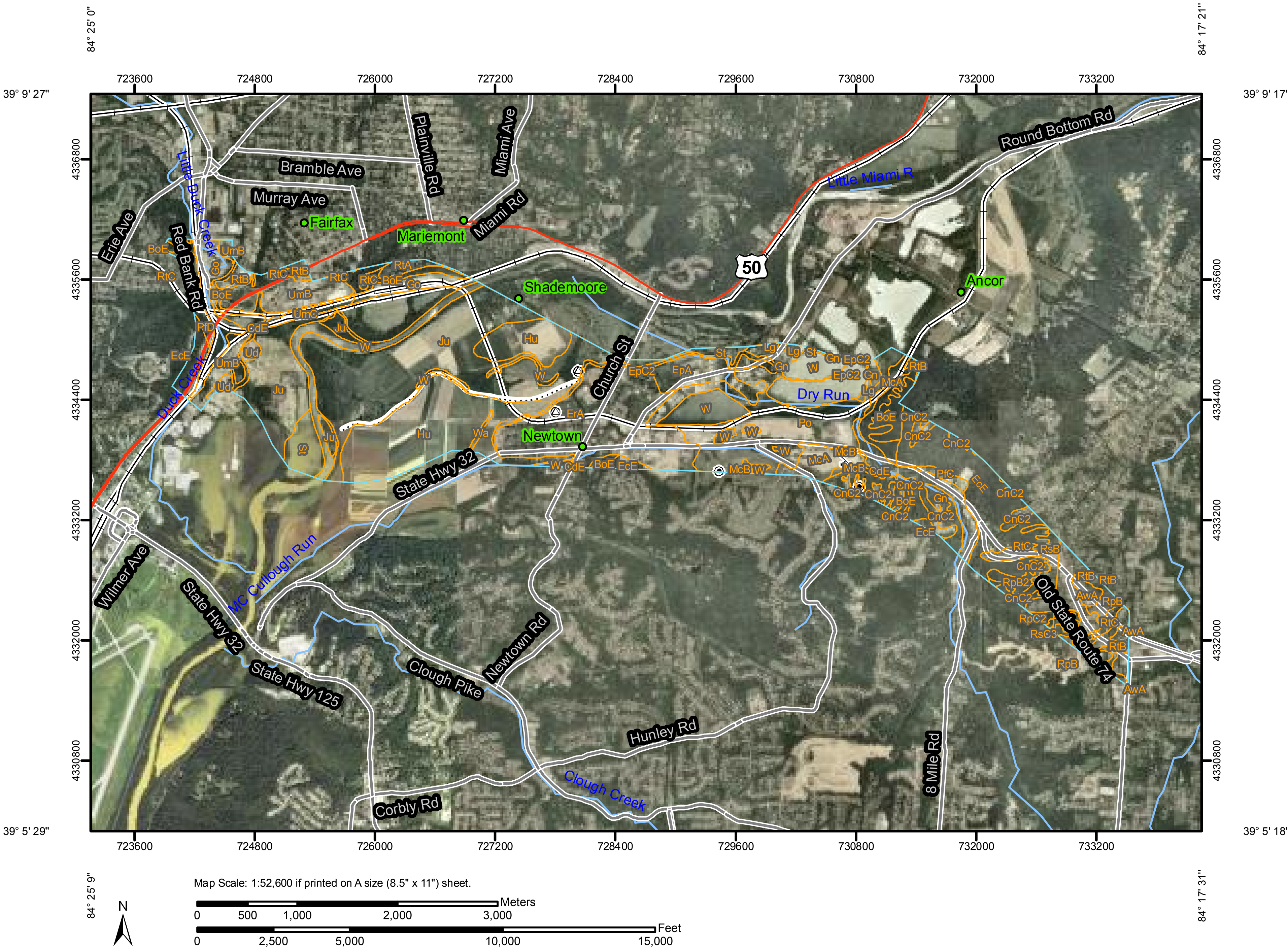
Soil Map—Clermont County, Ohio, and Hamilton County, Ohio
(EC Segment II/III)



Map Scale: 1:52,600 if printed on A size (8.5" x 11") sheet.

Meters: 0, 500, 1,000, 2,000, 3,000

Feet: 0, 2,500, 5,000, 10,000, 15,000

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Units

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

- Gully
- Short Steep Slope
- Other

Political Features

- Cities

Water Features

- Oceans
- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads

MAP INFORMATION

Map Scale: 1:52,600 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at scales ranging from 1:15,840 to 1:20,000.

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 16N NAD83

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

Soil Survey Area: Clermont County, Ohio
Survey Area Data: Version 9, Nov 9, 2009

Soil Survey Area: Hamilton County, Ohio
Survey Area Data: Version 10, Nov 9, 2009

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Date(s) aerial images were photographed: 9/22/2004; 6/24/2004; 9/20/2004

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

Clermont County, Ohio (OH025)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
AvA	Avonburg silt loam, 0 to 2 percent slopes	4.0	0.1%
AvB	Avonburg silt loam, 2 to 6 percent slopes	3.2	0.1%
AwA	Avonburg-Urban land complex, nearly level	21.8	0.7%
CkD3	Cincinnati and Hickory soils, 12 to 25 percent slopes, severely eroded	1.8	0.1%
EbE2	Edenton loam, 18 to 25 percent slopes, moderately eroded	3.3	0.1%
RpA	Rossmoyne silt loam, 0 to 2 percent slopes	1.7	0.1%
RpB	Rossmoyne silt loam, 2 to 6 percent slopes	28.3	0.9%
RsC3	Rossmoyne silty clay loam, 6 to 12 percent slopes, severely eroded	6.5	0.2%
RtB	Rossmoyne-Urban land complex, gently sloping	75.8	2.3%
RtC	Rossmoyne-Urban land complex, sloping	8.1	0.2%
Subtotals for Soil Survey Area		**154.6**	**4.7%**
Totals for Area of Interest		**3,319.9**	**100.0%**

Hamilton County, Ohio (OH061)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
BoE	Bonnell silt loam, 25 to 35 percent slopes	151.5	4.6%
CdE	Casco loam, 25 to 35 percent slopes	28.1	0.8%
CnC2	Cincinnati silt loam, 8 to 15 percent slopes, eroded	99.5	3.0%
EcE	Eden silty clay loam, 25 to 40 percent slopes	246.7	7.4%
EpA	Eldean loam, 0 to 2 percent slopes	71.8	2.2%
EpC2	Eldean loam, 6 to 12 percent slopes, eroded	28.2	0.9%
ErA	Eldean-Urban land complex, 0 to 2 percent slopes	309.9	9.3%
Gn	Genesee loam, occasionally flooded	82.8	2.5%
Go	Genesee-Urban land complex, occasionally flooded	103.3	3.1%
Hu	Huntington silt loam, occasionally flooded	347.8	10.5%
Ju	Jules silt loam, occasionally flooded	726.9	21.9%
Lg	Lanier sandy loam, occasionally flooded	6.4	0.2%
McA	Martinsville silt loam, 0 to 2 percent slopes	57.6	1.7%
McB	Martinsville silt loam, 2 to 6 percent slopes	11.3	0.3%
PfC	Pate silty clay loam, 8 to 15 percent slopes	10.1	0.3%
PfD	Pate silty clay loam, 15 to 25 percent slopes	10.3	0.3%
Po	Pits, gravel	268.0	8.1%
RoB	Rossmoyne silt loam, 2 to 6 percent slopes	0.2	0.0%

Hamilton County, Ohio (OH061)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
RpB2	Rossmoyne silt loam, 3 to 8 percent slopes, eroded	12.7	0.4%
RpC2	Rossmoyne silt loam, 8 to 15 percent slopes, eroded	1.2	0.0%
RsB	Rossmoyne-Urban land complex, gently sloping	35.7	1.1%
RtA	Rossmoyne-Urban land complex, 0 to 3 percent slopes	15.3	0.5%
RtB	Rossmoyne-Urban land complex, 3 to 8 percent slopes	22.4	0.7%
RtC	Rossmoyne-Urban land complex, 8 to 15 percent slopes	36.0	1.1%
St	Stonelick fine sandy loam, frequently flooded	54.4	1.6%
Ud	Udorthents, clayey	14.3	0.4%
UmB	Urban land-Martinsville complex, 3 to 8 percent slopes	140.5	4.2%
UmC	Urban land-Martinsville complex, 8 to 15 percent slopes	18.4	0.6%
W	Water	250.1	7.5%
Wa	Wakeland silt loam, occasionally flooded	3.8	0.1%
Subtotals for Soil Survey Area		**3,165.3**	**95.3%**
Totals for Area of Interest		**3,319.9**	**100.0%**

SURFICIAL GEOLOGY OF OHIO CINCINNATI AND FALMOUTH 30X60-MINUTE QUADRANGLES

EXPLANATION

Boundaries

Lithology Change

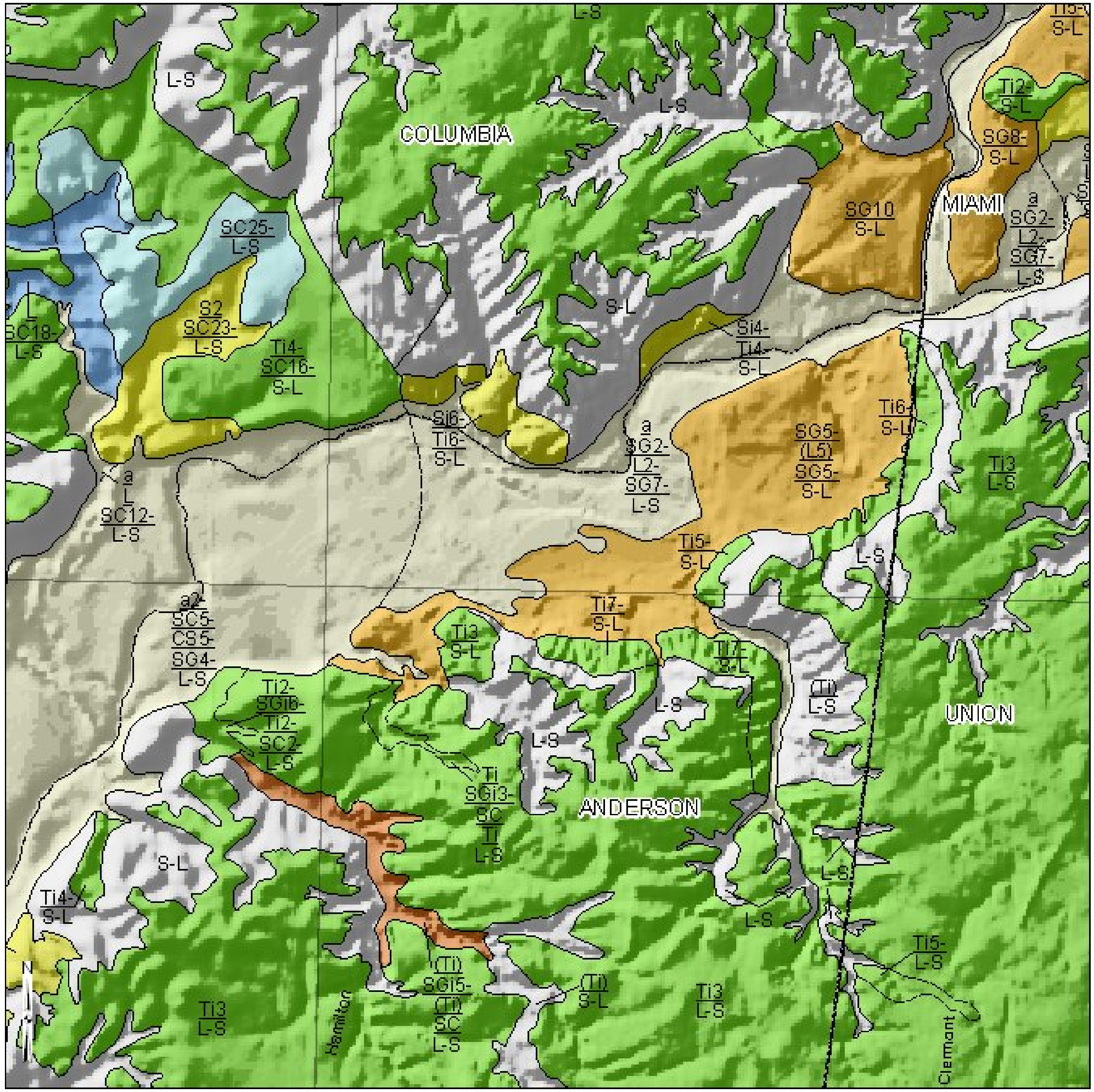
- — — Subsurface
- —— Surface

Surficial Geology

Lithology

- IM - Till and water laid deposits
- pit
- w - water
- m - made land
- a - alluvium
- C - Clay, Wisconsinan age
- Ci - Clay, Illinoian age
- Ck - Clay, Pre-Illinoian age
- G - Gravel, Wisconsinan age
- Gi - Gravel, Illinoian age
- IC - Ice-contact materials
- L - Silt, Wisconsinan age
- Li - Silt, Illinoian age
- LA - Silt, clay, sand, and gravel, Wisconsinan age
- S - Sand, Wisconsinan age
- Si - Sand, Illinoian age
- Sk - Clayey to pebbly sand, Pre-Illinoian age
- SC - fine sand, clay, and silt, unspecified age
- SG - Sand and gravel, Wisconsinan age
- SGi - Sand and gravel, Illinoian age
- SGA - Sand and gravel, Pre-Wisconsinan age
- SGC - Sand and gravel, silt clay, Wisconsinan age
- TA - Loam till, Wisconsinan age
- Ti - Loam till, Illinoian age
- Tk - Clay-loam till, Pre-Illinoian age
- Ls - Limestone bedrock
- S-L - Shale-dominant bedrock
- L-S - Limestone-dominant bedrock

OHIO DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL SURVEY
Map SG-3 CINCINNATI/FALMOUTH
3/2005



1:65,247

0.1 0.25 0.5 Miles

HOW TO READ THIS MAP

NOTE- A limited number of unlabeled, small polygons exist on this IMS map. These polygons are too small to place a label within or near. If label information on these small polygons is needed, please contact Mac Swinford via email from the "purchase/contact info" button located at the lower right-hand corner of the main page of the website.

What is a stack map? This map provides a three-dimensional framework of the area's surficial geology and depicts four important aspects of surficial geology:

1. the geologic deposits, indicated by letters which represent the major lithologies;
2. the thickness of the individual deposits, indicated by numbers and modifiers;
3. the lateral extent of the deposits, indicated by map-unit area boundaries;
4. the vertical sequence of deposits, shown by the stack of symbols within each map-unit area.

In effect, each stack represents a generalized cross section for each area.

Letters represent geologic deposits (lithologic units) and are described in detail below. Lithologic units may be a single lithology such as sand (S) or clay (C), or a combination of related lithologies that are found in specific depositional environments, such as sand and gravel (SG) or ice-contact deposits (IC). The bottom symbol in each stack indicates the bedrock lithologies that underlie the surficial deposits. The detailed lithologic unit descriptions below summarize:

1. geologic characteristics such as range of textures, bedding, and age;
2. engineering properties or concerns attributed to the unit;
3. depositional environment;
4. geomorphology or geomorphic location;
5. geographic location within the map area, if pertinent.

Numbers (without modifiers) that follow the lithology designator represent the average thickness of a lithologic unit in tens of feet (for example, 3 represents 30 feet). If no number is present, the average thickness is assumed to be 1 (10 feet). These unmodified numbers correspond to a thickness range centered on the specified value, but may vary up to 50 percent. For example, T4 indicates the average thickness of till in a map-unit area is 40 feet, but thickness may vary from 20 to 60 feet.

Modifiers provide additional thickness and distribution information:

1. Parentheses indicate that a unit has a patchy or discontinuous distribution and is missing in portions of that map-unit area. For example, (T2) indicates that till with an average thickness of 20 feet is present in only part of that map-unit area.
2. A minus sign following a number indicates the maximum thickness for that unit in areas such as a buried valley or ridge. Thickness decreases from the specified value, commonly near the center of the map-unit area, to the thickness of the same lithologic unit and vertical position specified in an adjacent

map-unit area. For example, an SG9- map-unit area adjacent to an SG3 area indicates a sand and gravel unit having a maximum thickness of 90 feet that thins to an average of 30 feet at the edge of the map-unit area. If the material is not present in an adjacent area, it decreases to zero at that boundary.

These **letters**, **numbers**, and **modifiers** are arranged in stacks that depict the vertical sequence of lithologic units for a given map-unit area. A single stack of symbols occurs in each map-unit area and applies only to the volume of sediments within that particular map-unit area. Figure 1 illustrates mapping conventions (below).

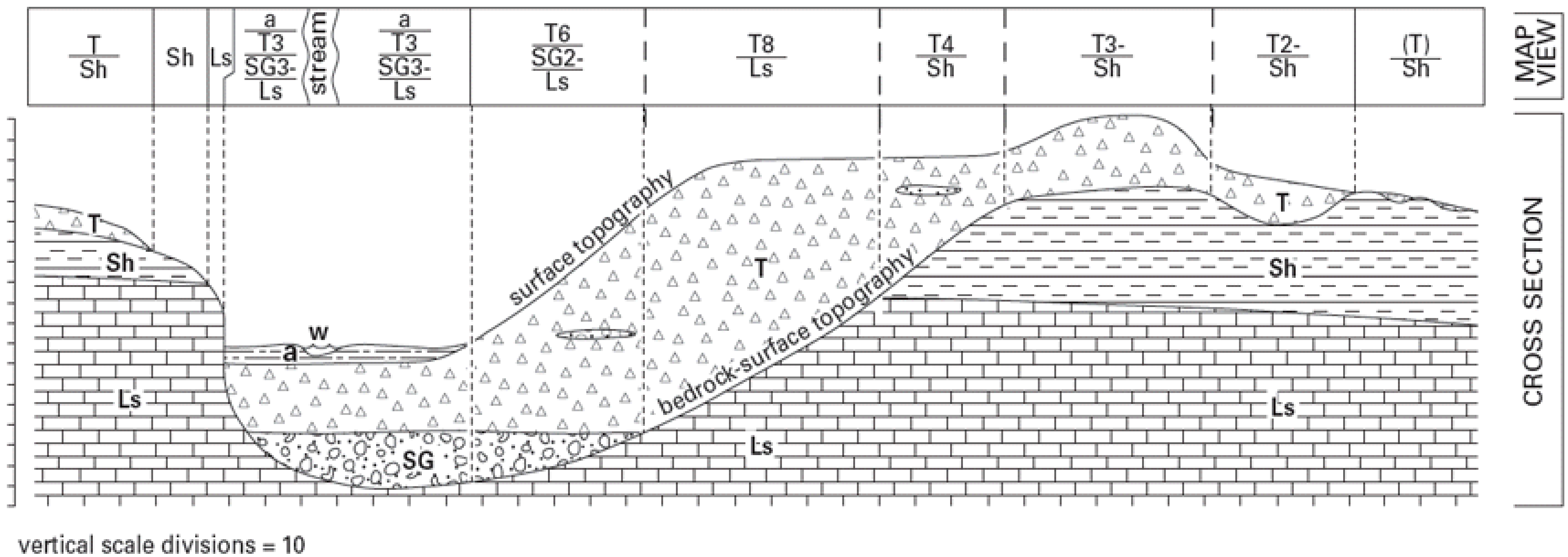


FIGURE 1. Map view and cross section of a hypothetical stack-unit map. See "Detailed Descriptions" button for explanation of symbols. In the map view (top), solid-line boundaries separate map-unit areas having different lithologic units at the surface; underlying lithologic units may or may not differ. Dashed-line boundaries separate map-unit areas having the same surface lithologic unit but different thickness or different underlying lithologic units. The cross section illustrates thickness and mapping conventions. Thickness values are in tens of feet. Values are gross averages that can vary up to 50 percent, except (1) those followed by a minus sign (-), which represent the maximum thickness of a thinning trough- or wedge-shaped sediment body, or (2) units in parentheses ( ), which indicate a discontinuous distribution of that unit. Precise surface topography can be determined from topographic maps that are available from the Division of Geological Survey at several scales; bedrock-surface topography and bedrock geology are available from the Division of Geological Survey as 1:24,000 scale quadrangle maps.

The small scale of this reconnaissance map generalizes the great local variability within surficial deposits. That variability is explained in the lithologic unit descriptions and by the use of thickness ranges. Some areas and lithologies are too small to delineate and have been included in adjacent areas. This map should serve only as a regional predictive guide to the area's surficial geology and not as a replacement for subsurface borings and geophysical studies required for site-specific characterizations.

Recommended Bibliographic Citation: Brockman, C.S., Pavey, R.P., Schumacher, G.A., Shrake, D.L., Swinford, E.M., and Vorbau, K.E., 2004, Surficial geology of the Ohio portions of the Cincinnati and Falmouth 30 X 60-minute quadrangles: Ohio Division of Geological Survey Map SG-2 Cincinnati-Falmouth, scale 1:100,000.

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DETAILED LITHOLOGIC UNIT DESCRIPTIONS*

SURFICIAL UNITS

w water. Lakes generally larger than 20 acres and not appearing on basemap.

m made land. Large cut and fill areas.

a alluvium, Holocene-age. Includes a wide variety of textural classes from silt to boulders with disseminated or concentrated organics; generally not compact; rarely greater than 20 feet thick. Found within floodplains of modern streams throughout the entire map area. Mapped only where areal extent and thickness are significant.

C Clay, generally Wisconsinan-age. Massive to laminated; may contain thin interbedded silt, fine sand, and minor gravel; clay content may exceed 80%. Laminated clay commonly contains thin silt or sand partings. May contain joints/fractures 6 to 12 inches apart and disseminated organics, fossil snails and clams. Unit may contain areas of modern alluvium. In deep buried valleys, includes till and may be older than Wisconsinan-age. Generally less than 30 feet thick; landslide-prone. Lacustrine deposit on lowland surfaces, low-level terraces, and buried valley-fills throughout the map area.

Ci Clay, Illinoian-age. Properties similar to unit C above except upper part of unit deeply leached and more deeply jointed where near surface; up to 30 feet thick. Unit found in high-level terraces and buried valleys in the central and eastern map area.

Ck Clay, Pre-Illinoian-age (Kansan-age in old terminology). Properties and deposition mode similar to unit C above with exceptions: Ck generally oxidized and entirely leached; may contain thin, laterally discontinuous, bedded, calcareous concretions in near-surface exposures; joints/fractures may contain linear concretions. Unit 10 to 20 feet thick, landslide-prone, found between elevations 650-870 feet in the southwestern map area.

CA Clay and silt, pre-Wisconsinan-age, with Sangamon-age paleosol developed in upper few feet of the unit. Patchy distribution of paleosol. Upper part of unit leached with loess and abundant organics, lower part of unit may contain till. Up to 100 feet thick. Lacustrine unit, restricted to the subsurface, formerly exposed to surface soil processes; limited to the New Haven Trough and Mill Creek Valley.

CB Clay and silt similar to unit CA, but with paleosol (Yarmouthian?-age) developed in Early Illinoian or Pre-Illinoian loess and lacustrine deposits. Unit coarsens downward, but does not contain till as does unit CA. Unit 10 feet thick, found in buried valley-fill east of Newtown.

CS Interlayered very fine grained materials, unspecified age. Clay and silt predominate with interbeds of fine sand, gravel is rare; may include till at depth. Variable thickness and sequence of lithologies. Unit identified from well logs; up to 150 feet thick. Deposited as fine overbank sediments or in lacustrine settings as lake bottom and distal deltaic facies. Found in area's largest valleys including Norwood Trough and Mill Creek Valley.

G Gravel, generally Wisconsinan-age. Contains minor amounts of disseminated sand and thin, discontinuous lenses of silt and thicker, more continuous beds of sand; unit well to poorly sorted, angular to well rounded; may be massive, cross bedded, or horizontally bedded. Clasts vary in lithology and in some areas are exclusively limestone derived from the immediate area. Up to 60 feet thick. Some stable slope exposures are locally cemented by calcium carbonate. In deep buried valleys, may be older than Wisconsinan-age. Fluvial deposit in low-level terraces and buried valleys throughout the map area.

Gi Gravel, Illinoian-age. Properties similar to unit G above except upper part of unit more deeply weathered and leached where near surface; up to 20 feet thick. Unit found in high-level terraces and buried valleys in the eastern part of the map area.

IC Ice-contact materials, highly variable deposits of poorly sorted sand and/or gravel, with common lenses of till, silt and clay, Wisconsinan-age. Generally high-angle bedding; 10 to 30 feet thick. Unit differs from SGB and Tif in containing less till and clay. Deposited in northern half of map area as kames, eskers or ice-contact deltas, partially covered or surrounded by till.

IM Till and water laid deposits juxtaposed near valley walls and the ice margin, Wisconsinan-age. Till in low-relief swells and swales and stratigraphically underlying other units. Till-swales are partially infilled with debris-flow material, lacustrine silt, clay, fine sand, and fluvial or ice-contact sand and gravel; fluvial units may be stratigraphically over and/or under lacustrine units. Up to 70 feet thick; unit thickness reflects maximum thickness of till. Mapped along the Mill Creek and Great Miami Valleys where individual units cannot be shown separately due to map scale. Deposited in ablational swales or lowlands of till on which meltwater was initially ponded (lacustrine deposition), until free-flowing conditions were established (fluvial conditions).

L Silt, generally Wisconsinan-age. Contains localized clay, sand, or gravel layers. Laminated to massive; disseminated organics commonly present, may contain fossil snails, clams, and small branches or logs. Carbonate-cemented concretions in finer silt. Up to 100 feet thick, but generally thinner. Fine silts develop shallow angle slumps; coarse silts prone to piping, may be thixotropic ("quick sand"). Lacustrine deposit found in low-level slackwater terraces and buried valley-fills throughout the map area.

Li Silt, Illinoian-age. Unit similar to L above except upper part of unit deeply leached and more deeply jointed where near surface; up to 50 feet thick. Unit found in high-level terraces and in buried valleys in the eastern part of the map area.

LA Silt, clay, sand and gravel as distinct interbeds 10 or more feet thick, Wisconsinan-age. Sequence of lithologies variable; 30 to 40 feet thick. Deposited in buried valleys, which alternated between free-draining and ponded conditions. Mapped where individual units cannot be shown separately due to map scale and insufficient data. Unit limited to valleys upstream of numerous bedrock narrows along the Little Miami River.

S Sand, generally Wisconsinan-age. Contains minor amounts of disseminated gravel and thin lenses of silt and gravel; grains well to poorly sorted, moderately to well rounded with high quartz percentage; finely laminated to massive, may be cross bedded; locally may contain organics as disseminated particles or sticks and logs. Beds may be lithified by calcium carbonate in stable valley-side exposures; concretions may be present with varying degrees of cementation. In deep buried valleys, may be older than Wisconsinan-age; up to 50 feet thick. A fluvial unit in low terraces and buried valleys throughout the map area.

Si Sand, Illinoian-age. Properties similar to unit S above except upper part of unit more deeply weathered and leached where near surface; usually less than 20 feet thick. Unit found in high-level terraces and buried valleys in the eastern part of the map area.

Sk Clayey to pebbly sand, Pre-Illinoian-age (Kansan-age in old terminology). Overlain by up to 5 feet of loess. Weathered and leached; B-horizon soil-clay accumulation greater than 10 feet thick. Sand to pebble-size nodules of iron oxide and manganese oxide concentrate near loess/sand contact. Sand mostly quartz and other resistant lithologies; pebble beds uncommon. Up to 30 feet thick; erodes easily when vegetation removed. Unit both fluvial (deposited in high-level "Teays-age" paleovalleys), and aeolian (loess and sheet sands in uplands). Limited to hilltops and slopes above 620 feet elevation in southwestern part of the map area.

SC Interlayered medium-fine to fine grained materials, unspecified age. Fine sand predominates and includes clay, silt, and thin gravel interbeds; variable thickness and sequence of lithologies. Similar to unit CS above but coarser; up to 150 feet thick. Deposited as lacustrine and proximal deltaic facies as well as overbank sediments within the area's largest valleys.

SG Sand and gravel, generally Wisconsinan-age. Intermixed and interbedded sand and gravel with thin, discontinuous layers of silt, clay, and till. Grain size, bedding, cementation, and distribution characteristics similar to units S and G above; up to 250 feet thick. In deep buried valleys, may be older than Wisconsinan-age. Widespread fluvial deposit in low-level terraces and in buried valleys.

SGi Sand and gravel, Illinoian-age. Properties similar to unit SG above except upper part of unit more deeply weathered and leached where near surface; up to 30 feet thick. On stable slopes, more of unit may be cemented by calcium carbonate than other SG-related units. Found in high-level terraces and buried valleys in the eastern part of the map area.

SGA Sand and gravel, pre-Wisconsinan-age, similar to unit SG above but with Sangamon-age paleosol developed in upper portions. Patchy distribution of paleosol. Paleosol red brown to green gray, clay to clayey gravel, 15 feet or thicker, found between elevations 530-550 feet. Below paleosol, unweathered sand and gravel of Illinoian-age, generally coarser than any overlying SG unit. Unit may also include sand and gravel overlying paleosol. Up to 190 feet thick. A fluvial unit generally limited to the New Haven Trough in the southwestern map area.

SGB Sand and gravel, generally Wisconsinan-age, similar to unit SG above, but including discontinuous, thick interbedded till or clay. Up to 100 feet thick. Differs from unit Tif in having a higher proportion of sand and gravel to till or clay. In deep buried valleys, may be older than Wisconsinan-age. Found in lowlands near valley sides where it was deposited as outwash receiving periodic flow-till deposition from the uplands. Unit associated with Great Miami River Valley, Mill Creek Valley and Turtle Creek Valley.

SGC Sand and gravel, Wisconsinan-age, similar to unit SG above, but included clay and silt interbeds are limited to the upper part of the unit, and concentrated just upstream of junctions with major tributaries. From 60 to 100 feet thick. Unit resulted as coarse-textured fans and deltas formed at the mouths of tributaries that were fed by a melting ice margin. Clay and silt accumulated in localized slackwater upstream of the tributaries. Unit found in the Little Miami River gorge between South Lebanon and Loveland.

TA Loam till, generally Wisconsinan-age. Overlain by up to 3 feet of loess; loess generally thin or absent on slopes. Till may contain silt, sand, and gravel lenses. Average sand/silt/clay percentages of till 25/45/30 percent, ranging from 15/50/35 percent to 30/45/25 percent (Wentworth classification). Clasts larger than medium pebbles average about 5% of total volume of till but vary from 1% to 20%. Flat, well-drained areas leached to a depth of about 3 feet, including loess cap. Joints/fractures common. Averages 20 to 30 feet thick and ranges to 90 feet thick in buried valleys and end moraines. In deep buried valleys includes pre-Wisconsinan till and may include clay and silt beds. Stratigraphic name: Shelbyville Till. Local relief is low and landslides are generally limited to valley walls. Deposited by glacial ice. Common surficial unit in the central and northern part of the map area.

Ti Loam till, Illinoian-age. Generally overlain by up to 3.5 feet of loess, but loess may be 10 feet thick along bluffs bordering major rivers. Till may contain silt, sand, and gravel lenses. Sand/silt/clay percentages of till vary widely averaging 25/47/28 percent and range from 8/43/49 percent to 34/41/25 percent (Wentworth classification). Upland areas leached to 6 feet, including loess cap. Joints/fractures common. Averages 20 to 30 feet thick and ranges to 90 feet thick in buried valleys. Stratigraphic names: Richmond and Centerville Tills approximately west of the Great Miami River, Rainsboro Till east of the river. Landsliding may occur in oversteepened, wet areas. Deposited by glacial ice. Most common surficial unit in the southeastern part of the map area.

Tif Flow-till with fine to coarse clastic interbeds, Illinoian-age. Flow-till, with characteristics of Ti above, in thin to moderately thick beds, interbedded with lesser amounts of horizontal to high angle layers of sand, gravel, fine sand, silt, and clay, inches to many feet thick. Unit averages 30 feet thick. Differs from unit SGB, which contains more sand and gravel, and unit IC, which contains less till. Stratigraphic name: Rainsboro Till. Found in high-level terraces near the Illinoian-ice margin, along the southern Mill Creek Valley. May have been deposited as till-derived debris-flows from a stagnant or drowned ice tongue in lowland trough, with some drift contribution from uplands.

Tk Clay-loam till, Pre-Illinoian-age (Kansan-age in old terminology). Overlain by well-weathered loess, 5 to 10 feet thick, entirely leached. Till highly weathered, leached, brown to strong brown color; thin to absent on slopes; clay averages 50%, with sand and pebbles of resistant lithologies only; sand to 20% but generally less than 10%; pebbles less than 1% by volume. Sand-size voids common. Unit less than 30 feet thick. Informal stratigraphic name: Cincinnati till. Unit has a large shrink-swell capacity from a high percentage of mixed-layer clays; foundation problems may result where water has been removed from the unit. Deposited from glacial ice. The unit remains on a relatively small upland plateau and nearby narrow ridge tops surrounded by bedrock slopes; southwestern part of the map area.

BEDROCK UNITS

Ls Limestone bedrock and limestone-derived colluvium, Silurian-age. Limestone, tan to reddish-tan, coarse-crystalline, medium to thin bedded; hard; Brassfield Formation. Present as a single, small outlier in the northeast portion of the study area.

L-S Limestone-dominant bedrock and bedrock-derived colluvium, Ordovician-age. Interbedded limestone, medium gray, thin to medium bedded, fossiliferous, and shale, gray, thin to medium bedded. Limestone ranges from 50% to 85% of the unit, although shale-dominant intervals are present. Includes Point Pleasant, Fairview, Grant Lake, Arnheim, Liberty and Whitewater Formations. On side-slopes and toe-slopes, unit is colluvium, predominantly clay with downslope-oriented limestone slabs and organic matter. Colluvium has relatively low shear strength and is the source of numerous landslides, especially on steep slopes.

S-L Shale-dominant bedrock and clay-rich, bedrock-derived colluvium, prone to landsliding, Ordovician-age.

Interbedded shale, gray, thin to thick bedded, and limestone, medium gray, thin to medium bedded, fossiliferous. Shale ranges from 50% to 85% of the unit, although minor limestone-dominant intervals are present. Unit associated with the shale-rich Kope Formation on steep slopes in the southern part of the map area, and with the Waynesville Formation in stream valleys in the northern part of the map area. On side-slopes and toe-slopes, unit is clay-rich colluvium with downslope-oriented limestone slabs and organic matter. Colluvium has relatively low shear strength and is the source of numerous landslides, especially on steep slopes. Landslides commonly form at the colluvium-bedrock interface.

* Underscored letters in the unit descriptions are the basis of unit abbreviations.

H. C. NUTTING
A Terracon COMPANY

HCN Division Office
611 Lunken Park Drive
Cincinnati, OH 45226
P: 513.321.5816
F: 513.321.0294
www.hcnutting.com
www.terracon.com

October 14, 2008

Project No. N1085488

Ms. Deborah Osborne
Environmental Services Manager
ENTRAN
1848 Summit Road
Cincinnati, OH 45237

**Re: Geotechnical Archive Review and Data Submittal
Eastern Corridor Segment II/III
Cincinnati/Newtown, Hamilton County, Ohio**

Dear Ms. Osborne:

We are pleased to present our findings for the Eastern Corridor Multimodal Project. The purpose of this study was to review and summarize existing soil data gathered from our archive Little Miami River valley area project sites within designated regions in the vicinity of the investigational sections for Project Segment II and Project Segment III of the Eastern Corridor Multi-Modal Project.

The report consists of regional geological history information followed by five maps and four tables (attached). The map outlining the four regions selected for review is shown in Figure 1 with four additional maps identifying approximate site locations (Figures 1A, 1B, 1C, and 1D). Following each map, the summarized soil data is tabulated for each of the four regions: Lunken Airport Region, Little Miami Park Region, Newtown Region, and Broadwell Road Region. The subsurface archive data from projects dating back to 1959 are organized by depth and soil type for each site. Each site represents a summary of data gathered from one to eight soil borings.

LITTLE MIAMI RIVER VALLEY GENERAL GEOLOGY

The geology of the valley region surrounding the lower reaches of the Little Miami River was greatly influenced by ice age events in North America. Prior to local glacial events, the Ancestral Ohio River was a northward flowing stream where it was joined by the Ancestral Little Miami River near the present day horseshoe-shaped bend in the modern Little Miami. At that time, the deepest portion of the Ancestral Ohio River channel was cut to an elevation of 380 feet before glaciers arrived and blocked the ancient drainage system. As the ice advanced, north flowing streams were dammed and proglacial lakes developed. In the quiescence of these lakes, sediment loads were dropped forming lakebed deposits of silts and clays.

During the ice age period, more than one ice sheet advanced into the Cincinnati area forcing the Ohio River into its present day channel. As the last ice lobe melted and dropped its final load of sand and gravel outwash, the melt water subjected the lakebed sediments to erosion while the modern channels of the Ohio and Little Miami Rivers evolved. Deposition of granular outwash from the retreating glaciers formed a complex stratification with the underlying glacial lake deposits; however, borings have shown that in parts of the modern lower Little Miami River Valley, the lake deposits were fully removed and replaced with granular outwash.

Currently, the uppermost zone in the modern valley is typically covered by a sandy alluvium which then grades up into silts and clays associated with recent flooding of the modern Ohio River and its tributaries. In addition, the flooding and alluvial deposits have contributed to modern day course changes and meandering for the Little Miami River and its tributaries. Presently, the Little Miami River is flowing on sand and gravel. There is a direct hydraulic connection between the channel and the outwash deposits beneath the Little Miami flood plain area. The groundwater or phreatic surface is significantly affected by water levels of the Little Miami and Ohio Rivers. Deep borings indicate the presence of two distinct aquifers; however, these aquifers may be interconnected beyond the lateral extent of these borings.

LITTLE MIAMI RIVER VALLEY GENERAL SUBSURFACE PROFILE

The Ohio Department of Natural Resources characterizes the geological setting as one of a buried valley where surficial deposits were formed. The modern Little Miami River has abraded a portion of the glacial lakebed deposits and glacial outwash through change of course and meandering. Modern flooding of the plain has produced deposits of recent alluvium. The bulk of the region lies within the lower flood plain area between the elevations of 475-480 feet. The general subsurface soil flood profile is characterized by a thin veneer of loam immediately underlain by a stratum of lean clay with variations in the clay typical of alluvial deposits. These alluvial deposits have a lower elevation ranging between 455 and 465 with variations in gradation due to past meandering as well as velocity fluctuations of the Little Miami River. Permeable silt and sand seams are common within this zone.

Underlying the alluvial flood deposits, the soil column may be described as a complex layering between sand and gravel with minor fines, thick sequences of outwash/valley train deposits with minor alluvium and lacustrine deposits. The local bedrock is Ordovician interbedded soft shale and limestone.

Groundwater depths over the valley area are dependent on Ohio River stage. The normal Ohio River pool elevation is 455 feet. The direction of groundwater flow may be reversed during periods of flooding; otherwise, the hydraulic gradient is toward the river. A 1987, University of Cincinnati, research study reported well pumping rates of 100 to 500 gpm (gallons per minute) within the Little Miami River flood plain. Additional pumping data may be available through the City of Cincinnati. Finally, it is noted that lowering the groundwater level table may induce ground subsidence. A drop in 30 feet of the groundwater table may induce subsidence on the order of 0.5 to 1.0 inches whereby an effect on existing utilities and pavement surfaces may result.

The subsurface profile can be characterized by six primary categories: fill, upper clayey alluvium, upper sands, lakebed clays, granular outwash and bedrock. The Little Miami Valley areas near the Eastern Corridor Multi-Modal Project have been grouped into geographical regions such that the soil may be characterized more specifically.

Lunken Airport Region

The valley area near Lunken Airport is bounded by Kellogg Avenue, Wilmer Avenue, the Beechmont Levee and the Little Miami River. The airport elevation stands at roughly 483 feet with the general nearby surface elevations ranging between 475 feet and 480 feet. The Lunken Airport area is above the Little Miami Buried Valley aquifer and the airport itself is surrounded by a deep de-watering system installed for the purposes of airport function. The 2004 FEMA Little Miami River 100 year flood level is 501 feet.

Upper Clay Alluvial Zone (10-15 feet thickness): The upper clay zone consists of water-deposited lean clays grading to fine sandy clays with increasing depth. The precise nature of the lean clay alluvial is site specific with varying amounts of silt and sand. In addition, sand seams lenses may also be found within this layer.

Outwash Granular Zone (to 100 feet below surface elevation): the outwash material lies directly below the alluvial soil. Generally, within this region, previous layers of lakebed deposits have been completely eroded and replaced by glacial outwash.

Little Miami River Park Region

This area is bounded by Wooster Road to the west, Beechmont Levee to the south and the Little Miami River to the east. The area includes soil investigation data gathered from test borings near the Red Bank Road and Wooster Pike intersections including the bridge construction and sewer installations as well as any investigations near Horseshoe Bend. The 2004 FEMA Little Miami River 100 year flood level is 501 feet at Horseshoe Bend.

Upper Clay Alluvium (minimum of 5 feet with localized varying depths): The upper clay zone consists of water-deposited lean clays grading to fine sandy clays with increasing depth. The precise nature of the lean clay alluvial is site specific with varying amounts of silt and sand. In addition, sand seams and lenses may also be found within this layer. Topsoil developed from organic decay within this stratum has been locally harvested within this region. Another primary soil use includes turf farming.

Upper Sands: The upper sands consist mostly of medium dense, silty fine sand to course sand and gravel. The top of the upper sand layer may be as shallow as 5 feet below the surface elevation.

Lakebed Clays: The lakebed clay presumably forms an aquiclude between the upper and lower granular strata. This clay has a consistency of stiff to very stiff with occasional silty to course sand and gravel lenses.

Lower Sands: The bottom outwash deposits consist primarily of medium to coarse sand with gravel. These soils are medium dense to very dense with occasional clay lenses.

Newtown Region

The valley area including Newtown and surrounding area is bounded by Wooster Road on the north to just below SR 32 on the south. The Little Miami Scenic River Park is to the west and the Newtown landfill is on the east. At the Newtown Road bridge over the Little Miami River, the 2004 FEMA Little Miami River 100 year flood level is 501 feet. The normal Pool stage for the Little Miami River at the bridge is 473 feet.

The overburden in this region is similar to the Little Miami Park Region. The region has been commercially developed and several locations have been mined for gravel and sand. Some of the mine excavations have been filled and, subsequently, the property has been commercially developed.

Broadwell Road Region

The Broadwell Road Region is to the south of the Little Miami River off Broadwell Road between Round Bottom Road and Mt. Carmel Road. The archived sites are located within the ancestral Little Miami River flood plain. This region and the Newtown Region are rich in sand and gravel glacial outwash. Both regions have been extensively quarried for gravel. The alluvial clay overburden generally has a higher sand content than the other three valley regions. In some locations, alluvial clay is absent and the unconsolidated surface material is granular.

CLOSING

H.C. Nutting Company appreciates the opportunity to provide our professional geotechnical services for this project. If there are any questions concerning the information in this letter, if you would like to meet with us to discuss our findings, or if further information is desired, please do not hesitate to contact us.

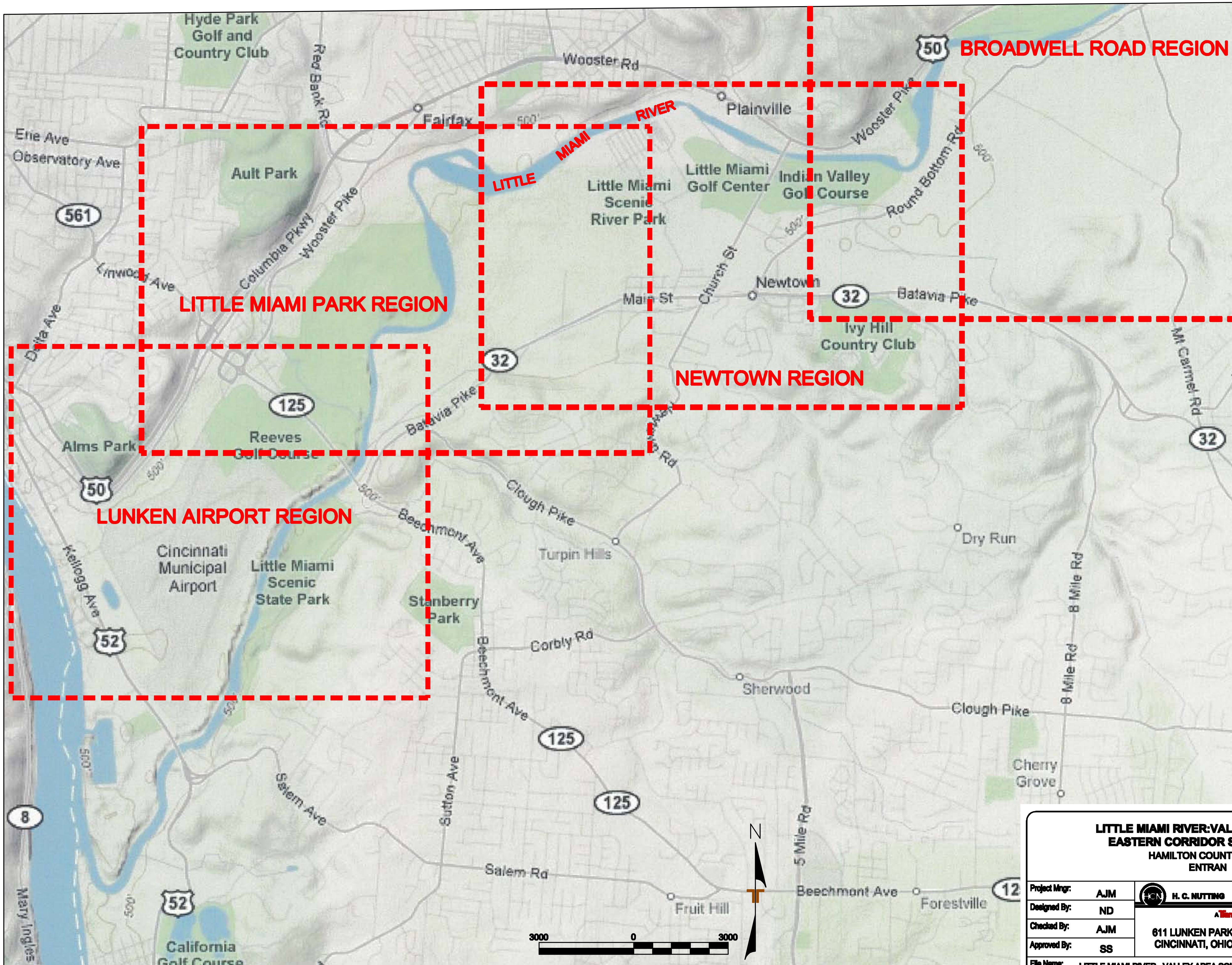
Respectfully submitted,
H.C. NUTTING (A TERRACON COMPANY)

Nancy Dendramis, E.I.
Geotechnical Engineer

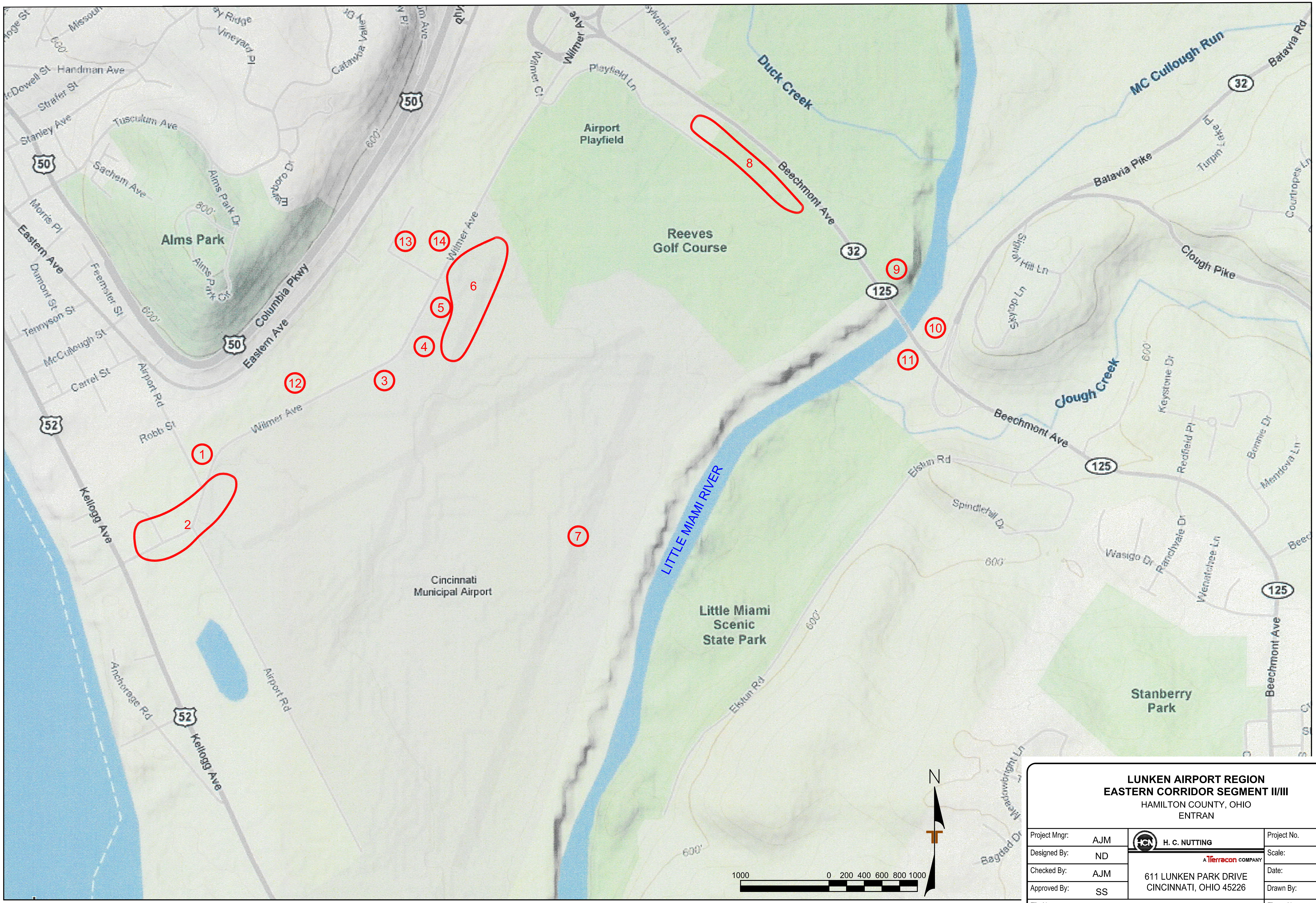
Aaron J. Muck, P.E.
Senior Associate/ Geotechnical Engineer

Swaminathan Srinivasan, P.E.
Senior Principal/ Chief Engineer

Attachments



LITTLE MIAMI RIVER:VALLEY AREA SOIL EASTERN CORRIDOR SEGMENT II/III HAMILTON COUNTY, OHIO ENTRAN				
Project Mngr:	AJM	H. C. NUTTING A Terracon COMPANY	Project No.	N1085488
Designed By:	ND		Scale:	1" = 3000'
Checked By:	AJM	611 LUNKEN PARK DRIVE CINCINNATI, OHIO 45226	Date:	10-10-08
Approved By:	SS		Drawn By:	KM(N1)
File Name:	LITTLE MIAMI RIVER - VALLEY AREA SOIL.DWG		Figure No.	1



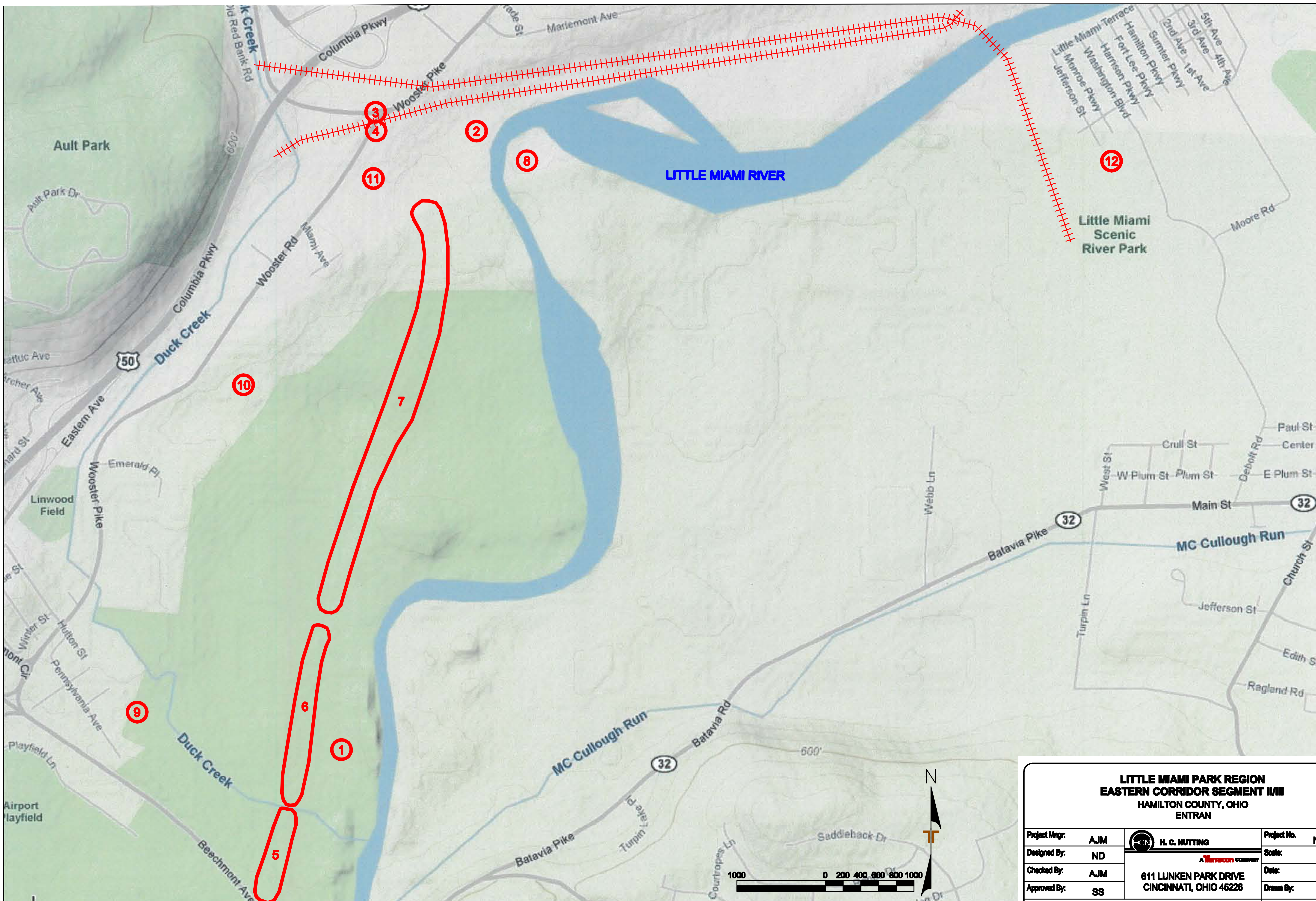
LUNKEN AIRPORT REGION **EASTERN CORRIDOR SEGMENT II/III** HAMILTON COUNTY, OHIO ENTRAN				
Project Mngr:	AJM	H. C. NUTTING A Terracon COMPANY	Project No.	N1085488
Designed By:	ND		Scale:	1" = 1000'
Checked By:	AJM	611 LUNKEN PARK DRIVE CINCINNATI, OHIO 45226	Date:	10-10-08
Approved By:	SS		Drawn By:	KM(N1)
File Name:	LUNKEN AIRPORT REGION.DWG		Figure No.	1A

Lunken Airport Region

Site	TOPSOIL/ FILL			COHESIVE ALLUVIUM				GRANULAR OUTWASH			COHESIVE			GRANULAR		COHESIVE			BEDROCK	
	Depth (ft)	Type	Debris	Depth (ft)	Type	% Granular	PI*	Depth (ft)	Type	% Fines	Depth (ft)	Type	Remarks	Depth (ft)	Type	depth (ft)	type	Remarks	Depth	Type
1	485-475	fill	bricks	475-452	CL-ML		13-23	452-448	SP										448	gray soft shale
2	489-485	fill	cinders	485-463	CL-ML			463-387	SP & GP										387-382	shale/limestone
3	475-472.5	fill		472.5-455	CL & CH		14-26													
4	476-474.5	topsoil/fill		474.5-466	CL		17													
5	477-467.5	topsoil		476.5-467	CL	0%-9%	21	450-457	SW-SM	9%-11%										
6				478-453	CL			453-433	GP & SP		433-426	CL								
7	477-475.5	fill		475.5-467	CL	1%-4%	14													
8				473-462	CL			462-453			453-433	CL								
9				468-458	CL			458-442	SP & GP		442-438	ML & CL		438-433	SP	433-422	CL	limestone frag.	422	gray soft shale
10				472-456	CL-ML			456-450	SP & GP		450-431	CL	rock frag.						431	gray soft shale/ thin limestone seams
11				474-472	CL			472-456	SP		456-449	CL							449	brown and gray soft shale
12				485-465	CL															
13				480-467.5	CL			467.5-460	SP & GP											
14	.			479-469	CL			469-463	SP & GP											

Remarks: Soils have been categorized in general terms for informational purposes, i.e. COHESIVE (clays and clayey silts) and GRANULAR (non-cohesive silts, sands and gravels). Percentages of gravel, sand, silt and clay may change over depth within each generalized layer. The tabulated information represents data collected over the last 50 years. Current surface elevations and depth of fill or topsoil may have changed as the result of subsequent construction and/or flooding events.

* PI = Plasticity Index



LITTLE MIAMI PARK REGION
EASTERN CORRIDOR SEGMENT II/III
HAMILTON COUNTY, OHIO
ENTRAN

Project Mngr:	AJM	H. C. NUTTING A Terracon COMPANY	Project No.	N1085488
Designed By:	ND		Scale:	1" = 1000'
Checked By:	AJM	611 LUNKEN PARK DRIVE CINCINNATI, OHIO 45226	Date:	10-10-08
Approved By:	SS		Drawn By:	KM(N1)
File Name:	LITTLE MIAMI PARK REGION.DWG		Figure No.	1B

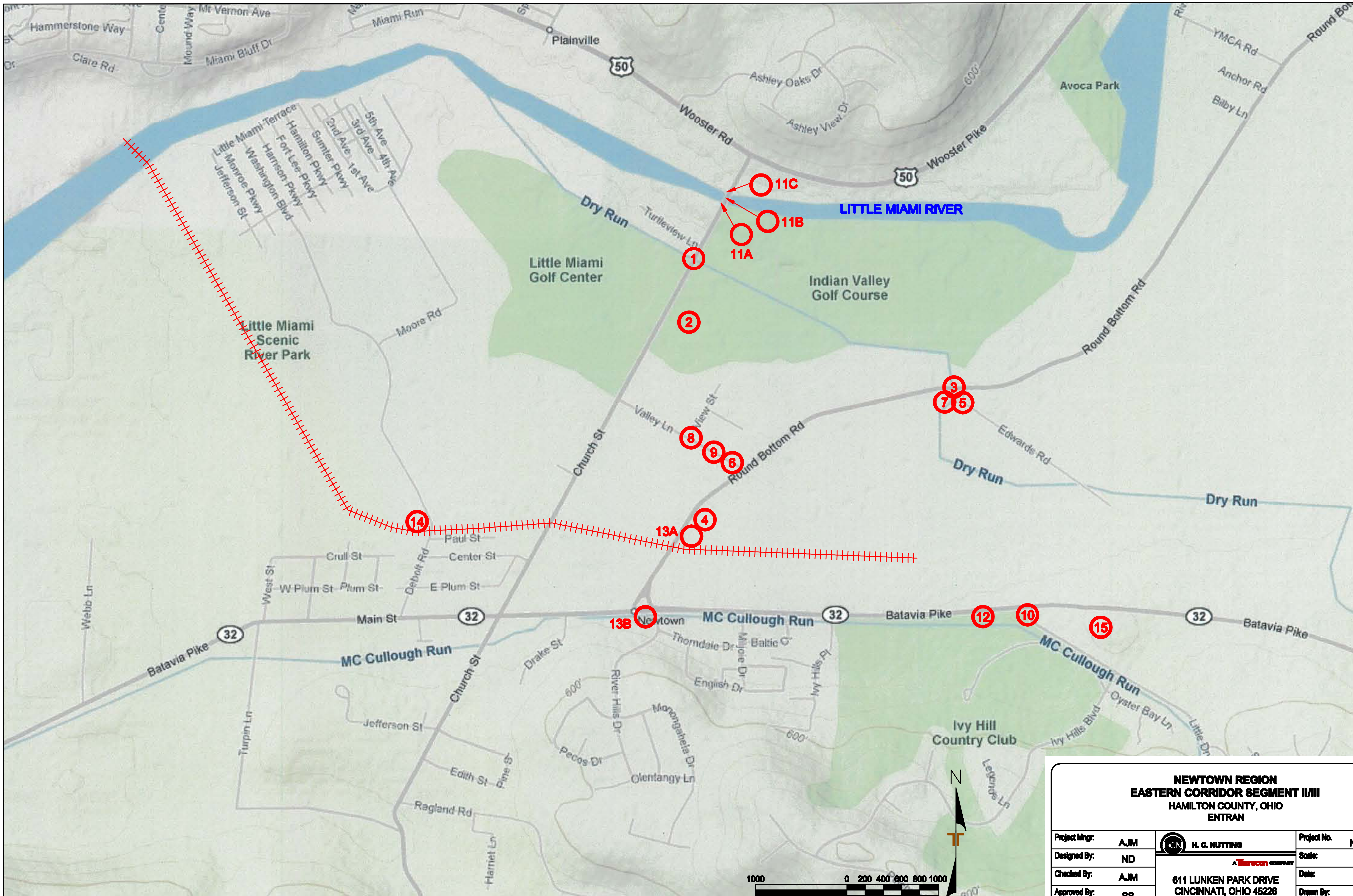
Little Miami River Park Region

site	TOPSOIL / FILL			COHESIVE ALLUVIUM				GRANULAR			COHESIVE				GRANULAR			COHESIVE					GRANULAR		BEDROCK	
	Depth (ft)	Type	Debris	Depth (ft)	Type	PI*	Remarks	Depth (ft)	Type	% Fines	Depth (ft)	Type	PI*	Remarks	Depth (ft)	Type	% Fines	Depth (ft)	Type	% Granular	PI*	Remarks	Depth (ft)	Type	Depth (ft)	Type
1	475-467	fill		467-454	CL		sand seams	454-451	SP																	
2				480-465	CL			465-445	SP-GP		445-430	CL														
3	530-510	topsoil/fill						510-505	SP		505-500	CL			500-475	SM&GM		475-469	CL			silt seams				
4	506-498	fill		498-496	CL			496-478	SP		478-461	CL		lakebed	461-441	SP-SM		441-436	CL			lakebed	436-424	GM & SM		
5				474-469	CL	14		469-454	SM&GM	25&12	454-419	CL	10	trace sand	419-391	SP-SM	11								391	shale
6				472-458	CL	13		458-448	SW-SM	9	448-427	CL			427-421	SP		421-390	CL			refusal at 390'				
7				475-465	CL	13		465-442	SP-SM	6	442-441	CL														
8				470-460	CL		sand seams	460-452	SP-SM to SP-GP	6	452-450	CL		tr org. (LOI=10)**	450-440	SP-SM	7	440-419	CL	19	13					
9	475-474	topsoil		474-460.5	CL			460.5-459	SP-GP																	
10	0-0.5	topsoil		0.5-15	CL			15-19	SP-GP																	
11	0-1.0	topsoil		1.0-7	CL			7-11.0	SP																	
12	0-1.0	topsoil		1-16.0	CL			16.0-18	SP-GP																	

Remarks: Soils have been categorized in general terms for informational purposes, i.e.. COHESIVE (clays and clayey silts) and GRANULAR (non-cohesive silts, sands and gravels). Percentages of gravel, sand, silt and clay may change over depth within each generalized layer. The tabulated information represents data collected over the last 50 years. Current surface elevations and depth of fill or topsoil may have changed as the result of subsequent construction and/or flooding events.

PI* = Plasticity Index

**LOI = Loss On Ignition



NEWTOWN REGION
EASTERN CORRIDOR SEGMENT II/III
HAMILTON COUNTY, OHIO
ENTRAN

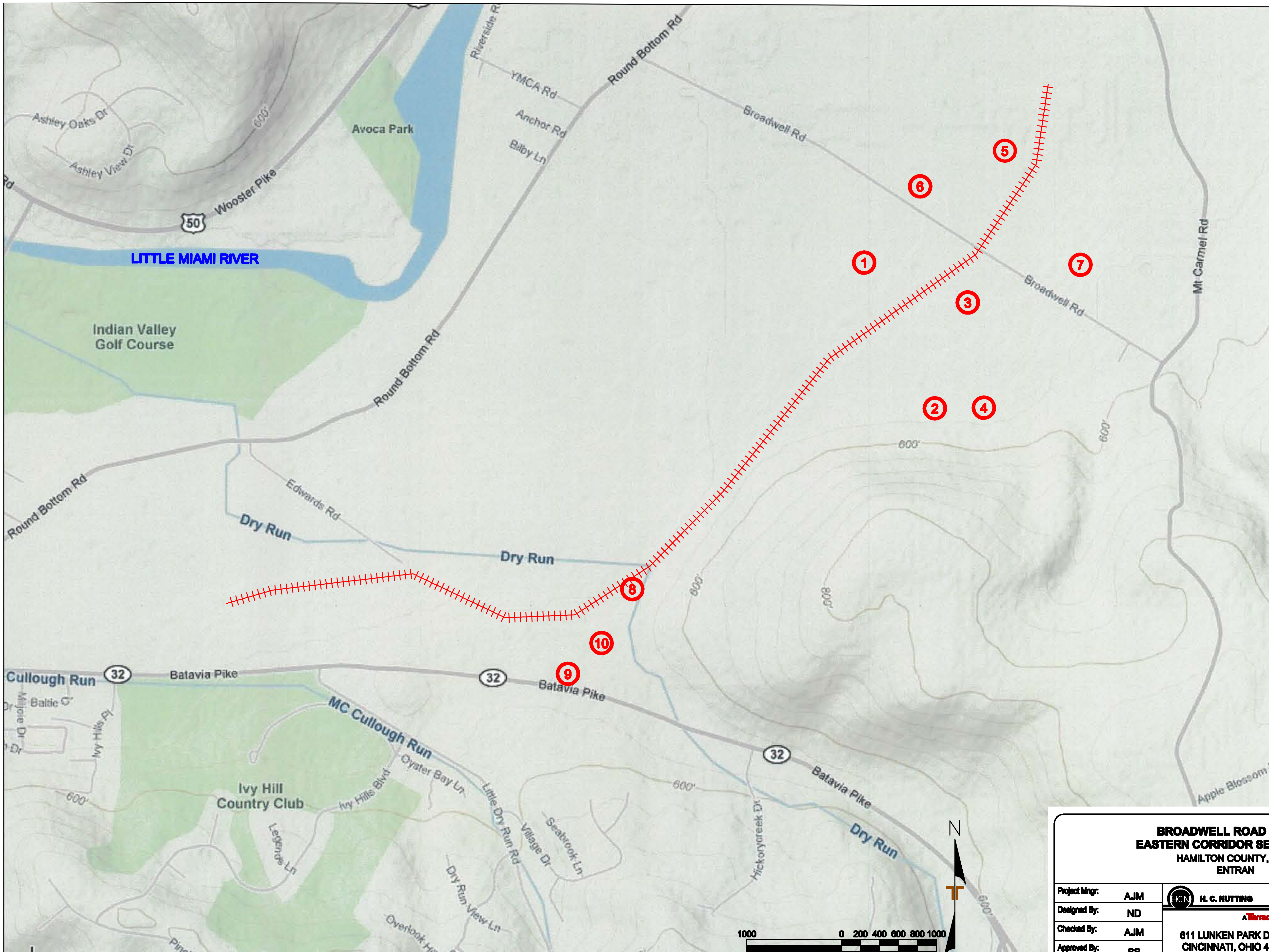
Project Mngr:	AJM	H. C. NUTTING A Terracon company 611 LUNKEN PARK DRIVE CINCINNATI, OHIO 45226	Project No.	N1085488
Designed By:	ND		Scale:	1" = 1000'
Checked By:	AJM		Date:	10-10-08
Approved By:	SS		Drawn By:	KM(N1)
File Name:	NEWTOWN REGION.DWG		Figure No.	1C

Newtown Region

site	TOPSOIL/ FILLFILL			COHESIVE ALLUVIUM				GRANULAR				COHESIVE				GRANULAR			COHESIVE			BEDROCK	
	Depth (ft)	Type	Debris	Depth (ft)	Type	PI*	Remarks	Depth (ft)	Type	% Fines	Remarks	Ddepth (ft)	Type	PI*	Remarks	Depth (ft)	Type	Remarks	Depth (ft)	Type	Remarks	Depth (ft)	Type
1	487-480	fill	concrete					480-470	GP			470-452	CL			452-435	SM &SP		435-417	CL		417	soft shale w/ limestone
2	489-482	topsoil/fill		482-474	CL	18		474-464	GP to SP		outwash	464-459	CL		lakebed	459454	GP	outwash	454-453	CL	galcial till		
3	497-487	fill	cinders/org					487-457	SW-SM	8		457-442	CL	16	4% sand	442-422	SP		422-417	CL		417-416	gray soft shale
4	500-490	fill		490-480	CL			480-476	SP-GP														
5	505-493.5	fill						495.5-481	SP & GP														
6	500-499.2	topsoil/fill		499.2-490	CL			490-480	SP & GP														
7	505-485	fill						485-455	GP														
8	500-499	fill	cinders	499-495	CL			495-485	SP-SM	7													
9				500-499.5	CL			499.5-493	SP & GP														
10	500-475	fill		475-453.5	CL																		
11A	509-484	fill						484-459	SP & GP		tr. shell frg.	459-444	CL			444-434	SP & GP		434-417	CL			
11B								465-446	SP & GP			446-412	CL									412	gray soft shale
11C	497-495	fill		495-477	CL			477-468	SM			468-457	CL		tr. gravel							457	gray soft shale
12	539-538	fill						538-518	SP & GP														
13A	506-505	fill	cinders					505-501	SP & GP														
13B				508-498	CL																		
14	498-493	fill		493-492	CL		tr gravel	492-482	SP & GP														
15				500-465	CL																		

Remarks: Soils have been categorized in general terms for informational purposes, i.e. COHESIVE (clays and clayey silts) and GRANULAR (non-cohesive silts, sands and gravels). Percentages of gravel, sand, silt and clay may change over depth within each generalized layer. The tabulated information represents data collected over the last 50 years. Current surface elevations and depth of fill or topsoil may have changed as the result of subsequent construction and/or flooding events.

* PI = Plasticity Index



BROADWELL ROAD REGION
EASTERN CORRIDOR SEGMENT II/III
HAMILTON COUNTY, OHIO
ENTRAN

Project Mngr:	AJM	H. C. NUTTING A Terracon COMPANY 611 LUNKEN PARK DRIVE CINCINNATI, OHIO 45226	Project No.	N1085488
Designed By:	ND		Scale:	1" = 1000'
Checked By:	AJM		Date:	10-10-08
Approved By:	SS		Drawn By:	KM(N1)
File Name:	BROADWELL ROAD REGION.DWG		Figure No.	1D

Broadwell Road Region

site	TOPSOIL/ FILLFILL		COHESIVE ALLUVIUM					GRANULAR				COHESIVE				GRANULAR				BEDROCK	
	Depth (ft)	Type	Depth (ft)	Type	PI*	% Granular	Remarks	Depth (ft)	Type	% Fines	Remarks	Ddepth (ft)	Type	% Granular	PI*	Depth (ft)	Type	% Fines	Remarks	Depth (ft)	Type
1			488-473	CL	15 to 13	4 tp 49		473-452	GM to SW-SM	24 to 10	tr. upper clay										
2	560-552		552-527.5	CL			tr gravel @ bottom													487.5-479	weathered shale
3	533-530	fill/ CL	530-523	CL				523-501.5	SP		some gravel										
4			561-536.5	CL			limestone frg.													536.5	weathered shale
5								541-526	SM	49		526-519	CL								
6								498-483	SM-SM to GP-GM												
7								540-518-5	SM		tr gravel										
8			521-511	CL	10	2	tr. sand	511-471	GM and SP	30 to 18	alluvium/till	471-456	CL	5 to 44	till	456-442	GM	18	refusal at 442		
9	539-523	topsoil/fill						523-522.5	SP		outwash										
10	539-529	topsoil/fill						529-524	SP		outwash	524-522	CL	17		522-518	SP	14	alluvium		

Remarks: Soils have been categorized in general terms for informational purposes, i.e. COHESIVE (clays and clayey silts) and GRANULAR (non-cohesive silts, sands and gravels). Percentages of gravel, sand, silt and clay may change over depth within each generalized layer. The tabulated information represents data collected over the last 50 years. Current surface elevations and depth of fill or topsoil may have changed as the result of subsequent construction and/or flooding events.

* PI = Plasticity Index