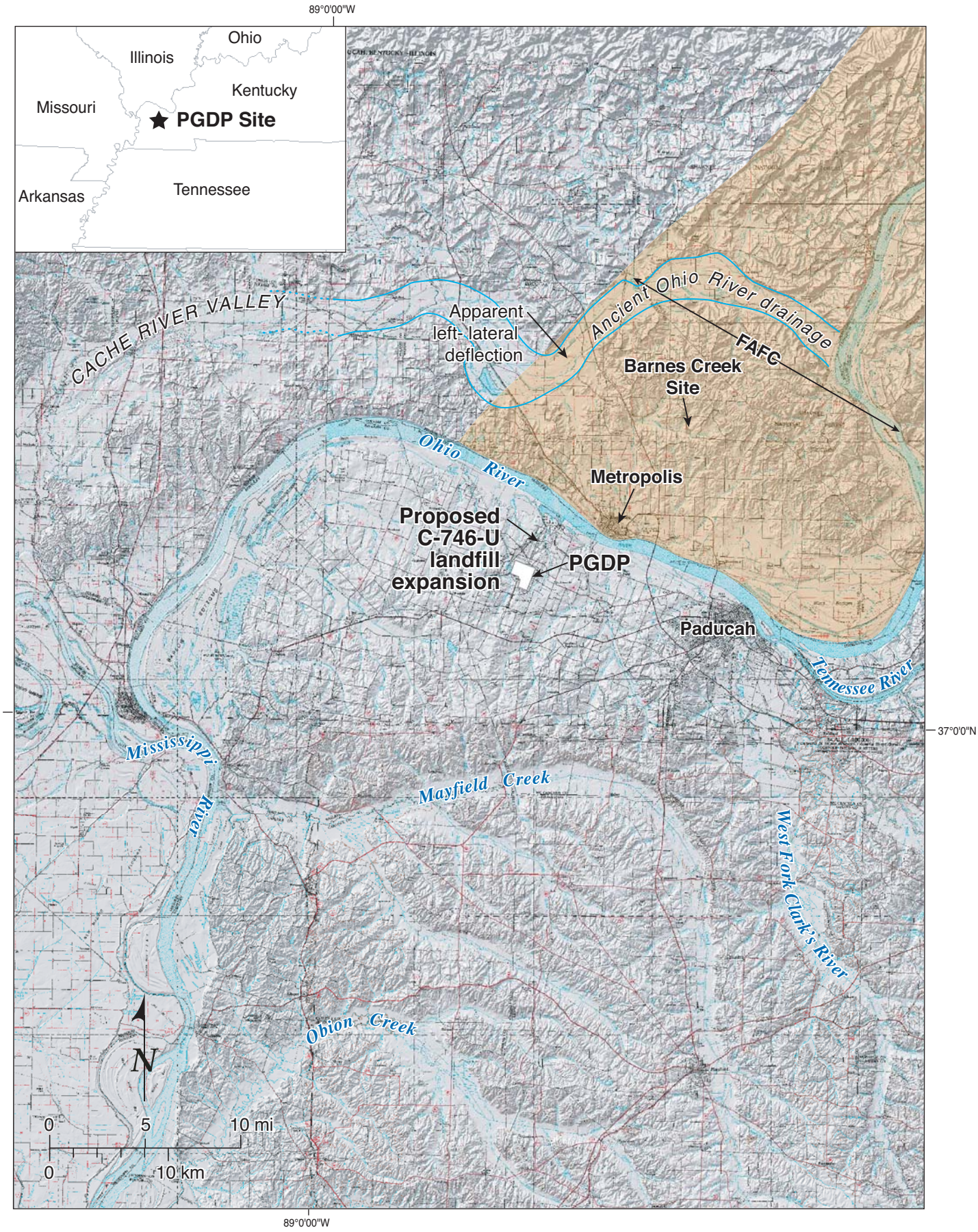


Figure 1. Location map of Paducah Gaseous Diffusion Plant (PGDP) and surrounding region. Note northeast-trending geomorphic lineaments associated with the westernmost part of the Fluorspar Area Fault Complex (FAFC) in southern Illinois. Also, note the apparent left-lateral deflection of the paleo-Ohio River along the western margin of the FAFC and absence of any deflection of the modern Ohio River along projection of the FAFC. Alternatively, the deflection is across the fault-line scarp of the Lusk Creek fault zone and the deflection represent differences in bedrock erodibility.

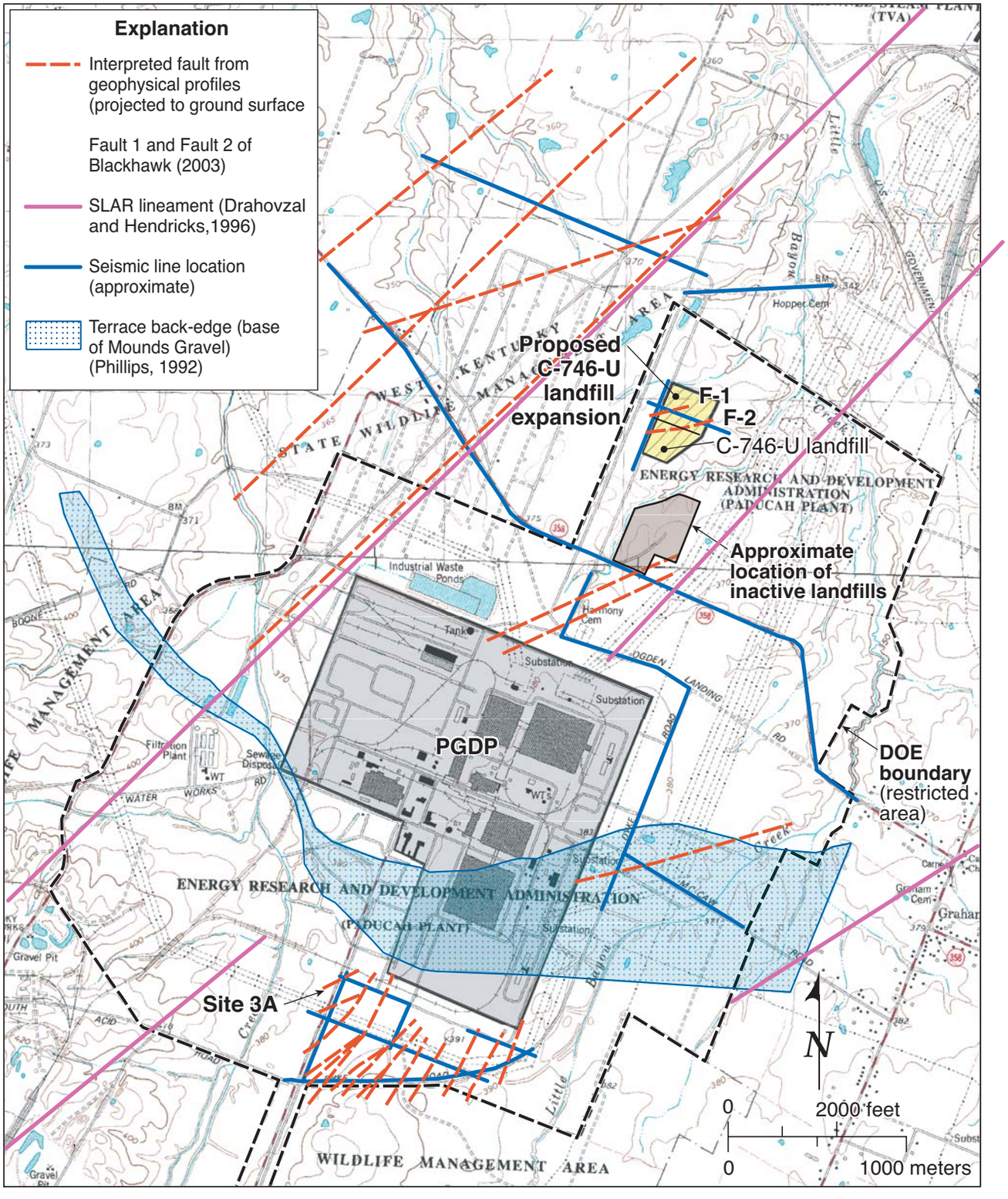


Figure 2. Site map of Paducah Gaseous Diffusion Plant (PGDP) and proposed C-746-U landfill expansion. Seismic line and fault traces considered approximate (taken from Langston and Street, 1998; Woolery and Street, 2002; and SAIC, 2004). SLAR lineaments from Drahovzal and Hendricks (1996). U.S.G.S. topographic base map from Joppa and Heath 7.5-minute quadrangles (1990).

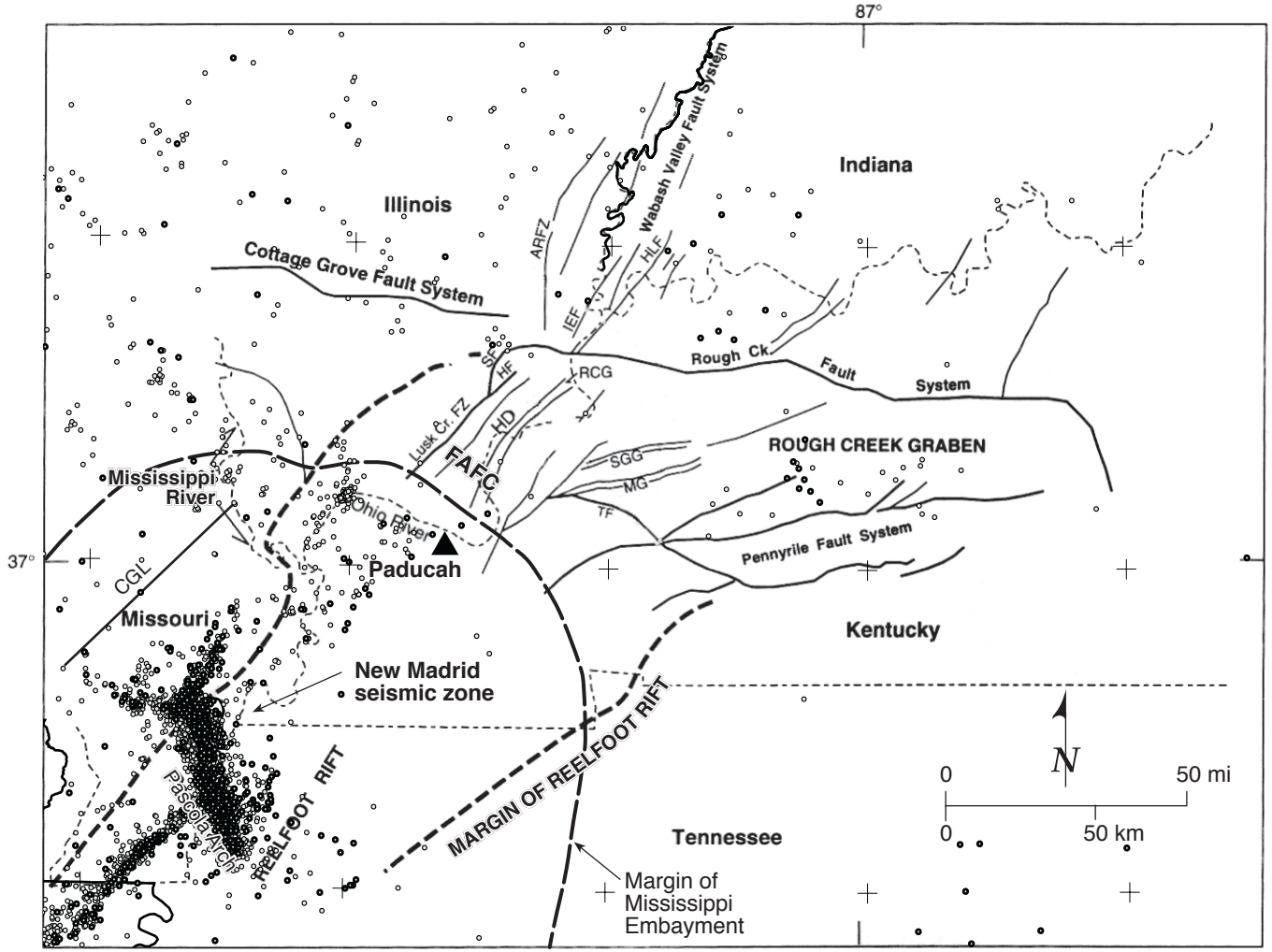


Figure 3. Seismotectonic map showing major geologic structures near Paducah (modified from Potter et al., 1997). Heavy solid lines are faults. Lusk Cr. FZ, Lusk Creek fault zone; HF, Herod fault; SF, Shawneetown fault; HD, Hicks dome; FAFC, Fluorspar area fault complex (shown schematically only - the number of faults is too large to illustrate at this scale); RCG, Rock Creek graben; TF, Tabb fault system; MG, Mexico graben; SGG, Shady Grove graben; ARFZ, Albion-Ridgway fault zone; IEF, Inman East fault; HLF, Hovey Lake fault. Seismicity from 1974 to 2004 (after Rhea et al., 1995; Johnston and Schweig, 1996; post-1992 seismicity from New Madrid earthquake catalog).

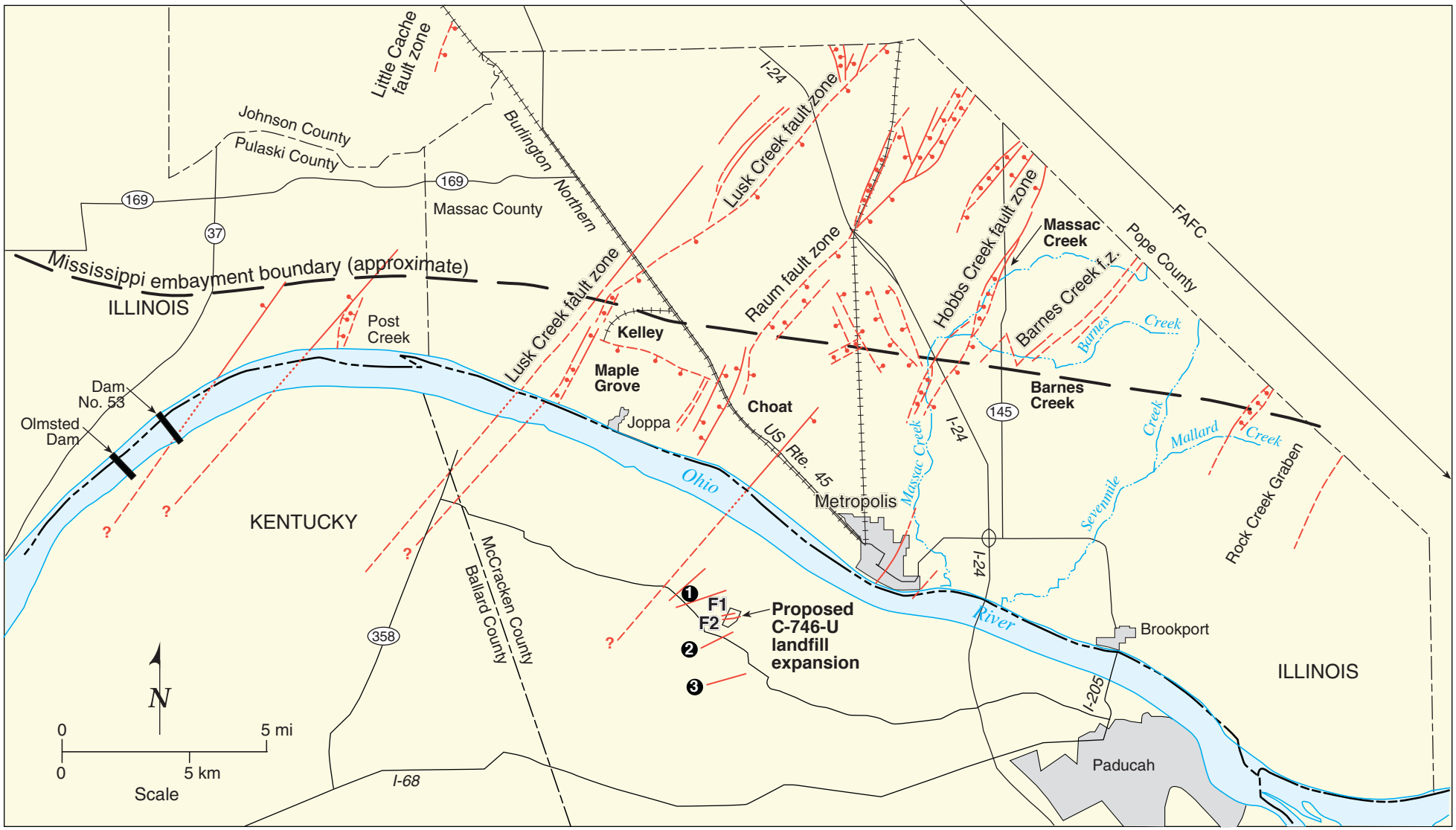
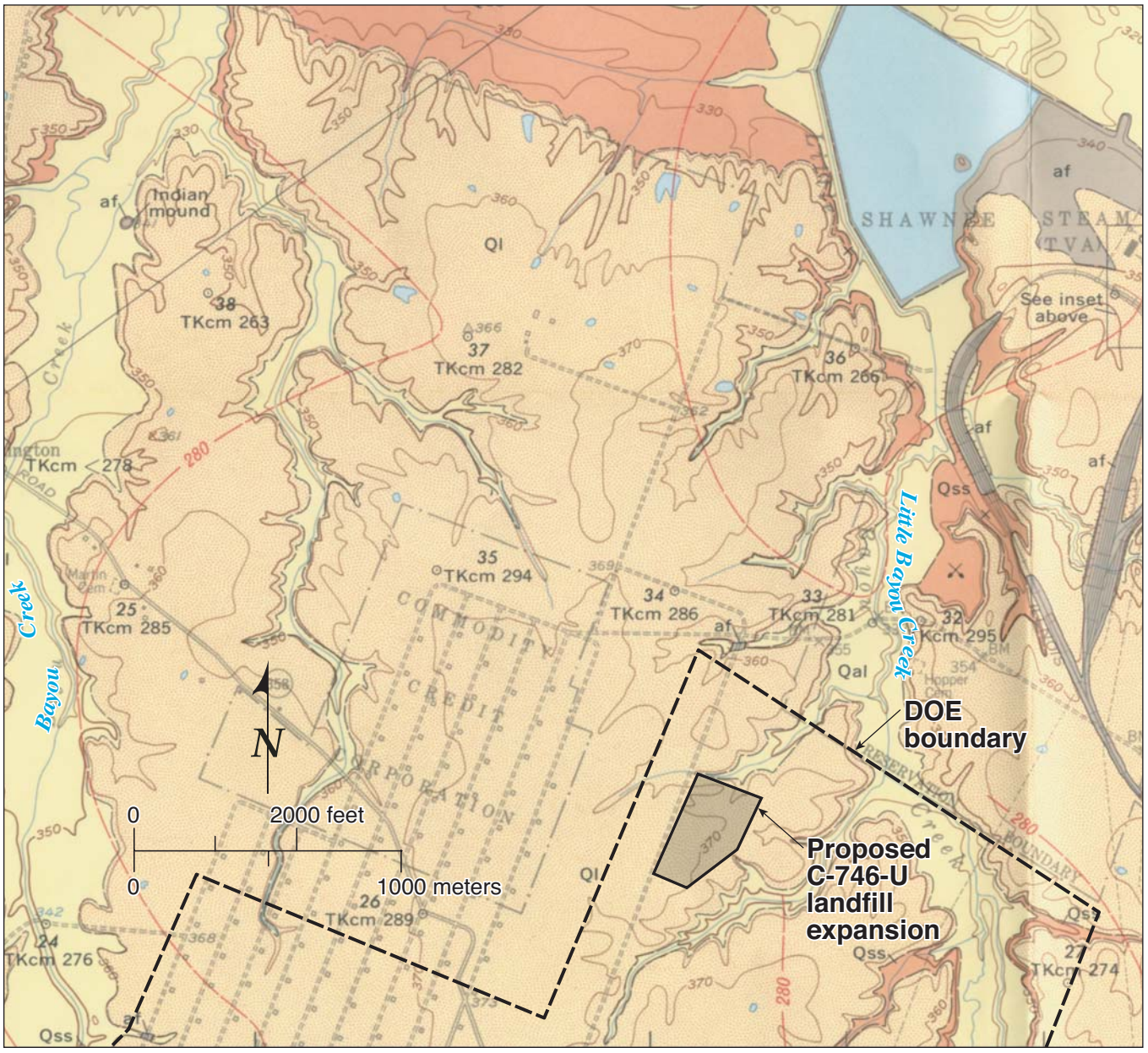


Figure 4. Regional fault map of site vicinity modified after McBride et al. (2002) and Woolery and Street (2002). Balls on downthrown side. Faults numbered 1 through 3 are those of Langston and Street (1998).



Explanation

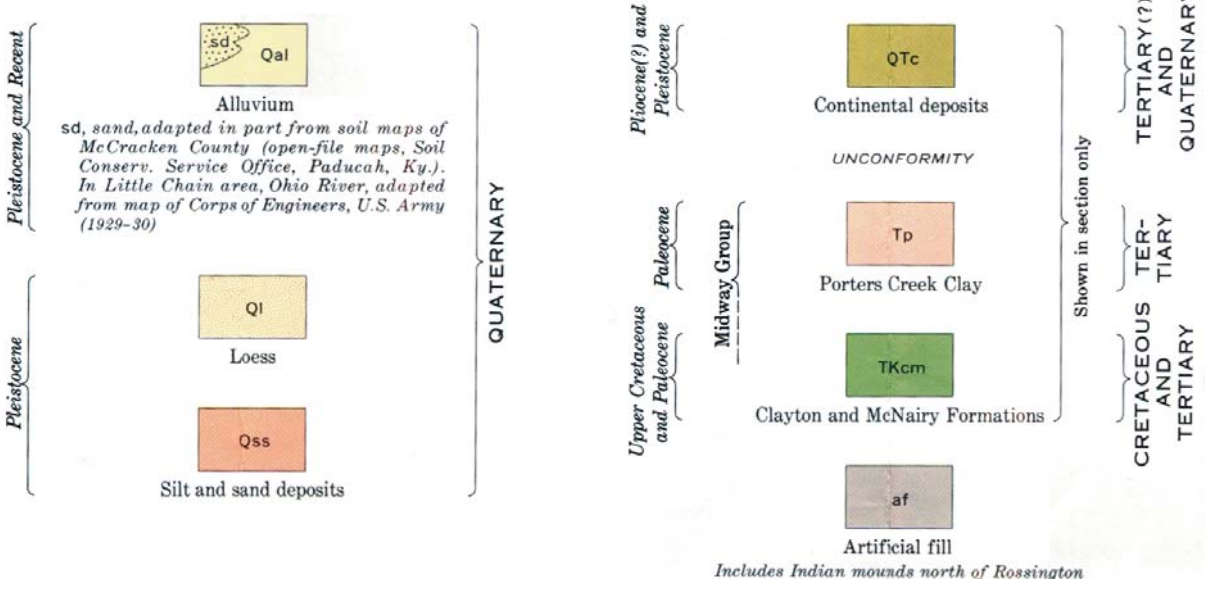


Figure 5. Regional geologic map (modified from Finch, 1967).

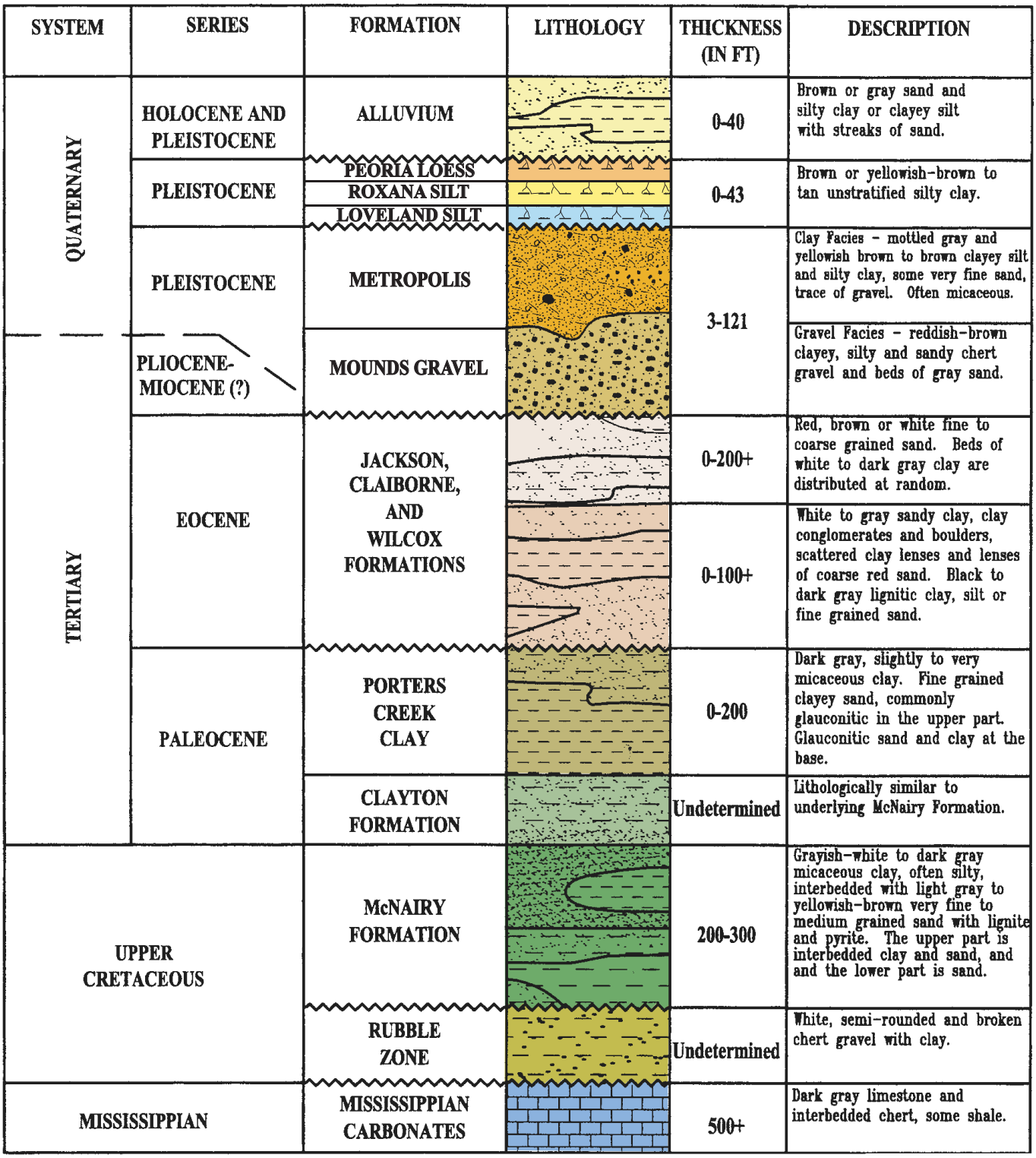


Figure 6. Schematic stratigraphic column of the PGDP region modified from Nelson et al. (2002) and SAIC (2004). Paleosols developed in the Loveland Silt (Sangamon Geosol), Roxana Silt (Farmdale Geosol) and Peoria Loess are noted by the root-like symbols in the upper half of each loess section.

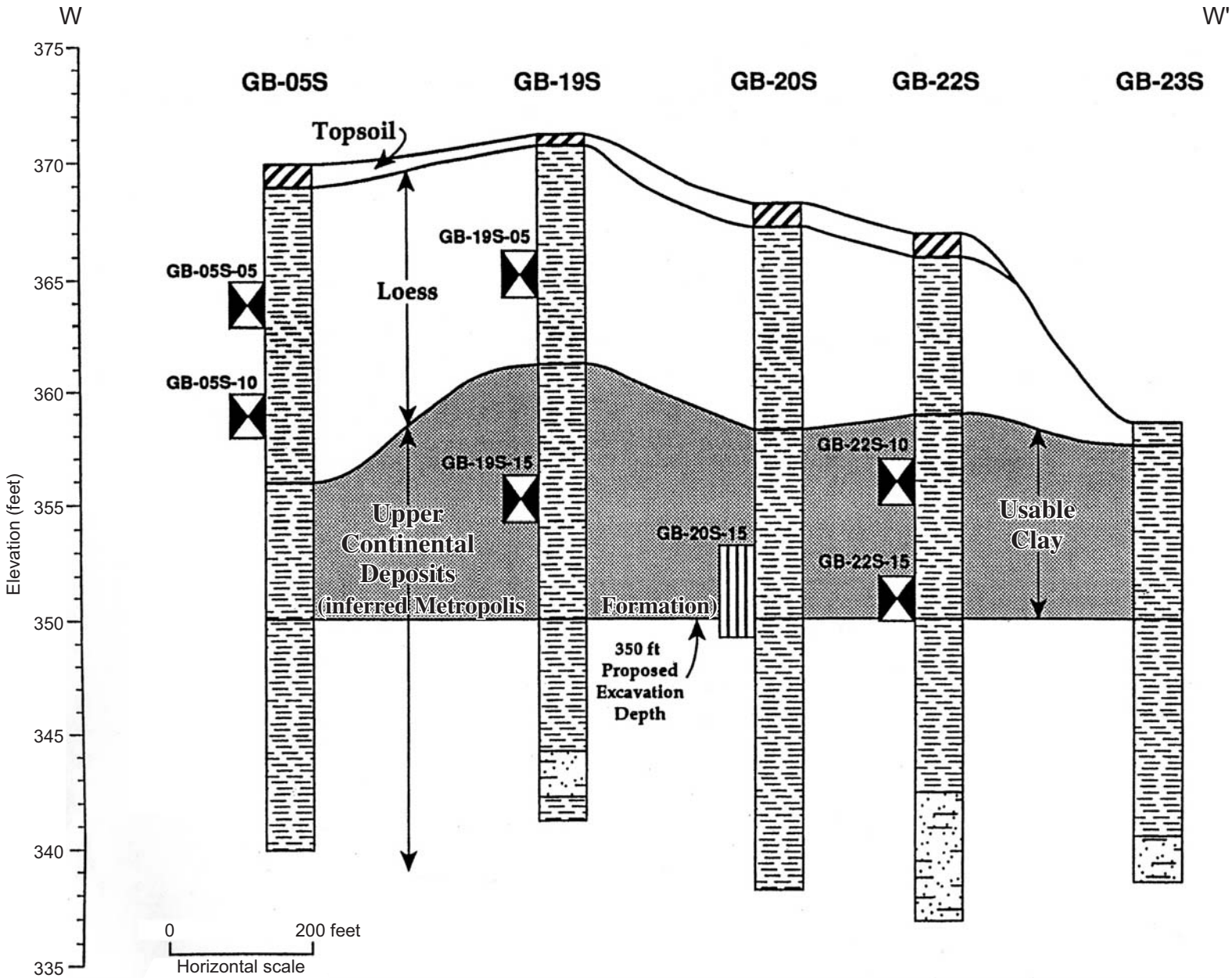
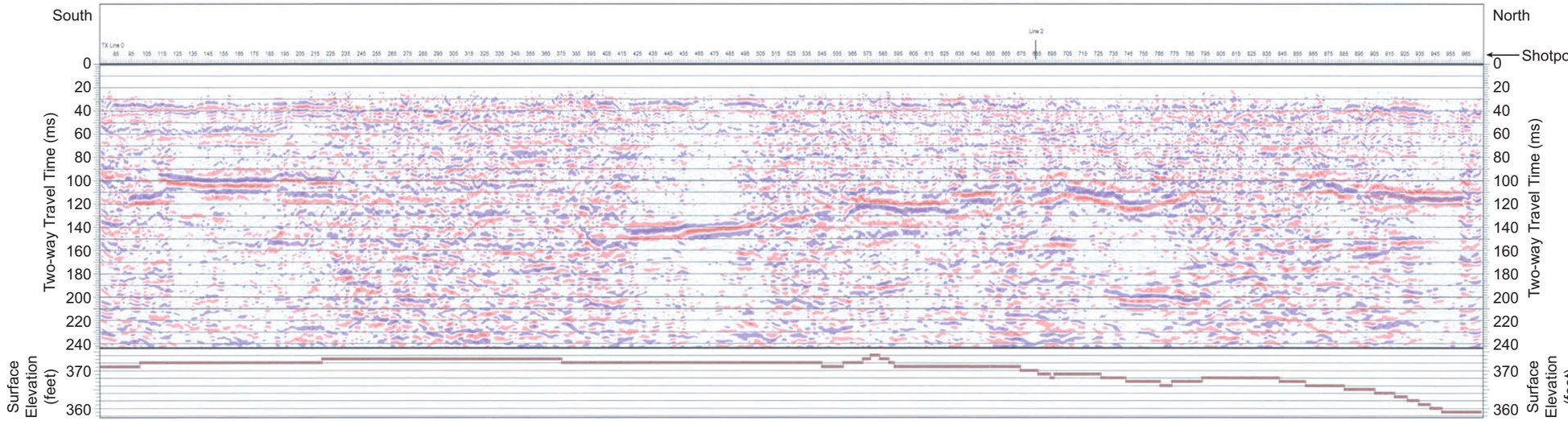


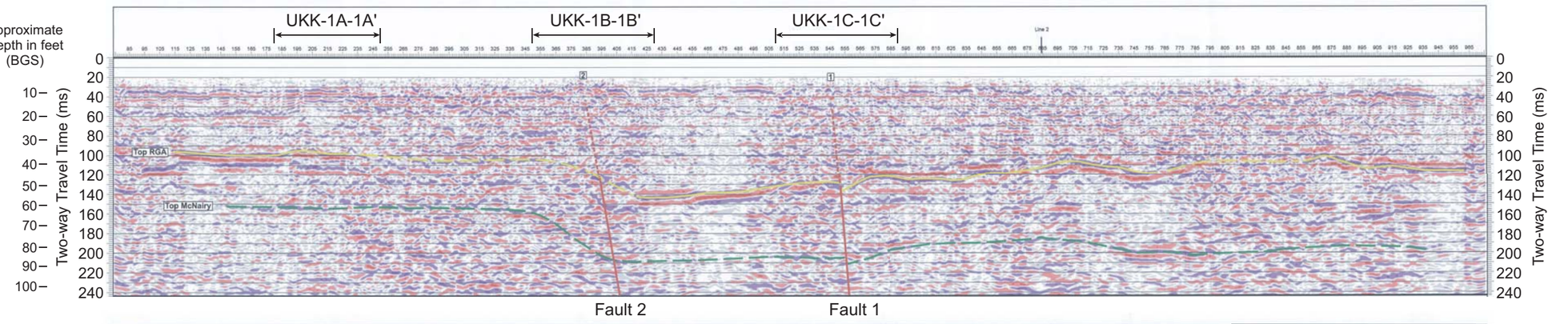
Figure 7. Geologic section from SAIC (1994) which depicts the generalized stratigraphy underlying C-746-U landfill. The topography shown represents the pre-grading slope conditions. See Plate 1 for the section location. Rectangles represent locations of geotechnical samples collected and analyzed by SAIC (1994). Vertical exaggereation approximately 32x.

A)



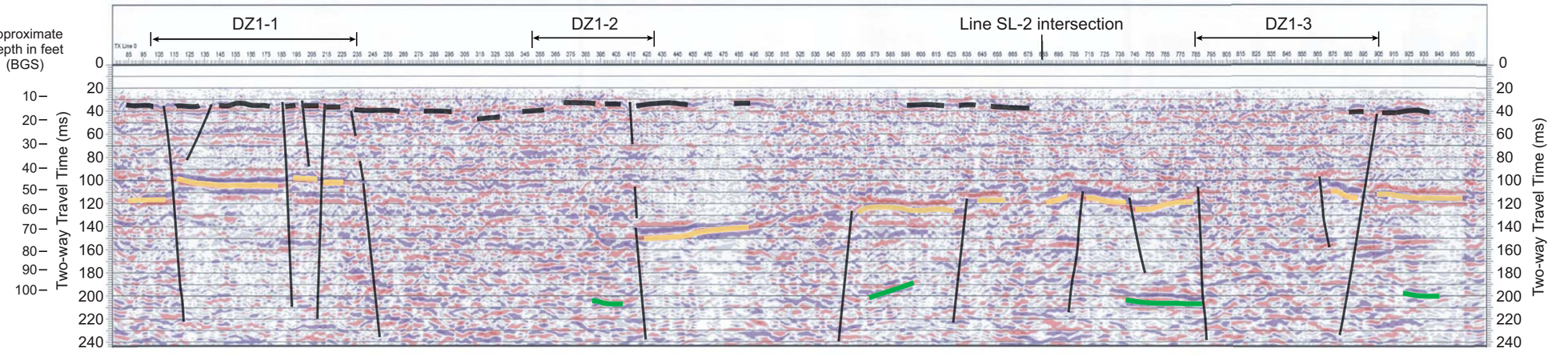
Processed Seismic Data
(Blackhawk, 2003)

B)



Geologic Interpretation
(Blackhawk, 2003)

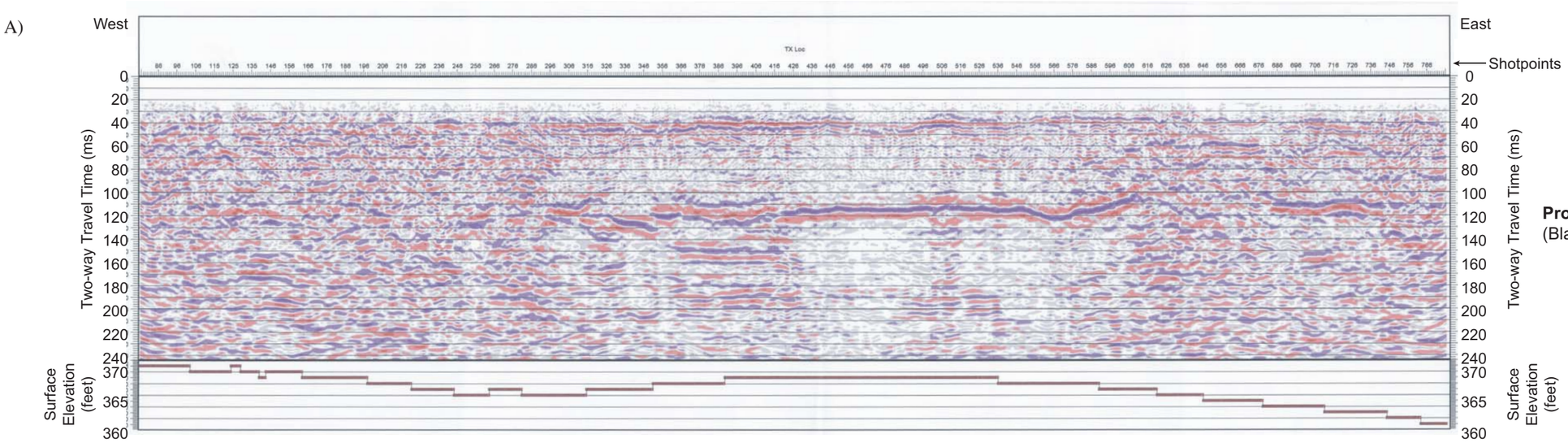
C)



Geologic Interpretation
(Woolery, 2005 personal communication)

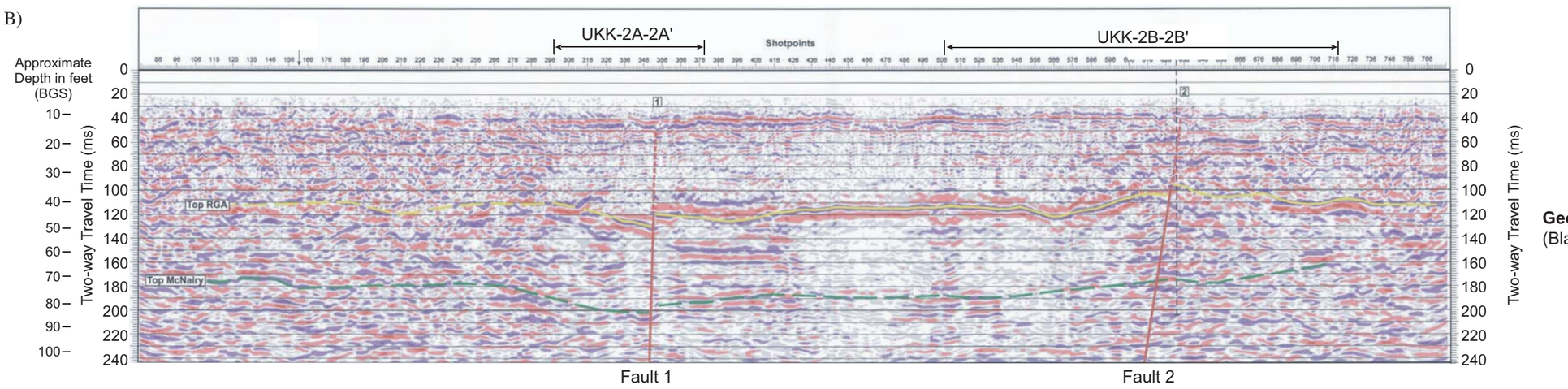
Figure 8. Seismic reflection profile SL-1 of Blackhawk (2003). A) Uninterpreted seismic reflection. B) Blackhawk (2003) interpretation. UKK-1A - 1A' refers to geologic cross section developed from DPT cores (this study). RGA = regional groundwater aquifer. C) Woolery (this study) interpretation DZ1-1, DZ1-2, and DZ1-3 refer to deformation zones of seismic line SL-1. Black subhorizontal lines denote stratigraphy within the Metropolis Formation; yellow colored line denotes the Mounds Gravel or top of the regional groundwater aquifer. Green colored subhorizontal line represents the top of the McNairy Formation. BGS = below ground surface.

A)



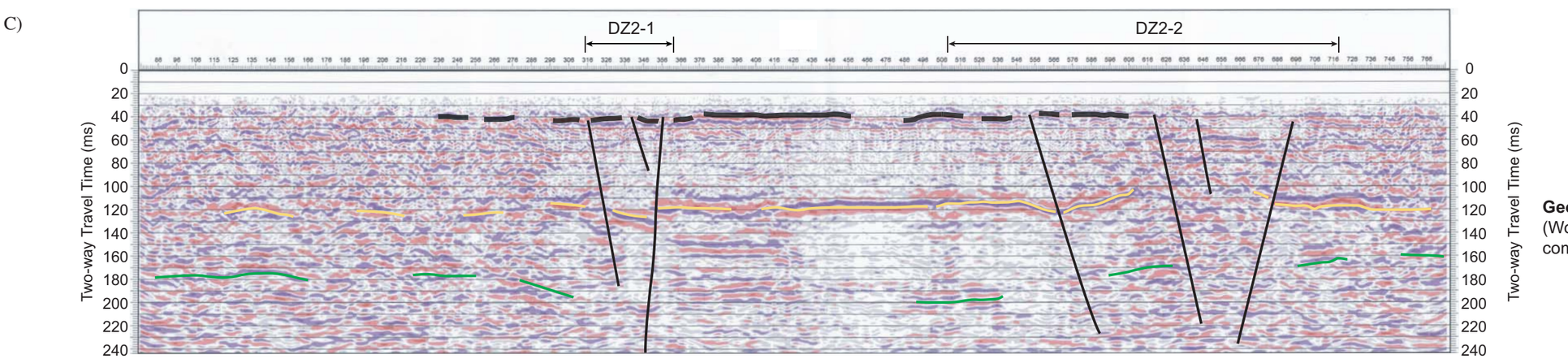
Processed Seismic Data
(Blackhawk, 2003)

B)



Geologic Interpretation
(Blackhawk, 2003)

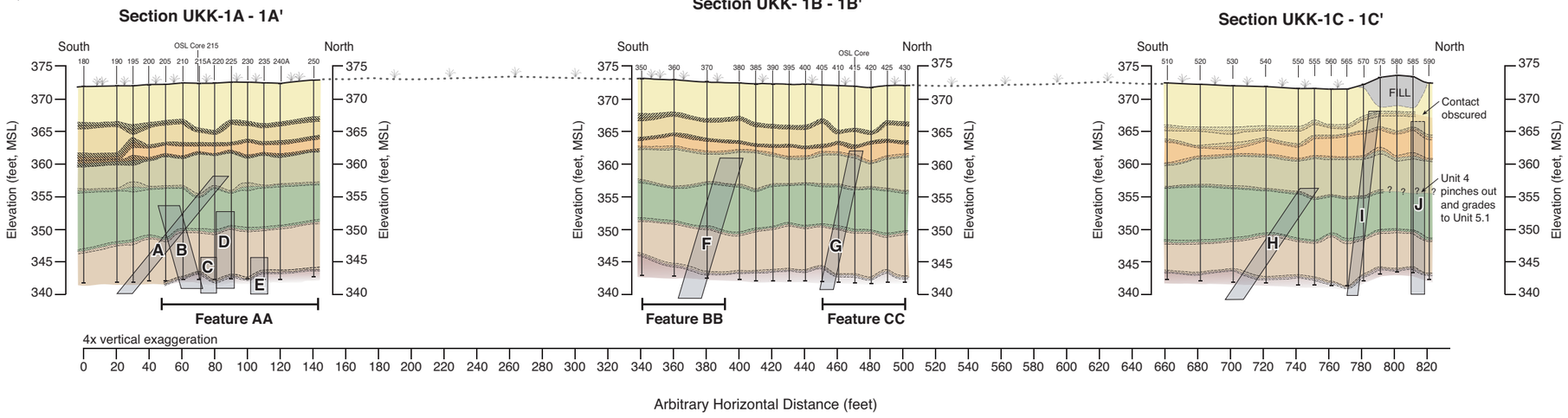
C)



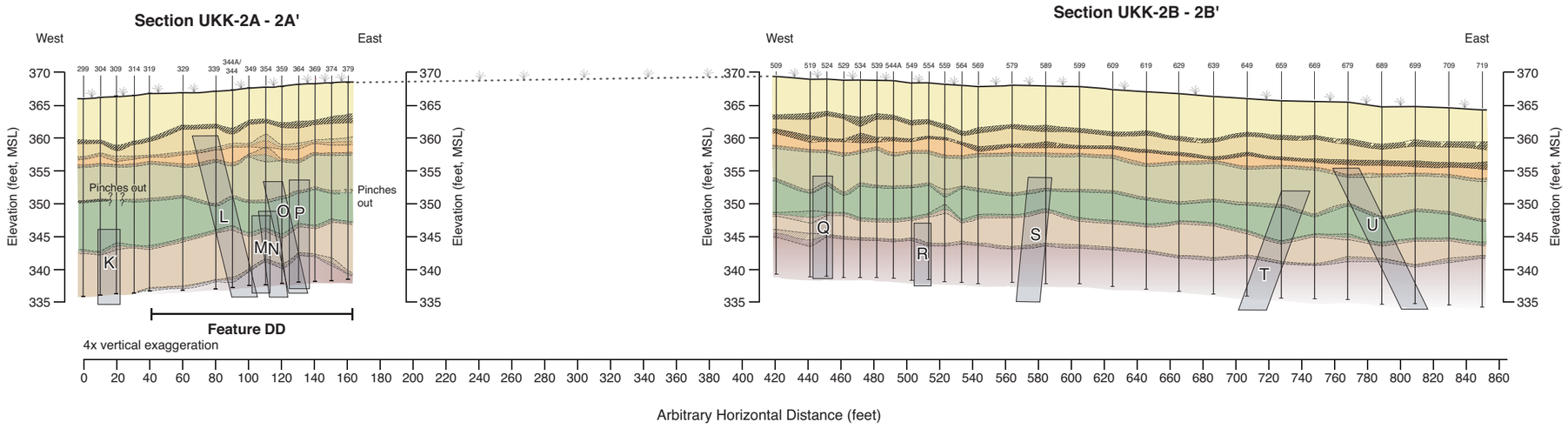
Geologic Interpretation
(Woolery, 2005 personal communication)

Figure 9. Seismic reflection profile SL-2 of Blackhawk (2003). A) Uninterpreted seismic reflection. B) Blackhawk (2003) interpretation UKK-2A-2A' represents location of geologic cross section based on DPT data (this study). RGA = regional groundwater aquifer. C) Woolery (this study) interpretation DZ2-1 and DZ2-2 and represent deformation zones of seismic line SL-2. Black subhorizontal lines denote stratigraphy within the Metropolis Formation; yellow colored subhorizontal line denotes the Mounds Gravel or top of the regional groundwater aquifer. Green colored subhorizontal line represents the top of the McNairy Formation.

A)



B)



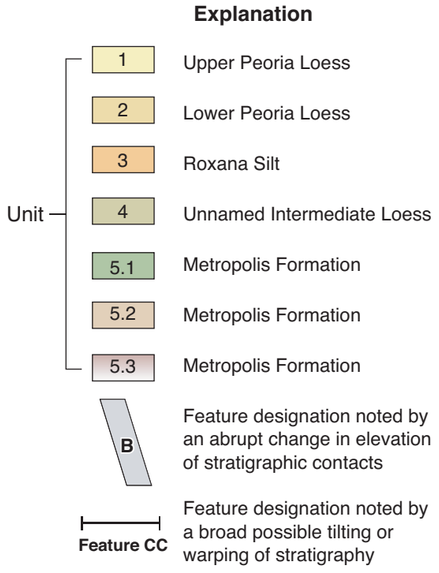
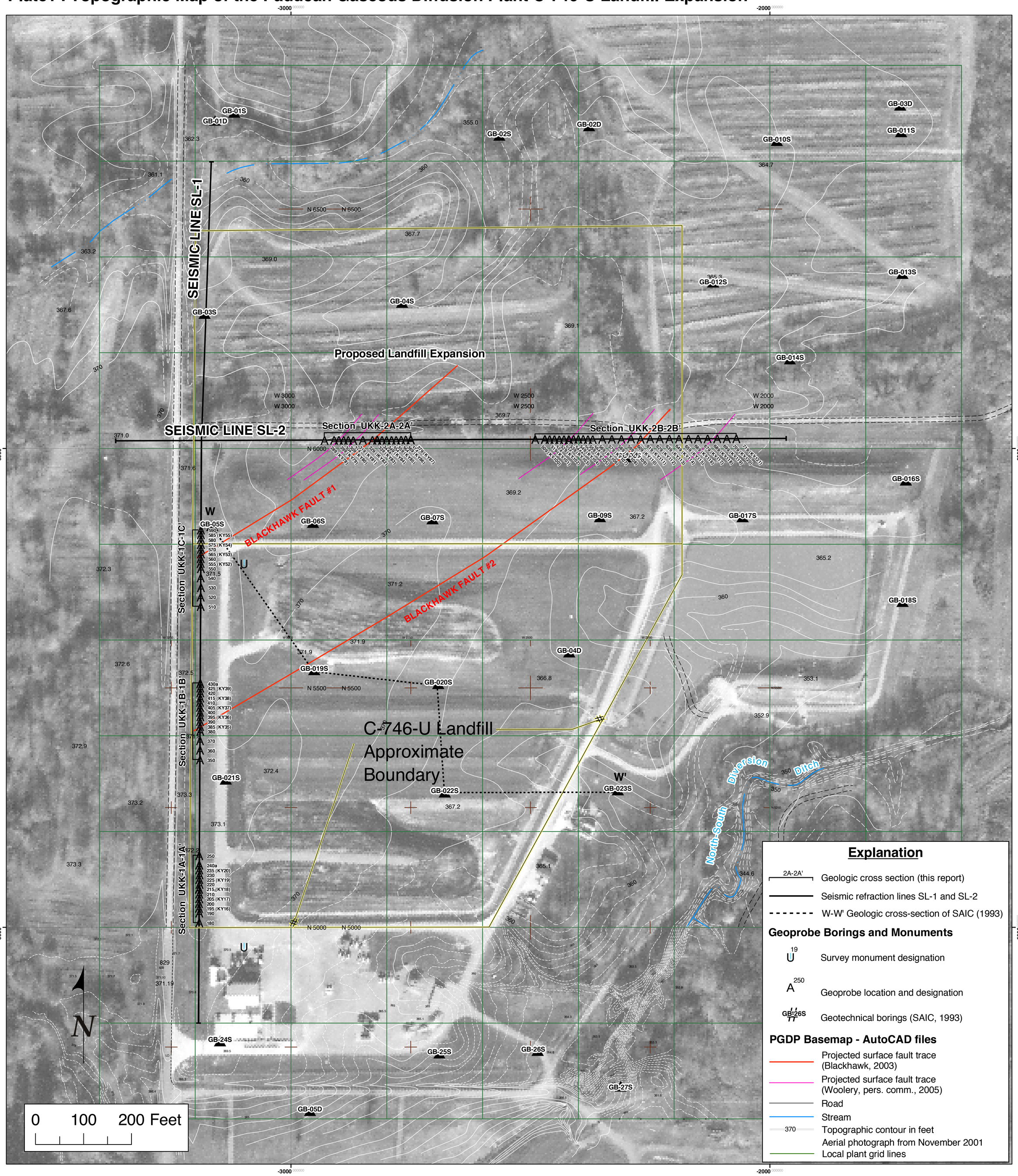


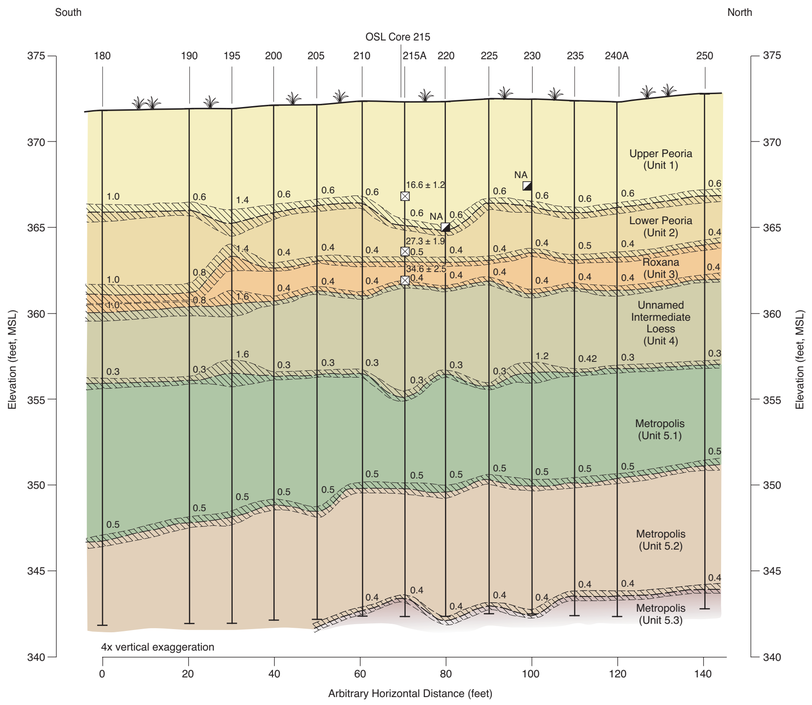
Figure 10. Index figure showing selected features discussed in the text and interpreted from the DPT data; see Plate 1 for locations, and Plates 2 and 3 for further geologic explanation.

1725 Paducah
Revised 07/26/06

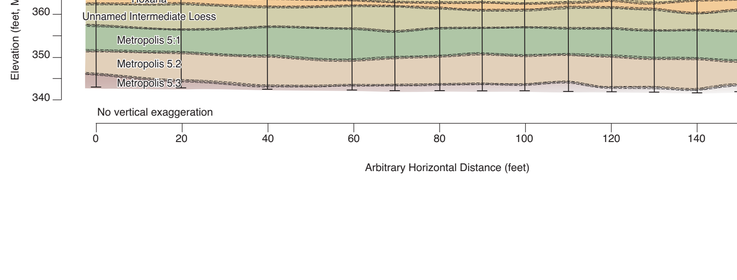
Plate1 . Topographic Map of the Paducah Gaseous Diffusion Plant C-746-U Landfill Expansion



Section UKK-1A - 1A'



Section UKK-1A - 1A'



Explanation

Symbols

- Unit contact
- Contact error[5] – contact error listed next to each boring contact and the methodology for determining error estimate described in section 5
- Radiocarbon (C^{14} sample location) – No ages reported because samples did not contain enough carbon for analyses
- 16.6 ± 1.2 ☒ Optically stimulated luminesence sample location and age (ka with 1σ); see Table 2

Notes

1. Boring designations correspond to shot-points in seismic lines SL-1 and SL-2.
2. Shot-points have 2-foot spacing.
3. Vertical exaggeration is 4x (1h:4v).
4. More complete descriptions of stratigraphic units and paleosols provided in section 6.
5. Graphic contact error not accurate.
6. Elevations tied into Paducah Gaseous Diffusion Plant coordinate system.

Unit Descriptions[4]

Upper Peoria - (Unit 1) brown (10YR5/3) to yellowish brown (10YR5/8) CLAYEY SILT (up to 15% clay) to a clean SILT with minor traces of clay. Massive and speckled (3-5%) with small (<3mm) angular to sub-rounded blackish nodules of iron-manganese oxyhydroxides. In places unit has poorly developed brown-orange iron-oxide zones defined as mottles and fine nodules. (Pleistocene loess)

Upper section of Unit 1 is overprinted by "modern" soil that began developing post deposition of loess (circa 12 ka; Foreman et al., 2002). This soil consists of a thin A-horizon with minor organic accumulation, a distinct whitish silt-rich E-horizon, a clay-rich A/B and B-soil horizons, and a C-soil horizon that is noted by a decrease in clay content with little to no mottling.

Lower Peoria – (Unit 2) brownish yellow (10YR6/6) to yellowish brown (10YR 5/4-5/8) SILT to CLAYEY SILT with discontinuous and subhorizontal whitish to light yellow silt laminae. Unit is generally massive, moist, and soft and compresses readily with the DPT sampling technique. Basal contact of Unit 2 is generally defined by relatively clean silt with laminae overlying a more clay-rich silt (Farmdale Geosol) with abundant relict root casts and mottling. (Pleistocene loess)

A poorly defined palesol represents the top of Unit 2. Identified in the cores based on the presence of subtle to moderate iron-manganese oxyhydroxides developed within the upper 0.5 feet of Unit 2.

Roxana - (Unit 3) yellowish brown (10YR-5/4) to pale brown (10YR-6/3) SILT with clay and SILTY CLAY with distinct, discontinuous, yellowish-white thin laminations. Unit 3 also contains prominent clay films along well developed pedogenic fractures, a significant clay content compared to overlying loess packages, extensive mottling, and well-developed, clay-filled root casts. Basal contact generally is clear and marked by a thinly laminated yellowish-brown silt with little to no manganese-oxides that overlie a darker brown to grayish-brown silty clay (interpreted as a buried paleosol) of an older unnamed loess. (Pliestocene loess)

The Farmdale Geosol and associated mottling and clay development overprints and obscures much of the massive nature of unit 3. Upper part of the Farmdale Geosol is noted by the concentration of fine- to medium-sized iron and manganese oxyhydroxide (5-10%). Prominent dark gray subvertical clay seams (pedogenic fractures and root casts) present down section with zones of prominent oxidation and clay film development.

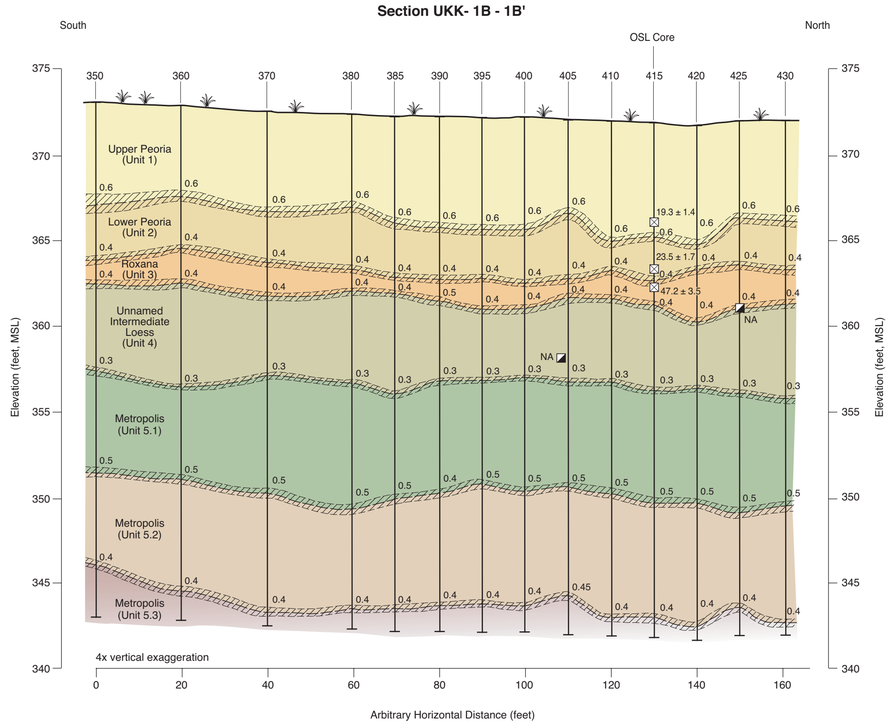
Unnamed Intermediate Loess – (Unit 4) yellowish brown (10YR5/6) or light brownish yellow (10YR6/4) to brown (10YR5/3) SILTY CLAY with thinly laminated silt interbeds. A well-developed paleosol present throughout unit 4. Upper part of unit is marked by an increase in clay content and manganese oxide staining and nodule development, consistent with paleosol features. Subvertical grayish clay-rich seams are found throughout the unit and cross-cutting softer yellowish-brown SILTY CLAY to CLAYEY SILT. Unit 4 is strongly mottled, generally moist and soft (silt) to stiff (clay). The basal contact, is generally clear and marked by a distinct, massive silty to silty sand horizon directly overlying a darker gray clay-rich unit (interpreted as a buried paleosol possibly associated with the Sangamon Geosol). (Pleistocene loess)

Metropolis Formation – (Unit 5.1) This unit is a light brownish gray (10YR-6/2) to grayish brown (10YR-5/2) CLAY to SILTY CLAY which grades down section to a gray (10YR-5/1) to light grayish brown (10YR-6/2), or grayish brown (10YR-5/2) CLAY with silty to sandy interbeds. Upper part of unit is generally massive with occasional faint silt laminations. Extensive vertical dark blue grey clay seams within upper two feet of deposit and interpreted as possible buried soil textures associated with the Sangamon Geosol. The lower part of the unit generally contains thin interbeds of sandy silt, silty sand, silt and clay. Iron-manganese oxyhydroxide staining is minor and consists of mottling primarily in the upper section. The basal contact is generally clear. (Pleistocene fluvial deposit)

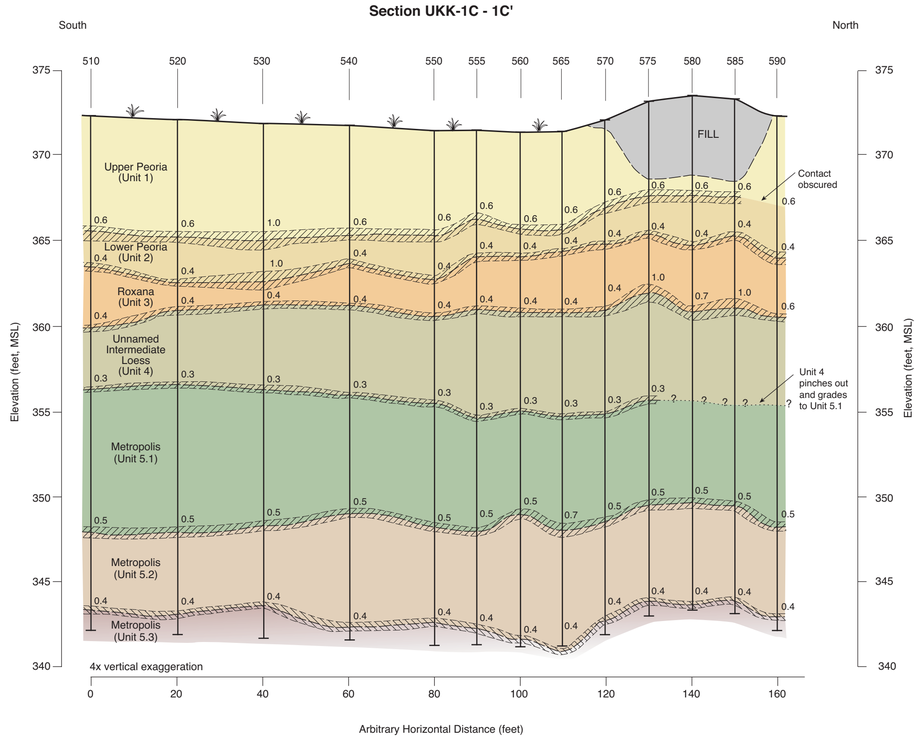
Metropolis Formation – (Unit 5.2) This unit consists of a reddish yellow (7.5YR-6/8 to 6/6) to a strong brown (7.5YR-5/8) SANDY CLAY or CLAYEY SAND (60-70% sand) with clay interbeds. Upper contact marked by an increase in silt, sand, gravel, and iron oxide staining. Upper portion of unit contains thin clay interbeds at about a foot below the upper contact with unit 5.1. Unit 5.2 is moist to very moist, soft, stiff to hard, with little or no iron-manganese oxyhydroxide staining. Base of unit often grades into a SILT or CLAY, which can be up to 2 feet thick. (Pleistocene fluvial deposit)

Metropolis Formation – (Unit 5.3) This unit is a bedded, brown (7.5YR-5/4) to strong brown (7.5YR-5/8) fine- to medium-grained SAND and GRAVEL with silt and some reddish yellow (7.5YR-6/8) clay laminations. This unit is moist and is often strongly stained an orange-brown from iron oxides. Minor subvertical blue-grey clay seams delineate ancient rootcasts or pedogenic clay seams possibly associated with the Yarmouth Geosol. Iron and manganese oxyhydroxide staining are either absent or weakly expressed when present. The base of this unit extends beyond the depth of subsurface exploration. (Pleistocene fluvial deposit)

Section UKK- 1B - 1B'

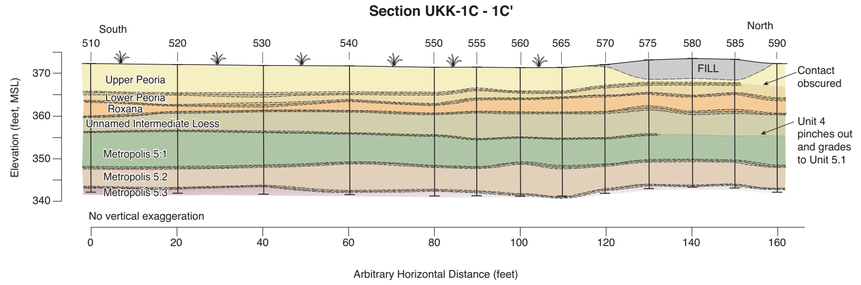


Section UKK-1C - 1C'



Section UKK- 1B - 1B'

Section UKK-1C - 1C'



C-746-U LANDFILL EXPANSION
PADUCAH, KENTUCKY

Sections UKK-1A-1A', UKK-1B-1B' and UKK-1C-C'

William Lettis & Associates, Inc. | Plate 2

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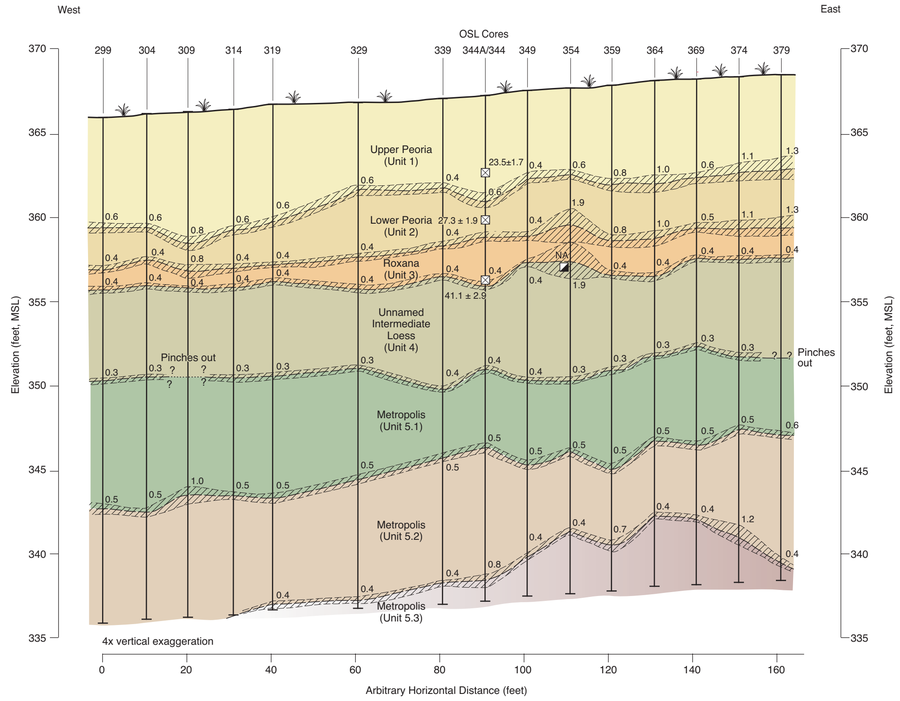
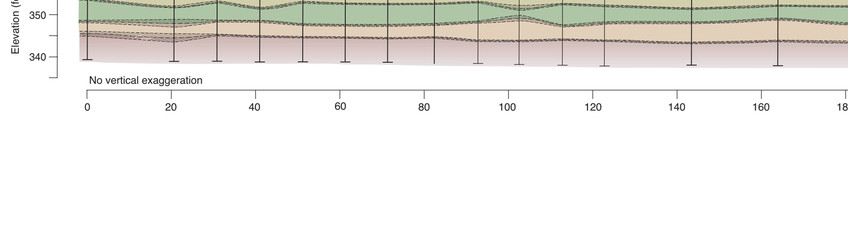
Section UKK-2A - 2A'



Section UKK-2A - 2A'



Explanation

Symbols

- Unit contact
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- Radiocarbon (C^{14} sample location) – No ages reported because samples did not contain enough carbon for analyses
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5. Graphic contact error not accurate.
6. Elevations tied into Paducah Gaseous Diffusion Plant coordinate system.

Unit Descriptions[4]

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A poorly defined paleosol represents the top of Unit 2. Identified in the cores based on the presence of subtle to moderate iron-manganese oxyhydroxides developed within the upper 0.5 feet of Unit 2.

Roxana Silt - (Unit 3) yellowish brown (10YR-5/4) to pale brown (10YR-6/3) SILT with clay and SILTY CLAY with distinct, discontinuous, yellowish-white thin laminations. Unit 3 also contains prominent clay films along well developed pedogenic fractures, a significant clay content compared to overlying loess packages, extensive mottling, and well-developed, clay-filled root casts. Basal contact generally is clear and marked by a thinly laminated yellowish-brown silt with little to no manganese-oxides that overlie a darker brown to grayish-brown silty clay (interpreted as a buried paleosol) of an older unnamed loess. (Pliestocene loess)

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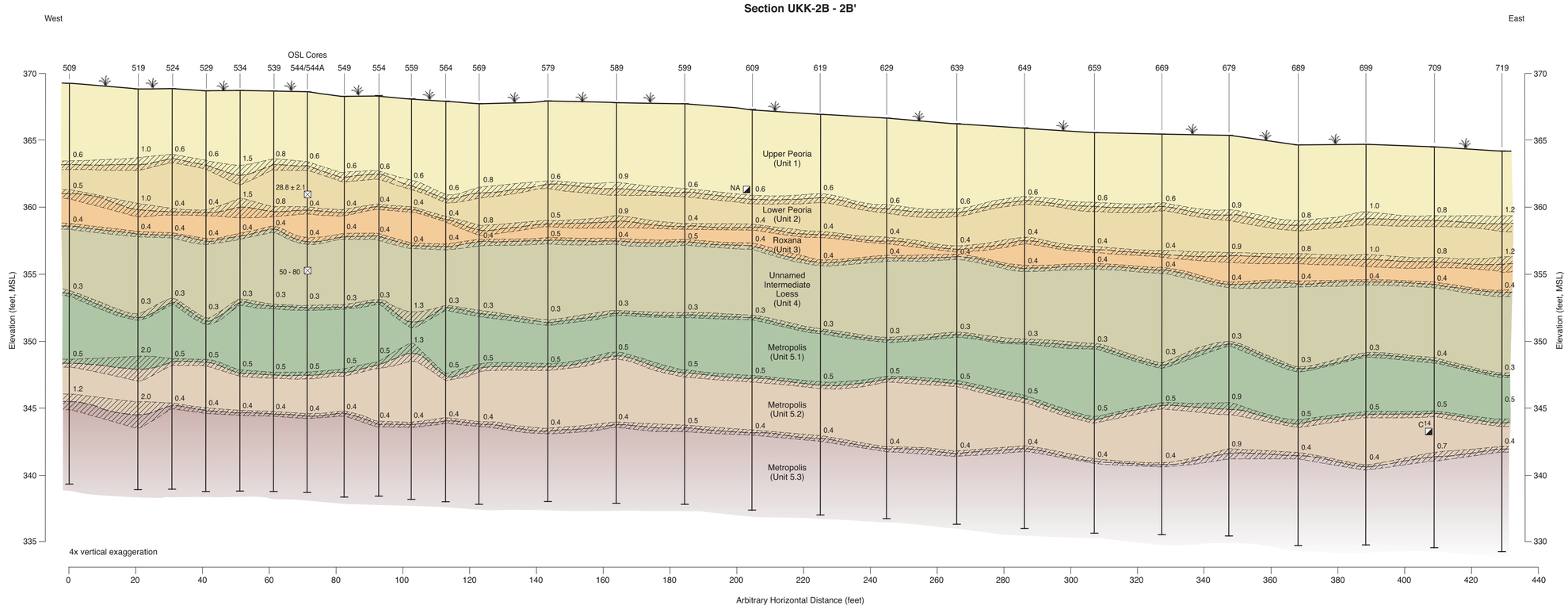
Unnamed Intermediate Loess – (Unit 4) yellowish brown (10YR5/6) or light brownish yellow (10YR6/4) to brown (10YR5/3) SILTY CLAY with thinly laminated silt interbeds. A well-developed paleosol present throughout unit 4. Upper part of unit is marked by an increase in clay content and manganese oxide staining and nodule development, consistent with paleosol features. Subvertical grayish clay-rich seams are found throughout the unit and cross-cutting softer yellowish-brown SILTY CLAY to CLAYEY SILT. Unit 4 is strongly mottled, generally moist and soft (silt) to stiff (clay). The basal contact, is generally clear and marked by a distinct, massive silty to silty sand horizon directly overlying a darker gray clay-rich unit (interpreted as a buried paleosol possibly associated with the Sangamon Geosol). (Pleistocene loess)

Metropolis Formation – (Unit 5.1) This unit is a light brownish gray (10YR-6/2) to grayish brown (10YR-5/2) CLAY to SILTY CLAY which grades down section to a gray (10YR-5/1) to light grayish brown (10YR-6/2), or grayish brown (10YR-5/2) CLAY with silty to sandy interbeds. Upper part of unit is generally massive with occasional faint silt laminations. Extensive vertical dark blue grey clay seams within upper two feet of deposit and interpreted as possible buried soil textures associated with the Sangamon Geosol. The lower part of the unit generally contains thin interbeds of sandy silt, silty sand, silt and clay. Iron-manganese oxyhydroxide staining is minor and consists of mottling primarily in the upper section. The basal contact is generally clear. (Pleistocene fluvial deposit)

Metropolis Formation – (Unit 5.2) This unit consists of a reddish yellow (7.5YR-6/8 to 6/6) to a strong brown (7.5YR-5/8) SANDY CLAY or CLAYEY SAND (60-70% sand) with clay interbeds. Upper contact marked by an increase in silt, sand, gravel, and iron oxide staining. Upper portion of unit contains thin clay interbeds at about a foot below the upper contact with unit 5.1. Unit 5.2 is moist to very moist, soft, stiff to hard, with little or no iron-manganese oxyhydroxide staining. Base of unit often grades into a SILT or CLAY, which can be up to 2 feet thick. (Pleistocene fluvial deposit)

Metropolis Formation – (Unit 5.3) This unit is a bedded, brown (7.5YR-5/4) to strong brown (7.5YR-5/8) fine- to medium-grained SAND and GRAVEL with silt and some reddish yellow (7.5YR-6/8) clay laminations. This unit is moist and is often strongly stained an orange-brown from iron oxides. Minor subvertical blue-grey clay seams delineate ancient rootcasts or pedogenic clay seams possibly associated with the Yarmouth Geosol. Iron and manganese oxyhydroxide staining are either absent or weakly expressed when present. The base of this unit extends beyond the depth of subsurface exploration. (Pleistocene fluvial deposit)

Section UKK-2B - 2B'



Section UKK-2B - 2B'

C-746-U LANDFILL EXPANSION
PADUCAH, KENTUCKY

Sections UKK-2A-2A' and UKK-2B-2B'

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