Ohio Valley Electric Corporation
Indiana- Kentucky electric corporation
3932 U. S. Route 23
P.O. Box 468
Piketon, Ohio 45661
740-289-7200
Writer's Direct Dial No:
(740) 897-7768

October 17, 2018

Mr. Bruno Pigott
Commissioner
Indiana Department of Environmental Management
100 N. Senate Avenue
Mail Code 50-01
Indianapolis, IN 46204-2251

Re: Indiana-Kentucky Electric Corporation
Clifty Creek Station
Notification of CCR Location Restrictions Posting

Dear Mr. Pigott:

In accordance with 40 CFR 257.107(e), the Indiana-Kentucky Electric Corporation (IKEC) is providing notification to the Commissioner (State Director) of the Indiana Department of Environmental Management that Coal Combustion Residual (CCR) units located at Clifty Creek Station in Madison, Indiana have undergone assessment by a qualified professional engineer and have been certified to be in compliance with the location restrictions outlined in 40 CFR 257.60 through 40 CFR 257.64. Reports documenting the process employed and final results of each assessment have been certified and posted to the facility's publically accessible internet site, as well as placed in the facility's operating record on October 17, 2018.

This information can be viewed at IKEC's publically accessible internet site at:

https://www.ovec.com/CCRCompliance.php

If you have any questions, or require any additional information, please call me at (740) 897-7768.

Sincerely,

Tim Fulk

Tim Fulk
Engineer II

TLF:klr

Stantec Consulting Services Inc.
11687 Lebanon Road, Cincinnati OH 45241-2012

October 16, 2018
File: 175534018
Revision 0

Indiana-Kentucky Electric Corporation
3932 U.S. Route 23
P.O. Box 468
Piketon, Ohio 45661

RE: Location Restrictions Compliance Demonstrations
Landfill Runoff Collection Pond
EPA Final Coal Combustion Residuals (CCR) Rule
Clifty Creek Station
Madison, Jefferson County, Indiana

1.0 PURPOSE

This letter documents Stantec's certification of the location restrictions compliance demonstrations for the Indiana-Kentucky Electric Corporation (IKEC) Clifty Creek Station's Landfill Runoff Collection Pond. Included in these demonstrations for the Landfill Runoff Collection Pond are assessments of a) Placement Above the Uppermost Aquifer, b) Wetlands, c) Fault Areas, d) Seismic Impact Zones, and e) Unstable Areas.

2.0 LOCATION RESTRICTION ASSESSMENTS

2.1 PLACEMENT ABOVE THE UPPERMOST AQUIFER

An existing CCR surface impoundment must be assessed to demonstrate that it meets the minimum location requirements for placement above the uppermost aquifer as per 40 CFR 257.60(a)-(d).

2.2 WETLANDS

An existing CCR surface impoundment must be assessed to demonstrate that it meets the location requirements for wetlands as per 40 CFR 257.61(a)-(d).

2.3 FAULT AREAS

An existing CCR surface impoundment must be assessed to demonstrate that it meets the minimum location requirements for fault areas as per 40 CFR 257.62(a)-(d).

2.4 SEISMIC IMPACT ZONES

An existing CCR surface impoundment must be assessed to demonstrate that it meets the minimum location requirements for seismic impact zones as per 40 CFR 257.63(a)-(d).

2.5 UNSTABLE AREAS

An existing CCR surface impoundment must be assessed to demonstrate that it meets the minimum location requirements for unstable areas as per 40 CFR 257.64(a)-(e).

RE: Location Restrictions Compliance Demonstrations
Landfill Runoff Collection Pond
EPA Final Coal Combustion Residuals (CCR) Rule
Clifty Creek Station
Madison, Jefferson County, Indiana

3.0 SUMMARY OF FINDINGS

The attached compliance demonstration reports outline the relevant project setting and technical elements considered for each of the location restriction demonstrations noted above in Section 2.0. Based on these assessments, the Clifty Creek Landfill Runoff Collection Pond is in compliance with the location restriction requirements in the Final CCR Rule.

4.0 QUALIFIED PROFESSIONAL ENGINEER CERTIFICATION

I, Stan A. Harris, being a Professional Engineer in good standing in the State of Indiana, do hereby certify, to the best of my knowledge, information, and belief:

1. that the information contained in this certification is prepared in accordance with the accepted practice of engineering;
2. that the information contained herein is accurate as of the date of my signature below; and
3. that the IKEC Clifty Creek Station's Landfill Runoff Collection Pond meets all requirements specified for locations restrictions outlined within the EPA CCR Final Rule.

SIGNATURE Stan A. Harris DATE 10/16/18

STAN A. HARRIS REGISTERED No. PE-19700150 STATE OF INDIANA PROFESSIONAL ENGINEER 10/16/18

ADDRESS: Stantec Consulting Services Inc.
11687 Lebanon Road
Cincinnati, Ohio 45241

TELEPHONE: (513) 842-8200

ATTACHMENTS:

A. Placement Above the Uppermost Aquifer Compliance Demonstration Report
B. Wetlands Compliance Demonstration Report
C. Fault Areas Compliance Demonstration Report
D. Seismic Impact Zones Compliance Demonstration Report
E. Unstable Areas Compliance Demonstration Report

ATTACHMENT A
PLACEMENT ABOVE THE UPPERMOST AQUIFER COMPLIANCE DEMONSTRATION REPORT

Placement Above the Uppermost Aquifer Demonstration

Landfill Runoff Collection Pond
Clifty Creek Station
Madison, Indiana

Prepared for:
Indiana-Kentucky Electric Corporation
Piketon, Ohio

Prepared by:
Stantec Consulting Services Inc.
Cincinnati, Ohio

October 11, 2018

Table of Contents

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

On April 17, 2015, the "Disposal of Coal Combustion Residuals (CCR) from Electric Utilities" (EPA Final CCR Rule) was published in the Federal Register. Stantec Consulting Services Inc. (Stantec) was contracted by the Indiana-Kentucky Electric Corporation (IKEC) to provide a compliance demonstration report and certification of the Placement Above the Uppermost Aquifer (UMA) Location Restriction for the Landfill Runoff Collection Pond (LRCP) CCR unit at the Clifty Creek Station as required by the EPA Final CCR Rule § 257.60.

1.1 OBJECTIVE

As required by §257.60 of the EPA Final CCR Rule, an owner or operator of new CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units is required by October 17, 2018 to demonstrate whether the unit is located no less than five feet above the upper limit of the UMA. The objective of this report is to demonstrate compliance with the location restriction for placement above the uppermost aquifer. Relevant sections of the EPA Final CCR Rule are cited below to provide context and additional detail regarding the objective (EPA, 2016).

The EPA Final CCR Rule § 257.53 provides definitions of CCR and CCR surface impoundments.

> *"Coal combustion residuals (CCR) means fly ash, bottom ash, boiler slag, and flue gas desulfurization materials generated from burning coal for the purpose of generating electricity by electric utilities and independent power producers." (257.53)*

> *"CCR surface impoundment means a natural topographic depression, manmade excavation, or diked area, which is designed to hold an accumulation of CCR and liquids, and the unit treats, stores, or disposes of CCR." (257.53)*

The EPA Final CCR Rule § 257.60 (a) requires that the CCR unit is 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). "(257.60 (a))*

IKEC must demonstrate that that the requirements of paragraph (a) of section 257.60 are met, and the demonstration must be certified to meet the requirements by a qualified professional engineer (P.E.) (§ 257.60 (b)). If the demonstration cannot be met, IKEC will be required to cease placing CCR and non-CCR waste streams into the LRCP and close the unit within the time specified in § 257.101(b)(1). The demonstration and certification must be completed no later than October 17, 2018 (§ 257.60 (c)(1)).

1.2 UNIT DESCRIPTION

The Clifty Creek Station is a coal-fired, electric-generating plant. The plant is located in Jefferson County, near the town of Madison, Indiana. The Ohio River is located directly southeast of the plant, and Clifty Creek is located to the east of the LRCP.

The LRCP is located within the southwest area of the Clifty Creek Station and is approximately 91 acres in size (Figure 1). To allow for additional disposal capacity, an on-site fly ash pond was developed into a landfill in 1988. The LRCP is located within an eroded bedrock channel. A limestone ridge known as Devil's Backbone is oriented northeast to southwest, and borders the eastern side of the LRCP (AGES, 2007).

The LRCP at the Clifty Creek Station meets the EPA definition of a CCR surface impoundment because it is a manmade area designed to hold CCR and liquids and is used to treat, store or dispose of CCR.

1.3 APPROACH AND METHODS

The following methods were used to determine whether the LRCP meets the requirements for placement above the UMA:

- Desktop review of historical documents; and
- Assessment of compliance with the EPA Final CCR Rule.

2.0 AFFECTED BOUNDARY (BASE OF CCR UNIT)

To determine if the CCR unit meets the requirement for placement above the UMA, the affected boundary (base elevation of the CCR material) must be identified.

The LRCP is located within an eroded bedrock channel (AGES, 2016). The LRCP dam was constructed on natural soils, and the abutments consists of the hillslopes of the Devil's Backbone and natural ground (AEP, 2016).

Stantec estimated the elevation of the affected boundary at monitoring well and piezometer location (Figure 2). Data used to complete the estimation of the affected boundary was interpreted using a preconstruction topographic map (USGS, 1938). Based on the abrupt topography in the area of the LFCP, the interpolated preconstruction elevation at one soil boring location (CF-9405) was inconsistent with surveyed ground surface elevations. For this demonstration, the surveyed ground surface elevation was used to represent the base of the CCR unit at boring location CF-9405. Table 1 presents a summary of the estimated elevation of the affected boundary at each soil boring location.

3.0 UPPERMOST AQUIFER (UMA)

3.1 CERTIFIED GROUNDWATER MONITORING WELL NETWORK

Stantec prepared a letter dated October 16, 2017 (Stantec, 2017) including a qualified professional engineer certification which stated that:

> *"…the groundwater monitoring system for the IKEC Clifty Creek Station's CCR Landfill, West Boiler Slag Pond, and Landfill Runoff Collection Pond have been designed and constructed to meet the requirements specified in 40 CFR 257.9(a), (b), (c), and (e)." (Stantec, 2017).*

A copy of this certification is available on the IKEC CCR Rule Compliance Data and Information website (IKEC, 2018).

3.2 DEFINITION

The EPA Final CCR Rule § 257.53 provides the following definitions of aquifer and uppermost aquifer (UMA):

> *"Aquifer means a geologic formation, group of formations, or portion of a formation capable of yielding usable quantities of groundwater to wells or springs."*

> *"Uppermost aquifer means the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers that are hydraulically interconnected with this aquifer within the facility's property boundary. Upper limit is measured at a point nearest to the natural ground surface to which the aquifer rises during the wet season."*

3.3 IDENTIFICATION

The stratigraphic sequence in the regional area of Clifty Creek Station consists of widespread discontinuous layers of Quaternary deposits of alluvial and glacial origin overlying sedimentary rocks. The exposed sedimentary rocks range in age from Mississippian to Ordovician. The Quaternary deposits are largely of glacial origin and consist of loess, till and outwash. Glacial outwash is present in nearly all of the stream valleys north of and including the Ohio River valley. The outwash is covered, in some cases, by a veneer of recent alluvial deposits from active streams (AGES, 2007).

Unconsolidated alluvial deposits are the major source of groundwater in the Ohio River basin. Overbank from the Ohio River, the alluvial deposits usually form a discontinuous blanket twenty (20) to thirty (30) feet thick within the river valley and some of its tributaries. These deposits range from an upper silty clay to a lower silty sand and gravel. Groundwater yield from these deposits varies greatly depending on their nature and occurrence. The upper silty clay deposits are a poor source of groundwater and do not yield adequate quantities of water to wells. However, in some areas, yields of five to 25 gallons per minute (gpm) can be developed from the lower silty sand and gravel deposits (AGES, 2007).

The Monitoring Well Installation Report (AGES, 2016) indicated that, based on a Hydrogeologic Study Report (AGES, 2007), an aquifer doesn't exist directly beneath the LRCP. These reports indicated that the silty sand and gravel alluvial aquifer material was only present northwest of the landfill and southwest of the LRCP. The report also indicated that the upper fine-grained alluvial deposits are relatively impermeable, and are considered to be an aquiclude (AGES, 2016). Alluvial deposits that consist of silty sand and gravel, overlain by approximately 15 feet of impermeable clay are present in locations southwest of the LRCP, but are not present beneath the LRCP. These alluvial deposits are designated as the uppermost aquifer for the LRCP (AGES, 2016).

Based on the absence of an aquifer directly beneath the LRCP, and for the purpose of this demonstration, separation was evaluated using data associated with certified monitoring wells CF-15-07, CF-15-08 and CF-15-09, and other available borings located adjacent to the LRCP. In borings and wells completed within the extent of the alluvial silty sand and gravel aquifer, the elevation of the aquifer was compared to the original ground surface elevation and the estimated bottom of the Unit. Borings and wells completed beyond the extent of the alluvial silty sand and gravel aquifer were reviewed for the presence of potential aquifer material within five feet of the original ground surface and the estimated bottom of the Unit.

Based on information from historical soil boring data, bedrock beneath the LRCP consists of impermeable limestone and shale overlain by 20 to 35 feet of clay.

3.4 UPPER LIMIT

According to the EPA Final CCR Rule, the upper limit of the UMA is measured at a point nearest to the natural ground surface to which the aquifer rises during the wet season. For a confined aquifer the top of the UMA is defined based on the structure of the top of the aquifer.

Recent groundwater elevation data collected from monitoring wells completed in the UMA was reviewed to evaluate if groundwater within the UMA is generally present under confined or unconfined conditions. Water levels were measured at nine monitoring wells completed in the UMA at Clifty Creek Station during three groundwater monitoring events between January 2016 and May 2016. Based on an August 2016 Monitoring Well Installation Report, groundwater elevations measured during these gauging events ranged from approximately 429 to 497 feet above mean sea level (ft amsl) and ranged from approximately 437 to 452 ft amsl at three monitoring wells located southwest of the LFCP (AGES, 2016). The measured groundwater elevations were above the elevation of the top of the UMA at the gauging locations, indicating confined conditions.

The review of groundwater elevation data indicates that groundwater within the UMA is generally present under confined conditions; therefore, the top of the UMA beneath the LRCP is defined based on the structure of the top of the UMA, when present. For this demonstration, the top of the UMA was identified as the transition from finer grained material consistent with the alluvium that is present above the UMA to coarse grained material consistent with the UMA. In areas where coarse grained alluvium was not present beneath the Unit, alluvial material within five feet of the original ground surface and estimated bottom of the Unit was evaluated (as discussed in Section 2.2).

3.5 DESKTOP REVIEW OF UMA ELEVATIONS

Stantec reviewed the boring logs of three, certified groundwater monitoring well network locations, and three piezometer locations that were completed adjacent to the LRCP at Clifty Creek Station. These borings and associated monitoring well locations are presented on Figure 2.

The following generalized sequences were identified based on the review of available boring logs:

- Fine-grained alluvium overlying course-grained alluvium (CF-15-08, CF-9405 and CF-9406);
- Fine-grained alluvium overlying bedrock (CF-9407); and,
- Fine-grained alluvium (CF-15-07).

The boring log associated with monitoring well CF-15-09 indicated that subsurface material was not characterized within the first 10 feet below ground surface (ft bgs), and that bedrock material was encountered at 10 ft bgs. For the purpose of this demonstration, the estimated top of the UMA at CF-15-09 was conservatively estimated to be the maximum historic groundwater elevation of 451.6 ft amsl.

For this demonstration, in areas where coarse grained alluvium was not present beneath the Unit, alluvial material within five feet of the original ground surface and estimated bottom of the Unit was evaluated. Within the borings where no course-grained alluvium was identified, available boring logs indicated that surficial fine-grained alluvium was present at a thickness greater than five feet.

Based on boring logs associated with soil borings with course-grained alluvium present, the estimated elevation of the top of the regional aquifer at LRCP ranged from 429.6 to 440.9 ft amsl. The estimated elevations of the top of the regional aquifer at each location where course-grained alluvium is present are presented as Table 1.

Stantec also reviewed historic documents that referenced soil borings and well logs in the vicinity of the LRCP; however, supporting documentation for the documents included well construction logs, with limited information associated with the boring soil stratigraphy. A Report of CCR Rule Stability Analyses included boring logs associated with five soil borings advanced to depths ranging from 18 to 31 ft bgs in the crest and toe of the LRCP dam. Based on information associated with the five borings, silty sand overlain by clay material was present at two locations at depths ranging from of approximately 13 to 58 ft bgs. The report also included cross-sections based on the soil borings that indicated the presence of silty sand overlain by clay and silty clay material in the area southwest of the LRCP (Stantec, 2016).

4.0 AQUIFER SEPARATION

4.1 COMPARISON OF ELEVATIONS

At locations where course-grained alluvial material was present, the estimated elevations representing the top of the UMA (Section 2.6) were subtracted from the estimated base of the CCR unit (Section 3.0 and Figure 3) at monitoring well and piezometer locations adjacent to the LRCP to represent the separation of the base of the CCR unit from the top of the UMA. Within the extent of the LRCP, the estimated separation between the base of the CCR unit and the UMA was greater than five feet. Estimated elevations representing the top of the UMA and base of the CCR unit are presented in Table 1.

4.2 EVALUATION OF ALLUVIUM BENEATH AFFECTED BOUNDARY

At locations where course-grained alluvial material was not present, alluvial material within five feet of the original ground surface and estimated bottom of the Unit was evaluated. At the boring locations where no course-grained alluvium was identified, available boring logs indicated that fine-grained alluvium was present at a thickness greater than five feet beneath the preconstruction surface elevation. Estimated elevations representing the base of the CCR unit and the description of alluvial material within five feet of the unit are presented in Table 1.

4.3 DISCUSSION

The following factors were considered to determine whether the LRCP located at the Clifty Creek Station meets the requirements for placement above the UMA:

- Identification of the UMA at the LRCP.
    - An aquifer is not present beneath the LRCP (AGES, 2016).
    - A regional aquifer (alluvial silty sand and gravel) is present in area southwest of the LRCP (AGES, 2016).
- Identification of the upper limit of the UMA at the LRCP.
    - Gauging data indicates that groundwater within the regional aquifer is confined.

- The top of the UMA was identified as the transition from finer grained material consistent with the alluvium that is present above the UMA to coarse-grained material consistent with the UMA, when present.
- In areas where coarse grained alluvium was not present, alluvial material within five feet of the original ground surface and estimated bottom of the Unit was evaluated.

- Estimated the elevation of the top of the UMA in borings with identified course-grained alluvium at the LRCP.
  - Based on data from available boring logs, the estimated elevation of the top of the UMA ranged from approximately 429.6 to 440.9 ft amsl within the area adjacent to the LRCP (Sections 2.3 through 2.6).
- Estimated elevation of the base of the CCR unit at the LRCP.
  - Within the extent of the LRCP, elevations representing the base of the CCR were estimated based on comparison to a historic topographic map.
  - Based on information presented in historic documents, the surveyed ground surface elevation was used to estimate the base of the CCR Unit at soil boring location CF-9405.
- Comparison of the elevations of the base of the CCR unit and the top of the UMA, when present, at the LRCP.
  - The thickness of the deposits separating the CCR material from the top of the UMA indicates that the separation distance between the base of the CCR unit and the UMA is greater than five feet (Section 4.1).
- Evaluation of fine-grained alluvium thickness at locations where course-grained alluvium was not present.
  - Available boring logs indicated that fine-grained alluvium was present at a thickness greater than five feet beneath preconstruction surface elevations.

5.0 CONCLUSIONS

Based on this assessment of the UMA and the CCR unit, the requirements of §257.60 of the EPA Final CCR Rule for placement above the UMA at the LRCP at KCGP have been met.

6.0 LIMITATIONS

Boring logs, and reports completed by others have been furnished to Stantec by IKEC which Stantec has used, as furnished, in preparing this demonstration report. For identification of the UMA at Clifty Creek Station, Stantec relied on the certification of the monitoring well network by a professional engineer which was included in the Stantec letter as discussed above (Stantec, 2017). Identification of separation distance relies of interpolation and estimation of data between data points.

7.0 REFERENCES

American Electric Power (AEP) (2016). History of Construction, Landfill Runoff Collection Pond, Clifty Creek Plant, Madison, Indiana.

Applied Geology and Environmental Science, Inc. (AGES) (2016). Coal Combustion Residuals Regulation (CCR) Monitoring Well Installation Report, Indiana-Kentucky Electric Corporation, Clifty Creek Station, Madison, Indiana.

Applied Geology and Environmental Science, Inc. (AGES) (2007). Hydrogeologic Study Report, Clifty Creek Coal Ash Landfill, Clifty Creek Station, Madison, Indiana, (Revision No. 1).

Environmental Protection Agency (EPA) (2016). Federal Register, Vol. 80, No. 74, Part II. 40 CFR Parts 257 and 261, Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities, Final Rule.

Ohio Valley Electric Corporation CCR Rule Compliance Data and Information, Clifty Creek Station (https://www.IKEC.com/CCRClifty.php)

Stantec Consulting Services Inc. (2017). Groundwater Monitoring System, CCR Landfill, West Boiler Slag Pond, and Landfill Runoff Collection Pond, EPA Final Coal Combustion Residuals (CCR) Rule, Clifty Creek Station, Madison, Jefferson County, Ohio.

United States Geological Survey (USGS) (1939). Madison West Quadrangle, IND-KY. Scale 1:24000

TABLES

Table 1
Placement Above Uppermost Aquifer Demonstration
Landfill Runoff Collection Pond
Clifty Creek Station
Madison, Indiana

Boring ID	Estimated Pre-Construction Ground Surface Elevation (ft amsl)	Soil Stratigraphy Within Five Feet of Pre-Construction Ground Surface Elevation	Estimated Top of UMA Elevation (ft amsl)	Conclusion
CF-15-07	434.07	Fine-grained alluvium	NA	Greater than five feet of fine-grained alluvium is present over the preconstruction ground surface elevation.
CF-15-08	471.90	Fine-grained alluvium	440.9	Greater than five feet of separation is present between the base of the CCR and UMA.
CF-15-09	467.62	Incomplete boring log	451.6[(2)]	Greater than five feet of separation is present between the base of the CCR and UMA.
CF-9405	455.80[(1)]	Fine-grained alluvium	440.8	Greater than five feet of separation is present between the base of the CCR and UMA.
CF-9406	459.37	Fine-grained alluvium	429.6	Greater than five feet of separation is present between the base of the CCR and UMA.
CF-9407	470.52	Fine-grained alluvium	NA	Greater than five feet of fine-grained alluvium is present over the preconstruction ground surface elevation.

Notes:
NA - not applicable; course-grained alluvium was not present at boring location.
UMA - uppermost aquifer
ft amsl - feet above mean sea level
(1) - elevation was determined from boring log
(2) - elevation conservatively estimated as highest historic groundwater elevation

FIGURES

0 2,000 4,000
Feet

1:48,000 (At original document size of 8.5x11)

Notes

1. Coordinate System: NAD 1983 2011 StatePlane Indiana East FIPS 1301 Ft US
2. Basemap Data Source: Copyright:© 2013 National Geographic Society, i-cubed

Stantec

Prepared by CNK on 2018-07-18
Technical Review by JSH on 2018-10-16

Client/Project

Ohio Valley Electric Corporation
Clifty Creek Generationg Station

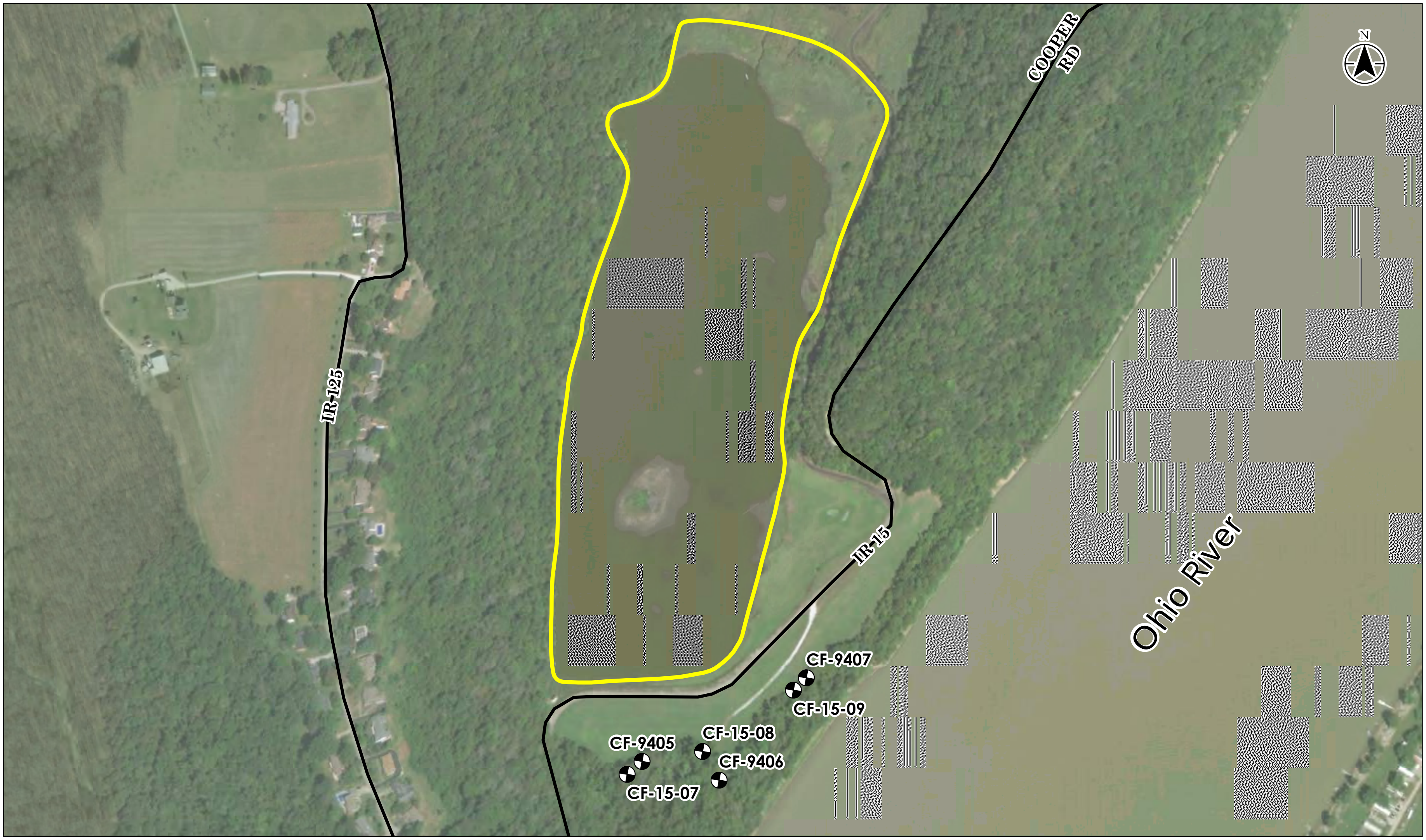
Figure No.
1

DRAFT

Title

SITE LOCATION MAP
CLIFTY CREEK

V:\1755\active\175534018\geotechnical\analysis\Uppermost Aquifer\St Paul folder - writable\03_data\gis_cad\2018_08\fig1_Site_Location_Map_Clifty_Creek_20180720_Clifty_Creek.mxd Revised: 2018-10-16 By: dhayson



Legend

- Monitoring Well
- Road
- Site Boundary

Notes
1. Coordinate System: NAD 1983 2011 StatePlane Indiana East FIPS 1301 Ft US
2. Basemap Data Source: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

0 290 580 Feet

1:6,600 (At original document size of 8.5x11)

Stantec

Prepared by CNK on 2018-08-28
Technical Review by ABC on 2014-01-21
Independent Review by ABC on 2014-01-21

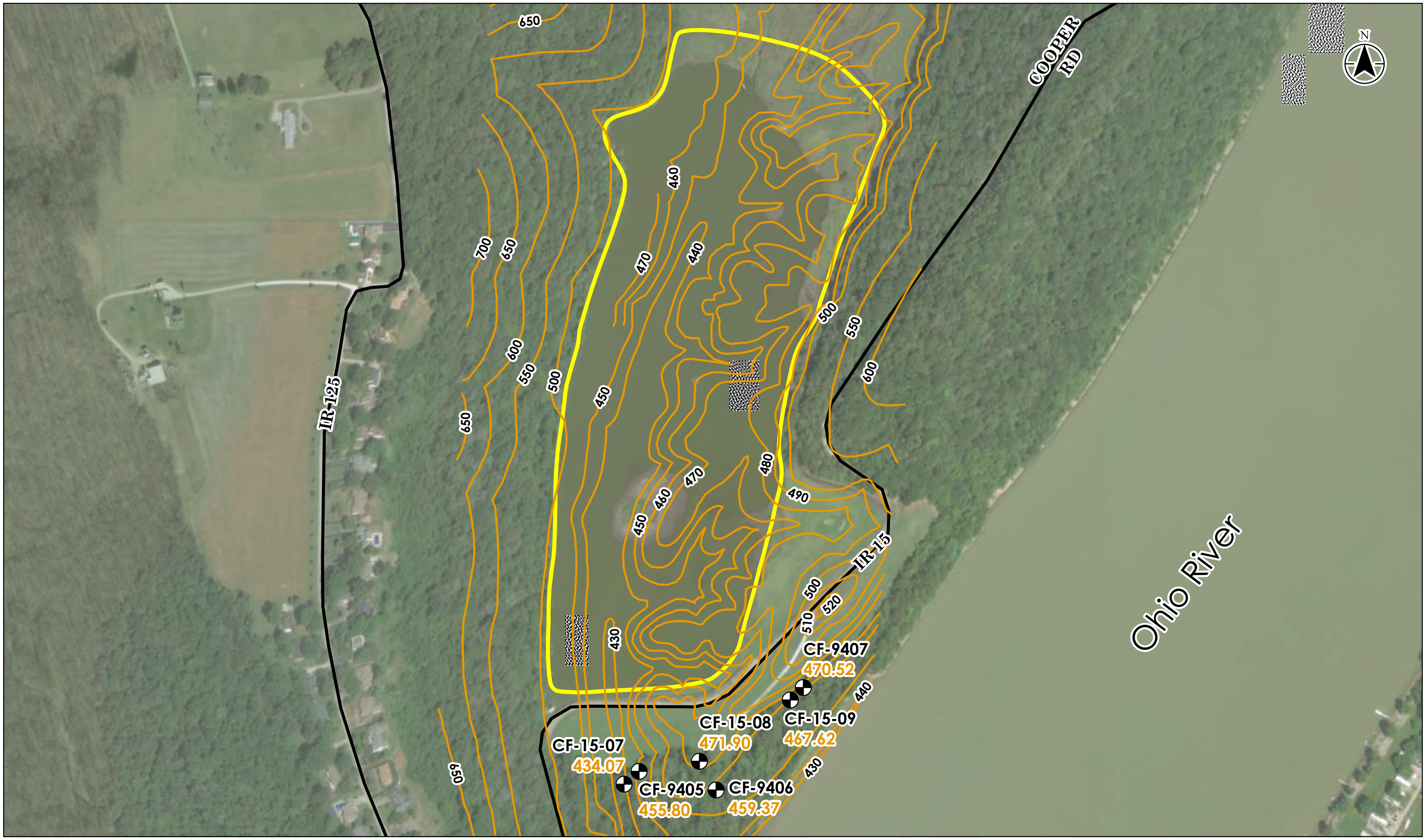
Client/Project
Ohio Valley Electric Corporation
Clifty Creek Generationg Station

Figure No.
2

DRAFT

Title
SITE MAP
LANDFILL RUNOFF
COLLECTION POND

Q:\active\175534018\03_data\gis_cad\2018_08\Landfill Runoff Pond\fig2_Site_Map_Landfill_Runoff_Pond_20180828_Clifty_Creek.mxd Revised: 2018-10-10 By: ckwiatkowski



Legend

- Monitoring Well
- Road
- Site Boundary
- Pre-Construction Ground Surface (USGS, 1948)

Notes

1. Coordinate System: NAD 1983 2011 StatePlane Indiana East FIPS 1301 Ft US
2. Basemap Data Source: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
3. Pre-Construction Ground Surface Contours from: United States Geological Survey (USGS) (1938). Madison Quadrangle for Madison West, IN. - KY. Scale 1:24000
4. 440.855 Base of the CCR Unit Elevation (FT AMSL)

0 290 580 Feet

1:6,600 (At original document size of 8.5x11)

Stantec

Prepared by CNK on 2018-08-28
Technical Review by ABC on 2014-01-21
Independent Review by ABC on 2014-01-21

Client/Project

Ohio Valley Electric Corporation
Clifty Creek Generationg Station

Figure No.
3

DRAFT

Title

ESTIMATED AFFECTED BOUNDARY (BASE OF CCR UNIT) LANDFILL RUNOFF COLLECTION POND

Q:\active\175534018\03_data\gis_cad\2018_08\Landfill Runoff Pond\fig3_Base_CCR_Landfill_Runoff_Pond_20180828_Clifty_Creek.mxd Revised: 2018-10-11 By: ckwiatkowski

ATTACHMENT B
WETLANDS COMPLIANCE DEMONSTRATION REPORT

Compliance Demonstration Report – Wetlands
Landfill Runoff Collection Pond
Clifty Creek Station

Indiana-Kentucky Electric Corporation
Madison, Jefferson County, Indiana

Prepared for:
Indiana-Kentucky Electric Corporation
Piketon, Ohio

Prepared by:
Stantec Consulting Services Inc.
10509 Timberwood Circle
Louisville, Kentucky 40223

October 16, 2018

Table of Contents

October 16, 2018

1.0 PROJECT BACKGROUND

On April 17, 2015, the "Disposal of Coal Combustion Residuals (CCR) from Electric Utilities" (EPA Final CCR Rule) was published in the Federal Register. Stantec Consulting Services Inc. (Stantec) was contracted by the Indiana-Kentucky Electric Corporation to demonstrate proficiency regarding wetlands at the applicable CCR units of the Clifty Creek Station and evaluate compliance with §257.61 of the CCR Rule.

As required by §257.61 of the EPA Final CCR Rule, an owner or operator of a new CCR landfill, existing or new CCR surface impoundment, or any lateral expansion of a CCR unit is required by October 17, 2018 to demonstrate that the unit is not located in a wetland, 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.

Wetlands are defined under Section 404 of the Clean Water Act (CWA) as:

> "Areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas."

Wetlands are further defined under §232.2 as a water having a "significant nexus" when any single function or combination of functions performed by the water, alone or together with similarly situated waters in the region, contributes significantly to the chemical, physical, or biological integrity of the nearest water of the U.S.

The U.S. Army Corps of Engineers, as described in the Corps of Engineers Wetland Delineation Manual (1987), provides further guidance in the identification of jurisdictional wetlands as:

> "Explicit in the definition is the consideration of three environmental parameters: hydrology, soil, and vegetation. Positive wetland indicators of all three parameters are normally present in wetlands. Although vegetation is often the most readily observed parameter, sole reliance on vegetation or either of the other parameters as the determinant of wetlands can sometimes be misleading. Many plant species can grow successfully in both wetlands and non-wetlands, and hydrophytic vegetation and hydric soils may persist for decades following alteration of hydrology that will render an area a non-wetland. The presence of hydric soils and

> wetland hydrology indicators in addition to vegetation indicators will provide a logical, easily defensible, and technical basis for the presence of wetlands. The combined use of indicators for all three parameters will enhance the technical accuracy, consistency, and credibility of wetland determinations."

Per §257.61(a), this provision prohibits the location of new CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units in wetlands unless the requirements of Sections 257.61(a)(1) through (5) are demonstrated to be met. If the unit is not in a wetland, no further analysis needs to be performed. The demonstration can be written based on evidence used to conclude that the unit is not in a wetland.

The following factors have been considered to determine whether the Landfill Runoff Collection Pond located at the Clifty Creek Station is in a wetland:

- Desktop review of available data,
- Field reconnaissance, and
- Experience in similar industrial settings.

2.0 UNIT DESCRIPTION

The Clifty Creek Station is located on the north shore of the Ohio River downstream of Madison, Indiana. The station consists of six coal-fired electric generating units, each nominally rated at 217 megawatts. The Clifty Creek Station is directly accessible from State Route 56. A plan view of the station is included in Attachment A.

The Landfill Runoff Collection Pond is located at the southern edge of the station. It is bordered by the station's coal combustion residuals (CCR) landfill to the north, natural grade to the east and west, and by a dam to the south that runs along the bank of the Ohio River. Approximately 508 acres of both landfill contact water and stormwater runoff drain to the Landfill Runoff Collection Pond. Upon the completion of the CCR landfill, the area draining to the Landfill Runoff Collection Pond will be reduced to approximately 443 acres (Stantec, 2016). The topography within the area varies from rolling hills to relatively flat, low-lying areas adjacent to major drainage features. Attachment A presents an overview of the Landfill Runoff Collection Pond study area boundary.

3.0 DESKTOP REVIEW

A desktop review of available data was performed to determine the likelihood of the unit being sited in a wetland by evaluating the potential for wetlands within the CCR unit boundary, as defined by the outside toe of slope of the exterior dike. The desktop review of publicly available data for the facility, included:

- U.S. Fish and Wildlife Service's National Wetlands Inventory (NWI) Mapping,
- U.S Geologic Survey Topographic Mapping,
- Natural Resources Conservation Service's (NRCS) Web Soil Survey, and
- FEMA Flood Maps.

Stantec reviewed available data for the presence or absence of wetlands within the Landfill Runoff Collection Pond boundary. The NWI mapping identified one wetland within the unit boundary; however, the identified wetland is within the treatment pond and not considered a wetland for the purposes of this demonstration.

The USGS topographic mapping indicates that no tributaries to the Ohio River, a traditional navigable water, originate in or near the unit boundary.

The NRCS Soils Survey for Jefferson County, Indiana identifies three soil types within the study area. These include Dumps, Eden-Caneyville complex, and Huntington silt loam. The soil units are all listed as non-hydric; however, Huntington silt loam has a minor hydric component.

A review of the FEMA flood maps indicates that the Landfill Runoff Collection Pond is designated Zone X, within the area of minimal hazard.

4.0 FIELD RECONNAISSANCE

Following the desktop data review, Stantec qualified biologists performed a field reconnaissance to assess the potential for jurisdictional features.

The reconnaissance investigation was conducted on May 7, 2018. Stantec biologists conducted a pedestrian survey to ascertain whether any areas of potential wetlands were present within the Landfill Runoff Collection Pond CCR Unit boundary (as shown on Attachment A). Upland plant communities typical of the region were the main species observed. Vegetation within the immediate vicinity of the unit boundary was predominately maintained grass turf vegetation. One wetland area was identified within the study area boundary; however, it was determined to be within the treatment pond and not considered a wetland for the purposes of this demonstration. Three locations were examined for potential wetland presence (TP-03, TP-04, and TP-05), but were found to be uplands. No other wetland indicators were observed within the Landfill Runoff Collection Pond study area.

5.0 CONCLUSIONS

The desktop review provided no indication that the subject ash pond is located within wetlands.

It is Stantec's professional opinion that the current conditions of the subject ash pond meet the wetlands location requirements of the EPA Final CCR Rule §257.61.

6.0 REFERENCES

Flood Map Service Center, FEMA, https://msc.fema.gov/portal/home, September 28, 2018.

Soil Resource Report for Jefferson County, Indiana, Natural Resources Conservation Service, Web Soil Service, https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm, September 28, 2018.

Stantec Consulting Services Inc. (2016). *Reservoir Routing Analysis. Landfill Runoff Collection Pond*. Clifty Creek Power Station. City of Madison, Jefferson County, Indiana. February.

Wetlands Mapper, U.S. Fish and Wildlife Service's National Wetlands Inventory (NWI) Mapping, https://www.fws.gov/wetlands/, September 28, 2018.

U.S. Geologic Survey Topographic Mapping, U.S. Geological Survey, https://www.usgs.gov/products/maps/topo-maps, September 28, 2018.

Attachment A: Site Reconnaissance Study Area Map

Attachment A

Title **CCR Wetlands Analysis**
Site Reconnaissance Study Area Map
Landfill Runoff Collection Pond

Client/Project
Clifty Creek Station
IKEC
CCR Analysis

Project Location 175534018
Madison, Jefferson County, Indiana
Prepared by SPK on 2018-10-10
Technical Review by BW on 2018-10-10
Independent Review by RVD on 2018-10-10

0 500 1,000 Feet
1:6,000 (At original document size of 11x17)

Study Area
Test Pit

Notes

1. Coordinate System: NAD 1927 StatePlane Indiana East FIPS 1301
2. ImagerySource: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
3. No hydric soils are located within the project area

Stantec

\\us1268-f01\workgroup\1755\active\175534018\gis\mxd\CCR_Wetlands_Analysis_Landfill_Runoff_Collection_Pond.mxd Revised: 2018-10-10 By: skelley

ATTACHMENT C
FAULT AREAS COMPLIANCE DEMONSTRATION REPORT

Compliance Demonstration Report - Fault Areas
Landfill Runoff Collection Pond
Clifty Creek Station

Indiana-Kentucky Electric Corporation
Madison, Jefferson County, Indiana

Prepared for:
Indiana-Kentucky Electric Corporation
Piketon, Ohio

Prepared by:
Stantec Consulting Services Inc.
11687 Lebanon Road
Cincinnati, Ohio 45241

October 16, 2018

Table of Contents

October 16, 2018

1.0 INTRODUCTION AND RULE REQUIREMENTS

1.1 OBJECTIVE

The objective of this document is to present an assessment and engineering conclusions regarding the subject CCR unit's compliance with the Environmental Protection Agency (EPA) Final Coal Combustion Residual (CCR) Rule, 40 CFR 257.62(c) regarding fault areas.

1.2 RULE REQUIREMENTS

As required by §257.62 (a) of the EPA Final CCR Rule:

> *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.*

2.0 ASSESSMENT

The Fault Areas demonstration was comprised of two phases: a literature survey/review and a Neotectonic analysis. A literature survey/review using available published data was performed, and the results are reported in "Literature Survey and Discussion of the Geology and Seismicity near Clifty Creek Fossil Plant, Southeastern Indiana". The result of this survey is included in Appendix A.

The Neotectonic analysis, a compilation of a lineament analysis and drainage analysis, was performed in the vicinity of and including the Landfill Runoff Collection Pond. The results of the neotectonics analysis are reported in "Neotectonics Analysis, CCR Unit Location Restrictions Demonstrations – Clifty Creek Station, Madison, Indiana". This report is included in Appendix B.

3.0 CONCLUSIONS

Based on this assessment, the Landfill Runoff Collection Pond located at Clifty Creek Station meets the requirements of §257.62 of the EPA Final CCR Rule.

4.0 REFERENCES

Stantec Consulting Ltd. (2018). Neotectonic Analysis, CCR Unit Location Restrictions Demonstrations – Clifty Creek Plant, Madison, Indiana. April.

Dr. Robert D. Hatcher, Jr. (2018). Literature Survey and Discussion of the Geology and Seismicity near Clifty Creek Fossil Plant, Southeastern Indiana. April.

APPENDIX A
LITERATURE SURVEY

Literature Survey and Discussion of the Geology and Seismicity near Clifty Creek Fossil Plant, Southeastern Indiana

Robert D. Hatcher, Jr., Ph.D., P.G.
Department of Earth and Planetary Sciences
and Science Alliance Center of Excellence
University of Tennessee–Knoxville

Robert D. Hatcher, Jr.

April 19, 2018
Introduction

The purpose of this report is to provide a literature survey and discussion of known active or potentially active faults in the vicinity of the Ohio Valley–Indiana-Kentucky Electric Corporation Clifty Creek Fossil Plant on the Ohio River floodplain immediately west of Madison and northeast of Hanover in southeastern Indiana (38°44'16.8" N, 85°25'8.4" W) (Fig. 1). The site is located ~80 mi (~130 km) southeast of Bloomington, Indiana, some 65 mi (~100 km) northwest of Frankfort, Kentucky, and ~35 mi (57 km) northeast of New Albany, Indiana. The Clifty Creek Plant is capable of producing 1,300 MW of electric power (Wikipedia). Concern is for seismic or other geologic hazards related to the West Boiler Slag Pond, Landfill Runoff Collection Pond, and Coal Combustion Residuals Landfill sites.

The references cited in this report are those considered critical for understanding the geology, paleoseismology, and seismicity of the region and near the Clifty Creek Fossil Plant in southeastern Indiana. Many of the papers, maps, and reports cited here contain a wealth of additional citations in their own references that provide much greater detail about the surface and subsurface geology and seismicity in the region. Several of these reports and publications include Swadley (1978), McDowell et al. (1981), Gray et al. (1987), Obermeier et al. (1991), Wheeler (1996), Marshak et al., (2016), McBride et al. (2002), and Petersen et al. (2014).

A useful definition of an active fault could be:

An active fault (or earthquake fault) is one that has been demonstrated to have moved during the Holocene (last 11,000 years). This would include the zone of deformation (damage zone) on either side of the fault, which would include geologic structures (folds, subsidiary faults, joints and shear fractures, etc.) that would have been produced as coseismic features during movement on the fault that produced seismicity (California Geological Survey, 2007).

Regional Geology and Seismicity

The Clifty Creek site is located immediately west of Madison and east of along the Ohio River in southeastern Indiana (Fig. 1). Surface geology consists of Pleistocene to Recent glaciogenic and river sediments on the Ohio River floodplain that overlie Ordovician to Devonian sedimentary rocks west and east of the river (Gibbons, 1978; Swadley, 1978; McDowell et al., 1981; Gray, 1972; Gray et al., 1987; Reed et al., 2005; Marshak et al., 2016).

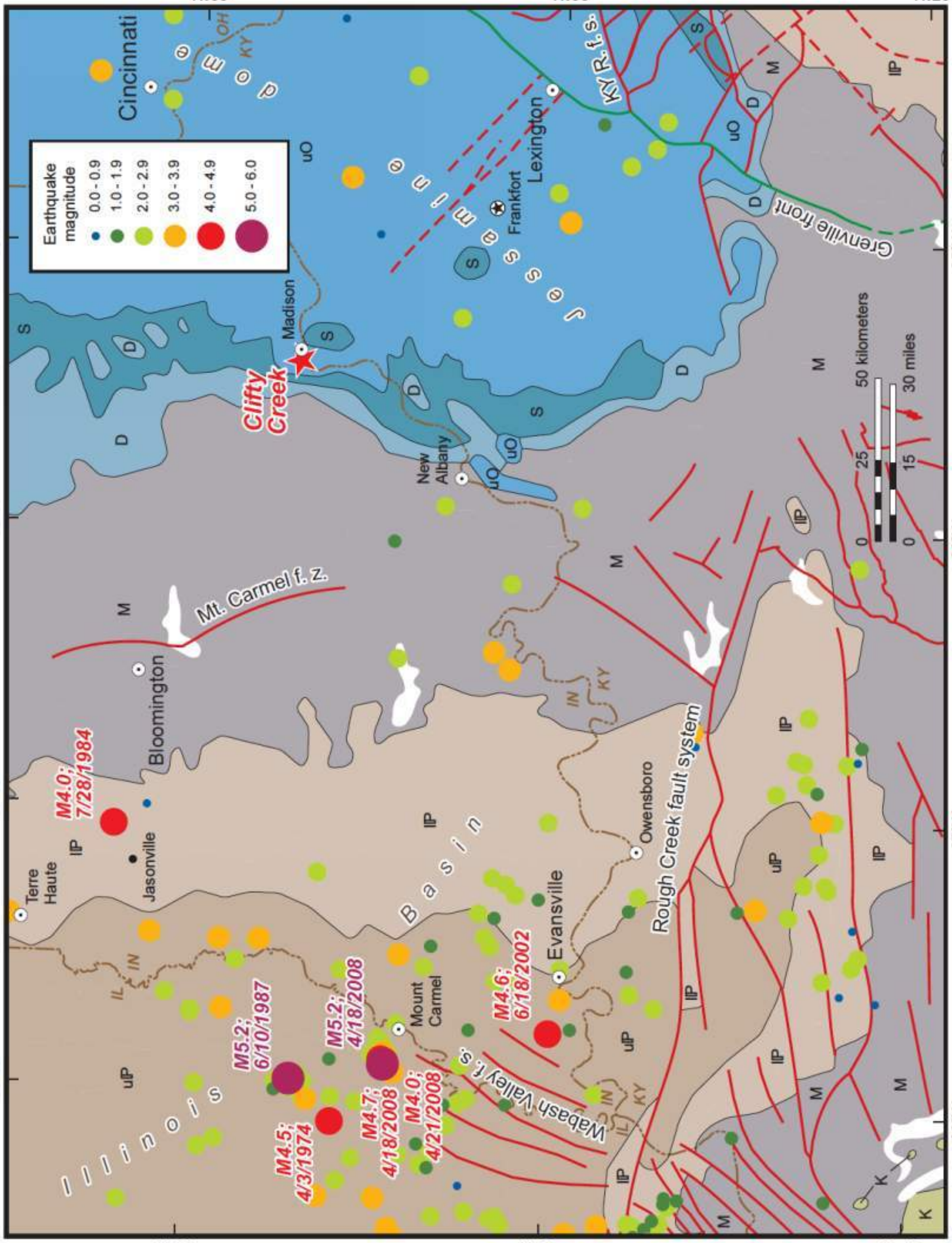


Figure 1. Simplified geologic map of region around the Clifty Creek Fossil Plant (red star) in southeastern Indiana. Locations of historic earthquakes are also shown, along with Paleozoic faults (red), and the Grenville front (green, not exposed). f.s.—fault system. uO—Upper Ordovician rocks. S—Silurian rocks. D—Devonian rocks. M—Mississippian rocks. lP—lower Pennsylvanian rocks. uP—upper Pennsylvanian rocks. Sources of data: Political boundaries - National Atlas Data; Geology - Garrity, C. P., and Soller, D. R., 2009, Database of the Geologic Map of North America; adapted from Reed et al. (2005), U.S. Geological Survey Data Series 424, 1:5,000,000 [https://pubs.usgs.gov/ds/424/]. Earthquakes - USGS Earthquake Hazards Program, NEIC. Northern California Earthquake Data Center (NCEDC), 2014, ANSS (Advanced National Seismic System) Dataset: UC Berkeley Seismological Laboratory. doi:10.7932/NCEDC. Catalog of Ohio Earthquakes of 2.0 or Greater Magnitude, 2017, Ohio DNR Division of Geologic Survey [http://geosurvey.ohiodnr.gov/earthquakes-ohioseis/quakes-felt-in-ohio/catalog-of-past-ohio-quakes/catalog-home].

Seismicity in this region is varied both geographically and temporally, with most seismic activity concentrated in both states along the Indiana-Illinois border. Obermeier et al. (1991) discussed the seismic hazard of the Wabash Valley fault zone along the Illinois-Indiana border, indicating that there have been significant earthquakes in this area in the prehistoric past, but with a recurrence interval of thousands of years. All of the largest earthquakes (>M 5.0) that have occurred in this region in the past several decades have occurred in the Wabash Valley seismic zone (Fig. 1). McBride and Nelson (2001) and McBride et al. (2002) recognized numerous faults in southwestern Illinois that cut young sediments there, and may pose a seismic hazard. There are, however, no known active faults within at least a hundred miles of the Clifty Creek Fossil Plant.

Clifty Creek Site Geology and Potentially Active Faults within Two Miles of the Site

The Clifty Creek site is located on the west flank of the Jessamine dome in the transition between Upper Ordovician and Silurian rocks of the dome and the younger Pennsylvanian rocks of the Illinois basin to the west (Fig. 1). Ordovician rocks consist mostly of limestone, with some shaly limestone and shale in the upper part of the section; Lower Silurian rocks consist of limestone, while Middle Silurian rocks consist of limestone and shale; and Lower and Middle Devonian rocks (all in Indiana) consist of limestone; and Upper Devonian rocks farther west are predominantly shale (New Albany black shale). Sediments on the Ohio River floodplain consist of Pleistocene glacial outwash (and reworked glacial sediments) and drift, while Quaternary alluvium consists of sands, clays, and gravels (Swadley, 1978).

Neither available detailed geologic maps of the Madison East or Madison West 7.5-minute quadrangles in Kentucky nor the exploratory studies of geology (Gibbons, 1978; Swadley, 1978) nor the geotechnical/hydrologic investigation in the area around the ash ponds by Miller and King (2016) identified any faults or active faults within 200 feet or several miles of the Clifty Creek site.

Conclusions

1. The Clifty Creek site is located east of the western flank of the Jessamine dome in northeastern Kentucky, resting on Pleistocene and Holocene Ohio River and tributary stream alluvium, and glacial outwash (and reworked sediments). The underlying bedrock consists of Upper Ordovician limestone and shale, with Silurian and Devonian rocks located a very short distance to the west in Indiana.

2. The Clifty Creek power plant is located in a region of low seismicity. The only significant historic seismic events in the region are several M 4.5 to 5.2 earthquakes that occurred from 1974 to 2008 in or near the Wabash Valley seismic zone along the border between Indiana and Illinois.

3. None of the literature reviewed, including published papers and reports from other organizations, have indicated the existence of any active faults within two miles of the Indiana-Kentucky Electric Corporation Clifty Creek Station and associated ash ponds.

REFERENCES CITED

California Geological Survey, 2007, Fault-rupture hazard zones in California: Special Publication 42, Interim Revision 2007.

Gibbons, A. B., 1978, Geologic map of part of the Madison East quadrangle, Trimble and Carroll Counties, Kentucky: U. S. Geological Survey and Kentucky Geological Survey GQ–1471, scale 1:24,000.

Gray, H. H., 1972, Geologic map of the 1° x 2° Louisville quadrangle, Indiana, showing bedrock and unconsolidated deposits: Indiana Geological Survey Regional Map 6, scale 1:100,000.

Gray H. H., Ault, C. H., and Keller, S. J., 1987, Bedrock geologic map of Indiana: Bloomington, Indiana Geological Survey, Miscellaneous Map 48, scale 1:500,000.

Marshak, S., Larson, T. H., and Abert, C. C., 2016. Geological and geophysical maps of the Illinois Basin-Ozark dome region: Illinois State Geological Survey, 13 p.

McBride, J. H., and Nelson, W. J., 2001, Seismic images of shallow faulting, northernmost Mississippi Embayment, north of the New Madrid seismic zone: Bulletin of the Seismological Society of America, v. 91, p. 1128–139.

McBride, J. H. Nelson, W. J., and Stephenson, W. J., 2002, Quaternary-age deformation in the northern Mississippi embayment: Seismological Research Letters, v. 73, no. 5, p. 597-627.

McDowell, R. C., Grabowski, G. J., and Moore, S. L., 1981, Geologic map of Kentucky: Kentucky Geological Survey, scale 1:250,000.

Miller, D. E., and King, R. W., 2916, Coal combustion residuals regulation monitoring well installation report Indiana-Kentucky Electric Corporation Clifty Creek Station, Madison, Indiana Draft Report: Applied Geology and Environmental Science, Inc., 24 p.

Obermeier, S. F., Bleuer, N. R., Munson, C. A., Munson, P. J., Martin, W. S., McWilliams, K. M., Tabaczynski, D. A., Odum, J. K., Rubin, M., and Eggert, D. L., 1991, Evidence of strong earthquake shaking in the lower Wabash Valley from prehistoric liquefaction features: Science, v. 251, p. 1061-1063.

Petersen, M. D., Moschetti, M. P., Powers, P. M., Mueller, C. S., Haller, K. M., Frankel, A. D., Zeng, Y., Rezaeian, S., Harmsen, S. C., Boyd, O. S., Field, E., Chen, R., Rukstales, K. S., Luco, N., Wheeler, R. L., Williams, R. A., and Olsen, A. H., 2014. Documentation for the 2014 update of the United States national seismic hazard maps: U.S. Geological Survey Open-File Report 2014–1091, 243 p. doi: https://dx.doi.org/10.3133/ofr20141091.

Reed, J. C., Wheeler, J. O., and Tucholke, B. E., 2005, Geologic map of North America: Boulder Colorado, Geological Society of America, Geology of North America, Continent-scale map 1, scale 1:5,000,000.

Swadley, W.C. 1978. Geologic map of part of the Madison West Quadrangle, Trimble County, Kentucky: Kentucky Geological Survey, Geological quadrangle map GQ-1469, scale 1:24,000.

Wheeler, Russell L., 1996, Earthquakes and the southeastern boundary of the intact Iapetan margin in eastern North America: Seismological Research Letters, v. 67, no. 5, p. 77-83.

APPENDIX B
NEOTECTONIC ANALYSIS

CCR Unit Location Restrictions Demonstrations – Clifty Creek Station, Madison, Indiana

Neotectonics Analysis

October 12, 2018

Prepared for:

Indiana-Kentucky Electric Corporation

Prepared by:

Stantec Consulting Ltd.
500 – 4730 Kingsway
Burnaby, British Columbia
V5H 0C6

Revision	Description	Author		Quality Check		Independent Review	
A	Draft	M. Verpaelst	2018-04-30	S. Tsang	2018-04-30	R. Guthrie	2018-04-30
0	Final	M. Verpaelst	2018-10-12	S. Tsang	2018-10-12	R. Guthrie	2018-10-12

Sign-off Sheet

This document entitled CCR Unit Location Restrictions Demonstrations – Clifty Creek Station, Madison, Indiana was prepared by Stantec Consulting Ltd. ("Stantec") for the account of Indiana-Kentucky Electric Corporation (the "Client"). Any reliance on this document by any third party is strictly prohibited. The material in it reflects Stantec's professional judgment in light of the scope, schedule and other limitations stated in the document and in the contract between Stantec and the Client. The opinions in the document are based on conditions and information existing at the time the document was published and do not take into account any subsequent changes. In preparing the document, Stantec did not verify information supplied to it by others. Any use which a third party makes of this document is the responsibility of such third party. Such third party agrees that Stantec shall not be responsible for costs or damages of any kind, if any, suffered by it or any other third party as a result of decisions made or actions taken based on this document.

Prepared by ____

(signature)

Manuel Verpaelst, M.Sc.

Reviewed by ____

(signature)

Sid Tsang, P.Geo. (AB, BC, MB)

Approved by ____

(signature)

Richard Guthrie, M.Sc., Ph.D., P.Geo. (AB, BC)

Table of Contents

LIST OF FIGURES

1.0 INTRODUCTION

Stantec Consulting Ltd. (Stantec) was retained by the Indiana-Kentucky Electric Corporation (IKEC) to conduct a Phase 1 Assessment for a fault area demonstration of the Clifty Creek Station in Madison, Indiana. The demonstration is required by the U.S. Environmental Protection Agency (EPA) Disposal of Coal Combustion Residuals (CCR) from Electric Utilities rule. In accordance with the Stantec proposal dated August 25, 2017, this investigation was to include:

- A literature review of publicly available data of known active or potentially active (last 11,000 years) faults in the vicinity of the CCR Landfill, West Boiler Slag Pond (WBSP) and Landfill Runoff Collection Pond (LRCP).
- A neotectonics analysis within a two-mile radius of the CCR Landfill, WSBP and LRCP sites, hereafter referred to as the study area (Figure 1-1).

The neotectonics analysis was conducted to support the fault area demonstration only and the conclusions are not valid for other applications. The neotectonics analysis is based on a literature review of cited references, desktop lineament and drainage mapping based on interpretation of LiDAR hillshade and aerial photographs, and no fieldwork was conducted to verify actual conditions within the study limits.

1.1 SCOPE OF WORK

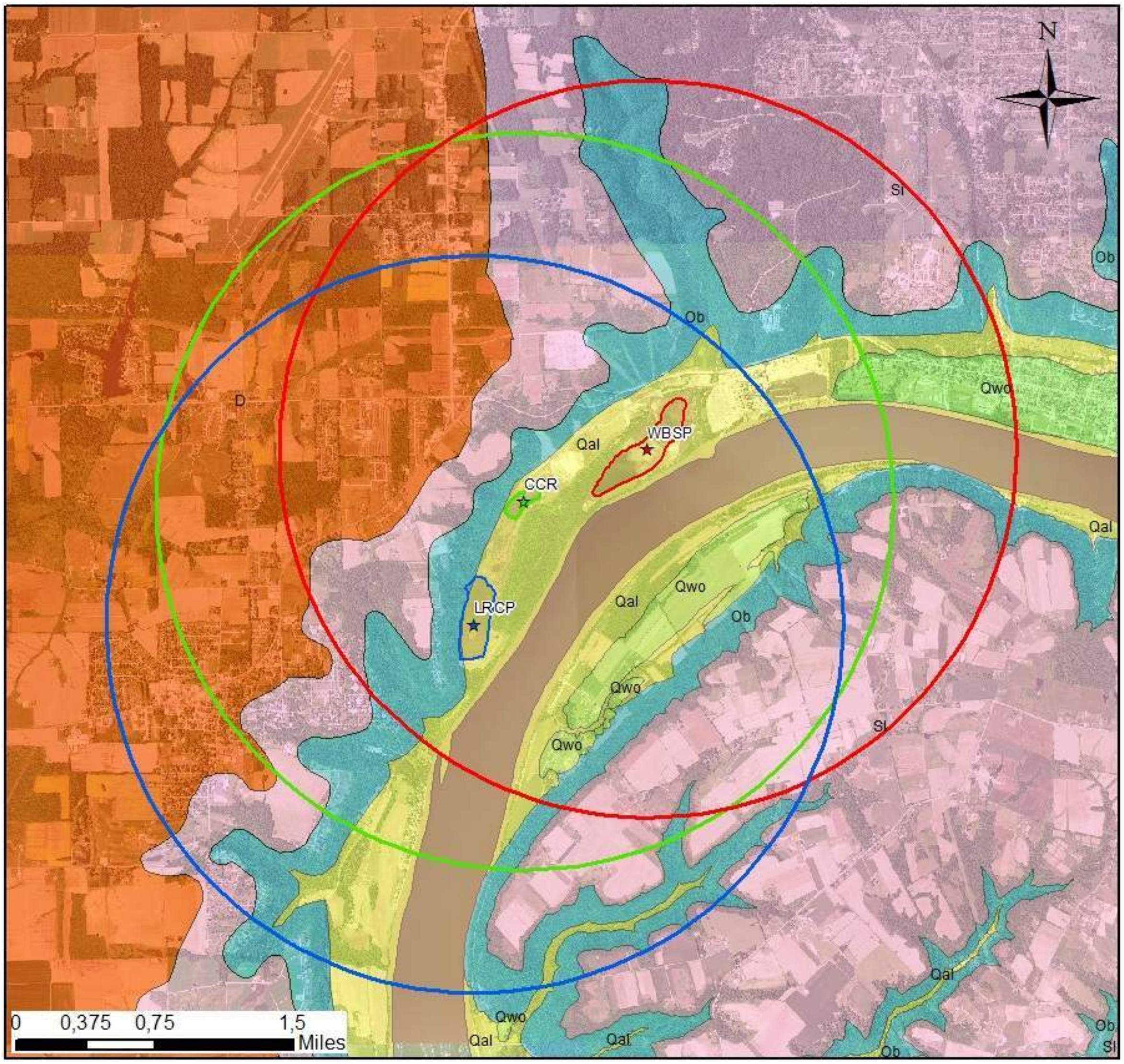
For this investigation, we define neotectonics as the study of geologically recent (last 11,000 years) movement and deformation of the earth's crust and measurement of its local effects on the creation of geomorphological features observed at the surface. The scope of work for this neotectonics analysis comprises three tasks:

Task 1 builds on the literature review findings by utilizing the online USGS seismic hazard map, the USGS online interactive faults map, the U.S. Department of Agriculture soil survey website, the Indiana Geological Survey map website, and the Kentucky Geological Survey geologic map information service website. Publicly available maps, reports, and scientific literature relevant to the terrain conditions in the vicinity of Clifty Creek Station were also reviewed.

Task 2 involves a lineament analysis where lineaments are mapped from air photographs and hillshade imagery built from Light Detection and Ranging (LiDAR) and Digital Elevation Model (DEM), within at least a two-mile radius of the CCR Landfill, WSBP and LRCP sites. The mapping was carried out in ESRI ArcGIS® software to facilitate plotting of maps and viewing spatial data.

Task 3 involves a drainage analysis of well-defined patterns (dendritic, parallel, trellis, rectangular, radial, annular, and contorted), which are not redirected by anthropogenic activity.

Figure 1-1 Geologic map of the study area[1]



CCR - Coal Combustion Residuals Landfill; LRCP - Landfill Runoff Collection Pond; WBSP - West Boiler Slag Pond

Map Symbol	Age	Description
Qal	Quaternary	Alluvial - Clay, silt, sand, and gravel
Qwo	Quaternary	Glacial outwash - Gravel, sand, silt, and clay
D	Devonian	Dolomite, limestone, sandstone, and gypsum
Si	Middle Silurian	Limestone, dolomite, and shale
Ob	Ordovician	Limestone, dolomite, shale, and sandstone

[1]Modified from Bedrock geology of Indiana (1:250,000) and Swadley (1978) (1:24,000 scale). Ordovician shales and limestones are inferred to be overlain by Quaternary alluvial and outwash deposits mapped along the Ohio River (Swadley 1978).

2.0 BACKGROUND INFORMATION

2.1 DATA SOURCES

Readily available background information relevant to the neotectonics analysis and geological conditions was gathered and reviewed. This information included (but was not limited to):

- The Physiographic Regions of Indiana (Gray and Sowder 2002)
- USGS National Seismic Map (Petersen et al. 2014)
- Kentucky Geological Survey (KGS) geologic map information service website
- Indiana Geological Survey (IGS) - map website
- United States Department of Agriculture - web soil survey
- U.S. Quaternary Faults and Folds Database (USQFFD)
- IGS - glacial information available on the Indiana University Bloomington website
- Geological and geophysical maps (Abert et al. 2016)
- Jefferson Country aeromagnetic survey (Henderson and Meuschke 1951)
- Hydrogeologic study report of the Clifty Creek Coal Ash Landfill (AGES 2006)
- 1: 24,000 scale Geologic map of Madison West Quadrangle, Kentucky (Swadley 1978)
- 1:500,000 scale geology map of Indiana (Gray et al. 1987)
- 2014 and 2016 aerial photographs from the USGS National Map office
- 2012 LiDAR[2] (5 foot-grid) from the USGS National Map office
- DEM[3] (30 foot-grid) from the USGS National Map office
- Publicly available literature relevant to the terrain conditions in the area (Homoya et al. 1985; Nickell 1985; Fullerton 1986; Parola et al. 2007)

2.2 PROJECT SETTING

Physiography

The study area is located within the Muscatatuck Plateau, Deadborn Upland, and Outer Bluegrass physiographic sub-regions of Indiana and Kentucky. The Muscatatuck Plateau (west of the study area) is a relatively flat plain with steep-walled canyons entrenched by major streams (Homoya et al. 1985). The Deadborn Upland (northeast of the study area) is characterized by deeply dissected rolling uplands, and, even though the region was glaciated, bedrock is near the surface and unconsolidated deposits are thin or absent (Homoya et al. 1985). The Outer Bluegrass region (southeast of the study area) is characterized by rolling to undulating hills with deep valleys and very little flat land (Parola et al. 2007).

The southerly flowing Ohio River dissected the study area. The range in relief in the study area is 465 feet from 425 feet (Ohio River) to 890 feet (southeast of WBSP) above sea level. The CCR, WBSP and LRCP sites are located at approximately 505 feet, 450 feet and 490 feet above sea level, respectively. The LRCP and CCR appear to be

---

[2] Covers the Indiana State section of the study area

[3] Covers the Kentucky State section of the study area

located on a dammed back-channel of the Ohio River and the WBSP is on a low terrace of the Ohio River (artificially dammed).

Bedrock Geology

Regional bedrock geologic mapping shows the study area lies east of the western flank of the Jessamine dome within the Cincinnati arch, and is underlain by Ordovician to Devonian Formations comprising carbonate and other horizontally-bedded sedimentary rocks that have been only slightly tilted by development of regional structures (Figure 1-1). With the presence of carbonate rocks in the study area the potential for karstification is high.

No recent or Quaternary faults and folds were recorded within the vicinity of the study area. The closest faults and folds were recorded 20 miles to the south and southeast, and about 40 miles to the west (KGS, IGS, and USQFFD online websites; Figure 2-1). Published geophysical data for the region show that the Clifty Creek site is in a magnetic low with small variations of amplitude (Henderson and Meuschke 1951; Abert 2016).

The Clifty Creek Station is located far from recorded earthquake epicenters (Figure 2-1). The 2014 USGS National Seismic Hazard Model contours probabilistic seismic hazard with a 2-percent probability of exceedance in 50 years (Figure 2-2). The map was derived from information on potential earthquake hazards based on probabilistic risk assessment, and incorporates new findings on earthquake ground shaking, faults, seismicity, and geodesy (Petersen et al. 2014). The seismic hazard map shows a low hazard for the Clifty Creek Station.

Figure 2-1 Fault and fold traces (left), and earthquakes epicenters (right) of the Illinois Basin-Ozark Dome region (Abert et al. 2016)

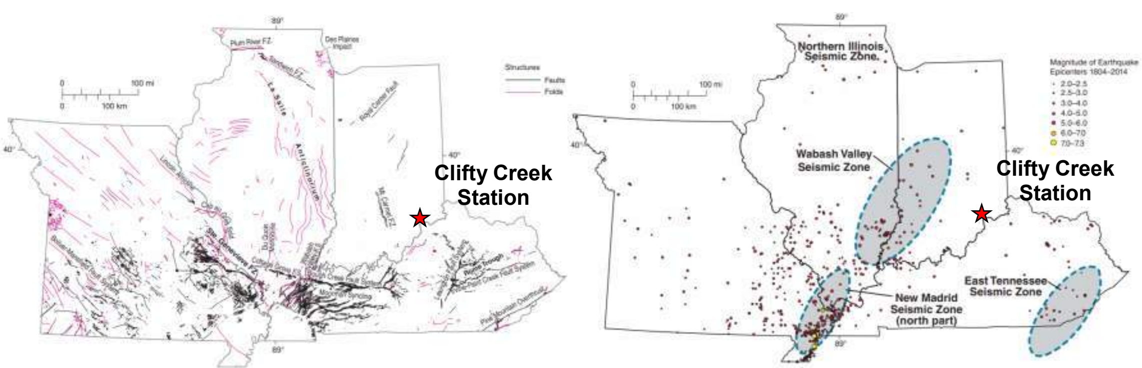
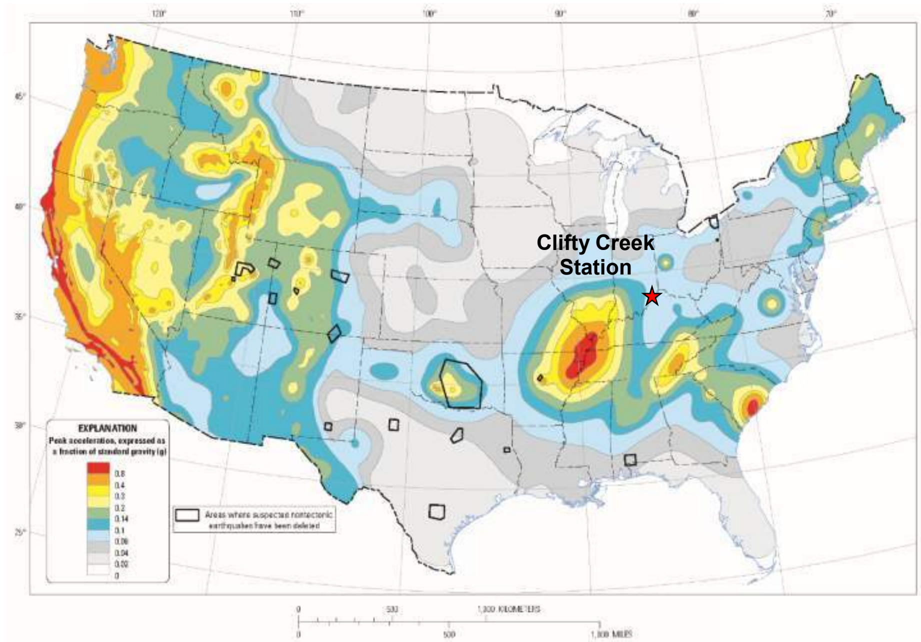


Figure 2-2 2014 USGS National Seismic Hazard Map, two-percent probability of exceedance in 50 years map of peak ground acceleration



Quaternary and Surficial Geology

During the Pleistocene (2.6 M to 12,000 years before present (ybp)), ice sheets coming from the north covered a large portion of Indiana. Two glacial boundaries of major significance mark the glacial history of the region. The outer boundary, results from the Illinoian (300,000 to 130,000 ybp) and pre-Illinoian glaciations and reaches the southernmost regions of Indiana and northern Kentucky, determining the course of the present-day Ohio River; the study area is found within this boundary. The inner boundary demarcates the late Wisconsinan glacial maximum (24,000 to 12,000 ybp) and reaches the middle of Indiana (Fullerton 1986; and online publications from Indiana University) but did not reach the study area.

These glacial advances carved the landscape and deposited till (morainal material) throughout the region. As the ice sheets stagnated and melted, large accumulations of meltwater eroded and sculpted channels across the landscape. Remnants of this epoch are still observed in the many incised canyons of the region.

Regional (1:500,000) scale Quaternary geology maps of Indiana (IGS map website), provide an overview of surficial geology within the study area. In the uplands, bedrock is unconformably overlain by silt to sandy silt till deposits dating from the pre-Wisconsinan epoch, and by a Wisconsinan loess complex. The loess complex (generally two to four feet-thick) mantles the till and was formed from windblown silt derived from the alluvial deposits along the Ohio River and other major rivers (Nickell 1985). Soils along the valley side-slopes mostly formed from the weathering of bedrock. Alluvial and glacial outwash deposits are mapped locally along the banks of the Ohio River.

Historical borehole drillings near the CCR Landfill and LRCP sites, indicate a depth to bedrock ranging from 9 to 91 feet below the surface (AGES 2006).

3.0 LINEAMENT ANALYSIS

The desktop lineament analysis utilizes 2014 and 2016 aerial photographs and hillshade imagery built from DEM and 2012 LiDAR. The aerial photographs and hillshade imagery, along with readily available GIS layers (faults and earthquakes epicenter inventory, geology, surficial material, drainage flowlines), were viewed and interpreted in ESRI ArcGIS® software.

The lineament analysis is based on visible interpretation of mappable linear, rectilinear, or curvilinear surface features that are suspected to reflect subsurface phenomena. Changes in elevation, slope gradients and surface patterns are also used to identify lineaments. Without local geophysical data the mapping of these surface features is subjective at best[4].

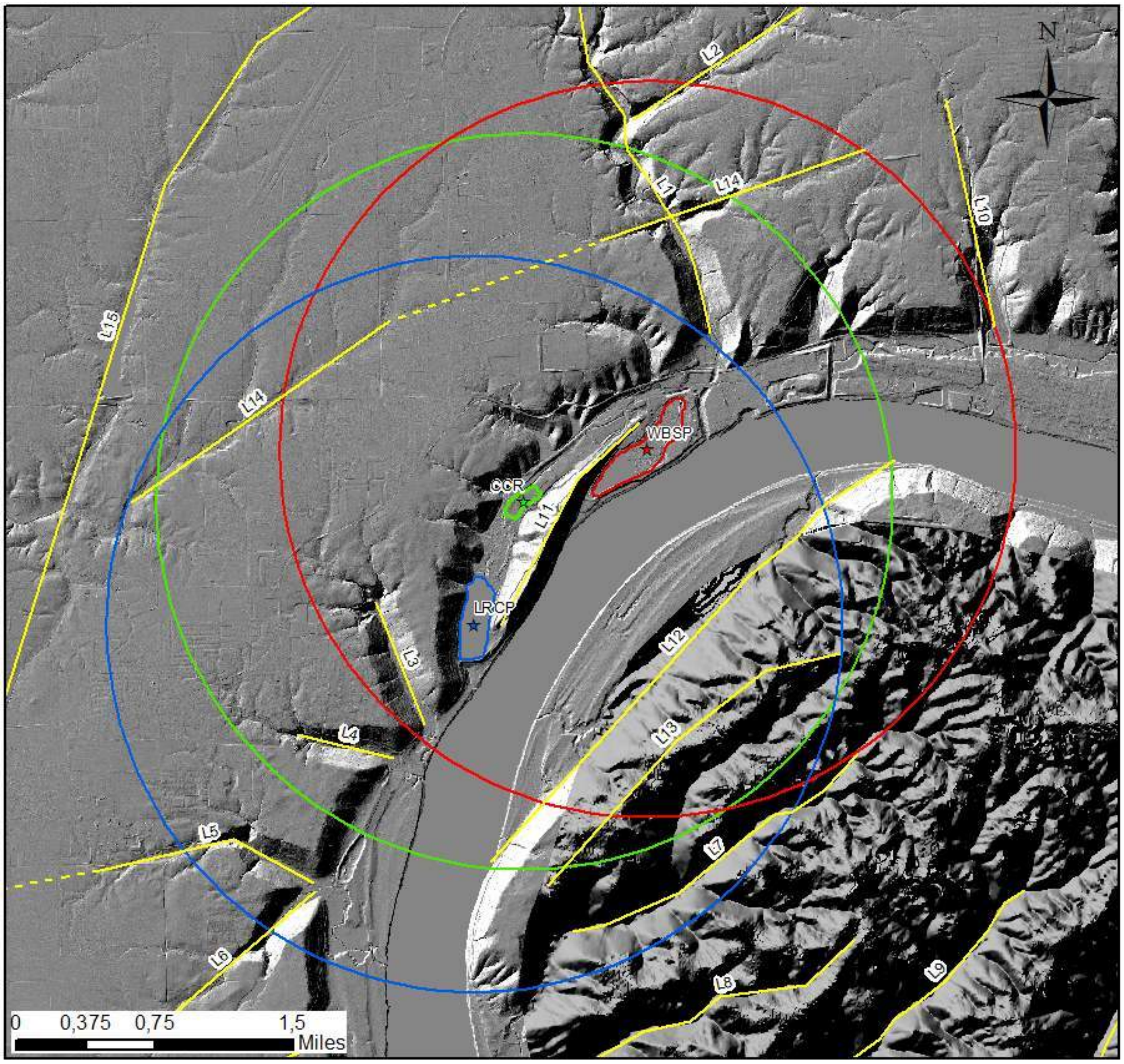
Eleven lineaments were mapped within the study area (L1 to L7, L11 to L14) and four were mapped outside (L8, L9, L10, L15) (Figure 3-1). Lineaments L1 to L10 were interpreted as the result of stream erosion of residual soils overlying soft sedimentary bedrock. However, it is possible that the streams exploited weaknesses in the bedrock (such as pre-Holocene faults or joint sets). In this situation, considering the geological setting, glacial history and topography of the region, these linear features would not be associated with active faults.

Lineaments L14 and L15 show a northeast-southwest trend and may be faults. However, being covered by till and loess dating from the pre-Wisconsinan and Wisconsinan era (300,000 to 12,000 ybp) these linear features would not be associated with active faults.

Based on hydrogeologic study report AGES (2006), lineament L11 is a bedrock-controlled feature (Devil's Backbone) that is likely a remnant of fluvial erosion that pre-dates the Holocene. Lineaments L12 and L13 were interpreted as a legacy of stream erosion on a bedrock-controlled ridge. These features are not likely to have developed from an active fault.

[4] Publicly available geophysical data include a 1:500,000-scale map (Abert et al. 2016) and a 1:63,360-scale aeromagnetic survey map from 1951 (Henderson and Meuschke 1951). These maps show no anomalies for the study area.

Figure 3-1 Mapped lineaments (yellow) overlain on LiDAR and DEM hillshade image



CCR - Coal Combustion Residuals Landfill; LRCP - Landfill Runoff Collection Pond; WBSP - West Boiler Slag Pond

4.0 DRAINAGE ANALYSIS

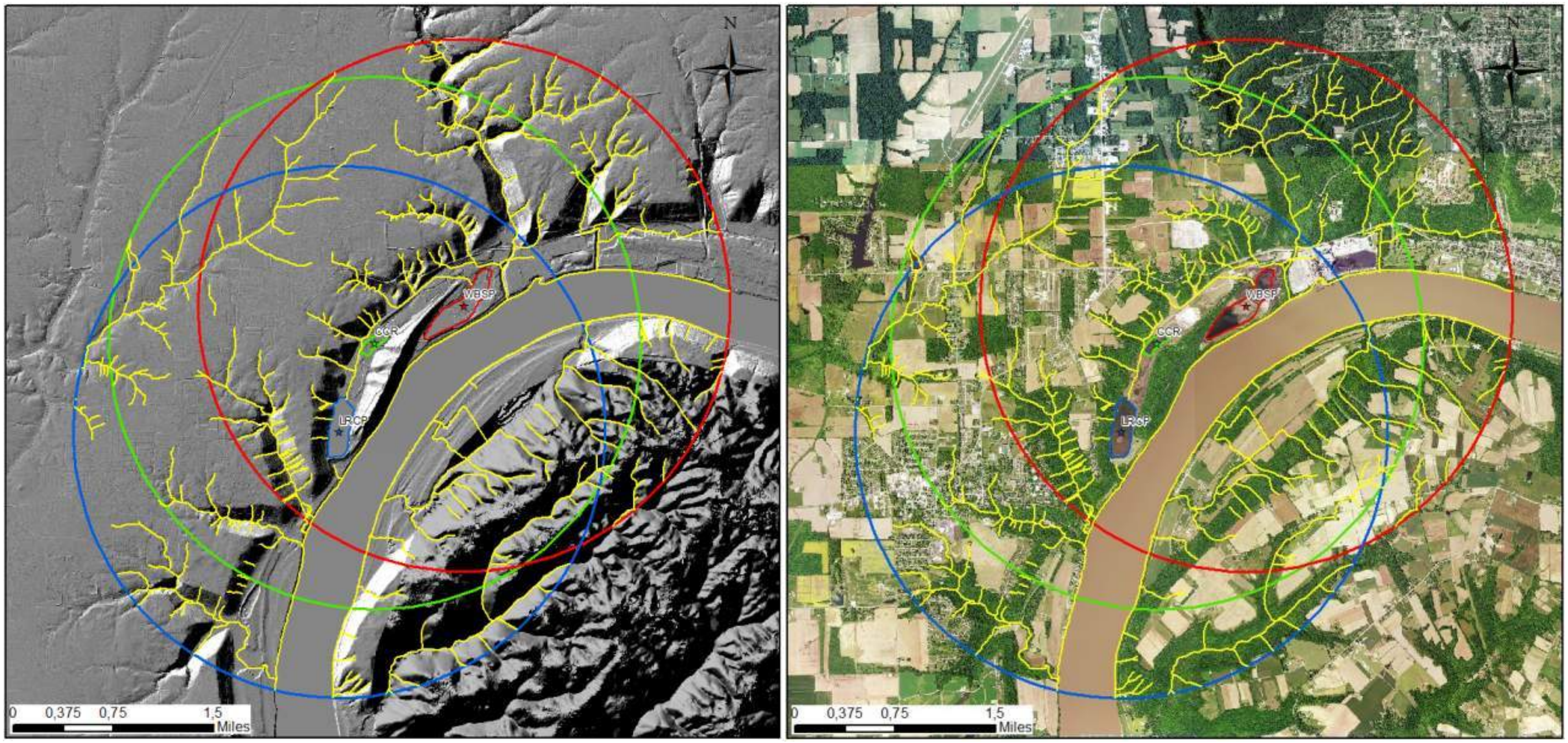
Drainage analysis is useful in structural geology interpretation - it includes consideration for drainage patterns, drainage texture, individual stream patterns and drainage anomalies. Deviations from an expected pattern, such as flow in a direction that is oblique from the regional topographical gradient, could be related to structural or lithologic discontinuities.

The drainage analysis was conducted using ESRI ArcGIS® software and carried out through the interpretation of aerial photographs, hillshade imagery, and the IGS map services hydrologic features dataset. The hillshade was used to delineate the drainage networks of streams at scales ranging from 1:2,000 to 1:5,000 (Figure 4-1). A comparison of the IGS map services hydrologic features dataset and mapping from the drainage analysis is presented in Figure 4-2.

In all CCR Landfill, WBSP and LRCP sites, the drainage network has a predominant dendritic drainage pattern, which is consistent with the underlying horizontal sedimentary strata. A small area with a parallel drainage pattern (northeast-southwest trend) was noted on the southeastern shore of the Ohio River. This pattern is the product of the uplands drainage through a three-mile-long valley-side slope (averages 20° and 320 feet drop).

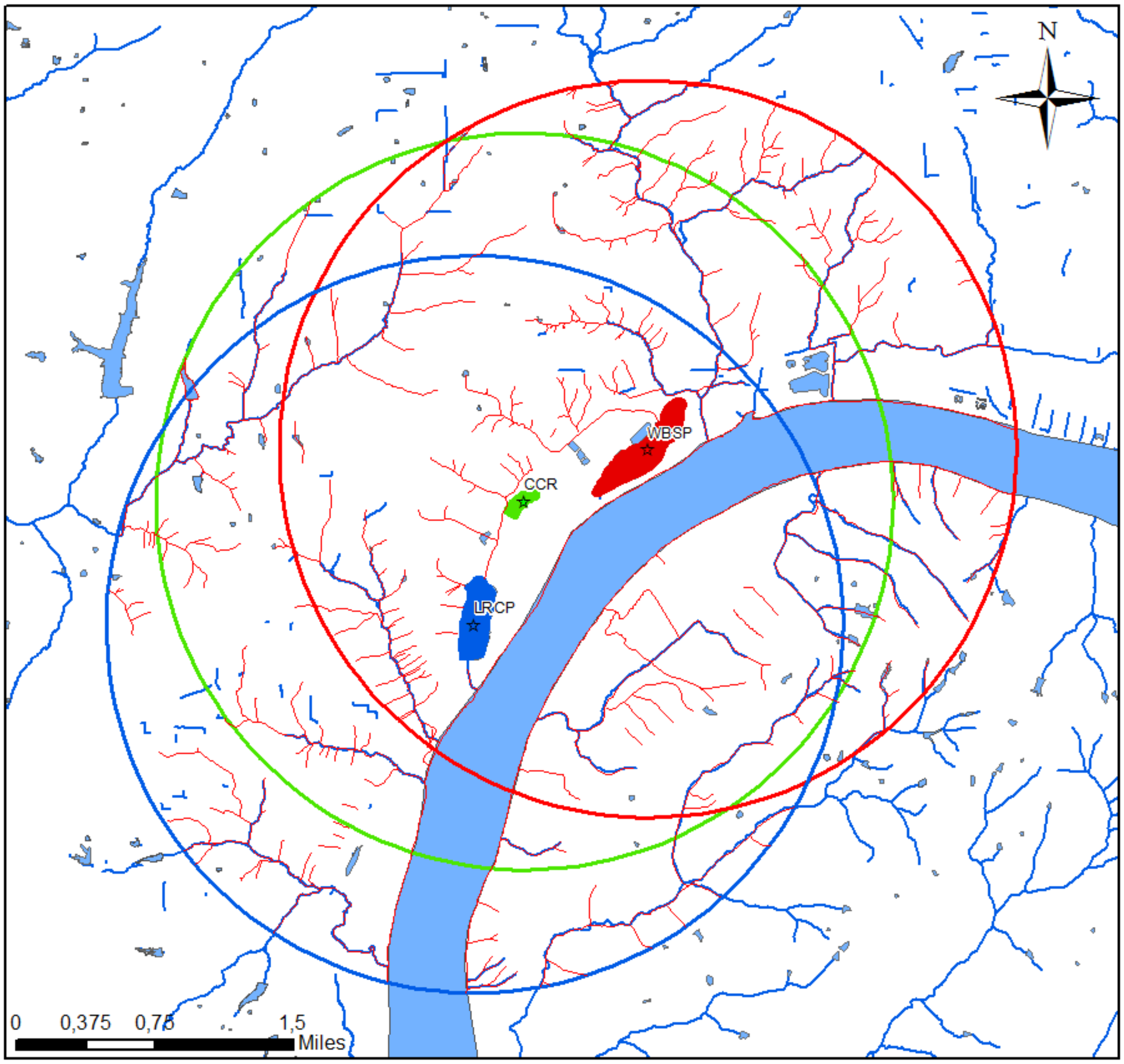
The only abnormal drainage deviations observed are the result of redirection by anthropogenic activity. No fault scarps or other tectonic features associated with active (Holocene-aged) faults were observed within the study area.

Figure 4-1 Drainage network mapping on LiDAR and DEM hillshade image (left) and overlay on aerial photographs (right)



CCR - Coal Combustion Residuals Landfill; LRCP - Landfill Runoff Collection Pond; WBSP - West Boiler Slag Pond

Figure 4-2 Indiana State Geological Survey map services hydrological features dataset (blue) compared with the detailed drainage analysis mapping (red)



CCR - Coal Combustion Residuals Landfill; LRCP - Landfill Runoff Collection Pond; WBSP - West Boiler Slag Pond

5.0 SUMMARY OF KEY FINDINGS

A neotectonics analysis of the Clifty Creek Station in Madison, Indiana, was completed within a two-mile radius centered on the CCR Landfill, WBSP and LRCP sites. The neotectonics analysis involved an extended review of publicly available information (geology, faults, hydrology, seismic hazard, geophysical surveys, Quaternary history, surficial deposits, pedology), lineament analysis, and drainage analysis. The findings from a separate literature review show that the study area is located east of the western flank of the Jessamine dome, an area of low seismicity (Hatcher 2018). None of the literature reviewed have indicated the existence of any active (Holocene-age) fault within two miles of the Indiana-Kentucky Electric Corporation Clifty Creek station and associated ponds (Hatcher 2018).

The lineament analysis identified ten linear features that have been interpreted as the result of stream erosion of residual soils overlying soft sedimentary bedrock. These features are interpreted to not be associated with Holocene-age faults. Two linear features with a northeast-southwest trend were interpreted as potential faults. However, being buried by pre-Holocene surficial deposits, these features were interpreted as inactive. Other lineaments were interpreted as remnants of pre-Holocene stream erosion and as features derived from a bedrock-controlled topography; these lineaments are not likely to have developed from active faults. Lineaments that suggest potential faults (all pre-Holocene) are not within 200 feet from the CCR Landfill, WBSP and LRCP sites.

The drainage analysis shows a predominant dendritic drainage pattern which is consistent with the underlying horizontal sedimentary strata. A parallel drainage pattern, observed on the southeastern shore of Ohio River, was interpreted as the result of the upland drainage through a three-mile-long valley-side slope. The only abnormal drainage deviations observed are the result of redirection by anthropogenic activity (e.g., ditches, river training).

No fault scarps or other tectonic features associated with active (Holocene-age) faults were observed within a two mile-radius of any of the CCR Landfill, WBSP or LRCP sites.

Limitations. The desktop neotectonics analysis presented in this report is based on a review of available aerial photographs and hillshade imagery derived from the LiDAR data and DEM. The LiDAR data date from a 2012 survey and may not represent current terrain conditions. Moreover, LiDAR data did not cover the Kentucky portion of the study areas. A 30-foot-grid DEM was used to cover this section; meaning lineament and drainage analysis may not be as accurate as the (5 foot-grid) LiDAR data. Also, stereoscopic air photo interpretation was not conducted as part of the assessment.

Note that the modification of surficial sediments due to the construction of the LRCP and WBSP can hamper the identification of neotectonics features.

Given that the region as a low seismic hazard and that no active (Holocene-age) fault features within 200 feet of the CCR Landfill, LRCP and WBSP sites were identified during the neotectonics analysis (lineament and drainage network mapping), then no further work is recommended.

6.0 CLOSURE

This report supports the fault area demonstration only for the Clifty Creek Plant and the conclusions are not valid for other applications. This report is based on a literature review of cited references, a desktop lineament and drainage mapping exercise based on interpretation of LiDAR hillshade and satellite imagery, and no fieldwork was conducted to verify actual conditions within the study limits.

We trust that the information contained in this report is adequate for your present purposes. If you have any questions about the contents of the report, or if we can be of any other assistance, please do not hesitate to contact us at your convenience.

This desktop terrain analysis was conducted by Manuel Verpaelst, M.Sc., technically reviewed by Sid Tsang, P.Geo.; and approved by Richard Guthrie M.Sc., Ph.D., P.Geo.

Yours very truly,

STANTEC CONSULTING LTD.

7.0 REFERENCES

Abert, C.C., Marshak, S., and Larson, T.H. 2016. Geological and geophysical maps of the Illinois Basin-Ozark Dome Region. Illinois State Geological Survey, 13 p.

Applied Geology and Environmental Science INC (AGES). 2016. Hydrogeologic study report of the Clifty Creek Coal Ash Landfill, Clifty Creek, Madison, Indiana. 250 p.

Fullerton, D.S. 1986. Stratigraphy and correlation of glacial deposits from Indiana to New York and New Jersey. Quaternary Science Review, 5: 23-37. doi: https://doi.org/10.1016/0277-3791(86)90171-X

Gray H.H., Ault, C.H., and Keller, S.J. 1987. Bedrock geology map of Indiana. Indiana Geological Survey, Miscellaneous map 48, scale 1:500,000.

Gray, H.H. and Sowder, K. 2002. Physiographic Regions of Indiana. Indiana Geological Survey, 1:500,000 scale map, doi: http://igs.indiana.edu/arcims/statewide/download.html

Hatcher, Jr., R.D. 2018. Literature survey and discussion of the geology and seismicity near Clifty fossil plant, Southeastern Indiana. Department of Earth and Planetary Sciences and Science Alliance Center of Excellence, University of Tennessee–Knoxville. April 19, 2018.

Henderson, J.R. and Meuschke, J.L. 1951. Total intensity aeromagnetic map of Jefferson County, Indiana. U.S. Geological Survey, Geophysical investigation, map GP-64, scale 1:63,360.

Homoya, M.A., Abrell, D.B., Aldrich, J.R., and Post, T.W. 1985. The natural regions of Indiana. Indiana Natural Heritage Program, Indiana Department of Natural Resources, Indianapolis, Indiana 46204.

Nickell, A.K. 1985. Soil survey of Jefferson County, Indiana. United States Department of Agriculture, Natural Resources Conservation Services: 169 p.

Parola, A.C., Vesely, W.S., Croasdaile, M.A., Hansen, C., and Jones, M.S. 2007. Geomorphic characteristics of streams in the Bluegrass Physiographic Region of Kentucky. Kentucky Division of Water, NPS 00-10 MOA M-02173863 and P02 0600000585.

Petersen, M.D., Moschetti, M.P., Powers, P.M., Mueller, C.S., Haller, K.M., Frankel, A.D., Zeng, Y., Rezaeian, S., Harmsen, S.C., Boyd, O.S., Field, E., Chen, R., Rukstales, K.S., Luco, N., Wheeler, R.L., Williams, R.A., and Olsen, A.H., 2014. Documentation for the 2014 update of the United States national seismic hazard maps: U.S. Geological Survey Open-File Report 2014–1091, 243 p. doi: https://dx.doi.org/10.3133/ofr20141091.

Swadley, W.C. 1978. Geologic map of part of the Madison West Quadrangle, Trimble County, Kentucky. Kentucky Geological Survey, Geological quadrangle map GQ-1469, scale 1:24,000.

Internet references

Indiana Geological Survey - map website
http://maps.indiana.edu/layerGallery.html
accessed on 2018-03-22

Indiana Geological Survey - glacial publication available on the Indiana University Bloomington
https://igws.indiana.edu/Surficial/IceAge.cfm#
Accessed on 2018-03-25

Kentucky Geological Survey - geologic map information
http://kgs.uky.edu/kgsmap/kgsgeoserver/viewer.asp
Accessed on 20118-03-23

United States Department of Agriculture - web soil survey
https://websoilsurvey.nrcs.usda.gov
Accessed on 2018-03-25

USGS – The national map office
https://viewer.nationalmap.gov/basic/
Accessed on 2018-03-21

U.S. Quaternary faults and folds database
http://usgs.maps.arcgis.com/apps/webappviewer/index.html?id=db287853794f4555b8e93e42290e9716
Accessed on 2018-03-23

ATTACHMENT D
SEISMIC IMPACT ZONES COMPLIANCE DEMONSTRATION REPORT

Compliance Demonstration Report – Seismic Impact Zones Landfill Runoff Collection Pond Clifty Creek Station

Indiana-Kentucky Electric Corporation
Madison, Jefferson County, Ohio

Prepared for:
Indiana-Kentucky Electric Corporation
Piketon, Ohio

Prepared by:
Stantec Consulting Services Inc.
11687 Lebanon Road
Cincinnati, Ohio 45241

October 16, 2018

Table of Contents

1.0 PROJECT BACKGROUND

On April 17, 2015, the "Disposal of Coal Combustion Residuals (CCR) from Electric Utilities" (EPA Final CCR Rule) was published in the Federal Register. Stantec Consulting Services Inc. (Stantec) was contracted by the Indiana-Kentucky Electric Corporation (IKEC) to demonstrate proficiency regarding seismic impact zones at the Clifty Creek Station and evaluate compliance with §257.63 of the CCR Rule.

As required by §257.63 of the EPA Final CCR Rule, an owner or operator of a new CCR landfill, existing or new CCR surface impoundment, or a lateral expansion of a CCR unit is required by October 17, 2018 to demonstrate that the unit is not located in a seismic impact zone unless the owner or operator demonstrates that all structural components of the CCR unit are designed to resist the maximum horizontal acceleration (MHA) in the lithified material on site.

In support of §257.63 of the EPA Final CCR Rule, §257.53 provides the following definitions:

Lithified Earth Material: all rock, including all naturally occurring and naturally formed aggregates or masses of minerals or small particles of older rock that formed by crystallization of magma or by induration of loose sediments. This term does not include man-made materials, such as fill, concrete, and asphalt, or unconsolidated earth materials, soil, or regolith lying at or near the earth surface.

Maximum horizontal acceleration in lithified earth material: the maximum expected horizontal acceleration at the ground surface as depicted on a seismic hazard map, with a 98% or greater probability that the acceleration will not be exceeded in 50 years, or the maximum expected horizontal acceleration based on a site-specific risk assessment.

Seismic impact zone: An area having a 2% or greater probability that the maximum expected horizontal acceleration, expressed as a percentage of the earth's gravitational pull (g), will exceed 0.10g in 50 years.

Structural components: liners, leachate collection and removal systems, final covers, run-on and run-off systems, inflow design flood control systems, and any other component used in the construction and operation of the CCR unit that is necessary to ensure the integrity of the unit and that the contents of the unit are not released into the environment.

2.0 UNIT DESCRIPTION

The Clifty Creek Station is located on the north shore of the Ohio River downstream of Madison, Indiana. The station consists of six coal-fired electric generating units, each nominally rated at 217 megawatts. The Clifty Creek Station is directly accessible from State Route 56.

The Landfill Runoff Collection Pond is located at the southern edge of the station. It is bordered by the station's coal combustion residuals (CCR) landfill to the north, natural grade to the east and west, and by a dam to the south that runs along the bank of the Ohio River. Approximately 508 acres of both landfill contact water and stormwater runoff drain to the Landfill Runoff Collection Pond. Upon the completion of the CCR landfill, the area draining to the Landfill Runoff Collection Pond will be reduced to approximately 443 acres (Stantec, 2010).

Figure 1 below presents an overview of the Clifty Creek Station and related appurtenances including the main plant and Landfill Runoff Collection Pond.

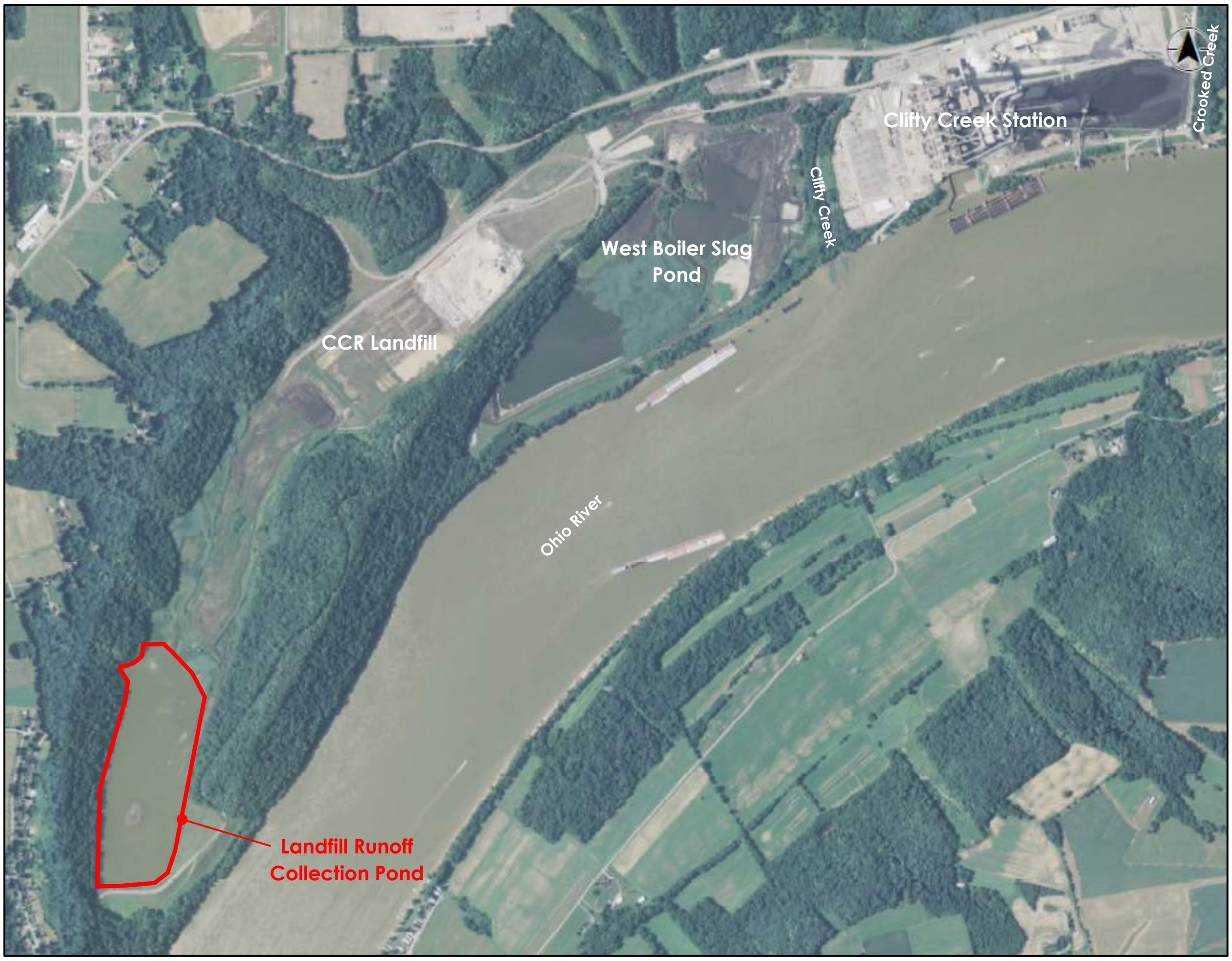


Figure 1. Aerial View of Clifty Creek Station

3.0 SEISMIC IMPACT ZONE DETERMINATION (§257.63(A))

Per §257.63(a) and §257.53, it must first be determined if the Landfill Runoff Collection Pond is located within a seismic impact zone.

Assessment of the existing surface impoundment was completed considering the following criteria related to the CCR rule:

- Review of the site's peak ground acceleration having a 2% or greater probability of being exceeded in 50 years as defined by the United States Geological Survey (USGS), Earthquake Hazard Program.
- Review documentation (including but not limited to geotechnical data reports, construction drawings, and published geologic mapping) containing information that indicate the foundation materials within the top 100 feet of the subsurface.

3.1 BACKGROUND

The Landfill Runoff Collection is located at approximately 38˚ 43' 13.368" (latitude) and -85˚ 26' 52.2924" (longitude). This converts to 38.720380, -85.447859 decimal degrees.

Boring logs and geotechnical laboratory testing are available for the original ash pond design (AEPSC, 2016) and for the ash pond embankment during the initial safety factor assessment for the EPA Final CCR Rule (Stantec, 2016b).

The Landfill Runoff Collection Pond is classified as an existing, unlined CCR surface impoundment (IKEC, 2016). A dam forms the southern boundary for the pond, approximately 700 feet from the Ohio River. It is an earthen dam with a crest length roughly 1,600 feet and a maximum height of 70 feet. The minimum dam crest elevation is 502.9 feet mean sea level (MSL) with a maximum of 505.9 feet along the left abutment (GZA, 2009). The LRCP Dam is registered with the Indiana Department of Natural Resources (IDNR) as Dam No. 39-12 (Stantec, 2016a).

The Landfill Runoff Collection Pond's dam consists of the main 70-foot high dam, a 25-foot high dike on top of an adjoining ridge, a natural rock ridge, and a 15-foot high saddle dike between the rock ridge and the east abutment (AEPSC, 1985). The main dam has a constructed downstream slope of approximately 2.7H:1V above elevation 474 feet and 3.3H:1V below elevation 474 feet and an upstream slope of about 4.4H:1V. The saddle dike has a downstream slope of 2H:1V and a length of 250 feet (GZA, 2009).

The dam's primary spillway is an inclined six-foot by three-foot reinforced concrete box culvert with a riser box structure containing grated inlets at 11-foot intervals in elevation. The inclined box is connected to a 400-foot long, 72-inch diameter concrete pipe that discharges to the Ohio River (Stantec, 2016c).

The inflow design flood control demonstration indicates that the surface impoundment does not overtop and maintains adequate freeboard (Stantec, 2016c).

The initial safety factor assessment analyzed the critical cross section of the Landfill Runoff Collection Pond dam for seismic conditions. The pseudo-static analysis used a horizontal seismic coefficient of 0.085g and estimated a factor of safety of 1.42 (Stantec, 2016b). Conventional guidelines for pseudo-static analyses assume a horizontal seismic coefficient (k_h) equal to one-half of the PGA on rock (Hynes-Griffin and Franklin, 1984). The referenced initial safety factor assessment conservatively assumed the full PGA on rock.

3.2 ASSESSMENT

The United States Geological Survey (USGS), Earthquake Hazard Program publishes seismic hazard maps to allow preliminary site assessments based on current understanding of:

- Known faults and historic earthquakes,
- The behavior of seismic waves as they propagate between a source and a site, and
- The near-surface conditions at specific locations of interest.

The National Hazard Maps referenced in the EPA Final CCR Rule show the distribution of earthquake shaking levels that have a certain probability of occurring in the United States (USGS, 2018). They are created to provide preliminary information to assist in the design of infrastructure (e.g. buildings, roads, utilities) to withstand shaking from earthquakes. The USGS provides probabilistic ground motion maps depicting earthquake hazard using contours to illustrate the earthquake ground motions of a particular frequency that have a given probability of being exceeded in a given time period (USGS, 2018).

For this demonstration, the ground motion used for seismic impact zone determination corresponds to predicted motion with a 2% or greater probability of exceedance in 50 years. Appendix A contains the 2014 National Hazard Map with the site located and a site-specific unified hazard report for the Landfill Runoff Collection Pond based on an input of latitude and longitude into the interactive Unified Hazard Tool. As established by the USGS reference, the peak ground acceleration (PGA) ground motion is estimated as 0.0891g. It should be noted that the USGS mapping referenced assumes a return period of 2,475 years (equivalent to 2% probability of exceedance in 50 years).

3.3 CONCLUSION

The preamble of the EPA Final CCR Rule (p. 21366, Vol. 80, No. 74 of the Federal Register) discusses the data determining seismic impact zone as being mapped and readily available through the USGS. This implies that the intended methodology was to determine seismic impact zone based on $PGA_{B/C}$ (USGS, 2018). The referenced USGS mapping indicates the Landfill Runoff Collection Pond has a $PGA_{B/C}$ of 0.0891g, which is below the 0.10g specified as a seismic impact zone.

Based on the interpretation of the EPA Final CCR Rule requirements outlined herein, it is Stantec's professional opinion that the subject CCR unit is not located within a seismic impact zone.

4.0 REFERENCES

American Electric Power Service Corporation (AEPSC) (2016). *History of Construction. CFR 257.73(c)(1). Landfill Runoff Collection Pond. Clifty Creek Station*. Madison, Indiana. October. Prepared for: Indiana-Kentucky Electric Corporation. GERS-16-141.

American Electric Power Service Corporation (AEPSC) (1985). *Flyash Dam Raising Feasibility Report*. Indiana-Kentucky Electric Corporation. Clifty Creek Plant. Madison, Indiana. January 31.

GZA GeoEnvironmental, Inc. (GZA) (2009). *Task 3 Dam Assessment Report. Project #0-381. Clifty Creek Station. South Fly Ash Pond*. Madison, Indiana. September 14.

Hynes-Griffin and Franklin (1984). *Rationalizing the Seismic Coefficient Method*. Miscellaneous Paper GL-84-13. Department of the Army. July.

IKEC (2016). *Liner Design. CFR 257.71. Landfill Run-off Collection Pond. Clifty Creek Station.* Madison, Indiana. October.

Stantec Consulting Services Inc. (2016a). *Initial Structural Stability Assessment. Clifty Creek Station. Landfill Runoff Collection Pond.* Madison, Jefferson County, Indiana. Prepared for: Indiana-Kentucky Electric Corporation. October.

Stantec Consulting Services Inc. (2016b). Report of CCR Rule Stability Analyses. AEP Clifty Creek Power Plant. Boiler Slag Pond Dam and Landfill Runoff Collection Pond. Madison, Jefferson County, Indiana. Prepared for American Electric Power, Columbus, Ohio. February 16.

Stantec Consulting Services Inc. (2016c). *Reservoir Routing Analysis. Landfill Runoff Collection Pond*. Clifty Creek Power Station. City of Madison, Jefferson County, Indiana. February.

United States Geological Survey (USGS) (2018). Unified Hazard Tool. https://earthquake.usgs.gov/hazards/interactive/. Accessed March.

Appendix A PEAK GROUND ACCELERATION

U.S. Geological Survey - Earthquake Hazards Program

https://earthquake.usgs.gov/hazards/interactive/
Accessed March 7, 2018

Unified Hazard Tool

Please do not use this tool to obtain ground motion parameter values for the design code reference documents covered by the U.S. Seismic Design Maps web tools (e.g., the International Building Code and the ASCE 7 or 41 Standard). The values returned by the two applications are not identical.

Input

Edition

Dynamic: Conterminous U.S. 2014 (v4.1.

Latitude

Decimal degrees

38.72038

Longitude

Decimal degrees, negative values for western longitudes

-85.447859

Site Class

760 m/s (B/C boundary)

Spectral Period

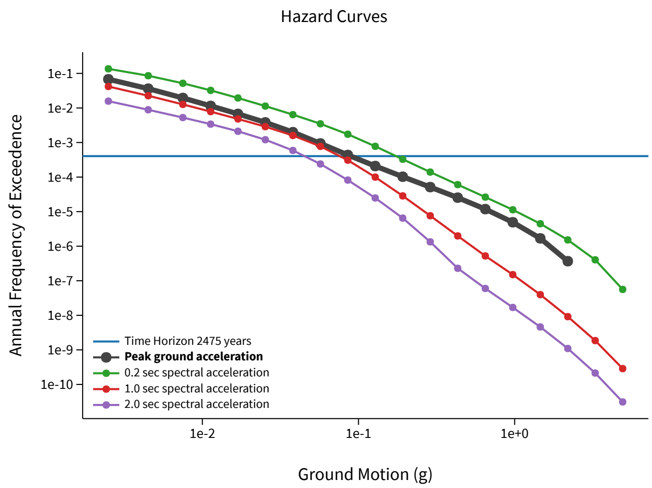
Peak ground acceleration

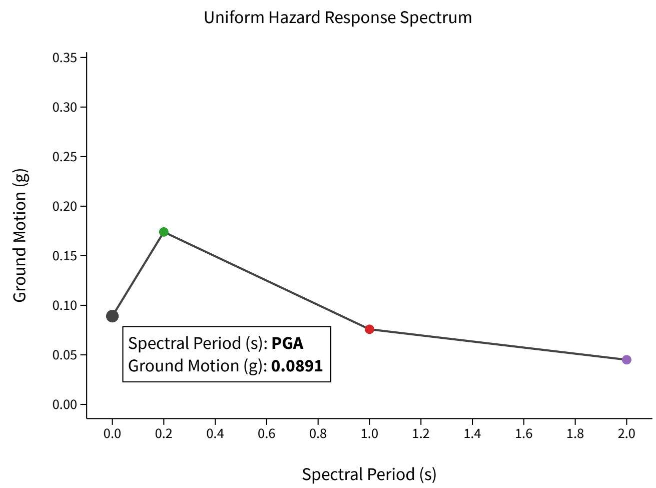
Time Horizon

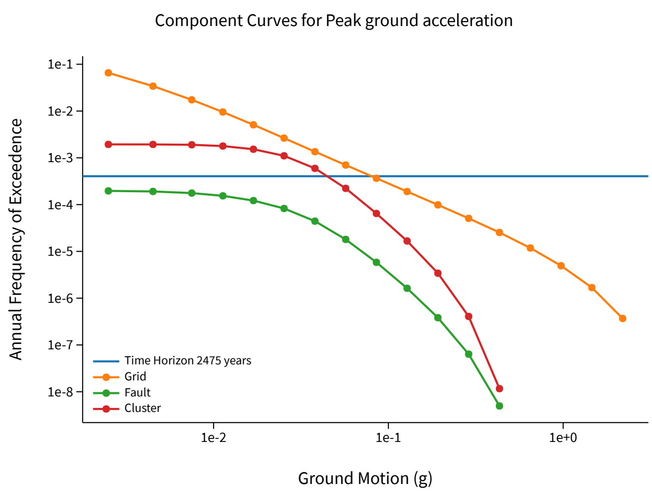
Return period in years

2475

Hazard Curve





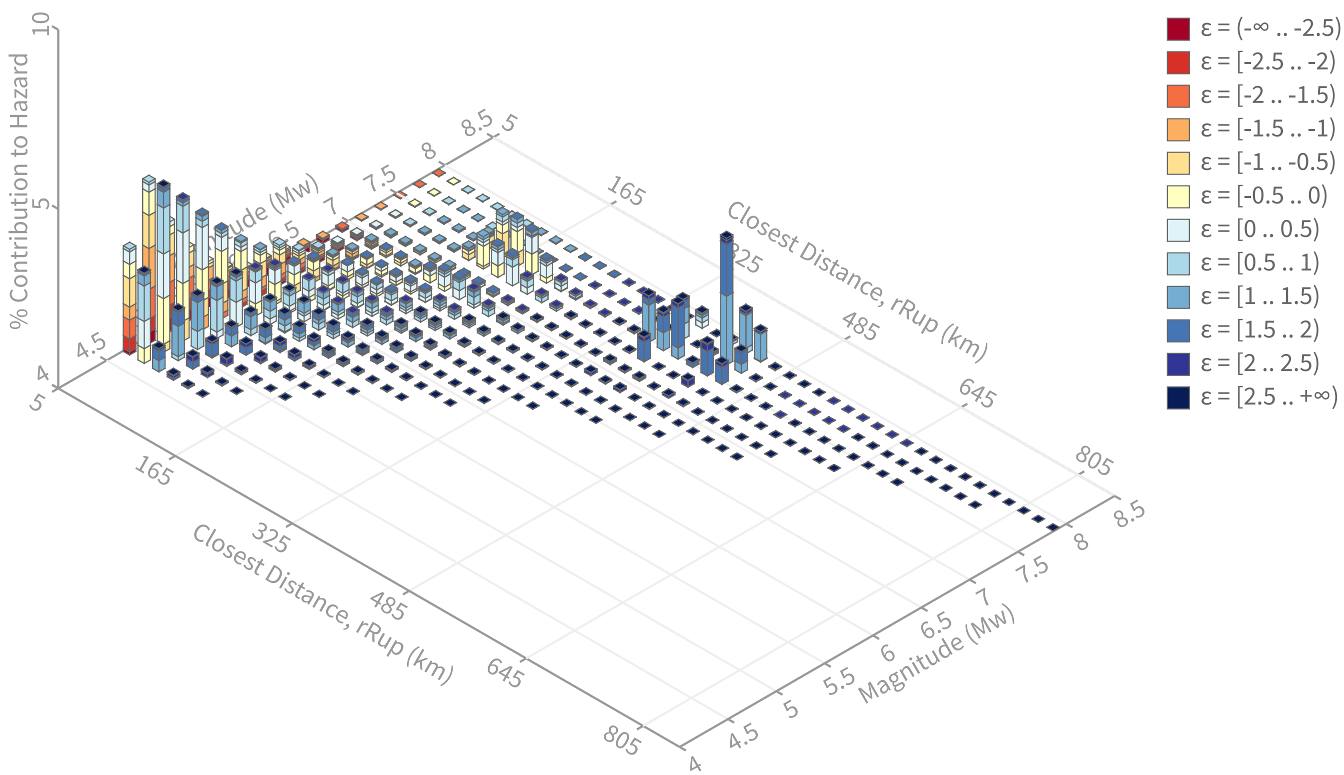


View Raw Data

Deaggregation

Component

Total



Summary statistics for, Deaggregation: Total

Deaggregation targets

Return period: 2475 yrs
Exceedance rate: 0.0004040404 yr^{-1}
PGA ground motion: 0.089062051 g

Recovered targets

Return period: 2501.5965 yrs
Exceedance rate: 0.00039974472 yr^{-1}

Totals

Binned: 100 %
Residual: 0 %
Trace: 1.84 %

Mean (for all sources)

r: 123.98 km
m: 6.1
ε_0: 0.27 σ

Mode (largest r-m bin)

r: 28.37 km
m: 4.9
ε_0: 0.35 σ
Contribution: 4.6 %

Mode (largest ε_0 bin)

r: 432.85 km
m: 7.78
ε_0: 1.35 σ
Contribution: 1.91 %

Discretization

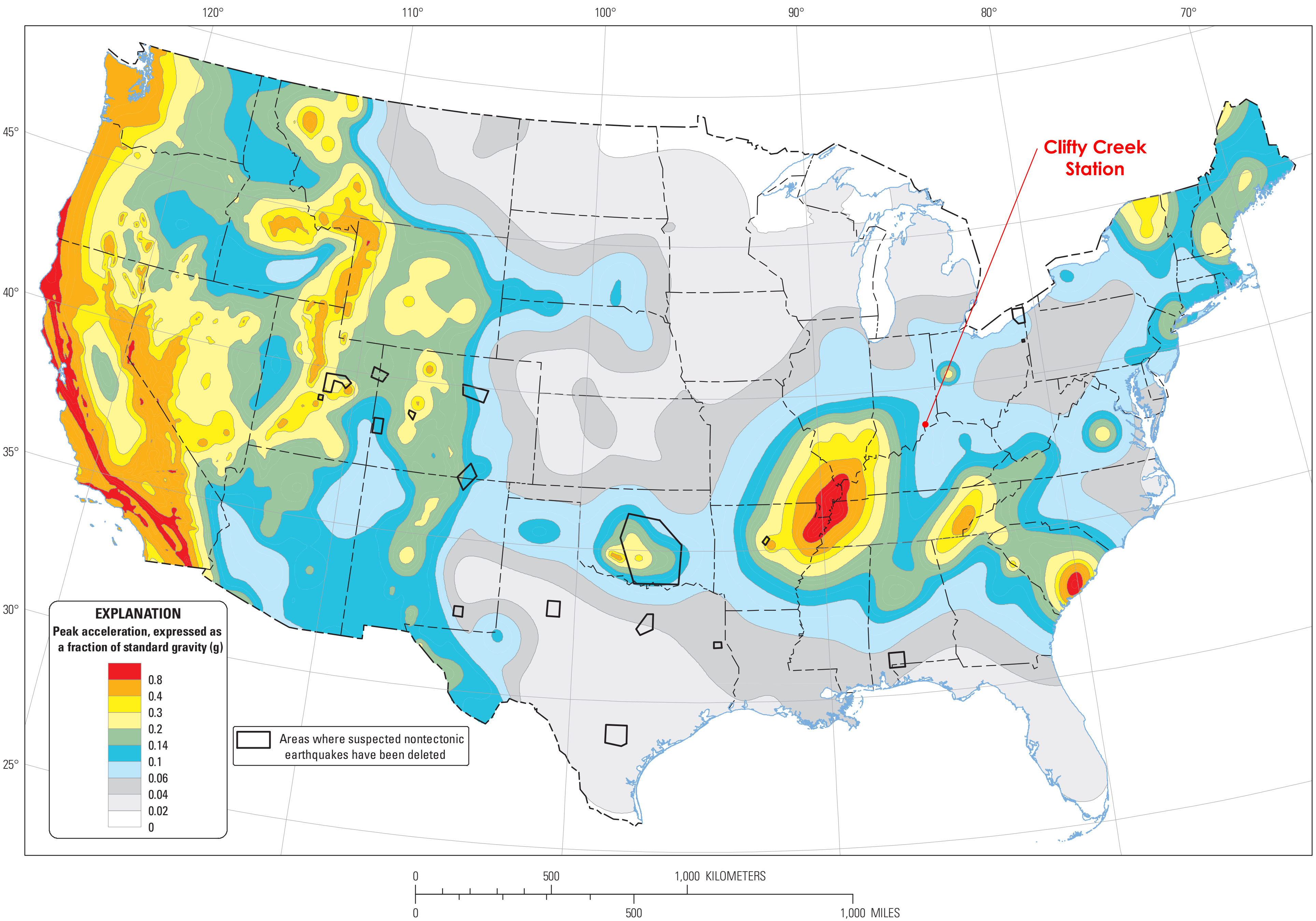
r: min = 0.0, max = 1000.0, Δ = 20.0 km
m: min = 4.4, max = 9.4, Δ = 0.2
ε: min = -3.0, max = 3.0, Δ = 0.5 σ

Epsilon keys

ε0: [-∞ .. -2.5)
ε1: [-2.5 .. -2.0)
ε2: [-2.0 .. -1.5)
ε3: [-1.5 .. -1.0)
ε4: [-1.0 .. -0.5)
ε5: [-0.5 .. 0.0)
ε6: [0.0 .. 0.5)
ε7: [0.5 .. 1.0)
ε8: [1.0 .. 1.5)
ε9: [1.5 .. 2.0)
ε10: [2.0 .. 2.5)
ε11: [2.5 .. +∞]

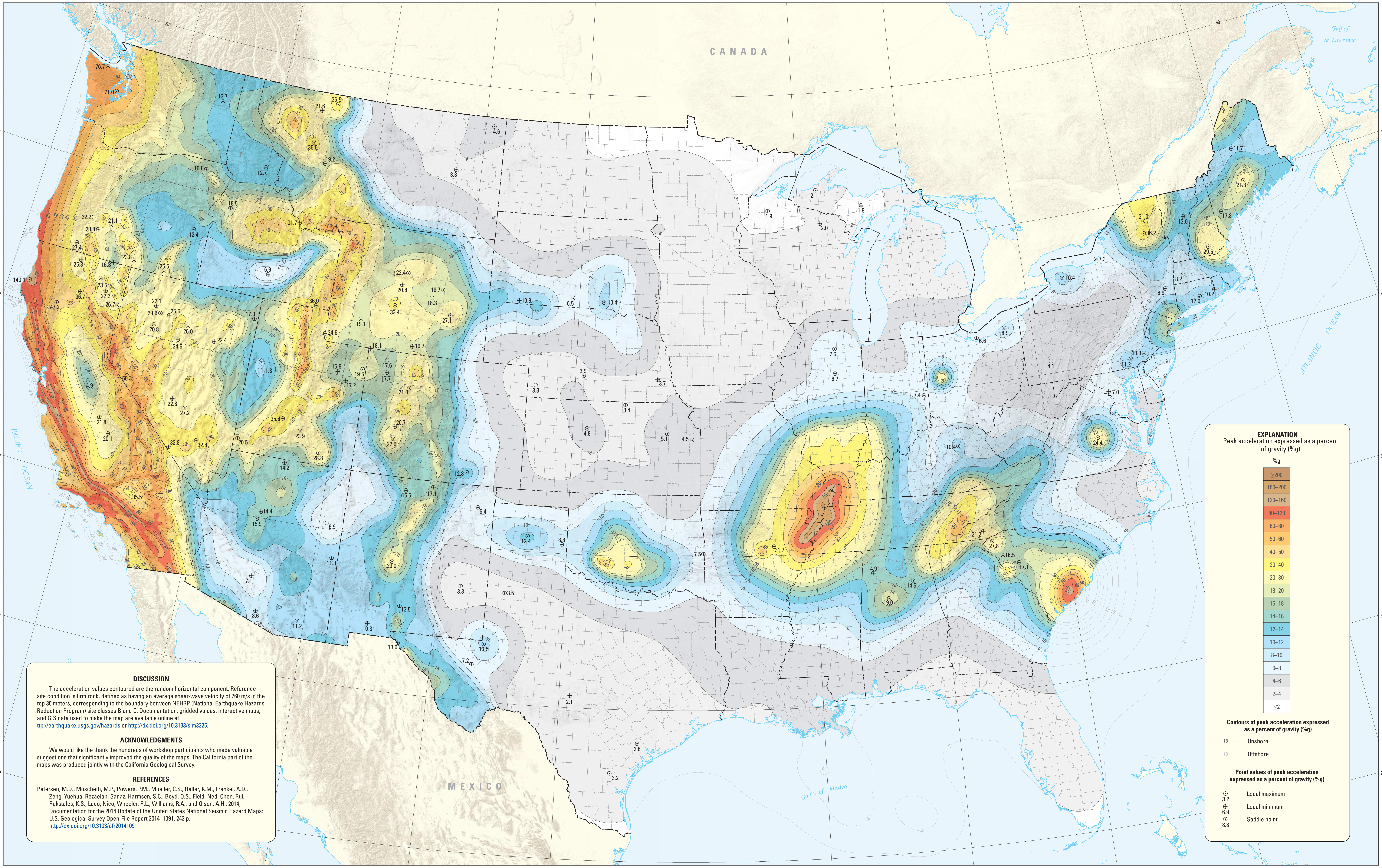
Deaggregation Contributors

Source Set ↳ Source	Type	r	m	ε_0	lon	lat	az	%
USGS Fixed Smoothing Zone 1 (opt)	Grid							28.07
PointSourceFinite: -85.448, 38.923		22.72	5.25	-0.48	85.448°W	38.923°N	0.00	3.51
PointSourceFinite: -85.448, 39.013		32.33	5.37	0.01	85.448°W	39.013°N	0.00	2.31
PointSourceFinite: -85.448, 38.833		13.29	5.16	-1.34	85.448°W	38.833°N	0.00	2.04
PointSourceFinite: -85.448, 38.788		8.91	5.14	-2.00	85.448°W	38.788°N	0.00	2.02
PointSourceFinite: -85.448, 38.878		17.96	5.20	-0.84	85.448°W	38.878°N	0.00	1.73
PointSourceFinite: -85.448, 39.058		37.13	5.43	0.18	85.448°W	39.058°N	0.00	1.63
PointSourceFinite: -85.448, 39.103		41.93	5.50	0.32	85.448°W	39.103°N	0.00	1.51
PointSourceFinite: -85.448, 38.968		27.52	5.31	-0.21	85.448°W	38.968°N	0.00	1.42
PointSourceFinite: -85.448, 39.148		46.71	5.56	0.44	85.448°W	39.148°N	0.00	1.27
SSCn Fixed Smoothing Zone 1 (opt)	Grid							22.59
PointSourceFinite: -85.448, 38.923		22.72	5.25	-0.48	85.448°W	38.923°N	0.00	3.51
PointSourceFinite: -85.448, 39.013		32.33	5.37	0.01	85.448°W	39.013°N	0.00	2.31
PointSourceFinite: -85.448, 38.833		13.29	5.16	-1.34	85.448°W	38.833°N	0.00	2.04
PointSourceFinite: -85.448, 38.788		8.91	5.14	-2.00	85.448°W	38.788°N	0.00	2.02
PointSourceFinite: -85.448, 38.878		17.96	5.20	-0.84	85.448°W	38.878°N	0.00	1.73
PointSourceFinite: -85.448, 39.058		37.13	5.43	0.18	85.448°W	39.058°N	0.00	1.63
PointSourceFinite: -85.448, 38.968		27.52	5.31	-0.21	85.448°W	38.968°N	0.00	1.42
PointSourceFinite: -85.448, 39.103		41.93	5.50	0.32	85.448°W	39.103°N	0.00	1.36
Wabash Valley	Grid							9.66
SSCn New Madrid	Cluster							8.25
NMFS RLME 1		420.49	7.67	1.56	89.288°W	36.995°N	241.54	2.24
NMFS RLME 5		422.19	7.67	1.57	89.288°W	36.995°N	241.54	1.45
NMFS RLME 4		397.52	7.64	1.53	89.020°W	37.270°N	243.85	1.26
USGS Adaptive Smoothing Zone 1 (opt)	Grid							8.18
SSCn Adaptive Smoothing Zone 1 (opt)	Grid							6.63
SSCn Fixed Smoothing Zone 8 (opt)	Grid							6.20
USGS New Madrid 500-year	Cluster							2.60
NMSZ: Center Model		403.49	7.65	1.56	89.070°W	37.165°N	242.55	1.83
SSCn Adaptive Smoothing Zone 8 (opt)	Grid							1.80
USGS New Madrid 750-year	Cluster							1.73
NMSZ: Center Model		403.49	7.65	1.56	89.070°W	37.165°N	242.55	1.22
USGS New Madrid 500-year	Fault							1.22



Two-percent probability of exceedance in 50 years map of peak ground acceleration

Source: The 2014 U.S. Geological Survey (USGS) National Seismic Hazard Map
https://earthquake.usgs.gov/static/lfs/nshm/conterminous/2014/2014pga2pct.pdf



DISCUSSION

The acceleration values contoured are the random horizontal component. Reference site condition is firm rock, defined as having an average shear-wave velocity of 760 m/s in the top 30 meters, corresponding to the boundary between NEHRP (National Earthquake Hazards Reduction Program) site classes B and C. Documentation, gridded values, interactive maps, and GIS data used to make the map are available online at ttp://earthquake.usgs.gov/hazards or http://dx.doi.org/10.3133/sim3325.

ACKNOWLEDGMENTS

We would like the thank the hundreds of workshop participants who made valuable suggestions that significantly improved the quality of the maps. The California part of the maps was produced jointly with the California Geological Survey.

REFERENCES

Petersen, M.D., Moschetti, M.P., Powers, P.M., Mueller, C.S., Haller, K.M., Frankel, A.D., Zeng, Yuehua, Rezaeian, Sanaz, Harmsen, S.C., Boyd, O.S., Field, Ned, Chen, Rui, Rukstales, K.S., Luco, Nico, Wheeler, R.L., Williams, R.A., and Olsen, A.H., 2014, Documentation for the 2014 Update of the United States National Seismic Hazard Maps: U.S. Geological Survey Open-File Report 2014–1091, 243 p., http://dx.doi.org/10.3133/ofr20141091.

Shaded relief base from Esri Inc., 2008, Data and Maps
All other base map data from Esri Inc., 1993, Digital Chart of the World
United States County base map from the U.S. Geological Survey National Atlas, available at http://nationalatlas.gov/

Projection: Albers equal-area conic
Standard parallels 29.5°N. and 45.5°N., central meridian 95°W

SCALE 1:7 000 000

Digital data prepared with ArcGIS 10.1 running under Windows 7

Publishing support provided by:
Denver Publishing Service Center
Edit and digital layout by L.J. Binder
Manuscript approved for publication on April 6, 2015

For more information concerning this publication, contact:
Center Director, USGS Geologic Hazards Science Center
Box 25046, Mail Stop 966
Denver, CO 80225
(303) 273-8579

Or visit the Geologic Hazards Science Center Web site at:
http://geohazards.cr.usgs.gov/.

Seismic-Hazard Maps for the Conterminous United States, 2014

Peak Horizontal Acceleration with 2 Percent Probability of Exceedance in 50 Years

By

Mark D. Petersen,[1] Morgan P. Moschetti,[1] Peter M. Powers,[1] Charles S. Mueller,[1] Kathleen M. Haller,[1] Arthur D. Frankel,[1] Yuehua Zeng,[1] Sanaz Rezaeian,[1] Stephen C. Harmsen,[1] Oliver S. Boyd,[1] Edward H. Field,[1] Rui Chen,[2] Nicolas Luco,[1] Russell L. Wheeler,[1] Robert A. Williams,[1] Anna H. Olsen,[1] and Kenneth S. Rukstales[1]

2015

[1]U.S. Geological Survey
[2]California Geological Survey, Sacramento, Calif.

ISSN 2329-132X (online)
http://dx.doi.org/10.3133/sim3325

This and other USGS information products are available at http://store.usgs.gov/.
U.S. Geological Survey
Box 25286, Denver Federal Center
Denver, CO 80225

To learn about the USGS and its information products visit http://www.usgs.gov/.
1-888-ASK-USGS

This report is available at:
http://pubs.usgs.gov/sim/3325/

Suggested citation: Petersen, M.D., Moschetti, M.P., Powers, P.M., Mueller, C.S., Haller, K.M., Frankel, A.D., Zeng, Yuehua, Rezaeian, Sanaz, Harmsen, S.C., Boyd, O.S., Field, E.H., Chen, Rui, Luco, Nicolas, Wheeler, R.L., Williams, R.A., Olsen, A.H., and Rukstales, K.S., 2015, Seismic-hazard maps for the conterminous United States, 2014: U.S. Geological Survey Scientific Investigations Map 3325, 6 sheets, scale 1: 7,000,000, http://dx.doi.org/10.3133/sim3325.

ATTACHMENT E
UNSTABLE AREAS COMPLIANCE DEMONSTRATION REPORT

Compliance Demonstration Report – Unstable Areas
Landfill Runoff Collection Pond
Clifty Creek Station

Indiana-Kentucky Electric Corporation
Madison, Jefferson County, Indiana

Prepared for:
Indiana-Kentucky Electric Corporation
Piketon, Ohio

Prepared by:
Stantec Consulting Services Inc.
11687 Lebanon Road
Cincinnati, Ohio 45241

October 16, 2018

Table of Contents

LIST OF FIGURES

LIST OF APPENDICES

1.0 PROJECT BACKGROUND

On April 17, 2015, the "Disposal of Coal Combustion Residuals (CCR) from Electric Utilities" (EPA Final CCR Rule) was published in the Federal Register. Stantec Consulting Services Inc. (Stantec) was contracted by the Indiana-Kentucky Electric Corporation (IKEC) to demonstrate proficiency regarding unstable areas at the Clifty Creek Station and evaluate compliance with §257.64 of the CCR Rule.

As required by §257.64 of the EPA Final CCR Rule, an owner or operator of an existing or new CCR landfill, existing or new CCR surface impoundment, or any lateral expansion of a CCR unit is required by October 17, 2018 to demonstrate that the unit is not located in an unstable area unless the owner or operator demonstrates that generally accepted good engineering practices have been incorporated into the design of the CCR unit to promote the geotechnical integrity of the unit in such a manner that structural components of the CCR unit will not be disrupted.

The following factors have been considered to determine whether the Landfill Runoff Collection Pond located at the Clifty Creek Station is in an unstable area:

- On-site or local soil conditions that may result in significant differential settling,
- On-site or local geologic or geomorphic features, and
- On-site or local human-made features or events (both surface and subsurface).

2.0 UNIT DESCRIPTION

The Clifty Creek Station is located on the north shore of the Ohio River downstream of Madison, Indiana. The station consists of six coal-fired electric generating units, each nominally rated at 217 megawatts. The Clifty Creek Station is directly accessible from State Route 56.

The Landfill Runoff Collection Pond is located at the southern edge of the station. It is bordered by the station's coal combustion residuals (CCR) landfill to the north, natural grade to the east and west, and by a dam to the south that runs along the bank of the Ohio River. Approximately 508 acres of both landfill contact water and stormwater runoff drain to the Landfill Runoff Collection Pond. Upon the completion of the CCR Landfill, the area draining to the Landfill Runoff Collection Pond will be reduced to approximately 443 acres (Stantec, 2010a).

Figure 1 below presents an overview of the Clifty Creek Station and related appurtenances including the main plant and the Landfill Runoff Collection Pond.

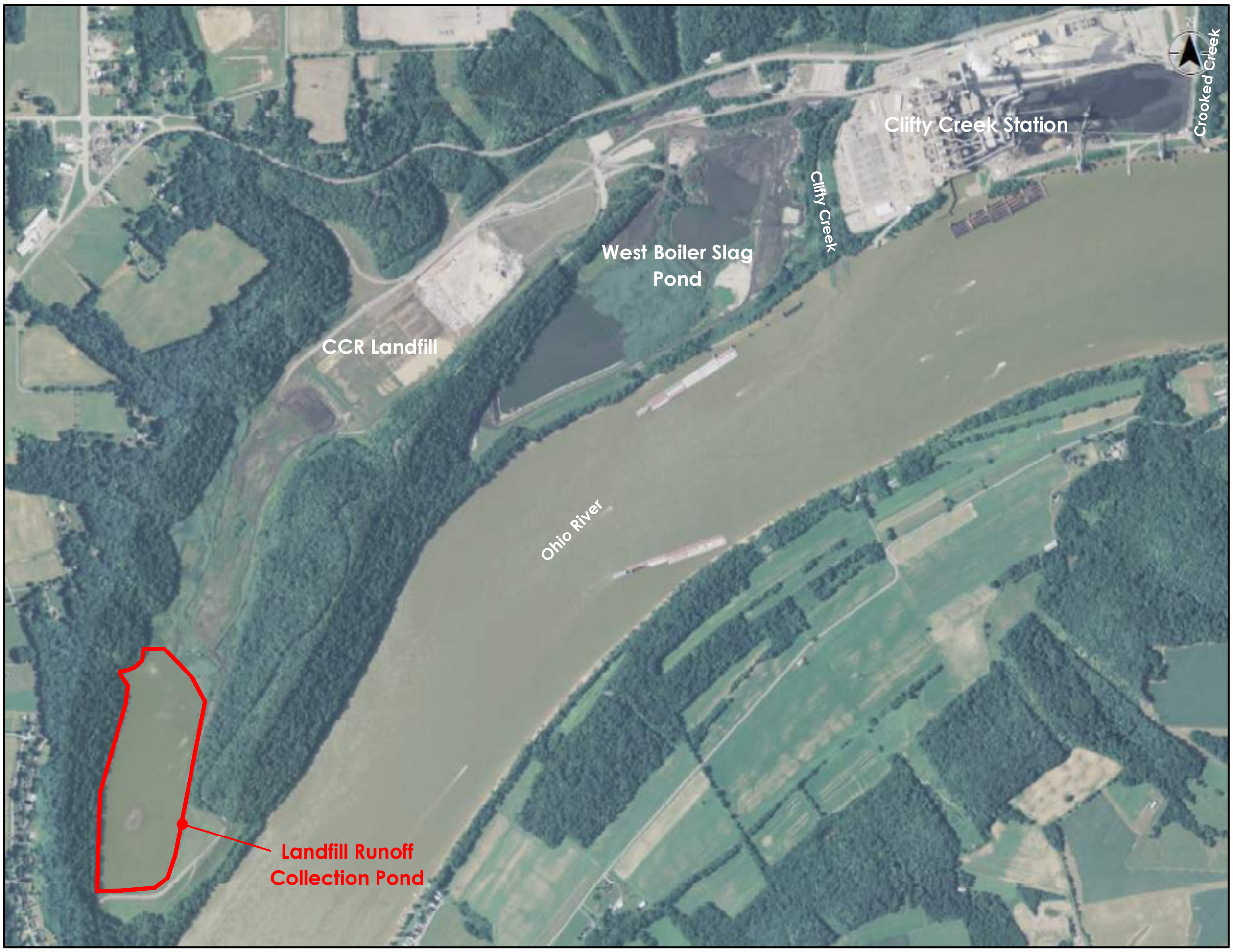


Figure 1. Aerial View of Clifty Creek Station

3.0 SOIL CONDITIONS (§257.64(B)(1))

Per §257.64(b)(1), the unstable areas demonstration must consider on-site or local soil conditions that may result in significant differential settling when determining whether the area is unstable.

Assessment of the soil conditions was completed considering the following criteria related to the CCR rule:

- Review inspection reports of the CCR unit that document deformations in the soils or movement of structural components indicating differential settlement of foundation soils.

- Review published soil surveys that indicate on-site or local presence of soft or compressible soil formation(s).
- Review documentation (including but not limited to geotechnical data reports, construction drawings, and field notes) containing information that may indicate the foundation materials are soft or compressible.
- Review results of existing analyses to confirm that any settlement of the unit would be marginal (within acceptable limits) and would not cause any unpermitted release of CCR into the environment.

3.1 BACKGROUND

Site inspections of the Landfill Runoff Collection Pond have been conducted and documented regularly since 1976 to present (Stantec, 2016b). These inspections include observations of vegetative cover, crest and slope conditions, and hydraulic structures for any signs of deformations in the soil or movement of the structural components that would indicate differential settlement of the foundation soils.

The U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) maintains an online web soil survey tool that provides information of local soils for a user-specified area of interest. The soil survey indicated the side slopes of rock ridge (Devil's Backbone) to the east and the ridge flanks to the west of the Landfill Runoff Collection Pond belong to the Eden-Caneyville complex (EgG). These soils are found on steep to very steep slopes ranging from 25 to 60 percent. The Eden-Caneyville complex consists of moderately deep and well-drained soils that formed on slopes facing the Ohio River and on back slopes facing adjacent to tributaries near the river.

The dam was designed by Arthur and Leo Casagrande of Cambridge, Massachusetts in the early to mid-1950s. They were also retained during the construction phase of the embankment and appurtenances. The firm was involved in the foundation preparation for the Landfill Runoff Collection Pond dam and the selection of the borrow soils (GZA, 2009).

According to IKEC (1985), significant upstream movement was observed during the construction of the southwest Landfill Runoff Collection Pond dam in October 1956. This was likely due to soft foundation materials. The movement was corrected by 10-foot high by 100-foot wide stability berm placed on the upstream toe. The dam has been observed for stability as part of the site inspections.

A geotechnical exploration was performed in 1984 to obtain geotechnical properties of the dam, dikes, and foundation material of the fly ash disposal area for a feasibility assessment of raising the dams by 30 feet (IKEC, 1985). The exploration included 29 soil borings, 11 cone penetrometer test

(CPT) borings, and the installation of 8 piezometers. According to GZA (2009), "The results of the feasibility study indicated several technical issues that prohibited the raising of the SFAP [Landfill Runoff Collection Pond] dam crest. Of particular concern were the results of the exploration program and stability analysis, which identified a soft, natural clay zone below the main dam having relatively low strength. The slope stability analysis resulted in factors of safety very close to 1.0 (approximately 1.03 to 1.05) for several critical dam cross sections for the increased crest elevation scenario. As a result, and due to the surficial topographical limitations, the downstream slope could not be flattened sufficiently to improve the dam stability and therefore the project was discontinued."

In 2004 and 2005, 28 piezometers were installed in various locations around the Clifty Creek Station (AGES, 2007). Twelve of those piezometers were installed southwest of the Landfill Runoff Collection Pond with three piezometers installed in the central portion of the CCR Landfill. Sixteen soil borings were advanced in 2005 to define the bedrock topography southwest of the Landfill Runoff Collection Pond. A figure produced in this report indicates that the CCR Landfill is underlain by gray clay and Dillsboro Formation shale and limestone.

Stantec performed geotechnical explorations in 2009 and 2015 to characterize the embankment of the Landfill Runoff Collection Pond dam. Stantec advanced four additional borings along the southern dam in 2009 (Stantec, 2010b), and one additional boring was advanced in 2015 to confirm subsurface conditions (Stantec, 2016a). These explorations indicated that the soils underlying the Landfill Runoff Collection Pond dam consisted primarily of lean clay, silty clay, silt, silty sand, silty with sand, and sand.

Two exploratory soil borings were completed south of the Landfill Runoff Collection Pond in 2015 to obtain geologic information specific to designing the CCR Rule monitoring networks (AGES, 2016). Nine monitoring wells were installed in 2015 at the CCR Landfill and Landfill Runoff Collection Pond. The boring logs from the exploratory soil borings and monitoring wells indicate that the subsurface conditions consist of silt, silty clay, and silty sand.

Appendix A includes the Web Soil Survey completed for the Landfill Runoff Collection Pond (USDA, 2018). Additional geologic information is included in Section 4.0.

3.2 ASSESSMENT

Inspections of the Landfill Runoff Collection Pond and dam have shown no visual signs of differential settlement or deformations of the structural components (AEPSC, 2017).

Historic soil reports and geotechnical exploration reports were reviewed for evidence of soft and compressible soils that may have been on site prior to the development of the Landfill Runoff

Collection Pond. For the purposes of this report, soft and compressible soils are fat clays, elastic silts, organic silts and clays, or highly organic soils (peat).

The subsurface investigations discussed in Section 3.1 did not indicate the presence of the above soil types underlying the Landfill Runoff Collection Pond and dam. However, several historic investigations indicate the presence of soft foundation clays. These soft foundation clay materials were recognized and considered in the design, construction, and continued operation of the Landfill Runoff Collection Pond and dam (GZA, 2009; AEPSC, 2016).

3.3 CONCLUSION

Based on the assessment of the soil conditions, the CCR Rule-related criteria listed above have been met.

4.0 GEOLOGIC OR GEOMORPHOLOGIC FEATURES (§257.64(B)(2))

Per §257.64(b)(2), the unstable areas demonstration must consider on-site or local geologic or geomorphologic features when determining whether the area is unstable.

Assessment of the geologic or geomorphologic features was completed considering the following criteria related to the CCR rule:

- Review of published geologic maps that indicate on-site or local geomorphologic features such as:
    - Karst potential,
    - Known sinkhole outlines,
    - Known spring locations, and
    - Known landslide locations.
- Review of inspection reports of the CCR unit that document characteristic features of karstic formation (e.g. sinkholes, vertical shafts, sinking streams, caves, seeps, large springs, or blind valleys).
- Review documentation (including but not limited to geotechnical data reports, construction drawings, and field notes) containing information regarding the on-site or local geology and geomorphology.

- Review of hillshade mapping by the Indiana Geological Survey (IGS) based on 5-foot Digital Elevation Models (DEM) derived from 1.5-meter LiDAR data to identify areas susceptible to mass movement.

4.1 BACKGROUND

Site inspections of the Landfill Runoff Collection Pond have been conducted and documented regularly since 1976 to present (Stantec, 2016b). These inspections include observations related to identifying characteristic features of karstic formations.

The Indiana Geological Survey (IGS) and Kentucky Geological Survey (KGS) maintain interactive geologic map information services that provides valuable, relevant information and retrievable data pertaining to geologic or geomorphologic features. Appendix B contains pertinent geologic and geomorphologic features from IGS and KGS mapping.

Physiographic mapping (IGS, 2018) indicates that the Clifty Creek Station is located in the Muscatatuck Plateau of the Southern Hills and Lowlands Region. The Muscatatuck Plateau is described as having broad till-covered uplands entrenched by major valleys.

According to quaternary geology mapping (IGS, 2018), the Landfill Runoff Collection Pond is underlain by alluvium deposited during the Holocene age. The alluvium consists of silt, sand, and gravel deposits of and along present streams and includes some colluvium along valley margins.

Indiana bedrock geologic mapping (IGS) indicates that the bedrock underlying the Landfill Runoff Collection Pond is in the Maquoketa Group of the Ordovician system. Bedrock in this group consists of limestone, dolomite, shale, and sandstone.

4.2 ASSESSMENT

Based on the information presented in the available inspection reports for the Landfill Runoff Collection Pond, there have been no documented characteristic features of sinkholes or karstic formation (AEPSC, 2017).

Sinkhole areas and sinking stream basins associated with karst geology are not located in the footprint of the Landfill Runoff Collection Pond (IGS, 2018). Large areas of known karst features are located in Lawrence, Washington, Orange, Harrison, and Floyd counties in Indiana, west of the Clifty Creek Station. Kentucky karst mapping (KGS, 2018) indicates that the Clifty Creek Station is near areas with low to medium karst potential.

The sinkhole inventory for southern Indiana and northern Kentucky developed by the IGS indicates that no sinkholes have been documented in the footprint of the Landfill Runoff Collection Pond (IGS, 2018). However, three sinkholes are located within a one-mile radius of the Landfill Runoff

Collection Pond, as shown in the mapping located in Appendix B. Note that no karst sinkhole areas, cave density, karst springs, or karst dye points are shown within one mile of the unit. The sinkhole inventory was created as a desktop exercise to support a statistical regression analysis of potential sinkhole development areas based on sinkhole density and a sinkhole-development risk layer; it is not based on field inspections.

Three landslides are located within 3 miles of the Clifty Creek Station in Kentucky according to the KGS landslide inventory (KGS, 2018). Similar mapping was not available for Indiana.

Mapping does not indicate any faults or other geologic deficiencies to be present in the immediate area of the impoundment (IGS, 2018; KGS, 2018).

The digital elevations models show no indication of areas susceptible to mass movement within the vicinity of the Landfill Runoff Collection Pond (IGS, 2018).

4.3 CONCLUSION

Based on the assessment of the geologic and geomorphologic features, the CCR Rule-related criteria listed above have been met.

5.0 HUMAN-MADE FEATURES OR EVENTS (§257.64(B)(3))

Per §257.64(b)(3), the unstable areas demonstration must consider on-site or local human-made features or events when determining whether the area is unstable.

Assessment of the human-made features or events was completed considering the following criteria related to the CCR rule:

- Review inspection reports of the CCR unit that document indications of tension cracking, settlement, depressions, or deformation of the unit's structural components (embankments, spillways, outlets, liners, leachate collection systems, or final covers).
- Review of routine operations and inspections at the landfill to maintain precaution from human-induced events or forces that might impair the integrity of some or all the structural components responsible for preventing unpermitted release of CCR into the environment.
- Review instrumentation installed to monitor the CCR unit to ensure readings are maintained within documented tolerances.
- Review of maps and other resources to confirm that the CCR unit is not located:

- On previously mined or quarried areas,
- On areas that have undergone excessive drawdown of groundwater, or
- On an old landfill.

5.1 BACKGROUND

Site inspections of the Landfill Runoff Collection Pond have been conducted and documented regularly since 1976 to present (Stantec, 2016b). These inspections include observations that document indications of human-induced events or forces that could have impaired the integrity of any structural components, which are responsible for preventing the unpermitted release of CCR to the environment.

Nine monitoring wells were installed in 2015 at the CCR Landfill and Landfill Runoff Collection Pond to meet the monitoring network requirements of the CCR Rule (AGES, 2016). The Annual Dam and Dike Inspection Report (AEPSC, 2017) included the maximum instrument readings for three piezometers (installed in 1994) and seven piezometers (installed in 1984).

Appendix C contains maps presenting the locations of mining activity, industrial waste sites, water wells, and oil and gas wells from available data and mapping in Indiana and Kentucky (IGS, 2018; KGS, 2018).

5.2 ASSESSMENT

Inspections of the Landfill Runoff Collection Pond have shown no visual signs of differential settlement or deformations of the structural components (AEPSC, 2017).

Mapping of mining activity in Indiana and Kentucky (IGS, 2018; KGS, 2018) indicates that no mines are located near the Clifty Creek Station. The nearest mine is located approximately 8 miles east of the site. There are no oil and gas wells located in the footprint of the Landfill Runoff Collection Pond. There is one dry petroleum well located approximately 1.5 miles northeast of the impoundment, and a 130-acre gas field is located approximately 3 miles east. The nearest industrial waste site is located approximately 1.5 miles east of the Clifty Creek Station. It is not expected that human events related to these industries or their operations pose any negative impact to the structural components of the Landfill Runoff Collection Pond.

According to IGS mapping (ODNR, 2018c), there are no wells shown in the footprint of the Landfill Runoff Collection Pond. There are four water wells owned by Hanover College approximately 0.4 miles southwest of the impoundment. As discussed in Section 5.1, 9 monitoring wells have been installed to meet the monitoring network requirements for the CCR Rule. Monitoring wells would not typically cause excessive drawdown of groundwater levels, thus posing no significant hazard.

5.3 CONCLUSION

Based on the assessment of the human-made features or events, the CCR rule-related criteria listed above have been met.

6.0 REFERENCES

American Electric Power Service Corporation (AEPSC) (2017). *2017 Annual Dam and Dike Inspection Report*. GERS-17-043. Clifty Creek Station. Madison, Indiana. November 7.

American Electric Power Service Corporation (AEPSC) (2016). *History of Construction, Landfill Runoff Collection Pond*. Clifty Creek Plant. Cheshire, Ohio. October.

Applied Geology and Environmental Science, Inc. (AGES) (2016). *Coal Combustion Residuals Regulation, Monitoring Well Installation Report, Indiana-Kentucky Electric Corporation, Clifty Creek Station, Madison, Indiana*. October.

Applied Geology and Environmental Science, Inc. (AGES) (2007). *Hydrogeologic Study Report. Clifty Creek Coal Ash Landfill, Clifty Creek Station*. Revision No. 1. April.

Casagrande, A. (1956). *Earth Dam for Fly Ash Storage. Clifty Creek Dam*. Letter to E. A. Kammer. March 10.

GZA GeoEnvironmental, Inc. (GZA) (2009). *Task 3 Dam Assessment Report. Clifty Creek Station. South Fly Ash Pond*. Prepared for Lockheed Martin. September 14.

Indiana Geological Survey (IGS) (2018). *IndianaMAP*. http://maps.indiana.edu/. Accessed February and March.

Indiana-Kentucky Electric Corporation (IKEC) (1985). *Flyash Dam Raising Feasibility Report, Clifty Creek Plant*. January 31.

Kentucky Geological Survey (KGS) (2018). *Kentucky Geologic Map Information Services.* http://kgs.uky.edu/kgsmap/kgsgeoserver_arch/viewer.asp. Accessed February and March.

Stantec Consulting Services Inc. (2016a). *Report of CCR Rule Stability Analyses. AEP Clifty Creek Power Plant. Boiler Slag Pond Dam and Landfill Runoff Collection Pond*. Madison, Jefferson County, Indiana. Prepared for American Electric Power, Columbus, Ohio. February 16.

Stantec Consulting Services, Inc. (Stantec) (2016b). *Initial Structural Stability Assessment. Clifty Creek Station, Landfill Runoff Collection Pond, Madison, Jefferson County, Indiana*. October 17.

Stantec Consulting Services Inc. (Stantec) (2010a). *Reservoir Routing Analysis. Landfill Runoff Collection Pond*. Clifty Creek Power Station. City of Madison, Jefferson County, Indiana. February.

Stantec Consulting Services Inc. (2010b). *Report of Geotechnical Exploration. AEP Clifty Creek Power, Landfill Runoff Collection Pond.* Prepared for American Electric Power, Columbus, Ohio. May.

United States Department of Agriculture (USDA) (2018). *Custom Soil Resource Report for Jefferson County, Indiana. Clifty Creek Landfill Runoff Collection Pond.* Natural Resources Conservation Service. February 21.

Appendix A SOIL CONDITIONS

Stantec

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for
Jefferson County, Indiana

Clifty Creek Landfill Runoff Collection Pond

February 21, 2018

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

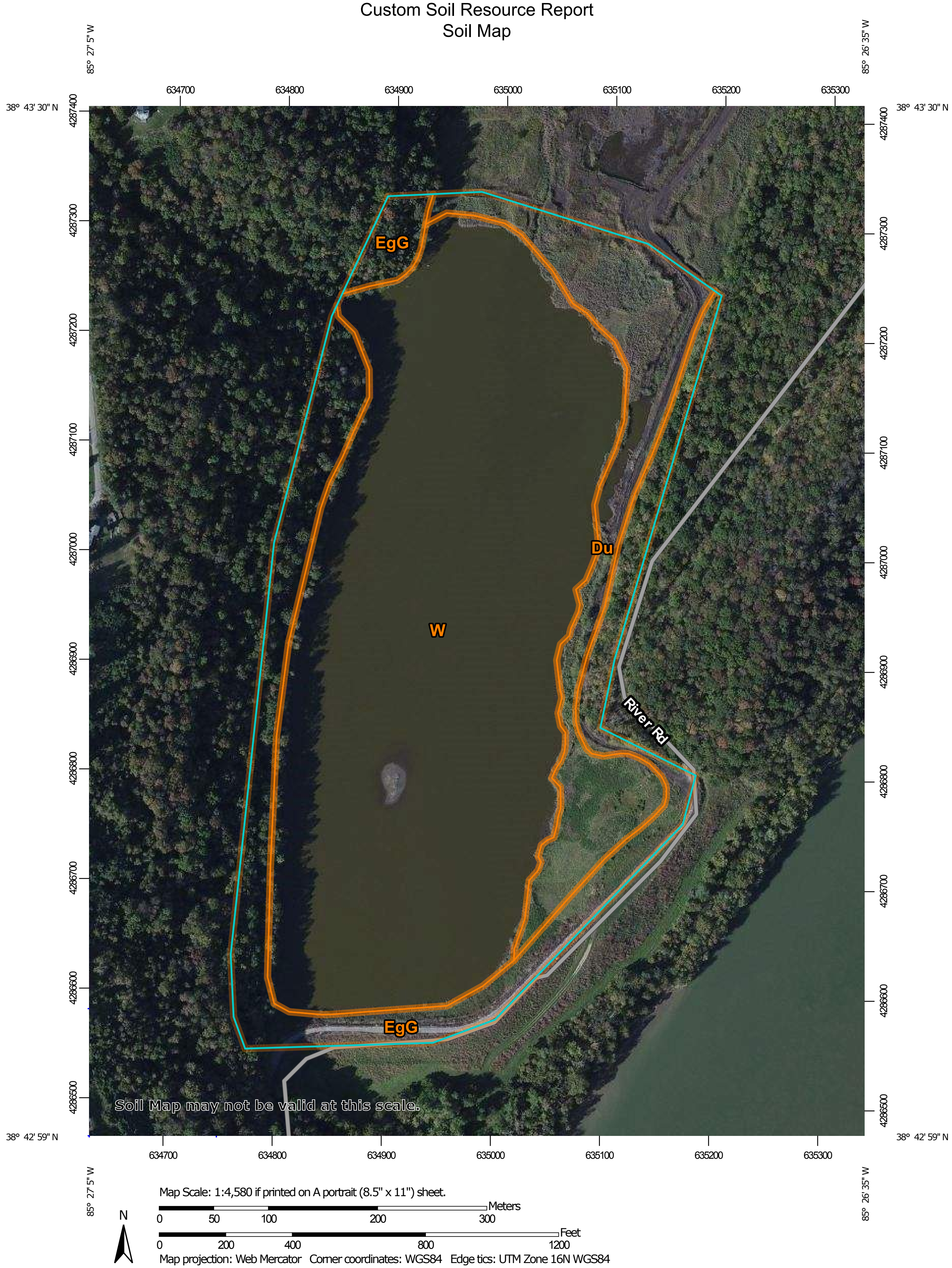
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map


85° 27' 5" W
85° 26' 35" W
634700
634800
634900
635000
635100
635200
635300
38° 43' 30" N
38° 42' 59" N
4287400
4287300
4287200
4287100
4287000
4286900
4286800
4286700
4286600
4286500
EgG
Du
W
River Rd
Soil Map may not be valid at this scale.
Map Scale: 1:4,580 if printed on A portrait (8.5" x 11") sheet.
Meters
0
50
100
200
300
Feet
0
200
400
800
1200
N
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 16N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Jefferson County, Indiana
Survey Area Data: Version 19, Oct 2, 2017

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Oct 3, 2011—Oct 4, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
Du	Dumps	8.9	14.3%
EgG	Eden-Caneyville complex, 25 to 60 percent slopes	12.1	19.3%
W	Water	41.6	66.4%
Totals for Area of Interest		**62.6**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Jefferson County, Indiana

Du—Dumps

Map Unit Setting

National map unit symbol: 11csk
Elevation: 350 to 1,020 feet
Mean annual precipitation: 40 to 46 inches
Mean annual air temperature: 51 to 56 degrees F
Frost-free period: 150 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

Dumps: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Dumps

Interpretive groups

Land capability classification (irrigated): None specified
Other vegetative classification: Trees/Timber (Woody Vegetation)
Hydric soil rating: No

EgG—Eden-Caneyville complex, 25 to 60 percent slopes

Map Unit Setting

National map unit symbol: 11csn
Elevation: 420 to 1,020 feet
Mean annual precipitation: 40 to 46 inches
Mean annual air temperature: 51 to 56 degrees F
Frost-free period: 150 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

Eden and similar soils: 75 percent
Caneyville and similar soils: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Eden

Setting

Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Clayey residuum over ordovician limestone and shale

Typical profile

A - 0 to 6 inches: flaggy silty clay
BA - 6 to 11 inches: flaggy silty clay

Bt - 11 to 39 inches: flaggy silty clay
Cr - 39 to 60 inches: weathered bedrock

Properties and qualities

Slope: 25 to 60 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 30 percent
Available water storage in profile: Low (about 4.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: D
Other vegetative classification: Trees/Timber (Woody Vegetation)
Hydric soil rating: No

Description of Caneyville

Setting

Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Clayey residuum over limestone

Typical profile

A - 0 to 8 inches: silt loam
Bt1 - 8 to 14 inches: silty clay loam
2Bt2 - 14 to 33 inches: clay
2R - 33 to 60 inches: unweathered bedrock

Properties and qualities

Slope: 25 to 60 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 5 percent
Available water storage in profile: Low (about 4.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: C
Other vegetative classification: Trees/Timber (Woody Vegetation)

Hydric soil rating: No

W—Water

Map Unit Composition

Water: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Water

Interpretive groups

Land capability classification (irrigated): None specified
Other vegetative classification: Trees/Timber (Woody Vegetation)
Hydric soil rating: No

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

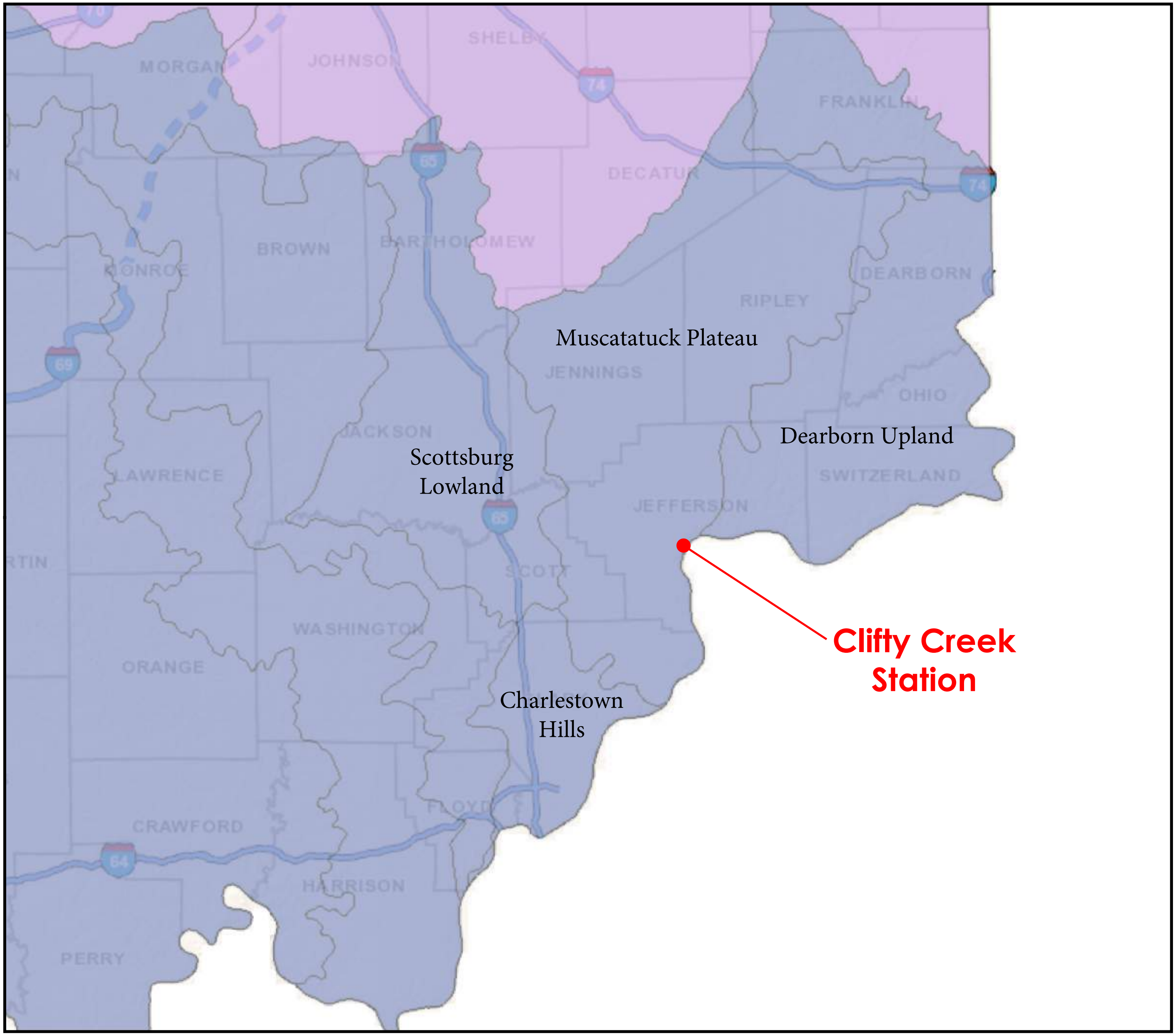
United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

Appendix B GEOLOGIC OR GEOMORPHOLOGIC CONDITIONS

Physiographic Regions

Date: 2/21/2018



Legend

Physiography

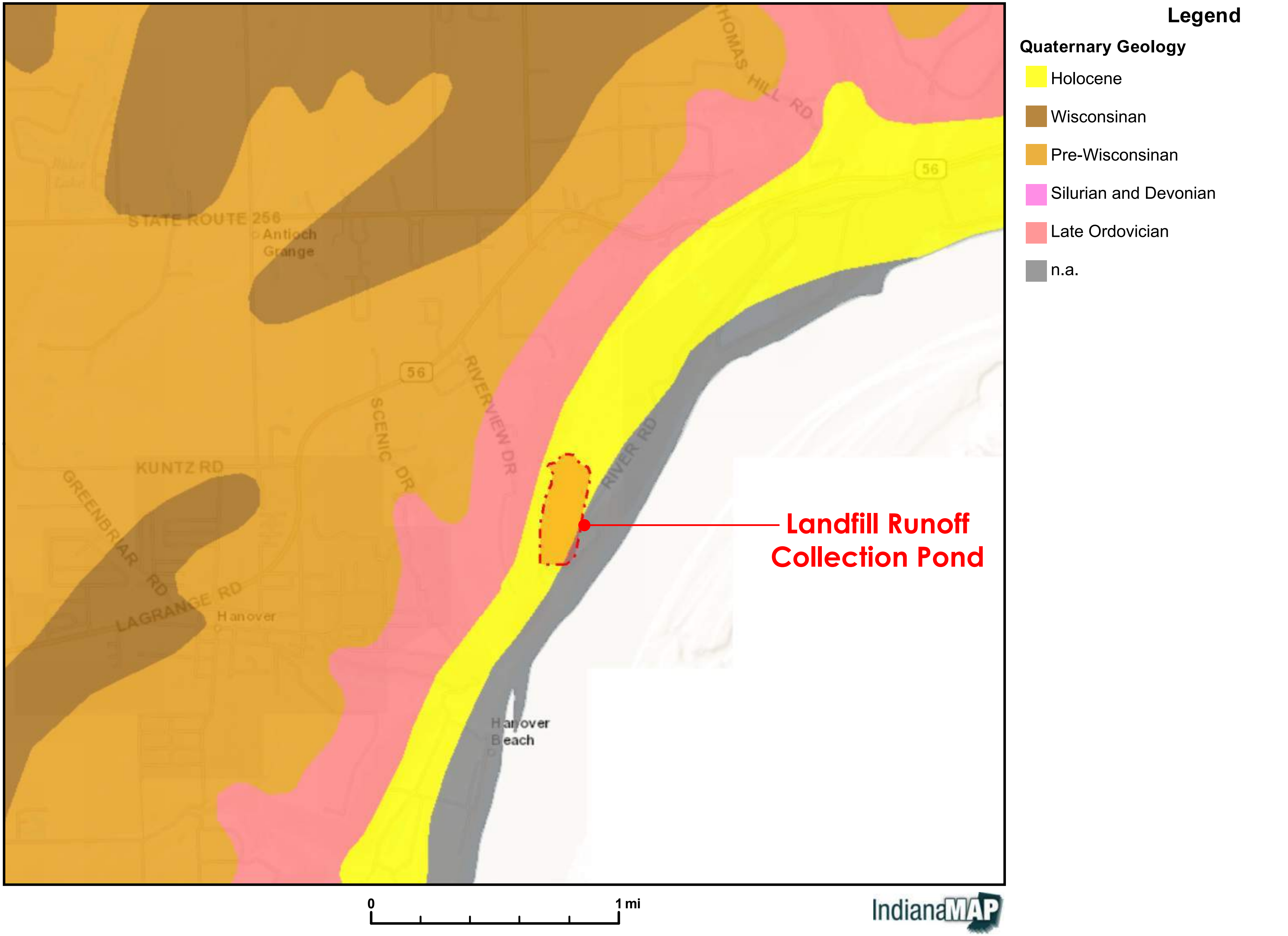
- Central Till Plain
- Maumee Lake Plain
- Northern Moraine and Lake
- Southern Hills and Lowlands

Author:

IndianaMAP

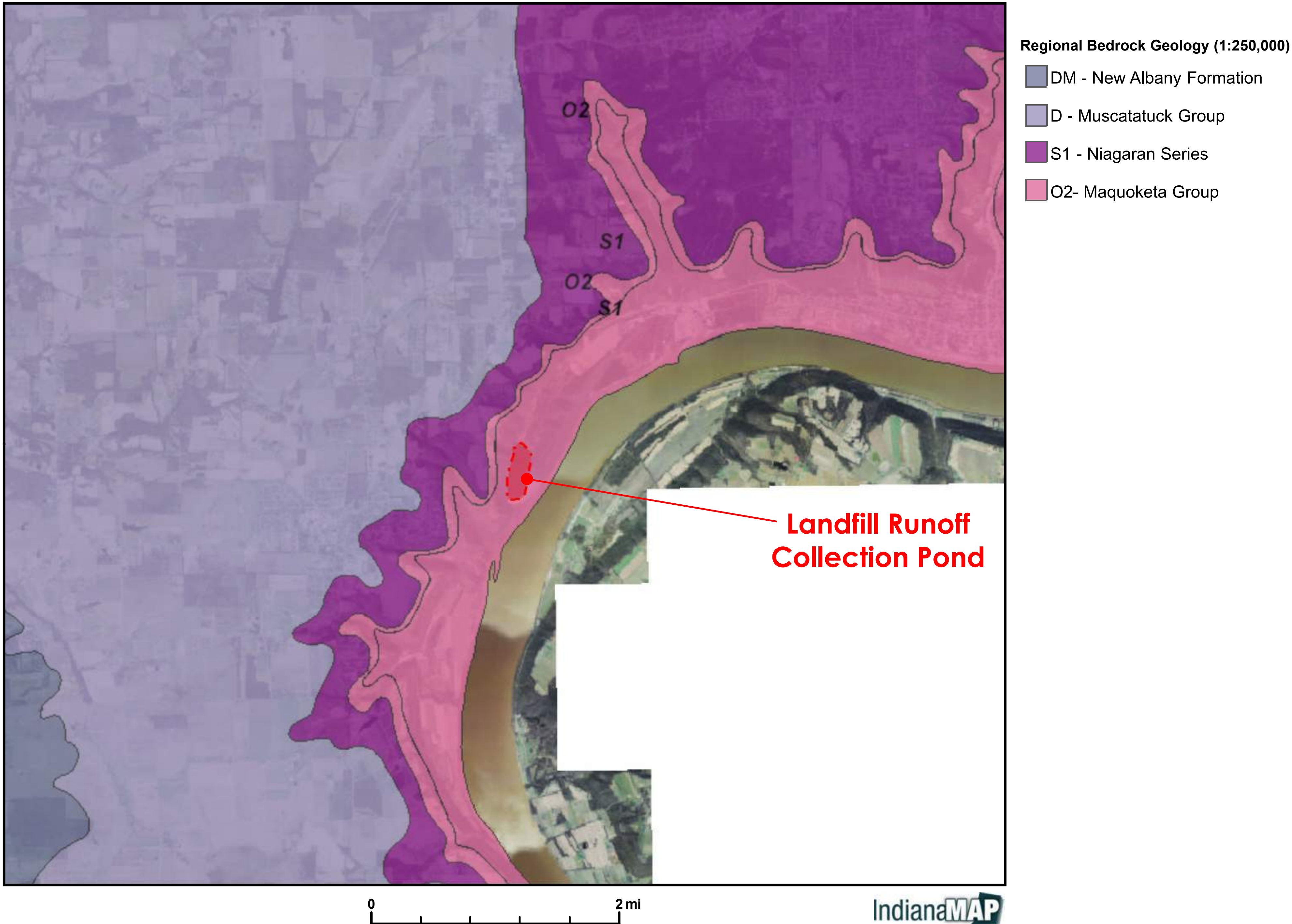
Quaternary Geology

Date: 2/22/2018



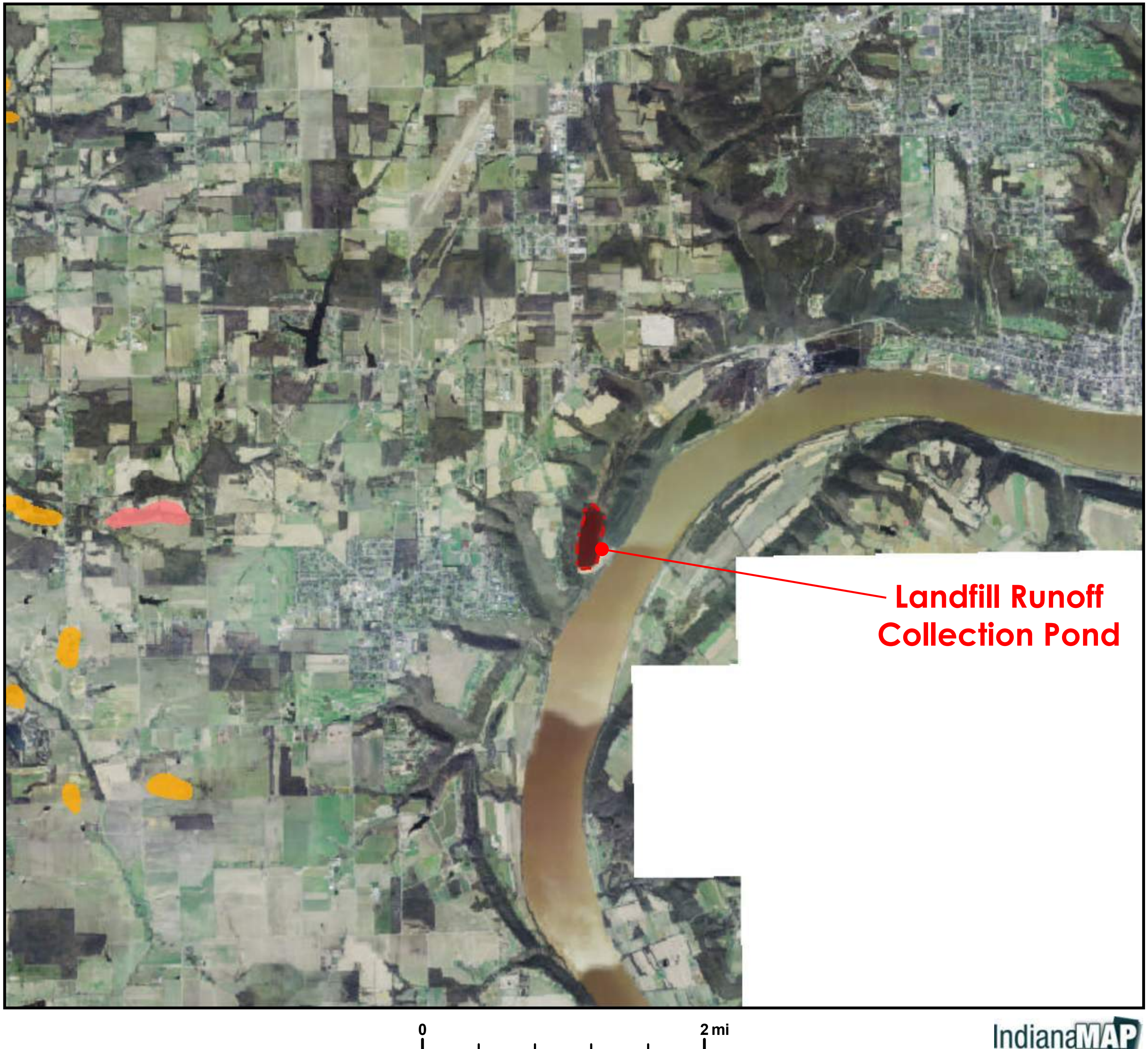
Bedrock Geology

Date: 2/21/2018



Karst Sinkhole Areas

Date: 2/21/2018



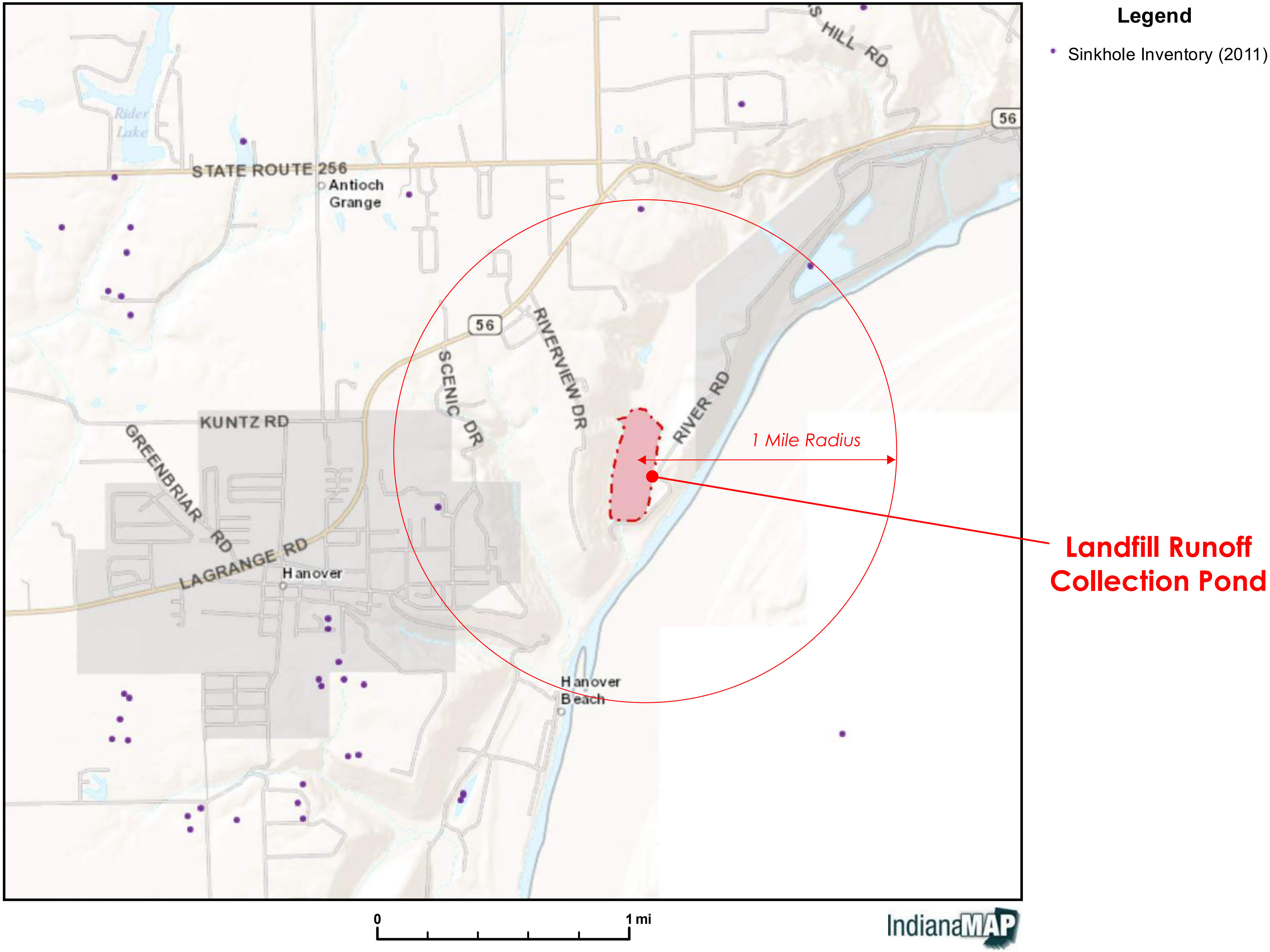
Legend

- Sinkhole Area
- Sinking Stream Basin

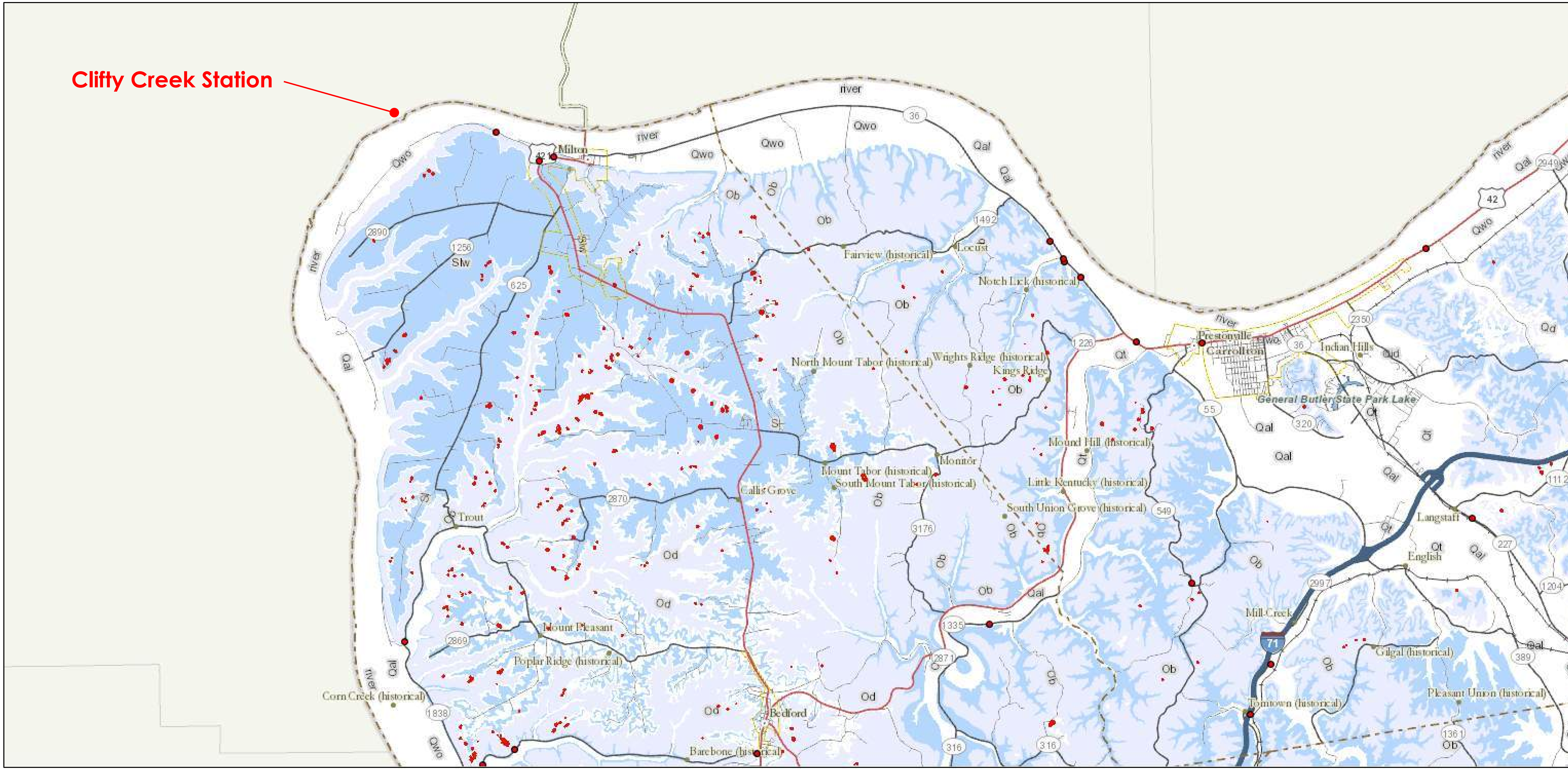
IndianaMAP

Sinkhole Inventory

Date: 2/22/2018



Kentucky Geologic Map Information Service



March 1, 2018

Karst Potential Units
- very high
- high
- medium
- low
- non-karst

KGS Landslide Locations

KGS landslide inventory data
- KGS landslide inventory data

1:24,000 geologic map landslides
- 1:24,000 geologic map landslides

Landslide areas derived from LiDAR
- Landslide areas derived from LiDAR

Landslide areas derived from aerial photography
- Landslide areas derived from aerial photography

KGS Sinkholes

Kentucky Sinkhole Outlines
- Sinkhole

KGS Geology

24K Geologic Faults
- fault - concealed
- fault
- fault - inferred
- fault - scarp
- fault - secondary

1:100,000

0 1 2 4 mi

0 1.75 3.5 7 km

Kentucky Geological Survey
Kentucky Division of Geographic Information (DGI)

author: Kentucky Geological Survey

Indiana LiDAR Color Hillshade

Date: 3/1/2018

Legend

High : 1256

Low : 247

Author:

0 — 0.5 mi

IndianaMAP

COMPLIANCE DEMONSTRATION REPORT –
UNSTABLE AREAS
LANDFILL RUNOFF COLLECTION POND
CLIFTY CREEK STATION

October 16, 2018

Appendix C HUMAN-MADE FEATURES OR EVENTS

Mining

Date: 2/21/2018

Legend

CoalMineUndergroundAffected

Mines - Surface

Mine Entries

Hoist

Slope

Other

Unknown

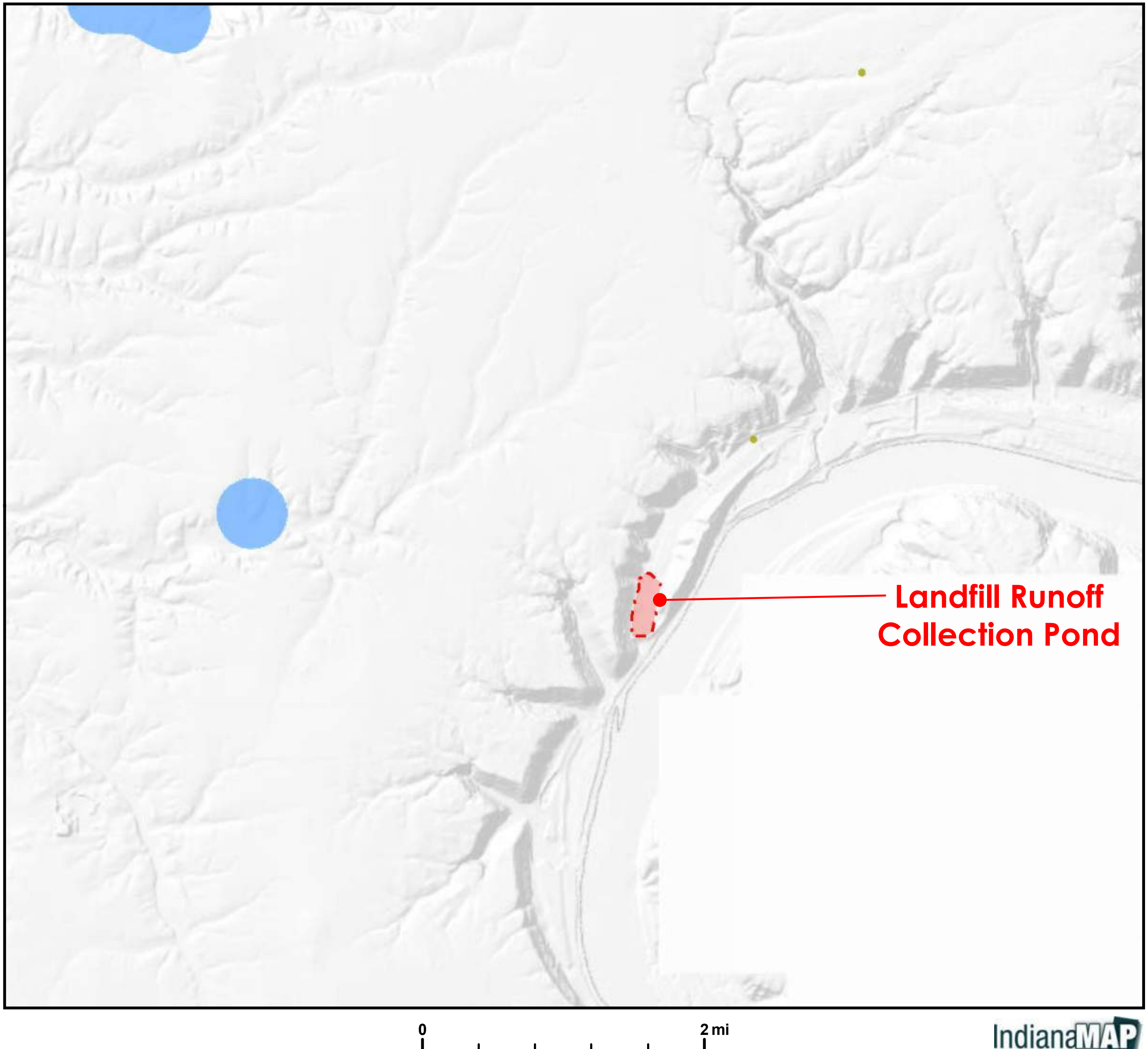
0 5 10 15 20 25 mi

Author:

IndianaMAP

Petroleum Wells/Fields

Date: 2/22/2018



Legend

Petroleum Wells (IGS, 2015)

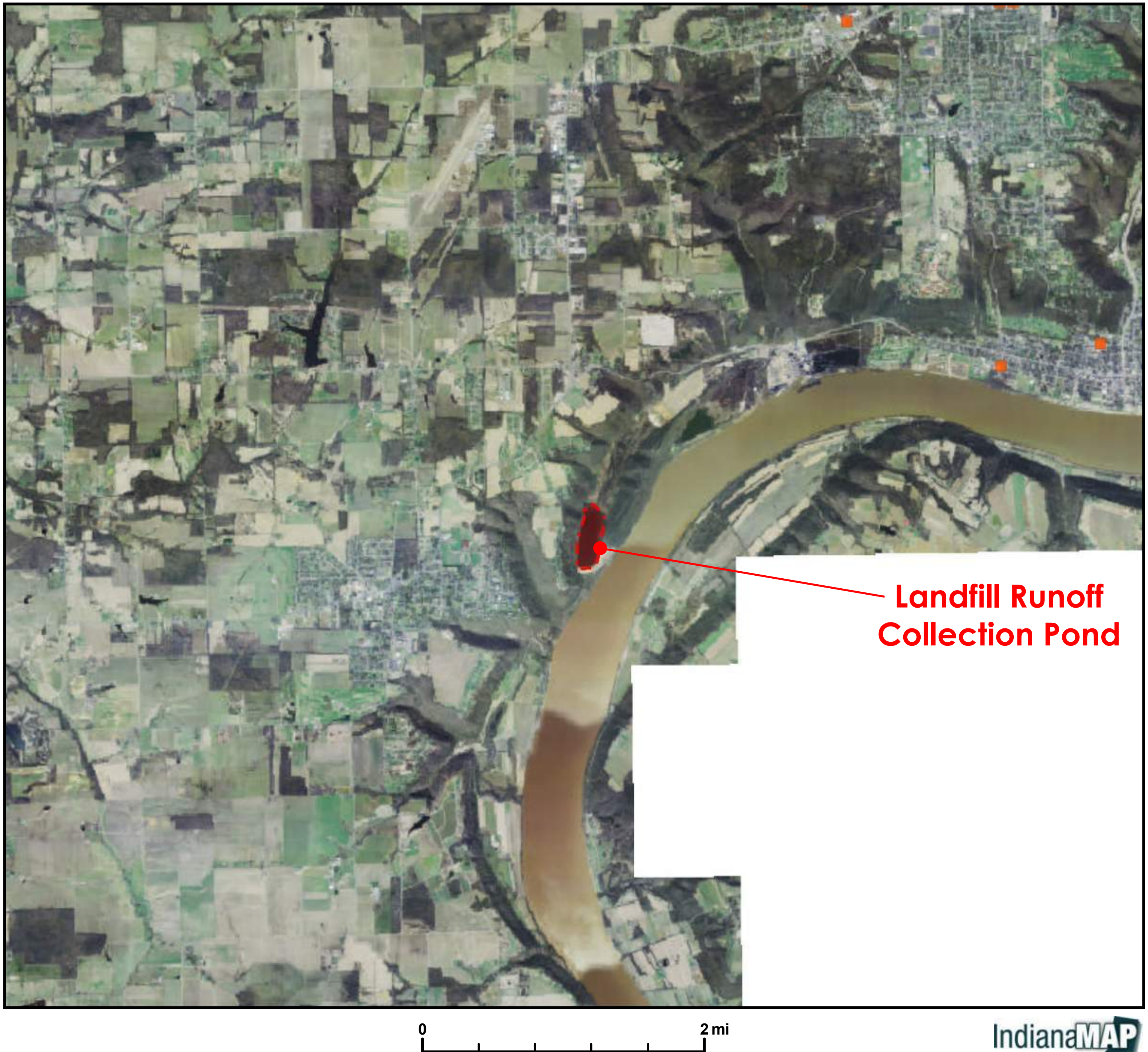
- Gas Wells
- Gas Storage Wells
- Oil Wells
- Service Wells
- Stratigraphic Test Wells
- Dry Wells
- Unknown Wells

Petroleum Fields (2015)

- Gas
- Oil
- Oil/gas

Industrial Waste Sites

Date: 2/21/2018

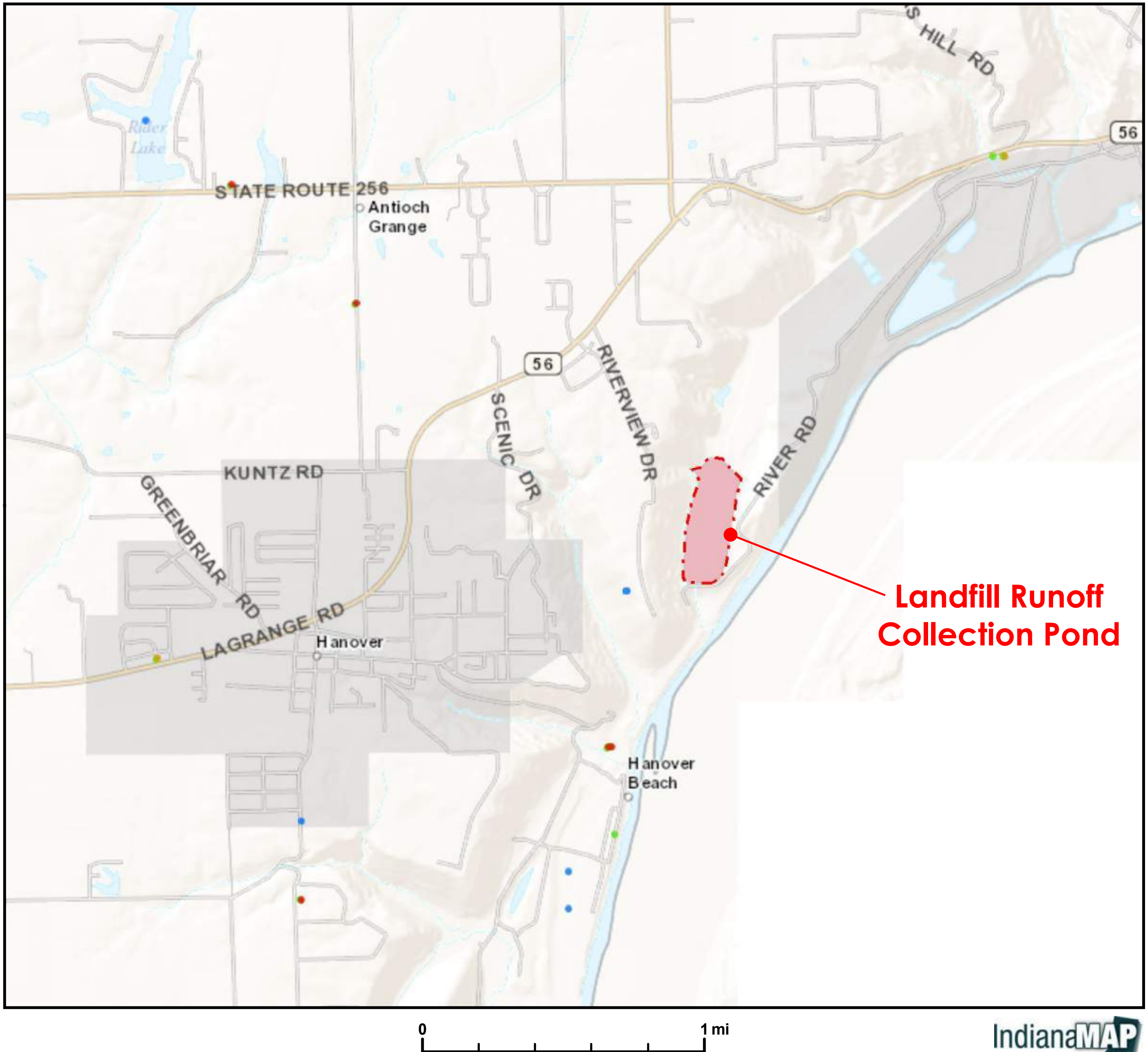


Legend

- Industrial Waste Sites

Water Wells

Date: 2/22/2018



Legend

Water Wells (IDNR)

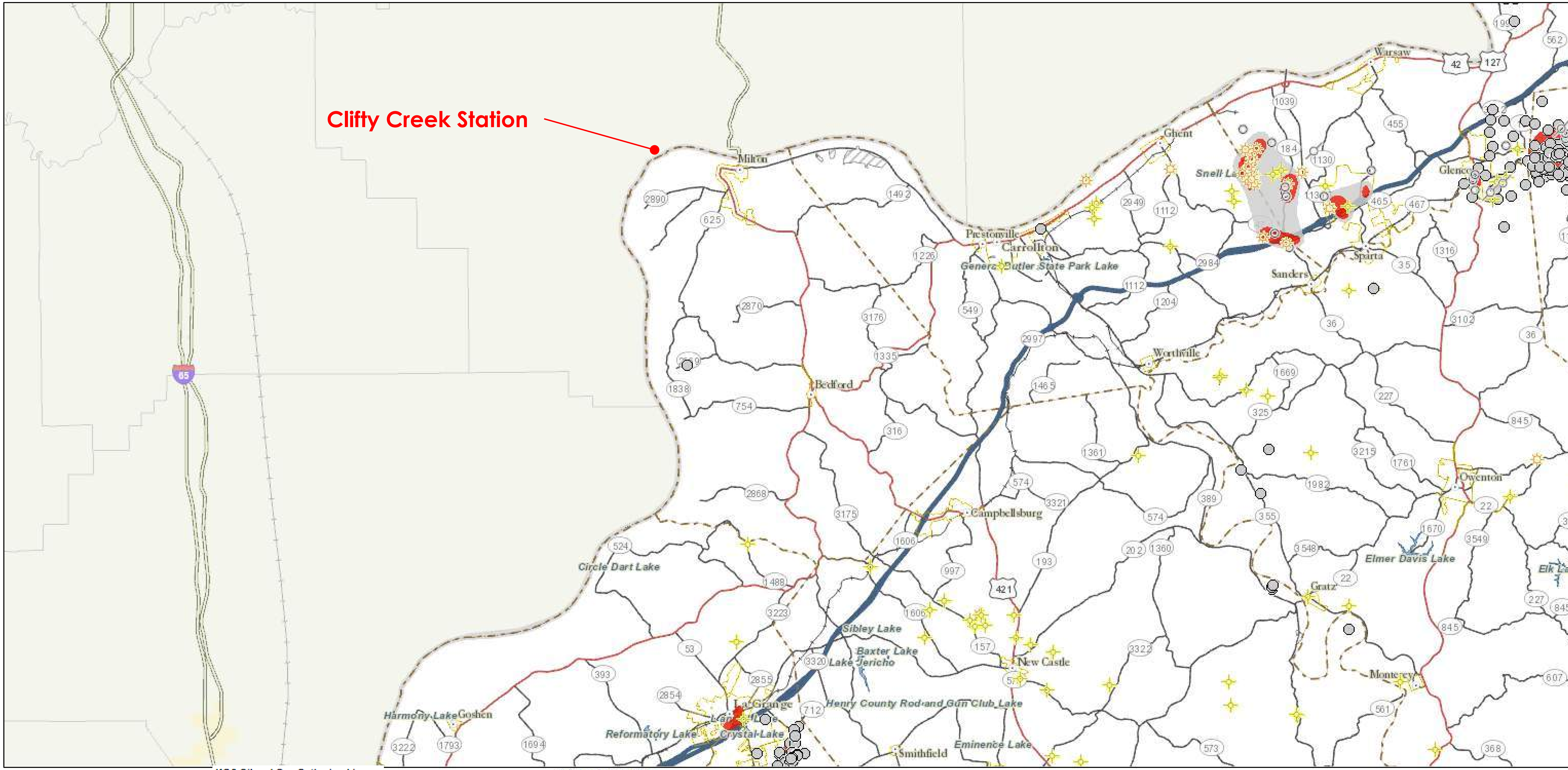
- Field Located
- Location Estimated

Water Wells (iLITH)

- 0 - 100
- 101 - 200
- 201 - 500
- 501 - 1000
- 1001 - 10000
- Observation Wells (USGS)

IndianaMAP

Kentucky Geologic Map Information Service



March 1, 2018

KGS Oil and Gas Gathering Lines

Oil and Gas Gathering Lines

- Other
- Oil and Gas Flow
- Oil and Gas Gathering
- Gas Flow
- Gas Gathering
- Oil Flow
- Oil Gathering
- Water Injection

KGS Oil and Gas Fields

KY Oil and Gas Fields

- Oil
- Gas
- Waterflood
- Big Sandy
- Consolidated

KY Oil and Gas Wells

- Other Well
- Service or Secondary Recovery Well
- Coal Bed Methane Gas Well
- Dry and Abandoned Well
- Gas Well
- Location
- Oil and Gas Well
- Oil Well

KGS Deviated Oil and Gas Wells

deviated well points

- deviated well point

deviated well traces

- approved deviated well (since 2006)

KGS Terminated Oil and Gas Records

KY Oil and Gas Terminated Permit

- Terminated Permit Well

KGS Non Coal Quarries

KY non coal quarries and pits

- Unknown
- Abandoned
- Active

Coal Borehole

- borehole

1:250,000

0 3 6 12 mi

0 4.75 9.5 19 km

Kentucky Geological Survey; KY Division of Oil and Gas
Kentucky Geological Survey; Kentucky Division of Oil and Gas
Kentucky Geological Survey
Kentucky Division of Geographic Information (DGI)