Submitted to
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Cooperative, Inc.
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March 2017

Location Restrictions for East Kentucky Power Cooperative at Area C Phase 3

Spurlock Station

Maysville, KY

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Figures

List of Attachments[1]

[1] AECOM relied on data in reference material produced by others as-provided.

Executive Summary

This Locations Restrictions Report for the Spurlock Landfill lateral expansion has been prepared in accordance with the requirements specified in 40 Code of Federal Regulations (CFR) §257.60 through §257.64, which states the CCR Rule requirements for location restrictions[2]. More specifically, the location restrictions sections are as follows:

- §257.60 Placement Above the Uppermost Aquifer
- §257.61 Wetlands
- §257.62 Fault Areas
- §257.63 Seismic Impact Zones
- §257.64 Unstable Areas

Each requirement of the CCR Rule requires the owner or operator to obtain certification from a qualified professional engineer stating that the demonstration meets the requirements of the applicable CCR Rule citation prior to placing CCR in the new unit. Area C Phase 3 of the Spurlock CCR Landfill represents a lateral expansion and meets the location restriction requirements, as outlined by this report.

[2] U.S. Environmental Protection Agency. (USEPA). (2015). *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals From Electric Utilities; Final Rule*, 40 CFR §257. Federal Register, Volume 80, Subpart D, April 17, 2015

1 Introduction

The purpose of the CCR location restriction report for the Spurlock Landfill Area C Phase 3 presented in this report is to document that the requirements in 40 Code of Federal Regulations (CFR) §257.60(a), §257.61(a), §257.62(a), §257.63(a), and §257.64(a) have been met to support certification for the existing active CCR units to remain in operation. These regulations require the owner or operator to obtain certification from a qualified professional engineer stating that the demonstration meets the specified aquifer, wetlands, fault distance, seismic acceleration, and unstable ground requirements of the CCR Rule prior to placing CCR in the lateral expansion area.

2 Facility and CCR Unit Description

The Spurlock Landfill is an existing special waste landfill owned by East Kentucky Power Cooperative, Inc. (EKPC). EKPC uses the landfill for disposal of coal combustion residuals (CCR) generated by the EKPC Spurlock Generating Station. The Spurlock Generation Station is located just northwest of Maysville on the Ohio River in Mason County, Kentucky. The landfill is located up on a ridge southwest of the station. The site location is found in Figure 1. Figure 2 depicts the station and also Landfill Area C Phase 3.

Coal Combustion Residuals (CCRs) are taken to and stored at the landfill, and as more land is required to store the CCRs, the landfill area is expanded. These expansions are planned in advance to accommodate projected production of the Spurlock Generating Station. Area C Phase 3 is the latest expansion area, advancing the landfill into the valley to the southeast.

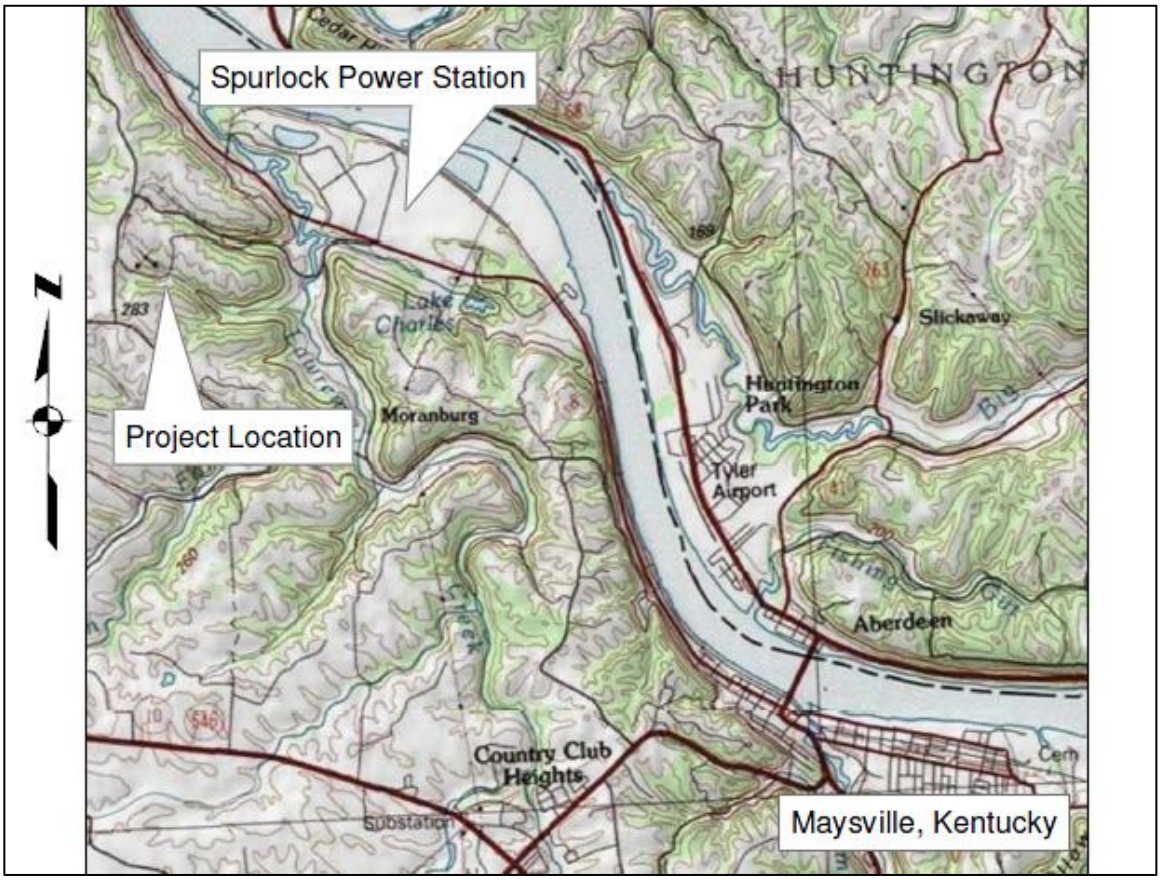

Figure 1 – Spurlock Generating Station Location Map (Ref: ArcGIS)

Not to scale

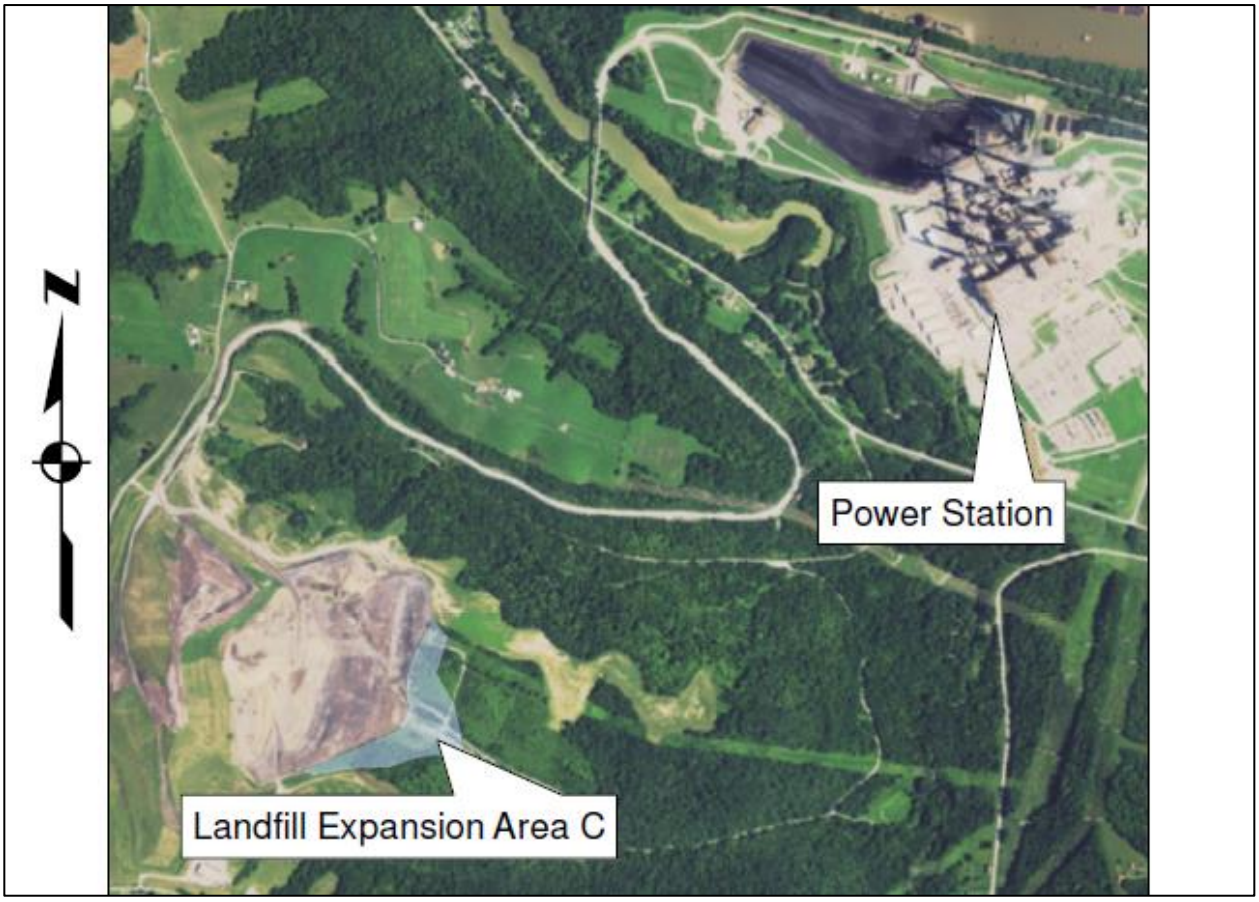

Figure 2 – Spurlock Station Site Plan (Ref: ArcGIS)

Not to Scale

3 §257.60 Placement Above the Uppermost Aquifer

3.1 §257.60(a) Citation

New CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must be constructed with a base that is located no less than 1.52 meters (five feet) above the upper limit of the uppermost aquifer, or must demonstrate that there will not be an intermittent, recurring, or sustained hydraulic connection between any portion of the base of the CCR unit and the uppermost aquifer due to normal fluctuations in groundwater elevations (including the seasonal high water table).

3.2 Separation of Aquifer to Base of CCR Unit

The Spurlock landfill expansion Area C Phase 3 is subject to Section §257.60 of the CCR Rule concerning the placement of the base of the CCR unit above the uppermost aquifer[3]. As stated on page 21362 of the Preamble of the CCR Rule, the base is considered to be located at the bottom of the liner components:

> *…the minimum vertical separation be at least three to five feet from the base of the liner components. After additional research, EPA is finalizing a minimum buffer of five feet instead of two feet. EPA's research confirmed the commenter's claims. In addition, EPA determined that several states consider five feet between the base of the surface impoundment and the top of the uppermost aquifer to be the minimum distance that is protective of human health and the environment. These are California, Michigan, Nebraska, New York, West Virginia, and Wisconsin. The Agency has concluded from geographic and climatic spacing of these states that the hydrogeologic conditions within them encompass the range of conditions found in the United States. Therefore, EPA is finalizing a minimum buffer of five feet instead of two feet.*

Based on the subsurface conditions observed during a field investigation by Fuller, Mossberger, Scott and May Engineers, Inc. (FMSM) in 2002, the soils at the valley bottom of Area C Phase 3 are mainly comprised of fill material. These fill soils can be classified as CL (clay of medium plasticity). The soils found on ridge tops and ridge flanks within Area C Phase 3 also classify as CL. The boring logs that contain the soil information are presented in Attachment A.

A review of AECOM's drawings showed the design details and elevations of the subgrade for Area C Phase 3. As mentioned in Section 2, the landfill expansion Area C Phase 3 has a liner consisting of two feet of compacted clay overlain by a 60-mil HDPE textured geomembrane liner. The elevations of the subgrade of Area C Phase 3 can be seen in Attachment B.

Piezometers were installed by Tetra Tech, Inc. in the vicinity of Area C Phase 3. These piezometers, in conjunction with the existing monitoring wells in the area were used to collect groundwater elevation data. As a preliminary measurement, groundwater elevation data from the monitoring wells and piezometers were taken as seen in Table 1.

Excerpt from the Preamble of the CCR Rule (Page 21362): EPA is revising the definition of "uppermost aquifer" to specify that the measurement of the upper limit of the aquifer must be made at a point nearest to the natural ground surface to which the aquifer rises during the wet season. This definition of "uppermost aquifer" will encompass large seasonal variations, and is more appropriate parameter than "seasonal high groundwater table" as suggested by several commenters and the proposed "natural water table" because it is more clearly defined.

Table 1 –Monitoring Well/Piezometer Groundwater Elevation

Monitoring Well/Piezometer	MW/PZ Elevation (NAVD, ft)
MW-2A	618.26
MW-3A	591.31
PZ-5	624.36
PZ-6	762.99
PZ-7	752.35

*The locations of these wells are outside the limits of Area C Phase 3.

The monitoring wells and piezometers are located outside the limits of Area C Phase 3. In order to produce a more thorough and accurate comparison, the groundwater elevation data was used to create piezometric contours in the project area, as seen in Attachment C1. Groundwater follows the topography, and flows down into the valley to the southeast. Because the groundwater beneath Area C Phase 3 can be designated as an unconfined aquifer, the piezometric contours based on the monitoring well and piezometer data are taken as the upper limit of the aquifer.

The piezometric contours were used to create a three dimensional “surface”, and then compared to the proposed subgrade elevations using the ArcGIS 3D Analyst tool package to subtract the elevation of the groundwater from the subgrade at every point in the study area. Two arbitrary locations are selected in these maps. According to Figure 3 the comparison has made it clear that Area C Phase 3 is far above the groundwater, with the minimum distance between the groundwater and the subgrade being approximately 36 feet. This is a reasonable conclusion considering the elevation of the site relative to the surrounding topography.

The liner design for Area C Phase 3 also includes an underdrain that would insure that there will not be an intermittent, recurring or sustained hydraulic connection between the base of the liner and any potential groundwater seepage from the uppermost aquifer, as required by the CCR Rule. An underdrain plan sheet and detail can be found in Attachment C2.

In summary, the comparison of the subgrade of the Spurlock Landfill Area C Phase 3 to the unconfined uppermost aquifer shows that 5 feet of separation exists between the upper limit of the aquifer and the base of the CCR landfill. The clays have low permeability and would not allow a sustained hydraulic connection between the base of the landfill and the aquifer during the seasonal high water table. Therefore, Landfill Expansion Area C Phase 3 meets the requirements of §257.60(a).

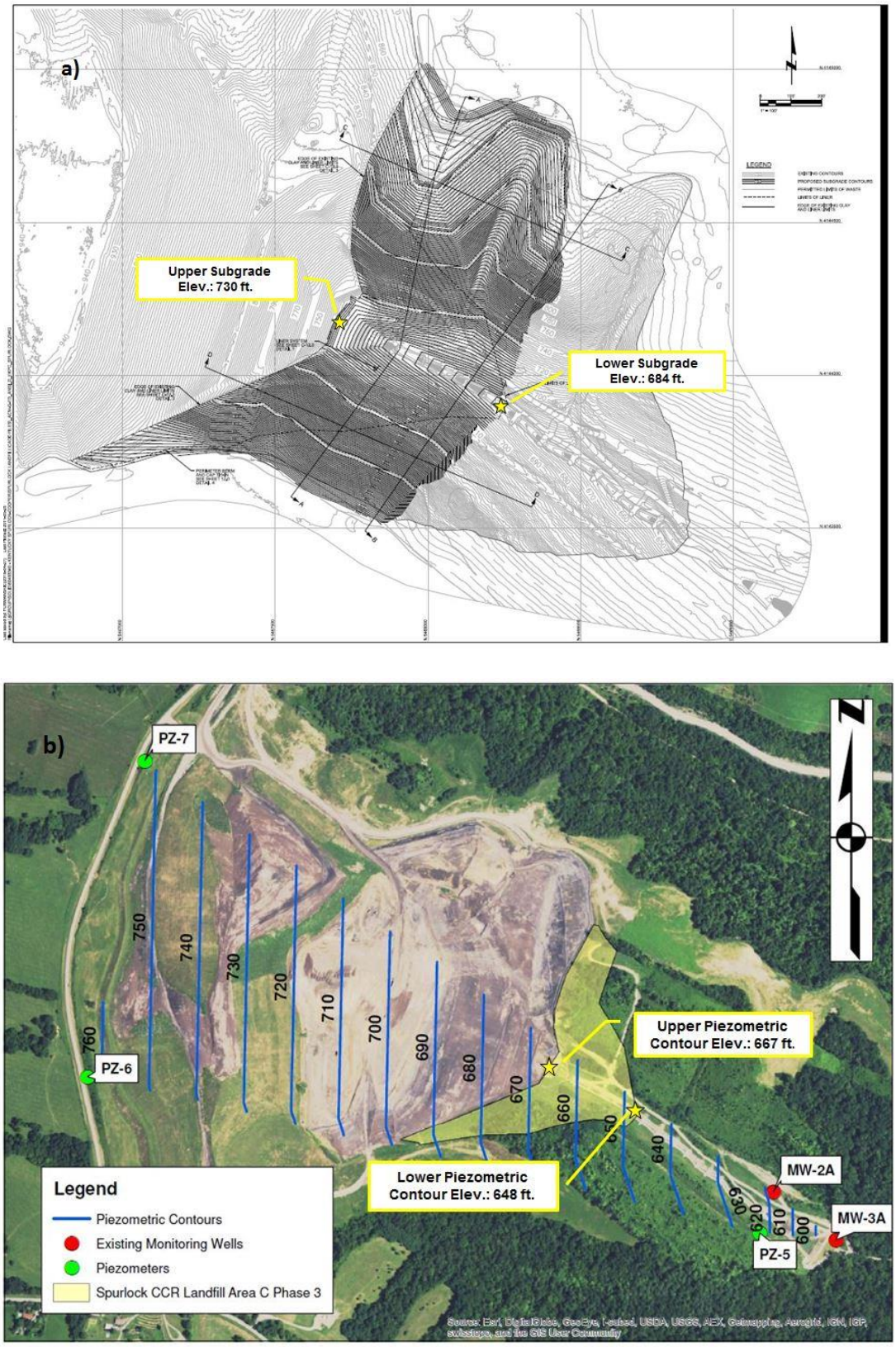

Figure 3 – Two Arbitrary (Upper and Lower) Locations in the a) Subgrade Contour Map and the b) Piezometric Contour Map

3.3 Federal Requirement [40 CFR §257.60]

Certification Statement 40 CFR § 257.60 – Placement of the Lateral Expansion of an Existing CCR Surface Impoundment Above the Uppermost Aquifer

CCR Unit: Spurlock Generating Station CCR Landfill Area C Phase 3

I, M. Brian Cole, being a Registered Professional Engineer in good standing in the State of Kentucky, do hereby certify, to the best of my knowledge, information, and belief, that the information contained in this certification has been prepared in accordance with the accepted practice of engineering. I certify, for the above-referenced CCR Unit, that the demonstration 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), as included in the Locations Restrictions Report dated 03/29/2017 meets the requirements of 40 CFR §257.60.

M. Brian Cole

_____

Printed Name

___3/29/2017_____

Date

4 §257.61 Wetlands

4.1 §257.61(a) Wetlands Citation

New CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must not be located in wetlands, as defined in §232.2 of this chapter, unless the owner or operator demonstrates by the dates specified in paragraph (c) of this section that the CCR unit meets the requirements of paragraphs (a)(1) through (5) of this section.

(1) Where applicable under section 404 of the Clean Water Act or applicable state wetlands laws, a clear and objective rebuttal of the presumption that an alternative to the CCR unit is reasonably available that does not involve wetlands.

(2) The construction and operation of the CCR unit will not cause or contribute to any of the following:

(i) A violation of any applicable state or federal water quality standard;

(ii) A violation of any applicable toxic effluent standard or prohibition under section 307 of the Clean Water Act;

(iii) Jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of a critical habitat, protected under the Endangered Species Act of 1973; and

(iv) A violation of any requirement under the Marine Protection, Research, and Sanctuaries Act of 1972 for the protection of a marine sanctuary.

(3) The CCR unit will not cause or contribute to significant degradation of wetlands by addressing all of the following factors:

(i) Erosion, stability, and migration potential of native wetland soils, muds and deposits used to support the CCR unit;

(ii) Erosion, stability, and migration potential of dredged and fill materials used to support the CCR unit;

(iii) The volume and chemical nature of the CCR;

(iv) Impacts on fish, wildlife, and other aquatic resources and their habitat from release of CCR;

(v) The potential effects of catastrophic release of CCR to the wetland and the resulting impacts on the environment; and

(vi) Any additional factors, as necessary, to demonstrate that ecological resources in the wetland are sufficiently protected.

(4) To the extent required under section 404 of the Clean Water Act or applicable state wetlands laws, steps have been taken to attempt to achieve no net loss of wetlands (as defined by acreage and function) by first avoiding impacts to wetlands to the maximum extent reasonable as required by paragraphs (a)(1) through (3) of this section, then minimizing unavoidable impacts to the maximum extent reasonable, and finally offsetting remaining unavoidable wetland impacts through all appropriate and reasonable compensatory mitigation actions (e.g., restoration of existing degraded wetlands or creation of man-made wetlands); and

(5) Sufficient information is available to make a reasoned determination with respect to the demonstrations in paragraphs (a)(1) through (4) of this section.

4.2 Wetlands Study

Two AECOM ecologists conducted a study of the proposed CCR Landfill units to identify any wetlands within proximity of the units. A field investigation was conducted at Spurlock CCR Landfill on July 6, 2016. An excerpt from “Waters of the U.S. Assessment” Draft for the EKPC CCR program is found in Attachment D.

The area that was evaluated for wetlands was primarily on steep hillsides and narrow ridgetops. Generally wetlands aren’t found on ridgetops or hillsides unless there are seeps or other disturbances that allow water to collect on a hillside. AECOM ecologists did not observe any seeps on the hillsides or wetland vegetation that might indicate the presence of a wetland. The valley bottom does have a perennial stream flowing that has been rock lined, collected some sediment, and appears to be routinely maintained to prohibit the growth of wetland vegetation. It is anticipated that a wetland will not develop on the assessed hillsides as they are to be developed based on information from the site escort.

4.3 Federal Requirement [40 CFR §257.61]

Certification Statement 40 CFR § 257.61 – Location of the Lateral Expansion of an Existing CCR Surface Impoundment in Wetlands

CCR Unit: Spurlock Generating Station CCR Landfill Area C Phase 3

I, M. Brian Cole, being a Registered Professional Engineer in good standing in the State of Kentucky, do hereby certify, to the best of my knowledge, information, and belief, that the information contained in this certification has been prepared in accordance with the accepted practice of engineering. I certify, for the above-referenced CCR Unit, that the demonstration that the CCR Unit is not located in wetlands, as included in the Location Restrictions Report dated 03/29/2017 meets the requirements of 40 CFR §257.61.

M. Brian Cole

_____

Printed Name

___03/29/2017_____

Date

5 §257.62 Fault Areas

5.1 §257.62(a) Citation

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.

5.2 Distance to Holocene Faults

As stated in the CCR Rule, a CCR unit is considered to be in a fault area if they are within 200 feet of the outermost damage zone of a fault that has seen displacement during the Holocene epoch, or within the last 12,000 years. As stated on page 21366 of the Preamble of the CCR Rule:

> *To investigate active faults, EPA expects owners and operators of CCR units to follow standard engineering and geologic practices. Technical considerations include:*
>
> > *(1) A geologic reconnaissance of the site to determine the location of active faults. Such a reconnaissance would include utilizing the seismic analysis maps and tools (Quaternary fault maps, earthquake probability maps) of the United States Geological Survey (USGS) Earthquake Hazards Program (http:// earthquake.usgs.gov/hazards/apps/); and*
> >
> > *(2) a site fault characterization within 1000 meters of a site to determine whether it is within 60 meters of an active fault. Such characterizations would include subsurface exploration, including drilling or trenching, to locate any fault zones and evidence of faulting, trenching perpendicular to any faults or lineaments found within 60 meters of the site, and determination of the age of any displacements.*)

AECOM researched the United States Geologic Survey (USGS) Geographic Information Systems (GIS) Database for known Holocene faults. Since the Holocene faults are defined within the Quaternary Period, which is the last 2.6 million years up to the present, a USGS map is provided which shows the Quaternary faults zones in proximity to Spurlock Po wer Station (Ref: Attachment E). Furthermore, the USGS has also produced a Geologic Map of the Maysville area (Attachment F).

Given the findings that the geologic reconnaissance did not determine the presence of active faults within 1000 meters of the CCR units, no further action (e.g., a site characterization) was performed.

Based on the results of the evaluation described herein, Area C Phase 3 landfill expansion is not located within 60 meters (200 feet) of the outermost damage zone of a fault that has seen displacement during the Holocene time. Therefore, it meets the requirements of §257.62(a).

5.3 Federal Requirement [40 CFR §257.62]

Certification Statement 40 CFR § 257.62 – Location of the Lateral Expansion of an Existing CCR Surface Impoundment within 60 Meters of a Fault Area

CCR Unit: Spurlock Generating Station CCR Landfill Area C Phase 3

I, M. Brian Cole, being a Registered Professional Engineer in good standing in the State of Kentucky, do hereby certify, to the best of my knowledge, information, and belief, that the information contained in this certification has been prepared in accordance with the accepted practice of engineering. I certify, for the above-referenced CCR Unit, that the demonstration regarding that the CCR Unit is not located within 60 meters (200 feet) of the outermost damage zone of a fault that has had a displacement in Holocene time, as included in the Location Restrictions Report dated 03/29/2017, meets the requirements of 40 CFR §257.62.

M. Brian Cole

_____

Printed Name

03/29/2017

Date

6 §257.63 Seismic Impact Zones

6.1 §257.63(a) Citation

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

6.2 Seismic Impact Zones

As stated on page 21471, the CCR Rule defines a *seismic impact zone* as "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 0.10 g in 50 years". The USGS produced a national map of the two-percent probability of exceedance in 50 years map of peak ground acceleration (Figure 4). The Spurlock Power Station is in the area of less than 0.1g, and the USGS provides a method to calculate the PGA of specific sites.

The United States Geologic Survey National Seismic Hazards Mapping Project, PSHA Deaggregation program, 2008 version was used to find the PGA. The results of the Deaggregation program are found in Figure 5. The result for the Spurlock Power Station is presented in the table below.

Table 2 – Peak Ground Acceleration at Spurlock Power Station

Location	Peak Ground Acceleration (PGA)
Spurlock Power Station	0.086 g

The PSHA deaggregation program reports all PGA results for lithified earth materials, which corresponds to seismic site classes A, B, or C. The PGA is below 0.1 g and meets the criteria. Therefore, the Spurlock CCR Landfill is not located in a seismic impact zone.

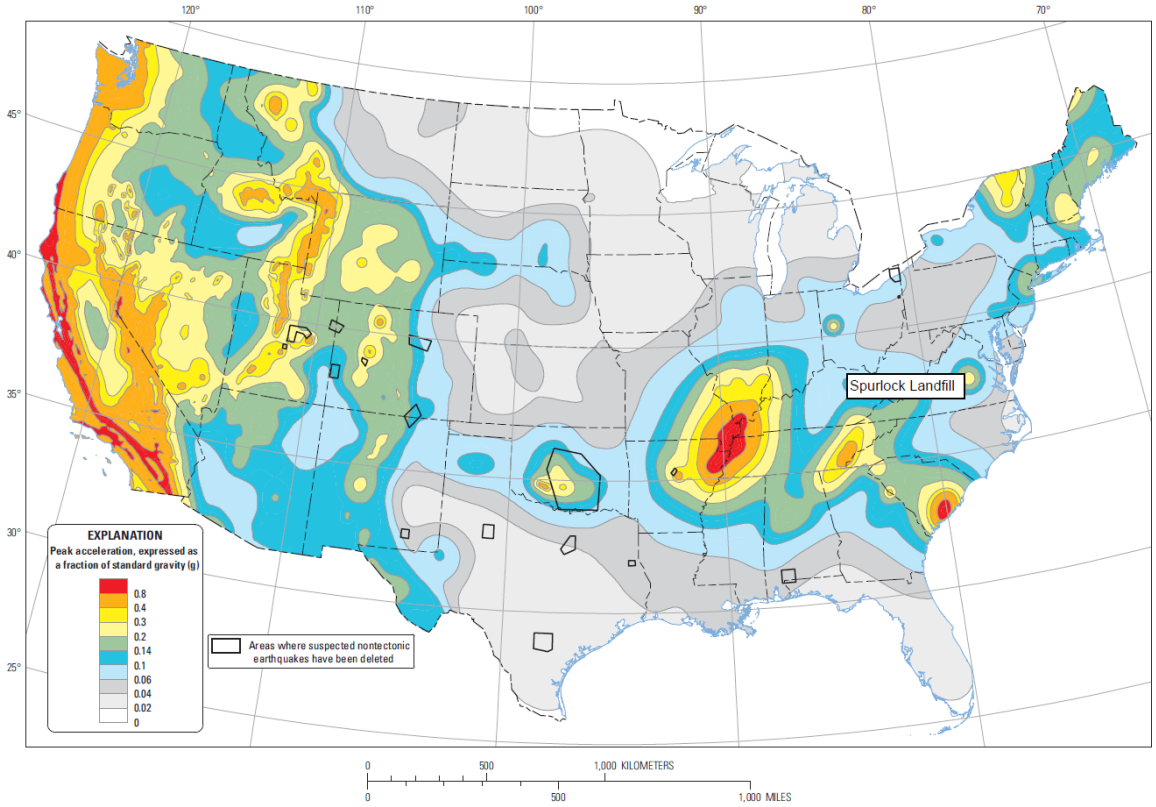

Figure 4 – Two-Percent Probability of Exceedance in 50 Years Map of Peak Ground Acceleration (Reference: USGS Website)

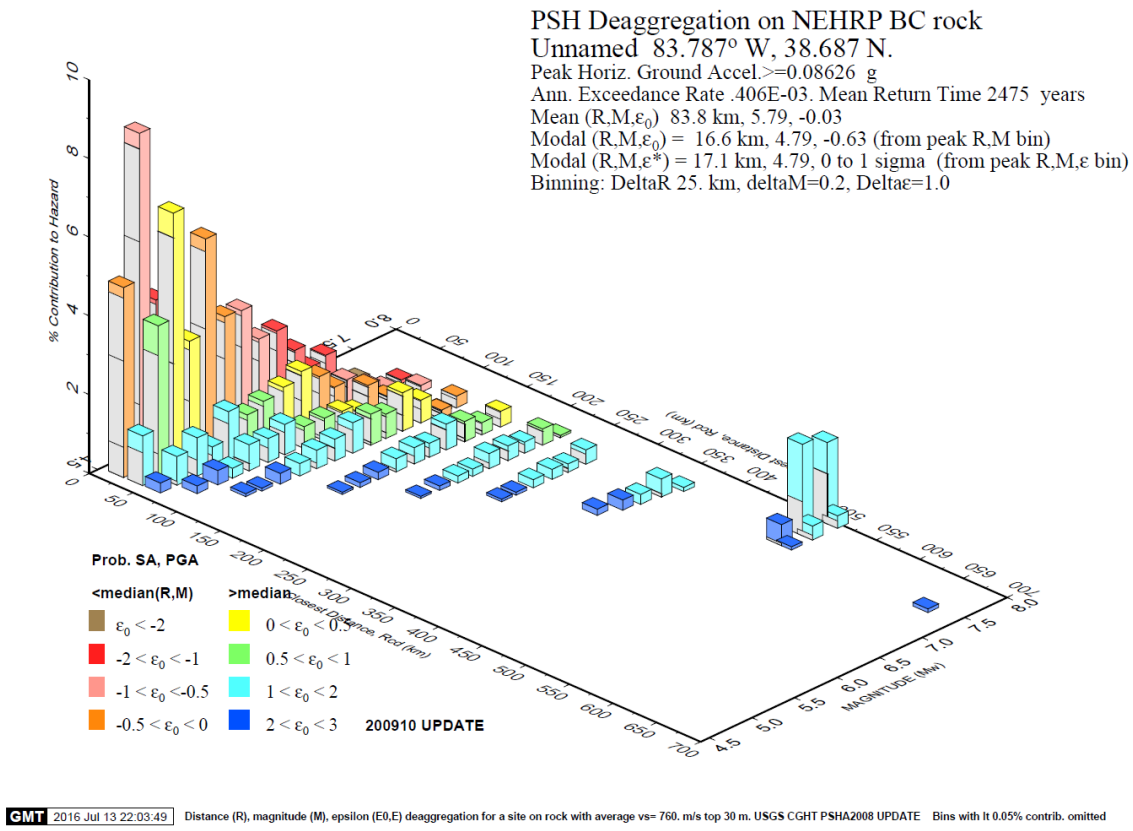

Figure 5 – The PSHA Deaggregation Program Result (PGA=0.086 g)
(Reference: USGS Website)

6.3 Federal Requirement [40 CFR §257.63]

Certification Statement 40 CFR § 257.63 – Location of the Lateral Expansion of an Existing CCR Surface Impoundment in a Seismic Impact Zone

CCR Unit: Spurlock Generating Station CCR Landfill Area C Phase 3

I, M. Brian Cole, being a Registered Professional Engineer in good standing in the State of Kentucky, do hereby certify, to the best of my knowledge, information, and belief, that the information contained in this certification has been prepared in accordance with the accepted practice of engineering. I certify, for the above-referenced CCR Unit, that the demonstration that the CCR Unit is not located in a seismic impact zone, as included in the Location Restrictions Report dated 03/29/2017, meets the requirements of 40 CFR §257.63.

M. Brian Cole

_____

Printed Name

03/29/2017

Date

7 §257.64 Unstable Areas

7.1 §257.64(a)-(b) Citation

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

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

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

(2) On-site or local geologic or geomorphologic features; and

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

7.2 Unstable Areas, Settlement, Collapsible Soils

All CCR landfill lateral expansions are subject to the unstable areas location restriction.

AECOM personnel reviewed federal, state, and plant documents and databases for information concerning stability of the Spurlock Landfill and the surrounding areas. Geologic maps show the presence of geologic features that may cause unstable areas in the general vicinity of the landfill, including karst features and the Kope formation, which can form an unstable colluvium when exposed to weathering at the surface.

Based on review of historical data, no settlement or collapsible soils were observed within Area C Phase 3. A review of the geological quadrangle (GQ) map, the Kope formation is exposed to the southeast, in a lower portion of the valley. The borings performed by FMSM in 2001 encountered soil thickness ranging from about 0.4 to 10 feet, underlain by limestone bedrock. The soils encountered were typically classified as medium plasticity clay (CL), and high plasticity clay (CH), and were typically stiff in consistency.

Based on review of historical data, no karst features were observed within Area C Phase 3. Furthermore, AECOM had a representative inspect the prepared subgrade of Area C Phase 3. They observed no evidence of the existence of sinkholes or other karst features within the footprint of Area C Phase 3. In accordance with the recommendation of Stantec's *Interim Stability Report* (2014), direct shear testing was performed on project-specific materials to confirm that the liner materials meet the interfacial shear strength envelope determined in their study. The inclusion of an underdrain in the design will help to maintain the long-term stability of the lined slopes, as designed. Therefore, for the Area C Phase 3 landfill expansion, the presence of unstable areas, settlement, or collapsible soils was not indicated and the demonstration that the expansion is not located in an unstable area meets the requirements of §257.62(b).

7.3 Federal Requirement [40 CFR §257.64]

Certification Statement 40 CFR § 257.64 – Location of the Lateral Expansion of an Existing CCR Surface Impoundment in an Unstable Area

CCR Unit: Spurlock Generating Station CCR Landfill Area C Phase 3

I, M. Brian Cole, being a Registered Professional Engineer in good standing in the State of Kentucky, do hereby certify, to the best of my knowledge, information, and belief, that the information contained in this certification has been prepared in accordance with the accepted practice of engineering. I certify, for the above-referenced CCR Unit, that the demonstration that the CCR Unit is not located in an unstable area, as included in the Location Restrictions Report dated 03/29/2017, meets the requirements of 40 CFR §257.64.

M. Brian Cole

_____

Printed Name

_____03/29/2017_____

Date

8 Limitations

In preparing this report, AECOM has reviewed background information, design basis, and other data furnished to AECOM by EKPC, as well as relevant available information from previous and current investigations of the site. AECOM has relied on this information as furnished without independent verification, and is not responsible for the accuracy or completeness of this information. AECOM shall not be held responsible for conditions or consequences arising from relevant facts that were concealed, withheld, or not fully disclosed by EKPC at the time this report was prepared. In addition, the conclusions expressed in this report are subject to certain conditions and assumptions, which are noted in this report and below. Any party reviewing this report must carefully review and consider all such conditions and assumptions.

The conclusions made in this report are based on the assumption that the subsurface soil, rock, and groundwater conditions at the site do not deviate appreciably from those conditions disclosed in the site-specific exploratory borings. The conclusions in this report are also based on AECOM's understanding of current plant operations, maintenance, storm water handling, and ash handling procedures at the station based on information provided by EKPC. The passage of time may result in changes in site conditions and variations, technology, economic conditions, and regulatory provisions, all which could render the report inaccurate.

This report was prepared by AECOM in accordance with generally accepted engineering and scientific practice in effect at the time of AECOM's assessment of the subject property. This report was prepared pursuant to an agreement between AECOM and EKPC and is for the exclusive use of the EKPC. Any reliance on this report shall be at the user's sole risk.

9 References

AECOM (2016). *Spurlock Station Landfill Area C Phase 3 Ash Landfill Design*, Prepared for the East Kentucky Power Cooperative, Inc.

FMSM Engineers (2002). *Report of Geotechnical Exploration, Spurlock Landfill Horizontal Expansion Modification to Permit No. 081-00005 Mason County, Kentucky*. Prepared for Kenvirons, Inc. Frankfort.

KentuckyNETR Online (2016). Website: //www.historicaerials.com

Stantec Consulting Services, Inc. (2014). *Interim Slope Stability Analysis, Area C Phase 2 Landfill Development, Spurlock Landfill*. Prepared for Kenvirons, Inc. Frankfort, Kentucky.

Tetra Tech, Inc. (2015). *Spurlock Landfill Hydrogeological Study*

A.B. Gibbons and Malcom P. Weiss (1972). *Geologic Map of the Maysville West Quadrangle, Kentucky-Ohio.* U.S Department of the Interior, U.S. Geologic Survey.

U.S. Environmental Protection Agency. (USEPA). (2015). *Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments*, 40 CFR §257. Federal Register, Volume 80, Subpart D, April 17, 2015.

U.S. Geologic Survey (2015). National Map. Website: ngmdb.usgs.gov/maps/mapview/

KGS Geology of Kentucky. Website: uky.edu/KGS/geoky/

U.S. Geologic Survey (2015). National Seismic Hazards Mapping Project, PSHA Deaggregation program, 2008 version. Website: geohazards.usgs.gov/deaggint/2008/

Natural Resources and Environmental Communications Process East Kentucky Power Cooperative (2009) *Borrower's Environmental Report For East Kentucky Power Cooperative, Inc. Kentucky 59 Fayette*

USGS (2016). U.S. Seismic Hazard Maps. *Two-percent probability of exceedance in 50 years map of peak ground acceleration.*
Website: ehp2-earthquake.wr.usgs.gov/hazards/products/conterminous/2014/2014pga2pct.pdf

USGS (2016). Seismic Hazard Analysis Tools. Interactive Deaggregations.
Website: earthquake.usgs.gov/hazards/apps/

Attachment A. Boring Map and Boring Logs

LEGEND

- Soil Boring
- Soil Boring with Undisturbed (Shelby) Tube Samples
- Soil Boring with Rock Core
- Existing Permit Boundary
- Existing Waste Boundary
- Proposed Waste Boundary
- Approximate Boundary between Areas A, B and C
- Approximate Property Boundary and Proposed Permit Boundary
- Proposed Permit Boundary

NOTES:

1. Topographic and survey information for the boring layout was taken from a survey drawing supplied by Photo Science, Inc., Lexington, Kentucky, photo date March 14, 2000. The information is believed to be correct, but is not to be used by the Contractor for construction of the project.
2. The permitted area of the landfill facility is divided into Areas A, B and C. Areas A and B have been bonded and approved by the Cabinet to receive waste. Area C is designated for future waste disposal.

LOCATION MAP

SCALE: 1"=3000'

BORING LOCATION TABLE

Boring	Northing	Easting	Elevation (Feet)
1	254201	1616202	893.3
2	254000	1616200	899.7
3	253800	1616200	897.4
4	253600	1616204	906.8
5	255189	1616400	900.7
6	255000	1616400	904.3
7	254800	1616400	906.6
8	254600	1616324	892.8
9	254400	1616234	894.5
10	254200	1616400	890.6
11	254002	1616400	881.3
12	253800	1616400	890.7
13	253600	1616400	900.4
14	253400	1616400	893.3
15	253200	1616400	899.6
16	255600	1616600	902.8
17	255400	1616600	899.5
18	255200	1616600	904.8
19	255000	1616600	915.7
20	254801	1616600	907.9
21	254602	1616523	886.4
22	254398	1616425	883.4
23	253801	1616601	882.3
24	253600	1616602	877.1
25	253400	1616600	852.6
26	253000	1616500	912.7
27	252800	1616509	917.5
28	252600	1616524	916.5
29	255000	1616800	898.6
30	254773	1616849	900.3
31	252601	1616876	914.3
32	253200	1617200	892.1
33	253130	1617399	891.9
34	253200	1617600	886.7
35	254997	1618595	894.5
36	254800	1618600	882.1
37	254600	1618600	865.7
38	253202	1618655	876.7
39	254800	1618800	857.9
40	254600	1618800	829.7
41	253200	1618867	841.9
42	254799	1618996	873.8
43	254595	1619000	870.7
44	254400	1619000	861.4
45	254200	1619000	856.9
46	254000	1619000	842.3
47	253200	1619077	767.2
48	254200	1619200	856.3
49	254005	1619197	821.3
50	253800	1619213	752.3
51	253004	1619189	800.1
52	254400	1619400	869.5
53	254200	1619400	835.7
54	254000	1619401	832.4
55	253800	1619400	817.1
56	253602	1619401	738.9
57	253001	1619381	731.4
58	254000	1619600	861.6
59	253800	1619600	831.7
60	253600	1619600	757.7
61	253400	1619599	710.8
62	254000	1619800	839.1
63	253801	1619800	820.1
64	253399	1619800	750.8
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66	253002	1619855	659.8
67	252616	1620375	606.8
68	254309	1616346	892.3
69	254227	1616277	895.0
70	254255	1616090	893.4
71	254392	1616163	892.2
72	254274	1616241	888.9
73	254280	1616237	888.7
74	254276	1616223	888.7
75	254266	1616232	889.1

150 0 300 600 FEET

GRAPHIC SCALE: 1" = 300'
CONTOUR INTERVAL = 2'

1 Revised proposed waste boundary and property boundary.

FULLER MOSSBARGER SCOTT AND MAY ENGINEERS, INC.
1409 N. Forbes Rd.
Lexington, Kentucky
40511-2050
859-422-3000

FSM ENGINEERS
COLUMBUS
CINCINNATI
LOUISVILLE
LEXINGTON

Fuller Mossbarger Scott & May

COMMONWEALTH OF KENTUCKY
JAMES L. SCOTT
19547
LICENSED PROFESSIONAL ENGINEER
3/13/03

GEOTECHNICAL EXPLORATION

SPURLOCK LANDFILL HORIZONTAL EXPANSION
MODFICATION TO PERMIT NO. 081-00005
EAST KENTUCKY POWER COOPERATIVE
MASON COUNTY, KENTUCKY

PROJECT NO.	LX2001036
DATE	MARCH, 2002
DRAWN BY	TJ
CHECKED BY	BLB
CHECKED BY	JSM
SCALE	1"=300'
REVISED	
1.	February, 2003
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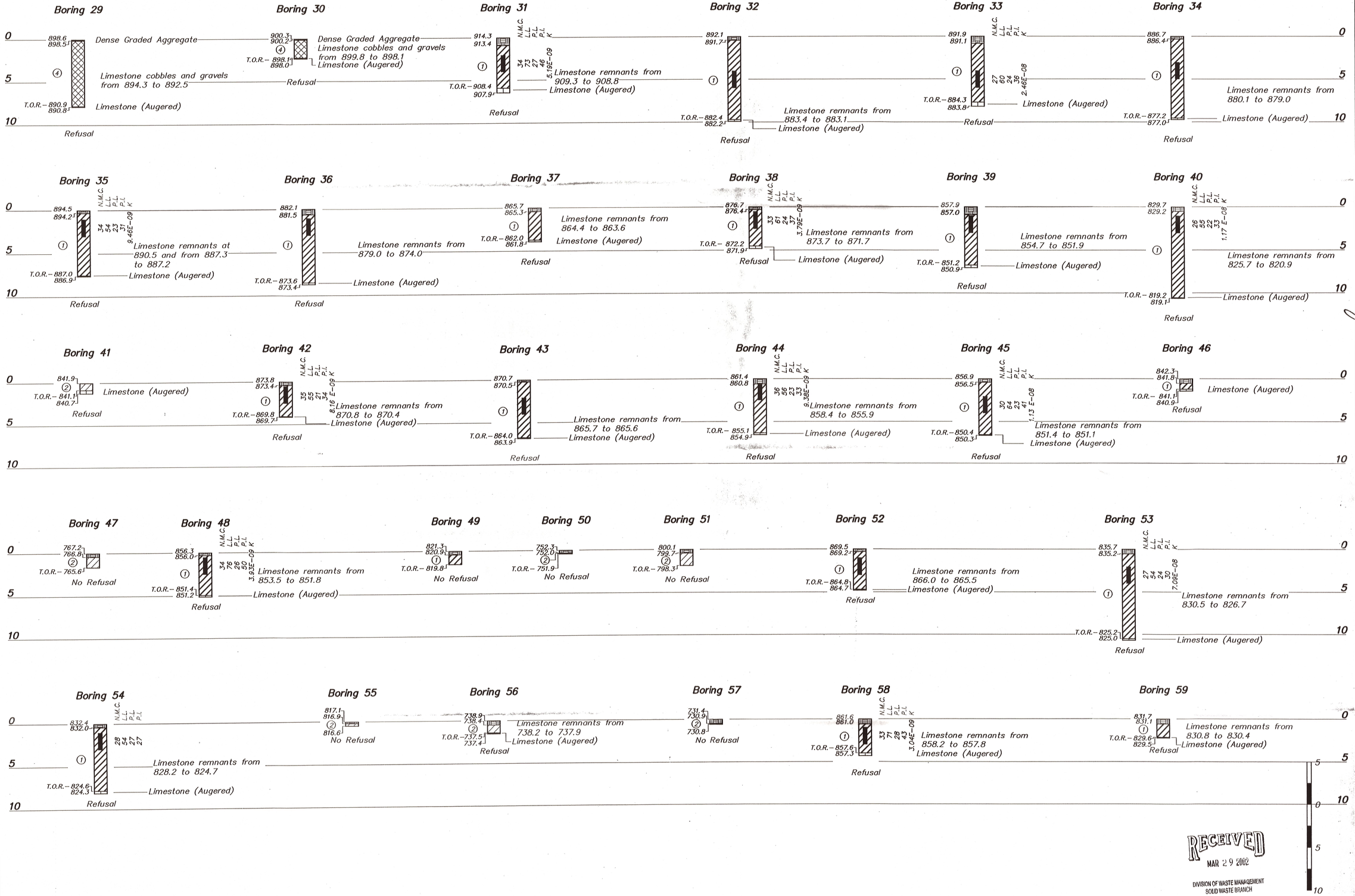
SHEET

1 OF 4



LOGS OF BORINGS
SCALE: 1"=5' (VERT. ONLY)

For Legend, Notes and Soil Summary, Refer to Sheet 2

RECEIVED
MAR 29 2002
DIVISION OF WASTE MANAGEMENT
SOLID WASTE BRANCH

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Lexington, Kentucky
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859-422-3000

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COLUMBUS CINCINNATI LOUISVILLE LEXINGTON
Fuller Mossbarger Scott & May

COMMONWEALTH OF KENTUCKY
BRENT L. BRYANT
19447
LICENSED PROFESSIONAL ENGINEER
3/27/02

GEOTECHNICAL EXPLORATION
SPURLOCK LANDFILL HORIZONTAL EXPANSION MODIFICATION TO PERMIT NO. 081-00005
EAST KENTUCKY POWER COOPERATIVE
MASON COUNTY, KENTUCKY

PROJECT NO.	LX20010.36
DATE	MARCH, 2002
DRAWN BY	TJ/CAL/ASA
CHECKED BY	BLB
CHECKED BY	JSM
SCALE	AS SHOWN
REVISED	
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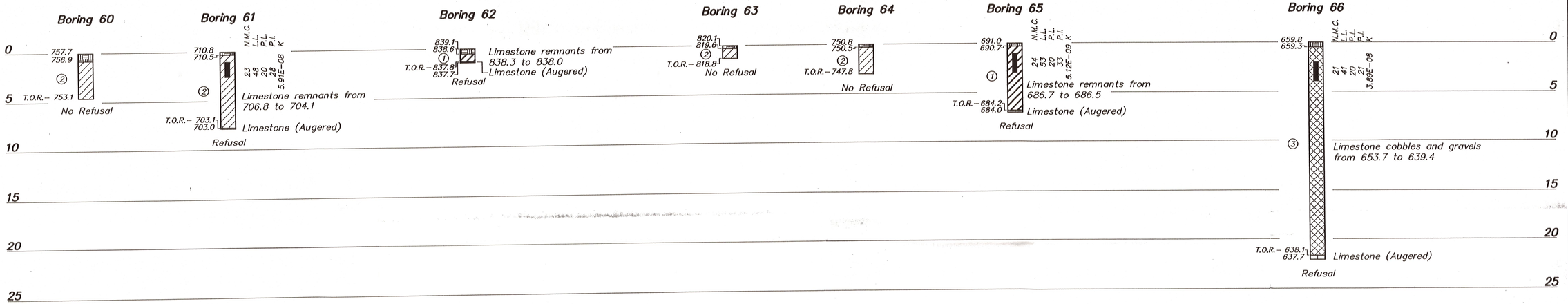
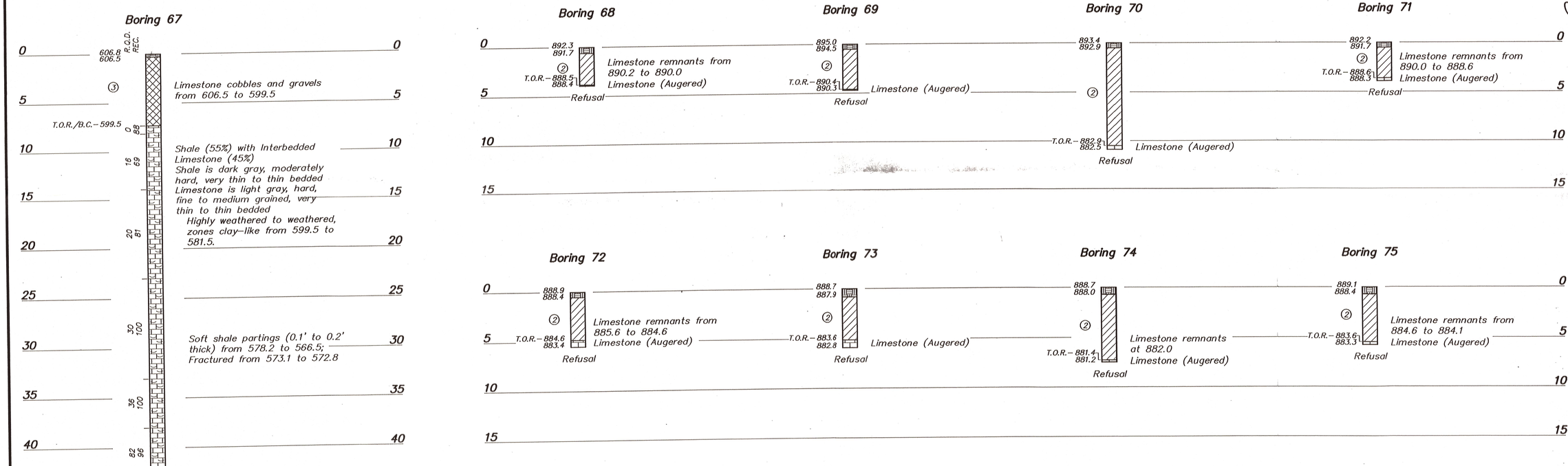
SHEET
3 OF 4





LOGS OF BORINGS
SCALE: 1"=5' (VERT. ONLY)

For Legend, Notes and Soil Summary, Refer to Sheet 2

RECEIVED
MAR 29 2002
DIVISION OF WASTE MANAGEMENT
SOLID WASTE BRANCH

VERTICAL GRAPHIC SCALE 1"=5'

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1400 N. Forbes Rd.
Lexington, Kentucky
40511-2050
859-422-3000
FMSM ENGINEERS
LEXINGTON LOUISVILLE CINCINNATI COLUMBUS
Fuller Mossbarger Scott & May

3/25/02

GEOTECHNICAL EXPLORATION
SPURLOCK LANDFILL HORIZONTAL EXPANSION MODIFICATION TO PERMIT NO. 081-00005
EAST KENTUCKY POWER COOPERATIVE
MASON COUNTY, KENTUCKY

PROJECT NO.	LX2001036
DATE	MARCH, 2002
DRAWN BY	TJ/CAL/ASA
CHECKED BY	BLB
CHECKED BY	JSM
SCALE	AS SHOWN
REVISED	
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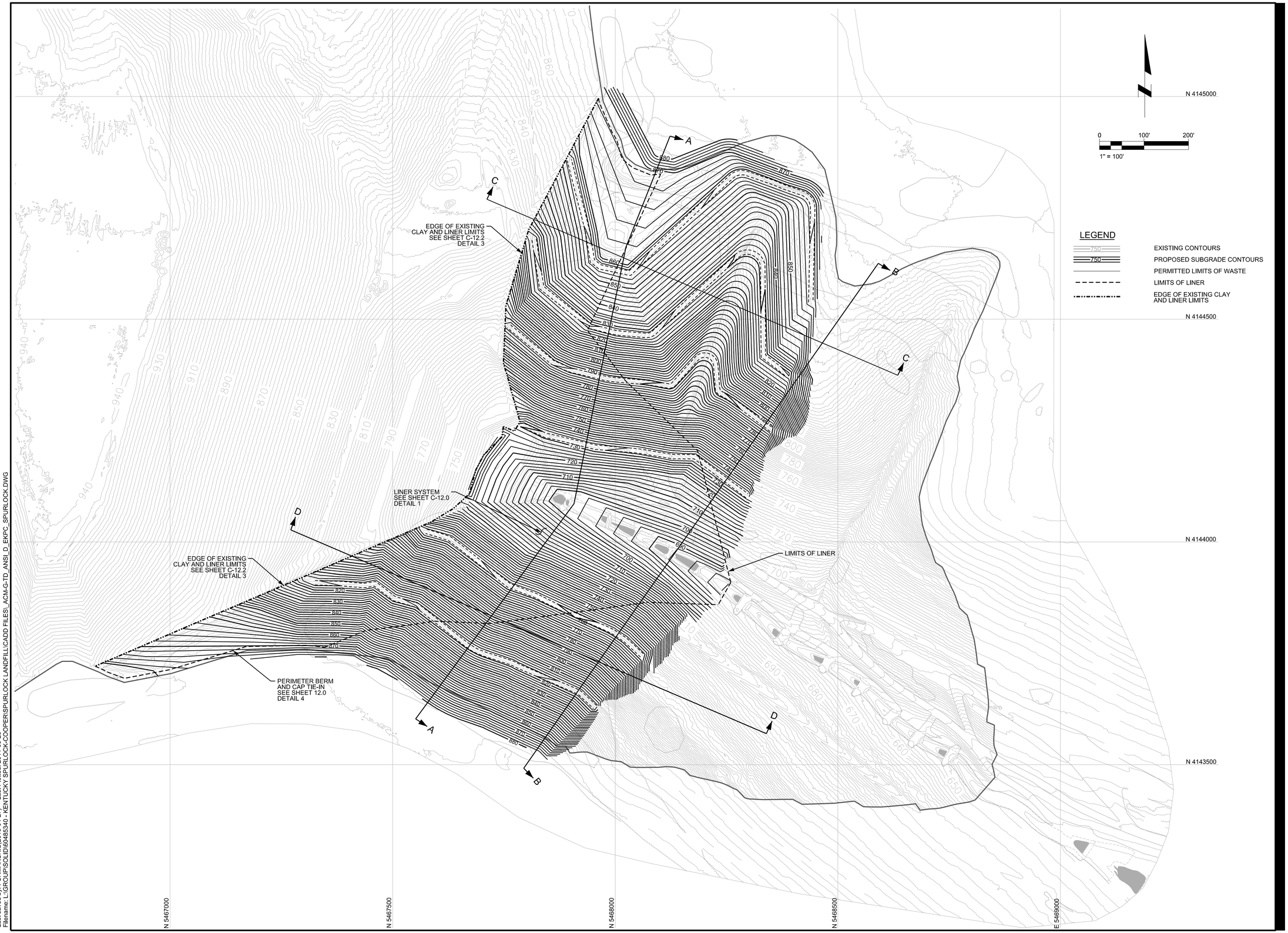
SHEET
4 OF 4

Attachment B. Subgrade Contour Map



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AECOM

PROJECT

SPURLOCK STATION
LANDFILL AREA C
PHASE 3 ASH
LANDFILL DESIGN

CLIENT

EAST KENTUCKY
POWER COOPERATIVE
4775 LEXINGTON ROAD
P.O. BOX 707
WINCHESTER, KY 40392-0707

CONSULTANT

AECOM
500 WEST JEFFERSON STREET
SUITE 1600
LOUISVILLE, KY 40202
502.569.2301 tel 502.569.2304 fax
www.aecom.com

REGISTRATION

ISSUE/REVISION

I/R	DATE	DESCRIPTION
I	2016-04-27	ISSUED FOR BID

KEY PLAN

PROJECT NUMBER

60485340

SHEET TITLE

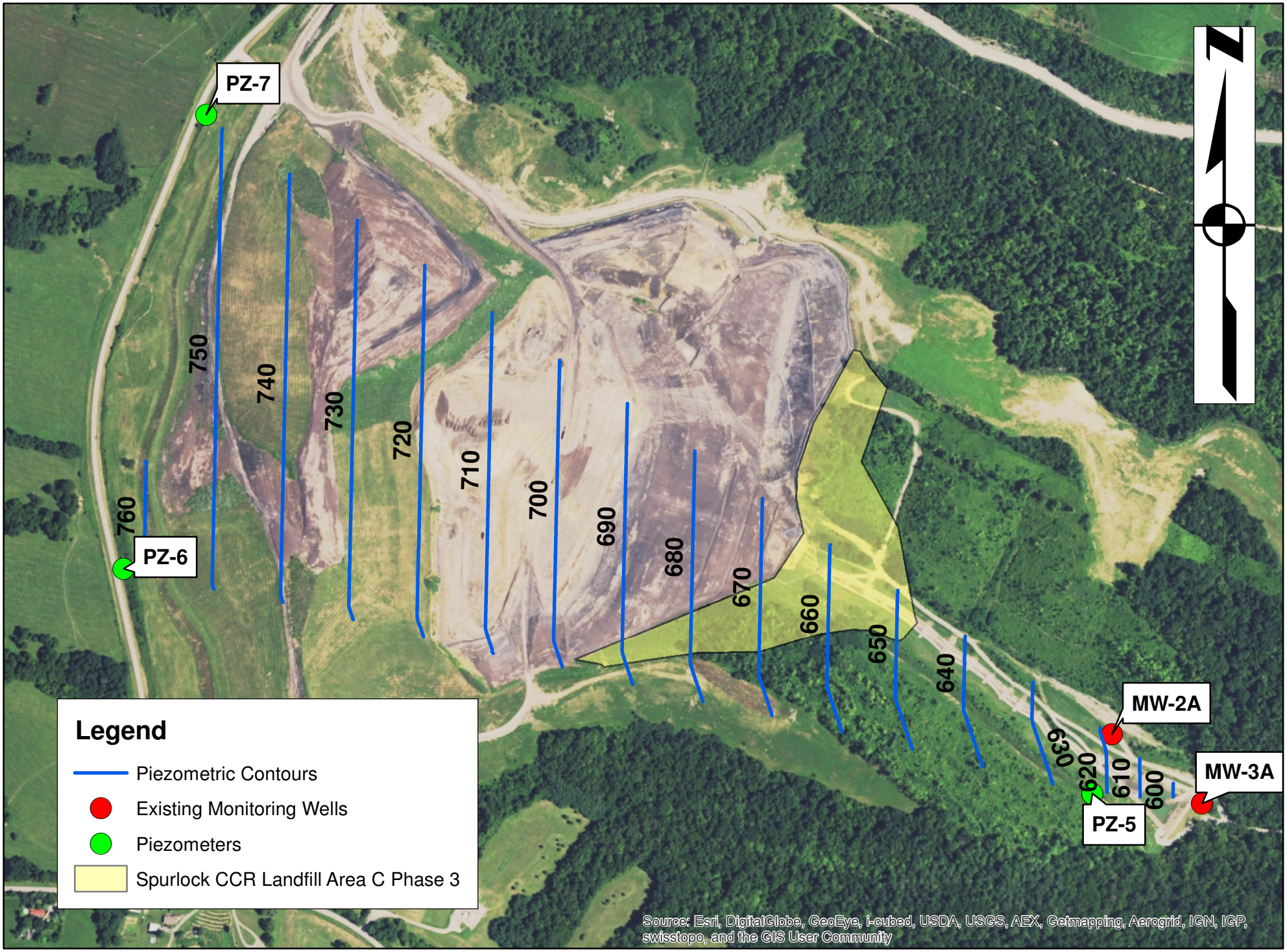
SUBGRADE PLAN

SHEET NUMBER

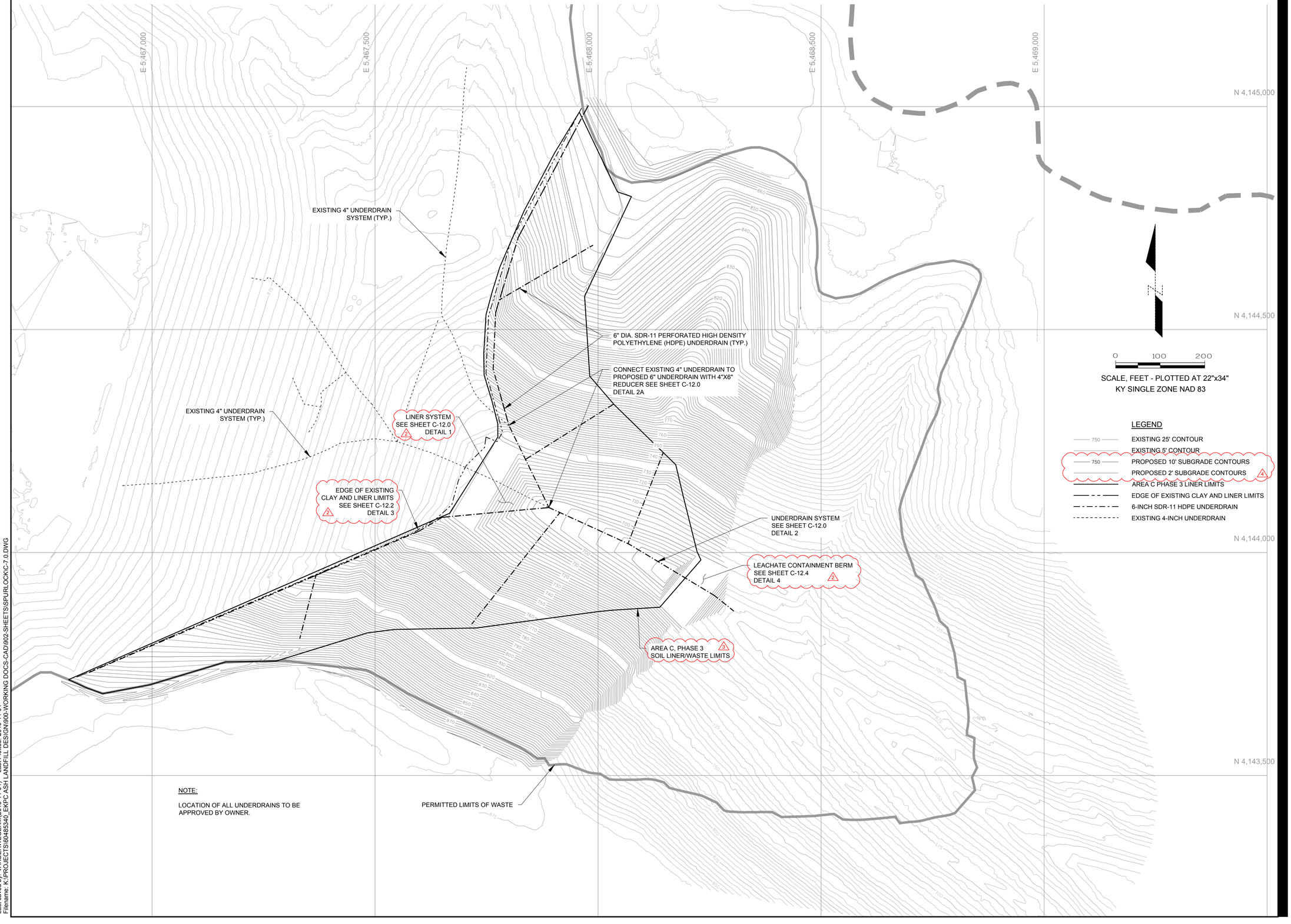
C-8.0

Attachment C1. Piezometric Contour Map

Piezometric Contours: Defining the Uppermost Aquifer



Attachment C2. Underdrain Plan and Detail Sheets – Liner Design for Area C Phase 3



NOTE:

LOCATION OF ALL UNDERDRAINS TO BE APPROVED BY OWNER.

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AECOM

PROJECT

SPURLOCK STATION
LANDFILL AREA C
PHASE 3 ASH
LANDFILL DESIGN

CLIENT

EAST KENTUCKY
POWER COOPERATIVE
4775 LEXINGTON ROAD
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REGISTRATION

ISSUE/REVISION

R	2016-11-03	REVISED SUBGRADE 4
R	2016-11-02	LINER AREA 3
R	2016-11-02	REVISED DETAILS 2
I	2016-06-10	ISSUED FOR CONSTRUCTION
I/R	DATE	DESCRIPTION

KEY PLAN

APPROVED FOR CONSTRUCTION

PROJECT NUMBER

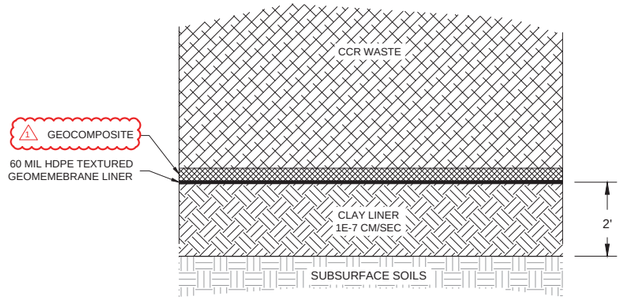
60485340

SHEET TITLE

UNDERDRAIN SYSTEM

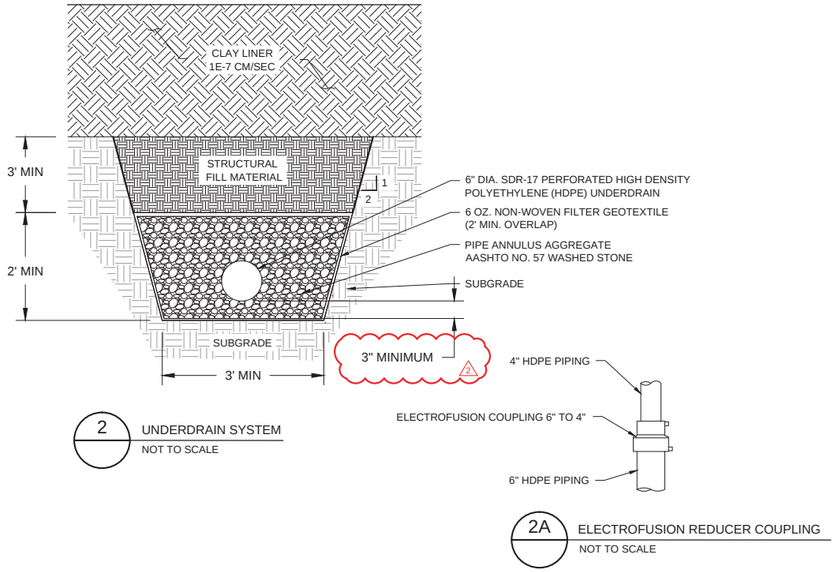
SHEET NUMBER

C-7.0



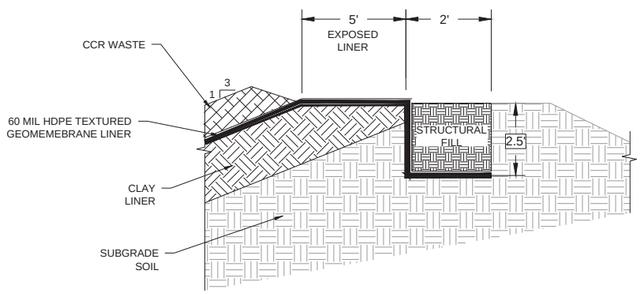
1 LINER SYSTEM
NOT TO SCALE

NOTE:
1. LINER SYSTEM FML TO BE TEXTURED 60-MIL HIGH DENSITY POLYETHYLENE (HDPE).
2. SHEAR STRENGTH TESTING OF THE SOIL-GEOSYNTHETIC INTERFACE TO BE CONDUCTED ON FIELD SAMPLES OF THE GEOSYNTHETIC LINER AND THE CLAY SOILS IN ORDER TO CONFIRM THAT THE SOIL-GEOSYNTHETIC INTERFACE RELATIONSHIP OBSERVED IN THESE MATERIALS MEETS OR EXCEEDS THE AS-DESIGNED SHEAR RESISTANCE.

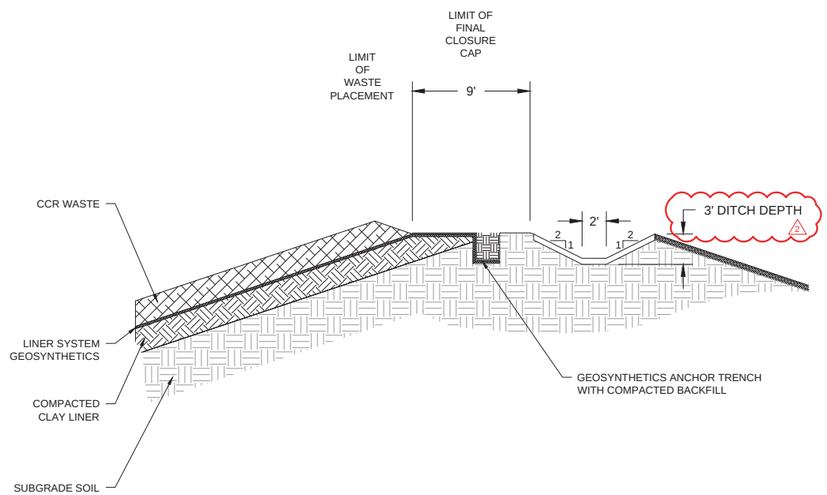


2 UNDERDRAIN SYSTEM
NOT TO SCALE

2A ELECTROFUSION REDUCER COUPLING
NOT TO SCALE



3 PERIMETER ANCHOR TRENCH
NOT TO SCALE



4 PERIMETER BERM AND CAP TIE-IN
NOT TO SCALE

AECOM

PROJECT

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LANDFILL AREA C
PHASE 3 ASH
LANDFILL DESIGN

CLIENT

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LOUISVILLE, KY 40202
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REGISTRATION

ISSUE/REVISION

I/R	DATE	DESCRIPTION
R	2016-11-02	REVISED DETAILS 2
R	2016-11-02	DRAINAGE LAYER 1
I	2016-06-10	ISSUED FOR CONSTRUCTION

KEY PLAN

APPROVED FOR
CONSTRUCTION

PROJECT NUMBER

60485340

SHEET TITLE

MISCELLANEOUS DETAILS

SHEET NUMBER

C-12.0

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Attachment D. Excerpts from Waters of the U.S. Assessment Draft for the EKPC CCR Program

Executive Summary

Per the recently promulgated coal combustion residual (CCR) rule (Disposal of Coal Combustion Residuals from Electric Utilities, 2015), East Kentucky Power Cooperative, Inc. (EKPC) is assessing existing CCR units at several of their power facilities. This report presents a summary of findings for the waters of the United States (waters of U.S.) assessment AECOM, on behalf of EKPC, conducted at EKPC's Spurlock Station Landfill located in Mason County, Kentucky.

AECOM surveyed an approximately 22 acre area around the Area C Phase 3 lateral expansion of the Spurlock CCR Landfill. No wetlands were identified by AECOM, however one waterbody identified by another consultant previously and permitted for was observed in the valley. The field assessor did not observe evidence of erosion, migration of wetland soils, or impacts to fish, wildlife and other aquatic resources. Findings of the waters of the U.S. assessment demonstrate the proposed Area C Phase 3 of EKPC's Spurlock CCR Landfill are not currently impacting any waters of the U.S. However, potential failure of these surface impoundments could likely impact nearby waters of the U.S. due to their close proximity.

Attachment E. USGS Faults of the Holocene Epoch Map

Faults in proximity to EKPC Spurlock Power Station

Attachment F. Geologic Map of the Maysville West Quadrangle, Kentucky - Ohio

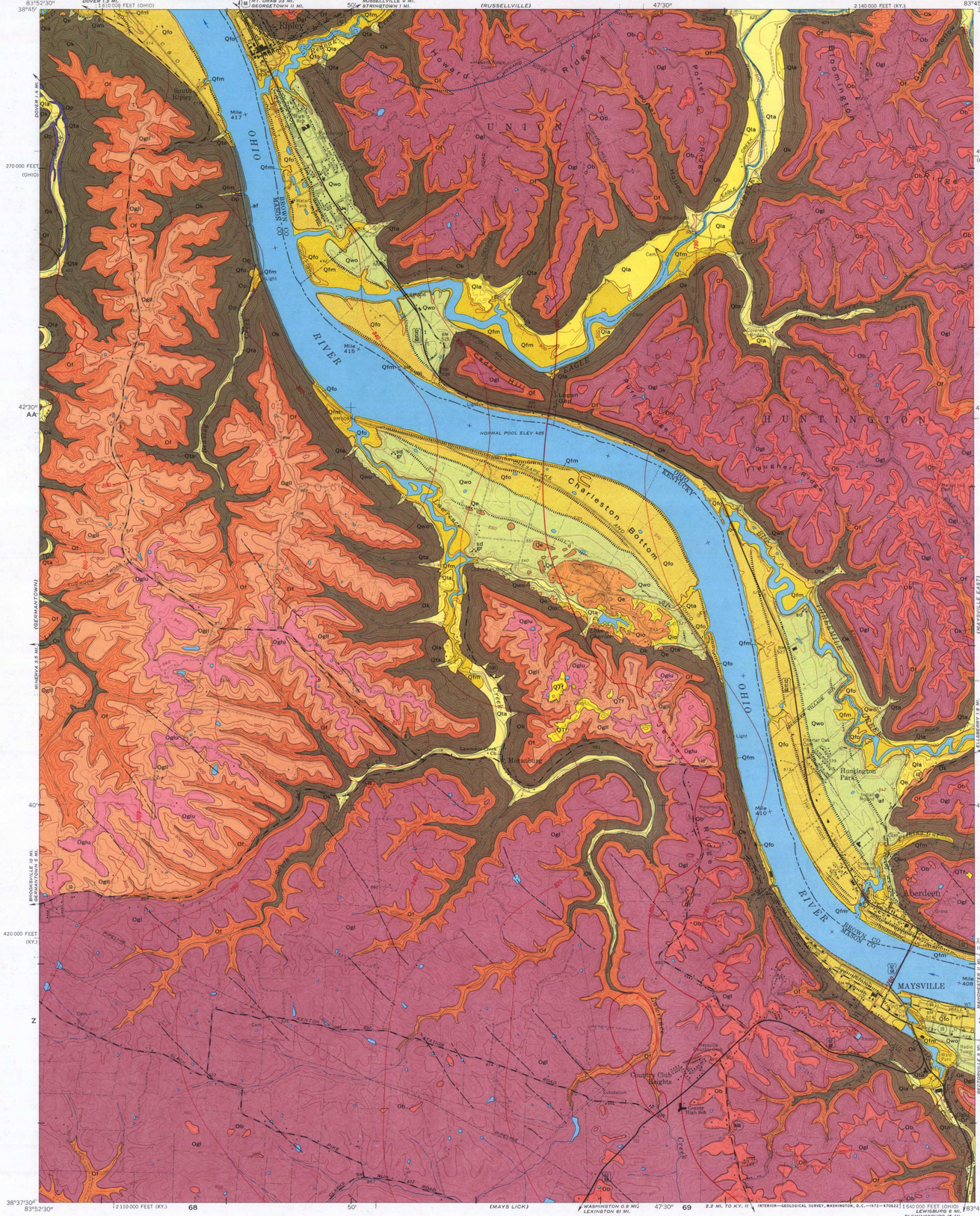
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
V. E. McKELVEY, DIRECTOR

PREPARED IN COOPERATION WITH
THE COMMONWEALTH OF KENTUCKY, UNIVERSITY OF KENTUCKY
KENTUCKY GEOLOGICAL SURVEY
WALLACE W. HAGAN, DIRECTOR AND STATE GEOLOGIST

GEOLOGIC QUADRANGLE MAP
MAYSVILLE WEST QUADRANGLE, KENTUCKY-OHIO
GQ-1005

NOMENCLATURE OF EARLIER WORKERS	SYSTEM	SERIES	GLACIATION	FORMATION AND MEMBER	LITHOLOGY	THICKNESS IN FEET	DESCRIPTION
Dunn and Wolford, 1930	QUATERNARY	Pleistocene and Holocene		Ohio River flood-plain, backwater, and low-terrace alluvium		0–40	Silt, sand, and clay. Beneath flood plain and low terraces, grades from clayey silt downward to sandy silt and fine to medium sand. Silt and sand, light-yellowish-brown to gray, noncalcareous, micaceous, obscurely to well bedded. Contains lenses of vegetable matter, gray silty clay, gravel, and detrital coal. Low ridges are sandy; poorly drained swales are clayey. Rests on surface cut on glacial outwash. Thickness generally increases from about 20 to 30 feet beneath higher terrace to 30 to 40 feet beneath modern flood plain. Backwater alluvium consists of obscurely bedded yellowish-brown carbonaceous silt and clay that intertongue with locally derived gravelly alluvium. Soils on modern alluvium show little color, texture, or ped development, and belong to the Huntington soil catena (Taylor and others, 1938, p. 36). In areas mapped as modern alluvium, flood couplets of sand and humic mud common. Soils on older alluvium show marked color and texture development, and belong to the Wheeling soil catena (Taylor and others, 1938, p. 37). Radioactive age determination of charcoal from 15 feet below lower terrace of older alluvium at east end of Charleston bottom yielded age of 9,010 ± 300 years B.P. Average 2-year flood of Ohio River reaches altitude of about 502 feet at Maysville which is thus considered the local upper limit of modern flood plain, although less frequent floods may cover lower terraces and deposit or erode a thin layer of mud. Highest recorded flood (1937) reached about 527 feet at Maysville.
				Tributary stream alluvium		0–20	
		Pleistocene	Wisconsin	Eolian deposits		0–70	
				Glacial outwash		0–130	Silt and gravel: Flood plains underlain by poorly sorted, yellowish-brown clayey silt and silty gravel. Channel deposits of most streams are limestone gravel in a silty matrix. Channel deposits of Redoak Creek and Eagle Creek, which drain areas of Illinoian glacial drift (Goldthwait and others, 1961), contain quartz sand. Gravel in these streams consists of as much as 5 percent glacially introduced rocks, including chert of various colors, quartzite, and igneous and metamorphic rock, most of it fine-grained and with abundant dark minerals. In most places tributary stream alluvium grades downstream into modern Ohio River alluvium.
			Illinoisan and Wisconsin	Lacustrine deposits		0–100	Silt and sand: Silt, well sorted, poorly to nonstratified; weathers light brown to yellowish brown. Mapped only where more than 5 feet thick or along bottom lands, but also occurs along valley walls and locally on upland flats within a few miles of Ohio River valley. Sand, light-yellowish-brown, very fine to medium, very well sorted, noncalcareous, generally forms ridges and mounds, locally mantled by silt.
							Sand, gravel, silt, and clay: Sand and gravel, yellowish-brown, well-sorted, locally calcareous; show cut-and-fill structure. Sand, fine to coarse, subangular, quartzose, with notable amounts of carbonate (5 percent), chert, feldspar, fragments of various types of rocks, heavy minerals, and coal grains. Gravel, dominantly pebble size, found mostly in upper and lower 15 feet of unit. Where unleached, gravel is of following approximate composition (in percent): chert, 35; siltstone and sandstone, 25; carbonate rocks, 10; crystalline rocks, 13; shale, 5; coal, 5; and vein quartz, 7. Unit locally contains lenses of gray and brown clayey silt, especially near valley walls. Outwash generally leached to depth of more than 25 feet. A mantle of silt 5 to 20 feet thick covers terrace surfaces, ranging from sandy silt on terrace ridges to sandy clayey silt in swales. Terraces may have following correlations with Scioto River terraces of Kempton and Goldthwait (1959): at 554 foot level on Charleston bottom with Kingston terrace, and at 540 foot level on the Maysville bottom and 538 foot level on the Charleston bottom with the Worthington terrace. Subsurface information given in Price (1964) indicates as much as 130 feet of Wisconsin glacial outwash beneath Charleston bottom.
							Silt, clay, and sand: Silt and clay, light-olive-gray to bluish-gray, commonly calcareous, in alternating silty and clayey beds, laminated in part, locally fossiliferous. Leached at surface and oxidized to light-yellowish-brown clayey silt; calcareous concretions at base of leached zone. Near Ohio River interbedded with sand from outwash deltas built into mouths of tributary valleys. Unit believed entirely of Wisconsin age in Kentucky part of area; outcrop of unit on Beetle Creek in Ohio part of area extends well above altitude of highest known Wisconsin terrace and is presumably of Illinoian age.
			Illinoisan	Glacial outwash		0–100	Sand, gravel, silt, and clay: Terrace remnants consist of sand and gravel, similar to Wisconsin outwash, except more gravelly. Weathered to a depth of more than 25 feet; weathered zone consists of noncalcareous, reddish, clayey sand and gravel. Around Lake Charles gray calcareous silt and clay, deposited on inside of valley meander, resemble lacustrine deposits.
	TERTIARY OR QUATERNARY	Pliocene or Pleistocene		High-level fluvial deposits		0–30	Sand, silt, and clay: Sand, moderate-yellowish-brown, very fine to medium, well-sorted, with subrounded, commonly frosted grains. Rock fragments and lesser proportions of heavy minerals less abundant than in Wisconsin outwash. Silt and clay, moderate-yellowish-brown, in thin beds; some silt beds moderately well sorted. Entire deposit deeply weathered and oxidized. Commonly mantled by silt (loess?). Deposit occurs at an altitude of about 850 feet apparently on remnants of old high-level valley floor only about 70 feet below the highest hills in area.
Richmond	ORDOVICIAN	Upper Ordovician		Bull Fork Formation		70+	Limestone and shale, interbedded: Limestone content decreases from about 75 percent near base of unit to about 50 percent in the highest beds preserved. Limestone is medium light gray to medium bluish gray; weathers grayish orange; evenly thin to thick bedded; locally ripple marked. Dominant limestone type composed of medium to coarse fossil fragments in a fine-grained matrix; contains sparse to common argillaceous inclusions. Less common types are coarse-grained well-sorted fossiliferous limestone (classes 1 and 2 of Weiss and Norman, 1960) and fine-grained well-sorted limestone with few fossils (classes 4 and 5 of Weiss and Norman, 1960). Shale is medium gray, weathers dusky yellow; calcareous; thin bedded, fissile; plastic when wet; in partings and sets as much as 12 inches thick. Most conspicuous fossils are brachiopods including large *Platystrophia* and *Hebertella*, especially near base. *Leptaena*, dalmanellid brachiopods, and *Strophomena*, occur no lower than about 20 to 30 feet above the base. Top of formation not exposed in area.
Arnheim							Limestone, rubbly-weathering, mottled medium light gray and light olive gray, thin-bedded, irregularly bedded to nodular; consists of whole fossils and coarse fossil fragments in a very fine to fine-grained argillaceous limestone matrix (class 3C of Ford, 1967); contains irregular partings and seams of gray shale. Minor coarse-grained, well sorted limestone locally present. Fossils include abundant *Hebertella* and *Platystrophia*.
? Mt. Auburn				Grant Lake Limestone: Upper member		15–50 / 45–55 / 30–35	Limestone and shale, interbedded: Limestone (65 to 85 percent of unit) is medium light gray to medium bluish gray, fine to coarse grained, fossil fragmental; evenly thin to medium bedded, medium to well sorted (classes 1 and 4 of Weiss and Norman, 1960). Minor thin irregularly bedded argillaceous limestone (classes 5 and 6 of Weiss and Norman, 1960). Shale is medium gray, fissile, calcareous. Unit grades laterally to irregularly bedded argillaceous limestone in southern part of area. Fossils collected from basal 5 feet of unit include pelecypods *"Ctenodonta" pectunculoides* (Hall), *Ambonychia* sp., and *Pterinea* sp. Shells of *"Ctenodonta,"* roughly the size and shape of a fingernail, commonly form almost the whole of one or more thin slabby limestone beds near base of unit.
? Corryville						100–115	
? Bellevue				Lower member		50–60	Limestone, rubbly-weathering, mottled medium light gray and light olive gray, irregularly thin bedded to nodular; consists of whole and coarsely broken fossils in a fine-grained argillaceous limestone matrix (class 3C of Ford, 1967). Gray shale occurs as irregular partings and thin beds. Minor fine- to coarse-grained, medium-sorted limestone in thin even beds, mostly in upper part. Gradational with underlying unit through a zone 3 to 10 feet thick. Fossils include abundant large brachiopods of genera *Platystrophia* and *Hebertella*.
Maysville				Fairview Formation		75–95	Limestone and shale, interbedded: Limestone (about 60 percent of formation) of two main kinds: light-olive-gray to light-bluish-gray, fine-grained, well-sorted, silty, evenly thin to medium bedded, sparsely fossiliferous limestone (class 5 of Weiss and Norman, 1960); and medium-gray to medium-bluish-gray, thin- to medium-bedded, fossil-fragmental limestone consisting of closely packed medium to coarse fossil fragments in finely to coarsely crystalline calcite cement (classes 1 and 4 of Weiss and Norman, 1960). Shale, olive-gray, fissile, calcareous; as partings and sets as much as 1 foot thick. Light-olive-gray silty limestone (class 6 of Weiss and Norman, 1960) in even to contorted thin to thick beds, locally conspicuous in upper part. At base, a ledge-forming bed, 3 to 6 feet thick, of obscurely layered very coarse grained limestone composed chiefly of cemented shells of brachiopod *Strophomena*.
? Fairmount							
? Mt. Hope							
? Garrard							
? McMicken				Kope Formation		260–275	Shale and limestone, interbedded: Shale (about 70 percent of unit), medium-gray, weathers light gray to dusky yellow; fissile, calcareous, fossiliferous in part. Limestone, medium-gray, thin- to medium-bedded. Coarse-grained fossiliferous limestone dominant (classes 1 and 2 of Weiss and Norman, 1960); fine-grained, silty, sparsely fossiliferous limestone (class 6 of Weiss and Norman, 1960) subordinate. Unit consists of sets of beds 3 to 10 feet thick, chiefly of shale, alternating with sets of beds 5 to 10 feet thick of closely interbedded shale and limestone in about equal abundance. Some beds very fossiliferous. Poorly exposed; forms moderate slopes commonly strewn with limestone float. Upper contact sharp; lower contact gradational.
Eden							
? Southgate-Economy-?							
? Fulton							
? Cynthiana				Point Pleasant Formation		25+	Limestone and shale interbedded: Limestone (about 65 percent of unit), light-gray to medium-gray, even-bedded or crossbedded, thin- to thick-bedded, pyritic and phosphatic in part. Coarse-grained fossil-fragmental limestone (classes 1 and 2 of Weiss and Norman, 1960) dominant. Fine-grained silty limestone, unfossiliferous, or with sparse whole fossils, commonly gastropods (classes 3 and 5 of Weiss and Norman, 1960) subordinate. Shale, medium-gray, weathers light gray or dusky yellow; fissile, calcareous. Base of formation not exposed. Fossils noted include bellerophontid gastropods, the trilobite *Cryptolithus*, bryozoans, both tubular types and *Escharopora*, dalmanellid brachiopods, and very common crinoid columnals.
		Middle Ordovician					

× denotes bed from which fossil collection was made. Identifications by John Pojeta



EXPLANATION

- Pleistocene and Holocene
  - Qfm / Qfo — Ohio River flood-plain, backwater and low-terrace alluvium
    - Qfm, *modern alluvium with little or no soil development*
    - Qfo, *older alluvium with some soil development*
  - Qta — Tributary stream alluvium
- Pleistocene
  - Wisconsin
    - Qe — Eolian deposits (*Stippling indicates areas where surface is markedly sandy*)
    - Qwo — Glacial outwash
  - Illinoian and Wisconsin
    - Qla — Lacustrine deposits
  - Illinoian
    - Qio — Glacial outwash
- Pliocene or Pleistocene
  - QTf — High-level fluvial deposits
- Upper Ordovician
  - Ob — Bull Fork Formation
  - Oglu / Ogll — Grant Lake Limestone (Oglu, *upper member*; Ogll, *lower member*; Ogl, *Grant Lake Limestone, undivided*)
  - Of — Fairview Formation
  - Ok — Kope Formation
- Middle and Upper Ordovician
  - Op — Point Pleasant Formation

QUATERNARY; TERTIARY OR QUATERNARY; ORDOVICIAN

- af — Artificial fill
- Contact — *Dotted where concealed; not shown where extensively concealed by mapped surficial deposits*
- Approximate southern limit of deposits formed in contact with glacial ice (after Goldthwait and others, 1961)
- Lineaments marked by solution features in limestone
- Structure contours — *Drawn on base of Grant Lake Limestone. Projected where contour horizon is missing. Arrows indicate direction of dip. Contour interval 20 feet*
- Slope between terraces or alluvial surfaces
- Abandoned quarry
- Abandoned pit — sd, *sand*; gr, *gravel*
- Locality of charcoal sample dated by carbon-14 method
- USGS fossil collection number 5998-CO — *Three localities in west-central part of map area*

Base by U.S. Geological Survey, 1961. Modified 1972

The Carter Coordinate System letters and numbers used to designate five-minute divisions of latitude and longitude are shown along the margins; tick marks indicate one-minute divisions

APPROXIMATE MEAN DECLINATION, 1972

SCALE 1:24 000

1 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

KENTUCKY
QUADRANGLE LOCATION

Geology mapped in Ohio by S. A. Ali, T. W. Essman, and M. P. Weiss in 1966 under supervision of W. C. Sweet and M. P. Weiss. Work supported by N. S. F. Grant G. P.–479.

Geology mapped in Kentucky by A. B. Gibbons, F. A. Schilling, Jr., and K. L. Pierce in 1962–66.

ECONOMIC GEOLOGY

Argillaceous limestone suitable for the manufacture of portland cement has been found in the upper 25 feet of the Grant Lake Limestone near Springdale about 4 miles east of the southeast corner of the quadrangle (Schilling and Peck, 1967; Riley and McGrain, 1964, p. 3). The bedrock units furnish construction materials for local use, including fill and unfinished limestone blocks for riprap and rough masonry. None of the limestones are believed to be low enough in insolubles to be used where high chemical purity is a requirement. Undesirable features encountered singly or in combination in most of the limestones include abundant interbedded shale and silt, thin bedding, and crumbling on exposure to the atmosphere. However, weathering-resistant limestone more than 5 feet thick without shale interbeds is present locally both in the basal 20 feet of the Fairview Formation and in the Point Pleasant Formation. All quarries were inactive at the time of mapping.

Outwash sand with as much as 10 percent gravel occurs beneath the higher Wisconsin terrace, below about 15 feet of silt and weathered outwash. This sand, dug from pits on Aberdeen and Charleston bottoms, is used for general construction purposes, but deleterious amounts of chert, coal, and weathered clasts in the sand and gravel hinder its use for high-grade concrete aggregate. Sand and gravel similar to the outwash are locally dredged from the bed of the Ohio River; a gravelly material is currently dredged from Charleston bar, formerly exposed off the mouth of Lawrence Creek, but now flooded by the new high pool.

Prior to about 1955, clayey silt for the manufacture of bricks was dug from the upper 20 feet of the low terrace upstream from Maysville in the Maysville East quadrangle (Weiss and others, 197–). Silt and clay from the same low terrace were used in construction of an impervious levee at Maysville.

Eolian sand on Charleston bottom is locally more than 70 feet thick, and is a potential source of very fine to medium, well sorted sand.

Steep slopes underlain by clay-rich units, particularly the Kope Formation, lacustrine deposits, and flood-plain and low-terrace alluvium tend to slump when wet. Fills derived from these units may be extremely liable to slump, particularly when designed without generous provision for drainage.

The northwest-trending lineaments plotted on the geologic map represent lines of solutional features, shown by the topographic contours or on aerial photographs. The lineaments are the traces of open fractures or zones of such fractures in bedrock, mainly in the Grant Lake Limestone. Water moving down and along the fractures has dissolved limestone, creating sinks at the surface and caverns underground that pose a concealed hazard to construction along the lineaments. Springs commonly issue where the lineaments intersect the larger stream valleys and may constitute a dependable low-volume water supply. Where a stream intersects a lineament above the level of its outlet spring, surface water tends to be diverted to subsurface flow along the lineament. A reservoir located at such a site would be particularly likely to leak, especially if impermeable soil were removed to expose bedrock.

Overall, the bedrock formations, including the Grant Lake Limestone where unfractured, are poor aquifers, yielding only small quantities of hard or very hard water to wells (Palmquist and Hall, 1960). Plentiful but moderately hard ground water is generally available in coarse outwash within 10 to 40 feet above bedrock in the Ohio River valley (Price, 1964).

REFERENCES CITED

Dunn, P. H., and Wolford, J. J., 1930, Geologic map of Mason County, Kentucky: Kentucky Geol. Survey, ser. 6.
Ford, J. P., 1967, Cincinnatian geology in southwest Hamilton County, Ohio: Am. Assoc. Petroleum Geologists Bull. v. 51, no. 6, p. 918–936.
Goldthwait, R. P., White, G. W., and Forsyth, J. L., 1961, Glacial map of Ohio: U.S. Geol. Survey Misc. Geol. Inv. Map I-316.
Kempton, J. P., and Goldthwait, R. P., 1959, Glacial outwash terraces of the Hocking and Scioto River valleys, Ohio: Ohio Jour. Sci., v. 59, p. 135–151.
Palmquist, W. N., Jr., and Hall, F. R., 1960, Availability of ground water in Bracken, Harrison, Mason, Nicholas, and Robertson Counties, Kentucky: U.S. Geol. Survey Hydrol. Inv. Atlas HA-16.
Price, W. E., Jr., 1964, Geology and hydrology of alluvial deposits along the Ohio River between the Manchester Islands and Silver Grove, Kentucky: U.S. Geol. Survey Hydrol. Inv. Atlas HA-94.
Riley, H. L., and McGrain, Preston, 1964, The mineral industry of Kentucky: reprint from Minerals Yearbook, 1963, v. 3, Washington, U.S. Govt. Printing Office, 22 p.
Schilling, F. A., Jr., and Peck, J. H., 1967, Geologic map of the Orangeburg quadrangle, northeastern Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ–588.
Taylor, A. E., Miller, J. T., Tharp, W. E., Fowler, E. D., Green, T. C., and Conrey, G. W., 1938, Soil survey of Adams County, Ohio: U.S. Dept. Agriculture, Bur. Chem. and Soils, ser. 1932, no. 29, 64 p.
Weiss, M. P., and Norman, C. E., 1960, The American Upper Ordovician Standard—4, Classification of the limestones of the type Cincinnatian: Jour. Sed. Petrology, v. 30, p. 283–296.
Weiss, M. P., Schilling, F. A., Jr., Pierce, K. L., and Ali, S. A., 197–, Geologic map of the Maysville East quadrangle, Ohio-Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ–1006 (in press).

GEOLOGIC MAP OF THE MAYSVILLE WEST QUADRANGLE, KENTUCKY-OHIO

By
A. B. Gibbons and Malcolm P. Weiss

1972

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