835
	Surface Abandoned	T10S, R15E, Sec. 11, NE Long: -95.70557, Lat: 39.19835
	Surface Active	T10S, R15E, Sec. 15, SE Long: -95.72433, Lat: 39.17661

	Surface Abandoned	T10S, R15E, Sec. 15, NE Long: -95.72446, Lat: 39.18388
	Surface Active	T10S, R15E, Sec. 15, SE Long: -95.72433, Lat: 39.17661
	Surface Active	T12S, R13E, Sec. 2, N2 Long: -95.93723, Lat: 39.04049
	Surface Active	T12S, R13E, Sec. 2, NW Long: -95.94186, Lat: 39.0405
	Surface Abandoned	T12S, R13E, Sec. 2, ALL Long: -95.93723, Lat: 39.03696
	Surface Abandoned	T12S, R17E, Sec. 8, SW Long: -95.55228, Lat: 39.01881
	Surface Abandoned	T13S, R16E, Sec. 13, SE Long: -95.58083, Lat: 38.91699
Martin Marietta Materials Inc 11252 Aurora Street Des Moines, Ia 50322 515-254-0050	Surface Active	T10S, R15E, Sec. 11, E2 Long: -95.70557, Lat: 39.19471
	Surface Active	T12S, R16E, Sec. 12, E2 Long: -95.58104, Lat: 39.02248
	Surface Active	T13S, R17E, Sec. 7, E2 Long: -95.56142, Lat: 38.93501
Concrete Materials	Abandoned	T10S, R15E, Sec. 14, NE Long: -95.70556, Lat: 39.18381
	Abandoned	T10S, R15E, Sec. 14, SE Long: -95.70556, Lat: 39.17654
	Abandoned	T10S, R15E, Sec. 14, SW Long: -95.71506, Lat: 39.17657
	Abandoned	T10S, R15E, Sec. 23, SW Long: -95.71475, Lat: 39.16204
	Abandoned	T11S, R14E, Sec. 36, Long: -95.80701, Lat: 39.05039
	Abandoned	T11S, R16E, Sec. 15, NW Long: -95.62668, Lat: 39.09889
	Abandoned	T12S, R14E, Sec. 2, N2 Long: -95.82561, Lat: 39.03967
	Abandoned	T12S, R16E, Sec. 12, SE Long: -95.5811, Lat: 39.01884
	Abandoned	T12S, R17E, Sec. 4, NW Long: -95.5336, Lat: 39.04054
	Abandoned	T13S, R14E, Sec. 17, SE Long: -95.87733, Lat: 38.91721
	Abandoned	T13S, R15E, Sec. 30, SW Long: -95.7933, Lat: 38.88718

	Abandoned	T13S, R16E, Sec. 10, SE Long: -95.61816, Lat: 38.93166
	Abandoned	T13S, R16E, Sec. 20, SW Long: -95.66411, Lat: 38.90266
P.H.Netherland	Abandoned	T10S, R15E, Sec. 26, NE Long: -95.70546, Lat: 39.15476

Sand & Gravel

Company	Type	Location
Holliday Sand & Gravel 6811 W 63rd Street Overland Park Ks 66202 913-236-5920	Pit Active	T11S, R16E, Sec. 23, W2S2 Long: -95.60766, Lat: 39.07708
Victory Sand & Gravel Inc 10820 W. 64th St. Shawnee, Ks 66203 913-962-1711	River Dredge Active	T11S, R15E, Sec. 24, SW Long: -95.70128, Lat: 39.07713
Kansas Sand And Concrete 531 N. Tyler Topeka, Kansas 66608 913-235-6284	River Dredge Active	T11S, R15E, Sec. 30, NE Long: -95.78445, Lat: 39.06879
Page	Abandoned	T11S, R13E, Sec. 10, SE Long: -95.95129, Lat: 39.1054
Consumers Sand Co.	Abandoned	T11S, R16E, Sec. 30, NW Long: -95.68288, Lat: 39.06995
Fufe Sand	Abandoned	T11S, R14E, Sec. 21, Long: -95.86261, Lat: 39.07989
Victory Sand Company 4919 Lamar Mission, Kansas 66022 913-233-3285	River Dredge Active	T11S, R15E, Sec. 25, NW Long: -95.70129, Lat: 39.06986
Consumers Sand Company, Inc. 924 West Railroad Street N. Topeka, Kansas 66608 913-232-5117	River Dredge Abandoned	T11S, R15E, Sec. 26, N2 Long: -95.7151, Lat: 39.06971

Meier Ready Mix	Abandoned	T11S, R16E, Sec. 26, Long: -95.60336, Lat: 39.06617
Miere Ready Mix	Abandoned	T11S, R16E, Sec. 32, Long: -95.65987, Lat: 39.05156
Martin Marietta	Abandoned	T12S, R17E, Sec. 19, Long: -95.5666, Lat: 38.99341
Kansas Sand Co.	Abandoned	T11S, R16E, Sec. 29, Long: -95.65971, Lat: 39.06622
	Abandoned	T11S, R16E, Sec. 30, NW Long: -95.68288, Lat: 39.06995
Kansas Sand & Concrete Inc Po Box 656 Topeka, Ks 66608 785-235-6284	River Dredge Active	T11S, R16E, Sec. 30, NW Long: -95.68288, Lat: 39.06995
Meier'S Ready Mix Inc Po Box 8477 Topeka, Ks 66608 785-233-2423	River Dredge Active	T11S, R15E, Sec. 29, NW Long: -95.77536, Lat: 39.06885
	Pit Active	T11S, R16E, Sec. 23, E2 Long: -95.59874, Lat: 39.08073
	Pit Active	T11S, R16E, Sec. 23, E2 Long: -95.59874, Lat: 39.08073
Kansas Sand & Concrete 531 N. Tyler Topeka, Ks 66608 913-235-6284	River Dredge Active	T11S, R15E, Sec. 30, NW Long: -95.7933, Lat: 39.06875
A.V.Adkins	Abandoned	T10S, R13E, Sec. 24, SW Long: -95.91914, Lat: 39.16231
	Abandoned	T10S, R13E, Sec. 24, SE Long: -95.90985, Lat: 39.16228
(Nels Olson)	Abandoned	T11S, R16E, Sec. 16, SW Long: -95.64526, Lat: 39.09145
Martin Marietta Aggregates 1303 W 42nd Street Topeka, Kansas 66609 913-267-5230	Abandoned	T11S, R15E, Sec. 25, NW Long: -95.70129, Lat: 39.06986
	Abandoned	T11S, R15E, Sec. 25, NW Long: -95.70129, Lat: 39.06986
	Abandoned	T12S, R17E, Sec. 19, ALL Long: -95.5666, Lat: 38.99341

	Surface Abandoned	T12S, R17E, Sec. 19, ALL Long: -95.5666, Lat: 38.99341
Shawnee County	Abandoned	T10S, R14E, Sec. 9, SE Long: -95.85439, Lat: 39.1913
	Abandoned	T11S, R15E, Sec. 9, SW Long: -95.75734, Lat: 39.10527
Topeka Sand Company Route 4 Topeka, Kansas 66603 913-233-9849	Surface Active	T11S, R16E, Sec. 23, SE Long: -95.59872, Lat: 39.07709
	Surface Active	T11S, R16E, Sec. 23, E2 Long: -95.59874, Lat: 39.08073
Name Unknown	Abandoned	T10S, R13E, Sec. 35, NE Long: -95.92861, Lat: 39.14062
	Abandoned	T10S, R13E, Sec. 36, SW Long: -95.91933, Lat: 39.13334
	Abandoned	T10S, R14E, Sec. 31, NE Long: -95.89143, Lat: 39.14059
	Abandoned	T10S, R14E, Sec. 31, NW Long: -95.90067, Lat: 39.14059
	Abandoned	T11S, R13E, Sec. 1, Long: -95.91866, Lat: 39.12292
	Abandoned	T11S, R13E, Sec. 1, NE Long: -95.91396, Lat: 39.12628
	Abandoned	T11S, R13E, Sec. 23, SW Long: -95.94182, Lat: 39.0766
	Abandoned	T11S, R14E, Sec. 1, NE Long: -95.80215, Lat: 39.12616
	Abandoned	T11S, R15E, Sec. 14, SW Long: -95.71992, Lat: 39.09127
	Abandoned	T11S, R15E, Sec. 30, NE Long: -95.78445, Lat: 39.06879
	Abandoned	T11S, R16E, Sec. 7, NE Long: -95.67355, Lat: 39.11305
	Abandoned	T11S, R16E, Sec. 9, NW Long: -95.64553, Lat: 39.11334
	Abandoned	T11S, R16E, Sec. 34, NW Long: -95.62695, Lat: 39.05522
	Abandoned	T12S, R13E, Sec. 23, NW Long: -95.94189, Lat: 38.99722
	Abandoned	T13S, R16E, Sec. 23, SE Long: -95.59912, Lat: 38.90249
	Abandoned	T13S, R16E, Sec. 24, NW Long: -95.59, Lat: 38.90971

	Abandoned	T13S, R16E, Sec. 24, NE Long: -95.58073, Lat: 38.90972
	Abandoned	T13S, R17E, Sec. 17, NW Long: -95.55177, Lat: 38.92408
Victory Sand & Concrete	Abandoned	T11S, R15E, Sec. 25, Long: -95.69665, Lat: 39.06618
Consumers Sand Co., Inc	Abandoned	T11S, R15E, Sec. 26, N2 Long: -95.7151, Lat: 39.06971
Meier'S Ready Mix, Inc. P. O. Box 8477 Topeka, Kansas 66608 913-233-2423	Active	T11S, R15E, Sec. 29, NE Long: -95.76604, Lat: 39.06893
	River Dredge Active	T11S, R16E, Sec. 23, SW Long: -95.60766, Lat: 39.07708
	Active	T11S, R16E, Sec. 26, ALL Long: -95.60336, Lat: 39.06617
	Active	T11S, R16E, Sec. 32, ALL Long: -95.65987, Lat: 39.05156
River Sand Co.	Abandoned	T11S, R15E, Sec. 26, N2 Long: -95.7151, Lat: 39.06971
Shoffner Sand	Abandoned	T11S, R16E, Sec. 23, NE Long: -95.59877, Lat: 39.08438

Kansas Geological Survey
Comments or questions to webadmin@kgs.ku.edu
URL=http://www.kgs.ku.edu/Magellan/Minerals/index.html
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