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SYNTHESIS GAS DEMONSTRATION PLANT

ENVIRONMENTAL REPORT

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MASTER

Prepared for the

U.S. DEPARTMENT OF ENERGY

Assistant Secretary for Energy Technology
Office of Fossil Fuels

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ENVIRONMENTAL REPORT

SYNTHESIS GAS DEMONSTRATION PLANT, BASKETT, KENTUCKY

PREPARED FOR THE

UNITED STATES
DEPARTMENT OF ENERGY

UNDER CONTRACT NO. ET-77-C-01-2577

VOLUME 2

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4.1 USES OF ADJACENT LAND AND WATER

Introduction

Four geographic analysis areas were delineated to develop the land use and socioeconomic sections of this report. As represented in Figure 4.1-1 these areas include the proposed site area, which is defined as the area within the property boundaries; an area within a three-mile radius of the site; an area within a twenty-mile radius of the site; and a region within sixty miles of the site.

The land use within the site area is analyzed in detail in order to determine the effects of future land alienation by preemptive use by the proposed project. The three-mile radius study area was delineated because it is within this radius that potential direct effects of plant construction and operation would have the most significant impact on adjacent land uses and population. The area encompassing a radius of 20 miles from the project site provides a regional framework for the presentation of information and analyses of the economic base, demographics, and land use. The sixty-mile radius has been selected to provide an overview of the region, and because this radius coincides with the air quality impact study area.

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4.1.1 LAND USES ON THE SITE AND WITHIN THREE MILES OF THE SITE

4.1.1.1 Site Area Land Use

The proposed site is located in Henderson County, in northwest Kentucky. The site's northwestern boundary is approximately 3.2 km (2 miles) from the confluence of the Ohio and Green Rivers. To the north the site is bounded by the Green River. To the east it is partially bounded by Tscharner Road. The southern boundary is generally parallel to the Louisville and Nashville Railroad, which at its closest point, is located approximately 256 m (750 ft) away.

The closest settlement to the site is Baskett, Kentucky approximately one mile to the east. The nearest population center to the site is the city of Henderson, Kentucky seven miles to the southwest of the site. Other cities within a twenty-mile area of the site include Owensboro, Kentucky in Daviess County, 19 miles southwest of the site; and Evansville, Indiana, 8 miles northwest of the site.

The site boundaries encompasses 284.6 ha (703.33 acres). The northern portion is lowland alluvial plain subject to flooding. A marked ridge line delineates this area from the upland areas where major plant features will be located. Site elevations range from 109.8 m (366 ft MSL) at the northern edge to 135 m (450 ft) in the southern section. The northern section of the site also contains a portion of forested wetland known as "Cypress Slough". The upland land area is primarily cultivated land, with some forest cover. A map showing land use currently found on the site is presented in Figure 4.1.1-1. (For a detailed discussion of land use codes utilized for this study, see Section 4.1.1.2.2, Land Use Classification). Current land uses include cropland and pasture, forest, forested wetland, and single-family residential. The acreages for each of these uses are shown in Table 4.1.1-1.

4.1.1.1.1 Cropland and Pasture

Cropland and pasture is the major land use on the site, comprising 211.3 ha (522.2 acres) or 74.2 percent of the site area. There are three productive farms on the site. The farms are approximately 111.7 ha (276 acres), 25.5 ha (63 acres) and 144.9 ha (358 acres) in size. The principal crops grown are corn, wheat and soybeans. Recent (1977) productivity estimates for these farms show a range of about 76-95 bushels of corn per acre, 34-40 bushels of soybean per acre, and about 32 bushels per acre of wheat[1]. These estimates, however, represent the yield established for the farms by the Agriculture Stabilization Conservation Service, and therefore are probably lower than actual productivites. The latest available Census of Agriculture statistics (1974) indicate that the average per acre production of Henderson County farms was 87.9 bushels of corn, 34.6 bushels of wheat, and 25.0 bushels of soybeans[2].

Approximately 122.7 ha or 55% of the farmland on site is in the flood plain area. The remaining portion (101.3 ha) lies in the upland area. In addition, approximately 75 percent of the proposed site contains the Soil Conservation Service mapping units which qualify as Prime Farmland with approximately 19 percent as Additional Farmlands of Statewide Importance

(3) (See Figure 4.1.1-2). The remainder of the site is in other classifications. (See Chapter 8.2 for further discussion of prime and unique farmland).

Horses are the only livestock currently raised on the site, although adjacent farms also raise cattle.

4.1.1.1.2 Forest Land

The site incorporates approximately 42.7 ha (105.6 acres) of forest land, which is about 15 percent of the total site acreage. The forest cover in the northern lowland, portion of the site is floodplain type vegetation, including such species as red maple and ash. The southern upland forest is predominantly an oak-hickory association. For a complete listing of tree species on the site, see Section 4.2.2, Terrestrial Ecology. There has been selective logging of the woodlots on site. However, the value of the remaining timber on site is considered to be marginal for commercial utilization.

4.1.1.1.3 Forested Wetland

The site contains approximately 29.7 ha. (73.5 acres) of forested wetland, which comprises about 10.5 percent of the total site acreage. The wetland area in the northern portion of the site is part of a larger area known locally as "Cypress Slough", which is currently under consideration by the Kentucky Nature Preserve Commission for designation as a Kentucky Nature Preserve. The slough flora and fauna are discussed in detail in Section 4.2.2, Terrestrial Ecology.

4.1.1.1.4 Residential

Single-family residential use comprises approximately 0.8 ha. (2 acres) or 0.3 percent of the site. There is one dwelling unit surrounded by a number of non-residential (farm) structures located in the central upland portion of the site. As this property is owned by the Applicant, there is currently no permanent resident of the dwelling. This site might be of some historical interest. For further discussion of this matter, see Section 4.6.5.1.3.

4.1.1.2 Land Uses Within Three Miles of the Site

4.1.1.2.1 General Description

The study area within three miles of the site, lies mostly within Henderson County, Kentucky, and includes a small portion of Vanderburgh County, Indiana. The study area is characterized as being primarily rural, with agricultural or forest being the main land uses. The northern portion of the study area is traversed by the Ohio and Green Rivers. At its closest point, the site is located about 2.4 km (1.3 miles) east of the confluence of these two rivers.

U S 60, the main east-west highway to Henderson, Kentucky and Evansville, Indiana, is about one mile south of the site. The main north-south road is Kentucky Route 1078, located about one mile east of the site. The Louis-

ville and Nashville Railroad, also running in an east-west direction within the study area, is located about 225 m (750 ft) from the site's southern property boundary.

Residental use within the area is found chiefly in the town of Baskett, about 1.28 km (0.8 miles) east of the site, and along Routes 1078 and 60. Seasonal (mostly summer) residences are located along the Ohio and Green Rivers.

4.1.1.2.2 Land Use Classification

Figure 4.1.1-3 is a map showing land use classification codes within the three-mile study area. Summary acreages for each of the categories are presented in Table 4.1.1-2. The land use information is derived from US Soil Conservation Service 1:24000 black and white aerial photography flown in October 1974 and 1975. This information was further updated to the Spring of 1978 through field reconnaissance.

The land use codes represented are based on national classifications developed by the U S Geological Survey for use with remote sensor data.[4] (The one-digit codes represent the first, or most generalized, classification, such as "4 - Forest Land", while two- and three-digit codes are utilized where information was readily available for more specific land use identification. For example, "111 - Single Family Residential" is a sub-category of "11 - Residential", which is a sub-category of "1 - Urban or Built-up Land".) The following is a discussion of land use, by classification, within the study area.

4.1.1.2.2.1 Urban or Built-Up Land

4.1.1.2.2.1.1 Residential

Residential use within the three-mile study area encompasses about 182.1 ha (450.0 acres), or 2.5 percent of the total acreage. Of the 182.1 ha (450 acres), 178.4 ha (440.8 acres) is comprised of single-family units. Multi-family residential use comprises only 3.7 ha (9.2 acres). Most residential development has occurred along Routes 1078 and 60 and in the town of Baskett. Residential use along the Ohio and Green Rivers, in the northern part of the study area is primarily seasonal. These residences are either summer homes, or camps used during the hunting season.

The locations of planned subdivisions in Henderson County indicate that about 20 percent of the county's growth is taking place within the three-mile radius of the study area[5]. At least two subdivisions within the area recently have gained approval from the Henderson County Planning Commission. Located off Route 1078 in the southeast section of the area, these subdivisions would contain of a total of about 50 lots[6]. Additional subdivisions are proposed for other parts of this area, including two located near the intersection of Route 60 and the Nashville and Louisville Railroad, in the southwest portion of the area. Existing and proposed lot sizes in the area range from one-quarter to three-quarters of an acre, although the smallest county lot not on sanitary sewer that is allowed is approximately one-third of an acre[5].

Most new apartment developments in Henderson County are located within the limits of the City of Henderson. Recently, however, there has been a trend toward expanding this type of development further away from the urban area, and at least three new apartment complexes have been planned for areas outside the city[5]. Of these, one apartment complex is currently being built off Route 60, near the entrance of the Henderson Golf and Country Club, which is about 0.5 km (0.3 miles) south of the site boundary[5]. The development is called New Country Club Estates, and it will have 103 apartment units and 15 single family residences[7].

4.1.1.2.2.1.2 Commercial and Services

Commercial and service land uses within the three-mile radius comprise approximately 10 ha. (24.8 acres), or about 0.1 percent of the total study area. About 6.3 ha. (15.6 acres) of the 10 ha. (24.8 acres) are in institutional uses. These include the Baskett Cemetery, which is located about 1.3 km (0.8 miles) east of the site, three churches, and a firehouse in Baskett. No schools or hospitals are located within this area. A Situation Identification Disposition (SID) unit, which is a non-medical detoxification facility for drugs and alcholism, is located off Route 60, about 1.6 km (1 mile) south of the proposed Baskett site. The SID is part of the Green River Comprehensive Care Center, a private nonprofit organization. The facility has a capacity for 40 patients, with a total of about 11 staff personnel[8].

4.1.1.2.2.1.3 Industrial

There are no major industrial uses within a three-mile radius of the site. However, there are a number of automobile junkyards in the area and a coal unloading facility on the Indiana side of the Green River (See Section 4.1.5), which, in total, encompass approximately 3.7 ha. (9.2 acres) or about .05 percent of the area.

There are also several several barge fueling facilities on the Green River, (not shown in Figure 4.1.1-2) two of which are located within one mile of the site. These are discussed in Section 4.1.5, Description of Activities on the Ohio and Green Rivers.

The following oil and gas wells are found within a three-mile radius of the site.

Oil Wells	-	45
Dry hole	-	46
Flow of oil	-	47
Flow of gas	-	1
Abandoned oil wells	-	1
Input well	-	1

The data indicates that within the nearby region there are shows of gas and oil. However, the output of these wells is considered small and few of them are commercially valuable. The presence of these wells is not considered to be a major industrial land use in the area.

4.1.1.2.2.1.4 Transportation

Major transportation uses within the three-mile radius include the Louisville and Nashville Railroad and U S 60 comprising approximately 78 ha (192.8 acres) within a three mile area. U S 60 is a 2 lane highway running in an east-west direction within the study area. Route 1073, not shown on the land use map, is a major north-south route in the area, connecting Baskett with U S 60. More detailed information on the highways, existing service and traffic counts, is presented in Section 4.6.3.

The closest railroad to the site is the Louisville and Nashville Railroad, located approximately 225 m (750 ft) south of the plant site at the closest point. An average of four trains pass the site daily. Each train has an average of 80 cars. The type of products shipped on the line include general products such as aluminum and other metal products, appliances, chemicals, wood products, construction aggregates and grain. In 1977, the annual tonnage shipped on this section of the rail line was 7,527,923 average tons per mile of rail[9].

4.1.1.2.2.1.5 Other Urban or Built-Up Land

4.1.1.2.2.1.5.1 Recreational

Recreational use comprises approximately 94.8 ha. (234.2 acres), or 1.3 percent of total land within the three-mile radius study area. Private recreation, with about 92.9 ha. (229.6 acres), is the largest subcategory. This includes the Henderson Golf and Country Club, the J B Resort, and the Coon Hunters Club.

The Henderson Golf and Country Club, which comprises about 67.7 ha. (167.4 acres), is located about 0.5 km (0.3 miles) to the south of the proposed project. In 1978 it had 527 members[10]. The Coon Hunters Club is located at the junction of Route 60 and the Louisville and Nashville Railroad, in the southwestern portion of this area. The J B Resort, essentially a cluster of about 10 cottages near the Green River, is located about 0.8 km (0.5 miles) from the project site. This resort offers fishing, swimming and boating.

Public recreational use within the three-mile radius comprises approximately 1.9 ha. (4.6 acres), consisting of a baseball field in Baskett.

4.1.1.2.2.1.5.2 Transitional Areas

Transitional areas are defined in the USGS Land Cover Classification as "those areas which are in transition from one land use activity to another[4]. Within the three-mile radius study area this land use consists of a sanitary landfill site of approximately 4.8 ha. (11.9 acres), or less than 0.1 percent of the total study area.

4.1.1.2.2.2 Agriculture

Within a three-mile radius of the site the most prevalent land use is argicultural, in the form of cropland and pasture. Agricultural use encompasses approximately 5258.8 ha. (12,994.5 acres), representing about 71.8 percent of the total acreage in the study area. Agricultural activities within the area include the cultiviation of corn, soybeans, tobacco and wheat, and the raising of cattle and hogs. The average farm size in this area is about 80.9 ha. (200 acres)[11]. According to the Agricultural Extension Agent for Henderson County, the flood plain area within the study area, as in the county in general, contains the highest quality agricultural land[11]. Corn and soybeans are the major crops produced on the flood plain and are generally rotated annually.

The study area contains approximately 5 percent of the total agricultural land in Henderson County, which was about 110,524 ha. (273,106 acres) in 1976[12]. Agriculture is the major industry in the County, with the total value of agricultural sales having exceeded 25.5 million dollars in 1976[12] and 32 million dollars in 1977[11]. Corn, soybeans and wheat are the three major crops produced in Henderson County.

4.1.1.2.2.3 Forest

Forest land comprising 362.2 ha (2130.4 acres), or 11.8 percent of the total area, is the second largest land use category within the three-mile radius study area. The upland portions contain a mixture of forest cover types, with oak-hickory predominating. The lowland areas contain flood plain or swamp forest type of vegetation. (For a more complete description of tree species in the area surrounding the site see Section 4.2.2, Terrestrial Ecology). While the tree species found in the area may have some commercial value, it is not known if any commercial harvesting takes place.

4.1.1.2.2.4 Water

About 6.6 percent, or 483.5 ha (1193.8 acres), of the area within the three-mile radius is made up of water courses consisting principally of the Ohio and Green Rivers. The confluence of these two rivers is located approximately 2.4 km (1.3 miles) to the northwest of the closest boundary of the site. The Ohio River is one of the largest and most important tributaries of the Mississippi River, and carries a major portion of Kentucky's waterborne commerce [13]. The Green River also plays an important role in transporting Kentucky coal[13]. A description of commercial and recreational activities on these rivers in the site vicinity is provided in Section 4.1.5 of this report.

Other water bodies within the study area consist of small ponds and streams.

4.1.1.2.2.5 Forested Wetland

Forested wetland encompasses approximately 341.9 ha (844.8 acres), or about 4.7 percent of the total area within a three-mile radius, and is located in the northern half of this area, in proximity to the Ohio and Green Rivers.

A portion of the wetland area is known locally as the Cypress Slough and it is presently under consideration by the Kentucky Nature Preserve Commission for designation as a Kentucky Nature Preserve.

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4.1.2 LAND USES WITHIN 20 MILES OF THE SITE

The area within a 20-mile radius of the proposed site, as shown in Figure 4.1.2-1, incorporates all or major portions of six counties within two states: Henderson and Daviess Counties in Kentucky; and Posey, Spencer, Vanderburgh, and Warrick Counties in Indiana. The most populated county in this region is Vanderburgh County, with a 1970 population of 168,772. The next most populous county is Daviess, having 79,486 persons in 1970. Spencer county has the smallest population, with a 1970 population of 17,134. Henderson, Posey, and Warrick Counties had 1970 populations of 36,031, 21,740, and 27,972, respectively[1]. More detailed information on the demographics of this region, including projections and populations characteristics, is presented in Section 4.6.2

Major population centers in the 20-mile study region are also shown in Figure 4.1.2-1. The largest population center is the City of Evansville, in Vanderburgh County, Indiana. Evansville is a major employment and service center for the entire area, and is located approximately 12.9 km. (8 mi) to the northwest of the Baskett site. In 1975 Evansville's population was estimated at 133,566 persons[2]. Only two other cities within the study area contain populations of over 10,000. These are Owensboro, in Daviess County, and Henderson, in Henderson County, Kentucky, with 1970 populations of 50,329 and 22,976, respectively[2]. Owensboro is located approximately 25 highway miles (90 km) to the northeast of the site, and only a portion of the city lies within the twenty-mile radius. Henderson, located approximately 8 highway km (5 mi) to the west of the site, is the nearest major population center to the site. In addition to these three cities, seven other cities in the region contain population of over 1,000. These cities are listed, along with their respective populations, in Table 4.6.2-2.

The topography within 20 miles of the site can be characterized as gently rolling landscape, primarily rural in nature. Most of the land is in agricultural use or is forested. The major physical feature in the area is the Ohio River, which traverses the center of the region in an east-west direction. The area also encompasses a portion of the Green River, a tributary of the Ohio, located in the southeast portion of the region.

As shown in Figure 4.1.2-1, there are two major east-west routes in the study area which also connect it to areas outside the twenty mile region: U.S. 460, connecting Boonville, Chandler, and Evansville, in the northern part of the study area; and the U.S. 60, connecting Owensboro and Henderson, in the southern part of the study area. U.S. 60 is also the nearest major highway to the site, located approximately one mile to the south. Another major road linking Owensboro and Henderson, although it does not extend beyond the study area, is Audubon Parkway, located about six miles to the south of the site. Major north-south routes in the area include U.S. 41-41A and the Pennyrile Parkway, in the central portion of the region. These highways and other major connectors are discussed in further detail in Section 4.6.3, Services and Infrastructure.

The nearest railroad to the site is the Louisville and Nashville Railroad, which at its closest point, is located approximately 750 feet from the southern property boundary. It serves both as an east-west and north-south corridor, traversing the center of the area. Other railroads in the area

include the Illinois Central & Gulf, located in the Southeast; the Penn Central, located in the northeast, and the Southern Railroad, found in the eastern portion of the study area.

There are three major airports within twenty miles of the proposed site. These are the Dress Regional Airport in Evansville, Indiana located approximately 17.7 km (11 air miles) north of the site; Henderson City - County Airport in Henderson, Kentucky, located approximately 20.8 km (13 air miles) southwest of the site; and Owensboro-Daviess County Airport, located approximately 30.4 km (19 air miles) to the southeast of the site (Figure 4.1.2-3).

Dress Regional is the largest of the three. It handles regularly scheduled commercial flights, and in 1976 had a total of 97,250 operations[3]. Henderson City - County Airport is a general aviation airport which currently has approximately 22,800 annual operations[4]. The Owensboro-Davies County Airport is larger than Henderson's and is served by Air Kentucky Lines, a regularly scheduled commuter airline. In 1976, the Owensboro-Daviess County Airport had a total of 60,491 operations[4].

4.1.2.1 Agriculture

Agriculture is the largest single land use in the study area. Among the six counties that comprise the study area, approximately 80 percent of the total land in four of the counties is devoted to agriculture. These include Henderson [5] and Daviess[6] in Kentucky, and Posey[7] and Spencer[8] in Indiana. Approximately 50 percent of Vanderburgh County and 40 percent of Warrick County, Indiana are agricultural land[7].

The principal crops in the area are corn, soybeans, and wheat, with Daviess County ranking second in Kentucky in soybean production and third in corn. Henderson ranks second in corn and forth in soybean production. Posey County ranked third in wheat production in Indiana[9].

Areas with concentrations of prime farmland occur primarily in fertile river bottomlands and upland areas with wind-deposited soils. In Henderson County, prime farmlands are found in the floodplains along the Ohio and Green Rivers, and within the Canoe Creek Watershed in the central portion of the county. In Daviess County agricultural lands are located primarily in the western and central portions of the county, which includes that portion of the county within the study area. Almost all of Spencer and Posey counties are suitable for agricultural purposes, whereas agricultural land is unevenly distributed throughout Vanderburgh and Warrick counties.

Argicultural land in all of the counties is threatened to some degree by the expansion of residential developments, primarily in Vanderburgh, Henderson, and Daviess counties. These counties contain relatively large urbanized areas that are encroaching upon the surrounding rural countryside. In some areas, particularly in Warrick and Henderson Counties, coal mining operations are also in competition with agricultural land use. While residential and industrial development is favored by planning commissions in the area, the importance of agriculture to the regional economy is generally recognized and incorporated in all planning documents[10][11][12].

4.1.2.2 Industrial

Major industries and products produced within a region of approximately 20 miles from the site are listed in Table 4.1.2-1. "Major" industries were those with known employment of approximately 500 or more persons. There are 18 such industries within the study region, located in Henderson and Owensboro, Kentucky; and Evansville and Newburgh, Indiana. The two nearest industries to the site are located in the vicinity of Henderson. These are Anaconda Aluminum Company, with 711 employees, and Firestone Steel Products, with 450 employees[13].

Thirteen major industries, the largest portion of the total within the study region, are located in Evansville. Two of the largest single employers within the region, Mead Johnson & Company and Whirlpool Corporation are located in Evansville and employ between 2500 to 5000 people respectively. As indicated in Table 4.1.2-1, Mead Johnson manufactures nutritional and pharmaceutical products, and Whirlpool produces electric household appliances[14]. Peabody Coal, a coal mining operation, with 1,000 to 2,499 employees, is another of the larger major industries in the Evansville area[14]. Other products produced by major employers in the Evansville area include machinery, furniture, hardware and bread. Two utilities, Indiana Bell Telephone, and Southern Indiana Gas and Electric, are also major employers in the area.

Major industries in the Owensboro area are General Electric Co., which manufactures radio, television and electronic parts, and Murphy-Miller, Inc., manufacturers of office chairs and desks. Newburgh, Indiana, is the location of one major industry, the Aluminum Company of America's (Alcoa) Warrick Operations. Alcoa is also one of the region's larger employers, with a range of 2,500 to 5,000 employees[14].

Coal mining is an important industrial land use in the study area, primarily in Warrick and Henderson Counties. Major active strip mining areas in Warrick County are located just east of Newburgh, north of Chandler, between Boonville and Lynville, and east of Lynville[7]. Nearly all of Henderson County west of the Green River is underlain with coal resources. Strippable coal reserves (within 150 feet of the surface) are located in the eastern one-third of the county west of the Green River. Reynolds Metals Corporation owns approximately 5261 hectares (13,000) acres within this area and has mineral rights to another 12,141 hectares (30,000 acres). Over fifteen percent of the county may be mined for coal in the future[5]. At present time, .02% of Henderson County's and 5.29% of Warrick County's total land areas are being mined for extractible materials[7].

In Posey County low sulfur coal deposits which would have to be deep mined are found primarily in the northern portion of the county[15]. Coal mining in Spencer is located in "the Knobs" area, in the Lincoln City-Chrisney area, in the central portion of the county[8]. In Daviess, coal mining is occurring in southwestern parts of the county. All of these areas are located just outside of the area within twenty miles of the site. There is currently no mining in Vanderburgh County.

4.1.2.3 Residential

In general, residential development throughout the study area is occurring in and around existing urbanized areas and along major transportation corridors. Vanderburgh County has a larger proportion of urbanized land than any other county in the study area, as about 25 percent of the county is developed. Suburban development is widespread in the area surrounding Evansville. Single family homes have been built in a large area between U.S. 41 and Ind. 57 to the north of Evansville. Suburban development also extends to the northwest along Ind. 65 and U.S. 460 and is scattered to the west of the city[7].

Most residents of Henderson County live in the City of Henderson. Expansion of the city is following U.S. 60 to the east and west and Ky. 351 to the east. Residential development is expected to continue along U S 60, Ky 136, U.S. 41A and US 41[5].

In Warrick County, residential development is found along main corridors such as U.S. 460 Ind. 66, and in the cities of Chandler, Boonville, and Newburgh. Most residential growth in Daviess County is occurring around Owensboro[6].

Spencer County does not have any major urban areas, and in Posey County, the area of most change and growth is expected to be around Mt. Vernon and I-64, which is outside the 20-mile study area[7].

4.1.2.4 Recreation

Major recreation areas and wildlife preserves within the study area are located in Figure 4.1.2-2 and listed, along with their acreages, in Table 4.1.2-2. Included in the category of "major recreation areas" are state parks, and county parks of over 40 hectares (100 acres). Municipal parks and golf courses were not included. There are no federally-operated areas within the study area.

There are three state parks, two large county parks, and one wildlife preserve within 20 miles of the site. The two nearest recreation areas to the site are Audubon State Park and Angel Mounds State Memorial, located approximately 6 km (3.8 mi.) to the east and 4.8 km (3 mi.) to the north of the site, respectively. Audubon State Park, which encompasses 291 ha (720 acres), is the largest park in the region and offers boating, fishing, hiking, picknicking, swimming, and golfing recreational activities. Angel Mounds is the site of a large prehistoric Native American town which flourished on the banks of the Ohio River from about 1300 to 1500 A.D. The site is approximately 103 acres in size.

Henderson Slough Wildlife Preserve, located approximately 16 km. (10 mi.) to the southeast of the site, encompasses 1224 hectares (3024 acres) and includes rare Cypress trees.

Portions of John James Audubon State Park, Wolf Hills, and the Cypress Slough including that portion of the Slough on the proposed coal gasification site have been proposed for Kentucky Nature Preserve status and are currently being studied by the Kentucky Nature Preserve Commission to deter-

mine whether they warrant such status[17]. Incorporation of these areas into the Kentucky Nature Preserve system would legislatively prohibit their industrial development although land uses not in conflict with the natural values of the area (eg, limited farming, recreational usage) might be allowed. The Commission's studies are ongoing and will depend upon the results of comparative studies in the region. It will probably be some time before a decision is reached regarding the desireability of preserve status. The Commission has, however, identified in the area some components of the floodplain flora (eg, Chelonia obigua variety speciosa) and fauna (eg. Sorex cinereus) as being relatively uncommon in Kentucky and will be concerned about impacts to the habitats of these species.

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2. U S Department of Commerce, Bureau of the Census, May 1977, Current Population Reports, Series P-25, Kentucky, Indiana.

3. Brennan, JT, Regional Counsel, Federal Aviation Administration, Great Lakes Region, to R Winley, Resources Planner, Ebasco/ Envirosphere Company, Personal Communication, March 15, 1978.

4. Pullen, SG, Transporation Planning Analyst, Kentucky Department of Transportation to G. M. Willant, Ebasco/Envirosphere Company, Personal Communication April 11, 1978.

5. Henderson City-County Planning Commission, "HUD '701' Comprehensive Planning Assistance Housing and Land Use Study for the City and County of Henderson and Corydon, Ky.", Henderson, Kentucky.

6. Owensboro Metropolitan Planning Commission, 1978 Community Directions, A Comprehensive Plan for Owensboro, Whitesville, and Daviess County, Ky., Owenboro, Kentucky.

7. Southwestern Indiana and Kentucky Regional Council of Governments, December 1975, Existing Land Use and National Resources Inventory, Evansville, Indiana.

8. Overall Economic Development Program Committee for Spencer County, Indiana, 1976, Overall Economic Development Program, Spencer County, Indiana.

9. U.S. Department of Commerce, Bureau of the Census, 1974 Census of Agriculture, Kentucky, Indiana State and County Data, Volume 1, Part 14, and Volume 1, Part 17.

10. Henderson City-County Planning, Commission, The Comprehensive Plan For Henderson and Henderson County, June 1972.

11. Green River Area Development District, Land Resources Policy Manual, June 1977.

12. Southwestern Indiana and Kentucky Regional Council of Governments, Regional Land Use Element, June 30, 1978.

13. Kentucky Department of Commerce, 1978 Kentucky Directory of Manufacturers , Frankfort, Kentucky.

14. Indiana State Chamber of Commerce, 1976 - 1977, The Indiana Industrial Directory, Indianapolis, Indiana.

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16. Personal Communication, Harker, Don, Kentucky Nature Preserve Commission, Frankfort, Ky., at a meeting between Envirosphere Company, Ebasco/Envirosphere, Kentucky Nature Preserve Commission and W/R Grace, June 19, 1978.

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18. Indiana State Highway Commission, 1977, Indiana State Highway System, Indianapolis, Indiana.

19. Kentucky Department of Parks, April, 1978, Kentucky Recreation Facilities Inventory, Frankfort, Kentucky.

20. Kentucky Department of Parks 1975, Kentucky Statewide Comprehensive Outdoor Recreation Plan, Frankfort, Kentucky.

21. Kentucky Department of Transportation, 1977 Kentucky Road Map.

4.1.3 PRINCIPAL FEATURES WITHIN 60 MILES OF THE SITE

The area within 60 miles of the site, shown in Figure 4.1.3-1, incorporates all or portions of 31 counties within Kentucky, Indiana, and Illinois. Within this area are a total of six major metropolitan areas with populations of over 10,000 persons, four of which are located in Indiana and two in Kentucky. Latest population estimates for these cities are presented in Table 4.2-8. The largest metropolitan area within the 60-mile region is Evansville, in Vanderburgh County, Indiana, which in 1970 had a population of 138,764[1]. Owensboro, in Daviess County, Kentucky, with a population of 50,329 person in 1970, constitutes the second largest population concentration in the region[1]. Evansville and Owensboro are located 14 and 22 highway miles to the northwest and east of the site, respectively.

In general, the topography of the region can be characterized as being an area of irregular plains, with open hills to the south and east, and elevations rarely rising above 500 ft MSL. The major land use in the area is cropland with pasture, woodlands and forest[2]. The dominant topographic feature within the 60-mile radius study region is the Ohio River, which extends from the eastern portion of the region and flows through the center to the southwest. Within the region the Ohio serves as the boundary line between Indiana and Kentucky, and Illinois and Kentucky. The Wabash River, a major tributary of the Ohio, found in the northwest portion of the region, forms the boundary line between Illinois and Indiana. Other major water courses in the study area are the White River, a tributary of the Wabash, in the northern portion of the study area; and the Green River, a tributary of the Ohio in the southeast, upon which the site is located.

The area is well-served by major highways in every part of the region. There are three major east-west routes: U.S. 460, in the northcentral portion of the region; U.S. 60, in the center of the region, extending to the southwest; and the Western Kentucky Parkway, located in the southern portion of the region. Major north-south routes include Illinois 1, to the west; U.S. 41-41A and the Pennyrile Parkway in the center of the region; and U.S. 231, 431 and the Green River Parkway located in the east. In addition there are numerous state and county routes linking these highways.

The Louisville and Nashville Railroad, which traverses the center of the region in both east-west and north-south directions is the closest railroad to the site. Other railroads in the region include the Illinois Central & Gulf in the south; the Penn Central in the north; and the Southern Railroad in the east.

4.1.3.1 Sensitive Land Uses

Table 4.1.3-1 is a listing of the locations and acreages of National Forests, wildlife preserves, and major recreational areas within the study region. Their locations are also shown in Figure 4.1.3-1. Included within the category of "major recreational areas" are federally-operated areas, and state forests or parks of 405 ha (1,000 acres) or more.

The study region encompasses major portions of two National forests: Hoosier National Forest in Indiana, approximately 72.4 km (45 miles) to the northeast of the site, and Shawnee National Forest in Illinois, approximately 67.6 km (42 miles) to the southwest. Hoosier National Forest encompasses 42942 ha (106,029 acres) in four counties in the study region[3] and Shawnee National Forest encompasses a total of 231,808 ha (572,798 acres) in 3 counties in the study region[4]. The only other Federally-controlled area in the study region is Lincoln Boyhood National Memorial, an area of 66.4 ha (164 acres) which is adjacent to Lincoln State Park, Indiana, located approximately 48.3 km (30 miles) to the northeast of the site. Within the study region are also 10 conservation areas (wildlife and nature preserves) and six State recreation areas. The majority of these are located in Indiana, in the northeast portion of the study region. The largest among these is Patoka Lake Reservoir, located approximately 85.5 km (55 miles) northeast of the site. This is the largest planned park in Indiana,[5] and is expected to encompass 10530 ha (26,000 acres).

There are no other planned National State forests, parks, or wildlife refuges within the study region[5,6,7].

There are no Indian Reservations within the study region.

REFERENCES - SECTION 4.1.3

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2 United States Department of the Interior Geological Survey, The National Atlas of the United States of America, Washington, D.C. 1970.

3 Indiana Department of Natural Resources, Outdoor Recreation Division, Indiana Inventory 1976, Indianapolis, Indiana.

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5 Feingold, John, Outdoor Recreation Planner, Indiana Department of Natural Resources, Indianaplois,, Indiana, to G. M. Willant, Ebasco/Envirosphere, Personal Communication, November 8, 1978.

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4.1.4 SCENIC FEATURES

To illustrate the general visual values of the Baskett site, a series of site area photographs are presented in Figures 4.1.4-2 to 4.1.4-6. The locations from which these photographs were taken is given on the map in Figure 4.1.4-1.

4.1.4.1 Introduction

The scenery of the Baskett site may be categorized into two visual entities: the upland areas, and the bottom land alluvial plain regions which are associated with the Ohio and Green Rivers (see Figures 4.1.4-2a, -2b and -3). Each of these broad categories of land forms has its own related topography, vegetation, and seasonal fluctuations which determine the visual aspects of specific scenes.

The upland areas are visually dominated by remnants of hardwood forests. Where soils are fertile and friable, fields are likely planted to corn, soybeans or wheat. The region is one of gently rolling and undulating earth forms.

In contrast, the alluvial plain bottomlands are quite flat, poorly drained, and subject to heavy spring flooding. Because of the flooding, certain low areas become sloughs, i.e. areas which capture and retain water, thereby remaining moist and developing a unique floral and faunal habitat. Where and when it is possible, the bottomlands are planted to corn or soybeans for the summer season.

4.1.4.2 Scenic Criteria

The scenic features which are discussed in the following sections constitute an inventory of the visual resources of the site and its immediately viewable environs. Areas which are not in an observational relationship with the site are either mentioned peripherally or are omitted. Examples of areas which are not in visual relationship with the site are the Wolf Hills area and Wathen Road.

Criteria which were established for features which have scenic value in the milieu of the plant site were:

- tree and shrub cover - quantity and type,
- attractiveness of land form(s),
- scenic or recreational or historic use of land areas, and
- degree of naturalness (absence of human development) found in areas.

4.1.4.3 Specific Scenic Features

Viewsheds from these scenic features and from "sensitive" viewer locations are shown in Figure 4.1.4-7.

4.1.4.3.1 The Rivers

The principal visual attractions of the site environs are the Green and Ohio Rivers and their confluence (Figure 4.1.4-4). There is a large amount of activity on these rivers by commercial and recreational users. The recreational and visual enjoyment of the rivers is evidenced by the numerous summer cottages which line their shoreline areas. In the spring and summer, mobile homes and tents appear in open shore areas on the Kentucky side of the rivers so that local residents and tourists can participate in water sports including swimming, fishing, and boating. (See Section 4.1.5.1.2 for a discussion of recreation).

Plant materials found along the river borders are typical of stream bank floral species for this section of the country. A survey of the Green River borders identified found the following woody plant materials:

Populus deltoides	- Cottonwood Poplar
P. heterophylla	- Swamp Cottonwood or Downy Poplar
Acer saccharinum	- Silver Maple or Water Maple
A. negundo	- Box Elder
Fraxinus tomentosa	- Pumpkin Ash
F. pennsylvanica subintegerrima	- Green Ash
Quercus michauxii	- Swamp Chestnut Oak or Basket Oak or Cow Oak
Platanus occidentalis	- American Sycamore
Gleditsia triacanthos	- Honey Locust
Cephalanthus occidentalis	- Buttonbush

4.1.4.3.2 The Slough

Cypress Slough is partially located on the northwestern lowland portion of the proposed site. It is roughly parallel to the Green River and lies south of that waterway and the "River Road". The observer is aware of the slough area principally because of the flora which occur within its boundaries. Areas around the slough are quite flat, and normally planted to corn during the growing season. The occurrence of prolific and lush slough vegetation in the otherwise flat and cultivated context of this bottomland area catches the eye and leads to observer visual investigation of the area.

The Cypress Slough has been proposed as a Kentucky State Nature Preserve. Woody plant material observed in and around the slough area is as follows:

Taxodium distichum	- Bald Cypress
Betula nigra	- River Birch
Carya illinoensis	- Pecan
C. laciniosa	- Big Shagbark Hickory or Big Shellbark Hickory or Ringnut
Acer rubrum	- Red Maple
A. saccharinum	- Silver Maple or Water Maple
Celtis laevigata - occidentalis	- Hackberry (natural hybrid)
Quercus bicolor	- Swamp White Oak
Q. lyrata	- Overcup Oak
Q. palustris	- Pin Oak

Morus rubra	- Red Mulberry
Diospyros virginiana	- Persimmon
Salix nigra	- Black Willow
Lindera benzoin	- Spicebush
Cephalanthus occidentalis	- Buttonbush
Forestiera acuminata	- Swamp privet

4.1.4.3.3 Upland Areas

The upland areas of the site and environs are separated from the low flood-plain areas by a steep bank, usually forested, of about 60-65 feet of vertical height. This grade separation occurs in about 850 horizontal feet which results in a road gradient of over 13 percent on Tscharner Road.

The upland areas are either planted to corn or left in woodlots, according to the fertility and tilth of the soils (see Figure 4.1.4-2a and -2b). At the present time, there are extensive stands of trees at the western boundary of the plant site and these stands extend in a roughly westerly direction into the Wolf Hills. The general mix of hardwood trees and shrubs which occurs in the uplands areas is as follows:

Ulmus americana	- American Elm or White Elm
U. rubra	- Slippery Elm or Red Elm
Acer saccharum	- Sugar Maple
A. negundo	- Box Elder
Quercus rubra	- Red Oak
Celtis spp.	- Hackberry species
Sassafras albidum	- Sassafras
Symphoricarpos spp.	- Coralberry and/or Snowberry
Lonicera spp.	- Bush honeysuckle species
Rubus spp.	- Dewberry species

Specifically, the hardwood plants found on the upland slopes on the western side of the site consist of abundant Acer saccharum and additional canopy species such as Cercis canadensis, Platanus occidentalis, Morus rubra, Sassafras albidum and Asimina triloba.

The average height of the major hardwood canopy trees - i. e. Quercus, Acer, Ulmus, Carya, Salix, and Platanus species - is approximately 70 feet with specimens probably attaining a height of 100 feet. There are no evergreen trees or shrubs in or around the site. (For a further discussion and description of site and regional plant materials, see Section 4.2.2.)

4.1.4.3.4 Parks

There are two major parks in the environs of the plant.

Audubon Memorial State Park is about 4 km (2.5 miles) from the site at its nearest point. It is heavily wooded, and contains a scenic lake, picnicking and camping grounds, and a nine-hole golf course. This is an extremely attractive facility and is heavily used during outdoor recreational seasons.

Angel Mounds State Memorial is located north of the site in Indiana about 6 km (2.3 miles) from the site at the closest point. This park-like area was the site of a large prehistoric Native American town which reached its peak of development between 1300 and 1500 AD. A number of buildings have been reconstructed from foundation excavations found on the site, and exhibits relating to Middle Mississippian culture have been installed in an interpretation center.

4.1.4.3.5 Other Features

Additional scenic and/or recreational features which are in an area of potential visual impact from the proposed plant are:

Ellis Park - This is a racetrack located at the Henderson County, Kentucky and Vanderburgh County, Indiana line on Green River Island in the Ohio River. It is bordered by U S 41.

The Henderson Golf and Country Club - This facility is located just off of U S 60, east of Tscharner Rd. This is a relatively new development (1975) and consists of a large clubhouse and an 18-hole golf course on an attractive, wooded site.

4.1.5 DESCRIPTION OF ACTIVITIES ON THE OHIO AND GREEN RIVERS

The Baskett Site is located on the Green River upstream from the confluence of the Green and Ohio Rivers at approximately River Mile 2. Both these rivers serve as important commodity transportation routes and recreational areas for Kentucky. The Ohio serves additionally as a transport route for the nation. The purpose of this section is to describe the commercial and recreational uses of each of these rivers in the vicinity of the site. Since site specific data are not available, commodity traffic and recreational use information is limited to that available for the total length of river or the nearest lock and dam at which data was recently collected. On the Green River the nearest lock and dam is Lock and Dam No. 1, located approximately 7.1 river miles from the site. On the Ohio River, the closest lock and dams are the Newburgh Lock and Dam at River Mile 766.1[1] (approximately 6.0 air miles from the site), and the Uniontown Lock and Dam at River Mile 846.0[1] (approximately 27.0 air miles from the site). These locks and dams are shown in Figure 4.1.5-1. (On the Green River, river miles are measured from the mouth of the river; on the Ohio River, river miles are measured downstream from Pittsburgh, Pennsylvania.)

4.1.5.1 Green River

The Green River is a narrow meandering river which runs from west-central Kentucky to the Ohio River just upstream from Evansville, Indiana. It joins the Ohio at approximately Ohio River Mile 784. The river is maintained by the Army Corps of Engineers, Louisville District. From the mouth to River Mile 103 it has a maintained depth of 9 feet, and a channel width of approximately 500 feet[2]. From River Mile 103 to Lock No. 4 the Green River has a maintained depth of 5.5 feet[2].

Presently there are three active locks on the Green River. Locks No. 1 and No. 2 recently have been rebuilt and modernized and are capable of handling modern coal tows[3]. Lock No. 3 is an older, smaller facility; its size restricts the number and size of barges accommodated in a single lockage[3]. Lock No. 4, at River Mile 149, which has been inoperative since May, 1965, restricts all commercial river traffic above this point on the river[2].

4.1.5.1.1 Commercial Use

The majority of the Green River traffic is bulk freight. Table 4.1.5-1 is a listing of the annual commodity movements on the Green River between 1964-1976. The amount of river traffic steadily increased until 1970 when it reached a peak of 16,665,793 tons[4]. From 1971 to 1976 the total river traffic remained fairly level, averaging about 15.5 million tons annually with the exception of two substantial declines in 1971 and 1976.

In 1976 the total tonnage shipped on the Green River was 13,781,231 tons[4]. Of this amount 98.7 percent, or 13,600,319[4] tons, was coal and lignite. Coal is overwhelmingly the major commodity shipped on the Green River. The Green River is unique in Kentucky in that it flows through rather than merely near a coal field. The river, therefore, plays a strategic role in the transportation of Kentucky coal[3].

In 1976, a total of 13,615,565[5] tons passed through Green River Lock No. 1. This accounted for approximately 98.8 percent of the total river traffic. Table 4.1.5-2 shows the total tonnage by commodity for this lock. Ninety seven (97) percent (13,296,562 tons) of the Lock No. 1 tonnage consisted of coal and comprised 97.8 percent of all the coal traffic on the river.

During 1976 a total of 25,826 vessels (barges and towboats) moved on the river[4]. In the same year, a total of 24,432 barges and towboats moved through Lock No. 1[5].

Since there are no major onshore docking and unloading facilities between the mouth of the Green River and Lock No. 1, the commodity and traffic statistics for Lock No. 1 are a good indication of the type and amount of traffic which passes directly by the site. During field trips to the site in the spring, summer, and fall of 1978, the river in the vicinity of the site at times became so congested with barge traffic as to virtually cut off any other traffic from coming through[7]. It was noted during these trips that the area around the site serves as a "parking lot" for barges and tows waiting for access through Lock No. 1, and for the unloading of coal from the Green River barges to the larger Ohio River Barges[7].

Between the mouth of the Green River and Lock No. 1 there are two river terminals. These are the Ashland Dry Docking Marine Midstream Service which is approximately 1.1 miles west of the site at River Mile 0.9 and C & C Welding, which is located approximately 1.5 miles west of the site at River Mile 0.5[6,7]. The Ashland Dry Docking terminal is used for crew changes and general servicing of tows. It serves approximately 3 to 4 towboats a day. C & C Welding is a barge maintenance and dry dock facility for towboat side and bottom repair. It services approximately 2 towboats a day.

4.1.5.1.2 Recreational Use

Figure 4.1.5-2 shows the number of pleasure craft locking through the Green River Lock No. 1 from 1955 - 1974. The graph shows that the recreational use of the Green River by pleasure craft has declined since 1964. In 1976 only 67 pleasure craft locked through Lock No. 1. (See Table 4.1.5-3). The decline of recreational use on the Green River can be attributed to the availability of Lake Barkeley, from the summer of 1966, and of the flood control lakes in the Green River Basin[8] as alternatives, and the continual increase in commercial river traffic.[8] Large barges and towboats which have to negotiate the many bends and twists in the narrow river make it unpleasant and unsafe for pleasure craft and river recreation in general. These vessels churn up the water and increase turbidity, cut trot lines, interfere with water skiing and create 2-1/2 to 3 feet high waves. This is especially true during the summer recreation season when the river levels are relatively low and the channel reaches its minimum width.[8]

There is only one pleasure craft dock between the mouth of the Green River and Lock No. 1. This is located at the J B Resort at Green River Mile 4. The area has no service facilities and is primarily for the use of the guests of the

resort which is essentially a cluster of 10 cottages near the Green River. It is estimated that only a small number of boaters use the facility.

Given the current amount of commercial traffic on the Green River in the vicinity of the plant site and the number of pleasure craft using Lock No. 1 in 1976, it can be concluded that the recreational use of the Green River in area of the plant site is minimal.

4.1.5.2 Ohio River

The Ohio River is one of the largest and most important tributaries of the Mississippi River. It flows approximately 981 miles from from the confluence of the Allegheny and Monongahela Rivers at Pittsburgh, Pennsylvania to the Mississippi River at Cairo, Illinois. The Ohio River forms the northern boundary of Kentucky from Cattlesburg, Kentucky to Cairo, Illinois.

4.1.5.2.1 Commercial

During 1976, there was a total of 296,588 vessel (passenger vessels, tankers, towboats and barges) movements on the Ohio River.

Table 4.1.5-4 gives the annual total tonnage shipped on the Ohio River from 1967-1976. The amount of commodity traffic has gradually increased over the years from 113,492,423 tons in 1967 to 148,417,810 tons in 1976[4].

The type of commodities shipped on the river cover a wide range of materials including farm products, nonmetalic minerals, coal and lignite, food and kindred products, and chemicals and allied products. Coal and lignite were the largest commodity shipped on the river comprising 78,285,143 tons or 52.7 percent of the total tonnage shipped in 1976[4]. The next largest shipment was sand, gravel, and crushed rock which comprised 16,113,378 tons, or 10.9 percent of the total river traffic[4].

The above statistics are for the total length of the Ohio River and are not indicative of the type and amount of Ohio River traffic in the vicinity of the Baskett Site. To define the river traffic in the vicinity of the site, available data for the nearest lock and dam were reviewed. For Baskett, Kentucky these are the Uniontown Lock and Dam at River Mile 846.0 and the Newburgh Lock and Dam at River Mile 766.1 (see Figure 4.1.5-1).

During 1976 the Uniontown and Newburgh Locks had 62,884 and 58,821 vessel movements, respectively[5]. The average for the two locks of 60,852.5 vessel movements is probably an accurate indication of the number of commercial vessels which used the Ohio River in the vicinity of the site in 1976.

Table 4.1.5-2 shows the total tonnage by commodity for 1976 for the Newburgh and Uniontown Locks and Dams. In 1976, 38,004,192 tons passed through the Newburgh Lock and 46,504,900 tons through the Uniontown lock[4]. Again the commodity shipped on the river in the largest amount was coal, which comprised 38.7 percent of the Newburgh Lock traffic and 40.7 percent of the Uniontown traffic. The average of the total commodity traffic for both locks is 42,254,546 tons, and would be representative of the type and amount of commercial traffic in the vicinity of the site.

Between the Newburgh and Uniontown Locks are approximately 36 commercial river terminals[6]. The closest to the plant site is the Evansville Terminal Company, 2.4 km (1.5 miles) northwest of the site on the northern bank of the Ohio River at River Mile 784.4. Evansville Terminal Company is a coal unloading facility that handles about 2-3 barges a day[9].

4.1.5.2.2 Recreational

The Ohio River has a substantial recreational use by pleasure crafts. In 1976, a total of 1687 recreational vessels locked through the Newburgh Lock and 2063 through the Uniontown Locks[5] (See Table 4.1.5-3). Although the above numbers provide a general indication of the recreational use they are probably lower than the actual use since many[13] boat harbors, landings and ramps are located between the two locks[10]. The closest ones to the site are the Twin Bridges Marina at River Mile 786.8 and Bridge Boat Club at River Mile 786.9. The Twin Bridges Marina has a concrete launch ramp, and snack bar, while the Bridge Boat Club has a clubhouse and three rail inclines with hoists for launching and dry storage[10].

In addition to the individual pleasure boat traffic, paddle wheel riverboats occasionally go up and down the Ohio River. During the summer there is an annual flat bottom boat race between Owensboro and Henderson.

REFERENCES - SECTION 4.1.5

1 U.S. Army Corps of Engineers, Revised January, 1976, Navigation Charts Ohio River, Louisville District, Cairo, Illinois to Foster Kentucky, Louisville, Kentucky.

2 U.S. Army Corps of Engineers, Revised January, 1977, Green River Navigation Charts, Louisville, Kentucky.

3 Commonwealth of Kentucky Department of Transportation, July 1976, Commercial Navigation on Kentucky's Rivers: Facilities and Commodities, Frankfort, Kentucky, July.

4 U.S. Army Corps of Engineers, 1974 - 1976, Waterborne Commerce of the United States, Part 2, New Orleans, Louisiana

5 Whitlock, W N, Chief of Operations Division, U.S. Army Corps of Engineers, Louisville, Kentucky to G. M. Willant, Ebasco/Envirosphere Company, Letter August 16, 1978

6 U.S. Army Corps of Engineers,1978 - 1979 River Terminals, Ohio River and Tributaries, Cincinnati, Ohio.

7 Ebasco/Envirosphere Field Observations, November, 1979

8 U.S. Army Corps of Engineer,June 1975, Draft Environmental Impact Statement, Continued Operation and Maintenance of the Navigation System, Green and Barren Rivers, Kentucky, Louisville, Kentucky.

9 Mrs. Mosby of Evansville Terminal Company to G.M. Willant, Ebasco/Envirosphere Company, Personal Communication November 11, 1978.

10 U.S. Army Corps of Engineers, 1977 - 1978, Ohio River and Tributaries, Small Boat Harbors, Ramps, Landings, Etc., Cincinnati, Ohio.

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4.1.6. USES OF ADJACENT WATER

4.1.6.1 Surface Water

The primary surface water source in the vicinity of the Baskett Site is the Green River. The stretch of the river from the point of confluence of the Green and Ohio Rivers upstream to River Mile 5 of the Green River has been searched and investigated for the existing and potential future water usage.

There are no existing water usage facilities such as pumping stations, intake structures, diversion pipes or canals on either bank of Green River in this river stretch. This statement of no significant surface water usage in the adjacent area is confirmed by the U.S. Army Engineer Green River Navigation Chart[1]. The attached Figure 4.1.6-1, indicates no permanent water usage structure for domestic, industrial or agricultural purposes. The future water use within this river span will be by the proposed Syngas Demonstration Plant.

A possible planned upstream surface water usage would be by the Henderson County Water District which is considering building a water treatment plant on the Green River. However, according to the county consulting engineers, Watkins & Associates of Lexington, Kentucky,[2] the potential intake structure for this proposed water treatment plant will likely be at the junction of Henderson, Webster and McLean Counties, at approximately River Mile 40 to 41.

4.1.6.2 Groundwater

After preliminary search and investigation, no commercial, industrial or agricultural usage of groundwater within a three (3) mile radius of the Syngas Project Site has been found. A few small private wells for domestic supply are found within the study area. There are no more than sixty families utilizing groundwater in the area, and the withdrawals for domestic use seldom exceed 500 gallons per day per well[3,4]. Most of these small private wells have a yielding capacity of only 30 gpm. The domestic utilization of groundwater has insignificant effects on the local hydrologic groundwater balance.

Approximately seventy percent of domestic water uses in the vicinity of the plant Site are presently supplied by the Henderson County Water District System[4]. The future planned expansion of the water treatment plant on the Green River will reduce the demand of groundwater in the area.

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REFERENCES - SECTION 4.1.6

1) U.S. Army Engineer District, January 1977, Green River Navigation Chart, Louisville, Kentucky.

2) Harmon, C B, Watkins & Associates, Lexington, Kentucky to A Sarkar, Ebasco/Envirosphere, Personal Communication, November 11, 1978

3) Radian Corporation Report, 1978, Evaluation of Factors Affecting the Acceptability of the Proposed Site for the GRACE/EBASCO Synthesis Gas Demonstration Plant, Report prepared for Division of Coal Conversion, U S Department of Energy, DCN # 78-200-151-10-02.

4) Blue, J, Henderson County Health Department, to A Sarkar, Ebasco/Envirosphere, Personal Communication, November 11, 1978

TABLE 4.1.1-1

LAND USES ON THE SITE

Land Use Code**	Classification	Approximate Site* Acreage	Percent of Total
4	Forest Land	105.6	15.0
21	Cropland and Pasture	522.2	74.2
61	Forested Wetland	73.5	10.5
111	Single Family Residential (one Dwelling Unit)	2.0	0.3
	Total	703.3	100.0

* Area within property line boundaries.
** Land use code as keyed to Figure 4.1.1-1.

Sources: Anderson, A, 1976 (4).

U S Soil Conservation Service Black & White Aerial Photography, 1:24,000, October 1974 and 1975, and Field Surveys April and May 1978

For more detailed land use classifications, see Table 4.1.1-2.

TABLE 4.1.1-2

LAND USE ACREAGES WITHIN THREE MILES OF THE SITE

Land Use Classification*	Approximate Acreage			Percent of Total		
Classification Level	Level I	Level II	Level III	Level I	Level II	Level III
1. Urban or Built-up Land	911.0	---	---	5.0	---	---
11. Residential		450.0		---	2.5	---
111. Single Family	---	---	440.8	---	---	2.4
112. Multi-Family	---	---	9.2	---	---	0.05
12. Commercial and Services	---	24.8	---	---	0.1	---
121. Except Institutional	---	---	9.2	---	---	0.05
123. Institutional, not including Schools	---	---	15.6	---	---	0.05
13. Industrial	---	9.2	---	---	0.05	---
14. Transportation	---	192.8	---	---	1.1	---
17. Other Urban or Built-up Land	---	234.2	---	---	1.3	---
171. Public Recreation	---	---	4.6	---	---	0.05
172. Private Recreation	---	---	229.6	---	---	1.2
2. Agricultural Land	12,994.5	---	---	71.8	---	---
21. Cropland and Pasture		12,994.5		---	71.8	---
4. Forest Land	2,130.4	---	---	11.8	---	---
5. Water Body	1,193.8	---	---	6.6	---	---

TABLE 4.1.1-2 (Cont'd)

Land Use Classification	Approximate Acreage			Percent of Total		
Classification Level	Level I	Level II	Level III	Level I	Level II	Level III
6. Wetland	844.8	---	---	4.7	---	---
61. Forested Wetland		844.8		---	4.7	---
7. Barren Land	11.9	---	---	0.05	---	---
76. Transitional Areas		11.9	---	---	0.05	---
Total, All Uses	18,086.4				100%	

* Anderson, A, 1976[4].

TABLE 4.1.2-1

MAJOR INDUSTRIES WITHIN 20 - MILE STUDY AREA

Name	Location	Type of Products	Approximate Employment*
Anaconda Aluminum Co	Henderson, Ky	Aluminum Products	711
Firestone Steel Prod.	Henderson, Ky	Truck Wheels & Rims	450
Arkla Industries, Inc	Evansville, Ind	Air Conditioners, Heaters	500 - 999
Ball Plastics	Evansville, Ind	Plastic Parts & Molding	500 - 999
Bucyrus - Erie Co.	Evansville, Ind	Excavators, Drilling Machinery	500 - 999
Bunny Bread Co.	Evansville, Ind	Bread	500 - 999
Faultless Div Bliss & Laughlin Ind.	Evansville, Ind	Furniture Hardware	500 - 999
Indiana Bell Telephone Co.	Evansville, Ind	Utility	500 - 999
International Steel Co.	Evansville, Ind	Structural Steel; Doors	500 - 999
George Koch Sons, Inc.	Evansville, Ind	Industrial Finishing Equipment & Ovens	500 - 999
Mead Johnson & Co.	Evansville, Ind	Nutritional and Pharmaceutical	2,500 - 5,000
Peabody Coal, East Div. Office	Evansville, Ind	Coal Mining	1,000 - 2,499
Southern Indiana Gas & Electric Co.	Evansville, Ind	Public Utility; Electricity & Gas	500 - 999
Whirlpool Corp	Evansville, Ind	Electric Household Appliances	2,500 - 5,000
Zenith Electronics Corp	Evansville, Ind	Wood Console TV and Stereo Cabinets	500 - 999

*Employment data for Indiana firms available only as a range.
Sources: Kentucky Dept of Commerce,[13]. Indiana State Chamber of Commerce[14].

TABLE 4.1.2-1 (Cont'd)

Name	Location	Type of Products	Approximate Employment*
Aluminum Co. of America	Newburgh, Ind	Aluminum Products	2,500 - 5,000
General Electric Co.	Owensboro, Ky	Radio, TV, Electronic Parts	1,610
Murphy-Miller, Inc.	Owensboro, Ky	Office Chairs and Desks	500

* Employment data for Indiana firms available only as a range.
Sources: Kentucky Dept of Commerce,[13].
Indiana State Chamber of Commerce[14].

TABLE 4.1.2-2

MAJOR RECREATION AREAS AND WILDLIFE PRESERVES WITHIN APPROXIMATELY 20 MILES OF THE SITE

Location (State, County)	Name	Owner/ Operator	Acreage
Indiana			
Vanderburgh	Angel Mounds State Memorial	State	429
	Burdette Park	County	185
Warrick	Scales Lake County Park	County	477
Kentucky			
Daviess	Benjamin W. Hawes State Park	State	300
Henderson	Audubon State Park	State	720
	Henderson Sloughs Wildlife Preserve	State	3,024

Sources: Indiana Dept of Natural Resources[17]

Indiana State Highway Commission[18]

Kentucky Department of Parks[19][20]

Kentucky Department of Transportation[21]

TABLE 4.1.3-1 (Sheet 1 of 2)

NATIONAL FORESTS, WILDLIFE PRESERVES AND
MAJOR RECREATIONAL AREAS WITHIN APPROXIMATELY 60 MILES OF SITE

Location (State, County)	Name	Owner/ Operator	Acreage
Illinois			
Hamilton	Hamilton County Conservation Area	State	1,683
Hardin, Gallatin & Saline	Shawnee National Forest	Federal	572,798
Saline	Saline County Conservation Area	State	1,208
Wabash	Beall Woods Nature Preserve and Conservation Area	State	635
Indiana			
Crawford, Perry, Martin & Orange	Hoosier National Forest	Federal	106,029
Daviess	Glendale State Fish & Wildlife Refuge	State	7,754
Dubois, Perry	Ferdinand State Forest	State	11,241
Gibson, Orange, Pike, Warrick	Patoka Fish & Wildlife Preserve	State	7,474
Orange	Patoka Lake Reservoir	State	26,000*
Pike	Pike County State Forest	State	2,858
Posey	Harmonie State Park	State	3,190
Posey	Hovey Lake Fish & Wildlife Preserve	State	4,200
Spencer	Lincoln State Park	State	1,731
Spencer	Lincoln Boyhood National Memorial	Federal	164
Vanderburgh	Lynville Park	State	11,000

TABLE 4.1.3-1 (Sheet 2 of 2)

Location (State, County)	Name	Owner/ Operator	Acreage
Kentucky			
Breckinridge	Yellowbank Wildlife Reserve	State	4,540
Christian	Pennyrile State Forest & Park	State	16,217
Henderson & Union	Henderson Sloughs Wildlife Preserve	State	3,024
Union	Uniontown Wildlife Area	State	4,000
Union	Higginson - Henry Wildlife Area	State	5,428

* Includes planned acreage.

Sources:

Ackerman, K E, Illinois Department of Conservation (8)

Illinois Department of Transportation (9)

Indiana Department of Natural Resources (3)

Indiana State Highway Commission (10)

Kentucky Department of Parks (11)

Kentucky Department of Transportation (12)

TABLE 4.1.5-1

ANNUAL COMMODITY MOVEMENTS ON THE GREEN RIVER (IN TONS)
1964-1976

Commodity	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
Coal and Lignite	10,353,876	11,294,937	11,655,995	13,503,224	15,810,950	15,324,518	16,665,793	14,494,824	16,190,505	15,458,181	15,377,705	15,797,944	13,600,319
Gasoline	7,544	2,289	---	---	---	---	---	---	---	---	---	---	---
Sand, Gravel and Limestone	---	6,153	19,700	---	378,049	33,038	236,614	6,775	3,841	---	---	1,171	1,439
Bauxite	---	---	---	---	---	---	---	---	---	---	2,890	1,582	---
Coke	---	600	---	---	---	---	---	---	---	2,187	---	1,487	1,470
Grain	---	1,400	---	---	---	---	1,320	104,701	47,498	56,969	---	---	---
Corn	---	---	---	---	---	---	---	---	---	---	31,552	47,497	102,201
Wheat	---	---	---	---	---	---	---	---	---	---	6,743	6,919	8,506
Soybeans	---	---	---	---	---	---	---	---	---	---	39,291	37,045	63,901
Asphalt, Tar, and Pitches	---	---	---	---	---	6,394	---	---	---	---	---	---	---
Basic Chemicals	---	---	---	---	---	---	---	---	---	---	181,440	---	3,092
Iron and Steel Shapes	300	---	600	793	509	2,947	---	861	649	---	100	---	---
Construction, Mining Machinery, Parts	1,800	---	---	---	---	---	---	---	---	---	---	---	---
Miscellaneous Manufactured Products	---	4,348	860	---	1,975	3,778	579	606	2,936	---	---	---	---
Waterway Improvement Material	---	---	---	4,396	---	---	---	3,150	300	---	---	---	---
Miscellaneous Non-Metallic Mineral Products	---	---	---	---	---	---	---	---	---	---	---	---	303
Unclassified	---	---	---	---	---	90	---	---	---	---	---	---	---
TOTALS	10,363,520	11,309,727	11,677,155	13,508,413	16,191,483	15,370,765	16,904,306	14,610,917	16,245,729	15,517,337	15,639,721	15,893,645	13,781,231

Source: 1964-1973, U S Army Corps of Engineers[8]
1974-1976, U S Army Corps of Engineers[4]

TABLE 4.1.5-2

TOTAL TONNAGE (BY COMMODITY) FOR 1976
FOR NEWBURGH AND UNIONTOWN LOCKS
AND THE GREEN RIVER LOCK NO. 1

Commodity	Newburgh	Uniontown	Green River Lock No. 1
Coal	14,712,376	18,921,752	13,296,562
Petroleum Fuels	7,022,434	7,821,352	0
Crude Petroleum	398,789	883,282	0
Aggregates	562,222	107,551	0
Grains	1,633,693	3,533,113	174,608
Chemicals	5,187,009	5,477,813	3,092
Ores & Minerals	2,369,375	3,391,671	141,000
Iron & Steel	3,031,081	2,971,032	0
All Others	3,087,213	3,397,334	303
Totals:	38,004,192	46,504,900	13,615,565

Source: U S Army Corps of Engineers[4]

TABLE 4.1.5-3

TOTAL NUMBER OF RECREATIONAL VESSELS (BY MONTH)
FOR 1976 NEWBURGH AND UNIONTOWN LOCKS AND GREEN RIVER LOCK NO. 1

Month	Newburgh	Uniontown	Green River Lock No. 1
January	1	12	0
February	0	6	0
March	2	19	0
April	11	54	0
May	247	351	20
June	311	332	12
July	657	516	16
August	242	299	18
September	125	271	0
October	69	77	1
November	20	83	0
December	2	43	0
Totals:	1,687	2,063	67

Source: U S Army Corps of Engineers[4]

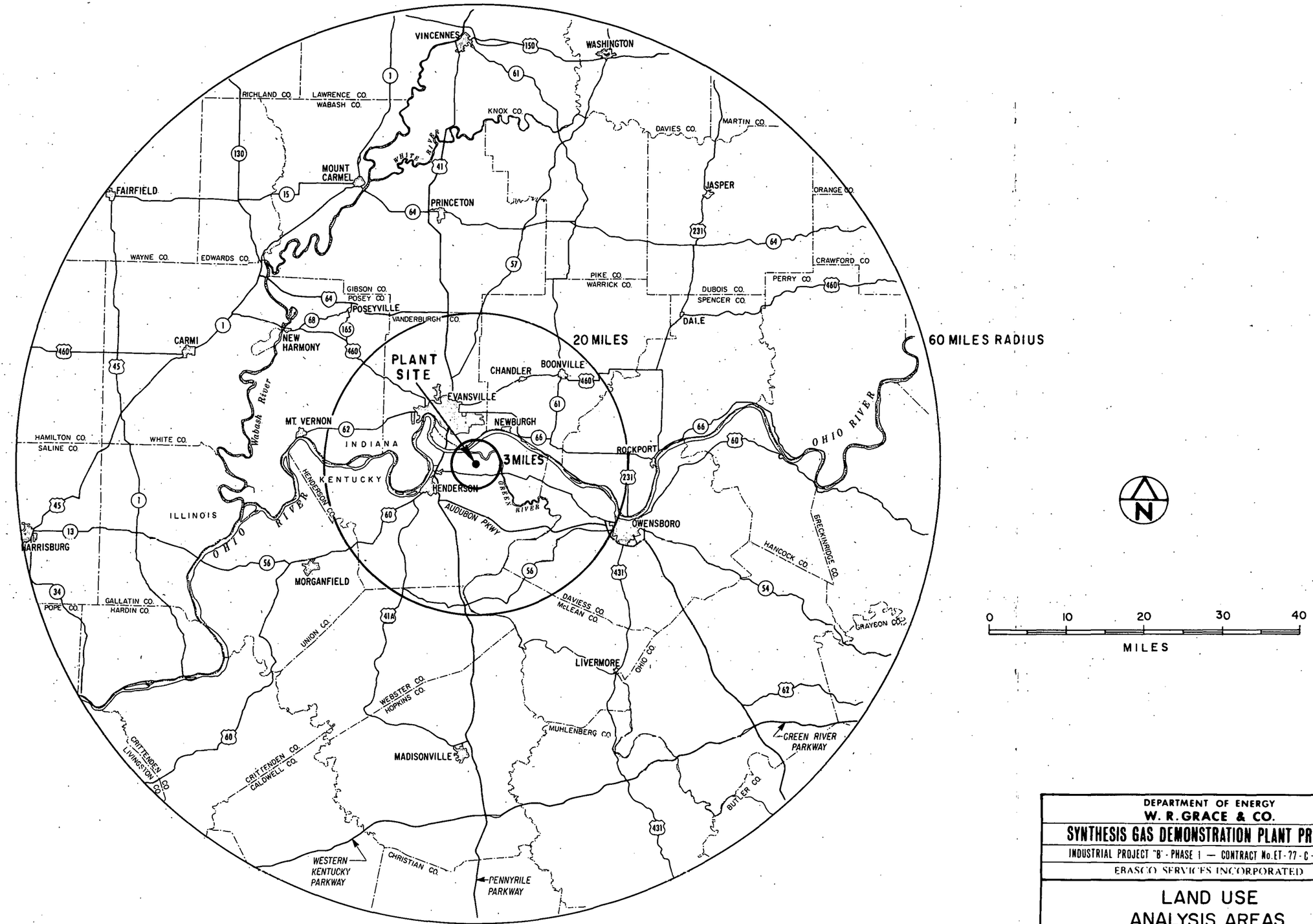
TABLE 4.1.5-4

TOTAL ANNUAL TONNAGE - OHIO RIVER

1967-1976

Year	Total Tons
1967	113,492,423
1968	120,204,227
1969	126,253,599
1970	129,584,668
1971	133,363,905
1972	138,877,692
1973	136,934,374
1974	139,294,213
1975	140,058,314
1976	148,417,810

Source: U S Army Corps of Engineers[4]



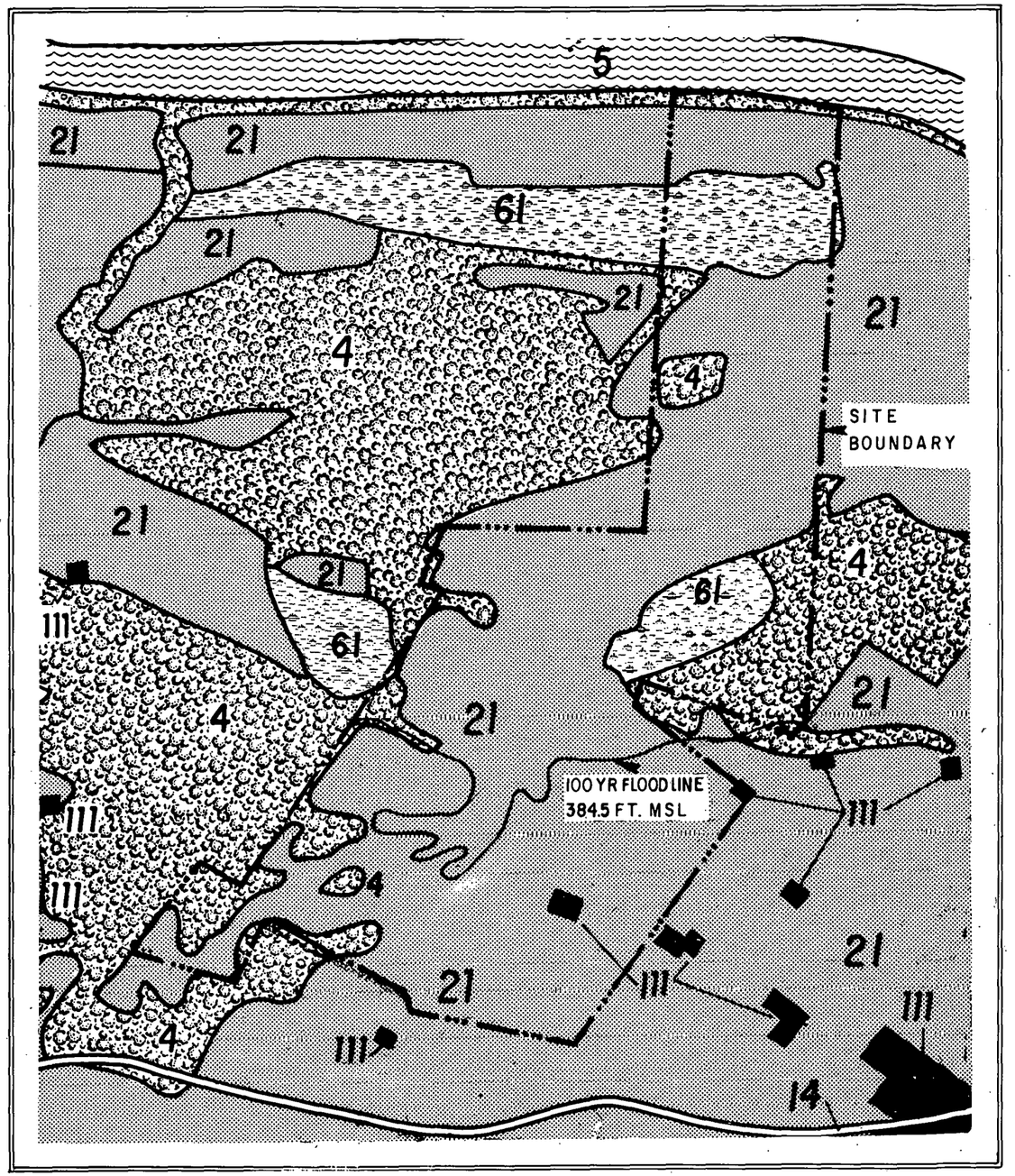
DEPARTMENT OF ENERGY
W. R. GRACE & CO.

SYNTHESIS GAS DEMONSTRATION PLANT PROGRAM

INDUSTRIAL PROJECT "B" - PHASE 1 — CONTRACT No. ET-77-C-01-2577

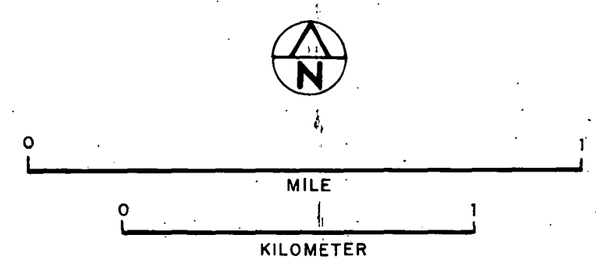
EBASCO SERVICES INCORPORATED

LAND USE
ANALYSIS AREAS
FIGURE 4.1-1



SEE TABLE 4.1.1-1

URBAN OR BUILT-UP LAND:	LAND USE CODE
-RESIDENTIAL:	
SINGLE FAMILY	111
-TRANSPORTATION	14
AGRICULTURAL LAND:	
-CROPLAND AND PASTURE	21
FOREST LAND	4
WATER BODY	5
WETLAND:	
-FORESTED WETLAND	61



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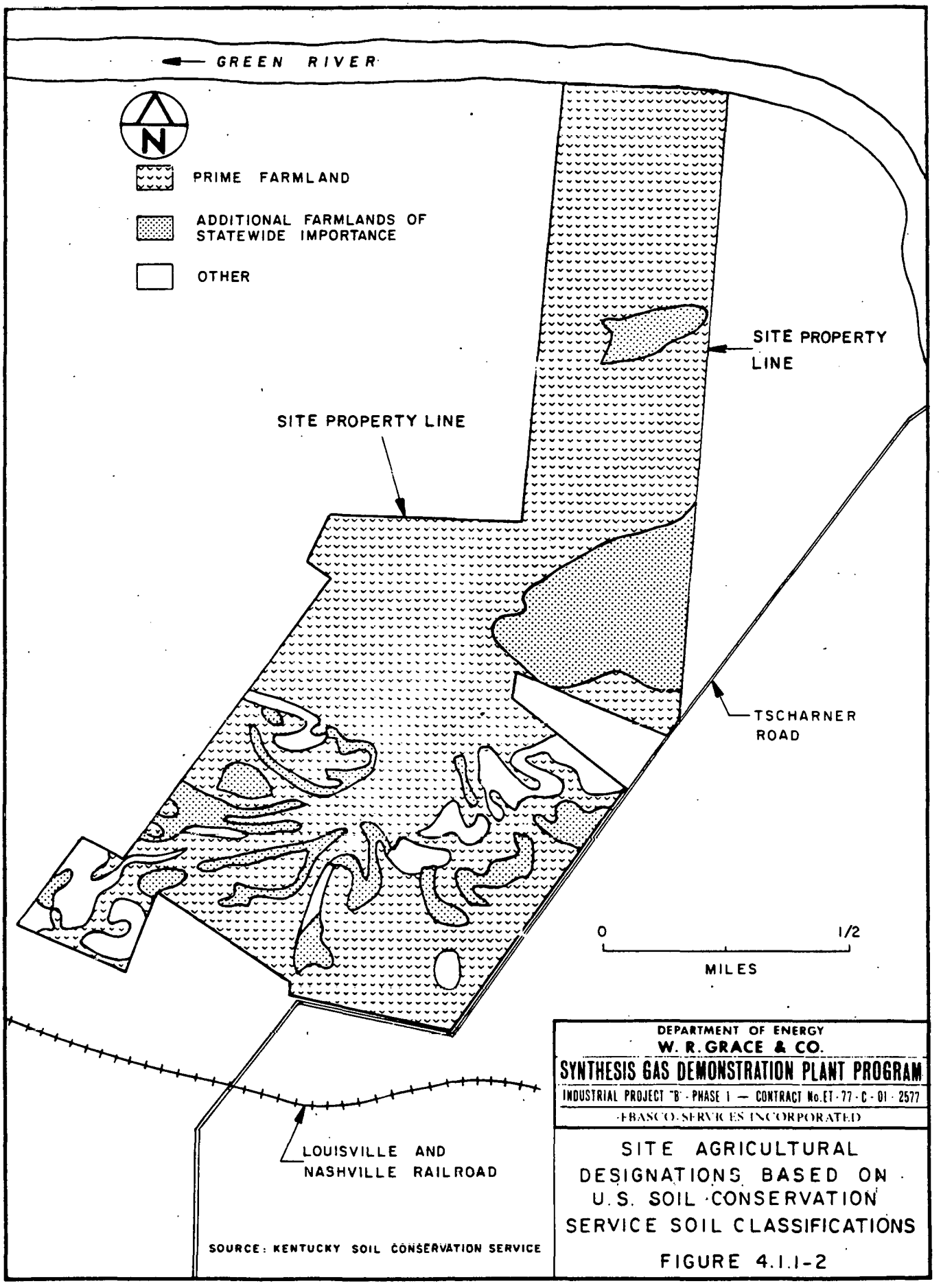
INDUSTRIAL PROJECT "B" - PHASE I — CONTRACT No. ET-77-C-01-2577
ERASCO SERVICES INCORPORATED

LAND USE ON THE SITE

FIGURE 4.1.1-1


GREEN RIVER
N
PRIME FARMLAND
ADDITIONAL FARMLANDS OF STATEWIDE IMPORTANCE
OTHER
SITE PROPERTY LINE
SITE PROPERTY LINE
TSCHARNER ROAD
0
1/2
MILES
LOUISVILLE AND NASHVILLE RAILROAD
SOURCE: KENTUCKY SOIL CONSERVATION SERVICE
DEPARTMENT OF ENERGY
W. R. GRACE & CO.
SYNTHESIS GAS DEMONSTRATION PLANT PROGRAM
INDUSTRIAL PROJECT "B" - PHASE I — CONTRACT No. ET-77-C-01-2577
EBASCO SERVICES INCORPORATED
SITE AGRICULTURAL DESIGNATIONS BASED ON U.S. SOIL CONSERVATION SERVICE SOIL CLASSIFICATIONS
FIGURE 4.1.1-2

URBAN OR BUILT-UP LAND	LAND USE CODE
RESIDENTIAL:	
SINGLE FAMILY	111
MULTI-FAMILY	112
COMMERCIAL AND SERVICES:	
COMMERCIAL, SERVICE	121
INSTITUTIONAL, NOT INCLUDING SCHOOLS	123
INDUSTRIAL	13
TRANSPORTATION	14
OTHER URBAN OR BUILT-UP LAND:	
PUBLIC RECREATION	171
PRIVATE RECREATION	172
AGRICULTURAL LAND	
CROPLAND AND PASTURE	21
FOREST LAND	4
WATER BODY	5
WETLAND	
FORESTED WETLAND	61
BARREN LAND	
TRANSITIONAL AREAS	76

SEE TABLE 4.1.1-2 FOR LAND USE ACREAGES

SOURCE: U.S. SOIL CONSERVATION SERVICE PHOTOGRAPHY OCTOBER 1974 & 1975 AND FIELD SURVEYS APRIL, MAY 1978.

1 0 1 MILE

1 0 1 KILOMETER

DEPARTMENT OF ENERGY
W. R. GRACE & CO.

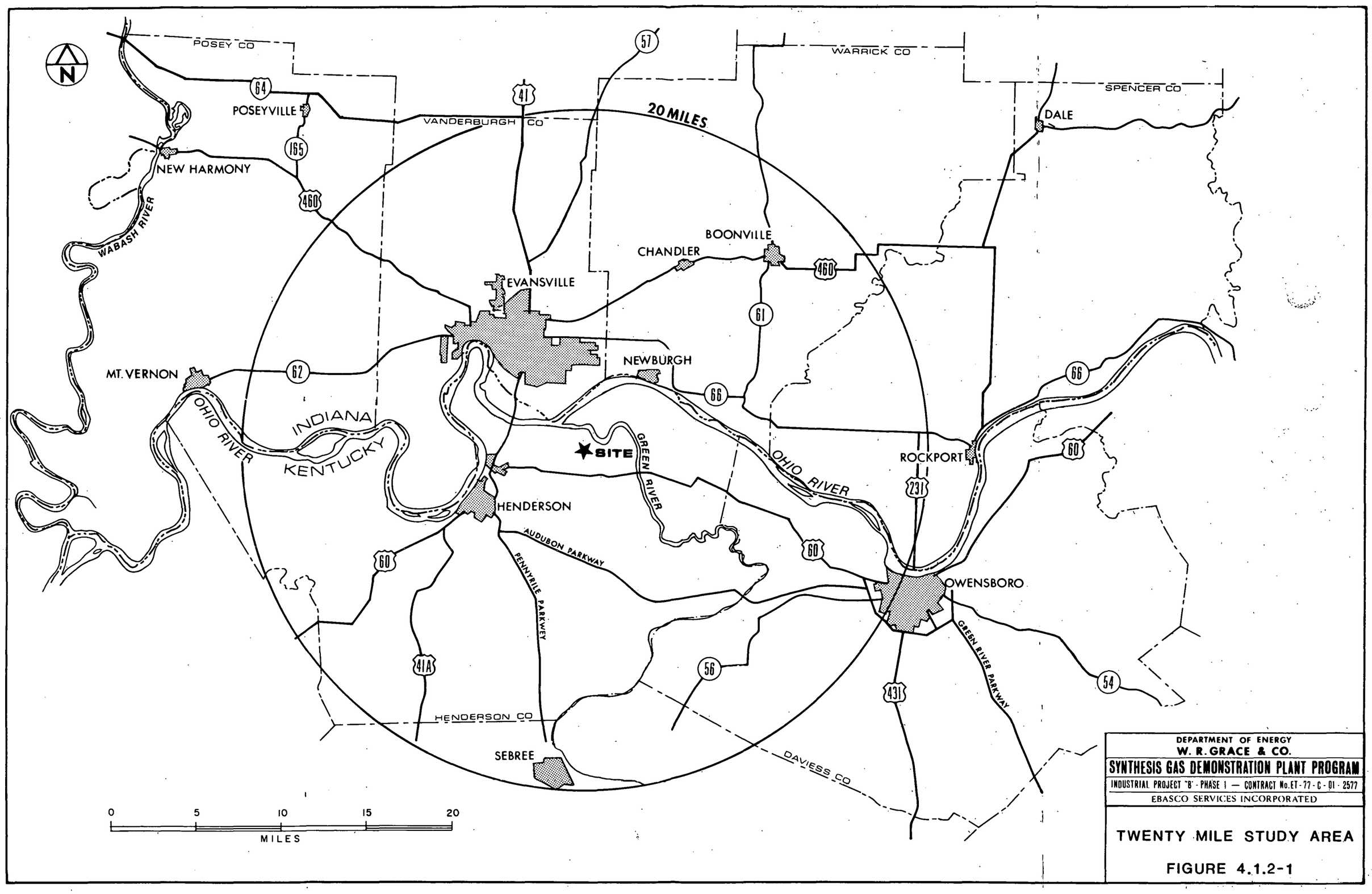
SYNTHESIS GAS DEMONSTRATION PLANT PROGRAM

INDUSTRIAL PROJECT "B" - PHASE 1 — CONTRACT No. ET-77-C-01-2577

EBASCO SERVICES INCORPORATED

LAND USE WITHIN 3 MILES OF SITE

FIGURE 4.1.1-3


N
POSEY CO
WARRICK CO
SPENCER CO
VANDERBURGH CO
HENDERSON CO
DAVIESS CO
20 MILES
POSEYVILLE
NEW HARMONY
WABASH RIVER
MT. VERNON
EVANSVILLE
CHANDLER
BOONVILLE
NEWBURGH
DALE
ROCKPORT
OWENSBORO
HENDERSON
SEBREE
SITE
OHIO RIVER
INDIANA
KENTUCKY
GREEN RIVER
AUDUBON PARKWAY
PENNYRILE PARKWAY
GREEN RIVER PARKWAY
64
165
460
41
57
62
61
66
60
231
41A
56
431
54
0
5
10
15
20
MILES
DEPARTMENT OF ENERGY
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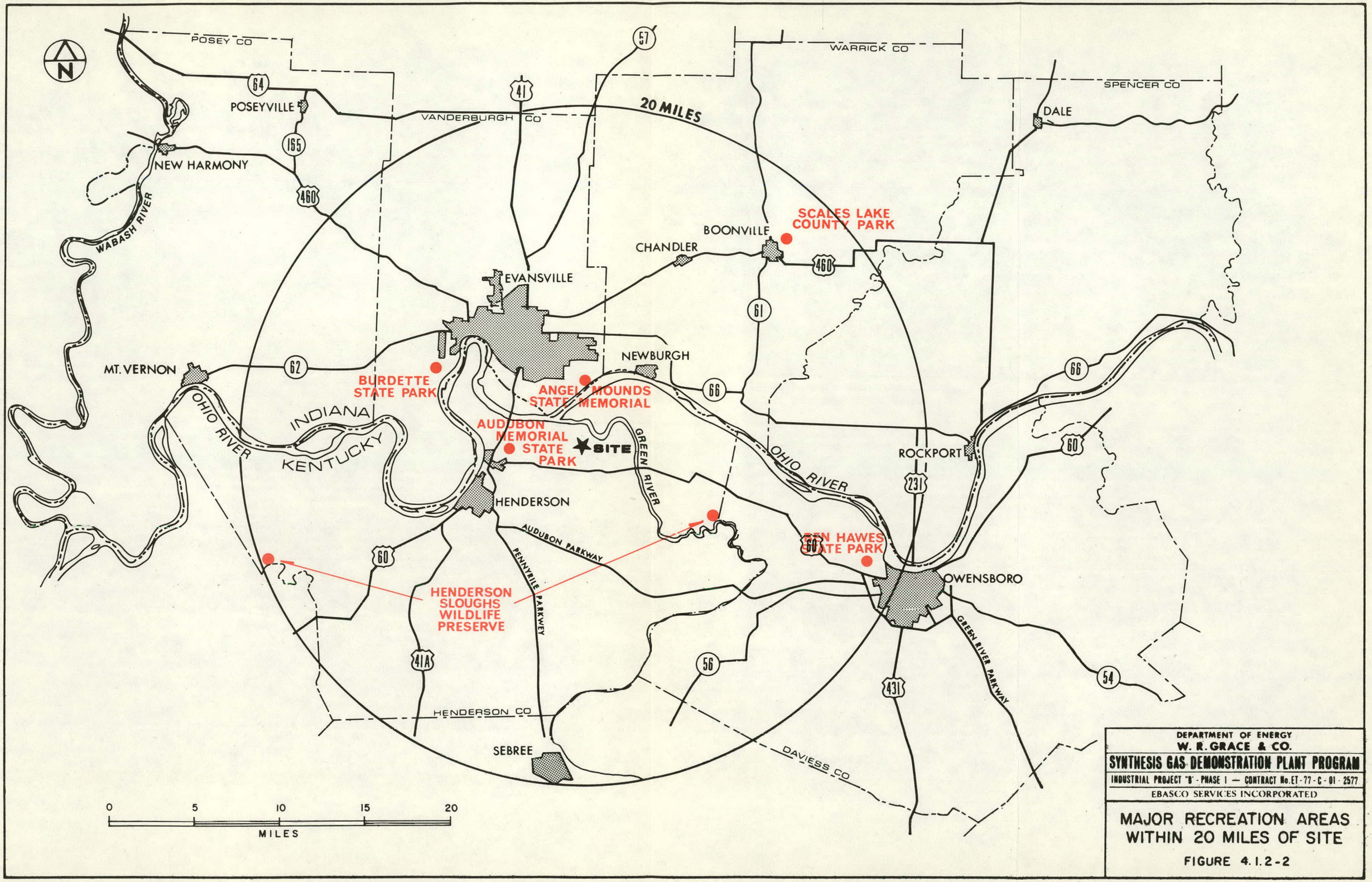
EBASCO SERVICES INCORPORATED
TWENTY MILE STUDY AREA
FIGURE 4.1.2-1



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INDUSTRIAL PROJECT "B" - PHASE I — CONTRACT No. ET-77-C-01-2577
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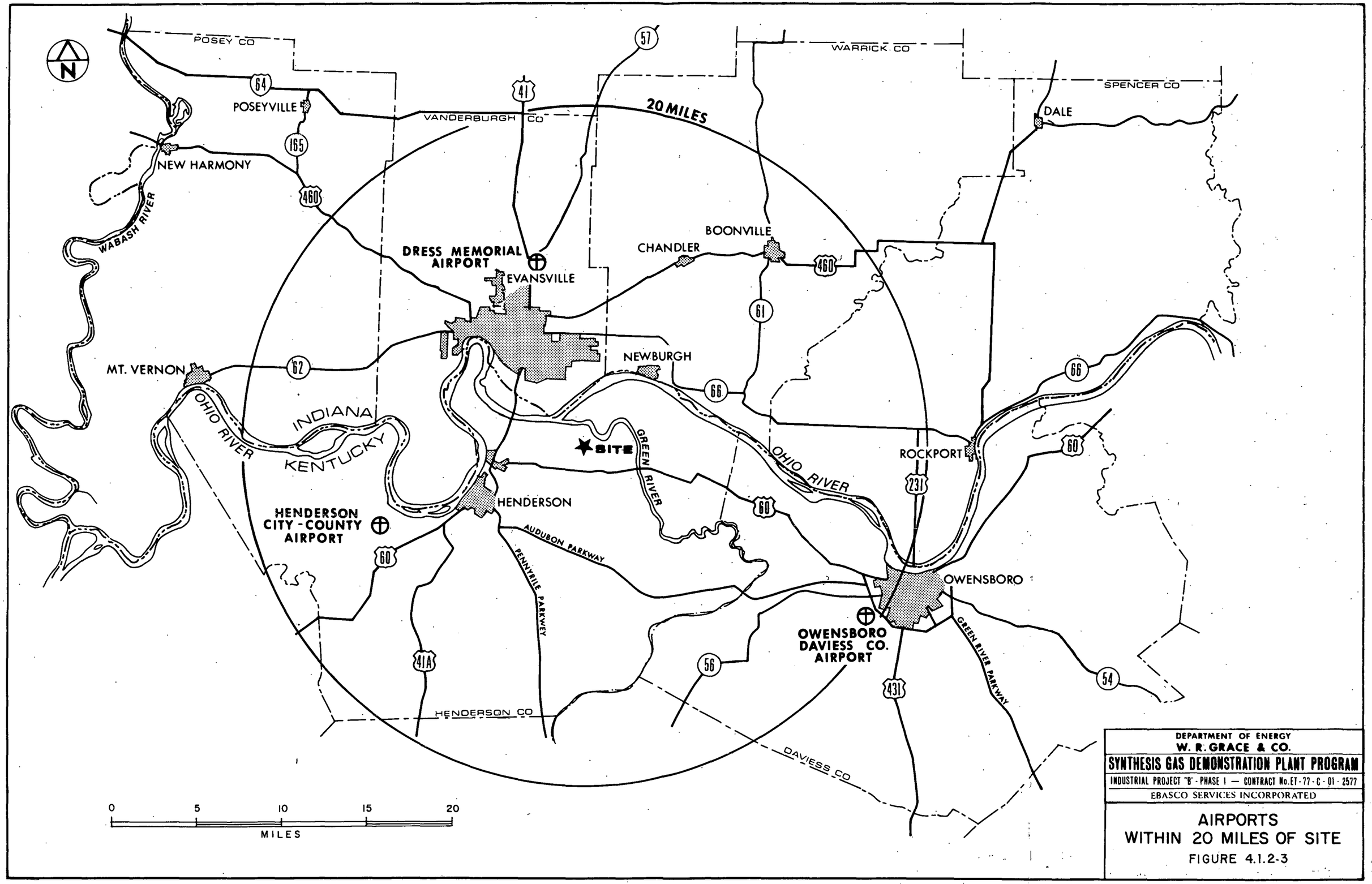
MAJOR RECREATION AREAS WITHIN 20 MILES OF SITE

FIGURE 4.1.2-2



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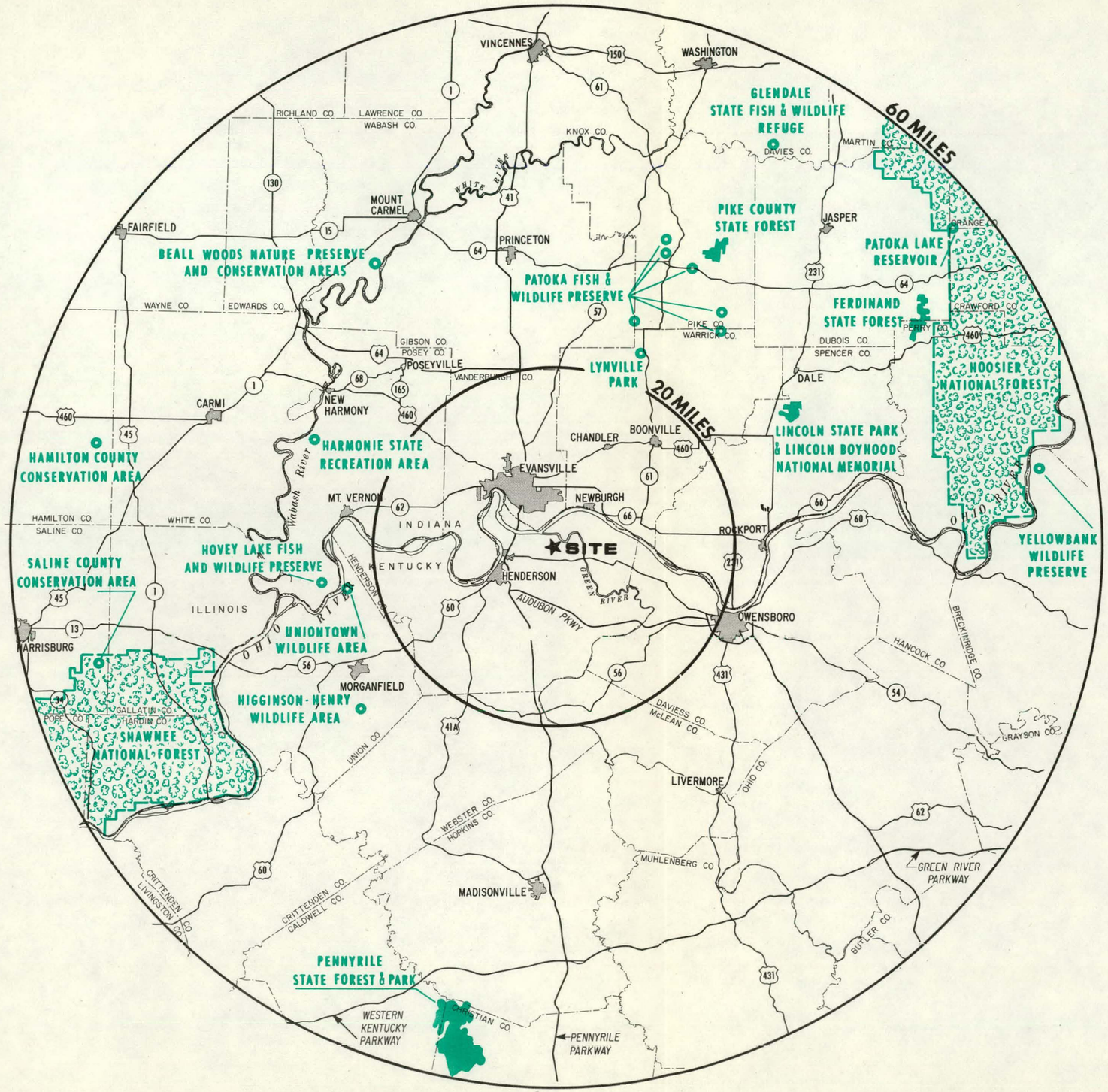
AIRPORTS
WITHIN 20 MILES OF SITE
FIGURE 4.1.2-3



NOTE:
RECREATION AREAS WITHIN 20 MILES ARE SHOWN ON FIG. 4.1.2-2

N

0 10 20 30 40
MILES

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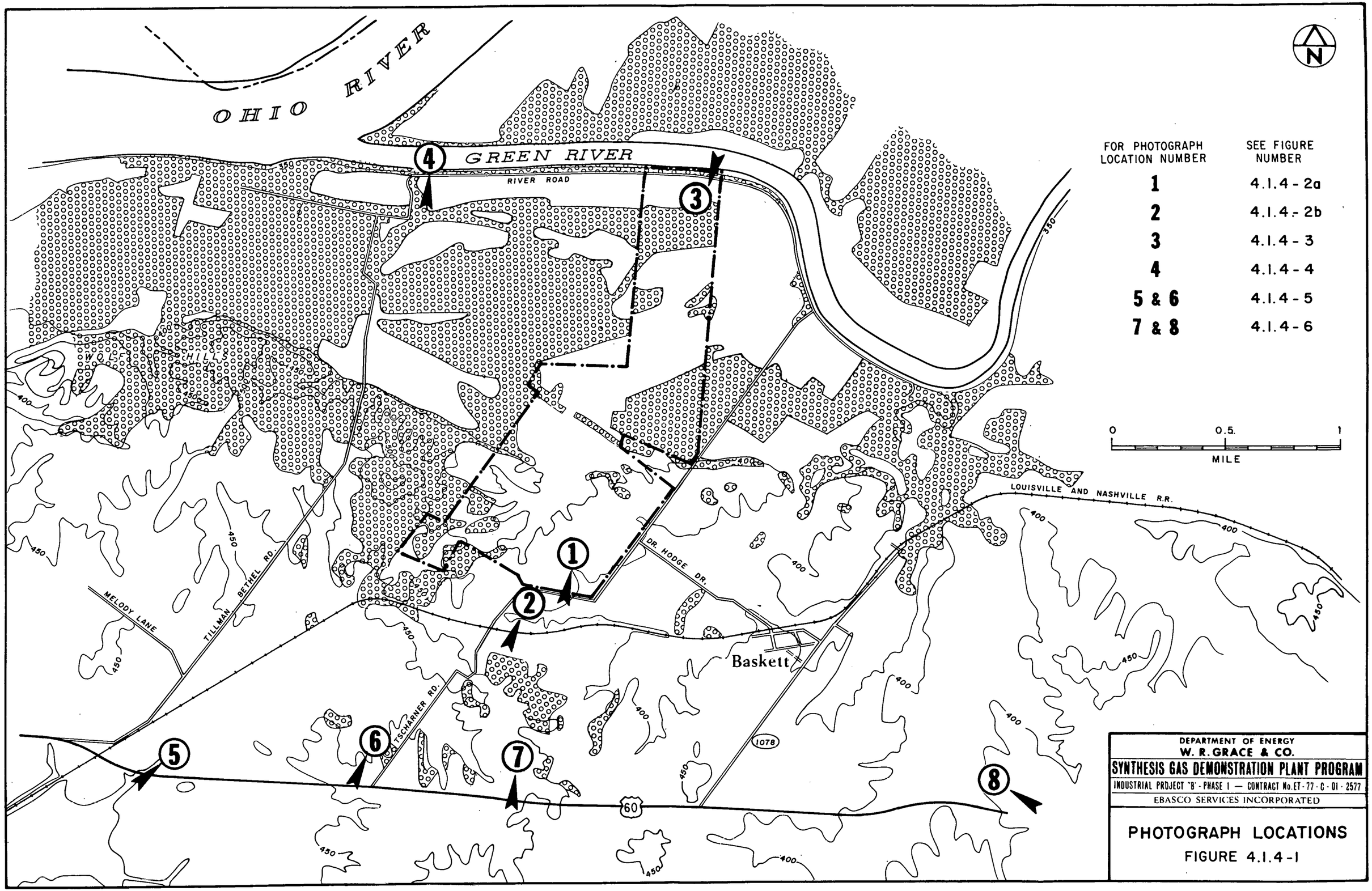
MAJOR FEATURES WITHIN 60 MILE RADIUS STUDY AREA
FIGURE 4.1.3-1


OHIO RIVER
GREEN RIVER
RIVER ROAD
WOLF CREEK HILLS
MELODY LANE
TILLMAN BETHEL RD.
TSCHARNER RD.
DR. HODGE DR.
LOUISVILLE AND NASHVILLE R.R.
Baskett
1078
60
1
2
3
4
5
6
7
8
N
FOR PHOTOGRAPH LOCATION NUMBER
SEE FIGURE NUMBER
1 4.1.4-2a
2 4.1.4-2b
3 4.1.4-3
4 4.1.4-4
5 & 6 4.1.4-5
7 & 8 4.1.4-6
0 0.5 1
MILE
DEPARTMENT OF ENERGY
W. R. GRACE & CO.
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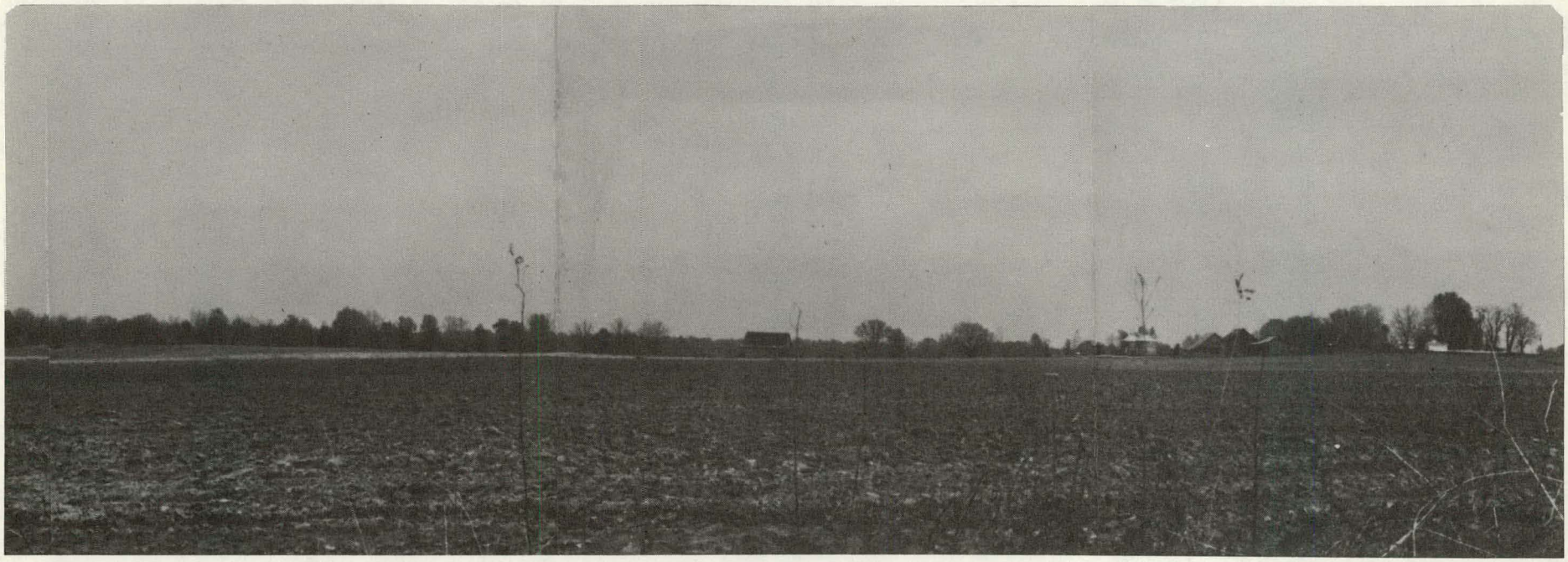
INDUSTRIAL PROJECT "B" - PHASE 1 — CONTRACT No. ET-77-C-01-2577
EBASCO SERVICES INCORPORATED
PHOTOGRAPH LOCATIONS
FIGURE 4.1.4-1



PANORAMIC VIEW OF SITE UPLAND AREA

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INDUSTRIAL PROJECT "B" - PHASE 1 — CONTRACT No. ET-77-C-01-2577
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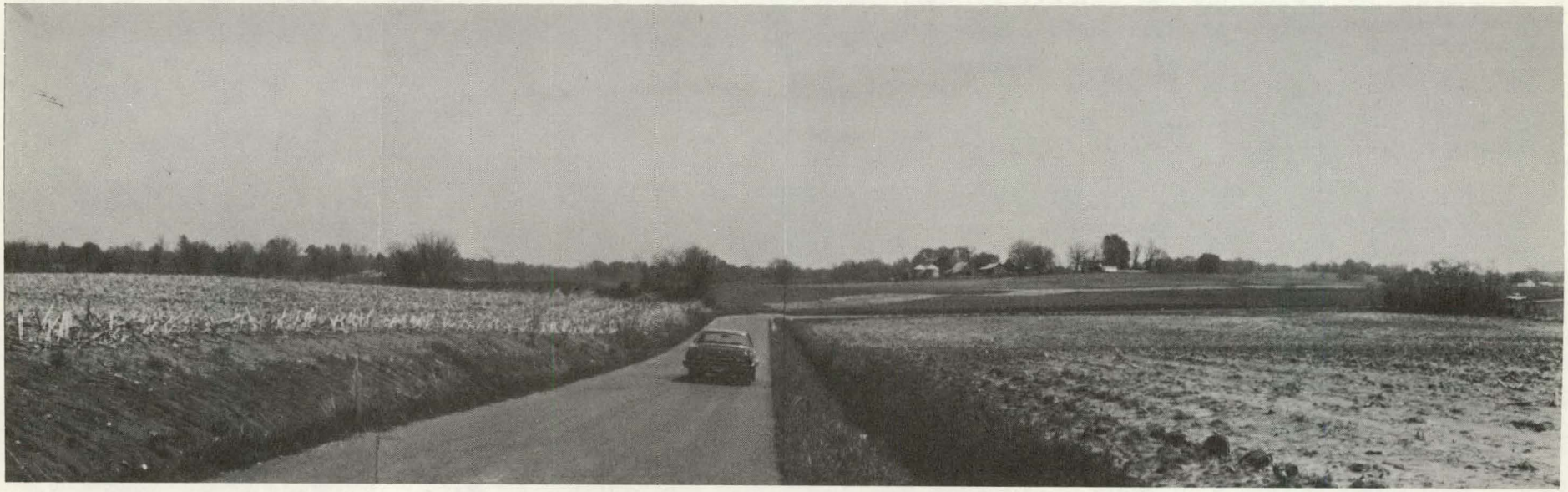
SITE AREA PHOTOGRAPHS

FIGURE 4.1.4-2a



PANORAMIC VIEW OF SITE UPLAND AREA

DEPARTMENT OF ENERGY
W. R. GRACE & CO.
SYNTHESIS GAS DEMONSTRATION PLANT PROGRAM
INDUSTRIAL PROJECT "B" - PHASE 1 — CONTRACT No. ET-77-C-01-2577
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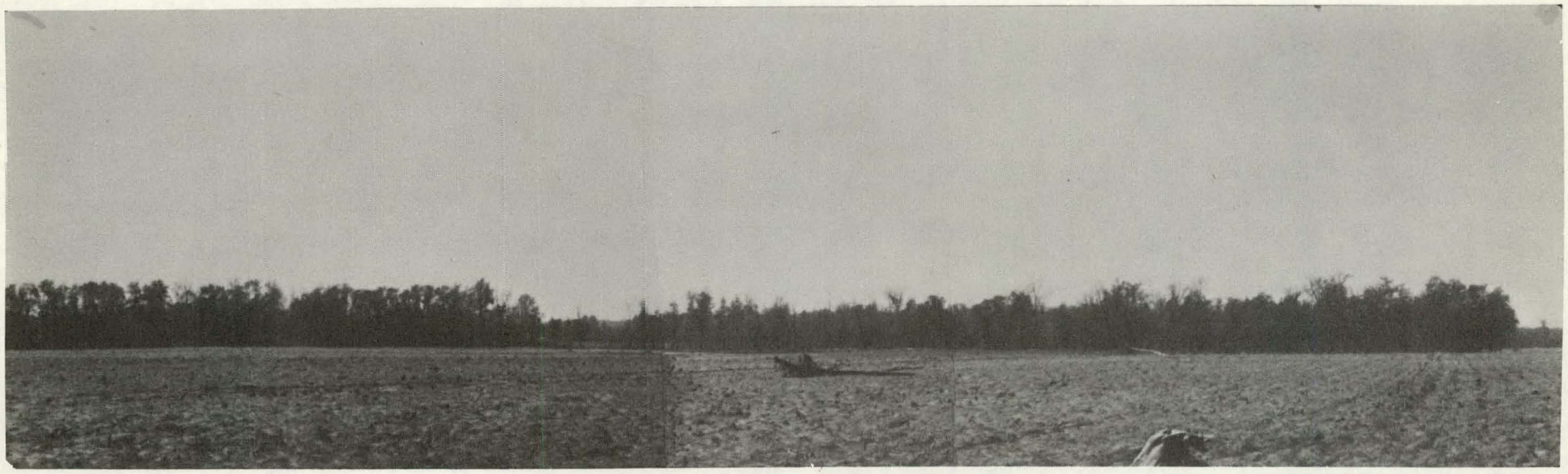
SITE AREA PHOTOGRAPHS

FIGURE 4.1.4-2 b

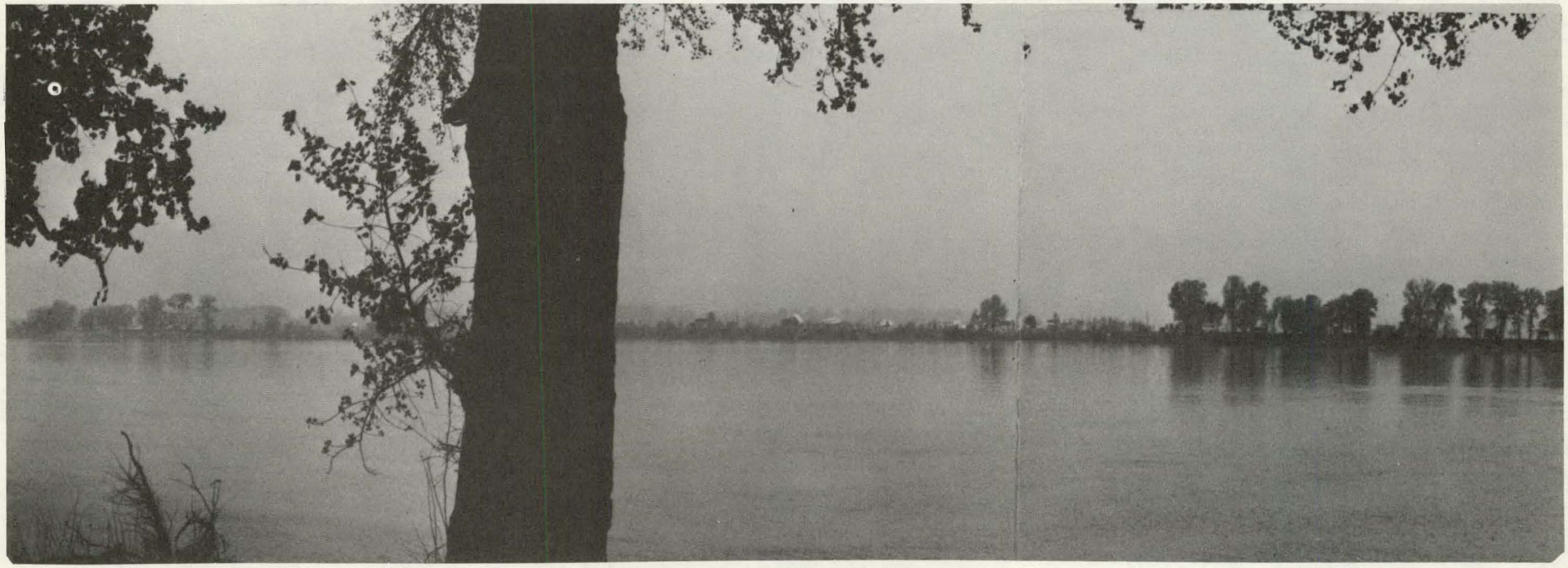


PANORAMIC VIEW OF BOTTOMLAND
LOOKING SOUTH ALONG EASTERN SITE PROPERTY LINE

DEPARTMENT OF ENERGY
W. R. GRACE & CO.
SYNTHESIS GAS DEMONSTRATION PLANT PROGRAM
INDUSTRIAL PROJECT "B" - PHASE 1 — CONTRACT No. ET-77-C-01-2577
EBASCO SERVICES INCORPORATED

SITE AREA PHOTOGRAPHS

FIGURE 4.1.4-3



VIEW NORTH FROM GREEN RIVER RD.
LOOKING ACROSS THE OHIO RIVER

DEPARTMENT OF ENERGY
W. R. GRACE & CO.

SYNTHESIS GAS DEMONSTRATION PLANT PROGRAM

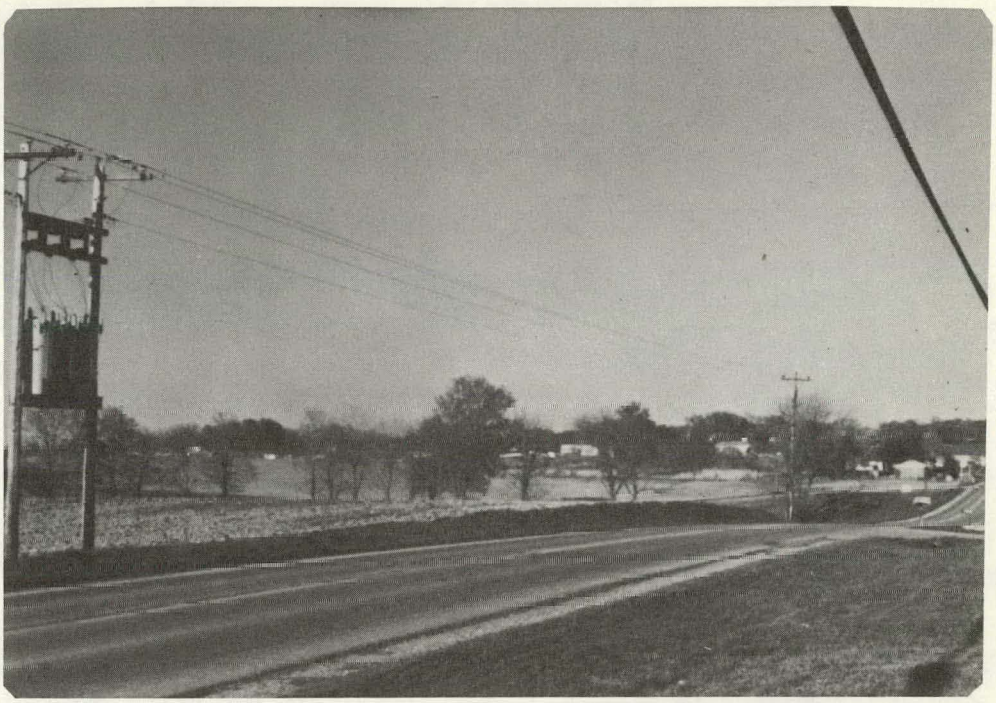
INDUSTRIAL PROJECT "B" - PHASE 1 — CONTRACT No. ET-77-C-01-2577

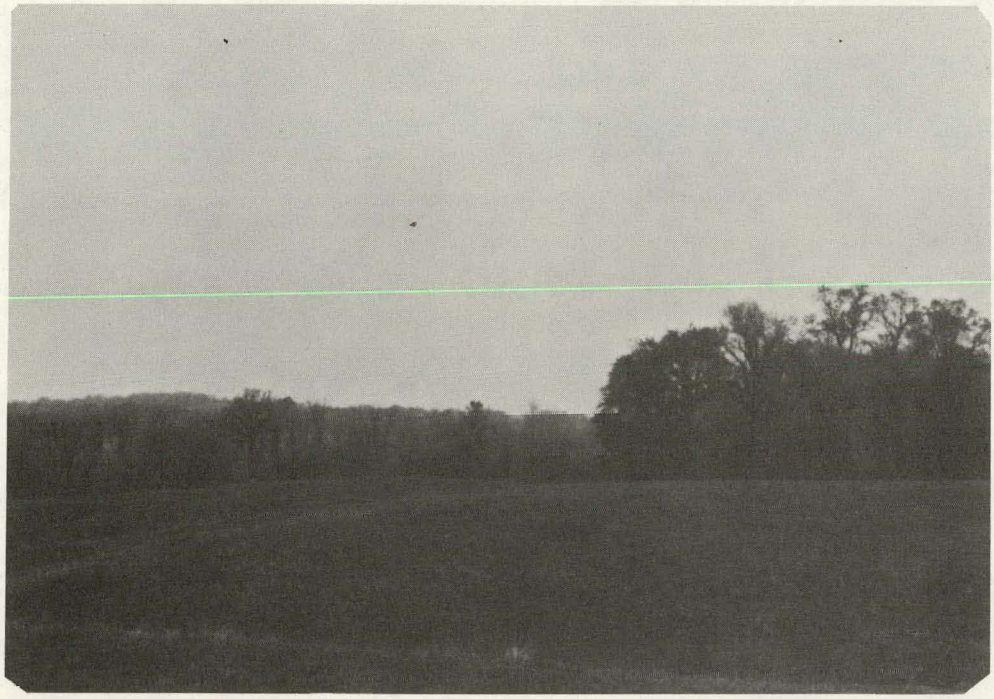
EBASCO SERVICES INCORPORATED

SITE AREA PHOTOGRAPHS

FIGURE 4.1.4-4

VIEW NORTHEAST FROM ROUTE 60 LOOKING TOWARD THE SITE





VIEW NORTH FROM ROUTE 60 - AT THE CORNER OF TSCHARNER ROAD

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W. R. GRACE & CO.
SYNTHESIS GAS DEMONSTRATION PLANT PROGRAM
INDUSTRIAL PROJECT "B" - PHASE 1 — CONTRACT No. ET-77-C-01-2577
EBASCO SERVICES INCORPORATED

SITE AREA PHOTOGRAPHS

FIGURE 4.1.4-5

VIEW NORTH FROM ROUTE 60 AT THE ENTRANCE TO THE HENDERSON COUNTY GOLF AND COUNTRY CLUB

VIEW LOOKING WEST (TOWARD SITE) FROM SMALL SUBDIVISION APPROX. 2 MILES FROM THE SITE

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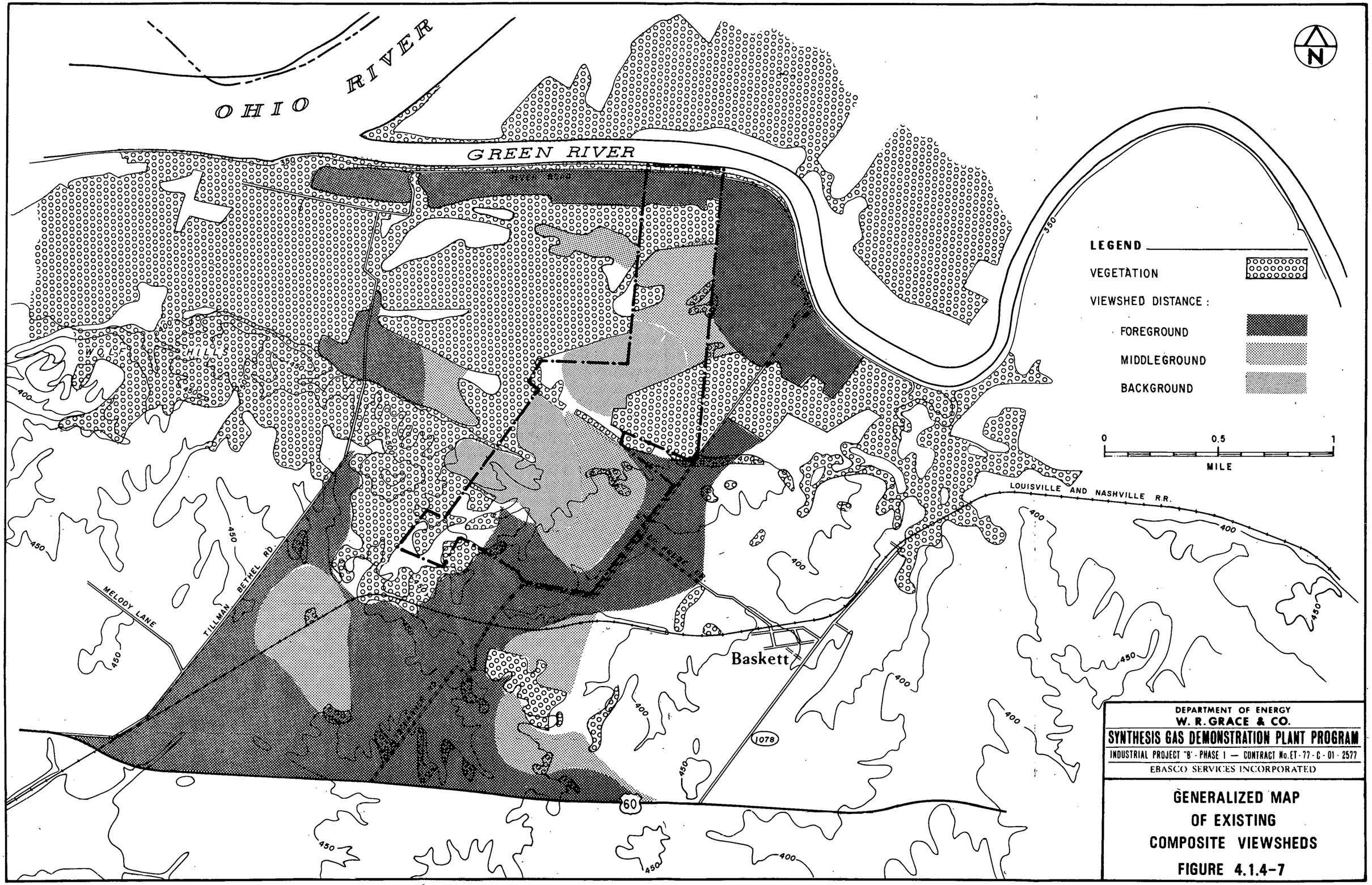
EBASCO SERVICES INCORPORATED

SITE AREA PHOTOGRAPHS

FIGURE 4.1.4-6


OHIO RIVER
GREEN RIVER
RIVER ROAD
LEGEND
VEGETATION
VIEWSHED DISTANCE :
FOREGROUND
MIDDLEGROUND
BACKGROUND
0
0.5
1
MILE
LOUISVILLE AND NASHVILLE R.R.
MELODY LANE
TILLMAN BETHEL RD
Baskett
1078
60
350
400
450
DEPARTMENT OF ENERGY
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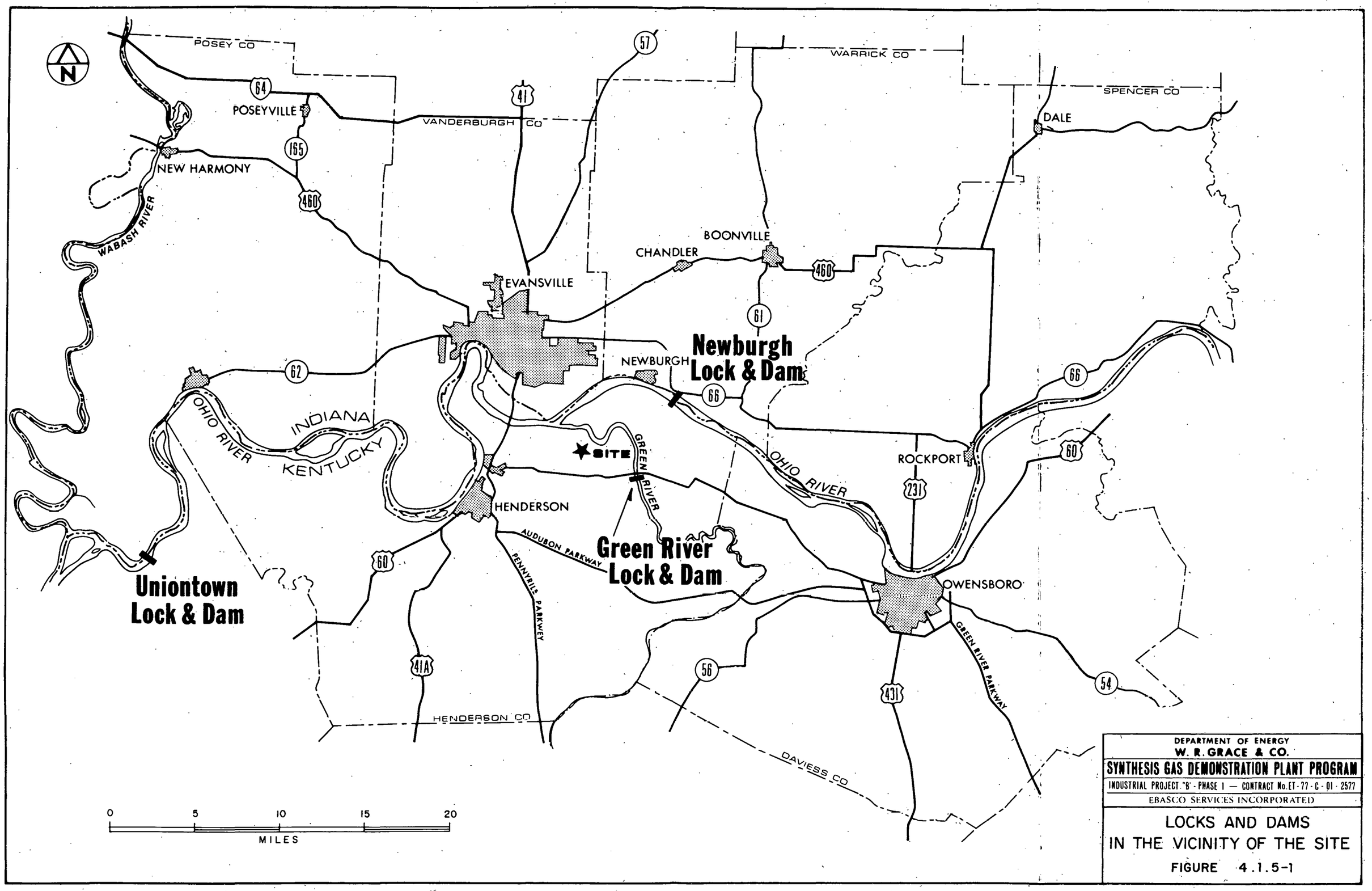
EBASCO SERVICES INCORPORATED
GENERALIZED MAP
OF EXISTING
COMPOSITE VIEWSHEDS
FIGURE 4.1.4-7


N
POSEY CO
WARRICK CO
SPENCER CO
VANDERBURGH CO
HENDERSON CO
DAVIESS CO
POSEYVILLE
NEW HARMONY
WABASH RIVER
EVANSVILLE
CHANDLER
BOONVILLE
DALE
NEWBURGH
Newburgh Lock & Dam
OHIO RIVER
INDIANA
KENTUCKY
SITE
GREEN RIVER
ROCKPORT
HENDERSON
AUDUBON PARKWAY
PENNYRILE PARKWAY
Green River Lock & Dam
OWENSBORO
GREEN RIVER PARKWAY
Uniontown Lock & Dam
64
165
460
41
57
61
62
66
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231
41A
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20
MILES
DEPARTMENT OF ENERGY
W. R. GRACE & CO.
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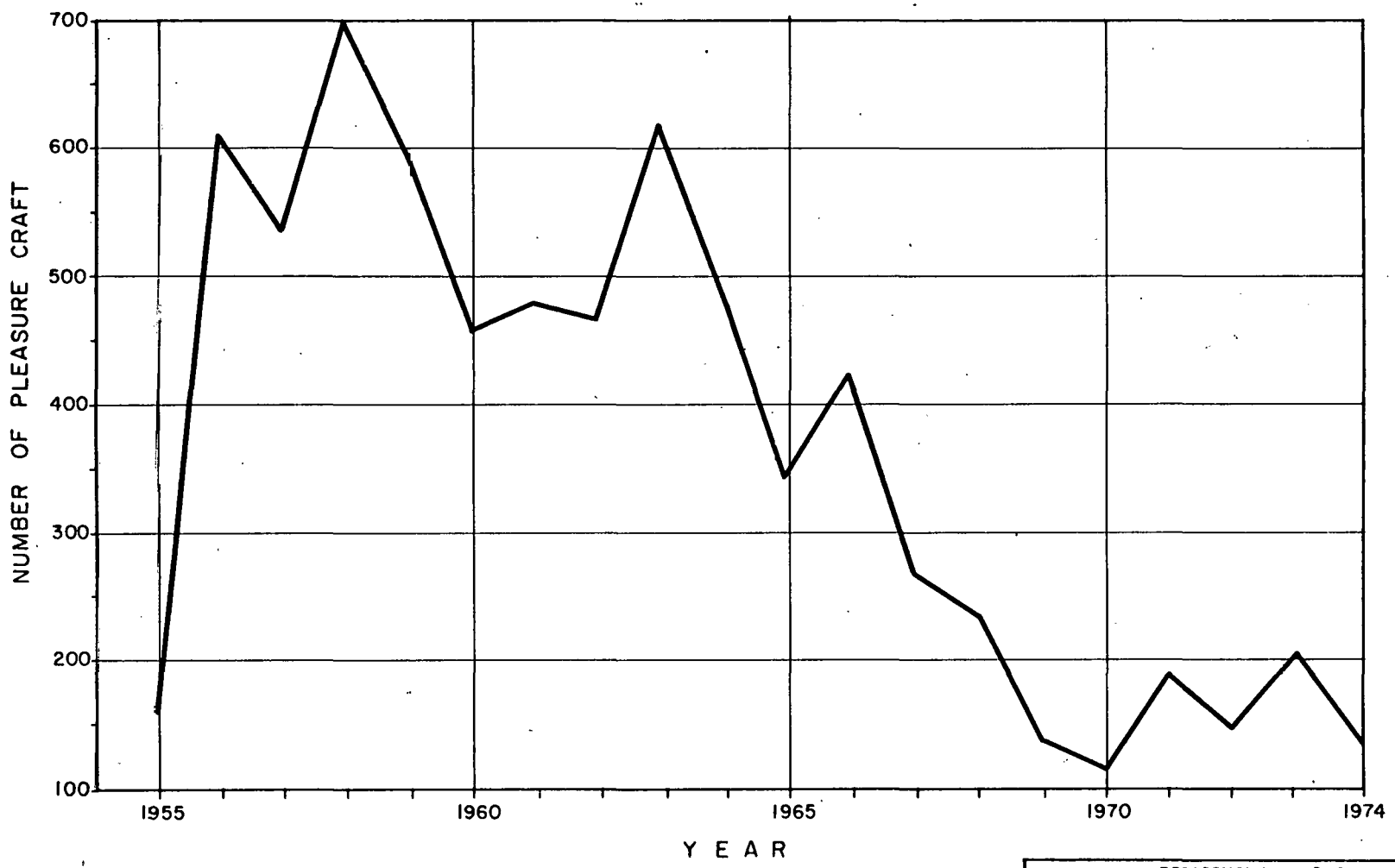
LOCKS AND DAMS
IN THE VICINITY OF THE SITE
FIGURE 4.1.5-1



Source: U.S. Army Corps of Engineers (8)

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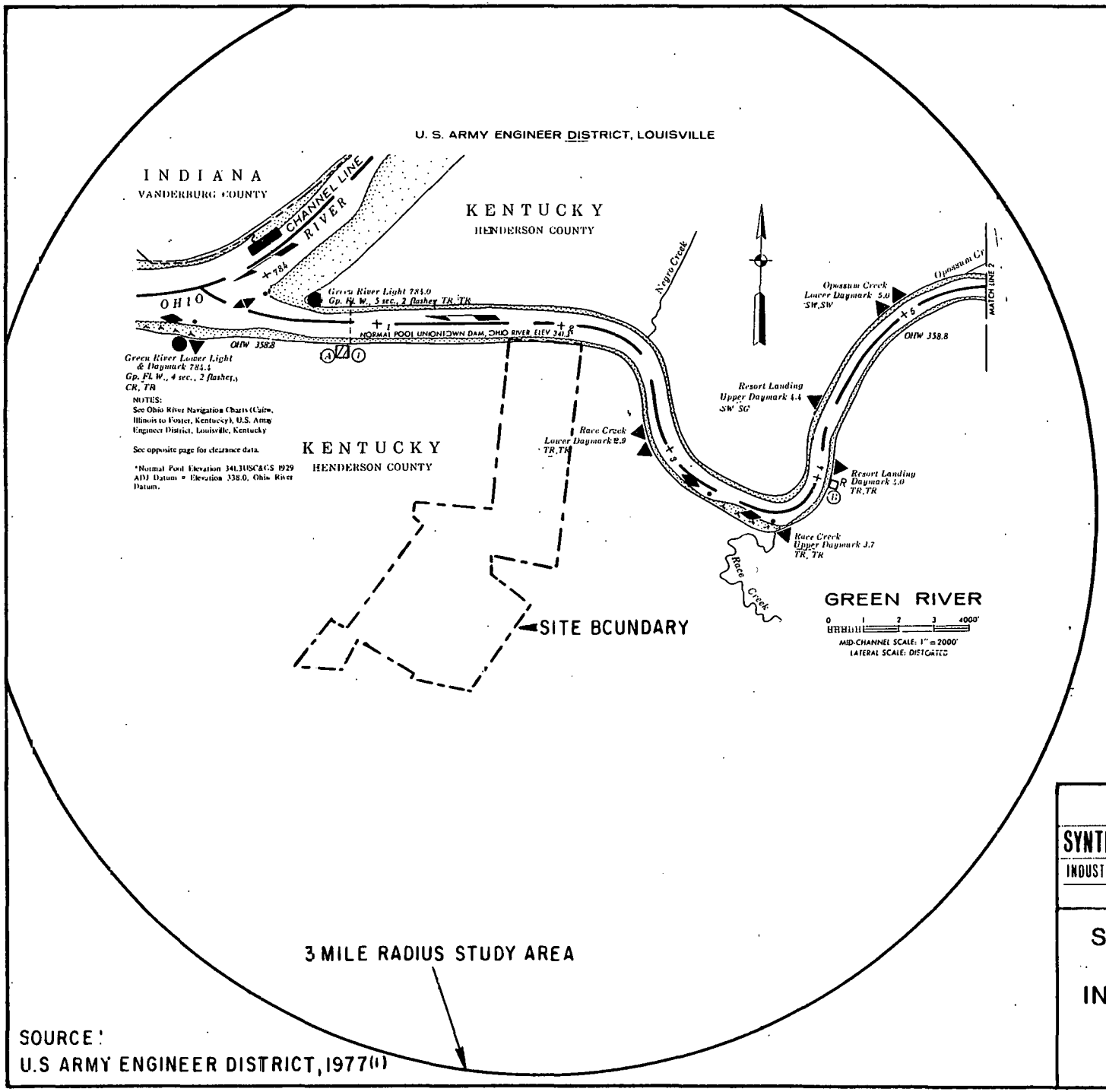
NUMBER OF PLEASURE CRAFT
LOCKING THROUGH
GREEN RIVER LOCK NO. I

FIGURE 4.1.5-2



SOURCE:
U.S ARMY ENGINEER DISTRICT, 1977(1)

LEGEND

- U.S. Light
- Daymark
- Permanent Buoys:
  - Can
  - Nun
- Gage
- Distorted Normal Pool Line
- Bars, with less than project 9' depth at pool stage:
- Aerial Crossing:
  - Power and Telephone
- Rock
- Sand
- Dock
- Intake
- Aids to Navigation Piers
- Submarine Crossing
- Mooring Facilities
- Recreational Facilities
  - Launching ramp
- Ordinary High Water Elevation — OHW 000

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EBASCO SERVICES INCORPORATED

SURFACE WATER USAGE
IN THE PLANT SITE AREA

FIGURE 4.1.6-1

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4.2 ECOLOGY

4.2.1 AQUATIC ECOLOGY

4.2.1.1 Existing Ecology

4.2.1.1.1 Regional

The Green River Basin is located in west-central Kentucky and north-central Tennessee. It comprises a total drainage area of 23,903 km^2 (9,229 mi^2) of which 22,846 km^2 (8,821 mi^2) are in Kentucky. This watershed, the largest river basin in Kentucky, is the second largest southern tributary of the Ohio River[1]. The topography varies from the rugged hilly terrain in the eastern section of the basin, bordering the southern part of the Bluegrass Region, to the karst topography, deep valleys and cavern areas of the central section. The western and northern sectors are predominantly swampy, wide alluvial floodplains of the Ohio River[2].

The Green River originates in Lincoln and Casey Counties in Kentucky and flows 531 km (330 mi) in a northwesterly direction to its confluence with the Ohio River near Evansville, Indiana. The principal tributaries are the Barren, Nolin, Rough, Mud and Pond Rivers[3]. During periods of normal flow the Green River varies in width from less than 1 m, in the upstream areas, to 120 to 150 m near its confluence. The 1970 through 1976 mean and minimum mean discharges measured at Lock and Dam No. 2, Calhoun, Kentucky (River Mile 63.1) were 13,057 and 1,105 cfs respectively[4]. Minimum 1975 flows occurred in August (742 cfs). Flows are regulated by upstream reservoirs on the Barren, Nolin, Rough and Green Rivers[5]. During high flows storm runoff and/or backwater from the Ohio River produce frequent flooding in the lower reaches of the Green. During dry weather the flow is sustained by groundwater discharge[2].

The mean and minimum monthly recorded Green River water temperatures from 1967 to 1976 measured at Lock and Dam No. 2, are listed in Table 5.2.1-1. Table 4.4.1-2 lists pertinent water quality parameters measured at Lock and Dam No. 1, Spottsville, Kentucky (River Mile 9.0).

The Army Corps of Engineers exercises jurisdiction over 729 km (453 mi) of the Green River and its tributaries for the purpose of protecting and preserving navigational waters. This river is extensively used for bulk coal transport and the Corps maintain a 2.7 m (9 ft) channel depth to River Mile 103 by periodic dredging. It also maintains and operates three locks and dams, at Spottsville, Calhoun and Rochester. These dams during low flows, in effect, form lentic environments in the waters above them.

Pollution sources in the Green River Basin are (i) municipal and domestic sewage effluents, (ii) public waste disposal, (iii) industrial discharges, (iv) coal mining activities, (v) agricultural and (vi) oil pollution[3]. These diverse sources of pollution do not simultaneously occur in each area of the Green River Basin, consequently aquatic habitats differ somewhat in quality as one progresses from the headwaters to the confluence. The aquatic habitats can be differentiated into three distinct types: erosional, depositional and intermediate. This partitioning is based primarily upon sediment load and the degree of turbidity within the water column.

The eastern part of the basin is characterized by the erosional habitats. These occur in cold or cool streams with rapid flows with corresponding removal of fine sediments. Below Lock and Dam No. 3 (River Mile 108.5), the habitat is primarily depositional. This area is characterized by slow currents and sediment deposition. This type of habitat also occurs near the mouths of the tributaries where the gradient is low and the floodplain is broad. The intermediate area has both erosional and depositional features, but is usually characterized by sand and gravel substrate[3].

Aquatic biota of the Green River Basin can be described in general terms given the above-mentioned community partitioning factors. More specific discussion is limited by the scarcity of published information available on the Green River; site-specific data collected by Ebasco/Envirosphere are discussed in Section 4.2.1.1.2.

The Green River below Lock and Dam No. 3 is extensively used by barges for the transport of coal. The littoral zones in this area are almost entirely devoid of aquatic macrophytes, probably a result of large amounts of sediment runoff and turbulance due to barge traffic[3]. The high turbidity precludes photosynthesis from occurring much below the first few centimeters and also prevents benthic macroinvertebrate colonization due to constant resuspension and deposition of sediments. This habitat does not support a diverse aquatic community and is characterized by planktonic invertebrates which are pollution tolerant and by opportunistic and/or pollution tolerant fish species from the Ohio River or from the more productive areas of the eastern basin.

The Green River above Lock and Dam No. 3 supports a more diverse and stable macrophyte community[3]. The lower sediment load and the absence of barge traffic is conducive to littoral colonization. This in turn provides breeding areas for many fish and protection for their young. Greater photosynthetic activity supports a varied invertebrate community from which the fish derive their food source.

The Green River, as a whole, supports an extremely diverse phytoplankton community, although from Lock and Dam No. 3 to the mouth of the Green River the plankton exhibit low diversity and are dominated by pollution tolerant forms[3][6]. Green algae (Chlorophyta) were the organisms most commonly reported by the Army Corps of Engineers[3]. Diatoms dominated samples taken at the Reid Power Plant (River Mile 41.2)[7] and Green River Power Station (River Mile 82.3)[8]. The dominance of heterotrophic periphyton observed at the Paradise Steam Plant (River Mile 99.6) was due to elevated temperatures and increased turbidity[9].

Inadequate documentation exists to describe the zooplankton community of the Green River. A description of common zooplankters, with notes on their occurrence in Kentucky, is given by Cole[10][11]. Information available is essentially limited to a discussion of patterns of dominance among rotifers, cladocerans, copepods and ciliated protozoans[7][8].

The Green River, in places, supports a rich and varied benthic macroinvertebrate population. But, this seems only to be true of areas above Lock and Dam No. 3[3]. The dominant benthic organisms found in the vicinity of the Green River Power Station were earthworms, Asiatic clams (Corbicula

spp), phantom midge larvae and midge larvae. With the exception of the Asiatic clams, these taxa are regarded as pollution tolerant[8]. At the Reid Power Plant only a few species of bivalves and olegocheates were collected[7]. The Green River has one of the most diverse mussel communities of any stream in the United States[12]. A total of 64 mussel species have been recorded from the Green River[3]. Williams[13] found poor mussel colonization in impounded areas of the Locks and Dams but good growth below all but one dam. Although once very abundant, the mussel populations of the Green River have undergone dramatic reductions over the last 15 years due to pollution and over-harvesting.

As many as 145 species of fish may occur in the Green River Basin[3]. In one study, 107 of the 177 species known to occur in Kentucky were identified from the Green River[2]. Each habitat, erosional, depositional and intermediate, is associated with a fish community which is fairly specific. Small mouth bass (Micropeterus dolomieui), walleye (Stizostedion vitreum vitreum), and white sucker (Catostomus commersoni) are species associated with erosional habitats. In the depositional habitats largemouth bass (Micropterus salmoides), catfish (Ictalurus spp), shiners (Notropis spp) and many species of rough fish are found together. The intermediate zone is less defined by species associations and is usually a transitional habitat between erosional and dispositional areas[3]. The gizzard shad (Dorosoma cepedianum) and the threadfin shad (Dorosoma petenense) were the two most abundant fish species impinged at the Paradise and Green River Power Stations[14]. Fish collection studies on the Ohio River between River Mile 700-800 (confluence of Green River is at River Mile 784) showed the gizzard shad to be the numerically dominant species followed in order by the freshwater drum (Aplodinotus grunniens), emerald shiner (Notropis atherinoides), channel catfish (I. punctatus) and threadfin shad. In the Ohio River the two numerically most abundant fish were also the most abundant by weight[15].

Principal game and pan fish in the streams, lakes and ponds of the Green River Basin are largemouth bass, smallmouth bass, rock bass (Ambloplites rupestris), Kentucky bass (Micropterus punctualatus), white bass (Morone chrysops), crappie (Pomoxis spp), walleye, muskellunge (Esox masquinongy), bluegill (Lepomis macrochirus) and channel catfish. Rough fish are the primary commercially harvested fish. Various species of catfish, buffalo (Ictiobus spp), carp (Cyprinus spp), and drum comprise a substantial portion of the catch[1].

4.2.1.1.2 Site

Aquatic biological samples were collected from: the Green River adjacent to and up river from the site; four on-site farm ponds; an on-site intermittent stream and the Cypress Slough (Figures 4A.2.1-1, 2 and 3). Two major sampling areas in the Green River were defined and each area was further sub-divided into three zones according to depth (Figure 4A.2.-1 and 2). The zone designations separated the channel area from the shore areas. Since the bottom contours showed a U-shaped channel, sampling in the shore zones was as close as possible to the shore line. Sampling was done seasonally except when weather and/or shore obstructions interfered (see Section 4.4.1.1). An attempt was made to sample all trophic levels representatively.

Four tributary stream stations were also established (Figure 4A.2.1-3). The tributary drains a major portion of the site and empties into Cypress Slough. It is intermittent, and during the summer it dries up. Flows are restored only after heavy rainfall. The stream bed has been channelized throughout much of its length. Water depth rarely exceeds a few inches (Section 4.4.1.1.3).

Four of the five on-site farm ponds (Figure 4A.2.1-3) were sampled during the 1978 and 1979 spring quarters. Pond 1 is located in the south western portion of the site and is approximately 0.2 ha (0.5 acre) in size with a mid-pond depth of about 1m (3 ft). The shoreline consists of dense vegetation. Ponds 2a, 2b and 3 located near the Williams residence and barns are approximately 0.1 ha (0.25 acre), 0.1 ha (0.25 acre) and 0.2 ha (0.5 acres) in size respectively. These ponds have little shoreline vegetation other than grasses and have a maximum depth of 2.1m (7 ft). Their primary use is for farm irrigation (Section 4.4.1.1.5).

Two locations within the Cypress Slough, one on-site (at the eastern end of the Slough) and the other about 300m (984 ft) west of the porposed site, were were selected for biological sampling (Figure 4A.2.1-3). The first (western end) location was a randomly selected sampling point within a 3.5 ha (8.6 acres) standing body water which ranged in depth from 1 to 1.7m (3 to 5 ft.). The second location, about 25m (82 ft) from the stream entry point into the Cypress Slough, was in a heavily vegetated area which had only a few inches of water immediately after the spring floods. During the summer this area completely dries up. (Section 4.4.1.1.4).

4.2.1.1.2.1 Phytoplankton

Phytoplankton are microscopic photosynthetic plants which float or passively move with the water currents[16]. River phytoplankton are largely represented by forms which are displaced into the river from shoal and/or backwater areas and those forms which are normally benthic in nature and are dislodged into the water colum by water turbulence and/or scour[17].

Phytoplankton are important in many aquatic systems since they may be the dominant primary producers, forming organic carbon through the photosynthetic process. They comprise the base of many food chains and the presence of certain forms may indicate the general well-being of the immediate or upriver environment[18].

4.2.1.1.2.1.1 Green River

Phytoplankton were collected during the four 1978-1979 sampling quarters from zones 1, 2, 3 and 5 (Figures 4A.2.1 and 2) (Appendix 4A.2.2; field collection and laboratory analysis techniques).

A total of 72 phytoplankton forms were identified. They represented seven major algal groups: Cyanophyta (blue-green), Chlorophyta (green), Euglenophyta (euglenoids), Chrysophyta (golden-yellow), bacillariophyceae (diatoms), Cryptophyta (cryptophytes), and Cyanobacterium. The cyanobacterium were photosynthetic, filimentous rod shaped bacteria.

During the 1978 spring quarter (26 May) 41 phytoplankton forms were identified (Table 4.2.1-1). Diatoms were the most abundant group with a mean density for all stations of 190,625 cells/l (Table 4.2.1-2) representing 26 forms. Diatoms accounted for more than 42 percent of the total number of organisms found (Figure 4.2.1-1). The most abundant diatoms were Melosira italica, Nitzschia spp, Synedra radians and S. rumpens (Appendix Tables 4B.2-1). The next most abundant group was cyanobacterium (110,000 cells/l and 24.4 percent of the total), while the green algae showed second highest number of forms (9). The cryptophytes were the third most abundant group with Cryptomonas spp the only form identified. The blue-green algae were observed in low densities. The 1978 spring quarter was the only sampling period in which representatives of all seven major groups appeared.

The mean phytoplankton density during 1978 summer quarter (11 July) showed a decrease of more than 75 percent of that observed during the preceeding quarter (Table 4.2.1-2). The mean total phytoplankton density during the summer sampling period was 106,845 cells/l, representing 29 forms (Table 4.2.1-1, 2). All major groups were represented except Chrysophyta, Cryto-phyta and cyanobacterium. Diatoms were dominant (62,500 cells/l), however their abundance was 75 percent less than that measured during spring. Diatoms accounted for 62 percent of the total number of organisms enumerated (Figure 4.2.1-1) and were represented by 16 forms (Table 4.2.1-1). The most abundant diatoms were Melosira granulata, M. italica and Synedra rumpens (Appendix Tables 4B.2-1). Melosira is a true planktonic form usually dominant in relatively calm conditions[19]. The second most abundant group was the blue-green algae (22,500 cells/l). The mean summer blue-green abundance was twice that observed in spring. Merismopedia spp was the dominant blue-green alga. Decrease in diatoms and increase in blue-greens from the spring to the summer, follows the classical successional patterns observed in riverine plankton communities[17].

The fall sampling quarter (12 September) showed a mean total phytoplankton density of 160,625 cells/l representing 37 forms (Tables 4.1.2-1 and 2). Diatoms were dominant (106,875 cells/l), represented by 23 forms and accounted for more than 66 percent of the total (Figure 4.2.1-1). Melosira granulata, M. italica and Synedra rumpens were dominant (Appendix Tables 4B.2-1). Green algae were second in mean abundance (29,375 cells/l) while the crytophytes, which were absent in summer, were third in total mean density (14,375 cells/l). Nine green algal forms were represented; Ankistrodesmus spiralis (a green alga) appeared in all samples, while Cryptomonas spp was the only cryptophyte found. The blue-green algae showed a four-fold decrease below mean summer densities.

The lowest mean total phytoplankton density (23,664 cells/l) was observed during the winter sampling (22 January) (Table 4.1.1-2). Thirty-three forms were identified including representatives of all major groups except Chrysophytes (Table 4.1.1-1). Diatoms dominated (15,776 cells/l) and were represented by 25 forms. Melosira was the most abundant genus, but no single taxa was clearly dominant at all zones (Appendix Tables 4B.2-1). Cyanobacterium comprised the second most abundant group (2,711 cells/l).

In summary, a normal successional pattern in phytoplankton abundances was observed; relatively high densities occurred during the spring and fall, and relatively low abundances occurred during summer and winter. Diatoms were the dominant group in all quarters. Hynes[19] indicates that diatoms are almost always the dominant phytoplankton group in riverine systems. The phytoplankton densities observed in the present study (Table 4.1.1-2) are within the normal range of 1×10^4 to 101×10^6 cells/l commonly seen in rivers of the United States[20].

Both types of river phytoplankton were observed; true plankton (e.g., Melosira, Cyclotella, Asterionella) and plankton derived from normally benthic genera (e.g., Nitzchia, Navicula and Diatoma). The planktonic forms were generally more evident during summer, while benthic forms appeared more often in the spring. No filamentous attached green algae were found during any of the sampling periods. During all sampling dates both secchi disc and photometric readings indicated poor light transmittance. This is caused primarily by the high sediment load in the river. These sediment particles also scour the river channel and banks.

The combination of poor light penetration and high scour, and a lack of good colonizable substrates, suggests that benthic algae are limited in the vicinity of the site. Many of the planktonic and benthic forms found in the study probably enter the Green River from upstream areas and backwaters, and thus may be considered allochthonous.

Certain algae identified during this study can be used as environmental indicators or organic pollution (e.g., Euglena spp, Ankistrodesmus falcatus and Scenedesmus quadricauda)[18]. Generally, these taxa appeared during summer when the water temperature was high and river height was near pool. Other forms are known to produce odors (e.g., Aphanizonmenon flos-aquae and Syndera ulna), however their abundances were below densities which should produce noticeable smells[18].

Generally the types of species identified, the major genera and the successional patterns observed in the present study parallel other studies performed in the Green River Basin[8]. The Army Corps of Engineers[3] in their Green River study, found the green algae to be the most abundant group with diatoms second. This is in contrast to the present study but it is not surprising since changes in algal community structure from year to year are often observed in aquatic ecosystems[17][19].

4.2.1.1.2.1.2 Ponds

Three on-site farm ponds (Figure 4A.2.1-3) were sampled during the 1978 spring quarter (24 May). The data derived from inshore and mid-pool areas for each pond were averaged, and descriptions and comparisons among ponds were based on these averages. (Appendix 4A.2.2; field collection and laboratory analysis techniques).

A total of 47 forms were identified from the ponds, representing basically the Chlorophyta (green algae) and the bacillariophyceae (diatoms) (Table 4.2.1-3). These groups had 21 and 17 forms, respectively. Other major groups identified were Chrysophyta (golden-yellow algae) Cryptophyta

(cryptophytes), Cyanophyta (blue-green algae) Euglenophyta (euglinoids), Pyrrophyta (dinoflagellates) and Xanthyophyta (yellow-green algae).

Pond 1 had the greatest number of forms (26) and the greatest total number of individuals (3,879 cells/ml) (Tables 4.2.1-3 and 4). Total phytoplankton density in pond 1 was 1.5 and 3.0 times the densities observed in ponds 2b and 3 respectively (Table 4.2.1-4). Pond 1 was dominated by the Chlorophyta with Pediastrum tetras var. tetradon the most abundant form (Appendix Tables 4B.2-2). The Crysophyta was represented by only two species Dynobryon bavaricum and D. divergens, however when combined represented the second most abundant group. Hutchinson[21] states that these two forms commonly occur together and are indicators of oligotrophic waters. Dynobryon was not identified from either pond 2b or 3 and may indicate more eutrified conditions in those ponds. Pond 1 also showed the largest diatom densities of the three ponds (Table 4.2.1-4).

Pond 2b was intermediate in both the number of forms and in total abundance (2,583 cells/ml) (Tables 4.2.1-3 and 4). The Chlorophyta were again dominant with Volvox aureus representing greater than 90% of the total (Appendix Tables 4B.2-2). This alga is an indicator of eutropic conditions[21]. All other major groups showed much lower abundances than those observed for the green algae. Pond 3 showed the lowest total abundance (1,275 cells/l) and the fewest number of different forms (14) (Tables 4.2.1-3 and 4). This pond was dominated by an unidentified nannoplankter and by the cryptophyte Rhodomonas spp. The Chlorophyta showed much lower abundances than in the other two ponds and the bacillariophyceae were present in greater densities than found in pond 2b (Table 4.2.1-4).

Pond 1 appears to be the oldest of the three ponds and it is situated in an area which is not heavily cultivated. It appears that less nutrients enter it though runoff since oligotrophic forms were abundant. Ponds 2b and 3 are adjacent to heavily cultivated areas and were characterized by eutrophic forms. These ponds have little herbaceous shore vegetation and receive full solar intensity. Trainor[16] states that excessive nutrient concentrations and intense sunlight can reduce the photosynthetic rate; thus perhaps the lower densities seen in ponds 2b and 3, compared to pond 1.

4.2.1.1.2.1.3 Cypress Slough

Phytoplankton were collected from both sampling locations within the Cypress Slough (Figure 4A.2.1-3) during the 1978 fall (September 9) and 1979 spring (May 24) quarters. (Appendix 4A.2.2; sampling and laboratory analyses techniques).

Seven major phytoplankton groups were identified: Cyanophyta (blue-greens), Chlorophyta (greens), Euglenophyta (euglenoids), Phyrrophyta (dinoflagellates), Chrysophyta (yellow-greens), bacillariophyceae (diatoms) and Cryptophyta (crytophytes). A total of 41 forms were identified with 25 of these diatoms (Table 4.2.1-5).

During the 1978 fall quarter, location 1 was dominated by euglinoids which represented greater than 63% of the total number of organisms identified (Table 4.2.1-6). The most abundant form was Euglena spp (Appendix Tables 4B.2-3). This genus is often used as in indicator of organic pollution and

eutrified conditions [18]. Cryptophytes were the second most abundant group while diatoms were not found from location 1. The phytoplankton community at location 2 was dominated by the blue-green algae which represented more than 48% of the total number identified (Table 4.2.1-6). The most abundant form was Lyngbya spp (Appendix Tables 4B.2-3). This genus is also indicative of high organic concentrations[18]. Cryptophytes were the second most abundant group while diatoms were seen to represent greater than 15% of the total (Table 4.2.1-6).

During the 1979 spring quarter, location 1 was clearly dominated by diatoms which represented more than 73% of the total (Table 4.2.1-6). Navicula was the most abundant genus (Appendix Tables 4B.2-3) which Palmer[22] lists as one of the more pollution tolerant-type phytoplankter. Euglinoids were the second most abundant group. Location 2 showed the euglinoids as the most abundant group (Table 4.2.1-6) with Trachelomonas spp the dominant form (Appendix Tables 4B.2-3). Diatoms were the second most abundant group.

In summary the presence of pollution tolerant forms and organic enrichment indicators (e.g., Euglena, Scenedesmus, Nitzschia and Navicula) suggest a high organic influx and field runoff into the Slough. However, while this might be expected, very few samples were collected from the Slough and the single sampling only allows very general inferences.

4.2.1.1.2.2 Microzooplankton

Zooplankton have been arbitrarily divided into two groups: micro and macrozooplankton. The microzooplankton are herein defined as those animal organisms captured by a 76 u mesh net. They generally have poor swimming ability and are the primary consumers of particulate matter[23].

The major importance of microzooplankton in the ecology of aquatic systems include being the primary predators of phytoplankton and a primary food source for many larval fishes[24]. In addition, some forms are indicators cators of the general well-being of the environment from which they were collected[25].

River zooplankton are generally dominated by rotifer and crustaceans. Most forms are added to rivers from tributaries and backwater areas. Therefore, their dominant forms and seasonal successional patterns will follow that observed in lentic-type habitats[19].

4.2.1.1.2.2.1 Green River

Microzooplankton were collected during the 1978 spring (26 May), summer (11 July), fall (12 September) and 1979 winter (22 January) sampling quarters. Day surface samples were collected from zones 1, 2, 3 and 5 during all four quarters (Figure 4A.2.1-1 and 2). (Appendix 4A.2.3; field collection and laboratory analysis techniques).

Three phyla were identified: Rotifera, Arthropoda and Protozoa. The arthropods were represented by the subclasses Branchiopoda (cladocerans), Copepoda and Ostracoda. The ostracods and protozoans combined, never accounted for more than 3% of the total mean density during any of the four sampling quarters. A total of 51 microzooplankton forms were identified from all day samples collected (Table 4.1.2-7). Rotifers, cladocerans and copepods were represented by 29, 10 and 10 forms respectively.

The 1978 spring quarter showed both the greatest mean total microzooplankton density (55 organisms/l) and the most number of forms identified (40) when all quarters were compared (Tables 4.2.1-7 and 8). Phytoplankton also showed maximum densities during the spring quarter (Section 4.2.1.2.1.1) indicating high food densities for the zooplankton. Copepods showed the highest mean total density (36 organisms/l) while rotifers were second highest (24 organisms/l) (Table 4.2.1-8). The dominant copepod form was the nauplii growth stage while Polyarthra spp, Keratella cochlearis and Synchaeta spp were the most abundant rotifers (Appendix Tables 4B.2-4). These rotifers are very common often being the dominant forms in riverine systems[19]. The mean total cladoceran density was 9 organisms/l. However, this density was the highest observed during any of the four quarters. The dominant cladoceran, Bosmina longerostris, is a common limnetic form with a cosmopolitan distribution[21]. No difference between zones in total mean densities was apparent (Table 4.2.1-8). The relatively high mean densities of copepods in zone 1 is attributed to the patchy distribution often observed in plankton populations.

The summer sampling showed both a lower total mean zooplankton density (34 organisms/l) and fewer number of forms identified (24) than the preceding quarter (Tables 4.2.1-7 and 8). Phytoplankton densities were also observed to decrease from spring to summer (Section 4.2.1.1.2.1.1). Copepods were the dominant group while cladocerans were second most numerous. Cladocerans are warm water forms generally becoming important during the summer months[19]. Rotifers showed the greatest decline in total mean density from the spring samples with no taxa showing dominance. Rotifers are generally more abundant during the cooler seasons[21]. The dominant copepod form was copepod nauplii while the most abundant cladocerans were B longerostris and Diaphanosoma brachyurum (Appendix Tables 4B.2-4).

The fall quarter showed the total mean zooplankton density to be 44 organisms/l representing 24 different forms (Table 4.2.1-7 and 8). This was an increase in the total mean density of more than 35% of that observed during the summer quarter. This paralleled a 40% increase in the mean phytoplankton density from summer to fall (Section 4.2.1.1.2.1.1). Rotifers were the most abundant group (26 organisms/l) and were represented by 11 forms. The dominant rotifer was Ploesoma truncatum. Copepods were the second most abundant group, although showing fewer organisms/l than during the summer, with nauplii being the dominant growth form (Appendix Table 4B.2.4). Total mean density of cladocerans increased slightly over that observed during the summer and B longerostris continued to be the dominant species.

The winter sampling showed both the lowest mean total zooplankton density (5 organisms/l) (Table 4.2.1-8) and fewest number of forms identified (22) (Table 4.2.1-7) when all quarters were compared. Phytoplankton also showed

the lowest total mean density during the winter (Section 4.2.1.1.2.1.1). Copepods were the most abundant group with the nauplii growth form being most numerous (Appendix Tables 4B.2-4). Rotifers showed the largest decrease in mean abundance from the previous quarter. Williams[26] states that low rotifer densities during the colder seasons is commonly observed in many rivers throughout the United States.

In summary, the most abundant forms found are generally common in riverine systems[19]. B longerostris and copepod nauplii were always the dominant cladoceran and copepod forms respectively. Both B longerostris and nauplii are small crustaceans and are circular in shape. In turbid flowing systems, such as the Green River, this size and shape lessens both their impingement against submerged objects and abrasion by suspended sediment particle[19]. Rotifers showed a bimodal seasonal distribution with K cochlearis, Polypartha spp and Syncheata spp the dominant forms during the spring and Ploesonea truncatum being dominant during the fall. The spring forms are considered cosmopolitan and may be indicators of eutrophic conditions[27].

The classical successional pattern of high relative microzooplankton densities during the spring and fall with low relative densities during the summer and winter was observed during the present study. The zooplankton seasonal pattern paralleled that observed for the phytoplankton (Section 4.2.1.1.2.1.1). Densities during all seasons were found to be low and similar to other studies conducted on the Green River[8].

In the report on the Green River by the Army Corps of Engineers[3] it is stated that the low zooplankton densities found below Lock and Dam 3 are probably due to pollution from acid mine drainage, high sedimentation from strip mine areas and organic pollution in the form of domestic sewage.

The highest total mean densities occurred during times of high water and flood conditions. Hynes[19] states that during this period the river plankton increases due to greater allochthonous additions from tributaries and backwater areas. However the accompanying turbidity, with flood conditions, has been observed to reduce most rotifers and filter feeding crustaceans[19][26]. No pattern in major zooplankton group abundances between zones within each sampling date appears evident indicating homogeneity within the zooplankton community (Table 4.2.1-8).

Diurnal Variations

Night surface and bottom microzooplankton samples were collected from zones 2 and 3 (Figure 4A.2.1-1) during the 1978 spring, summer and fall quarters (Appendix 4A.2.3; field collection and laboratory analysis techniques). In lentic environments, higher cladoceran and copepod densities at the surface are observed during the early evening[21].

Table 4.2.1-9 compares the mean total densities by depth of the major microzooplankton groups collected during each quarter. No consistent verticle stratification was obvious during the present study. Also those forms found during the night at the surface were, in most cases, also found at the bottom (Table 4.2.1-10). Hynes[19] states that even lake-plankters such as crustaceans can maintain themselves only against flows of up to millimeters

per second. Those crustaceans capable of verticle movement are generally adult forms. The present study showed few adult copepods and those dominant adult cladocerans (e.g., Bosmina) are not good swimmers[19]. Rotifers are generally not able to vertically migrate due to their poor swimming ability.

Net - Pump Comparisons

Microzooplankton were collected by net-tows and pumps during the 1978 spring, summer and fall quarters (Appendix 4A.2.3; field collection and laboratory analysis techniques). Surface net-tow samples were collected from zones 2 and 5 (Figure 4A.2.1-1 and 2). The purpose of this was to be able to compare relative abundances of organisms collected by the base technique chosen (pumps), to those which might have been obtained by an alternative method (nets).

Table 4.2.1-11 compares the relative abundances of major zooplankton groups collected by pumps and nets. Table 4.2.1-7 lists those forms collected by the net-tow and indicates which were common to both kinds of samples, versus those which were only collected by one or the other.

During the 1978 spring quarter, comparison of samples collected from both zones showed good similarity between sampling techniques. However, data from zone 2 showed the relative abundance of rotifers in the pump samples to be more than twice that observed in the net-tow sample (Table 4.2.1-11). Also, eight rotifers collected by the pump system were not seen in the net-tow sample (Table 4.2.1-7). This is not unusual, since many rotifers are smaller than the mesh size (76 u) of the net used in the net-tow collection[27]. The dominant forms, within each major group, were similar between collection techniques (Appendix Tables 4B.2-6).

During the summer quarter a high degree of similarity was also observed between the net and pump samples (Tables 4.2.1-11). However, at zone 2, cladocerans were relatively more important in the net-tow than pump samples. The adult cladoceran Diaphanosoma brachyurum showed a higher relative percent abundance in the net-low samples than in the pump samples (Appendix Tables 4B.2-6). This could be evidence of pump avoidance by D. brachyurum, on the other hand, the pump method sampled protozoans from zone 2, which did not appear in the net-tow samples. The high relative importance of rotifers during July was seen by both sampling techniques. The pump samples showed a greater taxonomic diversity than the net-tow samples did. However, the net-tow samples showed three cladoceran forms and one copepod form not observed in the pump samples (Tables 4.2.1-7).

The fall sampling data also showed good similarity in the relative importance of the major groups between the two sampling techniques (Table 4.2.1-11). Rotifers again showed lower relative importance in the net-tow samples then in the pump samples at zone 5. Ploesoma truncatum was the dominant rotifer in both sample types. However, Polyarthra spp was relatively more abundant in the pump than net-tows (Appendix Tables 4B.2-6). This may indicate passage through the net mesh by the smaller type rotifers. However, in contrast to this, 11 rotifer forms were identified from the net-tow samples which were not present in the pump samples (Table 4.2.1-7).

In summary, since the net-tow samples were basically qualitative, it is impossible to determine whether those observed differences in relative abundances between the two sampling techniques reflect significant differences in organism densities. It appears however, that some smaller forms (e.g., rotifers) escaped collection by the net and some larger forms (e.g., cladocerans) may have avoided the pump. However, good overall, similarity between the two sample types, (in the kinds of organisms found and in those forms which were dominant), indicates that the pump system collects a representable and reliable sample.

4.2.1.1.2.2.2 Ponds

Microzooplankton samples were collected from three on-site farm ponds (Figure 4A.2.1-3) during the 1978 spring quarter (24 May). Three samples were taken from both the mid-pool and shore areas of each pond. These data were averaged and the mean densities and percent relative abundance of the major groups is given in Table 4.2.1-13 (Appendix 4A.2.3; field collection and laboratory analysis techniques).

Forty-three microzooplankton forms representing three phyla: Rotifera, Arthropoda and Protozoa, were identified. The Arthropods were represented by three major groups; the subclasses Branchiopoda (cladocerans), Ostracoda and Copepoda (Table 4.2.1-12). The rotifers with 24 forms showed the greatest diversity. Copepods and cladocerans were represented by 9 and 6 forms respectively. Single ostrocod and protozoan forms were found.

Pond 1 had the lowest density of zooplankters (264/1) and the fewest number of forms identified (21) (Tables 4.2.1-12 and 13). This pond was dominated by rotifers which represented greater than 87% of the total number (Table 4.2.1-13). The dominant forms were Brachionus angularis and B.calyciflores (Appendix Tables 4B.2-7). There were relatively fewer cladocerans in Pond 1 as compared to the other ponds.

Pond 2h showed the highest mean zooplankton density (7141/1) and the most forms identified (27) (Tables 4.2.1-12 and 13). Protozoans were most abundant (5197/1) representing more than 72% of the total number. The dominant form was a member of the family volvocidae. Rotifere and cladocerans showed similar densities representing 10.5 and 11.0% of the total number respectively. The dominant rotifer was Keratella cochleairs while the dominant cladocerans were Ceriodaphnia lacustris and Chydorous sphearicus (Appendix Tables 4B.2-7). Both C lacustris and C sphearicus show increases when small flagellates are available as food[21]. The unidentified volvocacean observed in the zooplankton samples and the chlorophytes found in the phytoplankton samples (Section 4.2.1.1.2.1.2) may provide such a food source.

Pond 3 was intermediate in both mean zooplankton density (1214/1) and number of forms[24] identified (Tables 4.2.1-12 and 13). This pond was dominated by cladocerans which represented greater than 71% of the total number. Bosmina longirostris and Ceriodaphnia lacustris were the most abundant cladeceran forms found (Appendix Tables 4B.2-7). B longirostris a very cosmopolitan cladoceran has been found to be an indicator of euthrophic conditions[21]. This pond showed the highest and lowest mean density of rotifers and copepods respectively of the three ponds examined. The

protozoans observed from pond 2 were also found in pond 3 though the mean density of this form in the latter pond was only 6 organisms/l.

All three ponds were populated by common limnetic-type zooplankters. The zooplankton community at Pond 1 was clearly dominated by rotifers with B angularis the most abundant form. This form represented more than 50% of the total in all samples taken from that pond. High rotifer abundances are generally observed during periods of high algal densities[26] and Pond 1 showed the highest phytoplankton densities of all three ponds examined (Section 4.2.1.1.2.1.2). Pond 2b showed the highest mean total zooplankton densities and was dominated by a volocacean protozoan. Rotifers and cladocerans were equally important in this pond. The most abundant rotifer was Keratella cochlearis which may be the most common metazoan in the world[27]. The dominant cladoceran was Ceriodaphnia lacustris which may have been reproductively stimulated by the presence of the volvocacean. Pond 3 showed both the lowest rotifer and algal abundances (Section 4.2.1.1.2.1.2). The high cladoceran and copepod densities with the low rotifer abundances may reflect a feeding advantage by the former two groups. Bosmina longirostris was the dominant cladoceran and when present in high densities is used as an indicator of eutrophic conditions[28] which may reflect agricultural runoff into the pond.

4.2.1.1.2.2.3 Cypress Slough

The Cypress Slough was sampled for microzooplankton at locations 1 and 2 during the 1978 fall quarter (9 September) and at location 1 during the 1979 spring quarter (24 May) (Appendix 4A.2.3; field collection and laboratory analysis techniques). Only a qualitative assessment could be performed on these samples due to the difficulties of sampling this environment.

Two phyla, Rotifera and Arthropoda, accounted for all forms identified. The arthropds were represented by three major groups; the subclasses Brachiopoda (cladocerans), Ostracoda and Copepoda (Table 4.2.1-14). Twenty-nine forms were represented in samples from location 1 during the September sampling date (Table 4.2.1-14). Rotifers had the greatest number of forms (13) but represented only 12% of the total number of organisms (Table 4.2.1-14; Figure 4.2.1-2). Copepod were represented by nine forms and were most abundant numerically (70% of the organisms; Figure 4.2.1-2). Copepod nauplii (immature stages) was the dominant form and Diaptomus spp was the most abundant copepod adult (Appendix Tables 4B.2-8).

Location 2, during the September sampling, supported a similar community; rotifers comprised the most diverse portion of the community but copepods were numerically dominant (representing greater than 80% of the total; Figure 4.2.1-2.

During May only location 1 was sampled; location 2 didn't have enough water to sample using the gear available. Thirteen forms were identified. Rotifers, cladocerans and copepods were represented by 6, 3 and 3 forms respectively (Table 4.2.1-14). However, this time rotifers represented over 55 percent of the total number of organisms identified (Figure 4.2.1-2). Polyarthra spp was the dominant rotifer (Appendix Tables 4B.2-8). It is a

common shallow water form having a wide temperate distribution[21]. The greater relative importance of rotifers during May than September may reflect general successional pattern of high rotifer abundance during late spring-early summer observed in many lentic environments[21][29].

In summary, the microzooplankton community observed during both sampling dates was generally similar and composed of common limnetic forms. A greater number of forms were, however, identified during September than May. During the latter month flood conditions prevail causing unstable conditions. Few microzooplankton forms are able to establish populations during flood conditions. The greater number of forms during September may reflect a calmer, more stable environment. Rotifers accounted for a greater percentage of the total during May than September (Figure 4.2.1-2). Williams[26] states that spring is generally the most productive season for rotifers.

4.2.1.1.2.3 Benthos

4.2.1.1.2.3.1 Green River

Benthic macroinvertebrates were collected from the Green River during the 1978 spring (19 May), summer (13 July), fall (25 September) and 1979 spring (5 May) quarters. Biomass was determined during the 1978 fall and 1979 spring quarters (Appendix 4A.2.4; field collection and laboratory analyses techniques).

Twenty-nine benthic macroinvertebrate forms were identified representing four phyla; Annelida, Nematoda, Arthropoda and Mollusca. The arthropods (class insecta) showed the greatest number of different forms identified (11) (Table 4.2.1-15). Annelids and molluscs were the two most abundant phyla (Table 4.2.1-16).

During the 1978 spring quarter zones 1, 3 and 6 were sampled (Figure 4A.2.1-1 and 2). The mean density for this quarter was 101 organisms/m^2 (Table 4.2.1-16). Insects were observed from all zones with Procladius spp (midge larvae) and Hexagenia spp (nymph) the most abundant genera (Appendix Table 4B.2-9). Oligocheates were found at zones 1 and 6 but were absent at zone 3. Zone 3 showed the lowest total mean density (22 organisms/m^2) of those zones examined.

The greatest mean densities were observed during the summer quarter (Table 4.2.1-16). This quarter also showed the greatest number of different forms identified (17) (Table 4.2.1-15). The summer period generally shows good benthic growth in riverine systems due to increasing temperatures, lower river flow and reduced turbidity[19]. Zone 3 showed the highest total mean density (1029 organisms/m^2) and zone 2 the second highest (594 organisms/m^2) (Table 4.2.1-16). These two zones showed relatively greater percentages of the larger size substrate particles (gravel and sand) (Appendix Tables 4B.2-10). Hynes[19] notes that sediments composed of sand with silt generally show greater numbers of organisms. Oligocheates were the dominant form at zones 2, and 3 while insects and molluscs were most abundant at zones 1 and 5 respectively. The clay size fraction in zone 5 (channel) accounted for more than 25 percent of the total sediment sampled (Appendix Tables 4B.2-10). This reflects the general observation that stable sub-

strates are preferred by molluscs over loose, shifting substrates[19]. Limnodrillus spp was generally the most abundant olegocheate (Appendix Tables 4B.2-9). This form is considered pollution tolerant[30]. Sphaerium spp and chironominae larvae were the most abundant mollusc and insect forms respectively. This mollusc and many chironomid insects are considered facultative-type organisms[30].

During the fall quarter zones 1, 3 and 5 were sampled. The total mean density for the three zones was 251 organisms/m^2 (Table 4.2.1-16). Zone 3 showed the lowest mean density (0.2 organisms/m^2) while zone 5 showed the highest (652 organisms/m^2). Zone 1 showed oligocheates to be most abundant while molluscs were dominant at zone 5 with Sphaerium spp the dominant form (Appendix Tables 4B.2-9). Zone 3 showed greater than 95 percent of the sediment to be in the silt/clay fraction (Appendix Tables 4B.2-10). Williams and Mundie[31] showed that poor benthic colonization usually occurs in this type of habitat. The mean ash free dry weight (biomass) from zone 3 was 18.7 mg/organisms (Appendix Tables 4B.2-11) and represents a total of 12 pelecypod molluscs found from the three replicate samples.

During the 1979 spring quarter the total mean density from zones 1, 2 and 3 was less than 0.05 organisms/m^2 (Table 4.2.1-16). This was the lowest mean density observed during the sampling year. Biomass from zones 1 and 3 showed very low values (Appendix Tables 4B.2-11). Sediment analysis showed greater than 90 percent of the particles in the silt/clay fraction, indicating poor colonizable substrates (Appendix Tables 4B.2-10).

In summary, the majority of forms found were either pollution-tolerant or facultative type organisms[30][32]. The major groups and the total mean densities found in the present study were similar to those found by Charles[33] in polluted areas of the Green River. Corbicula spp was not found in this study but is known to occur in the Green River Basin[8]. The dominant forms found by Geo-Marine[8] were similar to those herein reported. The summer quarter was found to be the most productive period examined. Both spring quarters showed low densities probably reflecting the adverse effect of flood conditions and high siltation. Zone 3 showed relatively low densities during all quarters except during the summer when the highest mean total density was observed. Relatively high flows during the Fall as compared to those seen during the Summer, may have affected the benthos at zone 3 to a greater extent than that observed at zone 1. Zone 5 being in the channel was not adversly affected by increased river flows. Hynes[19] notes that water velocity often decreases near the substrate in river channels. Sediment analyses indicated that the silt/clay fractions always represented the greatest percentage of the sediment substrate. This type of substrate along with the high suspended solids, constant river turbulence and scour prevents colonization of all but the most pollution tolerant forms.

4.2.1.1.2.3.1 Mussels

Mussel brailing (sampling) was done in each of the four sampling quarters in zones 1, 2, 3 and 5 (Figure 4A.2.1-1,2) (Appendix 4A.2-4; field sampling technique). No mussels were collected in any of the sampling quarters. This is probably due to a lack of suitable substrate and constant resuspen-

sion and resettlement of sediments caused by high flows and barge caused turbulence. Pennak[29] states that substrates with shifting sands and muds with their accompanying high turbidities are completely unsuitable for bivalves. Williams[13] did not collect any mussels in the lower eight miles of the Green River and attributed this to the heavy silt layer on the bottom substrate and the lack of colonizable habitats. In addition to the absence of adult forms no mulluscan larvae were found in either micro- or macrozooplankton samples (Sections 4.2.1.1.2.2.1 and 4.2.1.1.2.5.1).

Macrophytes

During all sampling quarters field observations revealed no macrophyte colonization in any of the Green River shore zones (Figure 4A.2.1-1,2). This is attributed to the sediment load and scouring in the Green River, which limits substratum suitability and light penetration. The scarcity of aquatic macrophytes below Lock and Dam 3 was also observed by the U.S. Army Corps of Engineers[3] in their Green River study.

No macrophytes were found in either the three ponds nor the Cypress Slough.

4.2.1.1.2.3.2 Ponds

Three on-site farm ponds (Figure 4A.2.1-3) were sampled for benthic macroinvertebrates during the 1978 spring quarter (19 May). Two ponar grab samples were taken from the mid-pool and two from the shore areas of each pond (Appendix 4A.2-4; field collection and laboratory analysis techniques). Densities of the major benthic groups, from the four samples (Appendix Tables 4B.2-12), were averaged to yield single pond densities (Table 4.2.1-17). Four phyla (Annelida, Nematoda, Arthropoda and Mollusca), represented by 28 forms (Table 4.2.1-18), were found.

Pond 1 had the greatest mean number of organisms ($6425/m^2$) and the greatest number of forms identified (22) (Tables 4.2.1-17,18). Oligochaete annelids were the most abundant group; Limnodrillus spp was the dominant genus (Appendix Tables 4B.2-12). This organism is cosmopolitan in occurrence and generally occupies soft unconsolidated substrates[19]. It is indicative of organically polluted waters[34]. Dipterans were the second most abundant group and were represented by the greatest number of forms (9) (Table 4.2.1-18). Chironomus larvae was the most abundant dipteran. Groups which were only observed from Pond 1 were decopods, ephemeropteran and megalopteran insects and gastropod molluscs.

Pond 2b showed the lowest total mean density ($859/m^2$) (Table 4.2.1-17). Oligocheates were most abundant ($576/m^2$) with Limnodrillus spp and Branchiura sowerbyi the dominant forms (Appendix Tables 4B.2-12). B sowerbyi is a pollution tolerant species which is commonly found in the Ohio River drainage basin[32]. Dipterans were the second most abundant group but showed the lowest density among all sampled ponds. Procladius spp was the dominant dipteran form.

Pond 3 showed intermediate average density ($1337/m^2$) representing 13 forms (Tables 4.2.1-17,18). As in the previous two ponds, oligochaetes were the most abundant group with Limdnodrillus spp and B sowerbyi being dominant (Appendix Tables 4B.2-12). Dipterans were the second most

abundant group represented by 8 forms. No organisms were found in the mid-pool ponar grabs. This was the largest of the three ponds sampled and it has essentially no shore vegetation. It is subject to a high runoff, turbidity and deposition which may preclude benthic colonization in the mid-pool area.

In summary, all ponds were dominated by pollution tolerant organisms. This may be a response to field runoff which adds high nutrient and organic concentrations to the ponds. Pond 1 appears to be less affected by this runoff as it shows the greatest diversity and some facultative-type organisms (e.g., Sialis spp).

4.2.1.1.2.3.3 Cypress Slough

Benthic macroinvertebrates were collected from two locations in the Cypress Slough (Figure 4A.2.1-3) during both the 1978 fall and 1979 spring quarters (Appendix 4A.2-4; field collection and laboratory analysis techniques). Four phyla were identified; Annelida, Nematoda, Mollusca and Arthropoda. The arthropods were represented by the classes; insecta, arachnida and crustacea. A total of 33 forms were identified of which 16 were insects (Table 4.2.1-19).

During the 1978 fall quarter (September 8) location 1 had an estimated mean density of 5,348 organisms/m^2 (Table 4.2.1-20) with ten forms represented (Table 4.2.1-19). Annelids were the most abundant group (over 86 percent) of the organisms identified. Limnodrillus spp, the dominant annelid (Appendix Tables 4B.2-13), is considered a pollution tolerant organism[35] while the next most abundant annelid, Tubifex spp, is considered an indicator of organic pollution[29]. Insects ranked second to annelids in abundance, but they represented only 10% of organisms sampled (Table 4.2.1-20). Chaoborus spp was the most abundant insect. It is considered a facultative organism[32] which may live under various different environmental conditions.

The total mean density at location 2 (12,761 organisms/m^2) was more than double that observed at location 1 (Table 4.2.1-20). Also the presence of 22 different forms, at location 2, indicates a more diverse environment (Table 4.2.1-19). Annelid worms, dominated with Limnodrillus spp, were the most abundant group (Appendix Tables 4B.2-13). Tubifix spp was the second most abundant. The insects showed greater than a 10 fold increase in abundance over that observed at location 1 and were represented by 12 forms. The most abundant insects were the larval stages of Culicoides spp and Glyptotendipes spp. Both forms are common inhabitants of aquatic vegetation and of freshwater substrates[29]. Location 2 was overgrown with terrestrial vegetation at the time of sampling. This vegetation provides both shelter and ample food supplies as detrital material for the insects. This was not the case at location 1. The mollusc, Sphaerium spp, was also seen to occur at location 1 in relatively high densities. This is a cosmopolitan genus which generally occurs in soft substrates[36].

The second sampling of Cypress Slough benthos occurred during the 1979 spring quarter (24 May). The total mean abundance of 18,717 organisms/m^2 found at location 1 was the highest observed during the two sampling dates (Table 4.2.1-20) and was dominated, as during the first sampling by

annelids (15,283 organisms/m^2). This group accounted for over 81% of the total number of organisms and was represented by 3 forms of which Limnodrillus spp was the most abundant (Figures 4.2.1-19,20; Appendix Tables 4B.2-13). Molluscs were the second most abundant group (2,196 organisms/m^2) with Sphaerium spp the dominant form.

Location 2, during the 1979 spring quarter, showed the lowest mean total density (1,913 organisms/m^2) and the fewest number of forms identified (5) (Tables 4.2.1-19,20) during this survey. Annelids accounted for over 81% of this total. Limnodullus spp was again the dominant form (Appendix Tables 4B.2-13). Molluscs were second most abundant (103 organisms/m^2) with Spaerium spp the dominant form.

Appendix Tables 4B.2-14 show, that at both locations 1 and 2, over 60% of the sediment was composed of silt during the spring sampling. Pennak[79] states that it is this type of substrate which is most conducive for olegocheate annelid colonization.

In summary, both locations during both sampling periods were dominated by pollution tolerant forms. Location 1 was observed to have a high organic detrital load which provides an ample food source for detritevores which were the dominant type organisms. The on-site stream which drains the agricultured bottom land, flows into the Slough and probably adds some organics and nutrients.

The high organism densities at location 1, during the spring, reflects the normal biological increased activity generally observed during that season. The low densities at location 2 during the spring, may reflect the recent passage of the flood season. Since this location is dry preceding the flood season and benthic colonization is restricted during flood conditions, low densities after the floods are not unexpected. The high densities at location 2 during the fall indicates more stable conditions during that period.

4.2.1.1.2.3.4 Streams

Drift Net Collections

Drift collections were made during the 1978 spring sampling quarter (20 May) at four tributary stations (Figure 4A.2.1-3) (Appendix 4A.2-4; field collection and laboratory analysis techniques).

Forty-six forms representing 10 major groups were identified (Table 4.2.1-21). Members of the orders Isopoda and Amphipoda were dominant at stations 1, 2 and 3 during all times sampled (Table 4.2.1-22). The isopods Asellus spp and an unidentifiable juvenile form were dominant at station 1 (Appendix Tables 4B.2-15). Over the 24h sampling period isopods represented more than 60% of the total number of organisms found at station 1 (Table 4.2.1-22). The amphipods, Synurella spp and S dentata represented the second most abundant group.

Stations 2 and 3 were dominated by the amphipod Synurella spp (probably S dentata). Amphipods represented over 78% of the total at both stations (Table 4.2.1-22). Amphipod densities at stations 2 and 3 were 2 and 9 times the densities observed at station 1. Isopods were present in greater numbers at station 3 than 1 but represented a lower percentage of the total due to the much higher amphipod densities found at station 3. Isopods were the second most abundant group at both stations 2 and 3 with Asellus spp and Lirceus spp the dominant forms.

Station 4 samples (closest to the Cypress Slough) were dominated by insects some of which are considered terrestrial in nature (Table 4.2.1-21). Insects of the order collembola (isotomatidae) were the dominant forms. These are common inhabitants of moist conditions generally found along the edges of streams or ponds[37]. Amphipods (Synurella spp) were the second most abundant group, while the decapods belonging to the astacidae were third in numerical importance representing more than 6% of the total (Table 4.2.1-22).

In summary, stations 1, 2 and 3 were either dominated by isopods or amphipods with the genera Asellus and Synurella being the dominant forms. Synurella spp is a common inhabitant of springs and small streams[38] and Asellus spp in a facultative organism found in various different environments[32]. The large densities of isopods and amphipods found and stations 1, 2 and 3 may reflect the upstream migration by these organisms. This type of movement is commonly observed in small streams[19][29]. Station 4 showed insects (primarily terrestrial forms) to be dominant which may reflect the increased presence of stream-bank vegetation and close proximity to the Cypress Slough.

4.2.1.1.2.3.4 Streams

Surber Net Collections

Surber net collections were made during the 1978 spring (May, 21) sampling quarter. Each of the four stream stations (Figure 4A.2.1-3) were sampled once during both the day and night hours (Appendix 4A.2.4; field collection and laboratory analysis techniques).

Three phyla were identified; Annelida, Arthropoda and Platyhelmenthes. The arthropods were represented by the classes; arachnida, crustacea and insecta (Table 4.2.1-23). A total of 17 forms were identified with the insects being represented by 8. The greatest number of individuals were crustaceans, primarily isopods and amphipods (Table 4.2.1-24).

Sediment samples for particle size determination, were taken from each stream station during the 1979 spring quarter (24 May) (Appendix Table 4B.2-16). It is recognized that almost a year's time separated the biological and sediment sampling. The sediment information will be used to define habitat and correlate organism abundances with substrate only in the most conservative manner. It is felt however, that the dominant particle sizes at each station should not have significantly changed from year to year. This is based on a consistent use of the land, in this case farming.

Stream station 1 showed the second highest mean total density ($1832/m^2$) of all stream stations when day/night periods were combined (Table 4.2.1-24). This total represented 8 forms of which the amphipod Synurella spp was the dominant form (Appendix Tables 4B.2-17) accounting for over 78% of the total number of organisms. This form is a common inhabitant of springs and small streams within the area of the Green River Basin[38]. Isopods were the second most abundant group with Asellus spp and Lirceus spp the dominant forms. During the night sampling the class insecta represented over 30% of the organisms collected. No insects were noted from the day samples possibly indicating the increased activity generally observed during the evening in lotic systems[19] (Table 4.2.1-24).

Stream station 2 showed both the greatest mean density ($2553.7/m^2$) and number of forms when all stations are compared (Tables 4.2.1-23,24). The most abundant forms were the same as those observed at stations 1. However, the amphipod densities at station 2 was almost 4 times that observed at station 1. These higher densities, at station 2, could reflect the larger type sediment particles found at that station (Appendix Table 4B.2-16). Williams and Mundie[31] notes that higher densities of benthic invertebrates were observed in streams where the substrate was composed of gravel and sand particles. Also the greater densities at station 2 may have been affected by the upstream migration of crustaceans often observed in streams[19]. Insects were again found to be more abundant in night than day samples.

Steam stations 3 and 4 showed mean total densities of 573 and 156 organisms/m^2 respectively (Table 4.2.1-24). Synurella spp was the most abundant form at both stations while olegocheates and decapods (crayfish) were second most abundant at station 3 and 4 respectively. The relatively high olegocheate densities at station 3 may be a response to higher silt concentrations at that location (Appendix Table 4B.2-16). Pennak[29] notes that olegocheates prefer this type of substrate for colonization. Relatively high crayfish densities were observed at station 4. This reflects the visual observation of intense crayfish colonization in the adjacent fields. Adults normally burrow in wet meadows while immature forms are regularly found in shallow streams[29]. The adult crayfish become active at night and this may have been responsible for the higher night than day densities found at station 4. The isopods which had relatively high densities at stations 1 and 2 (Table 4.2.1-24) showed relatively low abundances at stations 3 and 4.

Densities and numbers of forms collected were greater in the evening than in day samples at both stations 1 and 2 (Tables 4.2.1-23,24). This reflects, for the most part, the greater number of amphipods found during the evening. Pennak[29] states that amphipods react negatively to light and generally stay hidden under and between debris and stones at the stream edges during the day. Stations 3 and 4 did not show this trend, however since the day/night differences at those stations were small, the overall densities for all stations showed greater abundances during the evening. Hynes[19] notes that benthic organisms generally become more active after sunset making them more susceptible to capture.

In summary, stream stations 1 and 2 were dominated by isopods and amphipods with Asellus and Lirceus and Synurella the most abundant genera respectively. These isopods are facultative organisms found in various different environments[32]. Synurella is a common form found in springs and small streams[38]. The densities of these organisms at stations 3 and 4 were lower than those observed at stations 1 and 2. The higher densities at the former two stations could possibly reflect the upstream migration of these organisms. Hynes[19] and Pennak[29] state that these forms commonly migrate into the flow of water in small streams. Also the relatively high percentage of silt found in sediment samples from stations 3 and 4 (Appendix Table 4B.2-16) could suppress the populations by inhibiting the normal feeding process in these crustaceans by clogging the feeding appendages.

Insects were observed in relatively high densities at stations 1 and 2 possibly reflecting the greater amount of shoreline vegetation and better habitat substrate found there. These stations show relatively low silt content which concurs with Hynes[19] who states that silty substrates are generally not conducive for insect colonization.

Diurnal variations, with greater densities at night, were observed at stream stations 1 and 2. This trend was not evident at stations 3 and 4 and may be due to the low number of organisms found at these locations.

4.2.1.1.2.4 Macrozooplankton

Macrozooplankton are defined as those invertebrate organisms captured by a 570 mesh plankton net. These organisms, for their size, are generally good swimmers, predators upon smaller zooplankters and are a major food source for many adult fish[37]. The results indicate that these samples can be used to define the river drift community since the most abundant forms were members of the class insecta.

4.2.1.1.2.4.1 Green River

Day and night macrozooplankton were collected during the 1978 spring (18-19 May), summer (12 July) and fall (5 September) quarters. These samples were also used for ichthyoplankton identification and enumeration. (Appendix 4A.2.5; field collection and laboratory analysis techniques).

Three phyla were recognized; Arthropoda, Annelida and Nematoda. The arthropods were represented by the classes insecta, crustacea and arachnida (Table 4.2.1-25). During all dates sampled, the class insecta showed the greatest densities and the most number of forms identified (Tables 4.2.1-25,26). Dipterans were the most abundant insect form during all sampling dates.

The greatest mean densities and the most number of forms were observed during the spring collection, (Table 4.2.1-25,26). Hynes[19] states that the river drift community shows the highest densities during the flood season caused primarily from the dislodging, from the bottom substrates, of attached forms. Dipterans were the most abundant form at all zones during both day and night (Tables 4.2.1-25,26). The dominant

genera during this quarter were Chaoborus larvae and pupae and Polypedilum larvae (Appendix Table 4B.2-18). The day samples showed the lowest (153/ $100m^3$) and the highest (556/$100m^3$) dipteran densities at zones 3 and 6 respectively. This may be attributed to the greater terrestrial shore vegetation and to the lesser disturbed bottom sediments at zone 6. Zone 3 is used daily for the mooring of barges which increases bottom scour and the resuspension and resettlement of sediment particles. This interferes with the attachment to the bottom susbrates of most aquatic insect larvae.

A t-test analysis (p=0.5) of data from zone 2 showed no significant difference between day and night densities during the spring quarter (Table 4.2.1-28). The high day densities observed during spring at all zones is probably a response to the high water and flood conditions observed then. The high abundances found during the day at zone 2 would probably obscure any possible day/night differences in total mean density, in view of sampling variation (Table 4.2.1-27). Also no clear differences were observed between those forms found only during the day or those only found during the night (Table 4.2.1-25).

Day samples collected during the summer period showed the lowest mean densities of the three quarters examined (Table 4.2.1-26). Dipterans were the most abundant form with Chaoborus larvae found at all zones sampled. No form showed clear dominance from samples collected during the day (Appendix Table 4B.2-18).

Significant differences in total mean densities were found between the day and night samples from zones 3 and 6 (Table 4.2.1-28). Table 4.2.1-27 shows that Dipterans were largely responsible for this difference with Chaoborus larvae and chironominae larvae being dominant in the night samples (Appendix Table 4B.2-19). This sampling occurred during calm river conditions which allowed the normal insect emmergence generally observed after sunset[19].

The day samples collected during the fall quarter showed greater densities at all zones than that observed during the summer (Table 4.2.1-26). Dipterans were again dominant with Chaoborus larvae and chironomiane pupae the most abundant forms (Appendix Table 4B.2-18). As during the summer quarter, significant differences in total mean densities were observed between day and night samples from both zones 3 and 6 (Table 4.2.1-28). Dipteran and trichopteran larvae showed the greatest diurnal variation (Table 4.2.1-27). The increases in the number of forms during the night at both zones 3 and 6 indicated a more diverse evening drift community (Table 4.2.1-25).

In summary, dipterans were the most abundant form during all sampling quarters. The spring quarter showed the highest mean day densities when all quarters were compared. These densities are probably a response to the high water and flood conditions observed during time of sampling. No significant difference was observed between day and night densities during the spring period. The summer quarter showed the lowest mean day densities with no form being clearly dominant. Day samples taken during the fall quarter also showed much lower densities than that observed during spring. Significant differences (p=0.05) between day and night mean den-

sities from zones 3 and 6 were observed during the summer and fall quarters, with the greater densities during the night. Dipteran densities were mainly responsible for this difference. This reflects insect immergence during the early evening generally observed in aquatic environments[19]. These significant differences indicate that most of the forms collected were indigenous to the study area and not merely forms which drifted from upstream areas.

Zone 6 showed the highest total mean density during the spring and fall quarters (Table 4.2.1-26). This probably reflects the greater terrestrial shore vegetation and the lesser disturbed bottom sediments at zone 6. The other zones, during the three sampling quarters, showed similar densities when the standard deviations are considered.

4.2.1.1.2.4.2 Cypress Slough

Macrozooplankton were collected from location 1 in the Cypress Slough (Figure 4A.2.1-3) during the 1979 spring quarter (24 May) (Appendix 4A.2.5; field collection and laboratory analysis techniques).

Oligochaete annelids were the dominant forms accounting for over 89% of the total number of organisms enumerated (Table 4.2.1-29; Appendix Table 4B.2-20). These organisms are benthic in nature and may have been accidentally collected in the plankton net since the water column was shallow (1-1.2m; 3-4 ft) and the net may have come close to the bottom. The second most abundant group were insects being represented by 14 forms (Table 4.2.1-30). Those larvae belonging to the order diptera were the dominant forms with Tanypus spp larvae the most abundant genus (Appendix Table 4B.2-20). This genus is a facultative-type organism[30].

The majority of the forms identified were either pollution tolerant or facultative-type organisms (e.g., Palpomyia, Procladius, Coleoptera (adults)[30]. This indicates that the Cypress Slough may be receiving, through runoff, high organic debris concentrations and agricultural pollution from the surrounding area.

4.2.1.1.2.5 Ichthyoplankton

4.2.1.1.2.5.1 Green River

Ichthyoplankton were sampled in the Green River from May 18 to September 25, 1978 and again from March 28 to May 18, 1979 (Appendix Tables 4B.2-21, 4B.2-22). Initial authorization to implement the sampling program was given in insufficient time to allow for the preferred start date of March 1978 for ichthyoplankton determination. Samples were taken at a mean average interval of 12 days in 1978 and 10 days in 1979. The collections described 17 species and 14 families or genera (Table 4.2.1-31). Ichthyoplankton were identified to the following stages: eggs, early embryo, protolarvae, mesolarvae, metalarvae, and juvenile. Use of the descriptors protolarvae, mesolarvae and metalarvae are after Snyder et al.[39]

Of 155 samples each representing 100 m^3 of water sampled an estimated 17,392 ichthyoplankters were collected. Dominating these samples were freshwater drum (44.8%), herring (keyed to family) (23.6%) and gizzard shad (20.6%) species that together accounted for 89.0 percent of the catch. These were followed by buffalo species (3.0%), carp (1.6%), white bass (1.1%) and Ohio shad (1.1%) accounting for an additional 6.8 percent of the total sample. The balance of the catch (4.2%) were represented by 25 species or families of fish.

Herring (keyed to family and species) and drum accounted for 90.2 percent of the ichthyoplankton found in the Green River. Several reasons exist to explain this. First is the presence of the eggs and larvae of these two fish types. Second is the spawning/life history characteristics. In this case a high fecundity in conjunction with open water egg release or broadcast eggs. The non-adhesive eggs and subsequent larvae either float on the waters surface of remain suspended in the water column. Finally the eggs and larvae of the herring and drum because of the characteristics noted above are particularly vulnerable to ichthyoplankton net tows.

The other species of fish offspring are not nearly as catchable by the sampling methods we used. In some cases such as sauger few eggs and larvae are produced as compared to freshwater drum. The sauger is higher up on the food web and is thus represented by fewer individuals within its community. In some cases the eggs are sticky (the sauger also is included here) and are not susceptible to towed net collecting. The catfish and some centrarchidae guard the nests in which they keep their offspring. Finally some species spawn in other locations so that they are not present for our collections. Both the channel and blue catfish are believed to spawn in small tributaries and guard their nests so that few of the eggs or larvae reach the Green River.

The habitat provided by the Green River is a critical factor in determining degree of success by a fish species. The Green River is generally warm with dissolved oxygen at or near saturation and a pH of approximately 7.0. This river periodically floods, primarily in the springtime, is pooled so that it appears lentic during the non-flood times, has a high silt load and suspended solids. This last characteristic results in little light penetration and determines to a considerable degree the type of substrate exhibited in the river. The substrate type in turn dictates types

and amount of food available for fish. Green River habitat of the kind described above is tolerated by some species of fish more easily than others. Typical of these tolerant fish are freshwater drum, herring, sauger and some species of shiners.

Fish spawning in the Ohio River basin is cyclical. Fish spawn sometime in the spring-summer-fall period of the year. The initiation and length of time that spawning occurs varies with the species. Clupeidae may start spawning as early as the end of April and continue to spawn until sometime in August. However, peak reproductive activity takes place over a much shorter interval of time. River herring in the Green River appeared to be most active during the month of June. Progressively older larvae continued to be captured through July and August (Table 4.2.1-32, Figures 4.2.1-3, 4.2.1-4).

Freshwater drum show similar characteristics suggesting that spawning occurs from late May through mid-September. Peak spawning takes place from mid-June to the end of June, a relatively short time span. In our observations almost 90 percent of the drum eggs and larvae were taken during this two week span out of the 15 week period that ichthyoplankton of this species were obtained (Table 4.2.1-38, Figures 4.2.1-9, 4.2.1-10).

In 1978 Ictiobinae species were taken in our initial sample of May 18 and was last observed June 19. These species did not appear until April 17 in 1979 and were still present in the final May 18 sample. Thus, over two spawning years these species were caught from April 17 to June 19. While the use of two spawning years to describe the length of a spawning season may be subject to some question we feel it at least gives a general idea of the Ictiobinae spawning year. The end of May 1978 with 45.3 percent of the organisms taken appear to represent the peak spawning period for Ictiobinae (Appendix Table 4B.2-21, Figures 4.2.1-5, 4.2.1-6).

A comparison of ichthyoplankton collected from Zones 3 and 6 was made. Of the three dominant species sampled, river herring, buffalo/carp sucker and freshwater drum no clear differences of ichthyoplankton density between zones were observed. The sample size of the other species taken was not considered large enough to warrant statistical sampling since even in those few cases where significance might appear it would have little biological meaning (Table 4.2.1-39).

4.2.1.1.2.5.2 Cypress Slough

Ichthyoplankton were found at location 1 of the cypress slough. Two species, catostomidae and clupeidae species were detected. Location 2 lacked sufficient water for sampling (Appendix Table 4B.2-23).

4.2.1.1.2.6 Fish

Seven methods were used (Appendix Table 4A.2-5) to collect 600 fish representing 30 species (Table 4.2.1-40) from the Green River, and the on-site water bodies consisting of 4 of the 5 ponds, 4 locations on the main stream draining the property and the cypress slough. The results of our efforts to describe the type of fish using the several habitats available to them are presented below by water body.

4.2.1.1.2.6.1 Green River

Of the 233 fish representing 24 species taken from the Green River, five species, gizzard shad, freshwater drum, rosyface shiner, emerald shiner and channel catfish with 50, 41, 23, 28 and 20 individuals respectively dominated the catch. These five species made up 74% of the catch by numbers of fish. Five additional species, carp, sauger, white crappie, blue catfish and large mouth bass with a total of 36 individuals made up 15% of the catch. The remaining 14 species representing 11% of the catch made up the balance (Table 4B.2-24).

By weight carp, freshwater drum, gizzard shad, blue sucker, sauger and river carpsucker represented 30.2, 22.6, 14.7, 7.7, 7.2 and 4.3% respectively for a total of 86.7% of the total catch. Thus, gizzard shad and freshwater drum were prominant in both number of individuals and biomass. Blue sucker, sauger and river carpsucker were present in few numbers but of those present most were large. Contrasting this were the rosyface shiner, emerald shiner and channel catfish represented by many small individuals. Seasonally, gizzard shad were taken in May, June and September. However, field results were characterized by catching substantial numbers of shad or few or none in each sample suggesting that shad when present were around in large numbers. Most of the shad taken in May and June ranged in size from 150 to 380 mm. Those obtained in September were smaller with sizes typically from 93 to 200 mm. The presence of the larger shad in May and June corresponded with the finding of large numbers of shad larvae late June and early July (Appendix Table 4B.2-25).

Freshwater drum were caught in May, June, July and September with about 70% of these taken in May and June. Like the shad larger specimens of freshwater drum were obtained in May and June and smaller fish in July and September (Appendix Table 4B.2-25). Drum larvae were observed as early as 28 May in our samples. However, it wasn't until 19 June that large numbers of larvae were observed. Freshwater drum larvae were taken until the 14th of September (Table 4.2.1-38). Thus, it appears that spawning by drum continues from late May through the middle of September with the spawning peak in late May early June. The capture of larger fish in the spring and fewer and smaller fish as fall approaches suggests that the larger fish move into the area in the spring to spawn. A few of these spawners remain in the Green River sample zone and continue as multi-spawners or new adults arrive later in the season. In September immature specimens appear. Age determination of scales shows freshwater drum in the 350 to 367 mm total length range to be 4 or 4+ years old. Those drum 175 to 200 mm in length were 1+ years old. Fish less than 175 mm were usually young of the year (yoy) (Table 4.2.1-42, Figure 4.2.1-11). These yoy were evident in our September collections. Thus the Green River is used as a spawning and nursery area for drum. Use of the area as a full time residence by adult drum does not seem to be the case.

Shiners were caught with gill nets, otter trawls, seines and electroshocking in June and September 1978 and May 1979. Larvae were collected from late May through July though absolute numbers of larvae were generally small (Appendix Table 4B.2-24). About 94% of the adult shiners were obtained by seine and electroshocker (Appendix Table 4B.2-25), with few exceptions along the shoreline. Electroshocking techniques indicate that

these shiners occupy the 1 to 3 m distance out from shore area though single specimens were occasionally caught further out in deeper water. Shiners were caught in almost equal numbers of 20, 22 and 19 from zones 1, 3 and 6 respectively (Table 4.2.1-44). Emerald shiners are known to feed on insects, amphipods, mayfly naiads and caddis worms in Doe Run, Ky[40], on microcrustacea in Lake Erie[41] and alewife eggs[42] though insects both aquatic and terrestrial appear to be the major foods[43]. Rosyface shiners have similar food habits[43]. Food of the type described may be more plentiful along the shoreline.

Channel catfish were obtained in June and September 1978 and May 1979 but not in July 1978 samples. Our results showed more but smaller catfish taken in September and May than in June (Appendix Table 4B. 2-24). However, this may reflect additional effort on our part as seines and the electroshocker were used in September 1978 and May 1979 but not in June 1978 (Appendix Table 4B. 2-25). Equal fishing effort was made for both zones 3 and 6 regardless of sampling time. Three times as many channel catfish were taken in zone 6 than was obtained from zone 3 (Table 4.2.1-45). The presence of terrestrial vegetation and fallen trees in the water along the shoreline of zone 6 provides habitat preferred by these catfish. The less suitable barren shoreline of zone 3 apparently was not as heavily used by these fish. Though few (20) channel catfish were caught in the Green River all but one of the 12 largest specimens were caught in late spring-early summer. Of the 8 smallest fish all but one was taken in the fall sample. Since fishing effort was considered equal between the May and September sampling periods this suggests that the adults are present in late spring-early summer and emigrate from this area by the fall. Channel catfish larvae were caught in small numbers in zones 3 and 6 in the 12 July 1978 night ichthyoplankton Tows (Appendix Table 4B.2-22). It may be that the adults move through the sample area preparatory to spawning in the spring. By July the larvae after leaving the male catfish guarded nest move out into the river from adjacent tributarys. The larvae then grow into the 38 to 105 mm long young that we catch in September.

Carp were caught in both zones 3 and 6 in the September 1978 and May 1979 samples (Apendix Table 4B.2-25). Most of these fish (78%) were obtained by electroshocking. Since the electroshocker was not used in the July 1978 sampling period it is not known if this species was present at that time. However, larval carp were taken from both zones 3 and 6 from mid-May through the end of June 1978 then again in the last week of July and last week of Aug. 1978. In 1979 carp larvae appeared in our nets as early as mid-April (Table 4.2.1-35). Carp spawn as early as March in Alabama[44], April to June in Illinois[45] and Mid-May to mid-August in Wisconsin[46,47]. Therefore, it appears that the appearance and growth of larval carp from the Green River follows similar patterns found in other parts of the United States.

Sauger were taken in small numbers in the June and September 1978 and May 1979 sampling periods (Appendix Table 4B.2-24). These fish were found in both zones 3 and 6. One specimen was taken in zone 1 (Table 4.2.1-47). No discernable pattern of distribution in the Green River with respect to location or time was observed for sauger. No larval sauger were found in this part of the Green River. The size of captured adult sauger ranged

from 132 mm length and 16.3g to 471 mm and 980 g. Using Nelson and Walburg's [48] average length of sauger at the end of each year of life the above length of 132 and 472 mm would result in sauger 1 to 5 or 6 years of age. Sauger appear to be present in this part of the Green River at least from May through September.

4.2.1.1.2.6.2 Ponds

Electrofishing and seine techniques were used to collect fish from four ponds on the site in April 1979. No fish were obtained from pond 1. Ponds 2a, 2b and 3 yielded 6, 26 and 279 bluegills respectively. In addition, two black crappies were taken from pond 2b (Appendix Tables 4B.2-24, 4B.2-25). Sampling effort between ponds was not uniform because of three factors. First, algae concentration varied from pond to pond. Larger amounts of algae in ponds 2a and 2b than in pond 3 tended to interfere with seining, the most productive of the sampling techniques used. In addition, only pond 3 provided a distinct shallow end with firm substrate to support the seiners. The sharper bottom gradient and thick mud and silt accumulations in ponds 2a and 2b prevented much movement out from shore and the speed with which the seine could be brought back to shore. Finally, the lack of suitable banks in ponds 2a and 2b added to the difficulty of landing the seine.

Pond 1 housed large numbers of crayfish and tadpoles. The algae mats observed in the previously discussed ponds were noticeably missing in pond 1. It is likely that the tadpoles, voracious feeders on algae of this type, feed on this algae accounting for this phenomenon.

Based on the large numbers of small bluegills taken from ponds 2a, 2b and 3 it appears that a stunted resident population of these fish exists. There is apparently no major predator available to cull the bluegill population. The ponds are some distance from a hard surface road and on private property. Because of this it is believed that little or no fishing pressure is on these populations. Discussions with the property owner supports this view. Two black crappie were taken from pond 2b. No other species of fish were observed in these four farm ponds.

In summary, the ponds house essentially stunted bluegill populations with the exception of a few black crappie in one pond. One pond (Number 1) lacks fish. These ponds serve as irrigation and livestock water sources. Because of this considerable water level fluctuations occur when water demand by the farmer is made. All the ponds appear to be spring fed and all were made years ago by the local farmers. Plowing of the land is done next to ponds 1 and 3 with the likely possibility of enhancing siltation runoff. Ponds 2a and 2b are surrounded by grassy areas that are probably infrequently plowed. It would be expected that these ponds receive a reduced level of siltation as compared to the previously mentioned ponds.

4.2.1.1.2.6.3 Cypress Slough

The two cypress slough locations sampled yielded 53 individuals representing 12 species of fish (Table 4.2.1-49). Location 1 consisting of open water had considerable terrestrial vegetation alongs its shores. Though

not on the site property this location was sampled since location 2 had so little standing water. The extent of the vegetation varied with respect to flooding and drought conditions. During the July and September 1978 and May 1979 sample periods the vegetation extended 10-20 m out from shore into the open water. Most of the fish taken were found in among the roots and tangle of branches of the shoreline vegetation. No one species of fish dominated our catches. Topminnow, warmouth and mosquito fish accounted for 64 percent of the catch by species. All representatives of the 12 species found in the slough except for the slough darter were retrived from location 1. It is suspected that the darter would also have been captured if it were not for the difficulty in sampling near the bottom. With the exception of the shad, pickerel, warmouth and sunfish all sampled fish were small with most weighing only a gram or two or in some cases less than a gram (Appendix Table 4B.2-24).

Location 2 was sampled in June, July and September 1978 and May 1979 for fish. Water depth maximums reached about 7 to 10 cm. Small open patches of water 1-4 m across usually in the 3 to 6 cm depth range were typical of this location. Six species of fish represented by 17 specimens were taken from this part of the cypress slough. Most fish were small and were less than a gram in weight. Location 2 was difficult to sample for fish because of the shallow water depth, heavy terrestrial swamp vegetation and soft silty bottom. Use of fire crackers to stun the fish prior to seining and dip netting were believed useful for obtaining the 13 specimens taken in July 1978. Electroshocking was of little use because of the samll size of fish at this end of the slough. The cypress slough appears to have a deverse fish fauna.

4.2.1.1.2.6.4 Streams

Electroshocking techniques turned up one bluegill out of approximately 2,400 m of stream examined. If not for some local construction even this one fish would probably not have been residing in the stream. Station 1 was located in the vicinity of a stream spanned by a five meter long wooden bridge. In early 1978 the bridge was observed to be in a deteriorated condition. Sometime prior to our sampling the stream in May 1979 the bridge had been replaced by a culvert and fill. The fill covered the pipe and provided the surface needed for the road bed. Some of the fill had collected on the upstream side and with the culvert had formed a small pool of water about 25 to 30 cm depth. It was in this newly formed habitat that the one bluegill was found.

All branches of the stream (Stations 1 and 2) as well as the main part of the stream (Stations 3 and 4) have been described as having intermittent flows. Sometime in late July or early August 1978 the stream dried up. Prior to that, in early July, water could be seen in the stream at Stations 3 and 4. However, a check of the stream downstream of Station 4 just as it enters the Cypress Slough revealed a dry or moist stream bed. Somewhere between Station 4 and the Cypress Slough the stream water seeped underground. During the flood periods of the Green River it is possible for the river waters to move inland as far up as stream Station 3. Because of an increase in elevation upstream of Station 3 it would be unusual if the effects of any flood extended past this station.

In summary , the stream is intermittent with the lower part once or twice a year coming under the influence of local Green River flooding. The lower part of the stream may provide habitat for fish for short periods following floods and local runoff. As indicated in previous sections local farm use has sharply altered this stream habitat.

4.2.1.1.3 Food Web and Life History of Dominant Species

4.2.1.1.3.1 Invertebrates

Based on preliminary data two invertebrate species, the rotifer Keratella cochlearis and the cladeceran Bosmina longirosties are considered the dominant microcrustaceans.

K. cochlearis is perhaps the most common freshwater metazoan in the world[49]. It is by far the most widely distributed and most abundant rotifer in the major rivers and Great Lakes of the United States[26].

Davis[50] found that K. cochlearis was present throughout the year in Lake Erie with abundance maxima recorded in August and September and a secondary peak in May. K. cochlearis reach maximum densities in June and July and low abundances in late August in two lakes in Northwest Ontario[51].

Vertical migration by K. cochlearis is not well documented although Hutchinson[21] citing Kekuckis (1930) observations in Lake Aoki indicated an upward vertical movement at night. This movement involved only the top two meters and may have been due to a retreat from the surface by day and a subsequent restoration of a random distribution by night[21].

Rotifers reproduce entirely by means of eggs or living young[27]. Reproduction is primarily by parthenogenesis where females are generally produced through the year and male occurrence is restricted to only one to three weeks during the year[29].

The rotifers are small animals with body lengths generally less than 1 mm[52]. Keratella is approximately 0.1 mm[53]. Brooks and Dodson[54] and Edmondson[55] state that K. cochlearis can generally ingest particles in the range of 1 to 15μ. This limits K. cochlearis to being essentially herbevorous. Saunders[56] indicates that algae comprise over 90% of Keratella's diet with bacteria accounting for the balance.

Keratella can serve as food for the carnivorous rotifers, Ploesoma and Asplancha[57][27]. K. cochlearis may also be preyed upon by Leptodora[58] by Cyclops bicuspidatus thomasi[59] and by Chaborous larvae[53].

Rotifers were always negatively selected by larval alewife[60][61]; but were found to be important prey foods for larval yellow perch, white suckers, and emerald shiners[62].

K. cochlearis was seen to produce longer spines and have a slower developmental times at low temperatures (10°C)[48]. The developmental time from eggs to adults increases with increasing temperatures[55].

Bosmina longirostris is categorized as a cosmopolitan species[21] and Pennak[29] lists it occurrence from North and South America, Europe and Asia. It can be found in lacustrine, riverine and estuarine systems[21].

The irregular seasonal occurrence of B. longirostris has been frequently observed. Hutchinson[21] cites several authors stating maximum densities of B. longirostris can occur during any season of the year.

B. longirostris has been observed to vertically migrate into the surface waters at dusk and return to lower depth (6 to 12m, 20 to 39 ft) at dawn in Gull Lake, Michigan[63]. Schendler and Noven[51] noted similar migration in two shallow lakes in Northwestern Ontario.

Reproduction, in most habitats, is parthenogenetic with only female young being produced[29] during the greater part of the year.

As a vertebrate prey species, B. longirostris when dominant in inshore areas, is selectively consumed by adult alewife as the fish move inshore during the evening to feed[21]. Macrozooplankters such as Chaoborus have been observed to feed on B. longirostris[53].

B. longirostris have been observed to replace B. coregoni as the ambient environment becomes more eutrophic. This suggests its use as an indicator of eutrophy[21][64].

Temperature was shown to be an important factor in the life of B. longirostris[65]. At 21°C the animals were able to grow to maturity and produce second generation. Animals grown at 6°C and 11°C had smaller body length and produced fewer eggs over two consecutive generations. Food type, concentrations and daylength also effected population fecundity[65].

Gihrs[66] cites Bhajan (1970) and states that in Sunfish Lake, Ontario, B. longirostris was found to be distributed throughout the water column so long as the water temperature remained below 11°C. As the temperature of the surface waters increased above 11°C the population became concentrated in the deeper cooler waters.

4.2.1.1.3.2 Vertebrates

Several species of fish have been sampled in sufficient numbers from the Green River or on-site water bodies to warrant life history description here. These are:

Gizzard Shad (Dorosoma cepedianum)

Description: Gizzard shad members of the family clupeidae (herrings) are deep bodied and laterally compressed. The last dorsal ray is elongated often being as long as the head. The caudal fin is widely forked. These fish are usually silvery on the sides and bluish on the back[67]. Adults typically reach 300 mm (12 in.) total length but can reach 520 mm (20.5 in.)[68].

Distribution: Widely distributed from the Northeast and Central States (St Lawrence River, Great Lakes, and West to the Dakotas) southward through the Mississippi Valley to the Gulf and Northeastern Mexico[69]. Gizzard shad are permanent residents everywhere in the Mississippi Valley[67] and are common in either lakes or large rivers.

Food and Feeding: Gizzard shad are essentially filter feeders subsisting on phytoplankton[70] and zooplankton. In Kentucky bottom fauna, tendipedids, oligochaetes, diatoms and spirogyra have been listed as principal foods[40]. Smith[71] found shad in Smith Mountain Reservoir feeding primarily on Blenodinium, Dinobryon and copepod nauplii. He concluded that shad were continuous feeders but did show food intake seasonal variations.

Growth: Nine year old fish have been reported[72] with weights reaching a maximum of 1350 g[73] Growth rate is dependent on water temperature and available food but commonly leads to about 100 mm long fish at the end of the first summer. Age I fish range from 99 to 315 mm, Age II from 175 to 411 mm, Age III from 185 to 429 mm and Age IV fish from 216 to 472 mm[74].

Reproduction: Spawning occurs from mid-March through the middle of August in sloughs, ponds, lakes and large rivers usually on a rising water temperature of between 10° to 21°C (50° to 70°F). The eggs are yellowish, demersal, adhesive and about 0.75 mm in diameter when fertilized. Hatching occurs in 95 h at 17°C (62°F) or 36 h at 27°C (80°F)[70]. Fecundity of 300,000 to 350,000 eggs for Age II to IV females appears typical. As is evidenced by the high fecundity of this fish mortality of the young is also high. Females appear to predominate the older age groups[73].

Behavior: Gizzard shad are pelagic schooling fish at least in their first year. Dendy[75] characterizes the young as schoolers but in Norris Reservoir said they ceased schooling upon reaching Age I. Overholtz, et al[76] studying gizzard shad in an Ohio quarry pond found the fish to select 12°C (54°F) or higher.

Channel Catfish (Ictalurus punctatus)

Description: The channel catfish is characterized by large, sharp spines in the dorsal and pectoral fins. It lacks scales, has an adipose fin, deeply forked caudal fin, upper jaw longer than lower jaw barbels and has its eyes in the dorsal half of its head. Its anal fin is said to have 24 to 30[77] or 23 to 29 rays[78]. Body coloration varies between individuals and size. Young fish 350 mm or less in length are bluish silvery or olivaceaus silvery dorsally and silvery white ventrally. Adults 350 to 600 mm in length are silvery blue, olive blue or slaty blue dorsally and yellow white or milk white ventrally. The number of spots on the body varies from many to none. Larger males frequently lack spots[77].

Distribution: The original range of the channel catfish extended from Montana and southern Manitoba to southern Quebec then southwest of the Appalachians to Florida and Mexico[77,79]. It has been introduced widely in the United States[80]. This catfish is found primarily in larger rivers and lowland lakes having sand, gravel, or cobble bottoms though it is known to inhabit silted or mud bottoms. It is rarely found occupying areas having dense aquatic vegetation. Young-of-the-year and immature specimens inhabit areas under boulders within fast flowing waters and generally tolerate faster currents than adults[77]. The adults utilize deep holes primarily during the day[81]. Baily and Harrison[82] indicate that even when channel catfish are found on mud bottoms, the water

is flowing. These fish appear to tolerate a wide range of total suspended solids and are found in clear and muddy waters. They are usually considered to be a species of clearwater streams[83].

Food and Feeding: Channel catfish are omniverous bottom feeders[82]. Surface feeding can occur but is not common. Food can be taken both by sight and taste[81] during day or night but night seems to be the most active time. Baily and Harrison[82] examined the feeding habits of channel catfish in the Des Moines River, Iowa. Catfish under 100 mm in length fed primarily on Diptera, but also included trichoptera and ephemeroptera in their diet. In Lake Pontchartrain, arthropods were also eaten[84]. For fish in the 100 to 300 mm length range, insects dominated the diet with larger insects being selected. Small fish and plant seeds were taken in some cases in significant amounts. Fish exceeding 300 mm fed on fish, insects and elm seeds. Channel catfish appear to be opportunistic feeders switching from dipterans in the spring to trichoptera during the summer and fall and elm seed in May and June. Terrestrial insect consumption correlated with major insect flights and forage fish were eaten in numbers related to their abundance[82]. Channel catfish in Virginia were observed to feed on filamentous green algae, blue crabs and small fish.[85]

Channel catfish principal feeding activity in the Des Moines River occurred from dusk to midnight. The largest numbers of forage fish were eaten after water cleared following a reduced water flow. Feeding may be inhibited as a result of light from full moonlight. These fish show little change in feeding activities between 10° and 34°C. During the spawning period mature catfish are believed to cease feeding[82]. Lewis et al[86] have observed that channel catfish prefer crayfish over fathead minnow and these minnows over bluegills, green sunfish and golden shiners.

In Lake Erie food consisted of a variety of dipterans, fish and cladocerans and this feeding was seasonally distinct based on prey availability[87]. More recent work now suggests that temperature exerts some influence on feeding activity. Channel catfish in ponds initiated feeding in March at 12°C and ceased feeding in October at 22°C. Each fish fed approximately the same time each day after acclimating to prevailing oxygen and temperature. Time of feeding was related to size of fish and existing oxygen and temperature[88]. Under pond conditions 43 percent and midnight and 36 percent between 12 noon and 6 pm[89].

Growth: Trautman[77] reports that young-of-the year channel catfish three to five months of age attain 50 to 100 mm in length. At age I typical lengths are 90 to 190 mm. Adults 275 to 750 mm long weigh 340 to 6,800 g. Largest specimens of 825 to 1,170 mm weigh 11,340 to 13,600 g. Commercial fisherman have described weights of 17,240 g. Clay[78] reports a slightly larger observed maximum length and weight of channel catfish in South Carolina of 1,200 mm and 26,300 g. Gabrielson and La Monte[90] discuss seeing catfish of 1,270 mm total length (TL). Weights of these fish, however, were 24,948 g, slightly less than the catfish reported by Clay[78].

Maximum age of channel catfish appears to be geographically or habitat related, with catfish of usually no more than seven years of age being observed in Kansas[81] and Oklahoma[91]. Stevens[92] in South Carolina and Kimsey et al[93] in California have reported Age XIV catfish. Magnin and Beaulieu[94] found age XL catfish in the St Lawrence River.

Channel catfish show surprisingly rapid growth under certain conditions. Stocked 75 to 100 mm long fish grew to as much as 375 mm long after one year in Southern California reservoirs[83]. Weights reached by stocked fingerling channel catfish of 45 to 360 g after two years, 180 to 910 g after five years in New York farm ponds have been recorded[95]. Carlander[74] feels that channel catfish mature at age II when in the 267 to 380 mm length range. Katz[96] in a review of the literature indicates maturation at ages IV to VI at 330 to 360 mm. While age may be of some importance, it appears that length or size is the critical factor determining maturation of this species.

Higher water temperatures derived from waste heat discharged from a steam-electric plant in Tennessee extended channel catfish growing season, enhanced growth rates and increased production poundage[97]. Kilgen[98] reported that channel catfish growth seemed adversely affected by the presence of water hyacinths. Kilgen[98] believed that the plants did not harbor an adequate supply of insects and probably interfered with feeding activity.

Channel catfish condition generally decreases with respect to increases of standing crop, decrease in akalinity, and increasing variability of circadian oxygen levels. Oxygen levels less than 3 mg/l will retard growth[99]. Little information concerning mortality has been reported in the literature. In the Sacramento Valley, California, tagging studies indicate annual mortalities of 56 percent with fishing mortality accounting for 30 percent of this figure[100].

Reproduction: Spawning for channel catfish occurs at temperatures between 11° and 20°C with about 17°C the optimum[101]. Katz[96] and McClellan[102] suggest higher spawning temperatures giving 23.9°C and 21.7°C, respectively. Water temperatures reach these points normally in the spring or early summer for most areas inhabited by these fish. Usually females spawn once, males twice each year[101] though two spawning periods have been identified in Kansas Rivers[103].

Fecundity of 2,000 to 70,000 eggs per female has been given by Katz[96]. Fecundity is size correlated with a fish 254 mm TL carrying 2,000 eggs[104] and a 660 mm long fish 37,500 eggs[105]. Adults typically migrate upstream, sometimes in small streams, to spawn[77]. Spawning takes place in isolated, poorly lit sites such as under rocks, logs, in holes, or other protected areas[81,106,107]. Males select and clean nest sites[81,106], then after spawning incubate and protect the eggs and aerate and clean the eggs by fanning with their pelvic fins[101]. Channel catfish are stocked annually in the Lower Colorado River since spawning does not occur. Barriers such as culvert gratings are believed to prevent migration thought to be necessary for spawning[108].

Unfertilized eggs taken from a ripe female were 3.5 to 4.0 mm in diameter[85]. Fertilized eggs, under hatchery conditions, hatch in 9 to 10 days at 16° to 18°C and in five to six days at 25°C[106]. Hybrids of male blue catfish and female channel catfish have been produced[109].

Paired channel catfish weighing about 680 g were induced to spawn in sections of concrete pipe located in an aluminum raceway culture tank. Hatching success ranged from 90 to 95 percent, the fry appearing to be in good condition. Fighting between catfish pair occurred if the nonspawning pair remained together for longer than two weeks or if the female was not removed after the eggs were laid[110].

Behavior: Channel catfish actively move about. In the Mississippi River tagged specimens were recaptured up to 344 km upstream of the tagging area after 33 months at liberty[111]. Movement to upstream sites in preparation for spawning is common. McCall[112] tagged, with ultrasonic transmitters, and tracked channel catfish in Cholla Lake, Arizona. He observed that their movements described a home area of about 483,000 m^2 and that they traveled 210 to 2,122 m from the point of tagging. These catfish were found associated with narrowleaf pondweed 29 percent of the tracking time and migrated seasonally in response to changing water temperatures.

Randolph and Clemens[113] observed that channel catfish behavior in 1.6 ha ponds fell into (i) occupancy of home areas (ii) feeding in nearby areas and (iii) traveling between home and feeding areas. Traveling was by specific routes. Home area and traveling route bottoms were hard and free of silt. Feeding areas (feeding was accomplished through demand feeders supplying pelleted food) had a layer of soft mud and silt. Home areas were in the shallow areas during the spring and fall and in deeper areas in the summer and winter. Though channel catfish can be active anytime they are considered crepuscular[114] or nocturnal feeders[77]. Fast currents appear more easily tolerated by young-of-the-year or early adults than by older fish. Locations under boulders or logs are preferred by smaller individuals[77]. Apparently older or larger fish commonly occupy open spots or areas lacking cover. Channel catfish have been observed to be attracted to the warmer waters resulting from a heated discharge[115]. These fish can tolerate high water temperatures and have an upper limit around 33.5°C[116] or 35°C[117].

Disease: Protozoan parasites of channel catfish have been described[118]. Other protozoan parasites, gill flukes, tapeworms and Columnaris are also known to afflict these animals[119]. Under hatchery conditions, Ichthyophthirius, Trichodina and Scyphidia outbreaks have been reported[120].

Blue Catfish (Ictalurus furcatus)

Description: The blue catfish lacks scales but has an adipose fin and is additionally characterized by its deeply forked caudel fin and a straight margined anal fin. It is bluish or slivery being somewhat darker along the back and upper sides then along the lower sides and ventral area[69,77]. Jordan and Evermann[67] claim that this fish can be plain or somewhat spotted.

Distribution: The catfish's original distribution included the Mississippi Valley west to Mexico principally in large rivers[69]. Jordan and Evermann[67] gave its range as Ohio to Iowa and Texas. Current references[78] show the blue catfish to be common to large rivers making up the Mississippi Valley and along the Gulf Coast to southern Mexico. This fish is found in Kentucky in the Mississippi and Ohio Rivers and the lower sections of their larger tributaries. Early reports from fisherman on the Ohio River indicated that blue catfish were more common prior to river ponding. It was believed that these fish fed in fast moving waters. In the winter it was not uncommon to find blue catfish in the deeper waters up to 9.1 m (30 ft) in depth. These fish tended to avoid silted bottom areas and sluggish pools[77].

Food and Feeding: Young catfish (<100 mm) have been reported to feed on zooplankton[84]. In another report describing 95 to 127 mm (3.7 to 5.0 in.) long fish they ate amphipods, shrimp and insects[121]. Perry[121] said that the intake of prey to include shrimps, crabs and fish increased as the catfish grew to 465 to 722 mm (18.3 to 28.4 in.) with the transition to fish as part of the diet occurring at 293 mm (11.5 in.) total length. Similar findings by Brown and Dendy[122] indicated that the inclusion of fish as prey in the blue catfish diet takes place as the catfish reaches lengths of 203 to 330 mm (8.0 to 13.0 in.) total length.

Growth: Age I blue catfish typically reach 226 to 264 mm (8.9 to 10.4 in.). Lengths increase slowly thereafter and reach a range of 348 to 470 mm at Age V[123,124]. Mean weights for mean total lengths of 229, 254, 356 and 457 mm are 95, 136, 386 and 871 g, respectively[125,126,127]. Moore[69] reported maximum weight for blue catfish of 68 kg (150 lb) while Cross[128] claimed enormous specimens up to 113 kg (250 lb) from the reports of early writers. The largest specimen reportedly caught in the Ohio River weighted 41.7 kg (92 lb) and was 1,370 mm (54 in.) long[77]. Today it would be a rare find to discover individual fish exceeding 18 kg (40 lb). Fish as old as Age X have been identified[123]. Large populations of blue catfish are known from South Louisiana estuaries where they reportedly out-number channel catfish 2:1[121].

Reproduction: Blue catfish are spring spawners[129] though little is known of its reproductive behavior. As a general rule Ictalurus sp. are known for their care of the young[130]. Hybreds of male blue catfish and female channel catfish have been successfully produced and raised to adult size[131].

Behavior: Blue catfish are migratory during the spawning season and move upstream in the spring and downstream in the fall[129].

Disease: Oxytetracycline (Terramycin) has been successfully used (in fish food) to reduce or eliminate mortality of blue catfish infected with Aeromonas liquefaciens or Pseudomonas sp.[132].

Sauger (Stizostedion canadense)

Description: Sauger are generally elongate in shape with a fusiform head. The widest part of the cylindrical body occurs adjacent to the posterior edge of the spiney operculum. The back is yellow olivaceous, sides brassy

or orange with three to four saddle like dark green-black blotches. The two dorsal fins have roundish dark spots. Canine teeth, partly scaled cheeks, forked caudal fin, 12 to 13 anal rays and 17 to 21 second dorsal fin rays characterize this fish[43,67,69,78].

Distribution: The sauger is distributed throughout the Mississippi drainage. This fish is found in the Missouri drainage as far west as Montana, is present in the Great Lakes and associated drainages, and its northern limit includes the provences of Saskatchewan, Manitoba, Ontario and Quebec

in Canada. The saugers southern limit includes the eastern end of Oklahoma, all of Arkansas and the northern parts of Mississippi and Alabama[67,77]. It is common to the Ohio River drainage and is found in all rivers of Kentucky[78].
More saugers were found in larger, deeper waters with low gradients in the Ohio River[77]. Their preferred habitat includes silty and therefore turbid rivers and large lakes[80]. They are inhabiters of slow moving water such as impoundments and slack water areas of rivers[78].

Food and Feeding: During June to September age I+ sauger living in Michigan lakes were observed to feed primarily on fish (96 to 100%) and incidently on invertebrates (0 to 4%). Age 0 sauger feed essentially on crustaceans with cladocera and copepoda as the primary prey. Sauger were observed to feed on other sauger and occasionally walleye though both prey were taken in relatively small numbers. Sauger sometimes became the prey of walleye. The sauger is thought to feed close to the bottom. The dominant food fish eaten by sauger in Michigan was yellow perch[133] or trout-perch[134].

Growth: Koenst and Smith[135] recorded the growth rates of juvenile sauger when held at test water temperatures of 16° to 26°C. Maximum growth was at 22°C and minimum growth at 16°C. Upper lethal temperatures (96 h test) of 26.6° and 30.4°C with acclamation temperatures of 10° and 26°C respectively for juvenile sauger were also documented. Maximum longevity of age VI[136] and age VII[48] are known. For unknown reasons the mortality of sauger males past three years of age appears to be greater than for females[136].

Reproduction: The sauger is potamodromous and thus moves from lakes and larger streams into tributaries to spawn. These fish are known to migrate long distances, one tagged specimen traveling 381 km (237 mi) in 11 days in the Tennessee River[78]. Sauger spawn in late April, early May in the upper Missouri River[48] or in April in northern Illinois[43]. The spawning season is typically under two weeks duration with most of the peak activity occurring in five to seven days.

Gravel, rubble and boulder substrate describes the sauger spawning area. One female is joined by one or more smaller males to fertilize the 15,000 to 40,000 released eggs. The broadcast distributed sticky eggs quickly adhere to the substrate material. Depending on water temperature hatching can take as long as three weeks[43,48]. The optimum fertilizing temperature is considered to be 9°C with optimum incubation temperature between 9° to 15°C[135]. The exposure of incubating eggs to air resulting from the release then non-release of water from the Fort Randall Dam, MO

resulted in reducing the abundance of this species in waters below the dam[48]. Sauger probably become sexually mature in their second year.

Behavior: Sauger are as indicated above a fresh-water migratory fish. The migratory behavior appears related to spawning activity only. This fish appears to prefer turbid waters and has been shown to have a less dense retinal epithelial pigment and a denser reflecting material than walleye. These retinal characteristics allow the sauger to function at low light levels typical of that in turbid waters[137]. Sauger have been harvested by commercial fisherman since prior to the turn of the century. In Lake Erie commercial landings peaked in 1916 and declined to virtual extinction by 1960[138].

Freshwater Drum (Aplodonotus grunniens)

Description: The freshwater drum is laterally compressed, has a horizontal inferior mouth, two-part dorsal fin, the anterior one spiney, the posterior fin soft, rounded caudal fin and a complete lateral line. The drum is silvery or grayish white, has ctenoid scales and large pharyngeal teeth. Two distinct characteristics of this fish are its extension of the lateral line across the anal fin and the presence of two anal spines, the first small, the second well developed[43,78]. Meristic analysis of freshwater drum from different parts of the United States show a high degree of similarity. This has been interpreted as indicative of an unusually strong level of stability within the species[139].

Distribution: The drum is primarily a fish of the Mississippi drainage though it is found in a few areas outside of the Mississippi. The southern limit includes the east coast of Mexico, then northward into New Mexico and over to Louisiana. It is found in most of the Mississippi, including the Ohio and Missouri Rivers. Its northern limit includes the Great Lakes (excluding Lake Superior) and the southern part of Canada, from north of North Dakota to the St Lawrence River[77]. The drum is suited to large lakes and rivers. It is a bottom dweller frequenting somewhat turbid waters having sand and/or silt bottoms[43]. It is present in most of the large rivers and creeks of Kentucky and is referred to locally as white perch[78].

Food and Feeding: Young-of-the year (YOY) freshwater drum feed on zooplankton during the daylight hours ingesting most of the organisms in the morning[140]. Smith[43] reported that food for young drum consisted of insects and crustaceans. YOY have been observed to feed on zooplankton until mid-July, then switch to chironomids (50% of intake) in August and

Hexagenia (Ephemeroptera) nymphs (40% of intake) subsequent to August[140]. Age I fish were found to feed on daphnia, cyclops and diaptomus during April through June. Hexagenia nymphs and chironomid larvae are commonly taken from April through October. Feeding activity, particularly for zoo plankton, occurs primarily during the daylight hours with peak ingestion around 6 pm. Bottom-fauna such as the Hexagonia larva are more frequently taken at night with peak activity occurring between 3 and 6 am. Age I drum rarely take fish as only 1.5% of the individuals examined by Swedberg[140] had eaten fish. Wren[122] reported that drum 25 mm (10 in.) in length fed primarily on diptera larvae.

Adult drum feed on mollusks, crayfish and other fish[43]. In one case the primary food taken by adult drum was the Asiatic clam[141]. Though freshwater drum eat food ranging from zooplankton, to aquatic insect larvae and fish, it is common for these food habits to become seasonally adjusted in relation to food availability[87].

Growth: Freshwater drum have been reported to mature as early as Age IV for males[141,142]. In Lake Winnebago, WI, some drum males did not mature until Age V[142]. Females usually mature two years later at Age VI[141]. Priegel[142] said a small proportion of females (7%) in his observed population matured at Age IV, as against 40% of the males, but that all the females had matured at Age V. No significant growth rate differences between the sexes were noticed. Drum in Lewis and Clark Lake attained Age VIII before all the females matured[143].

Six years after the creation of the Lewis and Clark Lake, drum growth rates improved. Swedberg[144] suggested that an increase in Hexagenia abundance was the primary factor. In cases where the fishes growth rate decreases, the age of sexual maturity increases[145].

The oldest drum found in Lake Winnebago, WI was Age X. Two fish attaining this longevity averaged 427 mm[142]. The largest drum reported from Kentucky weighted 16 kg (35 lbs)[78]. The largest from the Ohio River was 889-991 mm (35-39 in.) and weighed 16.5 kg (36 lbs)[77]. Drum in Wheeler Reservoir became commercially important at 7 to 8 years of age at lengths of 406 to 483 mm (16 to 19 in.)[141].

Reproduction: Mean fecundity has been reported as high as 686,000 eggs from 3.6 to 5.9 kg (8-13 lbs) fish[141]. Swedberg and Walburg[146] described fecundity of 34,000 to 66,500 from 307 to 386 mm long 6 to 9 year old drum. The mean fecundity equaled 49,300. Spawning took place in shallow water in July (Lake Erie)[147] and in June and early July at 18.0° to 24.5°C in Lewis and Clark Lake[146]. In Wheeler Reservoir, AL, spawning has been observed to occur as early as late May[141].

The floating eggs hatch at the surface[147]. Female drum may spawn more than once each year. Laboratory reared eggs hatch in 27 h at 23°C, and the prolarvae stage is completed in 45 h. Weak year classes have been observed with cold summer temperatures[146].

Behavior: A temperature tolerance (LD_{50}) of 32.8°C has been reported though no acclimation temperature was indicated[148]. A characteristic of the drum is the drumming or purring sound made with the aid of the swim bladder[43].

Disease: No difference in the degree of parasitism of drum in the influence of a thermal discharge versus those not in the discharge was found[149].

4.2.1.1.4 Threatened and Endangered Species

Table 4.2.1-1 lists those aquatic species known to occur in the Green River Basin considered by various groups and agencies as threatened and endangered and those which may become endangered[150]. Only those species listed by the U.S. Department of the Interior as threatened and endangered are legally protected. Although the Kentucky Department of Fish and Wildlife Resource's list of rare and endangered species is not legally recognized, the department continues to use the list. Therefore, it is felt that these organisms should be given special attention as to their possible occurrence in the vicinity of the proposed site. Those fish taxa designated as rare and endangered by the Kentucky Department of Fish and Wildlife Resources are not included on the national list.

The Kentucky Department of Fish and Wildlife Resources list three fish species, found in the Green River basin, as rare and/or endangered. The following defines these taxa as to their geographical range and preferred habitat[78],[151],[152][153].

Percina macrocephala (Longhead Darter)

Geographical Range - Large streams of the Ohio River system from Tennessee and Kentucky through southern Ohio, West Virginia to Pennsylvania and New York.

Kentucky Range - Green River system in Allens, Adair, Barren, Casey, Green and Monroe counties.

Habitat - Exists only in relatively large high gradient streams with bottoms that have not become highly silty.

Etheostoma tippecanoe (Tippecanoe Darter)

Geographical Range Tributaries of the Ohio River from the Wabash River system of Indiana through the Kentucky and Licking River systems of Kentucky. The Scioto of southcentral Ohio and the Miskingum River of southeastern Ohio to tributaries of the Allegheny in northwestern Pennsylvania and in isolated localities in the Cumberland and Tennessee basins.

Kentucky Range - Known from a few localities near the midpoint of the Kentucky and Lickings Rivers. The first report of this darter from Kentucky was by Clark[153] (1940 as Poecilichthys tippecanoe) from the Lickings River at Wyoming and at Johnson Ford. Subsequently taken from three locales in the Lickings and Kentucky Rivers.

Habitat - Long riffles of moderately large streams with water depth of 2 ft. and water velocity of 1 ft/s. Preferred bottom largely of sand mixed with sandstone or shale.

Etheostoma aspringine (Mud Darter)

Geographical Range - Lowlands of the Mississippi River Valley from Texas to Mississippi and northward to Iowa, Wisconsin and Minnesota.

Kentucky Range - Cumberland River system in Caldwell and Todd Counties, Green River System in Grayson and Warren Counties, Tennessee River system (Clark River) in Marshall County and Mississippi River tributary in Fulton County.

Habitat - Existing range from slow flowing streams to the standing waters of mud bottomed sloughs.

The U.S. Department of the Interior list three mussels found in the Green River basin as endangered and/or threatened. The following defines these taxa as to their geographical range and prefefred hatat.[150],[154]

Pleurobema plenum (Rough Pigtoe)

Geographical Range - Upper Mississippi River drainage and Saint Lawrence drainage from western New York west to Michigan, Wisconsin, Iowa and Kansas and south to Arkansas and Alabama.

Kentucky Range - Known from the Green River.

Habitat - Large clear water rivers, found often around shoals.

Lampsilis orbiculata (Pink Mucket)

Geographical Range - Ohio, Cumberland and Tennessee River systems.

Kentucky Range - One population found in the Green River.

Habitat - Prefers clear waters with gravelly bottoms.

Obovaria retussa (Gulf Stick)

Geological Range - Ohio, Cumberland, Tennessee and Mississippi River systems.

Kentucky Range - Located only in the Green River.

Habitat - Clear waters found in shoal areas.

4.2.1.1.5 Present Stress in System

The most common pollutant in the lower Green River is suspended sediment. The suspended sediment concentrations are high[1][5] and is evinced by excessive turbidity. This is the result of constant turbulance caused by the movement of commercial barge traffic, sediment runoff from agricultural farm land and acid mine drainage[1]. Most of the barges create enough turbulance to essentially scour the shallow channel and shoal areas. The effects of high turbidity on the rivers environment are many and varied. Heavy silt loads can reduce light penetration to a point which

curtails or completely prevents plant growth, including that of phytoplankton[17]. Suspended sediments can alter nutrient concentrations, have a shearing effect upon the plankton, clog egg membranes, smother benthic populations,[155] alter the rates of temperature change[156] and cover areas which might otherwise provide a suitable substrate for fish spawning. In addition, silt particles can interfere with gill functions and injure fragile gill membranes exposing fish to bacterial infection[157]. Resuspension of particles may also deplete dissolved oxygen concentration by raising the biochemical oxygen demand[155].

4.2.1.2 Sensitive/Important Species in the Receiving/Affected Water Bodies

Those forms collected during the Green River survey, from all trophic levels, appeared to be common-benthic organisms. Those found to be dominant were generally pollution tolerant or facultative, being able to exist under various environmental conditions. No rare or endangered species were collected nor were any commercially or recreationally important invertebrate or vertebrate forms found in any great abundance.

Those organisms described in the Food Web and Life History of Dominant Species (Section 4.2.1.1.3) were selected because of their numerical importance in the study area and because of their cosmopolitan distribution in freshwater systems. Those forms discussed in that section are considered to be generally the more important species identified and those forms which might reflect, in their abundance and distribution, possible environmental perturbation induced by the proposed plant.

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4.2.2 TERRESTRIAL ECOLOGY

4.2.2.1 Regional Ecology

4.2.2.1.1 Physical Environment

Henderson County, Kentucky is in the Shawnee section of the Interior Low Plateau Province (Fenneman, 1938, cited in USDA Soil Conservation Service, 1967) [1]. The Shawnee section is a low plateau in the northwestern corner of Kentucky extending west to the Tennessee River, and southwestern Indiana and southern Illinois. Most of the region is a low, moderately dissected plateau. Pleistocene alluvium occurs abundantly in the wide river valleys carved in the underlying weak shale[1]. Most of the soils in the county developed from loess or alluvium; a few developed from the underlying sandstone and interbedded shale[2].

The climate is continental. The summers are long and moderately hot, with an average July temperature of (250°C) 78°F. The average temperature in winter is (1.7°C) 35°F[1]. The average length of the growing season is 197 days, and mean annual precipitation is approximately 45 in. (114 cm), evenly distributed throughout the year[2].

4.2.2.1.2 Vegetation

The natural vegetation of Henderson County is included in the area identified by Braun[3] as the Western Mesophytic Forest Region, which is essentially transitional between the Mixed Mesophytic Forest to the east and the Oak-Hickory Forest to the west. Common tree species of the Western Mesophytic Forest in the upland region of Henderson County are oaks (Quercus spp.) and hickories (Carya spp.), which probably dominated original vegetation of the rolling plateau lands, and mesophytic species, characteristic of moist slopes, such as beech, (Fagus grandifolis), tulip-tree Liriodendron tulipifera) and sugar maple (Acer saccharum). The distribution of these species is greatly influenced by local soil conditions.

The wide silt-filled floodplain of the Green River originally supported extensive swamp forests. These contained a large proportion of southern species and were probably extensions of Mississippi River alluvial plain vegetation. Trees which could tolerate periodic flooding from the Green River include cottonwood, (Populus deltoides) black willow (Salix nigra), pecan (Carys illinoensis), pin oak (Quercus palustris), hackberry (Celtis occidentalis), American elm (Ulmus americana), river birch (Betula nigra), silver and red maple (Acer saccharinum and A rubrum), and bald cypress (Taxodium distichum). The distribution of these species was largely related to depth and duration of flooding[3].

Existing vegetation of the Site region reflects the dramatic changes resulting from agricultural and residential expansion. While most of Henderson County was originally forested[4], only 20 percent of the county was wooded in 1975[5]. The practical crops now grown are corn, soybean, hay and grain.

Approximate measurements of wooded area depicted on 7-1/2 minute series U S topographic maps, dated 1957-1971, were obtained for a circle with a

radius of 10 km (6.2 mi) from the Baskett Site. Assuming flooding occurs at elevations of up to 375 ft. (114m), floodplain forest covered approximately 8 percent of the 10 km (6.2 mi) radius area, and upland forest 6 percent. The most extensive tract of upland forest remaining in this region is on Wolf Hills (a loess covered sandstone formation) in a band 0.8-2.0 km (0.5 mi-1.2mi) wide extending west from the site 6.5 km (4.0 mi). Audubon State Park includes the western half of Wolf Hills, preserving a mature mesophytic forest community containing beech, sugar maple, tulip-tree, white ash (Fraxinus americana), oaks and hickories.

Relatively large tracts of floodplain forest once extended west from the site, paralleling Wolf Hills, and also directly northeast of the site between the Ohio and Green Rivers. From 1975 aerial photographs, it was determined that although upland forest distribution changed little since preparation of the 1957-1971 U S G S topographic maps, the occurrence of floodplain forest has been reduced by 25 percent. Most of the reductions have occurred northeast of the Site, where corn and soybean fields have replaced stands of floodplain forest.

4.2.2.1.2. Wildlife

4.2.2.1.2.1 Region Characterization

The Green River Valley and surrounding uplands provide a wide variety of habitats for wildlife species. Consequently, the fauna of the region is relatively diverse. Over 240 species of birds[6], 50 species of mammals[7], and 80 species of reptiles and amphibians[8] may occur in the region (Tables 4.2.2-1,-2,-3, and-4).

Much of the original fauna breeding in the region was found in woodlands. Extensive clearing for agriculture has eliminated a few species (eg, black bear), but has created suitable open grassland habitats for many other species. Aquatic habitats are generally limited to streams and backwater sloughs or oxbows. Additionally, regular flooding by the Green and Ohio Rivers makes large areas of flooded fields and forests available to migrant waterfowl.

4.2.2.1.2.2 Existing Use

Hunting is one recreational use of the fauna of the region. Thirty-three species of birds and six mammal species are considered game animals. Eleven other mammals are trapped as furbearers. The most important game species are bobwhite, mourning doves, rabbits, squirrels, and white-tailed deer. Muskrat, raccoon, opossum, and fox are the major furbearers. The Kentucky Department of Fish & Wildlife maintains three units in Henderson County, containing over 1200 hectares (over 3000 acres), as the Sloughs Wildlife Management Areas. Both upland game and waterfowl may be hunted on this land; and one unit near Geneva, is wintering grounds for over 20,000 geese, as well as other waterfowl. The portion of the management area known as Henderson Slough has been proposed for the National Registry of Natural Landmarks[15].

Nonconsumptive recreational use of wildlife includes bird watching, photography, and other forms of nature study. Although specific data are not

available on these forms of wildlife use, Henderson County is significantly used by interested naturalists. Henderson was once the home of the famous naturalist, John James Audubon, and Audubon State Park, named in his honor, is visited by many conservationists. There is an active Aubudon Society in Henderson which conducts field trips in the area, particularly to the State Park and to the Sloughs Wildlife Management Area.

4.2.2.1.2.3 Rare and Endangered Species

The Green River is at or near the range periphery of a number of species, found in Kentucky and as a result this area supports more regionally rare species than most other sections of the state. Although twenty-five species generally considered rare in the state may occur in the region, only four are declining on a national basis and are listed as endagered by State and Federal authorities (Table 4.2-5).

No critical habitat for any of these four species (Indiana bat, gray bat, peregrine falcon, and bald eagle) has been designated in the region. All four species may occur in the region as rare migrants and the Indiana Bat may also breed there.

4.2.2.2 Site Characterization

4.2.2.2.1 Physical Environment

The Baskett Site is located in the Green River drainage basin approximately two miles upstream from the confluence of the Green and Ohio Rivers. The Site is situated on the eastern portion of the Wolf Hills and ranges in elevation from 146m (480 feet) to 104m (342 feet) MSL which is the mean pool level of the Green River. Approximately 335 acres (136 hectacres) of the Site lie on the floodplain of the Green River. Flooding occurs annually during late winter and spring on much of the floodplain property. The remainder of the proposed Site includes low bluffs which extend east from Wolf Hills. This portion has been eroded to varying degrees by an intermittent stream and is characterized by rolling terrain which risses in elevation to the southwest.

The Site is underlain by silt loam and silty clay loam soils formed from alluvial and, in upland areas, aeolian deposits. Seventeen soil series derived from alluvium and mixed sediments comprise the floodplain component. Principal floodplain soils utilized for agriculture are the Wheeling, Weinbach, Lindside and Sciotoville series which are mostly well drained silt loams ranging in reaction from slightly acidic to very strongly acidic. Floodplain forest and slough vegetation overlie Ginat and Melvin silty clay loams and Lindside silt loam. The silty clay loams are poorly drained mixed sediments with medium to strong acid reactions[1].

Ten soil series occur in the upland portion of the site. Loring silt loam and Granada silt loam are more abundant than other series in cropland areas. Both these series are loessal and characterized as strongly acidic and well drained to moderately well drained. The larger wooded tracts are underlain by Loring silt loam and Memphis silty clay loam. The latter, developed from aeolian deposits, is strongly acid and well drained.

4.2.2.2.2 Vegetation Communities

4.2.2.2.2.1 Distribution

The distribution of vegetation cover types of the Site and corresponding measurements of aeral extent are presented in Figure 4.2.2-1, and Table 4.2.2-6, respectively. Approximately sixty-fice percent of the Site is cropland; the remaining area is predominantly floodplain forest (19 percent), upland forest (6 percent), fence rows and intermittent stream borders (5 percent) and Cypress Slough (3 percent).

Six broad vegetation cover types were identified and are described separetely in the following section. Data were obtained from field sampling and observations, as described in Appendix 4A.3. No sampling was conducted in croplands or pasture.

4.2.2.2.2.2 Community Type Descriptions

4.2.2.2.2.2.1 Upland Forest

Eighteen ha (44 acres) of the Site were identified as upland forest, which occurs as scattered wood lots in steeply sloping areas where soils are well-drained and mostly classified[1] as eroded and severely eroded. The larger stands are 2-5 ha (5-12 acres) in size. Portions of several stands have been logged within the past two years.

The natural vegetation of upland areas, as noted by Braun[3], includes a broad specturm of climax and seral species with no one, dominating, cover type. On site, the upland forest tracts are readily differentiated from floodplain forests by the presence of tree species such as sassafras (Sassafras albidum) and sugar maple (Acer saccharum) which rarely occur in the floodplain. Much of the upland forest area of the site is in a successional state. Large portions of two stands, on the western and southwestern property line, have been recently logged.

Estimates of frequency, occurrence by cover class and, for canopy trees (diameter 5 cm or greater), density, are presented for upland forest species of the canopy, shrub and herbaceous strata in Tables 4.2.2-7, -8 and -9, respectively. Species area curves obtained by plotting number of plots sampled versus species sampled are presented in Figure 4.2.2-2. The curves level off quickly in relation to sampling effort, which reflects the homogeneity of the stand selected. The herbaceous and shrub strata appeared similar in terms of species composition to that occurring in other upland forest patches on the Site.

The canopy differs from other on-site upland stands due to the predominance of mature sassafras, a common invader of abandoned fields on dry ridges and upper slopes[17]. Its occurrence in this stand could be a result of a past fire or logging activity. Other characteristic canopy species in upland forest stands on-site were American elm, sugar maple, and black locust (Robinia pseudo acacia). Additional species observed in upland forest tracts of the Site are included in Table 4.2.2-10.

Japanese honeysuckle (Lonicera japonica) and brambles (Rubus spp.) were conspicuous shrub components of much of the upland forest area. The principal canopy tree species occuring in the shrub stratum were red elm (Ulmus rubra) , American elm, and box-elder (Acer negundo). The herbaceous stratum was characterized by extensive stands of jewelweed (Impatiens capensis), relatively large patches of Japanese honeysuckle, and brambles.

Tree size and prevalence of sassafras indicate that the stand selected for sampling is the result of secondary succession. The more shade tolerant American red elm[17] were ubiquitous in the shrub stratum of most upland forest stands, and would be expected to become an important component of the canopy stratum.

The occurrence of sugar maple and occasional presence of tulip-tree in upland stands of the Site, and absence of extensive areas of oak-hickory canopy, suggest that these stands would develop into mesophytic forest types characteristic of ravine slopes[3], rather than oak-hickory types characteristic of rolling plateau lands.

A small 1-2 ha (4 acres) forested slope, the northernmost stand along the western border of the Site, (Figure 4.2.2-1) exhibited several species typical of mesophytic forest types and not found in other upland portions of the Site. In addition to sugar maple and basswood (Tilia heterophylla), this tract contained clumps of appendaged and broadleaf waterleaf Hydrophyllum appendiculatum and H. canadense), bloodroot (Sanguinaria canadensis), may-apple (Podophyllum peltatum) and green dragon (Arisaema dracontium). These species would be typical of the Wolf Hills forest included in Audubon State Park 6 km (4 miles) west of the site, where rich loess soils support a mesophytic forest community. Principal stresses affecting upland forest areas are logging and past soil erosion.

4.2.2.2.2.2.2 Fence Row, Field Edge, and Intermittent Stream Border

The species on the forest and field edges are a mixture of weeds and components of the floodplain and upland hardwood community types. The floodplain species are found in the ditches or intermittent streams draining the agricultural fields. They include American elm, red elm, hackberry, sycamore, box-leaved maple, elderberry (Sambucus canadensis), trumpet creeper (Campsis radicans), wood nettle (Laportea canadensis), and Joe-pye weed (Eupatorium fistulosum). Upland hardwood forest species found on the well drained banks or forest edges were basswood, Christmas fern (Polystichum acrostichoides), white ash and redbud (Cercus canadensis). Trees, shrubs, vines and herbaceous species characteristic of forest and field edges as well as disturbed areas were abundant. The more common of these were black locust, white mulberry (Morus alba), black cherry (Prunus serotina), honeysuckle, catbrier (Smilax rotundifolia), multiflora rose (Rosa multiflora), and giant ragweed (Ambrosia trifida).

4.2.2.2.2.2.3 Grasslands

The grassland portion of the Site consist of both pasture and old field. It covers 4 ha (10 acres) in the upland area south of the cultivated fields. The predominant species were grasses and perennial forbs typical

of old fields. Their relative abundance is given in Table 4.2.2-11. Some species, for example timothy (Phleum pratense), orchard grass (Dactylis glomerata) and Japanese clover (Lespedeza striata) may have been sown rather than invading naturally. Some portions of the grasslands were mowed and harvested as hay in 1978 (depicted as cropland-hay in Figure 4.2.2-1). The absence of woody species, except for one isolated section of grasslands in the southwest corner of the Site, suggests that these areas have been mowed in past years.

4.2.2.2.2.2.4 Cropland

Crops grown on the Site during 1978 were hay, winter wheat, corn and soybeans (207ha or 518 acres). Hay and winter wheat production were primarily restricted to upland slopes. Herbicides applied during the past two growing seasons include: TREFLAN, LASSO, AATREX, LEXONE, BASAGRAN, DYANAP and 2, 4, D. The chemical formulas of these are included in the 1978 Farm Chemicals Handbook[18].

4.2.2.2.2.2.5 Floodplain Forest

Floodplain forest occurs on the Site on the border of the Green River, on banks bordering the Cypress Slough, in the Western portion of the Site, and adjacent to the eastern border (Figure 4.2.2-1). These areas differ in soil type and species diversity, but are considered similar because they share most tree species and the more abundant shrub and herbaceous species. The total area covered by this community is 47 hectares (117 acres).

The large forest stand west of Tscharner Road is the most diverse of all the communities on the site. The soil type is Ginat, a poorly drained clay textured substrate with low natural fertility and low moisture-supplying capacity[1]. An area about 80 meters (87.5 yards) wide in the middle of this stand remains covered with water from the time of spring flooding till mid or later summer. The canopy is mature, 20 to 25m (65 to 82 feet) high. The ground cover is patchy. Sparsely vegetated or bare gound is present in much of the area in spring and early summer due to flooding. However, there are small areas with 50-100 percent ground cover. Dead trunks and branches litter much of the forest floor. Vines are abundant on both dead and live trees.

The frequency and abundance of species in this stand are shown in Tables 4.2.2-12,-13, and -14. Eighteen canopy tree species were observed. The most abundant were red maple, green ash (Fraxinus pennsylvanica), and pumpkin ash (Fraxinus tomentosa). American elm, swamp cottonwood, (Populus heterophylla), sweet gum, (Liquidambur styraciflua), hackberry, sugarberry (Celtis laevigata) swamp chestnut oak (Quercus michauxii), and kingnut hickory (Carya laciniosa) were also common. Many individuals of Celtis showed leaf characteristics intermediate between those of C. laevigata and C. occidentalis, perhaps because of introgression between the two species., Therefore, the values for both species are combined in Table 4.2.2-12 and -13.

Green ash and pumpkin ash also showed evidence of introgression based on intermediate leaf characteristics. The canopy trees were assigned to the species they most closely resembled, but the two species were combined in

the tables showing frequency and cover in the shrub and herbaceous layers (Tables 4.2.2-13 and-14).

The shrub layer was comprised of young individuals of the more common trees, six species in all, and vines (Table 4.2.2-13). The vines were wild grape (Vitis sp.), poison ivy (Rhus radicans), trumpet creeper, and Virginia creeper (Parthenocisus quinquefolia). True shrubs were rare in the forest. Buttonbush (Cephalanthus occidentalis) and a young coralberry (Symphoricarpus occidentalis), in the herbaceous stratum, were the only shrub species present. The buttonbush was unusually large. Many stems were canopy size with diameters of 6 to 8 cm (18-20 inches).

The species area curves for canopy and shrub layers (Figure 4.2.2-3) show that few additional species were observed after the first five to nine plots of the transects were sampled. A general survey of the species present in this stand confirmed that most tree and shrub-layer species present in the stand are included in the area sampled quantitatively.

In contrast, the graph of the number of species in the herbaceous layer plotted cumulatively against the number of plots sampled did not reach an asymptote. This layer was extremely diverse and a major portion of the stand would have to be sampled to portray the herbaceous layer quantitatively. The quantitative sampling of the herbaceous layer (Table 4.2.2-14) is supplemented therefore with a list (Table 4.2.2-10) of additional species observed.

The high species diversity of the herbaceous stratum can be attributed to the diverse microhabitats which result from site moisture gradients, light intensity gradients from the numerous canopy gaps caused by flooding damage and the high proportion of bare ground providing sites for seed germination.

The difference in habitat is most pronounced between the band of standing water and the drier sections of the forest. Species composition in the two areas reflects the difference. Lizard's-tail (Saururus cernuus), swampdock (Rumex verticillata), and southern blue flag (Iris virginica var. shrevei) were found only in the section where flooding was prolonged. Two annuals, richweed (Pilea pumila) and dayflower (Commelina diffusa) were found in September 1978 after this more persistently flooded area had dried. Tree species occurred in the more persistently flooded section that were not elsewhere in the stand: swamp poplar, buttonbush, and most of the black willow and silver maple. Conversely, trees occurring only in the drier regions were red mulberry, honey locust (Gleditsia triacanthos), hackberry, and most of the red maple.

The area where flooding is prolonged is not considered a community separate from the rest of the stand, because many species are shared in common and the change in water level is gradual over space and time.

The herbaceous stratum is made up of over 33 herbaceous species, 4 young tree species that are present in the canopy and 4 vines. Some of the Carex species did not have fruit and could not be identified. These are combined in Table 4.2.2-14. Carex species noted generally in the stand, however, include: C grayii, C hystricina, C muskingumensis, C

tribuloides and C intumescens. Grasses included: Eragrostis reptans, Elymus riparius, Glyceria striata and Cinna arundinacea.

The presence of young individuals of the same species present in the canopy layer indicates that an equilibrium in species composition has been reached in this stand (compare Tables 4.2.2-12 and 4.2.2-13).

Green River border: A small portion of the floodplain community is present on the border of the Green River. This border is severely disturbed by man as well as by flooding. The soil characteristics vary from sandy to silty[1]. The herbaceous layer is weedy and provides dense ground cover. Dominant species are giant ragweed and poison ivy. The tree species present are cottonwood, silver maple, pin oak, box-leaved maple, green ash, sycamore and honey locust.

Floodplain forest is also found on the border of the Cypress Slough which is steepply sloped on the south bank and flat on the northern edge. The soil type is Huntington silt loam, a well drained soil high in natural fertility and moisture supplying capacity[1]. The canopy stratum is sparse and relatively few tree species are present: river birch, pecan, silver maple, kingnut (Carya laciniosa), hackberry, red maple, and black willow. A few cypress seedlings were seen on the southern bank. The herbaceous layer provides moderate to complete coverage of the ground in most areas and is very diverse. Some species are shared with those in the larger floodplain forest stand (see Table 4.2.2-14). Others found only in this area included: Virgin's bower (Clematis virginiana), wood nettle, Smilax lasioneura, wild hyacinth (Camassia scilloides), green dragon, giant cane (Arundinaria gigantea), moonseed (Menispermum canadense) sensitive fern (Onoclea sensibilis), blue phlox (Phlox divaricata), wild yam (Dioscores quaternata), spangle grass (Uniola latifolia), dayflower (Commelina virginica), cucumber vine (Sicyos angulatus), halberd-leaved rose-mallow (Hibiscus militaris) and jumpseed (Tovara virginiana).

The floodplain community in the small on-site woods south of the slough has sparser tree cover and a denser shrub and herbaceous cover than the larger forest stand. The soil type is Lindside, a deep moderately well drained soil, high in natural fertility[1]. Poison ivy grows luxuriously amidst spicebush, (Lindera benzoin), the dominant shrub. Quercus lyrata and red mulberry are abundant. Other trees present were persimmon (Diospyros virginiana), hackberry, red maple, pin oak, kingnut, and pecan. Several colonies of turtlehead, Chelone obliqua var. speciosa were observed. Other herbaceous species were Carex grayii , wild yam, and fringed loosestrife (Lysimachia ciliata). Aster lateriflora and Aster simplex were abundant here as they are in the other floodplain forest stands on the Site.

The floodplain forest areas are similar in tree species composition, although the diversity in each stand differs. Shrub and herbaceous species are less similar because flooding frequency and duration, soil type and level of historical disturbance differ in each stand. However, the species are all typical of floodplains in general, and, in particular, southern floodplain forests[3]. The southern floodplain forest type found along the Mississippi River and its major tributaries reaches its northern limit in northern Kentucky-southern Indiana[3]. Many species found on the site

or nearby are at the northern limits of their range. A list of such species is shown in Table 4.2.2-15.

Floodplain forests play an important role in flood control and maintenance of water quality. The vegetation absorbs excess water, traps sediment, slows overflow current and retards run-off and soil erosion[21]. However, these stands are decreasing in size and number as agricultural development in the region expands. Floodplain stands occurring on Site are valuable both as northernmost representatives of southern floodplain forest and as protection for the floodplain and downstream areas.

4.2.2.2.2.2.6 Cypress Slough

4.2.2.2.2.2.6.1 Floral Composition

The Cypress Slough contains approximately 33 ha (80 acres); about 8 ha (20 acres) lie within the Baskett Site. Hosner and Minckler[22] defined sloughs as "shallow depressions in which water stands throughout the year except in periods of extreme drought." Braun[3] included sloughs in her category designated as swamp forests, and noted that those of the Green River flood plain are usually comprised of broad-leaved trees but forests in the Site area contain "a large proportion of southern species."

As can be seen in Figure 4.2.2-1 Cypress Slough is bordered by a fringe of flood plain forest. The latter covers the steep slope between crop field and the southern edge of the slough, as well as the wet flat land between the northern slough edge and fields. The slough proper, that is the area where water stands throughout most of the year, is predominatly cypress and buttonbush. The edge is readily marked by the lack of poison ivy and ash, and occurrence of dense stands of buttonbush mixed with silver maple and rose-mallow.

Observations and quantitative data were recorded along 4 transects traversing the slough in a north-south direction (Appendix 4A.3). Two transects were located within Site boundaries, and two further west (Figure 4A.3-1). The initial sampling effort (June 26-30, 1978) in the on-site transects yielded the data presented in Table 4.2.2-16. Isolated cypress trees occurred sporadically throughout the slough, only forming a closed canopy in isolated patches. Groups of current-year seedlings were observed along the slough edge. Cypress stems 1 cm or less in diameter were uncommon and mostly observed in one locale off-site. Except for widely dispersed areas of open water, buttonbush formed an extensive dense shrub stratum. Herbaceous submergents and emergents were notably scarce.

According to one local resident, cypress were logged from the slough approximately 50 years ago. No other obvious causes of tree mortality were observed. Standing dead cypress trees were sparse. Many large trees had been broken off at varying heights above water level. Perhaps this results from high winds, ice and snow accumulations, and/or flood conditions. Spring flooding deposits a great deal of natural and anthropogenic debris along the slough banks and presumably on the slough bottom. The slough serves as at least a temporary catchment for any water-borne chemicals applied to agricultural fields of the site.

4.2.2.2.2.2.6.2 Cypress Distribution by Size Class and Water Depth

Much evidence suggests that cypress distribution is limited on dry sites by competition with bottomland hardwoods and by seeding requirement for moist substrate[17], and on submerged sites by water fluctuations which may drown young seedlings[23,24,25]. Seedlings are more sensitive to hydrological conditions than adults. Mature trees can survive changes in water depth that may prevent seedling establishment.

Establishment of new trees under these hydrological conditions would likely occur only during occassional favorable years. In cypress swamps "young stands of cypress are established during periodic droughts when unoccupied areas of peatland are exposed for seedling establishment"[25].

To investigate whether distribution of cypress in the Cypress Slough might reflect hydrological parameters, data on tree size class and water depth were collected. These data were also analyzed to evaluate the capability of the slough habitat to support continued cypress establishment.

The number of cypress recorded in each size class as defined by diameter above swelling, is diagramed in Figure 4.2.2-4. This distribution is based on data recorded from all four north-south transects. A comparison between data collected on-site and off-site using the Kolmogorof-Smirnov test[26], did not permit rejection of the null hypothesis that the two sets of data (Off-site and On-site) were drawn from the same population ($\alpha = 0.05$).

The frequency distribution shown in Figure 4.2.2-4 indicates a majority of trees are of diameter less than 30 cm. A distribution of this shape could arise from a relatively recent increase in seedling and/or small tree survival, or disproportionate mortality of large trees. Examples of the latter include logging and perhaps storms. Many large broken-off (but no sawn) trunks were observed throughout the slough. The possibility of logging, however, cannot be discounted as stumps could be hidden below 1978 summer water levels or covered with sediment and debris.

The numbers of on-site cypress (all sizes classes) occurring at various estimated water depths (September levels) are depicted in Part A of Figure 4.2.2-5. The number of points recorded along the two transects for each water depth class appears in part B. Part B of Figure 4.2.2-5 is an indication of the proportional amount of area available for tree establishment at each water depth class. If cypress survival is independent of water depth, one would expect tree distribution to reflect the amount of area available. This is apparently not the case, as most of the trees (35) occur at depths of 41-70 cm while only four were found at shallower locales. The distribution shown in Figure 4.2.2-5 conforms to that expected if repeated occurrence of extended periods of dry substrate discouraged seed germination or seedling survival. That is, shallow areas may tend to dry out too much, and too frequently, to support much seeding establishment.

The occurrence of cypress in the two off-site north-south transects at various water depths (September, 1978 levels), is shown in Figure 4.2.2-6. The distribution pattern is similar to that of the on-site transects: a scarcity of trees at shallower depths and a peak occurrence at 41-50 cm depth. The off-site data, however, exhibit a second mode of tree abundance at depths greater than 80 cm. This may simply reflect the availability of "deep water" habitat (no areas deeper than 80 cm were present along the on-site transects). It could also result from areas, presently deep, having shallower (but not so shallow as to dry out) and thus favorable environments during past episodes of extended drought.

The occurrence of trees (all north-south transects) with water depth is again diagramed in Figure 4.2.2-7 in which the data are separated according to two size classes: trees of diameter greater than 10 cm, and trees of diameter 10 cm or less. Both small and large trees tend to occur at depths greater than 40 cm. Trees observed at depths greater than 80 cm, however, are mostly larger (greater than 10 cm diameter) trees. The deeper area now occupied by larger trees may have been suited for seedling survival during a previous dry period, but subsequently has been too deep for recruitment.

The distributions shown in Figures 4.2.2-4 to 4.2.2-7 would be predicted from known hydrological influences on cypress seedling survival, although other factors such as mortality of mature trees could also explain them. A relatively large number of trees less than 30 cm diameter are present, suggesting that the slough is a reproducing viable community. The current paucity of very small saplings in much of the slough is probably typical of a community in which habitat suitable for seed germination and survival, occurs intermittently over time and in select locales.

4.2.2.2.2.3 Threatened, Endangered and Uncommon Flora and Vegetation Types

4.2.2.2.2.3.1 Endangered Flora

None of the 20 plant species listed by the U.S. Fish and Wildlife Service as endangered, occur in Kentucky[13].

Seven plant species initially proposed for status as endangered[27], but not currently listed, could potentially occur in Kentucky. None of these seven were observed during field studies. Six of the species are not likely to occur on the Site for lack of suitable habitat. Apios priceana (groundnut or potato-bean) grows in "woods and thickets"[19] of Kentucky and Tennessee and could conceivably occur in wooded areas on the site.

The State of Kentucky has not legislated a list of rare and endangered plant species.

4.2.2.2.2.3.2 Uncommon Vegetation Types and Flora

Two vegetation types identified on Site, flood plain forest and slough, may be considered relatively uncommon in the Site region. Much of the Green River and Ohio River flood plains were once forested[4], but have now been extensively cleared for agricultural production. Presently about 12

percent of the 314 km^2 (121 square miles) within 10 km (6 miles) of the Site are forested, and approximately half of these are flood plain forests.

The flood plain forests of Henderson County represent an extension of Mississippi River alluvial plain vegetation [3] and support a variety of species typical of more southern vegetation communities. Species in this category which were found on the Baskett Site and are considered sufficiently uncommon to the Site region to be of botanical interest are noted in Table 4.2.2-15. One species, Chelone obliqua var. speciosa , observed in a small woodlot south of the Cypress Slough, is considered "threatened" according to a recent Smithsonian Institution Report [28]. Swamp cottonwood, which occurs on-site in both the slough and floodplain forest, is included on an unpublished list of "peripheral" species (species rare in Kentucky but common throughout their principal range) developed by botanists in the Kentucky Academy of Sciences. Swamp cottonwood range is mostly southern although disjunct populations occur as far north as Michigan and Massachusetts. Throughout its range it is sparsely distributed [17].

Pumpkin ash is not identified as a threatened or peripheral species, but is considered rare throughout its range [17]. It grows from New York and southern Illinois south to Louisiana and Florida [29]. On Site, this species was common in the floodplain forest.

The Cypress Slough, including off-site portions, is approximately 33 ha (80 acres). It is the first cypress-dominated slough vegetation encountered as one proceeds west from Owensboro, and is therefore probably the northeastern-most cypress slough vegetation in Kentucky [30]. No other sizeable discrete stands of cypress occur within 10 km (6 miles) of the site. The Henderson Sloughs area, 32 km (20 miles) west of the Site, is considerably larger than Cypress Slough, although some portion has been disturbed apparently by oil drilling operations. The Henderson Sloughs area is currently recommended for Natural Landmark status [15].

Two major components of the Cypress Slough, cypress and swamp privet (Table 4.2.2-16), are considered uncommon to the Site region. Both species are near the northern extent of their range. The northern-most occurrence of cypress in Indiana is southwestern Knox County [31], less than 100 km (62 miles) northwest of the Baskett site. Cypress sloughs occur in McCacken County, Ballard County and western Kentucky counties bordering the Mississippi River. Their occurrence in Northern Kentucky is of ecological interest, as evidenced by Wharton and Barbour's [32] reference to them as "ecological museums" meriting protection.

The Cypress Slough, and extensive areas of flood plain forest located west of the Baskett Site, are being considered for future incorporation into a state-wide network of nature preserves. The Kentucky Nature Preserve Commission (Department of Natural Resources and Environmental Protection) is developing a report of their investigations conducted in these areas.

4.2.2.2.3 Wildlife

4.2.2.2.3.1 Wildlife Habitats

Much of the proposed Site has been cleared of natural vegetation and is under intensive cultivation. Remnants of the pre-existing upland and floodplain forests still persist in areas too wet or steep to cultivate and a portion of an undrained cypress swamp lies within the Site boundaries (Figure 4.2.2-1). Although all of these habitats have been subjected to loging, and possibly other human perturbations (eg, fire), each of them offers good food and cover for wildlife. In particular, Cypress Slough and nearby large floodplain forest, are both relatively undisturbed and offer the most valuable natural habitats on the Site. In addition to these natural areas, the agricultural and riparian areas and hedgerows are acceptable habitats for some wildlife species. Intensive agricultural practices in recent years, eg, clearing of hedgerows and use of herbicides, have significantly reduced the value of these habitats. Consequently, most wildlife use of the proposed Site occurs in the forest and slough areas.

Although upland forest habitat is widely distributed in the county, floodplain forest is restricted to the Green and Ohio River valleys and has undergone a tremendous decrease in extent, principally due to draining and clearing for agriculture. Cypress swamp habitat, always uncommon in the region, has suffered similar losses due to lumbering and draining. These swamps or sloughs are preferred habitats for a number of southern species (eg, swamp rabbit, western lesser siren, amphiuma, and bird-voiced treefrog) which reach the northern limit of their distribution in western Kentucky and southern Indiana. The Green River, which originates in southern Kentucky and flows north, remains relatively warm year-round. Consequently, several aquatic and semiaquatic animals reach the northern periphery of their range in the Green River drainage.

4.2.2.2.3.2 Existing Fauna

4.2.2.2.3.2.1 Birds

Although only remnants of the original natural vegetation cover remain on the site, most of the 240 species of birds known from the region probably occur on or near the proposed Site as visitants, migrants, or breeders. One hundred forty one species were recorded during the spring, summer and fall Site surveys (Table 4.2.2-1). Sixty-three of these species were found during breeding bird surveys (Table 4.2.2-17). The cypress slough and upland and floodplain forests supported the only significant breeding bird populations on the Site. Red-bellied woodpeckers, white-eyed vireos, common yellow-throats, yellow-breasted chats and cardinals were common in upland forests while acadian flycatchers, blue-gray gnatcatchers and prothonotary warblers were the most abundant species in all lowland habitats. Indigo buntings were common in all forest areas. Wood duck brood counts on the cypress slough indicated that an estimated 20 to 25 females produced 110 to 140 young (average 5.5 young/female) in 1978. A few bobwhite also occur on the Site, however, no coveys were seen and the total population is low. The only unusual breeding bird was the red-shouldered hawk which apparently bred in the flood plain forest surrounding the cypress slough. This species is on the National Audubon Society's "Blue List"[33] and is

generally considered to be declining throughout its range.

The forested areas and ecotones provide the best year-round habitat for birds on the site. The agricultural fields have limited habitat value to species other than blackbirds and sparrows at any time of year. Floodplain fields are used as foraging areas by some waterfowl during the spring floods. Surveys indicated that most spring waterfowl occurred upstream on the Green River. An aerial survey in March 1978 found 6,500 ducks, mostly redheads, scamp and American wigeon, 3.1 to 6.2 km (five to ten miles) upstream from the site. The cypress slough offers excellent food and cover for migrant ducks. Hunting rights to the slough are leased annually to local sportsmen, however only limited hunting, principally for mallards, occurs since local sportsmen apparently prefer to hunt geese at the Sloughs Wildlife Management Area Southwest of Henderson.

4.2.2.2.3.2.2 Mammals

Eighteen of the thirty mammal species found in the region were recorded on the Site (Table 4.2.2-2). Several other species, including swamp rabbit, deer mouse, prairie vole, longtail weasel, mink, and red fox, probably occur at least occasionally, but were not encountered in field surveys. The swamp rabbit has been recorded in the vicinity of Cypress Slough in past years[34], however, clearing of bottomland forest has significantly reduced the amount of habitat suitable for this species. The remaining species are probably absent due to a lack of suitable habitat or are bats which are difficult to capture or observe and thus may have been unidentified.

Most mammals recorded reside in forests and at forest edges. Only house mice were found in agricultural fields and grasslands although deer, opossum, raccoon, cottontails and other species forage in these habitats. Species most commonly encountered in upland and flood plain forests include opossum, raccoon, eastern cottontail, and gray and fox squirrel. Cypress Slough provided habitat for beaver, muskrats and masked shrews. The masked shrew was believed at the initiation of these studies to be rare in the region. The only previous record from western Kentucky was made in Henderson County just west of Audubon State Park[35]. Field studies around Cypress Slough and Henderson Sloughs in Union County conducted by the Kentucky Nature Preserve Commission yielded several dozen captures indicating that the species is fairly common and probably distributed in moist bottomland forests along the Ohio River and its tributaries.

The white-tailed deer was the only large mammal recorded on the site. Deer tracks were infrequently seen and the number of deer on the Site is believed to be low. Aerial surveys conducted during March and September 1978 found no deer on the Site. Other game mammals present on the Site include gray and fox squirrels, and eastern cottontail rabbits all of which were fairly common in suitable habitat. Furbearer (eg, beaver and muskrat) numbers generally appeared low; however, raccoons and opossums were common. Raccoons, in particular, are hunted extensively in the area.

4.2.2.2.3.2.3 Reptiles and Amphibians

The Site offers a variety of habitats to reptiles and amphibians. The most important aquatic habitats are the Cypress Slough and several small ponds (Figure 4.2.2-1). A wooded swamp in the floodplain forest is also an important spring breeding area but dries up later in the year (Figure 4.2.-2-1). Upland forest is also inhabited by a few species but crops and grassland are poor habitat for most reptiles and amphibians.

Nineteen of the seventy-four species of reptiles and amphibians which may occur in the region were recorded on the Site (Tables 4.2.2-3 and -4). Leopard frogs, American and Fowler's toads, cricket frogs, gray treefrogs, and chorus frogs were the most abundant amphibians; while snapping turtles, box turtles, sliders, and garter snakes were the most commonly encountered reptiles. Although several regionally rare species could occur on the Site, particularly in the Cypress Slough, none were found. No species of reptile or amphibian on the State or Federal list of endangered and threatened species is likely to occur on the Site.

4.2.2.2.3.3 Existing Stresses

Two major stresses are imposed upon wildlife on the Site on an annual basis. The first, of natural origin, is the flooding of most of the bottomland habitat for three to four months each spring. Although this flooding has little effect on birds, reptiles and amphibians, it forces most mammals to retreat to forested areas on the bluffs and uplands to the south. Absence of suitable retreat cover near the large on-site floodplain forest may preclude existence of viable populations of some bottomland species (eg, swamp rabbit).

A large portion of the site is currently devoted to intensive agriculture (Figure 4.2.2-1) which places stresses on the wildlife of the Site. Clearing of forests and fencerows to increase farm acreages has resulted in habitat loss. Intensive cultivation and the application of herbicides further reduces the value of cropland for foraging wildlife.

Cropland on the Site appeared to have minimal value to wildlife and intensive agricultural practices in recent years are probably responsible for the decline of small game (bobwhite and rabbit) populations.

4.2.2.2.3.4 Rare and Endangered Wildlife

None of the four endangered species of wildlife known to occur in the region (Table 4.2.2-5) were recorded on the Site although all might occur there as rare transients. The Indiana bat could breed in forested areas on the Site but it apparently has not been recorded from Henderson County and the probability of its occurrence on-site is slight.

A number of species reach the periphery of their range in the region of the Site and are considered regionally rare (Table 4.2.2-5). The masked shrew was the only one of these species recorded on the Site. Pit trapping results indicate that this species is common in the vicinity of Cypress Slough and additional captures from Union County indicate that the species is probably widespread in suitable bottomland forests and sloughs. Al-

though no other regionally rare species were recorded, several may have escaped detection and may occur since Cypress Slough offers good habitat.

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4.2.3 ECOLOGICAL QUALITY

4.2.3.1 Aquatic Biota Quality

The quality of aquatic biota in the lower Green River appears to be adversly affected by agricultural runoff, high sedimentation and suspended solids and barge induced turbulence.

Many of the planktonic forms found in the present study, are allochtonous in nature being added to the river from upstream tributaries and backwater areas. The planktonic organisms found are commonly observed in river and lake environments. Most of the dominant forms have been found to be pollution tolerant or facultative, being able to exist under various different environmental conditions. The low phytoplankton abundances generally observed may be a result of the shallow photic zone and turbulence while the absence or low abundance of large or adult crustaceans may reflect the effect of particle scour. Low benthic macroinvertebrate densities and biomass reflect the high resuspension and resettlement of particles and inability of colonization caused by scour.

Most of the adult fish captured are considered transients either moving upstream or into the Ohio River. Low numbers of fish captured may indicate that there maybe a very small or non-existent indiginous community established in the lower Green. The absence of backwaters during low flows and macrophyte shore colonization indicates the lack of good spawning sites in the study area. Some of the eggs and larvae may be native to the lower Green however it is felt that most of the forms captured are recruted from upriver areas.

As discussed in sections 4.2.1.1.2 and 5.1.2.2 species found in the on-site ponds and stream suggest a stressed community with poor diversity. The Green River study area was observed to have a moderate diversity of species even though habitat was constrained in its available variety as a function of a heavy silt load overlying a clay river bottom. The suspended solids exacerbated the existing poor benthic substrate. The Green River was observed to have water temperatures warmer than the Ohio River and dissolved oxygen levels usually at or near saturation. The temperature and dissolved oxygen levels may enhance the habitat and help to explain why we observed the variety and numbers of fish we did. However, most of the species of fish found in the Green River are those that are known to tolerate turbid conditions. The Cypress Slough appears to have the greatest diversity and productivity of the on-site water bodies. Of the water bodies observed the Cypress Slough is the least stressed.

4.2.3.2 Terrestrial Vegetation Quality

The purpose of this section is to identify plant species or groupings which are sensitive to perturbation or important for commercial, recreational or ecological reasons. All species uncommon to a region are sensitive to construction activities in the sense that loss of habitat for these species could appreciably change their regional abundance. Another criterion for identifying sensitive species is dependence on physical resources or processes potentially affected by site development activities. Included in this category are species restricted to floodplain communities. These

species distributions are greatly affected by depth and duration of flooding.

None of the species found on the Baskett Site have been proposed or listed by the U.S. Fish and Wildlife Service as endangered or threatened [1,2,3]. Chelone obliqua var. speciosa, a variety of turtlehead, has recently been listed by the Smithsonian Institution [4] as threatened. Several patches of this species were found in a small flood plain woodlot immediately south of Cypress Slough, on-site. It was not observed in the larger flood plain forest on the east border of the site, but was found in the large flood plain forest between the western site boundary and Tillman-Bethel Road [5]. Chelone obliqua variety speciosa occurs in alluvial woods and swamps [6]. Although not listed in the Smithsonian report as occurring in Kentucky, it has been found in several other portions of the state [7].

Swamp cottonwood (Populus heterophylla) occurs occasionally on site in the flood plain forest and in the Cypress Slough. This species is characteristically sparse where it occurs, which is generally in southern states, and is included on an unpublished list of species considered uncommon in Kentucky.

Pumpkin ash is another species which occurs only sparsely throughout its range, and is therefore considered uncommon. This species occurred on site in the canopy and shrub strata of the flood plain forest. Other species which occur in the flood plain forest on site, and which are to some degree uncommon to the site region, are noted in Table 4.2.2-15. In addition to being sensitive to habitat loss, uncommon species found in flood plain forests would be affected by changes in flooding depth, duration and periodicity.

The Cypress Slough also contains flora considered uncommon to the region, and, as a wet land, is also sensitive to hydrological parameters. Cypress (Taxodium distichum) and swamp privet (Forestiera acuminata) are species typical of southern swamp forests and are near the northern edge of their range in the site region. Since cypress seedlings cannot tolerate a dry soil environment or prolonged flooding, slough water levels during floods and throughout the growing season determine availability of cypress habitat.

Floodplain and wetland natural vegetation are considered valuable natural resources; their development by Federal agencies is discouraged by Executive Orders 11988 and 11990 (May 24, 1977).

4.2.3.3 Terrestrial Vertebrate Population Quality

The Site supports a complex array of wildlife forms (Tables 4.2.2.1,-2,-3, and -4). Where known the relative abundance and distribution of these species has been determined. Woodland habitats, i.e., flood plain forest, Cypress Slough, and upland forests, support the greatest number of species. Fluctuations in populations of most species occur on a seasonal basis with limited usage of the Site during the winter and early spring when snow and/or flood waters are present. Areas under cultivation provide some food and cover for wildlife but are of limited value to most natural populations.

The major threat to the continued existence of most species on the Site at the present time is loss of habitat due to the continual encroachment by agricultural interests.

Game species which reside on or near the Site include bobwhite, mourning doves, wood ducks, deer, squirrels, raccoon, gray fox and rabbits. Several of these species are well adapted to agricultural/forest ecotones. Other species which require more mature or extensive woodlands and whose populations are apt to suffer first from increases in cultivated land include wood duck, gray squirrel and swamp rabbit. At this time no game species are intensively hunted on the Site although both waterfowl (principally mallards) and upland game (mostly squirrels, raccoons and rabbits) hunting occurs.

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TABLE 4.2.1-1

TAXONOMIC LIST OF PHYTOPLANKTON COLLECTED FROM THE GREEN RIVER

	Sampling Quarters			
	Spring	Summer	Fall	Winter
Phylum Cyanophyta				
Class Cyanophyceae				
Order Chroococcales				
Family Chroococcaceae				
Merismopedia spp		X	X	
Microcystis spp		X	X	
Order Hormogonales				
Family Nostocaceae				
Anabaena spp	X			
Aphanizomenon spp	X			
Aphanizomenon flos-aquae		X		
Family Oscillatoriaceae				
Lyngbya spp	X			X
Phylum Chlorophyta				
Class Chlorophyceae				
Order Chlorococcales				
Family Chlorococcaceae				
Tetraedron lunula	X	X	X	
Schroederia setigera		X		
Family Oocystacea				
Ankistrodesmus falcatus		X		X
Ankistrodesmus falcatus mirabillis	X		X	
Ankistrodesmus spiralis	X	X	X	X
Closteriopsis spp		X		
Selenastrum spp			X	
Family Scenedesmaceae				
Crucigenia finestrata	X	X	X	
Scenedesmus acuminatus			X	
Scenedesmus bernardi		X		
Scenedesmus denticulatus	X		X	
Scenedesmus opoliensis	X	X	X	
Scenedesmus quadricauda		X		
Order Volvocales				
Family Chlamydomonadaceae				
Carteria spp			X	
Family Volvocaceae				
Pandorina spp			X	
Quadriqula spp				X
Phylum Euglenophyta				
Class Euglenophyceae				
Order Euglenales				
Family Euglenaceae				
Euglena spp	X	X	X	X
Phacus spp	X			
Trachelomonas spp	X	X	X	

TABLE 4.2.1-1 (Cont'd)

TAXONOMIC LIST OF PHYTOPLANKTON COLLECTED FROM THE GREEN RIVER

	Sampling Quarters			
	Spring	Summer	Fall	Winter
Phylum Chrysophyta				
Class Bacillariophyceae				
Order Pennales				
Family Achnanthaceae				
Achnanthes spp	X			
Achnanthes lanceolata			X	X
Achnanthes minuta				X
Family Cymbellaceae				
Cymbella affinis			X	
Cymbella cistula				X
Cymbella cymbiformis				X
Cymbella ventricosa	X	X	X	
Epitehmia sorex	X			
Family Eunotiaceae				
Eunotia spp	X			
Family Fragilariaceae				
Asterionella formosa			X	
Diatoma vulgare	X			
Fragilaria spp		X		
Fragilaria crotonensis				X
Fragilaria pinnata			X	
Frustulia rhomboides				X
Synedra spp			X	
Synera radians	X	X		
Synedra rumpens	X	X	X	
Synedra ulna	X	X		
Family Gomphonemaceae				
Gomphonema parvulum	X			
Family Naviculaceae				
Gyrosigma spp	X	X	X	X
Navicula spp	X		X	X
Navicula bacillum	X			X
Navicula cryptociphala	X			X
Navicula eligininsis	X			X
Navicula pupula	X	X	X	X
Navicula radiosa	X	X	X	X
Pinnularia appendiculata				X
Pinnularia biceps	X	X		X
Family Nitzschiaceae				
Hantzschia spp	X		X	X
Nitzschia spp	X	X	X	X
Family Surirellaceae				
Surirella spp	X			X
Surirella linearis			X	

TABLE 4.2.1-1 (Cont'd)

TAXONOMIC LIST OF PHYTOPLANKTON COLLECTED FROM THE GREEN RIVER

	Sampling Quarters			
	Spring	Summer	Fall	Winter
Order Centrales				
Family Coscinodiscaceae				
Cyclotella spp		X	X	
Cyclotella meneghiniana				X
Cyclotella ocellata	X	X	X	X
Cyclotella steligeria	X		X	X
Melosira crenulata		X		
Melosira granulata	X	X	X	X
Melosira granulata angustissima		X	X	
Melosira italica	X	X	X	X
Melosira varians		X	X	X
Stephanodiscus spp		X	X	
Family Rhizosoleniaceae				
Attheya spp	X			
Class Chrysophyceae				
Order Chrysomonoadales				
Family Ochromonadaceae				
Dynobryon divergens	X			
Dynobryon bavaricum	X			
Phylum Cryptophyta				
Class Cryptophyceae				
Order Cryptomondales				
Cryptomonas spp	X		X	X
Phylum Pyrrhophyta				
Class Dinophyceae				
Order Peridiniales				
Family Peridiniaceae				
Peridinium spp				X
Unidentified Nannoplankton				
Cyanobacterium	X			X

TABLE 4.2.1-2

SEASONAL MEAN DENSITIES (No./l) OF MAJOR PHYTOPLANKTON GROUPS

COLLECTED FROM THE GREEN RIVER

Sampling Quarter	Cyanophyta	Chlorophyta	Euglenophyta	Bacillariophycea	Chrysophyta	Cryptophyta	Cyanobacterium	Total
Spring	11,250	60,000	9,375	190,625	6,250	63,750	110,000	451,250
Summer	22,500	11,875	6,250	66,250	-	-	-	106,875
Fall	5,625	29,375	4,375	106,875	-	14,375	-	160,625
Winter	1,232	1,232	739	15,776	-	1,972	2,711	23,664

TABLE 4.2.1-3

TAXONOMIC LIST OF PHYTOPLANKTON COLLECTED FROM THE ON-SITE FARM PONDS

	Ponds		
	1	2	3
Phylum Cyanophyta			
Class Cyanophyceae			
Order Chroococcales			
Family Chroococcaceae			
Chroococcus dispersus var *minor*		X	
Coelosphaerium maegelianum			X
Phylum Chlorophyta			
Class Chlorophyceae			
Order Chlorococcales			
Family Oocystaceae			
Ankistrodesmus spiralis	X		
Kirchneriella subsolitaria	X		
Selenastrum minimum	X	X	
Tetraedron regulare var *granulata*	X		
Oocystis spp		X	
Family Scenedesmaceae			
Crucigenia finestrata	X		
Crucigenia lauterbirnii	X		
Crucigenia tetrapedia	X		
Crucigenia rectangularis		X	
Scenedesmus acuminatus	X		
Scenedesmus quadricauda	X	X	X
Tetradesmus wisconsinense	X		
Family Chlorococcaceae			
Golenkinia radiata	X		
Schroederia setigera		X	X
Phylum Pyrrophyta			
Class Dinophyceae			
Order Peridiniales			
Family Peridiniaceae			
Peridinum spp	X		
Family Achnathacea			
Achnanthes lanceolata		X	X
Rhoicosphenia curvata		X	
Family Nitzschiaceae			
Nitzschia spp		X	
Nitzschia amphibia			X
Family Cymbellaceae			
Cybella affinis			X
Class Xanthophyceae			
Order Heterococcales			
Family Centritractaceae			
Centritractus belanophorus	X		

TABLE 4.2.1-3 (Cont'd)

TAXONOMIC LIST OF PHYTOPLANKTON COLLECTED FROM THE ON-SITE FARM PONDS

	Ponds		
	1	2	3
Phylum Chrysophyta			
Class Chrysophyceae			
Order Chrysomonadales			
Family Ochromonadaceae			
Dynobryon bavaricum	X		
Dynobryon divergens	X		
Class Bacillariophyceae			
Order Pennales			
Family Naviculaceae			
Navicula cryptociphala	X		
Navicula radiosa			X
Pinnularia viridis			X
Navicula pupula	X		
Navicula cuspidata	X		
Navicula exigua			X
Family Surirellaceae			
Surirella linearis	X		
Family Fragilariaceae			
Synedra tenera	X		
Synedra rumpus		X	
Family Gomphonemaceae			
Gomphonema spp	X	X	
Gomphonema augustatum			X
Family Hydrodictyaceae			
Pediastrum boryanum	X		
Pediastrum tetras var *tetradon*	X		
Order Zygnenatales			
Family Desmidiaceae			
Cosmarium spp	X		
Staurastrum spp	X		
Order Volvocales			
Family Volvacaceae			
Volvox aureus		X	
Order Tetrasporales			
Family Palmellaceae			
Gloeocystis spp		X	
Phylum Euglenophyta			
Class Euglenophyceae			
Order Euglenales			
Family Euglenaceae			
Trachilomonos spp		X	X

TABLE 4.2.1-3 (Cont'd)

TAXONOMIC LIST OF PHYTOPLANKTON COLLECTED FROM THE ON-SITE FARM PONDS

	Ponds		
	1	2	3
Phylum Crypthophyta			
Class Cryptophyceae			
Order Cryptomondales			
Cryptomonas spp	X	X	X
Rhodomonas spp			X

TABLE 4.2.1-4

MEAN DENSITIES (No./ml) OF MAJOR PHYTOPLANKTON GROUPS COLLECTED FROM THE ON-SITE FARMS PONDS

	Ponds		
	1	2	3
Cyanophyta	0	135	9
Chlorophyta	2,484	2,520	135
Euglenophyta	0	9	13.5
Phyrrophyta	4.5	0	0
Chrysophyta	1,129	0	0
Bacillariophyceae	135	31.5	81
Xanthrophyta	9	0	0
Cryptophyta	117	9	252
Nannoplankter (unidentified)	0	0	783
Totals	3,879	2,583	1,263

TABLE 4.2.1-5

TAXONOMIC LIST OF PHYTOPLANKTON COLLECTED FROM THE CYPRESS SLOUGH

	Fall 1978		Spring 1978	
	Sampling Locations			
	1	2	1	2
Phylum Cyanophyta				
Class Cyanophyceae				
Order Chroococcales				
Family Chroococcaceae				
Merismopedia spp		X		
Family Oscillatoriaceae				
Lyngbya spp		X		
Oscillatoria spp			X	
Phylum Euglenophyta				
Class Euglenophyceae				
Order Euglenales				
Family Euglenaceae				
Euglena spp	X	X	X	X
Phacus spp			X	
Trachelamonas spp	X	X	X	X
Phylum Pyrrhophyta				
Class Dinophyceae				
Order Peridiniales				
Family Ceratiaceae				
Ceratium hirundinella	X			
Family Peridiniaceae				
Peridinium spp	X			
Phylum Cryptophyta				
Class Cryptophyceae				
Order Cryptomondales				
Cryptomonas spp	X	X	X	X
Phylum Chrysophyta				
Class Chrysophyceae				
Order Chrysomonadales				
Family Mallomonadaceae				
Mallomonas spp	X	X	X	X
Family Ochromonadacea				
Dynobryon behningii		X		

TABLE 4.2.1-5 (Cont'd)

TAXONOMIC LIST OF PHYTOPLANKTON COLLECTED FROM THE CYPRESS SLOUGH

	Fall 1978		Spring 1978	
	Sampling Locations			
	1	2	1	2
Class Bacillariophyceae				
Order Pennales				
Family Cymbellacea				
Cymbella spp			X	
Cymbella ventricosa			X	
Family Fragilariaceae				
Diatoma vulgare			X	
Fragilaria spp		X		
Synedra spp		X		
Synedra radians			X	X
Synedra rupens		X	X	
Family Naviculaceae				
Amphipleura pellucida				X
Gyrosigma spp			X	X
Navicula aurora			X	
Navicula bacillum			X	X
Navicula pupula			X	X
Navicula radiosa		X	X	
Navicula rhynchocephala			X	X
Pinnularia biceps			X	X
Family Nitzschiacea				
Nitzschia spp		X	X	X
Nitzschia filiformis			X	X
Nitzschia longissma			X	X
Stauroneis spp			X	
Family Surirellaceae				
Surirella spp			X	X
Surirella ovalis			X	
Order Centrales				
Family Coscinodiscaceae				
Melosira granulata			X	
Melosira italica				X
Melosira varians				X
Phylum Chlorophyta				
Class Chlorophyceae				
Order Chlorococcales				
Family Botryococcaceae				
Botryococcus spp				X
Family Oocystacea				
Ankistrodesmus spp				X
Closterium spp		X		
Family Scenedesmaceae				
Scenedesmus spp				X

TABLE 4.2.1-5 (Cont'd)

TAXONOMIC LIST OF PHYTOPLANKTON COLLECTED FROM THE CYPRESS SLOUGH

	Fall 1978		Spring 1978	
	Sampling Locations			
	1	2	1	2
Order Volvocales				
Family Chlamydomonadacea				
Carteria spp			X	

TABLE 4.2.1-6

RELATIVE PERCENT ABUNDANCE OF MAJOR PHYTOPLANKTON GROUPS COLLECTED FROM THE CYPRESS SLOUGH

	Fall 1978		Spring 1979	
	Sampling Locations			
	1	2	1	2
Cyanophyta	-	48.3	0.6	-
Chlorophyta	-	1.4	8.8	1.3
Euglenophyta	63.5	1.4	13.2	83.1
Pyrrophyta	2.4	-	-	-
Chrysophyta	8.7	3.4	1.9	0.6
Bacillariophyceae	-	15.2	73.6	7.7
Cryptophyta	25.4	30.3	1.9	7.3

TABLE 4.2.1-7

TAXONOMIC LIST OF MICROZOOPLANKTON COLLECTED FROM THE GREEN RIVER

	SPRING 1978				SUMMER 1978				FALL 1978				WINTER 1979			
	SAMPLING ZONES															
	1	2	3	5	1	2	3	4	1	2	3	5	1	2	3	5
Phylum Rotatoria																
Class Monogononta (unidentified)	x	+	x	+			x		x	+	x	+	x	x	x	x
Order Ploima																
Family Asplanchnidae																
Asplanchna priodonta	x	+	x	+					x	+	x	+				
Family Brachionidae																
Brachionus spp								o								
Brachionus angularis	x	+	x	+								o		x		x
Brachionus bidentata	x	+	x	+						+	x	o				
Brachionus calycifloris	x	+	x	x								o	x		x	
Brachionus caudatus	x	+	x	+						o		o		x		
Brachionus havanaensis										x		o				
Brachionus plicatilis										o						
Brachionus quadridentata	x	+	x	+					x			o				
Euchlanis spp															x	
Euchlanis dilatata		x										o				
Kellicottia bostoniensis	x	+	x	+									x	x	x	x
Keratella spp					x	x				o		o				
Keratella cochlearis	x	+	x	+		x	+		x	+	x	+	x	x	x	x
Keratella gracilienta		o														
Keratella quadrata	x	+		x			x						x	x	x	x
Keratella serrulata				x												
Keratella volga	x	+	x	+						o		o			x	
Platyias spp		x			x	x		o		x	x					
Platyias patulus	x	+	x	x		o	x	+	x	+		+				
Platyias quadricornis			x						x							
Family Lecaninae																
Lecane spp		+		x				x		o		+				
Monostyla spp									x	+		o				
Family Ploesomatidae																
Ploesoma truncatum									x	+	x	+				
Family Synchaetidae																
Polyarthra spp	x	+	x	+			x	x	x	+	x	+	x	x	x	x
Synchaeta spp	x	+	x	x					x							x
Family Trichocercidae																
Trichocerca multicrinis		+		o												
Trichoerca spp			x													
Order Flosculariacea																
Family Filiniidae																
Filinia longiseta	x	x	x	x			x					o	x	x	x	x
Family Hexarthridae																
Hexarthra mira	x	o	x	+			x	x								
Family Testudinellidae																
Testudinella patina		x		x								x				

TABLE 4.2.1-7(Cont'd)

TAXONOMIC LIST OF MICROZOOPLANKTON COLLECTED FROM THE GREEN RIVER

	SPRING 1978				SUMMER 1978				FALL 1978				WINTER 1979			
	SAMPLING ZONES															
	1	2	3	5	1	2	3	4	1	2	3	5	1	2	3	5
Phylum Arthropoda																
Class Crustacea																
Order Cladocera (juvenile)	x			x			x									
Family Bosminidae																
Bosmina longirostris	x	+	x	+	x	+	x	+	x	+	x	+	x	x	x	x
Family Chydoridae																
Alona costata	x	o														
Alona rectangula															x	
Chydorus sphaericus	x	+	x	o												x
Family Daphnidae																
Ceriodaphnia spp										o		o				
Ceriodaphnia lacustris	x	+	x	o		o	x		x			x				
Daphnia sp												x		x		
Daphnia parvula	x	+	x	+			x			+		o				
Scapholeberis kingi	x	o														
Family Sididae																
Diaphanosoma brachyurum					x	+	x	+	x	+	x	+				
Subclass Ostracoda (planktonic)		o	x			x				+		x				
Subclass Copepoda																
Order Eucopepoda																
copepod nauplii	x	+	x	+	x	+	x	+	x	+	x	+	x	x	x	x
Family Calanoidae																
Calanoid copepodites	x	+		x	x	+	x	+	x	+	x	+	x	x	x	
Diaptomus spp	x	+	x	x	x	o	x	+	x	+		+	x	x		x
Diaptomus pallidus						o										
Family Cyclopoidae																
cyclopoid copepodites	x	+	x	+	x	+	x	+	x	+	x	+	x	x	x	x
Cyclops spp										o		o				
Cyclops bicuspidatus thomasi		+	x													
Cyclops scutifer							x									
Cyclops varicans rubellus	x	+	x				x		x	+		o	x	x		
Cyclops vernalis	x	+								o	x	+				
Ectocyclops spp				x												
Eucyclops prionophorus													x			
Mesocyclops edax						o		o				o				
Tropocyclops prasinus										o		o				
Family Harpacticoidae																
Tachidius spp									+							
Phylum Protozoa																
Class Mastigophora																
Order Phytomonadina																
Family Volvocidae					x	x										

x = those forms collected by pump only
o = those forms collected by net only
+ = those forms collected by both techniques
- = those forms representing greater than 5% in pumped samples averaged over 3 replicates

TABLE 4.2.1-8

MEAN DENSITIES (NO./1) OF MAJOR MICROZOOPLANKTON GROUPS COLLECTED FROM THE GREEN RIVER

	Zones	Rotifera	Cladscera	Copepoda	Ostracoda	Protozoa	
26 May, 1978	1	20.6	6.1	86.3	-	-	54.95 -/+ 17.43
	2	19.3	13.7	26.3	-	-	59.35 -/+ 37.60
	3	34.8	8.6	20.6	0.4	-	64.20 -/+ 5.27
	5	19.8	7.8	9.5	-	-	42.60 -/+ 6.10
Mean Total		23.6	9.1	35.7	0.1	-	55.3
11 July, 1978	1	1.5	2.1	24.4	-	1.0	29.82 -/+ 2.87
	2	2.8	4.1	35.1	0.1	2.8	44.75 -/+ 16.83
	3	1.0	2.5	22.7	-	-	26.31 -/+ 5.89
	5	2.1	2.7	30.5	-	-	35.20 -/+ 9.41
Mean Total		1.8	2.8	28.2	*	0.9	34.0
12 September, 1978	1	46.0	9.6	14.1	-	-	69.76 -/+ 30.16
	2	21.0	2.5	13.6	0.1	-	37.22 -/+ 9.68
	3	14.2	3.3	10.3	-	-	27.74 -/+ 1.83
	5	25.6	3.4	11.9	*	-	40.96 -/+ 6.13
Mean Total							43.9
22 January, 1979	1	1.0	0.3	3.3	-	-	4.43 -/+ 0.26
	2	1.1	0.3	3.7	-	-	4.96 -/+ 0.14
	3	1.1	0.6	4.8	-	-	6.57 -/+ 0.36
	5	1.0	0.4	3.0	-	-	4.39 -/+ 0.44
Mean Total		1.0	0.4	3.7	-	-	5.1

Note:
* = 0.05.

TABLE 4.2.1-9

DIURNAL MEAN DENSITIES (NO./l) OF MAJOR MICROZOOPLANKTON GROUPS COLLECTED FROM THE GREEN RIVER

		Sampling Zones					
		2			3		
		Surface		Bottom	Surface		Bottom
		D	N	N	D	N	N
26 May, 1978	Protozoa	-	1.5	1.1		-	
	Rotifera	19.3	7.6	8.3	34.8	2.2	17.7
	Cladocera	13.7	17.0	17.7	8.6	7.5	18.8
	Copepoda	26.3	43.2	19.8	20.6	26.8	51.9
	Ostracoda	-	-	-	0.4	-	0.1
11 July, 1978	Protozoa	2.8	0.5	1.4	-	0.1	0.9
	Rotifera	2.8	0.8	0.4	1.0	0.4	0.8
	Cladocera	4.1	11.4	9.1	2.5	10.9	14.2
	Copepoda	35.1	31.2	37.7	22.7	22.0	31.2
	Ostracoda	0.1	-	-	-	-	-
12 September, 1978	Protozoa	-	-	-	-	-	-
	Rotifera	21.0	12.2	8.7	14.2	16.5	11.2
	Cladocera	2.5	3.9	2.9	3.3	3.3	2.5
	Copepoda	13.6	9.0	8.7	10.3	10.5	7.7
	Ostracoda	0.1	1.0	*	-	0.1	-

Note:

D = Day samples

N = Night samples

* = <0.05

TABLE 4.2.1-10

TAXONOMIC LIST OF MICROZOOPLANKTON COLLECTED DURING THE DIURNAL MIGRATION STUDY FROM THE GREEN RIVER

	SPRING 1978				SUMMER 1978				FALL 1978			
	SAMPLING ZONES											
	2		3		2		3		2		3	
	S	B	S	B	S	B	S	B	S	B	S	B
Phylum Rotatoria												
Class Monogononta (unidentified)	x	x		x					x	x	x	x
Order Floscularacea												
Family Filiniidae												
Filinia spp	x											
Filinia longiseta	x	x	x	x								
Family Hexartridae												
Hexarthra mira		x									x	
Order Ploima												
Family Asplanchnidae												
Asplanchna priodonta	x	x		x					x	x	x	x
Asplanchnopus spp											x	x
Family Brachionidae												
Brachionus spp	x	x	x	x								
Brachionus angularis		x		x					x		x	x
Brachionus bidentata	x	x	x	x							x	
Brachionus calycifloris	x	x		x								
Brachionus havanaensis	x										x	x
Brachionus plicatilis	x											
Brachionus quadridentata	x	x	x						x			x
Kellicottia spp			x									
Kellicottia bostoniensis	x	x	x								x	
Keratella spp	x	x	x	x	x			x	x	x		
Keratella cochlearis	x	x		x					x	x	x	x
Keratella quadrata	x											
Keratella valga		x								x		
Mytilina spp				x								
Platyias spp	x	x	x	x	x	x	x	x				
Platyias patulus		x	x	x					x	x	x	x
Platyias quadricornis			x									
Family Lecaninae												
Monostyla spp									x	x	x	x
Family Plocsomatidae												
Ploesoma truncatum									x	x	x	x
Family Synchaetidae												
Polyarthra spp	x	x		x					x	x	x	x
Synchaeta spp		x										
Family Trichoceridae												
Trichocera multicrinis		x									x	
Phylum Arthropoda												
Class Crustacea												
Subclass Branchiopoda												
Order Cladocera (juvenile)	x								x		x	
Family Bosminidae												
Bosmina longerstris	x	x	x	x	x	x	x	x	x	x	x	x

TABLE 4.2.1-10 (Cont'd)

TAXONOMIC LIST OF MICROZOOPLANKTON COLLECTED
DURING THE DIURNAL MIGRATION STUDY
FROM THE GREEN RIVER

	SPRING 1978				SUMMER 1978				FALL 1978			
	SAMPLING ZONES											
	2		3		2		3		2		3	
	S	B	S	B	S	B	S	B	S	B	S	B
Family Chydoridae												
Chydorus sphaericus	x	x	x	x								
Family Daphnidae												
Ceriodaphnia spp										x		
Ceriodaphnia lacustris	x	x	x	x				x	x			
Daphnia spp	x			x								
Daphnia dubia		x										
Daphnia parvula	x	x	x	x					x	x		
Scapholeberis kingi	x		x	x								
Family Sididae												
Diaphanosoma brachyurum	x	x			x	x	x	x	x	x	x	x
Subclass Copepoda												
Order Eucopopoda												
copepod nauplii	x	x	x	x	x	x	x	x	x	x	x	x
Family Calanoidae												
calanoid copepedites	x	x	x	x	x	x	x	x	x	x	x	x
Diaptomus spp		x	x	x		x			x	x	x	x
Diaptomus bergei			x	x								
Diaptomus pallidus	x	x	x				x					
Diaptomus siciloides			x	x								
Family Cyclopoidae												
cyclopoid copepodites	x	x	x	x	x	x	x	x	x	x	x	x
Cyclops spp		x										
Cyclops scutifer	x	x	x									
Cyclops varicans rubellus		x								x	x	
Cyclops vernalis	x								x	x	x	x
Eucyclops agilis	x			x								
Mesocyclops edax					x	x	x	x	x		x	x
Paracyclops spp	x											
Tropocyclops prasinus	x		x	x								
Subclass Ostracoda				x					x	x	x	
Phylum Protozoa												
Class Mastigophora												
Order Phytomonadina												
Family Volvocidae	x	x			x	x	x	x				

NOTE: S = surface samples
B = bottom samples

TABLE 4.2.1-11

MEAN RELATIVE PERCENT ABUNDANCE OF MAJOR MICROZOOPLANKTON GROUPS COLLECTED FROM THE GREEN RIVER

Net-Pump Comparisons

	Spring				Summer				Fall			
	Zone 2		Zone 5		Zone 2		Zone 5		Zone 2		Zone 5	
	N*	P	N	P	N	P	N	P	N	P	N	P
Rotifer	13.9	28.8	53.8	59.2	2.0	6.0	2.3	6.4	58.5	55.4	46.8	62.7
Cladocera	26.7	24.3	21.3	18.0	20.6	9.0	12.9	8.1	11.2	7.0	15.0	8.3
Copepoda	59.3	45.9	24.9	22.8	77.4	79.6	84.8	85.5	30.2	37.3	38.1	28.9
Ostracoda	0.1	-	-	-	-	0.1	-	-	0.1	0.3	0.1	0.1
Protozoa	-	-	-	-	-	5.3	-	-	-	-	-	-

Means are based on sets of 3 samples unless noted.

NOTE:

* Relative percent abundance determined from one net-tow sample.

** Relative percent abundance determined from two net-two samples

N = Net P = Pump

TABLE 4.2.1-12

TAXONOMIC LIST OF MICROZOOPLANKTON COLLECTED FROM THE ON-SITE FARM PONDS

	PONDS		
	1	2	3
Phylum Rotatoria			
Class Monogononta (unidentified)	X	X	X
Order Plioma			
Family Asplanchnidae			
Asplanchna priodonta			X
Family Brachionidae			
Brachionus angularis	X		X
Brachionus calycifloris	X		
Brachionus havanaensis	X		X
Brachionus quadridentata	X	X	
Euchlanis spp	X	X	X
Euchlanis dilatata	X		
Keratella spp		X	X
Keratella cochlearis	X	X	X
Lepadella spp		X	
Mytilina spp		X	X
Platyias spp			X
Platyias patulus			X
Family Filiniidae			
Filinia longiseta	X		
Family Hexarthridae			
Hexarthra mira		X	X
Family Lecaninae			
Lecane spp		X	X
Monostyla spp			X
Family Notommatidae			
Cephalodella spp	X		
Family Synchaetidae			
Polyartha spp	X		
Synchaeta spp	X		
Family Testudinellidae			
Testudinella patina		X	
Family Trichocercidae			
Trichocerca spp	X		
Trichocerca multicrinis	X	X	X

TABLE 4.2.1-12 (Cont'd)

TAXONOMIC LIST OF MICROZOOPLANKTON COLLECTED FROM THE ON-SITE FARM PONDS

	PONDS		
	1	2	3
Phylum Arthropoda			
Class Crustacea			
Subclass Copepoda			
Order Eucopepoda			
copepod nauplii	X	X	X
Family Calanoidae			
calanoid copepodites	X	X	
Diaptomus spp	X	X	
Family Cyclopoidae			
cyclopoid copepodites	X	X	X
Cyclops spp		X	
Cyclops scutifer	X		
Cyclops varicans rubellus	X	X	
Cyclops vernalis	X		
Eucyclops agilis	X	X	
Paracyclops spp		X	
Tropocyclops prasinus		X	
Subclass Branchiopoda			
Order Cladocera (juvenile)		X	
Family Bosminidae			
Bosmina longirostris	X	X	X
Family Chydoridae			
Chydorus sphaericus		X	X
Family Daphnidae			
Ceriodaphnia lacustris	X	X	X
Daphnia parvula			X
Family Sididae			
Diaphanosoma brachyurum		X	X
Subclass Ostracoda (planktonic)	X	X	X
Phylum Protozoa			
Class Mastiogophora			
Order Phytomonadina			
Family Volvocidae		X	X

TABLE 4.2.1-13

MEAN DENSITY (No/l) AND RELATIVE PERCENT ABUNDANCE OF MAJOR MICROZOOPLANKTON GROUPS COLLECTED FROM THE ON-SITE FARM PONDS

	Ponds					
	1		2		3	
	Abundance		Abundance		Abundance	
	No.	%	No.	%	No.	%
MAJOR GROUPS						
Rotifers	230.5	87.3	750.0	10.5	82.2	6.8
Cladocerans	0.8	0.3	784.1	11.0	872.1	71.8
Copepods	32.2	12.2	150.1	2.1	219.2	18.0
Ostracods	0.7	0.2	262.1	3.7	34.1	2.8
Protozoans	-	-	5197.0	72.8	6.3	0.5
Mean Total	264.1		7141.3		1214.0	

TABLE 4.2.1-14

TAXONOMIC LIST OF MICROZOOPLANKTON COLLECTED FROM THE CYPRESS SLOUCH

	Fall 1978		Spring 1979
	Sampling Locations		
	1	2	1
Phylum Rotatoria			
Class Monogononta (unidentified)	X	X	X
Order Ploima			
Family Asplanchnidae			
Asplanchna priodonta	X		X
Family Brachionidae			
Brachionus angularis	X		
Brachionus bidentata	X		
Brachionus calycifloris			X
Brachionus havanaensis	X		
Brachionus quadridentata	X		
Euchlanis spp	X		
Euchlanis dilatata	X		
Diplois daviesiae	X		
Keratella cochlearis			X
Platyias patulus	X		
Family Lecaninae			
Lecane spp	X		
Monostyla spp	X	X	
Family Notommatidae			
Cephalodella spp		X	
Family Synchaetidae			
Polyarthra spp	X	X	X
Phylum Arthropoda			
Class Crustacea			
Subclass Branchiopoda			
Order Cladocera			
Family Bosminidae			
Bosmina longirostris			X
Family Chydoridae			
Alona costata	X		
Chydorus sphaericus	X		X
Family Daphnidae			
Ceriodaphnia spp	X	X	
Ceriodaphnia lacustris			X
Daphnia parvula	X		
Scapholeberis kingi	X	X	
Family Sididae			
Diaphanosoma brachyurum	X	X	
Subclass Ostracoda	X		X
Subclass Copepoda			
Order Eucopepoda			
copepod nauplii	X	X	X

TABLE 4.2.1-14 (Cont'd)

	Fall 1978		Spring 1979
	Sampling Locations		
	1	2	1
Family Calanoidae			
calanoid copepodites	X	X	
Diaptomus spp	X		X
Family Cyclopoidae			
cyclopoid copepodites	X	X	X
Cyclops spp	X	X	
Cyclops varicans rubellus	X		
Eucyclops agilis	X		
Mesocyclops edax	X		
Tropocyclops prasinus	X		

TABLE 4.2.1-15

TAXONOMIC LIST OF BENTHIC MACROINVERTEBRATES
COLLECTED FROM THE GREEN RIVER

	Spring 1978			Summer 1978				Fall 1978			Spring 1979		
	Sampling Zones												
	1	3	6	1	2	3	5	1	3	5	1	2	3
lum Annelida											X		
ass Oligochaeta					X	X		X		X	X		X
rder Plesiopora													
Family Aeolosomatidae													
Aeolosoma spp				X	X								
Family Naididae					X	X							
Dero spp				X									
Pristina spp			X										
Family Tubificidae													
Branchiura sowerbyi					X	X	X			X			
Limnodrillus spp	X			X	X	X	X			X			
Order Opisthopora													
Family Haplotaxidae													
Haplotaxis						X							
lum Nematoda	X												
lum Arthropoda													
lass Arachnoidea											X		X
lass Insecta													X
Order Diptera											X		
Family Ceratopogonidae													
Culicoides spp (larvae)								X		X			
Family Chironomidae													
(larvae)	X												
(pupa)					X	X							
Family Culicidae													
Chaoborus spp (larvae)										X			
Family Tendipedidae										X			
Clinotanyptus spp										X			
Coelotanypus spp										X			
Procladius spp	X	X	X		X					X			
Order Ephemeroptera													
Family Ephemeridae													
Hexagenia spp (nymph)	X		X	X	X								X
Order Odonata													
Family Gomphidae													
Gomphus spp						X							
lum Mollusca													
ass Gastropoda					X								
rder Pulmonata													
Family Planorbidae													

TABLE 4.2.1-15 (Cont'd)

	Spring 1978			Summer 1978				Fall 1978			Spring 1979		
	Sampling Zones												
	1	3	6	1	2	3	5	1	3	5	1	2	3
Gyraulus spp										X			
Family Physidae													
Physa spp							X						
Class Pelecyopoda									X			X	X
Family Sphaeriidae					X								
Musculium spp				X									
Sphaerium spp				X	X	X	X			X			

TABLE 4.2.1-16

MEAN DENSITIES (NO./m^2) OF MAJOR BENTHIC

MACROINVERTEBRATE GROUPS COLLECTED FROM THE GREEN RIVER

	Spring 1978			Summer 1978				Fall 1978			Spring 1979		
	SAMPLING ZONES												
	1[a]	3[a]	6[a]	1	2	3	5	1	3	5	1	2	3
Annelida	43.5		21.6	101.5	449.3	913.1	101.5	87.0		159.4	*		0.3
Nematoda	21.6												
Insecta	87.0	21.6	108.7	144.9	58.0	43.5		14.5		86.0	*		
Mollusca				72.5	87.0	72.5	405.8		0.2	405.8		0.2	*
Arachnida											*		*
Mean Total	152.2	21.6	130.4	318.9	594.2	1029.0	507.3	101.5	0.2	652.2	*	0.2	*

Note a = Mean Density of 2 samples. All others based on 3 samples.

* = Mean Density <0.05 organisms/m^2

TABLE 4.2.1-17

MEAN DENSITIES (No./m^2) OF MAJOR BENTHIC MACROINVERTEBRATES GROUPS COLLECTED FROM THE ON-SITE FARM PONDS

Benthic Group	Ponds		
	1	2	3
Annelida			
Oligochaeta	3304	576	826
Nematoda	11	11	
Crustacea			
Decapoda	22		
Insecta			
Ephemeroptera	11		
Hemiptera	33	11	
Diptera	1685	250	489
Megaloptera	33		
Mollusca			
Gastropoda	315		
Polecypoda	1011		11
Arachnida			
Lebertiidae		11	
Unionicolidae			11
TOTAL	6425	859	1337

TABLE 4.2.1-18

TAXONOMIC LIST OF BENTHIC MACROINVERTEBRATE COLLECTED FROM THE ON-SITE FARM PONDS

	Ponds		
	1	2	3
Phylum Annelida			
Class Oligochaeta	X	X	X
Order Opisthopora			
Family Haplotaxidae			
Haplotxus spp		X	
Order Plesiopora			
Family Naididae	X		
Dero spp	X		
Family Tubificidae			
Brachiura sowerbyi		X	X
Limnodrillus spp	X	X	X
Phylum Nematoda	X	X	
Phylum Arthropoda			
Class Arachnoidae			
Order Hydracarina			
Family Lebertiidae			
Lebertia spp		X	
Family Unionicolidae			
Neumania spp			X
Class Crustacea			
Order Decapoda			
Family Astacidae	X		
Class Insecta			
Order Diptera			
Family Ceratopogonidae (adult)	X		
Culicoides spp (larvae)	X	X	X
Family Culicidae			
Chaoborus spp (larvae)	X		X
Family Tendipedidae			
Clinotanypus spp (larvae)	X	X	
Procladius spp (larvae)	X	X	X
Sub-family Chironominae	X	X	X
Anatophynia spp (larvae)	X		X
Chirononums spp (larvae)	X		X
Cryptochironomus spp (pupae)	X	X	X
Glyptotendipes spp (larvae)		X	
Tanytarsus spp (larvae)			X
Order Ephemeroptera			
Family Ephemeridae			
Hexagenia spp (nymph)	X		
Order Hemiptera			
Family Notonectidae			
Notonecta spp (nymph)	X		X
Order Metaloptera			
Family Sialidae			
Sialis spp (larvae)	X		

TABLE 4.2.1-18 (Cont'd)

TAXONOMIC LIST OF BENTHIC MACROINVERTEBRATE COLLECTED FROM THE ON-SITE FARM PONDS

	Ponds		
	1	2	3
Phylum Mullusca			
Class Gastropoda			
Order Pulmonata			
Family Ancylidae			
Ferrissia spp (juvenile)	X		
Family Physidae			
Physa spp	X		
Class Pelecypoda			
Family Sphaeriidae			
Sphaerium spp	X		X

TABLE 4.2.1-19

TAXONOMIC LIST OF BENTHIC MACROINVERTEBRATES
COLLECTED FROM CYPRESS SLOUGH

	FALL 1978		SPRING 1979	
	Sampling Locations			
	1	2	1	2
Phylum Annelida				
Class Oligochaeta (unidentified)		x		
Order Plesiopora				
Family Naididae			x	
Dero spp		x		
Family Tubificidae		x	x	x
Limnodrillus spp	x	x	x	x
Tubifex spp	x	x		
Phylum Arthropoda				
Class Arachnoidea				
Order Hydracarina				
Family Unionicolidae				
Brachypoda spp	x			
Class Crustacea				
Order Amphipoda (juvenile)			x	
Family Talitridae				
Hyalella azteca		x		
Order Isopoda				
Family Asellidae				
Asellus spp			x	
Lirceus spp		x		
Class Insecta				
Order Ephemeroptera				
Family Baetidae				
Caenis spp (nymph)		x		
Family Ephemeridae				
Hexagenia spp (nymph)				x
Order Odonata				
Family Coenagrionidae				
Enallagma spp (nymph)		x		
Order Diptera				
Family Ceratopogonidae				
Palpomyia spp (larvae)		x	x	
Family Chironomidae (larvae)	x	x		
(pupae)	x			
Chironomus spp (larvae)		x		
Parachironomus spp (larvae)		x		
Family Culicidae				
Chaoborus spp (larvae)	x			
(pupae)	x			
Culicoides spp (larvae)		x	x	

TABLE 4.2.1-19 (Cont'd)

TAXONOMIC LIST OF BENTHIC MACROINVERTEBRATES
COLLECTED FROM CYPRESS SLOUGH

	FALL 1978		SPRING 1979	
	Sampling Locations			
	1	2	1	2
Family Tendipedidae				
Clinotanypus spp (larvae)		x		
Glyptotendipes spp (larvae)		x		
Pentaneura spp (larvae)		x		
Procladius spp (larvae)		x	x	x
Tanypus spp (larvae)		x		
Phylum Mollusca				
Class Gastropoda				
Order Pulmonata				
Family Lymnaeidae				
Lymnaea spp			x	
Family Physidae				
Physa spp	x	x	x	
Family Planorbidae				
Gyraulus spp		x	x	
Class Pelecyopoda				
Family Sphaeriidae	x			
Sphaerium spp	x	x	x	x
Phylum Nematoda				
Class Aphasmidia				
Order Enoplida				
Family Dorylaminida			x	

TABLE 4.2.1-20

MEAN DENSITY (No./m^2) AND PERCENT RELATIVE ABUNDANCE

OF MAJOR BENTHIC GROUPS COLLECTED FROM THE CYPRESS SLOUGH

	1978 FALL LOCATIONS				1979 SPRING LOCATIONS			
	1 Abundance		2 Abundance		1 Abundance		2 Abundance	
	No.	%	No.	%	No.	%	No.	%
Annelida	4695.7	86.1	6217.5	48.6	15282.7	81.6	1673.9	87.4
Insecta	477.8	10.0	5130.6	40.3	978.2	5.2	108.8	5.9
Arachnida	43.5	0.9	-	-	-	-	-	-
Mollusca	130.5	3.0	811.6	9.6	2195.7	11.7	103.4	6.7
Crustacea	-	-	195.6	1.5	239.2	1.3	-	-
Nematoda	-	-	-	-	21.8	0.2	-	-
Mean Total	5,347.8		12,760.9		18,717.4		1,913.1	

TABLE 4.2.1-21

TAXONOMIC LIST OF DRIFT INVERTEBRATES
COLLECTED FROM THE ON-SITE STREAM

	STREAM STATIONS															
	1				2				3				4			
Sampling Period	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Phylum Annelida																
Class Oligochaeta							x									
Order Prosopora																
Family Branchiobdellidae		x			x								x	x	x	x
Family Lumbriculidae											x					
Family Naididae						x			x	x	x					
Class Hirundinia																
Order Rhynchobdellida																
Family Glossiphoniidae																
Helobdella spp									x					x		
Phylum Platyhelminthes																
Class Tubellaria																
Order Tricladida																
Family Planariidae		x	x		x	x	x		x		x					
Phylum Nematoda			x									x				
Phylum Arthropoda																
Class Crustacea																
Order Amphipoda																
(juvenile)				x												
Family Gammaridae																
(juvenile)							x									
Synurella spp		x	x			x	x		x	x	x	x	x	x	x	x
Synurella spp (juvenile)	x			x			x	x								
Synurella dentata	x		x				x	x								
Order Decapoda																
Family Astacidae													x	x	x	x
Order Isopoda																
(juvenile)			x	x	x	x			x	x	x	x		x		x
Family Asellidae																
Asellus spp	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Lirceus spp	x	x	x	x	x	x	x		x		x	x	x		x	
Order Mysidacea																
Family Mysidae																
Mysis relicta										x						
Class Myriapoda*						x										
Class Arachnida*									x		x					
Order Acarina*									x	x	x		x			x

* = Terrestrial origin

TABLE 4.2.1-21 (Cont'd)

TAXONOMIC LIST OF DRIFT INVERTEBRATES
COLLECTED FROM THE ON-SITE STREAM

	STREAM STATIONS															
	1				2				3				4			
Sampling Period	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Class Insecta																
Order Coleoptera																
(adults)*		x	x			x			x	x	x	x	x	x	x	x
Family Corculionidae																
(adults)*			x			x			x	x	x	x				
Family Dryopidae																
(larvae)				x												
Family Staphylinidae																
(adults)*			x			x			x	x	x	x	x			x
Order Collembola*																
Family Entamobryidae	x															
Family Isotomatidae			x	x	x		x	x	x	x	x	x	x	x	x	x
Family Smynthuridae	x		x	x			x	x			x		x			x
Order Diptera (adults)*				x					x	x	x	x	x	x	x	x
(larvae)								x								
(pupae)*							x		x			x	x	x	x	x
Family Ceratopogonidae																
Culicoides spp						x								x		
Family Chironomidae		x							x			x				
Family Tipulidae																
Pseudolimnophilia spp						x			x							x
Order Hemiptera (nymph)*			x		x				x	x			x			
Family Aphidae*											x		x			x
Family Cicadellidae*						x			x		x		x	x		x
Order Hepidoptera*											x					
Order Hymenoptera																
(adults)*			x		x	x			x	x		x				
(larvae)*		x	x						x	x		x	x	x		x
Family Formicidae*						x			x	x	x		x	x		
Order Odonata																
Suborder Anisoptera		x														
Order Orthoptera*																
Tridactylus spp*					x											
Order Thysanura*										x			x			

* = Terrestrial origin

TABLE 4.2.1-21 (Cont'd)

TAXONOMIC LIST OF DRIFT INVERTEBRATES
COLLECTED FROM THE ON-SITE STREAM

	STREAM STATIONS															
	1				2				3				4			
Sampling Period	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Order Trichoptera																
Family Limnephilidae																
Caborius spp			x						x							
Phylum Mollusca																
Class Gastropoda		x											x	x		
Order Pulmonata																
Family Physidae																
Physa spp	x	x	x						x							

* = Terrestrial origin

TABLE 4.2.1-22

RELATIVE PERCENT ABUNDANCE OF MAJOR GROUPS OF DRIFT INVERTEBRATES COLLECTED FROM THE ON-SITE STREAMS

	Isopoda	Amphipoda	Decapoda	Insecta	Arachnida	Mollusca	Myriapoda	Platyhelminthes	Annelida	Nematoda
Station 1										
Sample 1	47.0	50.5		2.3		0.2				
Sample 2	80.8	18.1		0.3		0.2		0.1	0.5	
Sample 3	56.4	41.4		1.5		0.1		0.4		0.2
Sample 4	57.7	41.7		0.6						
Mean	60.5	37.9		1.2		0.1		0.1	0.1	0.1
Station 2										
Sample 1	23.6	74.6		0.4				0.7	0.7	
Sample 2	13.5	82.4		3.5			0.1	0.3	0.2	
Sample 3	15.6	80.9		1.5				1.9	0.1	
Sample 4	24.9	74.4		0.7						
Mean	19.4	78.1		1.5			*	0.7	0.2	
Station 3										
Sample 1	37.3	56.0		6.4	0.1	0.1		*	*	
Sample 2	6.6	90.4		2.9	*				*	
Sample 3	8.3	89.8		1.7	0.1				*	
Sample 4	8.8	77.2		13.8				*		0.1
Mean	15.3	78.3		6.2	0.1	*		*	*	*
Station 4										
Sample 1	4.7	7.5	1.9	85.1	0.3	0.1			0.4	
Sample 2	0.6	8.4	0.7	90.1		*			0.2	
Sample 3	1.9	71.8	13.9	11.4					1.0	
Sample 4	0.7	17.1	7.7	71.8	1.0				0.7	
Mean	2.0	26.2	6.0	64.6	0.3	*			0.6	

* = density <0.05

TABLE 4.2.1-23

TAXONOMIC LIST OF BENTHIC MACROINVERTEBRATES
COLLECTED FROM THE ON-SITE STREAM
BY SURBER NET

	STREAM STATIONS							
	1		2		3		4	
Sampling Period	AM	PM	AM	PM	AM	PM	AM	PM
Phylum Annelida	X	X	X	X	X	X	X	X
Class Oligochaeta								
Order Prosopora								
Family Brachiobdellidae				X				
Phylum Platyhelminthes								
Class Tubellaria								
Order Tricladida								
Family Planariidae				X				
Phylum Arthropoda								
Class Crustacea								
Order Amphipoda								
Family Gammaridae								
Synurella spp	X	X	X	X	X	X	X	X
Order Decapoda								
Family Astacidae							X	X
Order Isopoda	X	X	X					
Family Asellidae								
Asellus spp	X	X	X	X	X			
Lirceus spp	X	X	X	X				X
Class Insecta								
Order Coleoptera*	X							
Order Collembola								
Family Isotomidae*			X		X		X	
Order Diptera								
Family Ceratopogonidae								
Palpomyia spp			X					
Family Ceratopogonidae								
Paradelphonyia spp*	X	X	X	X	X		X	
Family Tabanidae								
Chrysops spp	X	X	X					
Order Hemiptera*			X					
Order Hymenoptera*			X					
Order Orthoptera								
Tridartylus spp*					X			
Class Arachnida								
Order Araneida*				X				

* = Terrestrial Origin

TABLE 4.2.1-24

DENSITY (NO/m^2) AND RELATIVE PERCENT ABUNDANCE OF BENTHIC MACROINVERTIBRATES COLLECTED FROM THE ON-SITE STREAM

BY SURBER NET

Stream Stations

	1				2				3				4			
	Day Abundance		Night Abundance		Day Abundance		Night Abundance		Day Abundance		Night Abundance		Day Abundance		Night Abundance	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Major Group																
Annelida	10.7	2.0	32.3	2.5	43.0	2.6	451.5	12.8	75.3	13.0	43.0	7.5	10.7	6.3	32.3	23.1
Platyhelminthes							21.5	0.6								
Isopoda	107.5	19.6	494.7	39.7	53.8	3.4	139.9	4.0	32.3	5.5	-	-	-	-	10.7	7.6
Amphipoda	430.1	78.4	688.2	55.2	1473.1	92.6	2795.7	79.5	430.1	74.1	494.6	86.8	129.0	75.0	32.3	23.1
Decapoda	-	-	-	-	-	-	-	-	-	-	-	-	32.3	18.7	43.0	30.8
Insecta	-	-	32.1	2.6	21.4	1.4	107.4	3.1	32.3	5.5	32.1	5.7	-	-	21.4	15.4
Arachnida	-	-	-	-	-	-	-	-	10.7	1.9	-	-	-	-	-	-
Total	584.3		1247.3		1591.4		3516.1		580.7		569.9		172.0		139.8	

TABLE 4.2.1-25

TAXONOMIC LIST OF MACROZOOPLANKTON (DRIFT)
COLLECTED FROM THE GREEN RIVER

	SRRING					SUMMER			FALL			
	Zones					Zones			Zones			
	1	2	3	5	6	2	3	6	1	2	3	6
Phylum Arthropoda												
Class Arachnida												
Order Acrina				X		X	+	0	X	X	+	0
Family Arachnoidea					X		X				0	
Class Crustacea												
Order Amphipoda												
Hyalella azteca		0	X	X	X		0	0				
Order Copepoda												
Family Argulidae												
Argulus spp						X	+	0	X	X	+	0
Order Isopoda												
Family Asellidae												
Asellus spp		X		X								
Class Insecta (larvae)				X								0
(adult)							0	0			0	
Order Coleopter (larvae)		0	X	X	X		+	0	X			
Order Collembola												
Family Isotomatidae		0										
Sminthurides spp		0										
Sotomuris palustris		+	X	X	X							
Order Diptera (larvae)		X										X
(pupac)		+					0					
Family Ceratopogonidae		0			X							
Culicoides spp (larvae)	X											
Probezzia spp (larvae)	X	+		X	X							
(pupae)	X	0			X							
Family Chironomidae (larvae)		0		X								
(pupae)		+	X	X	X	X	0	0			+	+
Chironomus spp (larvae)				X	X							
Endochironomous spp (larvae)		X										
Parachironomous spp (larvae)		X					0				0	
Smittia spp (larvae)							X					
Family Culicidae (larvae)		+										
Aedes spp (larvae)				X	X				X			
Chaoborus spp (larvae)	X	+	X	X	X	X	+	+	X	X	0	+
(pupae)	X	+	X	X	X		+	0	X	X	0	+
Family Tanypodinae (larvae)		X		X	X		0		X		0	0
(pupae)		X	X	X	X	X	0	0	X		+	0
Family Tendipedidae												
Anatopynia spp (larvae)		+										
Clinotanypus spp (larvae)		+									X	
Coelotanypus spp (larvae)	X	+		X	X							
(pupae)	X											

TABLE 4.2.1-25 (Cont'd)

TAXONOMIC LIST OF MACROZOOPLANKGON (DRIFT)
COLLECTED FROM THE GREEN RIVER

	SPRING					SUMMER			FALL			
	Zones					Zones			Zones			
	1	2	3	5	6	2	3	6	1	2	3	6
Epoicocladius spp (larvae)							0					
Glyptotendipes spp (larvae)		X										
Orthocladiinae (pupae)			X	X	X		0					
Polypedilum spp (larva)	X	+	X	X	X	X	0	0	X	X	+	+
Procladius spp (larvae)	X	+	X	X	X		0	0				+
Tanypus spp (larvae)		X										
Order Emphemeropter		X										
Family Baetidae (nymph)					X							
Family Ephemeridae (nymph)		0	X	X								
Hexagenia spp (nymph)	X	+			X		0	0			0	0
Orianthus spp (nymph)					X							
Family Heptageniidae (nymph)			X				0	0			0	0
Order Hemiptera								0				0
Family Corixidae (larvae)									X		0	
Family Hebridae		0										
Family Notonectidae		0		X	X							
Family Pleidae					X							
Order Megaloptera												
Family Corydalidae					X							
Order Neuroptera												
Family Sisyridae												
Sisyra spp (larvae												0
Sisyra vicaria												0
Order Odonata												
Family Coenagrionidae (nymph)	0											
Argia spp (nymph)	0		X			0	0					
Family Gomphidae (nymph)											0	
Family Libellulidae												
Macromia spp (nymph)												0
Order Plecoptera		0										
Order Trichoptera (larvae)		0	X	X	X		0	0			X	0
Family Hydropsychidae (larvae)							0	0			0	0
Family Leptoceridae (larvae)												0
Family Rhyacophilidae (larvae)							0				0	0
Phylum Annelida												
Class Hirudinia							0	0			0	0
Class Oligochaeta		X									0	
Order Prosopora												
Family Branchiobdelliadae		+	X	X	X		X					
Phylum Nematoda		0										0

Note: X = Collected only during the day sampling
0 = Collected only during the night sampling
+ = Collected during both day and night sampling

TABLE 4.2.1-26

MEAN DENSITIES (No./100m^3) OF MAJOR MACROZOOPLANKTON GROUPS
COLLECTED DURING THE DAY FROM THE GREEN RIVER

	SPRING					SUMMER			FALL			
	ZONES SAMPLED											
	1	2	3	5	6	2	3	6	1	2	3	6
Insecta				0.4	1.9							
Diptera	333.9	152.5	78.4	280.7	556.4	0.8	0.4	0.1	5.5	4.0	7.7	15.8
Ephemeroptera	2.5	0.6	3.5	2.0	5.0							
Megaloptera					1.6							
Collembola		8.8	3.2	2.1	3.7							
Hemiptera	2.1			0.1	5.3				0.2			
Plecoptera												
Neuroptera												
Coleoptera	1.4	0.6	0.2	0.2	3.5		0.1		0.1	0.2		
Trichopera		0.1	0.2	2.2	3.5		0.2			0.1		
Odonata				2.0								
Crustacea		0.6	0.4	2.9	1.6	0.2	0.2		0.1	0.1	0.1	
Arachnida				0.1		0.3		0.3	0.7	0.7	0.7	1.7
Nematoda	0.3											0.1
Annelida		6.8	7.8	14.7	15.7							
Mean Total	339.9	170.0	93.6	307.4	605.4	1.2	2.1	0.1	6.6	6.1	8.6	16.2
	±	+	±	±	±	±	±	±	±	±	±	±
Standard Deviation	335.5	200.4	116.0	203.2	261.1	0.6	1.5	0.2	1.9	1.2	9.9	8.8

TABLE 4.2.1-27

MEAN DENSITY (No./100m^3) OF DAY/NIGHT MAJOR MACROZOOPLANKTON GROUPS COLLECTED FROM THE GREEN RIVER

	Spring		Summer				Fall			
	Zone 2		Zone 3		Zone 6		Zone 3		Zone 6	
	D	N	D	N	D	N	D	N	D	N
Insecta										
Diptera	152.5	121.6	0.4	300.4	0.1	176.5	7.7	252.5	15.8	227.4
Ephemeroptera	0.6	13.7		13.1		3.4		1.3		2.0
Megaloptera										
Collembola	88.9	1.9								
Hemiptera		0.1				0.1		0.2		0.1
Plecoptera		1.5								
Neuroptera										
Coleoptera	0.6	0.4	0.1	3.8		1.8				
Trichopera	0.1	0.2	0.2	26.4		30.6		10.0		27.6
Odonata		1.7		2.5		1.2		0.1		0.1
Crustacea	0.6	0.1	0.2	0.4		0.5	0.1			0.1
Arachnida			0.7	0.4		0.6	0.9	0.7	0.3	0.6
Nematoda		1.5							0.1	0.1
Annelida	6.8	10.4		0.4				0.6		1.1
Mean Total	170.0	153.1	2.1	347.5	0.1	215.5	8.6	265.4	16.2	259.3

NOTE: D = Day Samples
N = Night Samples

TABLE 4.2.1-28

MEAN DENSITY (NO/100m^3), STANDARD DEVIATION AND t-VALUE OF DAY/NIGHT MACROZOOPLANKTON COLLECTED FROM THE GREEN RIVER

Date	Zone	Time	Mean Density		Standard Deviation	Calculated t-Value
18 May 1978	2	Day	169.8	±	200.4	0.243
		Night	153.1	±	160.5	
12 July 1978	3	Day	2.1	±	1.5	-14.910*
		Night	347.5	±	40.1	
	6	Day	0.1	±	0.2	- 8.265*
		Night	215.5	±	45.2	
5 September 1978	3	Day	8.6	±	9.9	- 6.806*
		Night	265.4	±	55.5	
	6	Day	16.2	±	8.8	- 7.037*
		Night	259.4	±	51.5	

$t_{0.05\ [2]} = 4.303$

Reference: Sokal and Rohlf[158]

TABLE 4.2.1-29

MEAN RELATIVE PERCENT ABUNDANCE OF MAJOR MACROZOOPLANKTON GROUPS COLLECTED FROM THE CYPRESS SLOUGH

	Location 1
Annelida	89.5
Insecta	6.6
Arachnida	3.4
Nematoda	0.1
Crustacea	0.1

TABLE 4.2.1-30

TAXONOMIC LIST OF MACROZOOPLANKTON COLLECTED FROM THE CYPRESS SLOUGH

	Location 1
Phylum Annelida	
Class Oligochaeta	
(unidentified)	x
Phylum Arthropoda	
Class Crustacea	
Order Isopoda	
Family Asellidae	
Asellus spp	x
Class Arachnoidea	
Order Acarina	
(unidentified adults)	x
Class Insecta	
Order Coleoptera (adults)	x
Order Diptera	
(unidentified adults)	x
Family Ceratoponidae	
Palpomyia spp	x
Probezzia spp (larvae)	x
(pupae)	x
Family Culicidae	
Chaoborus spp (larvae)	x
Family Tendipedidae	
Subfamily Tanypodinae (larvae)	x
Anatopynia spp (larvae)	x
Clinotanypus spp (larvae)	x
Procladius spp (larvae)	x
Tanypus spp (larvae)	x
Subfamily Chironominae (pupae)	x
Parachironomus spp (pupae)	x
Phylum Nematoda	
(unidentified)	x

TABLE 4.2.1-31

SUM OF ICHTHYOPLANKTON DENSITY (NO./100m^3)
FROM THE GREEN RIVER 18 MAY 1978 TO 18 MAY 1979

Type Ichthyoplankter	Number (%)	Dominant Groups Number (%)
Vertebrata, unidentified	134.9 (0.8)	
Clupeidae spp.	4,094.1 (23.6)	
Dorosoma spp.	10.6 (<0.1)	
Dorosoma cepedianum	3,583.6 (20.6)	7,890.3 (45.4)
Dorosoma petenense	11.3 (<0.1)	
Alosa chrysochloris	190.7 (1.1)	
Hiodon tergisus	31.2 (0.2)	
Cyprinidae spp.	19.4 (0.1)	302.8 (1.7)
Cyprinus carpio	283.4 (1.6)	
Notropis spp.	1.6 (<0.1)	
Notropis atherinoides	126.7 (0.7)	
Semotilus atromaculatus	0.3 (<0.1)	
Catostomidae spp.	39.6 (0.2)	
Ictiobinae spp.	526.6 (3.0)	
Ictiobus spp.	181.9 (1.0)	734.4 (4.2)
Carpoides spp.	25.9 (0.1)	
Ictalurus furcatus	0.3 (<0.1)	
Ictalurus punctatus	22.9 (0.1)	
Pylodictus olivaris	8.7 (<0.1)	
Morone spp.	47.7 (0.3)	244.6 (1.4)
Morone chrysops	196.9 (1.1)	
Pomoxis spp.	37.4 (0.2)	
Pomoxis annularis	4.5 (<0.1)	
Pomoxis nigromaculatus	0.3 (<0.1)	
Lepomis spp.	1.9 (<0.1)	
Lepomis megalotus	7.2 (<0.1)	
Micropterus spp.	0.7 (<0.1)	
Micropterus punctulatus	3.7 (<0.1)	
Percina spp.	1.9 (<0.1)	
Percina flavecens	0.3 (<0.1)	
Etheostoma spp.	1.2 (<0.1)	
Aplodinotus grunniens	7,795.0 (44.8)	7,795.0 (44.8)
Total	17,392.4 (100.0)	

TABLE 4.2.1-32

DOROSOMA CEPEDIANUM ICHTHYOPLANKTON MEAN DENSITY (NO./100m^3)
BY ZONE IN THE GREEN RIVER

Date	Zone	Surface or Bottom	Eggs	Early Embryo	Proto-Larvae	Meso-Larvae	Meta-Larvae	Juvenile	Stage Unidentified
19 May 78	1	S							
18 May	2	S							
19 May	3	S							
18 May	5	S							
19 May	6	S							
18 May	2	S(DVM)							
28 May*	3	S				62.4			
28 May	6	S				9.2			
8 Jun	3	S						0.1	
8 Jun	6	S							
19 Jun	3	S				0.2			
19 Jun	6	S							
28 Jun	3	S			323.7	171.6	0.2		
28 Jun	6	S			77.5	228.7			
12 Jul	2	S			6.9	87.8	2.0		
12 Jul	3	S			4.4	51.9	7.3		
12 Jul	6	S			5.8	88.4	7.4		
12 Jul	3	S(DVM)			0.3	27.0	7.0		
12 Jul	6	S(DVM)			0.4	22.1	17.9		
26 Jul	3	S						0.1	
26 Jul	6	S							
9 Aug	3	S				2.4			
9 Aug	6	S				1.2			
22 Aug	3	S							
22 Aug	6	S							
5 Sep	1	S				0.3			
5 Sep	2	S							
5 Sep	3	S							
5 Sep	6	S							
5 Sep	3	S(DVM)							
5 Sep	6	S(DVM)				0.1			
14 Sep	3	S							
14 Sep	6	S							
25 Sep	3	S							
25 Sep	6	S							
28 Mar 79	3	S							
28 Mar	6	S							
7 Apr	3	S							
7 Apr	3	B							
7 Apr	6	S							

*Two replicates. All other dates represent three replicates.

TABLE 4.2.1-32 (Cont'd)

DOROSOMA CEPEDIANUM ICHTHYOPLANKTON MEAN DENSITY (NO./100m^3)
BY ZONE IN THE GREEN RIVER

Date	Zone	Surface or Bottom	Eggs	Early Embryo	Proto-Larvae	Meso-Larvae	Meta-Larvae	Juvenile	Stage Unidentified
17 Apr	3	S							
17 Apr	3	B							
17 Apr	6	S							
27 Apr	3	S					0.3		
27 Apr	3	B							
27 Apr	6	S							
6 May	3	S							
6 May	6	S							
18 May	1	S					0.7		
18 May	2	S							
18 May	3	S							
17 May	6	S							

TABLE 4.2.1-33

ALOSA CHRYSOCHLORIS ICHTHYOPLANKTON MEAN DENSITY (NO./100m^3)
BY ZONE IN THE GREEN RIVER

Date	Zone	Surface or Bottom	Eggs	Early Embryo	Proto-Larvae	Meso-Larvae	Meta-Larvae	Juvenile	Stage Unidentified
19 May 78	1	S							
18 May	2	S							
19 May	3	S							
18 May	5	S							
19 May	6	S							
18 May	2	S(DVM)							
28 May*	3	S							
28 May	6	S							
8 Jun	3	S							
8 Jun	6	S							
19 Jun	3	S							
19 Jun	6	S							
28 Jun	3	S					1.7		
28 Jun	6	S					0.7		
12 Jul	2	S					1.7		
12 Jul	3	S					22.8		
12 Jul	6	S					13.3		
12 Jul	3	S(DVM)					10.8		
12 Jul	6	S(DVM)					12.4		
26 Jul	3	S							
26 Jul	6	S							
9 Aug	3	S							
9 Aug	6	S						0.2	
22 Aug	3	S							
22 Aug	6	S							
5 Sep	1	S							
5 Sep	2	S							
5 Sep	3	S							
5 Sep	6	S							
5 Sep	3	S(DVM)							
5 Sep	6	S(DVM)							
14 Sep	3	S							
14 Sep	6	S							
25 Sep	3	S							
25 Sep	6	S							
28 Mar 79	3	S							
28 Mar	6	S							
7 Apr	3	S							
7 Apr	3	B							
7 Apr	6	S							

*Two replicates. All other dates represent three replicates.
DVM - Diurnal vertical migration.

TABLE 4.2.1-33 (Cont'd)

ALOSA CHRYSOCHLORIS ICHTHYOPLANKTON MEAN DENSITY (NO./100m^3)
BY ZONE IN THE GREEN RIVER

Date	Zone	Surface or Bottom	Eggs	Early Embryo	Proto-Larvae	Meso-Larvae	Meta-Larvae	Juvenile	Stage Unidentified
17 Apr	3	S							
17 Apr	3	B							
17 Apr	6	S							
27 Apr	3	S							
27 Apr	3	B							
27 Apr	6	S							
6 May	3	S							
6 May	6	S							
18 May	1	S							
18 May	2	S							
18 May	3	S							
17 May	6	S							

TABLE 4.2.1-34

HIODON TERGISUS ICHTHYOPLANKTON MEAN DENSITY (NO./100m^3)
BY ZONE IN THE GREEN RIVER, KENTUCKY

Date	Zone	Surface or Bottom	Eggs	Early Embryo	Proto-Larvae	Meso-Larvae	Meta-Larvae	Juvenile	Stage Unidentified
19 May 78	1	S			2.1				
18 May	2	S							
19 May	3	S							
18 May	5	S							
19 May	6	S							
18 May	2	S(DVM)							
28 May*	3	S				3.0			
28 May	6	S				0.1			
8 Jun	3	S				0.1			
8 Jun	6	S							
19 Jun	3	S					0.1		
19 Jun	6	S					0.1		
28 Jun	3	S							
28 Jun	6	S							
12 Jul	2	S							
12 Jul	3	S							
12 Jul	6	S							
12 Jul	3	S(DVM)							
12 Jul	6	S(DVM)							
26 Jul	3	S							
26 Jul	6	S						0.1	
9 Aug	3	S							
9 Aug	6	S							
22 Aug	3	S							
22 Aug	6	S							
5 Sep	1	S							
5 Sep	2	S							
5 Sep	3	S							
5 Sep	6	S							
5 Sep	3	S(DVM)							
5 Sep	6	S(DVM)							
14 Sep	3	S							
14 Sep	6	S							
25 Sep	3	S							
25 Sep	6	S							
28 Mar 79	3	S							
28 Mar	6	S							
7 Apr	3	S							
7 Apr	3	B							
7 Apr	6	S							

*Two replicates. All other dates represent three replicates.
DVM - Diurnal vertical migration.

TABLE 4.2.1-34 (Cont'd)

HIODON TERGISUS ICHTHYOPLANKTON MEAN DENSITY (NO./100m^3)
BY ZONE IN THE GREEN RIVER

Date	Zone	Surface or Bottom	Eggs	Early Embryo	Proto-Larvae	Meso-Larvae	Meta-Larvae	Juvenile	Stage Unidentified
17 Apr	3	S							
17 Apr	3	B							
17 Apr	6	S							
27 Apr	3	S			0.2	0.2			
27 Apr	3	B			0.7	0.7			
27 Apr	6	S			0.3	2.7	1.0		
6 May	3	S							
6 May	6	S							
18 May	1	S							
18 May	2	S							
18 May	3	S							
17 May	6	S							

TABLE 4.2.1-35

CYPRINUS CARPIO ICHTHYOPLANKTON MEAN DENSITY (NO./100m^3)
BY ZONE IN THE GREEN RIVER

Date	Zone	Surface or Bottom	Eggs	Early Embryo	Proto-Larvae	Meso-Larvae	Meta-Larvae	Juvenile	Stage Unidentified
19 May 78	1	S		12.5	12.9				
18 May	2	S			0.3				
19 May	3	S			2.3				
18 May	5	S			0.6				
19 May	6	S			18.0				
18 May	2	S(DVM)			1.0				
28 May*	3	S				3.6			
28 May	6	S			0.4	3.0			
8 Jun	3	S							
8 Jun	6	S			0.1				
19 Jun	3	S			10.5	0.4			
19 Jun	6	S			6.3	0.1			
28 Jun	3	S			0.2	0.1			
28 Jun	6	S							
12 Jul	2	S							
12 Jul	3	S							
12 Jul	6	S							
12 Jul	3	S(DVM)							
12 Jul	6	S(DVM)							
26 Jul	3	S			0.2	0.5			
26 Jul	6	S			0.1	0.1			
9 Aug	3	S							
9 Aug	6	S							
22 Aug	3	S			0.1				
22 Aug	6	S							
5 Sep	1	S							
5 Sep	2	S							
5 Sep	3	S							
5 Sep	6	S							
5 Sep	3	S(DVM)							
5 Sep	6	S(DVM)							
14 Sep	3	S							
14 Sep	6	S							
25 Sep	3	S							
25 Sep	6	S							
28 Mar 79	3	S							
28 Mar	6	S							
7 Apr	3	S							
7 Apr	3	B							
7 Apr	6	S							

*Two replicates. All other dates represent three replicates.
DVM - Diurnal vertical migration

TABLE 4.2.1-35 (Cont'd)

CYPRINUS CARPIO ICHTHYOPLANKTON MEAN DENSITY (NO./100m^3)
BY ZONE IN THE GREEN RIVER, KENTUCKY

Date	Zone	Surface or Bottom	Eggs	Early Embryo	Proto-Larvae	Meso-Larvae	Meta-Larvae	Juvenile	Stage Unidentified
17 Apr	3	S			0.4				
17 Apr	3	B							
17 Apr	6	S			0.3				
27 Apr	3	S			4.8				
27 Apr	3	B			0.3				
27 Apr	6	S			12.4	2.3			
6 May	3	S							
6 May	6	S			0.2	1.4			
18 May	1	S			0.4				
18 May	2	S			0.3				
18 May	3	S							
17 May	6	S			0.1				

TABLE 4.2.1-36

NOTROPIS ATHERINOIDES ICHTHYOPLANKTON MEAN DENSITY (NO./100m^3)
BY ZONE IN THE GREEN RIVER

Date	Zone	Surface or Bottom	Eggs	Early Embryo	Proto-Larvae	Meso-Larvae	Meta-Larvae	Juvenile	Stage Unidentified
19 May 78	1	S							
18 May	2	S							
19 May	3	S							
18 May	5	S							
19 May	6	S							
18 May	2	S(DVM)							
28 May*	3	S			24.9				
28 May	6	S							
8 Jun	3	S			0.2				
8 Jun	6	S			0.5	0.2			
19 Jun	3	S			0.2		0.9		
19 Jun	6	S			1.8	13.4	4.0		
28 Jun	3	S				0.1	0.2		
28 Jun	6	S							
12 Jul	2	S							
12 Jul	3	S							
12 Jul	6	S							
12 Jul	3	S(DVM)					0.1		
12 Jul	6	S(DVM)					0.2		
26 Jul	3	S							
26 Jul	6	S						0.8	
9 Aug	3	S							
9 Aug	6	S							
22 Aug	3	S							
22 Aug	6	S							
5 Sep	1	S							
5 Sep	2	S							
5 Sep	3	S							
5 Sep	6	S							
5 Sep	3	S(DVM)							
5 Sep	6	S(DVM)							
14 Sep	3	S							
14 Sep	6	S							
25 Sep	3	S							
25 Sep	6	S							
28 Mar 79	3	S							
28 Mar	6	S							
7 Apr	3	S							
7 Apr	3	B							
7 Apr	6	S							

*Two replicates. All other dates represent three replicates.
DVM - Diurnal vertical migration

TABLE 4.2.1-36 (Cont'd)

NOTROPIS ATHERINOIDES ICHTHYOPLANKTON MEAN DENSITY (NO./100m^3)
BY ZONE IN THE GREEN RIVER

Date	Zone	Surface or Bottom	Eggs	Early Embryo	Proto-Larvae	Meso-Larvae	Meta-Larvae	Juvenile	Stage Unidentified
17 Apr	3	S							
17 Apr	3	B							
17 Apr	6	S							
27 Apr	3	S			0.5				
27 Apr	3	B							
27 Apr	6	S							
6 May	3	S							
6 May	6	S							
18 May	1	S			1.3				
18 May	2	S			0.2				
18 May	3	S			0.8				
17 May	6	S			0.2				

TABLE 4.2.1-37

MORONE CHRYSOPS ICHTHYOPLANKTON MEAN DENSITY (NO./100m^3)
BY ZONE IN THE GREEN RIVER

Date	Zone	Surface or Bottom	Eggs	Early Embryo	Proto-Larvae	Meso-Larvae	Meta-Larvae	Juvenile	Stage Unidentified
19 May 78	1	S							
18 May	2	S							
19 May	3	S							
18 May	5	S							
19 May	6	S							
18 May	2	S(DVM)							
28 May*	3	S			22.1				
28 May	6	S			20.4	19.9			
8 Jun	3	S			0.1				
8 Jun	6	S			0.4				
19 Jun	3	S							
19 Jun	6	S							
28 Jun	3	S				0.2			
28 Jun	6	S				0.1			
12 Jul	2	S							
12 Jul	3	S							
12 Jul	6	S							
12 Jul	3	S(DVM)							
12 Jul	6	S(DVM)							
26 Jul	3	S							
26 Jul	6	S							
9 Aug	3	S							
9 Aug	6	S							
22 Aug	3	S							
22 Aug	6	S							
5 Sep	1	S							
5 Sep	2	S							
5 Sep	3	S							
5 Sep	6	S							
5 Sep	3	S(DVM)							
5 Sep	6	S(DVM)							
14 Sep	3	S							
14 Sep	6	S							
25 Sep	3	S							
25 Sep	6	S							
28 Mar 79	3	S							
28 Mar	6	S							
7 Apr	3	S							
7 Apr	3	B							
7 Apr	6	S							

*Two replicates. All other dates represent three replicates.
DVM - Diurnal vertical migration

TABLE 4.2.1-37 (Cont'd)

MORONE CHRYSOPS ICHTHYOPLANKTON MEAN DENSITY (NO./100m^3)
BY ZONE IN THE GREEN RIVER

Date	Zone	Surface or Bottom	Eggs	Early Embryo	Proto-Larvae	Meso-Larvae	Meta-Larvae	Juvenile	Stage Unidentified
17 Apr	3	S							
17 Apr	3	B							
17 Apr	6	S							
27 Apr	3	S							
27 Apr	3	B							
27 Apr	6	S							
6 May	3	S							
6 May	6	S							
18 May	1	S							
18 May	2	S							
18 May	3	S							
17 May	6	S							

TABLE 4.2.1-38

APLODINOTUS GRUNNIENS ICHTHYOPLANKTON MEAN DENSITY (N)./100m^3)
BY ZONE IN THE GREEN RIVER

Date	Zone	Surface or Bottom	Eggs	Early Embryo	Proto-Larvae	Meso-Larvae	Meta-Larvae	Juvenile	Stage Unidentified
19 May 78	1	S							
18 May	2	S							
19 May	3	S							
18 May	5	S							
19 May	6	S							
18 May	2	S(DVM)							
28 May*	3	S		28.9	44.9				
28 May	6	S		4.1					
8 Jun	3	S		0.8	20.7				
8 Jun	6	S		0.4	6.7				
19 Jun	3	S		42.2	342.7				
19 Jun	6	S		22.3	97.3				
28 Jun	3	S			277.6	389.8			
28 Jun	6	S		0.2	389.4	754.7			
12 Jul	2	S			0.1		0.1		
12 Jul	3	S			0.4	0.1	0.3		
12 Jul	6	S			0.2				
12 Jul	3	S(DVM)			1.7	12.4	25.5		
12 Jul	6	S(DVM)			0.9	4.5	32.4		
26 Jul	3	S			65.4	10.2	1.3	0.1	
26 Jul	6	S			10.6	0.5	0.1		
9 Aug	3	S							
9 Aug	6	S			0.5	0.1			
22 Aug	3	S		1.4	1.7				
22 Aug	6	S		0.4	0.7				
5 Sep	1	S		0.4	1.4	0.8			
5 Sep	2	S			6.4	2.6			
5 Sep	3	S			0.4				
5 Sep	6	S			1.4	1.4			
5 Sep	3	S(DVM)			1.4	1.8			
5 Sep	6	S(DVM)			1.8	1.1			
14 Sep	3	S			2.1	0.8			
14 Sep	6	S			1.3	0.3			
25 Sep	3	S							
25 Sep	6	S							
28 Mar 79	3	S							
28 Mar	6	S							
7 Apr	3	S							
7 Apr	3	B							
7 Apr	6	S							

*Two replicates. All other dates represent three replicates.
DVM - Diurnal vertical migration

TABLE 4.2.1-38 (Cont'd)

APLODINOTUS GRUNNIENS ICHTHYOPLANKTON MEAN DENSITY (NO./100m^3)
BY ZONE IN THE GREEN RIVER

Date	Zone	Surface or Bottom	Eggs	Early Embryo	Proto-Larvae	Meso-Larvae	Meta-Larvae	Juvenile	Stage Unidentified
17 Apr	3	S							
17 Apr	3	B							
17 Apr	6	S							
27 Apr	3	S							
27 Apr	3	B							
27 Apr	6	S							
6 May	3	S							
6 May	6	S							
18 May	1	S							
18 May	2	S							
18 May	3	S							
17 May	6	S							

TABLE 4.2.1-39

SUM OF ICHTHYOPLANKTON DENSITY (NO/100m^3)
BY ZONES FROM THE GREEN RIVER 18 MAY 1978 TO 18 MAY 1979

Type Ichthyoplankter	ZONES 3	ZONES 6
Vertebrata unidentified	76.2	24.6
Clupeidae spp.	984.9	1,117.3
Dorosoma spp.	1.7	6.7
Dorosoma cepedianum	1,811.4	1,254.5
Dorosoma petenense	0.7	10.6
Alosa chrysochloris	73.7	42.4
Hiodon tergisus	10.6	14.4
Cyprinidae spp.	7.2	10.4
Cyprinus carpio	65.6	127.9
Notropis spp.	-	-
Notropis atherinoides	57.7	61.5
Semotilus atromaculatus	0.3	-
Catostomidae spp.	1.2	35.7
Ictiobinae spp.	214.4	197.8
Ictiobus spp.	116.3	30.4
Carpoides spp.	12.4	12.8
Ictalurus furcatus	-	-
Ictalurus punctatus	-	-
Pylodictus olivaris	0.3	-
Morone spp.	6.5	28.9
Morone chrysops	74.3	122.6
Pomoxis spp.	15.8	20.8
Pomoxis annularis	2.9	1.6
Pomoxis nigromaculatus	-	-
Lepomis spp.	-	0.8
Lepomis megalotus	3.6	3.6
Micropterus spp.	-	0.7
Micropterus punctulatus	-	-
Percina spp.	0.3	1.6
Percina flavecens	-	0.3
Etheostoma spp.	-	0.6
Aplodinotus grunniens	3,630.8	3,878.0

TABLE 4.2.1-40

ALPHABETICAL LISTING BY SCIENTIFIC NAME OF FISH COLLECTED

JUNE 1978 THROUGH MAY 1979

Scientific Name	Common Name
Alosa chrysochloris	Skipjack herring
Aplodinotus grunniens	Freshwater drum
Carpiodes carpio	River carpsucker
Cycleptus elongatus	Blue sucker
Cyprinus carpio	Carp
Dorosoma cepedianum	Gizzard shad
Esox americanus vermiculatus	Grass pickerel
Etheostoma gracile	Slough darter
Fundulus notatus	Blackstripe topminnow
Fundulus olivaceus	Blackspotted topminnow
Gambusia affinis	Mosquitofish
Hiodon alosoides	Goldeye
Hiodon tergisus	Mooneye
Hybopsis storeriana	Silver chub
Ictalurus furcatus	Blue catfish
Ictalurus punctatus	Channel catfish
Ictiobus niger	Black buffalo
Lepomis gulosus	Warmouth
Lepomis macrochirus	Bluegill
Lepomis megalotis	Longear sunfish
Lepomis microlophus	Redear sunfish
Micropterus salmoides	Largemouth bass
Morone chrysops	White bass
Moxostoma anisurum	Silver redhorse
Notemigonus crysoleucas	Golden shiner
Notropis atherinoides	Emerald shiner
Notropis rubellus	Rosyface shiner
Pomoxis annularis	White crappie
Pomoxis nigromaculatus	Black crappie
Stizostedion canadense	Sauger

TABLE 4.2.1-41

ALPHABETICAL LISTING BY COMMON NAME OF FISH COLLECTED
JUNE 1978 THROUGH MAY 1979

Common Name	Scientific Name
	Clupeiformes
	Clupeidae
Skipjack herring	*Alosa chrysochloris*
Gizzard shad	*Dorosoma cepedianum*
	Osteoglossiformes
	Hiodontidae
Goldeye	*Hiodon alosoides*
Mooneye	*Hiodon tergisus*
	Salmoniformes
	Esocidae
Grass Pickerel	*Esox americanus vermiculatus*
	Cypriniformes
	Cyprinidae
Carp	*Cyprinus carpio*
Silver chub	*Hybopsis storeriana*
Golden shiner	*Notemigonus crysoleucas*
Emerald shiner	*Notropis atherinoides*
Rosyface shiner	*Notropis rubellus*
	Catostomidae
River carpsucker	*Carpiodes carpio*
Blue sucker	*Cycleptus elongatus*
Black buffalo	*Ictiobus niger*
Silver redhorse	*Moxostoma anisurum*
	Siluriformes
	Ictaluridae
Blue catfish	*Ictalurus furcatus*
Channel catfish	*Ictalurus punctatus*
	Atheriniformes
	Cyrprinodontidae
Blackstripe topminnow	*Fundulus notatus*
Blackspotted topminnow	*Fundulus olivaceus*
	Poeciliidae
Mosquitofish	*Gambusia affinis*

TABLE 4.2.1-41 (Cont'd)

ALPHABETICAL LISTING BY COMMON NAME OF FISH COLLECTED
JUNE 1978 THROUGH MAY 1979

Common Name	Scientific Name
	Perciformes
	Percichthyidae
White bass	*Morone chrysops*
	Centrarchidae
Warmouth	*Lepomis gulosus*
Bluegill	*Lepomis macrochirus*
Longear sunfish	*Lepomis megalotis*
Redear sunfish	*Lepomis macrolophus*
Largemouth bass	*Micropterus salmoides*
White crappie	*Pomoxis annularis*
Black crappie	*Pomoxis nigromaculatus*
	Percidae
Slough darter	*Etheostoma gracile*
Sauger	*Stizostedion canadense*
	Sciaebudae
Freshwater drum	*Aplodinotus grunniens*

TABLE 4.2.1-42

AGE DETERMINATION (by scale reading) FOR GREEN RIVER FISH

Freshwater Drum (*Aplodinotus grunniens*)

Length (mm)	Weight (gm)	Sex	Age Determination
367	510	Ukn	4
350	500	Ukn	4+
340	390	M	2+
332	410	F	2+
332	390	M	2+
327	400	M	2+
312	350	M	2+
310	280	Ukn	2+
282	200	M	2
272	220	F	2
267	210	I	2
252	200	I	2
185	75	I	1+
180	85	I	1+
172	50	I	1+
165	45	I	1
165	49	I	1
111	15	I	<1
76	3	I	<1

Gizzard Shad (*Dorosoma cepedianum*)

215	108	I	1+
210	89	I	1+
205	88	I	1+
155	34	I	1
145	28	I	1
115	13	I	<1
93	6	I	<1

TABLE 4.2.1-43

NUMBERS OF GIZZARD SHAD COLLECTED FROM THE GREEN RIVER BY TIME AND LOCATION (ZONE)

Date	ZONE 1	ZONE 3	ZONE 6	Total
June 78		1	2	3
Sep 78	2	2	1	5
May 78	3	5	34	42
Total	5	8	37	50

TABLE 4.2.1-44

NUMBERS OF SHINERS (ROSYFACE AND EMERALD) COLLECTED FROM THE GREEN RIVER BY TIME AND LOCATION (ZONE)

Date	ZONE 1	ZONE 3	ZONE 6	Total
Jun 78		1		1
Sep 78	7	9	11	27
May 79	13	12	8	33
Total	20	22	19	61

TABLE 4.2.1-45

NUMBERS OF CHANNEL CATFISH COLLECTED FROM THE GREEN RIVER

BY TIME AND LOCATION (ZONE)

Date	ZONE 1	ZONE 3	ZONE 6	Total
Jun 78			3	3
Sep 78	1	1	6	8
May 79		4	5	9
Total	1	5	14	20

TABLE 4.2.1-46

NUMBERS OF CARP COLLECTED FROM THE GREEN RIVER

BY TIME AND LOCATION (ZONE)

Date	ZONE 3	ZONE 6	Total
Sep 78	2		2
May 79	1	6	7
Total	3	6	9

TABLE 4.2.1-47

NUMBERS OF SAUGER COLLECTED FROM THE GREEN RIVER

BY TIME AND LOCATION (ZONE)

Date	ZONE 1	ZONE 3	ZONE 6	Total
Jun 78		1	1	2
Sep 78		1	1	2
May 79	1	2		3
Total	1	4	2	7

TABLE 4.2.1-48

NUMBERS OF FRESHWATER DRUM COLLECTED FROM THE

GREEN RIVER BY TIME AND LOCATION (ZONE)

Date	ZONE 3	ZONE 6	Total
Jun 78	11	8	19
Jul 78	5	1	6
Sep 78	3	3	6
May 79	5	5	10
Total	24	17	41

TABLE 4.2.1-49

SPECIES OF FISH COLLECTED IN THE CYPRESS SLOUGH

BY DATE AND LOCATION

Collection		Fish Species												
Date	Location	Gizzard Shad	Grass Pickerel	Golden Shiner	Emerald Shiner	Blackstripe Topminnow	Blackspotted Topminnow	Mosquito Fish	Warmouth	Bluegill	Longear Sunfish	Largemouth Bass	Slough Darter	Total
Jun	1													-
78	2			1										1
Jul	1					1								1
78	2			2		3		4	2				2	13
Sep	1	3		3		4	8*	4	4	2				28
78	2													-
Jul	1		1		1				2	1	1	1		7
79	2		3											3
Zone	1	3	1	3	1	5	8	4	6	3	1	1		36
Total	2		3	3		3		4	2				2	17
Total		3	4	6	1	8	8	8	8	3	1	1	2	53

*Identified as blackspotted or blackstripe topminnow

TABLE 4.2.1-50

"ENDANGERED" AQUATIC BIOTA OF THE GREEN RIVER BASIN

Taxa	Status*	Status Determining Agency
Phylum: Mollusca Class: Pelecypoda		
Villosa (Micormya) ortmani (Ortman's Pearly Mussel)	Marginal	U.S. Department of the Interior (DOI)
Pleurobema plenum (Rough Pigtoe)	Endangered	DOI
Lampsilis orbiculata (Pink Mucket)	Endangered	DOI
Obovaria retussa (Golf Stick)	Endangered	DOI
Dysonomia (Epioblasma) sulcata (Purple Cat's Paw)	Marginal	DOI
Phylum: Chordata Class: Agnatha		
Ichthyomyzon fossor (Northern Brook Lamprey)	Indeterminate	American Fisheries Society (AFS)
Ichthyomyzon greeleyi (Allegheny Brook Lamprey)	Rare & Endan-dangered (Possible)	Clay, 1975[40]
Lampetra lamottei (American Brook Lamprey)	Indeterminate	AFS
Class: Osteichthyes		
Acipenser fulvescens (Lake Sturgeon)	Rare	World Wildlife Fund
Esox masquinongy (Ohio Muskellunge)	Depleted	AFS
Cycleptus elongatus (Blue Sucker)	Indeterminate	AFS

TABLE 4.2.1-50 (Cont'd)

Taxa	Status	Status Determining Agency
Class: Osteichthyes (Cont'd)		
Icitiobus cyprinellus (Big Mouth Bufalo)	Indeterminate	AFS
Moxostoma atripinne (Blackfin Sucker)	Rare	AFS
Moxostoma macrolepidotum breviceps (Southern Shorthead Redhorse)	Indeterminate	AFS
Hybopsis insignis (Blotched Chub)	Indeterminate	AFS
Notrophis ariomus (Popeye Shiner)	Depleted	AFS
Notropis blennius (River Shiner)	Depleted	AFS
Notropis fumeus (Ribbon Shiner)	Indeterminate	AFS
Notropis heterolepis (Blackhose Shiner)	Indeterminate	AFS
Notropis lutrensis (Red Shiner)	Indeterminate	AFS
Phenacobius uranops (Stargazing Minnow)	Indeterminate	AFS
Noturus stigmosus (Northern Madtom)	Indeterminate	AFS
Aphredoderus sayanus (Pirate Perch)	Indeterminate	AFS
Typhlichthys subterraneus (Lesser Blindfish)	Indeterminate	AFS
Amblyopsis spelaeus (Mammouth Cave Blindfish)	Indeterminate	AFS
Centrarchus macropterus (Flier)	Indeterminate	AFS

TABLE 4.2.1-50 (Cont'd)

Taxa	Status	Status Determining Agency
Class: Osteichthyes (Cont'd)		
Stizostedion canadense (Sauger)	Indeterminate	AFS
Stizostedion vitreum (Walleye)	Depleted	AFS
Percina copelandi (Channel Darter)	Rare	AFS
Percina evides (Gilt Darter)	Rare	AFS
Percina macrocephala (Longhead Darter)	Rare and Endangered	Kentucky Department of Fish and Wildlife Resources (KDFWR)
Percina phoxocephala (Slenderhead Darter)	Rare	AFS
Percina shumardi (River Darter)	Rare	AFS
Percina uranidae (Stargazing Darter)	Rare	AFS
Ammocrypta asprella (Crystal Darter)	Indeterminate	AFS
Ammocrypta pellucida (Eastern Sand Darter)	Depleted	AFS
Ammocrypta vivax (Scaly Sand Darter)	Rare	AFS
Etheostoma asprigene (Mud Darter)	Rare and Endangered	KDFWR
Estheostoma maculatum (Spotted Darter)	Depleted	AFS
Etheostoma tippecanoe (Tippecanoe Darter)	Rare and Endangered	KDFWR
Percopsis omiscomaycus (Trout Perch)	Rare and Endangered	KDFWR

*Status Definitions:

Endangered - Any species which is in danger of extinction throughout all or a significant portion of its range.

Threatened - Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Marginal - Between endangered and threatened.

Rare - Not under immediate threat of extinction but occurring in such small numbers and/or in such a restricted or specialized habitat that it could quickly disappear.

Depleted - Although still occurring in numbers adequate for survival the species has been heavily depleted and continues to decline at a rate substantially greater than can be sustained.

Indeterminate - Apparently threatened, but insufficient data currently available on which to base a reliable assessment of status.

Source: Babcock, 1977[39].

TABLE 4.2.2-1

BIRDS LIKELY TO OCCUR IN THE REGION OF THE BASKETT SITE

Common Name Scientific Names	Regional Status	Onsite Occurrence	Preferred Habitat
Common Loon *Gavia immer*	UC		Lakes and rivers
Horned Grebe *Podiceps auritus*	UC		Nests, lakes, ponds
Red-necked Grebe *Podiceps grisegens*	UC		Large ponds and lakes
Pied-billed Grebe *Podilymbus podiceps*	UC		Shallow vegetation, choked ponds, marshes and creeks
Double-crested Cormorant *Phalacrocorax auritus*	FC		Inland lakes, rivers
Canada Goose *Branta canadensis*	C		Breeds lakeshores, grazes open fields
Snow Goose *Chen caerulescens*	C		Rivers and impoundments
Pintail *Anas acuta*	C	X	Ponds, large streams, marshes, flooded fields
Blue-winged Teal *A. discors*	C	X	Ponds, marshes, bays, mud flats, creeks
Green-winged Teal *A. crecca*	UC	X	Ponds, lakes, open freshwater
Mallard *A. platyrhynchos*	C	X	Ponds, shallow water, freshwater marshes, grain fields
Black Duck *A. rubripes*	C	X	Medium to large water courses, ponds, lakes
Gadwall *A. strepera*	UC		Ponds, backwaters, flooded fields
American Wigeon *A. americana*	C	X	Shallow ponds, lakes, and large rivers
Northern Shoveler *A. clypeata*	FC	X	Ponds, impoundments, rivers, mudflats, flooded marshes
Wood Duck *Aix sponsa*	C	X	Woodland near lakes and streams, marshes and ponds
Lesser Scaup *Aythya affinis*	C		Lakes, ponds, major rivers, quiet water
Redhead *Aythya americana*	UC	X	Small reservoirs, ponds, lakes - summer
Ring-necked Duck *Aythya collaris*	C		Swampy ponds, woodland ponds, streams
Greater Scaup *Aythya marila*	R		Larger bodies of water
Canvasback *Aythya valisineria*	UC		Ponds, rivers, lakes, impoundments
Bufflehead *Bucephala albeola*	C		Wooded lakes, rivers, and impoundments
Common Goldeneye *Bucephala clangula*	C		Lakes, rivers
Oldsquaw *Clangula hyemalis*	R		Large bodies of water
Ruddy Duck *Oxyura jamaicensis*	UC		Lakes, ponds, rivers
Hooded Merganser *Laphodytes cucullatus*	UC		Wooded lakes, streams, swamp-forests, ponds
Common Merganser *Mergus merganser*	FC		Rivers, creeks
Red-breasted Mergenser *Mergus serrator*	FC		Small streams, ponds, large water bodies
Turkey Vulture *Cathartes aura*	C	X	Field and roadside scavenger
Black Vulture *Coragyps stratus*	UC		Fields, rocky ledges, cliffs, forests
Cooper's Hawk *Accipiter cooperii*	UC		Woods, woodland edge
Sharp-shinned Hawk *Accipiter striatus*	R		Woodland and wood edges
Marsh Hawk *Circus cyaneus*	UC	X	Grasslands, marshes

TABLE 4.2.2-1 (Cont'd)

BIRDS LIKELY TO OCCUR IN THE REGION OF THE BASKETT SITE

Common Name Scientific Names	Regional Status	Onsite Occurrence	Preferred Habitat
Golden Eagle *Aquila chrysaetos*	R		Mountains, grasslands, near water bodies
Red-tailed Hawk *Buteo jamaicensis*	C	X	Nests in woodlands, feeds open country
Red-shouldered Hawk *B. lineatus*	C	X	Cultivated fields, woodlands, flood plains, river valley
Broad-winged Hawk *B. platypterus*	UC		Woodlands, hills, forests
Northern Bald Eagle *Haliaeetus leucocephalus alascanus*	E		Near large bodies of water
Osprey *Pandion haliaetus*	UC		Rivers, lakes
Merlin *Falco columbarius*	R		Grassland, woodland openings, borders of quiet water
Peregrine Falcon *F. peregrinus*	E		Mountains, woods, large streams
American Kestrel *F. sparverius*	C	X	Tree cavities, open farm land
Bobwhite *Colinus virginianus*	C	X	Brushland, abandoned fields
Wild Turkey *Meleagris gallopavo*	R		Woodland or forest clearing
Great Blue Heron *Ardea herodias*	C	X	Farm ponds, lakes, large streams
Little Blue Heron *Florida caerulea*	UC		Freshwater marshes, swamps
American Bittern *Botaurus lentiginosus*	C		Tall vegetation, wet meadows, marshes
Green Heron *Butorides striatus*	C	X	Ponds, lakes, wooded streams, marshes
Great Egret *Casmerodious albus*	C		Streams, ponds, rice fields, marshes, mudflats
Least Bittern *Ixobrychus exilis*	UC		Tall freshwater grasses and sedges
Yellow-crowned Night Heron *Nyctanassa violacea*	UC		Swamps, marshes, streams
Black-crowned Night Heron *Nycticorax nycticorax*	UC		Freshwater swamps, ponds along streams
American Coot *Fulica americana*	C	X	Freshwater ponds
Common Gallinule *Gallinula chloropus*	R		Marshes, lake edges, open water, dense vegetation
Sora *Porzana carolina*	FC		Marshes, fresh dense vegetation
King Rail *Rallus elegans*	UC		Freshwater marshes
Virginia Rail *R. limicola*	R		Marshes
Black-bellied Plover *Pluvialis squatarola*	UC		Artic tundra, Karst lakes
American Golden Plover *P. dominica*	UC		Fields, pastures, mudflats, marshes
Piping Plover *Charadrius melodus*	UC		Sandy beaches, sand bars, mudflats, rocky shores
Semipalmated Plover *C. semipalmatus*	UC	X	Beaches, mudflats
Killdeer *C. vociferous*	C	X	Cultivated fields, cropped pastures, sand bars, mudflats
Ruddy Turnstone *Arenaria interpres*	R		Coasts, rocky tidal shores

TABLE 4.2.2-1 (Cont'd)

BIRDS LIKELY TO OCCUR IN THE REGION OF THE BASKETT SITE

Common Name Scientific Names	Regional Status	Onsite Occurrence	Preferred Habitat
Spotted Sandpiper *Actitis macularia*	CM	X	Farm ponds, streams
Upland Sandpiper *Bartramia longicauda*	UC		Grasslands, short grasses
Sanderling *Calidris alba*	R		Sandbars, rocky shores and mudflats
Western Sandpiper *C. mauri*	UC		Sandbars, mudflats
Dunlin *C. alpina*	R		Mudflats, sandbars, rocky shores
Baird's Sandpiper *C. bairdii*	R		Dry short grass, marshes, shores and mudflats
White-rumped Sandpiper *C. fuscicollis*	R	X	Wide variety of shore habitats, flooded fields
Pectoral Sandpiper *C. melanotes*	C	X	Grassy mudflats, wet meadows
Least Sandpiper *C. minutilla*	FC	X	Muddy river shores
Semipalmated Sandpiper *Ereunetes pusillus*	UC	X	Sandy, rocky shores and flats
Short-billed Dowitcher *Limnodromus griseus*	UC		Mudflats, sandbars, rocky shores; feeds in shallow water
Stilt Sandpiper *Micropalama himantopus*	R		Mudflats, sandbars, rocky shores
Lesser Yellowlegs *Tringa flavipes*	C	X	Sandbars, mudflats, shallow water around lakes and ponds, fair
Greater Yellowlegs *T. melanoleucus*	UC	X	Marshes, sandbars, mudflats, ponds, rivers, lakes, fair
Solitary Sandpiper *T. solitaria*	C		Streams, swamps, lakes
Common Snipe *Capella gallinago*	C		Flooded fields, lake margins, drainage ditches, marshes
American Woodcock *Philohela minor*	UC	X	Moist woodlands, swamps, thickets
Herring Gull *Larus argentatus*	UC		Coasts, harbors, garbage dumps, lakes, rivers
Ring-billed Gull *L. delawarensis*	UC		Lakes, large rivers
Bonaparte's Gull *L. philadelphia*	R		Lakes, large rivers
Black Tern *Chlidonias niger*	UC		Lakes, fresh marshes; feeds open fields
Caspian Tern *Hydroprogne caspia*	R		Large water courses, lakes, ponds
Least Tern *Sterna albifrons*	UC		Major rivers, lakes, ponds
Forster's Tern *S. forsteri*	UC		Fresh and salt marshes
Common Tern *S. hirundo*	UC		Large rivers to streams
Rock Dove *Columba livia*	A	X	Farm yards, city parks
Mourning Dove *Zenaida macroura*	C	X	Fields, pastures, ponds, farms
Yellow-bellied Cuckoo *Coccyzus americanus*	C	X	Woods, brush
Black-billed Cuckoo *C. erythropthalmus*	UC		Woodlands
Saw-whet Owl *Aegolius acadicus*	UC		Thickets; prefers conifers, low lying woods to uplands
Short-eared Owl *Asio flammeus*	UC		Open country plains, sloughs, marshes
Long-eared Owl *A. otus*	R		Deciduous or coniferous woods near open country
Great Horned Owl *Bubo virginianus*	C	X	Woodland, dry forested uplands

TABLE 4.2.2-1 (Cont'd)

BIRDS LIKELY TO OCCUR IN THE REGION OF THE BASKETT SITE

Common Name Scientific Names	Regional Status	Onsite Occurrence	Preferred Habitat
Screech Owl *Otus asio*	UC	X	Towns, orchards, small woodlots and edges of woods
Barred Owl *Strix varia*	UC	X	Swamps and river bottoms, northern woods
Barn Owl *Tyto alba*	UC		Open country, old buildings, towers
Chuck-wills-widow *Caprimulgus carolinensis*	UC		Pine woods, dry areas, farm woodlots, oak-hickory groves
Whip-poor-will *C. vociferus*	UC	X	Forest, woods near fields
Common Nighthawk *Chordeilies minor*	C	X	Open country to towns
Chimney Swift *Chaetura pelagica*	C	X	Chimneys, hollow trees, settled areas
Ruby-throated Hummingbird *Archilochus colubris*	C	X	Woodlands, farmlands
Belted Kingfisher *Megaceryle alcyon*	C	X	Along streams, ponds, lake margins
Common Flicker *Colaptes auratus*	C	X	Edges and openings of mature forests
Pileated Woodpecker *Dryocopus pileatus*	UC	X	Deciduous, mixed forests
Red-bellied Woodpecker *Centurus carolinus*	UC	X	Rolling farmlands, scattered mixed trees on floodplains
Downy Woodpecker *Dendrocopos pubescens*	C	X	Woodlands
Hairy Woodpecker *D. villosus*	UC	X	Woodlands, along forested water courses
Red-headed Woodpecker *Melanerpes erythrocephalus*	C	X	Open country, mixed woodlands, forest edges
Yellow-bellied Sapsucker *Sphyrapicus varius*	C		Open deciduous woodlands, pine groves, orchards
Eastern Kingbird *Tyrannus tyrannus*	C	X	Widely spaced trees
Great Crested Flycatcher *Myiarchus crinitus*	C	X	Deciduous and mixed woods
Eastern Phoebe *Sayornis phoebe*	C		Near farm buildings, bridges and cliffs
Eastern Wood Pewee *Contopus virens*	C	X	Forests, woodland edges to dense woods; prefers dry woods
Yellow-bellied Flycatcher *Empidonax flavivehtris*	UC		Spruce-fir forests, deep-woods and thickets
Least Flycatcher *E. minimus*	UC	X	Scrub growth, wood margins, unsprayed orchards
Willow Flycatcher *E. traillii*	R		Alders and willows along streams, open brushy fields
Acadian Flycatcher *E. virescens*	C	X	Moist woodlands, deciduous flood plain forests
Olive-sided Flycatcher *Nuttallornis borealis*	R	X	Conifer, woodland edges, scattered trees
Horned Lark *Eremophila alpestris*	C	X	Fields, shores
Barn Swallow *Hirundo rustica*	C	X	Open farmland, ponds, lakes, barns, ridges
Tree Swallow *Iridoprocne bicolor*	UC	X	Tree cavities near water
Cliff Swallow *Petrochelidon pyrrhonota*	R	X	Water, cliffs, dams, bridges
Purple Martin *Progne subis*	C		Open ground, towns, rural residences
Bank Swallow *Riparia riparia*	C		Major streams, steep riverbanks, gravel pits
Rough-winged Swallow *Stelgidopteryx ruficollis*	C	X	Cliff cavities, road cut crevices, water seep holes
Blue Jay *Cyanocitta cristata*	C	X	Oak, pine woods, wet or dry parklands, farms, towns
Common Crow *Corvus brachyrhynchos*	C	X	Mixed farmland, woodland

TABLE 4.2.2-1 (Cont'd)

BIRDS LIKELY TO OCCUR IN THE REGION OF THE BASKETT SITE

Common Name Scientific Names	Regional Status	Onsite Occurrence	Preferred Habitat
Carolina Chickadee *Parus carolinensis*	C	X	Forests and forest-edges, woodlands
Tufted Titmouse *P. bicolor*	C	X	Deciduous woodlands along streams
Red-breasted Nuthatch *Sitta canadensis*	UC		Woodland, dry pinoak forests
White-breasted Nuthatch *S. carolinensis*	UC	X	Forests, dry woods, oak-hickory, swamps, woods
Brown Creeper *Certhia familiaris*	UC	X	Woodlands, mature forests, sheltered stream valleys
Short-billed Marsh Wren *Cistothorus platelsis*	R		Sedge meadows, hay fields
Long-billed Marsh Wren *Telmatodytes palustris*	R		Cattail marshes, dense field vegetation, brushland
Bewick's Wren *Thryomanes bewickii*	CS,UW		Farmyards, brush, fence rows
Carolina Wren *Thryothorus ludovicianus*	Carolina	X	Thick underbrush, swamps, woodlands, barns
House Wren *Troglodytes sedon*	UC	X	Shrubbery, brush
Winter Wren *T. troglodytes*	C		Undergrowth, bottom-land forests, brushy creek banks
Gray Catbird *Dumetella carolinensis*	C	X	Dense shrubbery
Mockingbird *Mimus polyglottos*	C	X	Open trees, dense shrubbery
Brown Thrasher *Toxostoma rufum*	C	X	Brush, forest edges
American Robin *Turdus migratorius*	C	X	Lawns, moist woods, fruit bearing trees
Veery *Catharus fuscescens*	UC	X	Woods and edges, ferns, briars, vines
Hermit Thrush *C. guttata*	UC	X	Woodlands, hillsides, ravines
Gray-cheeked Thrush *C. minima*	C	X	Brush, wooded hill-sides, fairly
Wood Thrush *Hylocichia mustelina*	C	X	Woodlands, vines, shrubs, deciduous forests
Swainson's Thrush *Catharus ustulata*	C	X	Woodlands
Eastern Bluebird *Sialia sialis*	C	X	Open country, small clearings in extensive woods
Blue-gray Gnatcatcher *Polioptila caerulea*	C	X	Treetop, open woods, forest edges, moist forests
Ruby-crowned Kinglet *Regulus calendula*	UC	X	Forests, open brush
Golden-crowned Kinglet *R. satrapa*	C	X	Woodlands, conifers
Water Pipit *Anthus spinoletta*	UC		Muddy shores, plowed fields
Cedar Waxing *Bombycilla cedrorum*	UC		Berry-bearing trees, shrubs
Loggerhead Shrike *Lanius ludovicianus*	UC		Open hedgerows and scattered trees, and in woods
Starling *Sturnus vulgaria*	C	X	Farmland, cities
Yellow-throated Vireo *Vireo flavifrons*	UC	X	Clearings, near water, mixed pine-deciduous woods
Warbling Vireo *V. gilvus*	C	X	Tall, deciduous shadetrees
White-eyed Vireo *V. griseus*	C	X	Deciduous thickets, wood margins, along streams, hedgerows
Red-eyed Vireo *V. olivaceus*	C	X	Deciduous forests

BIRDS LIKELY TO OCCUR IN THE REGION OF THE BASKETT SITE

Common Name Scientific Names	Regional Status	Onsite Occurrence	Preferred Habitat
Philadelphia Vireo *V. philadelphicus*	UC	X	Deciduous shrubs, wood margins
Solitary Vireo *V. solitarius*	R	X	Mixed northern hardwood, conifers, dry open woods
Worm-eating Warbler *Helmitheros vermivorus*	R		Deciduous slopes, mixed mesophytic forests
Swainson's Warbler *Limnothlypis swainsonii*	R		Wooded swamps, cane breaks
Black-and-white Warbler *Mniotilla varia*	UC	X	Deciduous woods, dense mesophytic woodlands
Prothonotary Warbler *Protonotaria citrea*	C	X	Wooded swamps along streams
Golden-winged Warbler *Vermivora chrysoptera*	R	X	Deciduous growth
Blue-winged Warbler *V. pinus*	UC	X	Brushy areas
Northern Parula *Parula americana*	R	X	Mature deciduous, coniferous woods, river swamps
Tennessee Warbler *Vermivora peregrina*	C	X	Aspen-spruce woods high in trees
Nashville Warbler *V. ruficapilla*	C	X	Open second-growth deciduous woods
Orange-crowned Warbler *V. celata*	R		Thickets, low trees, brushy open woods
Yellow-rumped Warbler *Dendroica coronata*	C	X	Open woods, brush, field borders
Magnolia Warbler *D. magnolia*	C	X	Wooded habitats
Yellow Warbler *D. petechia*	C	X	Willow thickets, orchards, shrubbery
Cape May Warbler *D. tigrina*	UC	X	Conifers, deciduous woods
Black-throated Blue Warbler *D. caerulescens*	R	X	Evergreens, brush, deciduous growth, mixed forest
Bay-breasted Warbler *D. castanea*	UC	X	Conifers, mixed woodlands
Cerulean Warbler *D. cerulea*	FC	X	River bottoms, near streams, mixed forests
Prairie Warbler *D. discolor*	UC	X	Shrubs, old fields, slash, pine-oak woods
Yellow-throated Warbler *D. dominica*	C	X	Tops of pines and sycamores
Blackburnian Warbler *D. fusca*	C	X	Conifer & mixed forests, treetops
Palm Warbler *D. palmarum*	UC	X	Forest clearings, lawns and open ground
Chestnut-sided Warbler *D. pensylvanica*	C	X	Deciduous brush, clearings in woodlands
Pine Warbler *D. pinus*	R		Pines, orchards, deciduous trees
Blackpoll Warbler *D. striata*	UC	X	Woodlands
Black-throated Green Warbler *D. virens*	C	X	Woodlands
Common Yellowthroat *Geothlypis trichas*	C	X	Thickets, brush; marshes, overgrown meadows, forest edges
Yellow-breasted Chat *Icteria virens*	C	X	Deciduous thickets, woodland edges, old fields, brush
Ovenbird *Seiurus aurocapillus*	R	X	Deciduous woods, ground-dwelling
Louisiana Waterthrush *S. motacilla*	C	X	Woodlands, sloughs, rushing, sluggish streams
Northern Waterthrush *S. noveboracensis*	C	X	Along water, well-shaded habitats, flooded forests
Connecticut Warbler *Oporornis agilis*	R		Moist woodlands, dense understory, brush
Kentucky Warbler *O. formosus*	C	X	Ground dwelling, moist, mixed forest
Mourning Warbler *O. philadelphia*	R		Brush, high weeds, lowlands

TABLE 4.2.2-1 (Cont'd)

BIRDS LIKELY TO OCCUR IN THE REGION OF THE BASKETT SITE

Common Name Scientific Names	Regional Status	Onsite Occurrence	Preferred Habitat
American Redstart *Setophaga ruticilla*	UC	X	Woodland edges, mixed forests
Canada Warbler *Wilsonia canadensis*	C	X	Forest underbrush
Hooded Warbler *W. citrina*	UC		Moist deciduous woods
Wilson's Warbler *W. pusilla*	UC	X	Thickets, fencerows, tree groves, open woodlands
House Sparrow *Passer domesticus*	A	X	Farms, suburbs, wood lots, cities
Red-winged Blackbird *Agelaius phoeniceus*	C	X	Open country, ponds, marshes, lowlands, meadows
Bobolink *Dolichonyx oryzivorus*	FC		Hayfield, alfalfa, clover fields
Rusty Blackbird *Euphagus carolinus*	UC	X	Wooded swamps
Brown-headed Cowbird *Molothrus ater*	C	X	Farmland
Common Grackle *Quiscalus quiscula*	C	X	Farms, evergreens, cities, suburban parks, gardens
Eastern Meadowlark *Sturnella magna*	C	X	Fields, grasslands, meadows, edges of cultivated fields
Northern Oriole *Icterus galbula*	UC	X	Forest edges, suburban gardens, parks
Orchard Oriole *I. spurius*	C	X	Unsprayed orchards, woods margin, shade trees
Scarlet Tanager *Piranga olivacea*	UC	X	Deciduous, pinoak woods, moderately open woods
Summer Tanager *P. rubra*	C	X	Open woodland, city and suburban parks
Purple Finch *Carpodacus purpureus*	UC		Weedy fields, overgrown fencerows
Evening Grosbeak *Hesperiphona vespertina*	R		Conifers
Indigo Bunting *Passerina cyanea*	C	X	Hedgerows, wood margins, shrubs, vines, forest edge
Rose-breasted Grosbeak *Pheucticus ludovicianus*	UC	X	Deciduous woods, old orchards, suburban areas
Cardinal *Cardinalis cardinalis*	C	X	Woodland edges, open forest understory, shrubs, weeds
Pine Siskin *Spinus pinus*	UC		Conifers, open woodlands, parks
American Goldfinch *S. tristus*	C	X	Open country, brush growth, clearings in woodlands
Rufous-sided Towhee *Pipilo erythrophthalmus*	C	X	Heavy undergrowth, overgrown fields, wood margins
Dickcissel *Spiza americana*	UC		Grain fields, weed patches, grasslands
Grasshopper Sparrow *Ammodramus savannarum*	C		Hayfields, weedy fallow fields, grasslands
Lark Sparrow *Chordestes grammacus*	UC		Dry fields near trees or brush
Savannah Sparrow *Passerculus sandwichensis*	C	X	Large fields, short grass, weedy fields, meadows
Le Conte's Sparrow *Passerherbulus caudacutus*	R		Tall marsh grass, uncommonly in dry fields
Henslow's Sparrow *P. henslowii*	R		Broom sedge fields, orchard grass meadows
Vesper Sparrow *Pooecetes gramineus*	UC		Open country, well-grazed pasture with rocky outcrops
Bachman's Sparrow *Aimophila aestivalis*	UC		Abandoned fields, scattered vegetation, dense ground cover

TABLE 4.2.2-1 (Cont'd)

BIRDS LIKELY TO OCCUR IN THE REGION OF THE BASKETT SITE

Common Name Scientific Names	Regional Status	Onsite Occurrence	Preferred Habitat
Dark-eyed Junco *Junco hyemalis*	C	X	Brush, borders, conifers, fields, wood margins
Chirping Sparrow *Spizella passerina*	C	X	Lawns, sparse grasslands, scattered trees
Tree Sparrow *S. arborea*	C	X	Weedy fields, fence rows, woodland edges
Field Sparrow *S. pusilla*	C	X	Fields, tall grass, scattered saplings, shrubby meadows
White-throated Sparrow *Zonotrichia albicollis*	C	X	Dense undergrowth, brush
White-crowned Sparrow *Z. leucophrys*	C	X	Thickets, wood margins, adjacent to fields, open areas
Fox Sparrow *Passerella iliaca*	UC	X	Dense conifer thickets, deciduous brush
Swamp Sparrow *Melospiza georgiana*	C	X	Fields, marshes, bogs
Lincoln's Sparrow *M. lincolnii*	UC	X	Bogs, streams, brush, old fields, forest edges
Song Sparrow *M. melodia*	C	X	Moist areas, brush, wood margins, stream sides
Snow Bunting *Plectrophenax nivalis*	UC	X	Bare fields and shores

Key:

A = Abundant in suitable habitat

C = Common in suitable habitat

FC = Fairly common in suitable habitat

UC = Uncommon in suitable habitat

R = Rare in suitable habitat

X = Recorded on site

E = On U S Fish & Wildlife Service Endangered Species List[13]

Source: Barbour, R W, C T Peterson, D Rust, H E Shadower, and A L Whitt, Jr, (1973).[9]
Robbins, C S, B Bruun, H S Zim, (1966).[10]
Mengel, R M, (1965).[6]
Peterson, R T, (1954).[11]
U S Corps of Engineers (1975).[12]

TABLE 4.2.2-2

MAMMALS LIKELY TO OCCUR IN THE REGION OF THE BASKETT SITE

Species	Regional Status	On Site Occurrence	Preferred Habitat
Virginia Opossum *Didelphis virginiana*	A	X	Forest edge
Eastern Mole *Scalopus aquaticus*	A	X	Loose, well-drained soils
Masked Shrew *Sorex cinereus*	R	X	Moist woodlands
Southeastern Shrew *Sorex longirostris*	R		Swampy lowlands
Least Shrew *Cryptotis parva*	FC		Grasslands
Shorttailed Shrew *Blarina brevicauda*	A	X	Floodplain forest
Little Brown Myotis *Myotis lucifugus*	C		Near water
Southeastern Myotis *Myotis austroriparius*	FC		Near quiet water
Gray Myotis *Myotis grisescens*	R		Caves
Keen's Myotis *Myotis keenii*	R		Near wooded streams
Indiana Myotis *Myotis sodalis*	E		Caves, cavities
Small-footed Myotis *Myotis leibii*	UC		Structures, cavities
Eastern Pipistrelle *Pipistrellus subflavus*	A		Forest edges
Big Brown Bat *Epstesicus fuscus*	A	X	Structures, forest
Evening Bat *Nycticeius humeralis*	UC		Structures, cavities
Silver-haired Bat *Lasionycteris noctivagans*	R		Near woodland ponds
Hoary Bat *Lasiurus cinereus*	UC		Forests
Red Bat *Lasiurus borealis*	A		Forests
Rafinesque's Big-eared Bat *Plecotus rafinesquii*	UC		Structures, forest edges
Raccoon *Procyon lotor*	A	X	Woodlands near water

TABLE 4.2.2-2 (Cont'd)

MAMMALS LIKELY TO OCCUR IN THE REGION OF THE BASKETT SITE

Species	Regional Status	On Site Occurrence	Preferred Habitat
Longtail Weasel *Mustela frenata*	FC		Brushlands, streambanks
Mink *Mustela vison*	FC		Near water
River Otter *Lontra canadensis*	R		Near water
Striped Skunk *Mephitis mephitis*	C	X	Open land, forest edge
Red Fox *Vulpes vulpes*	C		Open farmlands
Gray Fox *Urocyon cinereoargenteus*	UC	X	Hardwood forests
Coyote *Canis latrans*	R		Open brushlands
Woodchuck *Marmota monax*	C	X	Forest edge, fields
Eastern Chipmonk *Tamias striatus*	C		Woodlands
Eastern Gray Squirrel *Sciurus carolinensis*	C	X	Forests
Eastern Fox Squirrel *Sciurus niger*	FC	X	Open woodlands
Southern Flying Squirrel *Glaucomys volans*	C		Woodlands
Beaver *Castor canadensis*	FC	X	Aquatic
Eastern Harvest Mouse *Reithrodontomys humilis*	UC		Weedfields
Deer Mouse *Peromyscus maniculatus*	C		Grasslands, weedfields
White-footed Mouse *Peromyscus leucopus*	A	X	Numerous
Golden Mouse *Ochrotomys nuttall*	UC		Greenbrier thickets
Eastern Woodrat *Neotoma floridana*	UC		Cliffs, caves
Southern Bog Lemming *Synaptomys cooperi*	FC		Dense grass
Meadow Vole *Microtus pennsylvanicus*	R		Grasslands

TABLE 4.2.2-2 (Cont'd)

MAMMALS LIKELY TO OCCUR IN THE REGION OF THE BASKETT SITE

Species	Regional Status	On Site Occurrence	Preferred Habitat
Prairie Vole *Microtus ochrogaster*	A		Grasslands
Pine Vole *Microtus pinetorum*	C		Grassland, woodland
Muskrat *Ondatra zibethicus*	A	X	Aquatic
Norway Rat *Rattus norvegicus*	C		Outbuildings
House Mouse *Mus musculus*	C	X	Buildings, fields
Meadow Jumping Mouse *Zapus hudsonius*	R	X	Moist grasslands
Eastern Cottontail *Sylvilagus floridanus*	A	X	Fields, forests
Swamp Rabbit *Sylvilagus aquaticus*	R		Floodplain forest
White-tailed Deer *Odocoileus virginianus*	UC	X	Forests
Bobcat *Lynx rufus*	UC		Forests

Key:

A = Abundant in suitable habitat

C = Common in suitable habitat

FC = Fairly common in suitable habitat

UC = Uncommon in suitable habitat

R = Rare in suitable habitat

E = Endangered Species

X = Recorded on site

Source:

Barbour and Davis (1974)[7]

TABLE 4.2.2-3

REPTILES OF POTENTIAL OCCURRENCE IN THE REGION OF THE BASKETT SITE

Species	Regional Status	On Site Occurrence	Preferred Habitat
Turtles			
Snapping Turtle *Chelydra serpentina*	C	X	Ponds, rivers
Alligator Snapping Turtle *Macroclemys temmincki*	R		Large rivers
Stinkpot *Sternotherus odoratus*	A	X	Mud bottomed ponds and creeks
Mud Turtle *Kinosternon subrubrum*	UC		Shallow water
Box Turtle *Terrapene carolina*	A	X	Woodlands
Map Turtle *Graptemys geographica*	UC		Large rivers
False Map Turtle *Graptemys pseudogeographica*	R		Large rivers
Painted Turtle *Chrysemys picta*	A	X	Ponds, sloughs
Pond Slider *Chrysemys scripta*	A	X	Larger ponds
Slider *Chrysemys concinna*	R		Rivers, cypress swamps
Cooter *Chrysemys floridana*	UC		Muddy rivers
Smooth Softshell Turtle *Trionyx muticus*	UC		Clear rivers
Spiny Softshell Turtle *Trionyx spinifer*	C		Streams, large ponds
Lizards			
Fence Lizard *Sceloporus undulatus*	A		Dry, open woodlands
Ground Skink *Lygosoma laterale*	A		Moist woods
Five-lined Skink *Eumeces fasciatus*	C	X	Abandoned dwelling, debris
Broad-headed Skink *Eumeces laticeps*	R		Woodlands
Six-lined Racerunner *Cnemidophorus sexlineatus*	UC		Sparce vegetation
Slender Glass Lizard *Ophisaurus attenuatus*	R		Dry, brushy upland fields and woodlands

TABLE 4.2.2-3 (Cont'd)

REPTILES OF POTENTIAL OCCURRENCE IN THE REGION OF THE BASKETT SITE

Species	Regional Status	On Site Occurrence	Preferred Habitat
Snakes			
Worm Snake *Carphophis amoenus*	A		Woodlands
Mud Snake *Farancia abacura*	C		Swamps, lowlands
Ringneck Snake *Diadophis punctatus*	C		Woodlands
Hognose Snake *Heterodon platyrhinos*	C		Woodland edges
Rough Green Snake *Opheodrys aestivas*	C		Woods and woodland edges
Black Racer *Coluber constrictor*	C	X	Woods and fields
Rat Snake *Elaphe obsoleta*	C	X	Woodlands and fields
Prairie Kingsnake *Lampropeltis calligaster*	UC		Old fields and grasslands
Kingsnake *Lampropeltis getulus*	UC		Dry woods and pastures
Milk Snake *Lampropeltis triangulum*	C		Woods and fields
Scarlet Snake *Cemophora coccinea*	UC		Woodlands
Crowned Snake *Tantilla coronata*	UC		Dry, rocky woods
Eastern Ribbon Snake *Thamnophis sauritus*	UC		Near water
Garter Snake *Thamnophis sirtalis*	A	X	Woodlands and fields
Earth Snake *Virginia valeriae*	UC		Woodlands
Brown Snake *Storeria dekayi*	UC		Ubiquitous
Red-bellied Snake *Storeria occipitomaculata*	UC		Woodlands
Queen Water Snake *Regina septemvittata*	C		Rocky Streams
Red-bellied Water Snake *Nerodia erythrogaster*	UC		River bottom swamps

TABLE 4.2.2-3 (Cont'd)

REPTILES OF POTENTIAL OCCURRENCE IN THE REGION OF THE BASKETT SITE

Species	Regional Status	On Site Occurrence	Preferred Habitat
Kirtland's Water Snake *Nerodia kirtlandi*	R		Wet meadows
Diamond-backed Water Snake *Nerodia rhombifera*	UC		Streams, rivers and lakes
Common Water Snake *Nerodia sipedon*	A		Flowing water and ponds
Cottonmouth *Agkistrodon piscivorous*	UC		Cypress swamps and sluggish streams
Copperhead *Agkistrodon contortrix*	UC		Woodlands
Rattlesnake *Crotalus horridus*	UC		Dry, rocky woodlands

Key:

A = Abundant in suitable habitat

C = Common in suitable habitat

UC = Uncommon in suitable habitat

R = Rare in suitable habitat

X = Recorded on site

Source:

Barbour (1971)[8]

Conant (1975)[14]

TABLE 4.2.2-4

AMPHIBIANS OF POTENTIAL OCCURRENCE IN THE REGION OF THE BASKETT SITE

Species	Regional Status	On Site Occurrence	Preferred Habitat
Siren *Siren intermedia*	R		Cypress swamps
Hellbender *Cryptobranchus alleganiensis*	C		Larger streams
Jefferson's Salamander *Ambystoma jeffersonianum*	UC	X	Low woodlands
Small-mouthed Salamander *Ambystoma texanum*	C		Woods near streams
Marbled Salamander *Ambystoma opacum*	C		Low woodlands
Spotted Salamander *Ambystoma maculatum*	C		Near woodland pools
Tiger Salamander *Ambystoma tigrinum*	C		Burrows
Newt *Notophthalmus viridescens*	C		Woods and ponds
Amphiuma tridactylum *Amphiuma means*	UC		Cypress swamps, sluggish streams
Dusky Salamander *Desmognathus fuscus*	C		Woodland streams
Red-backed Salamander *Plethodon cinereus*)	R		Woodlands
Zig-zag Salamander *Plethodon dorsalis*	UC		Rocky areas
Slimy Salamander *Plethodon glutinosus*	C		Woodlands
Two-lined Salamander *Eurycea bislineata*	UC		Rocky streams
Long-tailed Salamander *Eurycea longicauda*	UC		Rocky streams, shale banks
Cave Salamander *Eurycea lucifuga*	UC		Limestone caves, woodlands
Mudpuppy *Necturus maculosus*	C		Slow streams
Spadefoot Toad *Scaphiopus holbrooki*	UC		Subterranean
Bullfrog *Rana catesbeiana*	A	X	Permanent water
Green Frog *Rana clamitans*	C	X	Standing water

TABLE 4.2.2-4 (Cont'd)

AMPHIBIANS OF POTENTIAL OCCURRENCE IN THE REGION OF THE BASKETT SITE

Species	Regional Status	On Site Occurrence	Preferred Habitat
Leopard Frog *Rana pipiens*	A	X	Wetlands, meadows
Pickerel Frog *Rana palustris*	UC		Clear waterbodies
Wood Frog *Rana sylvatica*	UC		Woodlands
Crawfish Frog *Rana areolata*	R		Burrows
Narrow-mouthed Toad *Gastrophryne carolinensis*	UC		Ubiquitous
American Toad *Bufo americanus*	A	X	Ubiquitous
Fowler's Toad *Bufo woodhousei*	A	X	Ubiquitous
Cricket Frog *Acris crepitans*	A	X	Ponds and rivers
Spring Peeper *Hyla crucifer*	C	X	Woodlands
Gray Treefrog *Hyla versicolor*	A	X	Woodlands
Bird-voiced Treefrog *Hyla avivoca*	R		Cypress swamps
Chorus Frog *Pseudacris triseriata*	A	X	Grasslands

Key:

A = Abundant in suitable habitat

C = Common in suitable habitat

FC = Fairly common in suitable habitat

UC = Uncommon in suitable habitat

R = Rare in suitable habitat

X = Recorded on site

Source:

Barbour (1971)[8]

Conant (1975)[14]

TABLE 4.2.2-5

LIST OF TERRESTRIAL RARE OR ENDANGERED SPECIES WHICH MAY OCCUR IN THE BASKETT SITE VICINITY

	Preferred Habitat	Regional Status	Regional Occurrence	Food Habits
Mammals				
Gray Bat *Myotis grisescens*	Caves	E	v	Insectivorous
Indiana Bat *Myotis sodalis*	Caves, forests	E	v,pr	Insectivorous
Masked Shrew *Sorex cinereus*	Moist woodlands	Rare	PR	Insects, small vertebrates
Swamp Rabbit *Sylvilagus aquaticus*	Cypress sloughs, bottomland forest	Rare	PR	Herbivorous
Bobcat *Lynx rufus*	Large woodlands	Rare	pr	Small vertebrates
Birds				
Peregrine Falcon *Falco peregrinus*	Wetlands, woods, fields	E	v	Birds
Bald Eagle *Haliaeetus leucocephalus*	Near water	E	v	Scavenger, fish
Golden Eagle *Aquila chrysaetos*	Near water	Rare	v	Small mammals, scavenger
Osprey *Pandion haliaetus*	Near water	Rare	v	Fish
Amphibians				
Western Lesser Siren *Siren intermedia*	Cypress swamps	Rare	ps	Insects, small aquatic vertebrates
Amphiuma *Amphiuma tridactylum*	Cypress swamps, sluggish streams	Rare	ps	Insects, small aquatic vertebrates

TABLE 4.2.2-5 (Cont'd)

LIST OF TERRESTRIAL RARE OR ENDANGERED SPECIES WHICH MAY OCCUR IN THE BASKETT SITE VICINITY

	Preferred Habitat	Regional Status	Regional Occurrence	Food Habits
Amphibians (Cont'd)				
Red-backed Salamander *Plethodon cinereus*	Woodlands	Rare	ps	Algae (larval stage), insects
Bird-voiced Tree-frog *Hyla avivoca*	Cypress swamps	Rare	ps	Insects
Northern Crayfish Frog *Rana areolata*	Burrows	Rare	ps	Algae (larval stage), insects
Reptiles				
Slender Glass Lizard *Ophisaurus attenuatus*	Dry uplands, fields	Rare	pr	Insects, small vertebrates
Eastern Ribbon Snake *Thanophis sauritus*	Near water	Rare	ps	Insects, small vertebrates
Prairie kingsnake *Lampropettis calligaster*	Old fields and grasslands	Rare	ps	Insects, small vertebrates
Scarlet Snake *Cemophora coccinea*	Woodlands	Rare	ps	Insects, small vertebrates
Southeastern Crowned Snake *Tantilla coronata*	Dry, rocky woods	Rare	pr	Insects, small vertebrates
Red Milk Snake *Lampropeltis triangulum syspila*	Woods and fields	Rare	ps	Insects, small vertebrates
Kirtland's Water Snake *Nerodia kirtlandi*	Wet meadows	Rare	pr	Insects, small vertebrates

TABLE 4.2.2-5 (Cont'd)

LIST OF TERRESTRIAL RARE OR ENDANGERED SPECIES WHICH MAY OCCUR IN THE BASKETT SITE VICINITY

	Preferred Habitat	Regional Status	Regional Occurrence	Food Habits
Reptiles (Cont'd)				
Alligator Snapping Turtle *Macroclemys temmincki*	Large rivers	Rare	pr	Small vertebrates
False Map Turtle *Graptemys pseudogeographica*	Large rivers	Rare	pr	Vegetarian, some insects
Slider *Chrysemys concinna*	Rivers, cypress sloughs	Rare	ps	Vegetarian; small animals (when young)

Key:

E = Species on Kentucky and U.S. Endangered Species List.

Rare = Species on periphery of range; may be more abundant in other areas but considered rare in this portion of Kentucky.

PR = Permanent Resident occurring on Site.

v = Possible visitor

pr = Possible Resident in region.

ps = Possible Resident of region with suitable habitat on Site.

Babcock, J.V. (1977)[16]

Barbour, R.W. (1971)[8]

Fed. Register 1978[13]

TABLE 4.2.2-6

VEGETATION COVER TYPE COMPOSITION OF SITE

Cover Type (map symbol)		Areal Extent (hectares)	(acres)	(percent)
Upland Forest	(UF)	18	44	6.2
Fence Rows and Intermittent Stream Borders	(FR)	13	32	4.5
Grassland and Pasture	(GR)	5	12	1.7
Flood Plain Forest	(FF)	55	136	19.4
Cypress Slough	(S)	8	20	2.9
Cropland (Wheat, Soybeans and Corn)	(C)	171	425	60.4
Cropland (Hay)	(H)	13	31	4.4
Pond	(P)	1	2	0.3
Residential	(R)	1	1	0.2
Total		285	703	100

Note: Percent cover values obtained from dot-planimetry measurements of 1978 aerial photographs, scale ≈ 1:6965. Total site area obtained from property descriptions.

TABLE 4.2.2-7

FREQUENCY, DENSITY AND BASAL AREA OF CANOPY TREE SPECIES IN UPLAND FOREST

Species 1/	Frequency 2/ (percent)	Density (Stems/ hectare)	Relative Density (percent)	Basal Area (m^2/ hectare)	Relative Basal Area (percent)
Sassafras albidum	71	386	53	803.4	54
Ulmus americana	57	100	14	48.3	3
Carya illinoensis	29	100	14	349.5	24
Acer negundo	29	71	10	175.6	12
Quercus palustris	14	29	4	80.3	5
Ulmus rubra	14	14	2	17.8	1
Celtis occidentalis	14	14	2	4.5	1
Robinia pseudo-acacia	14	14	2	5.5	1

1/ Canopy trees were defined as those with diameter, at 137 cm height, of 5 cm or greater.

2/ Based on occurrence in 7 10m by 10m quadrats located on two parallel transects.

TABLE 4.2.2-8

FREQUENCY AND COVER OF SHRUB SPECIES IN UPLAND FOREST

Species	Occurrence By Cover Class (number of plots)				Frequency Of Occurrence In Sampled Plots (percent)
Cover Class:	6%	6%-25%	26%-50%	51%-75%	
Lonicera japonica	2	2	1	1	86
Rubus sp. (prob. *allegheniensis*)	1	2			43
Ulmus americana	2	1			43
Acer negundo	3				43
Parthenocissus quinquefolia	3				43
Ulmus rubra	1	1			29
Campsis radicans	2				29
Symphoricarpus occidentalis			1		15
Acer saccharum	1				15
Quercus rubra	1				15
Sassafras albidum	1				15
Celtis occidentalis	1				15

Note: Based on occurrence in 7 2m by 4m plots located along two parallel transects.

TABLE 4.2.2-9

FREQUENCY AND COVER OF SPECIES IN HERBACEOUS STRATUM OF UPLAND FOREST

Species	Occurrence By Cover Class (number of plots)						Frequency Of Occurrence In Sampled Plots (percent)
Cover Class:	1%	1%-5%	6%-25%	26%-50%	51%-75%	76%-100%	
Impatiens capensis	1		1		3	1	86
Lonicera japonica		2	1	2	1		86
Geum canacense	1	3					57
Parthenocissus quinquefolia	2	2					57
Coryealis flavola		2		1			43
Galium boreale	1	2					43
Rubus spp. (prob. *allegheniensis* and one prostrate sp.)			2	1			43
Cardamine pennsylvanica	1	1					29
Carex sp.		2					29
Poa trivialis			2				29
Rhus racicans		2					29
Acer negundo		1					14
Clematis virginiana		1					14
Phytolacca americana		1					14
Agastache nepetoides	1						14
Pilea pumila	1						14
Polygonum scandens	1						14

Note: Based on occurrence in 7 1m by 1m plots located along two parallel transects.

TABLE 4.2.2-10

PLANT SPECIES OBSERVED ON THE BASKETT SITE

A. Woody Species	Floodplain Forest	Upland Forest	Fencerow and Borders	Cypress Slough	Grasslands
Acer negundo	X	X	X		
Acer rubrum	X				
Acer saccharum		X			
Acer saccharinum	X			X	
Ampelopsis cordata	X				
Arundinaria gigantea	X				
Asimina triloba	X				
Betula nigra	X			X	
Campsis radicans	X	X	X		X
Carya illinoensis	X	X			
Carya laciniosa	X				
Celtis laevigata	X				
Celtis occidentalis	X	X	X		
Cephalanthus occidentalis	X			X	
Cercis canadensis		X	X		
Crataegus sp					X
Diospyros virginiana	X				
Forestiera acuminata				X	
Fraxinus americana			X		
Fraxinus pennsylvanica var. *subintegerrima*	X				
Fraxinus tomentosa	X				

TABLE 4.2.2-10 (Cont'd)

PLANT SPECIES OBSERVED ON THE BASKETT SITE

A. Woody Species (Contd)	Floodplain Forest	Upland Forest	Fencerow and Borders	Cypress Slough	Grasslands
Gleditsia triacanthos	X	X			
Juglans nigra			X		
Lindera benzoin	X	X			
Liquidambar styraciflua	X	X			
Lonicera japonica		X	X		X
Morus alba	X				
Morus rubra	X		X		
Parthenocissus quinquefolia	X	X			
Platanus occidentalis	X	X	X		
Populus deltoides	X				
Populus heterophylla	X				
Prunus serotina			X		
Quercus bicolor	X				
Quercus lyrata	X				
Quercus michauxii	X				
Quercus palustris	X	X			
Quercus rubra		X			
Rhus radicans	X	X	X		
Robinia pseudo-acacia		X	X		
Rosa multiflora			X		X
Rubus spp (one prostrate sp., and one upright, probably *allegheniensis*)	X	X			

TABLE 4.2.2-10 (Cont'd)

PLANT SPECIES OBSERVED ON THE BASKETT SITE

A. Woody Species (Cont'd)	Floodplain Forest	Upland Forest	Fencerow and Borders	Cypress Slough	Grasslands
Salix nigra	X			X	
Sambucus canadensis	X		X		
Sassafrass albidum		X	X		
Smilax rotundifolia	X		X		
Symphoricarpos occidentalis	X	X			
Taxodium distichum				X	
Tilia heterophylla		X	X		
Ulmus americana	X	X	X		
Ulmus rubra	X	X	X		
Vitis cinerea	X		X		
Vitis riparia	X				
B. Herbaceous Species					
Acalypha gracilens	X				
Achillea millefolium					X
Agastache nepetoides	X	X			
Agrostis perennans					X
Allium vineale					X
Ambrosia artemisiifolia					X
Ambrosia trifida	X		X		
Andropogon virginicus					X
Arisaema dracontium	X				
Asclepias perennis	X				
Aster lateriflorus	X		X		

TABLE 4.2.2-10 (Cont'd)

PLANT SPECIES OBSERVED ON THE BASKETT SITE

B. Herbaceous Species (Cont'd)	Floodplain Forest	Upland Forest	Fencerow and Borders	Cypress Slough	Grasslands
Aster pilosus					X
Aster simplex	X		X		
Barbarea vulgaris			X		
Bidens tripartita	X				
Boehmeria cylindrica	X		X		
Bromus sp			X		
Camassia scilloides	X				
Cannabis sativa			X		
Cardamine pennsylvanica		X			
Carex crinita	X				
Carex flaccosperma	X				
Carex grayii	X				
C. hystricina	X				
C. intumescens	X				
C. muskingumensis	X				
C. tribuloides	X	X			
Cerastium vulgatum					X
Chelone obliqua var. *speciosa*	X				
Cinna arundinaceae	X				
Cirsium discolor					X
Clematis virginiana	X	X			

TABLE 4.2.2-10 (Contd)

PLANT SPECIES OBSERVED ON THE BASKETT SITE

B. Herbaceous Species (Cont'd)	Floodplain Forest	Upland Forest	Fencerow and Borders	Cypress Slough	Grasslands
Commelina diffusa	X				
C. virginica	X				
Corydalis flavula		X			
Cryptotaenia canadensis		X			
Cuscuta sp	X				
Cystoperis fragilis		X			
Dactylis glomerata					X
Dentaria laciniata		X			
Delphinium tricorne		X			
Digitaria sanguinalis					X
Dioscorea quaternata	X				
Elymus riparius	X				
Eragrostis reptans					X
Erigeron annuus					X
Eupatorium fistulosum	X				
Galium boreale	X	X			
Geum canadense	X	X			
Glyceria striata	X				
Helenium flexuosum					X
Hibiscus militaris	X			X	
Hydrophyllum appendiculatum		X			
Hyrdophyllum canadense		X			
Impatiens capensis	X	X	X		

TABLE 4.2.2-10(Cont'd)

PLANT SPECIES OBSERVED ON THE BASKETT SITE

B. Herbaceous Species (Cont'd)	Floodplain Forest	Upland Forest	Fencerow and Borders	Cypress Slough	Grasslands
*Ipomea sp			X		
Iris virginica var. shrevii	X				
Juncus tenuis					X
Laportea canadensis	X				
Leersia oryzoides	X				
Leersia lenticularis	X				
Lespedeza striata					X
Lobelia cardinalis	X				
Lobelia syphilitica	X				
Lycopus rubellos	X				
Lysimachia ciliata	X				
Medicago lupulina					X
Menispermum canadense	X				
Mimulus ringens	X				
Oenothera pilosella	X				
Onoclea sensibilis	X				
Osmorrhiza longistylis		X			
Oxalis stricta	X				X
Panicum sp					X
Panicum stipitatum					X
Paspalum ciliatifolium					X

*Includes I. lacunosa, I. hederacea, I. pandurata, and I. purpurea

TABLE 4.2.2-10 (Cont'd)

PLANT SPECIES OBSERVED ON THE BASKETT SITE

B. Herbaceous Species (Cont'd)	Floodplain Forest	Upland Forest	Fencerow and Borders	Cypress Slough	Grasslands
Paspalum dilatatum					X
Paspalum fluitans			X		
Perilla frutescens					X
Phleum pratense					X
Phlox divaricata	X	X			
Phytolacca americana	X	X			
Pilea pumila	X	X			
Plantago lanceolata					X
Poa alsodes					X
Poa pratensis					X
Poa trivialts		X			
Podophyllum peltatum		X			
Polygonum caespitosum	X				
Polygonum punctatum	X				
Polygonum scandens		X			
Polystichum acrostichoides		X	X		
Potentilla recta					X
Rananculus abortivus	X				
Rananculus scleratus	X				
Rumex acetosella					X
Rumex crispus			X		
Rumex verticillata	X				
Samolus parviflorus	X				

TABLE 4.2.2-10 (Cont'd)

PLANT SPECIES OBSERVED ON THE BASKETT SITE

B. Herbaceous Species (Cont'd)	Floodplain Forest	Upland Forest	Fencerow and Borders	Cypress Slough	Grasslands
Sanguinaria canadensis		X			
Saururus cernua	X				
Scutellaria lateriflora	X				
Sedum ternatum	X				
Sicyos angulatus	X				
Smilax lasioneura	X				
Solanum carolinense					X
Solidago canadensis			X		X
S. rugosa					X
Stachys tenuifolia	X				
Torilis japonica			X		
Tovara virginiana	X				X
Tridens flava					X
Trifolium repens					X
Trillium grandiflorum		X			
Uniola latifolia	X				
Verbesina alternifolia	X				
Vernonia altissima					X
Viola cucullata	X				
Viola pensylvanica		X			
Viola sororia		X			
Viola striata	X				
Xanthium strumarium			X		

TABLE 4.2.2-11

FREQUENCY AND COVER OF GRASSLAND SPECIES

Species	Occurrence By Cover Class (number of plots)						Frequency Of Occurrence In Sampled Plots (percent)
Cover Class:	< 1%	1%-5%	6%-25%	26%-50%	51%-75%	76%-100%	
Dactylis glomerata		1	3	2		3	90
Poa alsades		2	4	2			80
Lespedeza striata		1	4	1		2	80
Rumex acetosella		7	1				80
Medicago lupulina		3	3	1			70
Panicum stipitatum		5	2				70
Plantago lanceolata		6					60
Panicum sp		5					50
Ambrosia artemisiifolia		3	1				40
Achillea millefolium		3					30
Agrostis perennans		3					30
Andropogon virginicus	1	1	1				30
Perilla frutescens		2					20
Phleum pratense		2					20
Erigeron annuus		2					20
Oxalis stricta	1	1					20
Aster pilosus		1	1				20
Trifolium repens		2					20
Solidago canadensis		2					20
Potentilla recta			2				20
Tridens flava			1				10

TABLE 4.2.2-11(Cont'd)

FREQUENCY AND COVER OF GRASSLAND SPECIES

Species	Occurrence By Cover Class (number of plots)						Frequency Of Occurrence In Sampled Plots (percent)
Cover Class:	< 1%	1%-5%	6%-25%	26%-50%	51%-75%	76%-100%	
Crataegus sp			1				10
Poa pratensis		1					
Solanum carolinense		1					
Allium vineale	1						10
Cerastium vulgatum		1					10
Solidago rugosa		1					10
Campsis radicans		1					10
Lonicera japonica			1				10
Rosa multiflora		1					10
Cirsium discolor		1					10
Digitaria sanguinalis		1					10
Juncus tenuis	1						10
Paspalum ciliatifolium		1					10

Note: Sampling carried out in June and September. Data presented for each species from month of its maximum cover value, and based on 10 1m by 1m plots.

TABLE 4.2.2-12

FREQUENCY, DENSITY AND BASAL AREA OF CANOPY SPECIES IN FLOOD PLAIN FOREST

Species[1/]	Frequency[2/] Transect I (percent)	Frequency[2/] Transect II (percent)	Density (stems/ha)	Relative Density (percent)	Basal Area (m^2/ha)	Relative Basal Area (percent)
Acer rubrum	70	30	145	19	2.53	11
Fraxinus pennsylvanica var. *subintegerrima*	30	50	85	11	2.40	10
F. tomentosa	50	20	95	13	2.70	11
Populus heterophylla	30	20	45	6	1.21	5
Salix nigra	40	10	25	3	4.73	20
Ulmus americana	30	10	35	5	0.21	1
Liquidambar styraciflua	10	30	30	4	1.07	5
Celtis spp[3/]	40	0	30	4	0.17	1
Quercus michauxii	0	30	50	7	3.19	13
Carya laciniosa	20	10	40	5	1.48	6
Quercus palustris	20	0	20	3	1.33	6
Acer saccharinum	10	10	25	3	0.29	1
Gleditsia triacanthos	10	10	15	2	0.23	1
Ulmus rubra	0	20	15	2	0.32	1
Platanus occidentalis	10	10	10	1	0.85	4
Cephalanthus occidentalis	10	0	75	10	0.38	2
Morus rubra	10	0	5	1	0.40	2
M. alba	10	0	5	1	0.32	1

1/ Canopy trees were defined as those with diameter, at 137 cm, of 5 cm or greater.

2/ Based on twenty 10m by 10m quadrats located along 2 parrallel transects.

3/ Both *Celtis occidentalis* and *C. laevigata* were present. Many individuals appeared to represent introgressive hybridizations between the two species, and could not be confidently assigned to one species or the other.

TABLE 4.2.2-13

FREQUENCY AND COVER OF SHRUB SPECIES IN FLOOD PLAIN FOREST

Species	Occurrence By Cover Class[1/] (number of plots)		Frequency Of Occurrence In Sampled Plots[1/]		
Cover Class:	6%	6%-25%	Transect I (no. of plots)	Transect II (no. of plots)	Transects I and II Combined (percent)
Fraxinus pennsylvanica and *tomentosa*	12		4	8	60
Ulmus americana	11		6	5	55
Acer rubrum	5	1	4	2	30
Quercus michauxii	4	1	1	4	25
Celtis spp.[2/]	3		3	1	20
Acer saccharinum	3		2	1	15
Vitis cinera	3		1	2	15
Cephalanthus occidentalis	1	1		2	10
Campsis radicans	2		2		10
Parthenocissus quinquefolia	1		1		5
Rhus radicans	1		1		5

1/ Based on occurrence in 20 2m by 4m plots located along two parallel transects.

2/ Both *Celtis occidentalis* and *C. laevigata* were present. Many individuals appeared to represent introgressive hybridization between the two species, and could not be confidently assigned to one species or the other.

3/ Both *Fraxinus pennsylvanica* and *F. tomentosa* were present. Many individuals appeared to represent introgressive hybridization between the two species, and could not be confidently assigned to one species or the other.

TABLE 4.2.2-14

(Sheet 1 of 2)

FREQUENCY AND COVER OF SPECIES IN HERBACEOUS STRATUM OF FLOOD PLAIN FOREST

Species	Occurrence by Cover Class[3] (number of plots)					Frequency of Occurrence In Sampled Plots[1]		
	1%	1% - 5%	6% - 25%	26% - 50%	51% - 75%	Transect I (Number of Plots)	Transect II (Number of Plots)	Transects I & II Combined (percent)
Carex spp[2]	1	8		1		4	5	45
Rhus radicans	1	6	1	1		4	5	45
Pilea pumila		7				5	3	40
Aster lateriflorus		2	3	2	1	2	6	40
Bochmeria cylindrica			3	1		2	4	30
Rumex verticillata		1	3	1		2	4	30
Impatiens capensis	1	3		1		3	2	25
Ranunculus scleratus		4	1			3	2	25
Vitis spp	1	2				1	3	20
Acer rubrum		2	1		1	3	1	20
Fraxinus tomentosa and pennsylvanica var subintegerrima		3		1		2	2	20
Lycopus sp		2		1		1	2	15
Geum canadense		3				2	1	15
Quercus palustris		3				1	2	15
Parthenocissus quinquefolia	1	2				3	0	15
Saururus cernuus				2		1	1	10
Lobelia cardinalis		2				0	2	10
Campsis radicans	1		1			1	1	10
Scutellaria lateriflora		2				1	1	10
Acer saccharinum		2				1	1	10
Rubus sp (probably allegheniensis)		1				0	1	10
Iris virginica var shrevei				1		0	1	5
Bidens tripartita			1			0	1	5

(continued)

TABLE 4.2.2-14 Cont'd) (Sheet 2 of 2)

FREQUENCY AND COVER OF SPECIES IN HERBACEOUS STRATUM ON FLOOD PLAIN FOREST

Species	Occurrence by Cover Class[3/]					Frequency of Occurrence In Sampled Plots[1/]		
	1%	1% - 5%	6% - 25%	26% - 50%	51% - 75%	Transect I (Number of Plots)	Transect II (Number of Plots)	Transects I & II Combined (percent)
Acer negundo		1				1	0	5
Leersia lenticularis		1				1	0	5
Cinna arundinacene		1				1	0	5
Mimulus ringens		1				1	0	5
Ranunculus abortivus		1				1	0	5
Symphoricarpus occidentalis		1				0	1	5
Oxalis stricta		1				0	1	5
Cuscuta sp		1				0	1	5
Elymus riparius		1				0	1	5
Galium boreale		1				0	1	5
Ampelopsis cordata						0	1	5

1/ Ten 1m by 1m plots sampled in each transect. Derived from May, June and September observations.

2/ Includes *Carex tribuloides*, *C muskingumensis*, *C flaccosperma*, and *C louisianica*.

3/ Derived from May and June observations.

TABLE 4.2.2-15

PLANTS ON OR NEAR THE BASKETT SITE WITH A PREDOMINANTLY SOUTHERN RANGE

Arundinaria gigantea

Carex louisianica

Carya illinoensis

Chelone obliqua var. *speciosa*

Forestiera acuminata

Fraxinus tomentosa

Hymenocallis occidentalis (off-site)

Hypericum tubulosum

Iris virginica var. *shrevei*

Paspalum fluitans

Populus heterophylla

Quercus lyrata

Quercus michauxii

Taxodium distichum

Ulmus alata (off-site)

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*information on range from Fernald (1950)[19] and Harlow and Harrar (1958)[20].

TABLE 4.2.2-16

FREQUENCY, DENSITY AND BASAL AREA OF WOODY SPECIES IN CYPRESS SLOUGH

	Transect V[1/]			Transect VI[2/]		
Canopy Tree Species	Frequency (percent)	Density (stems/ hectare)	Basal Area (m^2/ hectare)	Frequency (percent)	Density (stems/ hectare)	Basal (m^2/ hectare)
Forestiera acuminata	12	824	344.7	35	1,087	75.4
Salix nigra				13	174	166.0
Taxodium distichum	12	118	55.5	9	87	419.3
Fraxinus pennsylvanica var. *subintegerrima*				4	44	60.2
Betula nigra				4	44	4.9
Acer saccharinum	6	59	97.8			
Shrub Species						
Cephalanthus occidentalis	88	25,173		96	26,496	
Acer saccharinum	18	759		22	1,304	
Forestiera acuminata	6	882		44	957	
Fraxinus pennsylvanica var. *subintegerrima*				18	313	

1/ Data obtained from 17, contiguous, 10m plots. Canopy data obtained from plots 4m wide, and shrub data from plots 1m wide.

2/ Data obtained from 23, contiguous, 10m plots. Plot width as described above.

TABLE 4.2.2-17

DENSITY OF BREEDING BIRDS ON THE BASKETT SITE DURING JUNE 1978

	Birds per 100 Acres				
	Upland Forest	Floodplain Forest	Cypress Slough	Grassland	Agriculture
Green Heron			3.1		
Wood Duck		2.6	21.6		
Turkey Vulture	X				
Red-shouldered Hawk		X	X		
Bobwhite	X				X
Killdeer					X
American Woodcock			X		
Mourning Dove	X	X	6.2		
Yellow-billed Cuckoo	7.7	15.4	9.2		
Screech Owl		X			
Barred Owl		X	X		
Chimney Swift			X	X	
Ruby-throated Hummingbird	X		6.2		
Common Flicker			3.1		
Red-bellied Woodpecker	27.0	15.4	9.2		
Red-headed Woodpecker		2.6	9.2		
Hairy Woodpecker		2.6	3.1		
Downy Woodpecker	15.4	18.0			
Eastern Kingbird				X	
Great Crested Flycatcher	7.7	7.7	9.2		
Acadian Flycatcher		30.8	24.6		
Eastern Wood Pewee	19.2	20.6	12.3		
Barn Swallow				X	
Blue Jay	3.8	5.1			
Common Crow	X		X		
Carolina Chickadee	3.8	7.7	3.1		
Tufted Titmouse	X	10.3	6.2		
White-breasted Nuthatch			X		
House Wren			24.6		
Carolina Wren	3.8				
Northern Mockingbird	X				
Gray Catbird			6.2		
American Robin	X	X			
Wood Thrush	3.8	15.4			

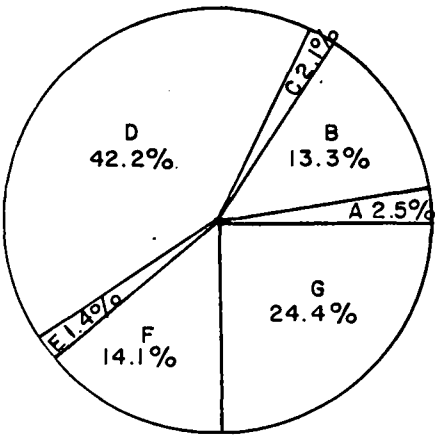
TABLE 4.2.2-17 (Cont'd)

DENSITY OF BREEDING BIRDS ON THE BASKETT SITE DURING JUNE 1978

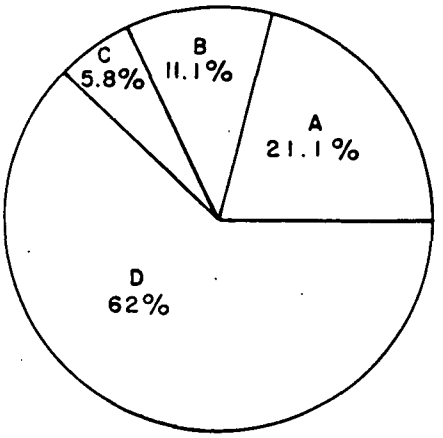
	Birds per 100 Acres				
	Upland Forest	Floodplain Forest	Cypress Slough	Grassland	Agriculture
Blue-gray Gnatcatcher	7.7	28.3	46.2		
Starling	X	X	X	X	X
White-eyed Vireo	27.0	2.6	15.4		
Yellow-throated Vireo		2.6			
Red-eyed Vireo		20.6			
Warbling Vireo			X		
Prothonotary Warbler		33.4	77.0		
Northern Parula		X			
Yellow Warbler			3.1		
Cerulean Warbler		X			
Yellow-throated Warbler	3.8				
Kentucky Warbler		5.1			
Common Yellowthroat	3.08	18.0	33.9		
Yellow-breasted Chat	46.2	X			
American Redstart			21.6		
House Sparrow					X
Eastern Meadowlark				X	
Red-winged Blackbird	X		3.1	X	X
Northern Oriole	X	X			
Common Grackle	19.2	7.7	52.4		
Brown-headed Cowbird	23.1	7.7	30.8		
Scarlet Tanager	7.7		X		
Summer Tanager		2.6			
Cardinal	34.6	20.6	9.2		
Indigo Bunting	46.2	30.8	46.2		X
American Goldfinch			3.1		
Rufous-sided Towhee	15.4				
Field Sparrow	X				
Song Sparrow		X			
Total Number of Species	32	36	37	6	6

X = Recorded in habitat type but not during survey.

26 MAY 1978



11 JULY 1978



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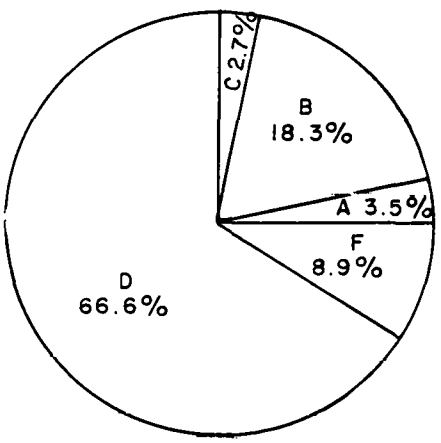
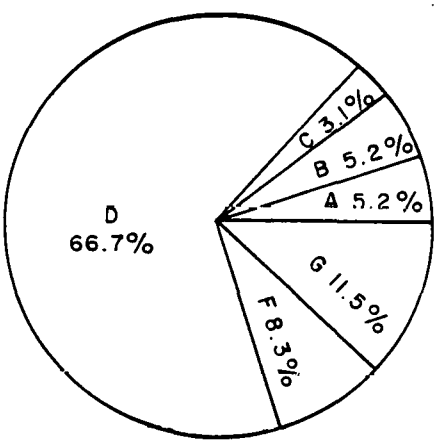


22 JANUARY, 1979

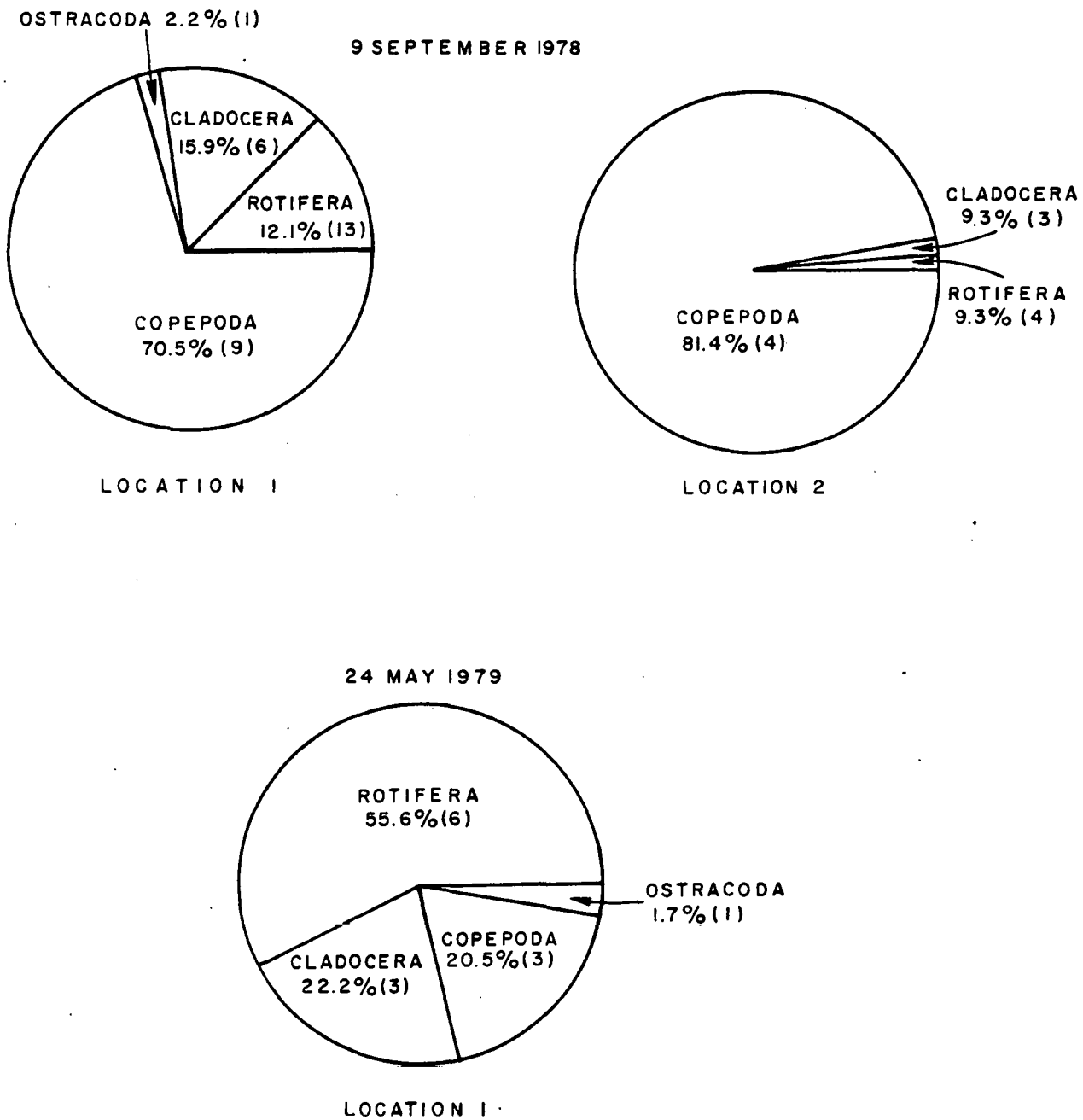


A - CYANOPHYTA
B - CHLOROPHYTA
C - EUGLENOPHYTA
D - BACILLARIOPHYCEAE
E - CHRYSOPHYTA
F - CRYPTOPHYTA
G - CYANOBACTERIUM

DEPARTMENT OF ENERGY
W. R. GRACE & CO.
SYNTHESIS GAS DEMONSTRATION PLANT PROGRAM
INDUSTRIAL PROJECT "B" - PHASE 1 — CONTRACT No. ET-77-C-01-2577
EBASCO SERVICES INCORPORATED

RELATIVE PERCENT ABUNDANCE OF MAJOR PHYTOPLANKTON GROUPS COLLECTED FROM THE GREEN RIVER

FIGURE 4.2.1-1



( ) = NUMBER OF TAXA

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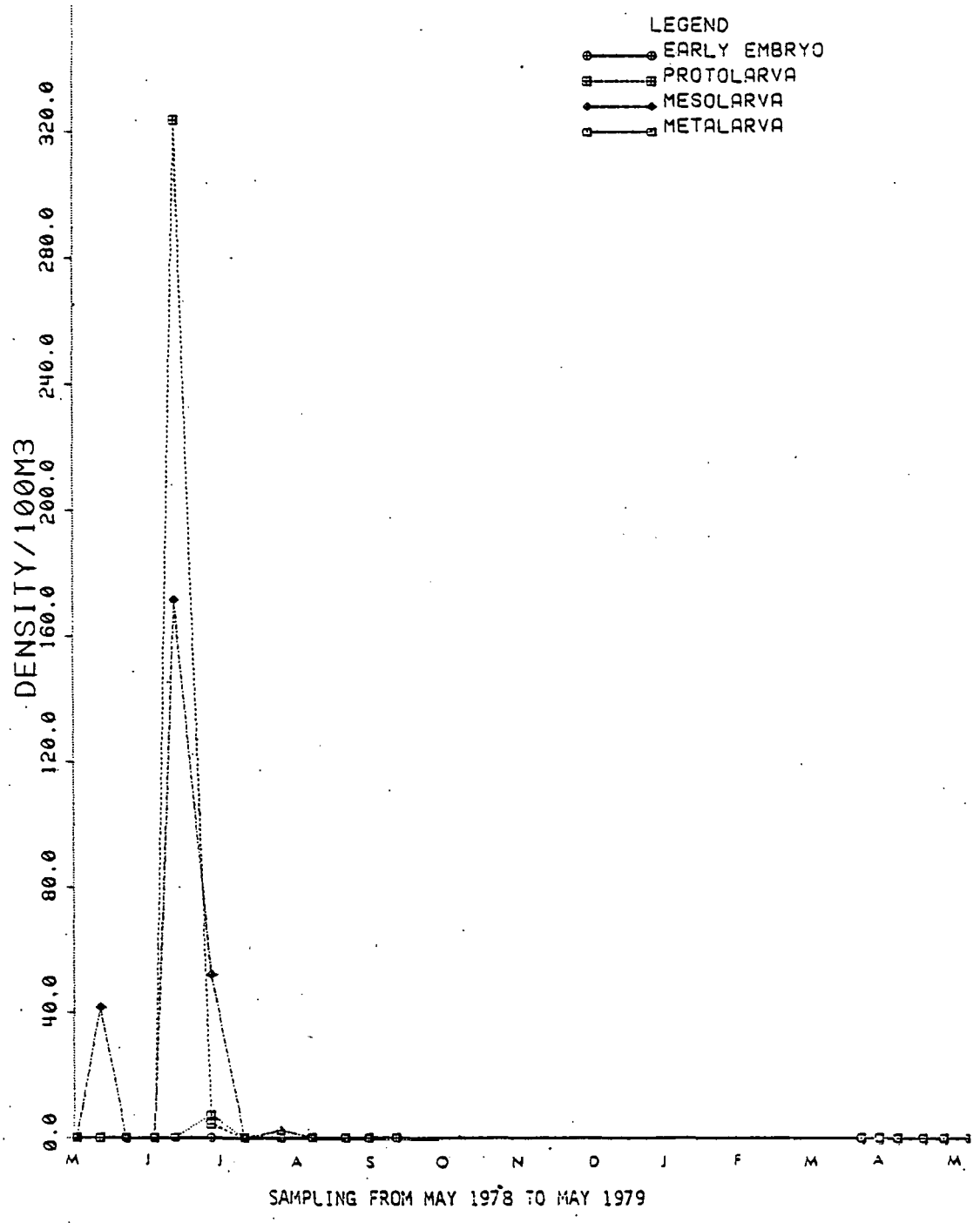
RELATIVE PERCENT ABUNDANCE OF MAJOR MICROZOOPLANKTON GROUPS COLLECTED FROM THE CYPRESS SLOUGH

FIGURE 4.2.1-2



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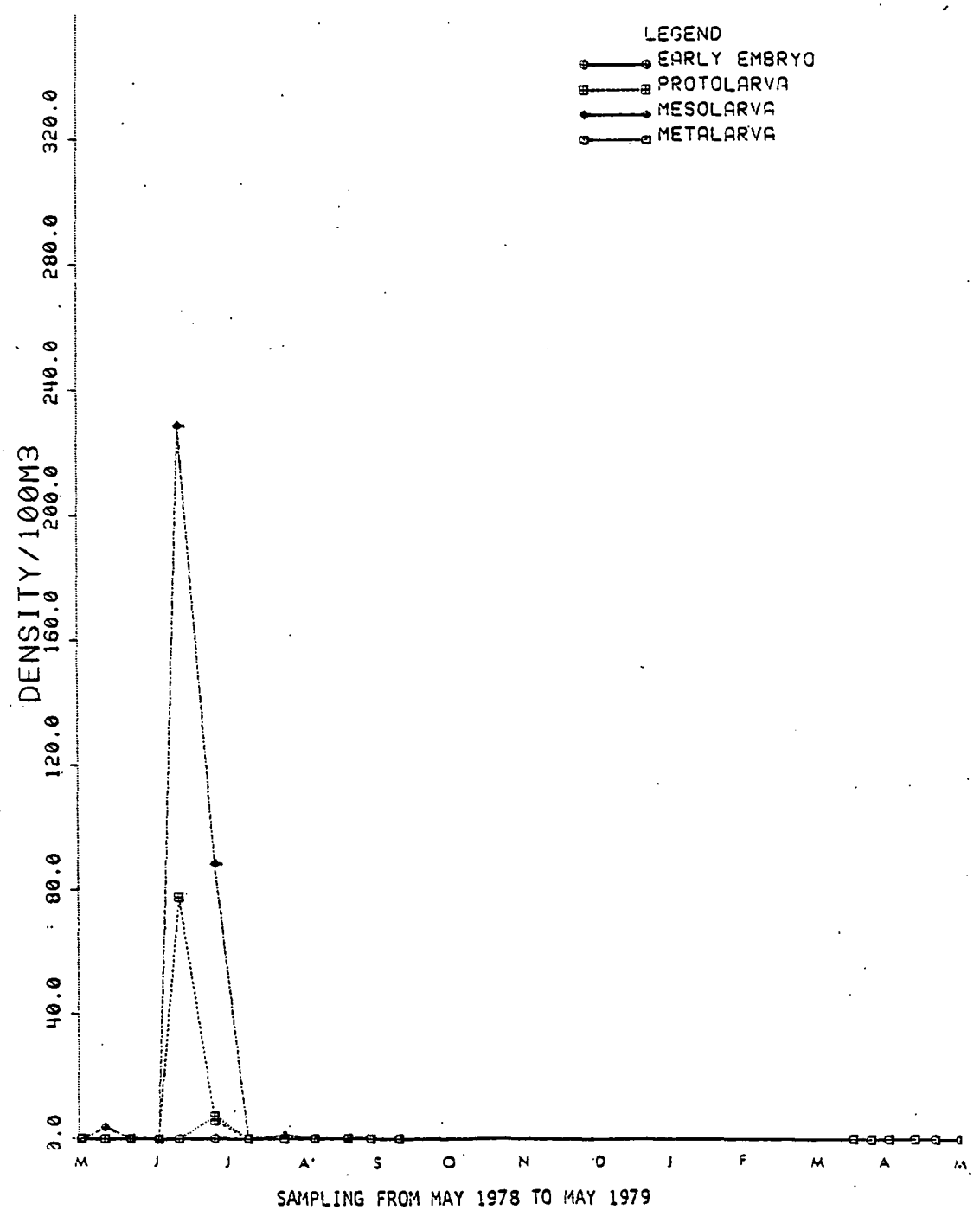
GREEN RIVER ICHTHYOPLANKTON
ABUNDANCE-ZONE 3
GIZZARD SHAD
FIGURE 4.2.1-3



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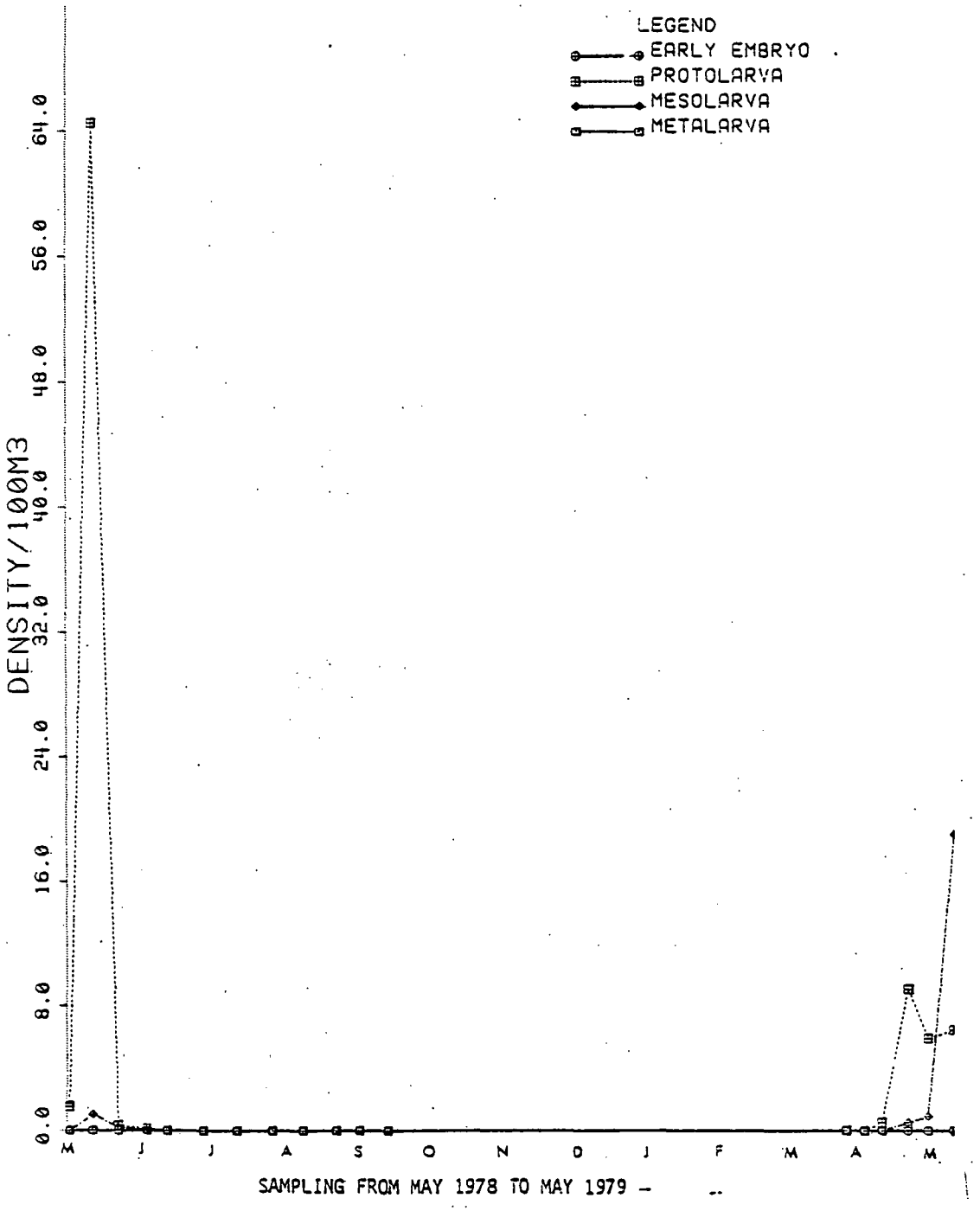
GREEN RIVER ICHTHYOPLANKTON
ABUNDANCE-ZONE 6
GIZZARD SHAD
FIGURE 4.2.1-4



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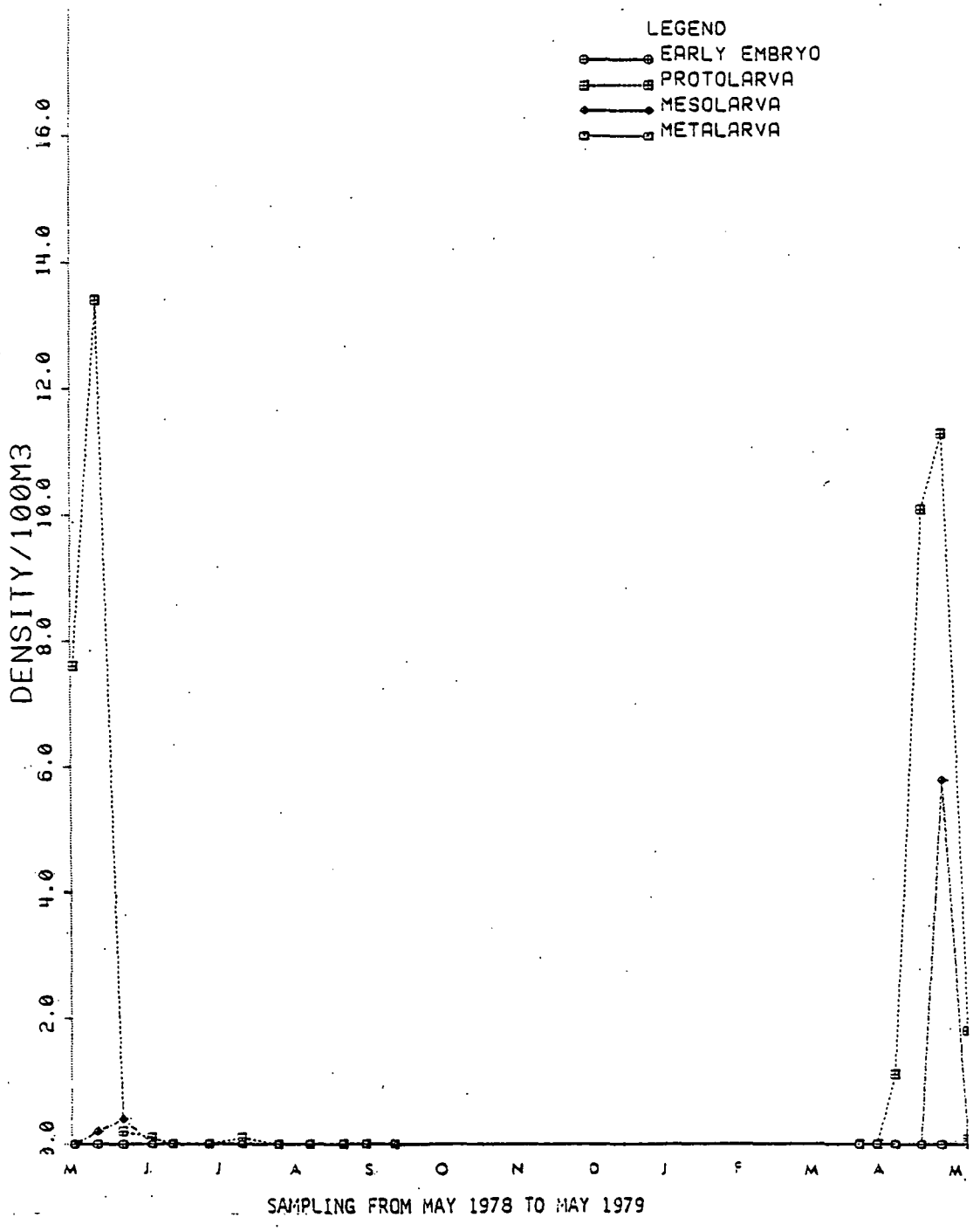
GREEN RIVER ICHTHYOPLANKTON
ABUNDANCE-ZONE 3
BUFFALO AND CARPSUCKERS
FIGURE 4.2.1-5



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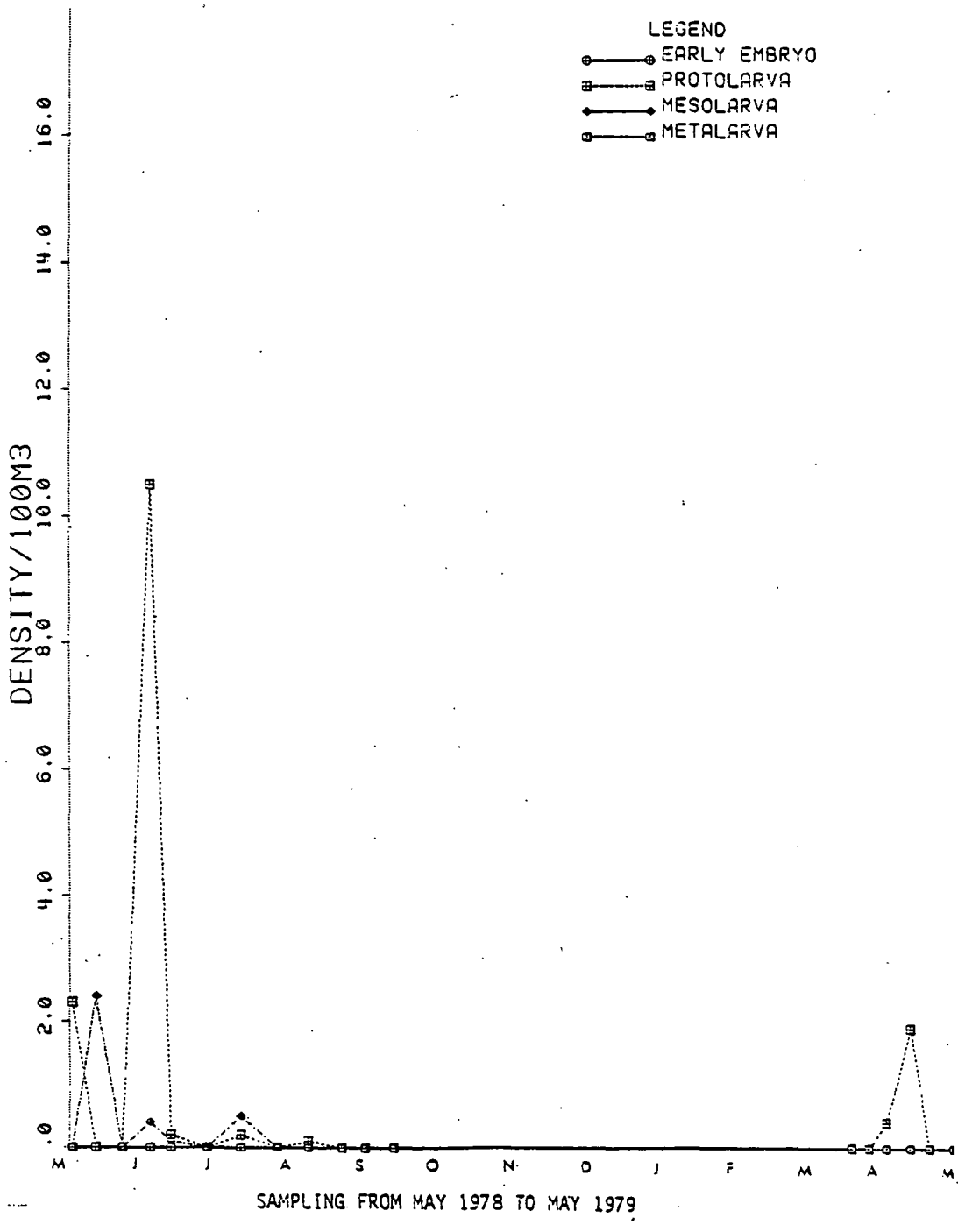
GREEN RIVER ICHTHYOPLANKTON
ABUNDANCE-ZONE 6
BUFFALO AND CARPSUCKERS
FIGURE 4.2.1-6



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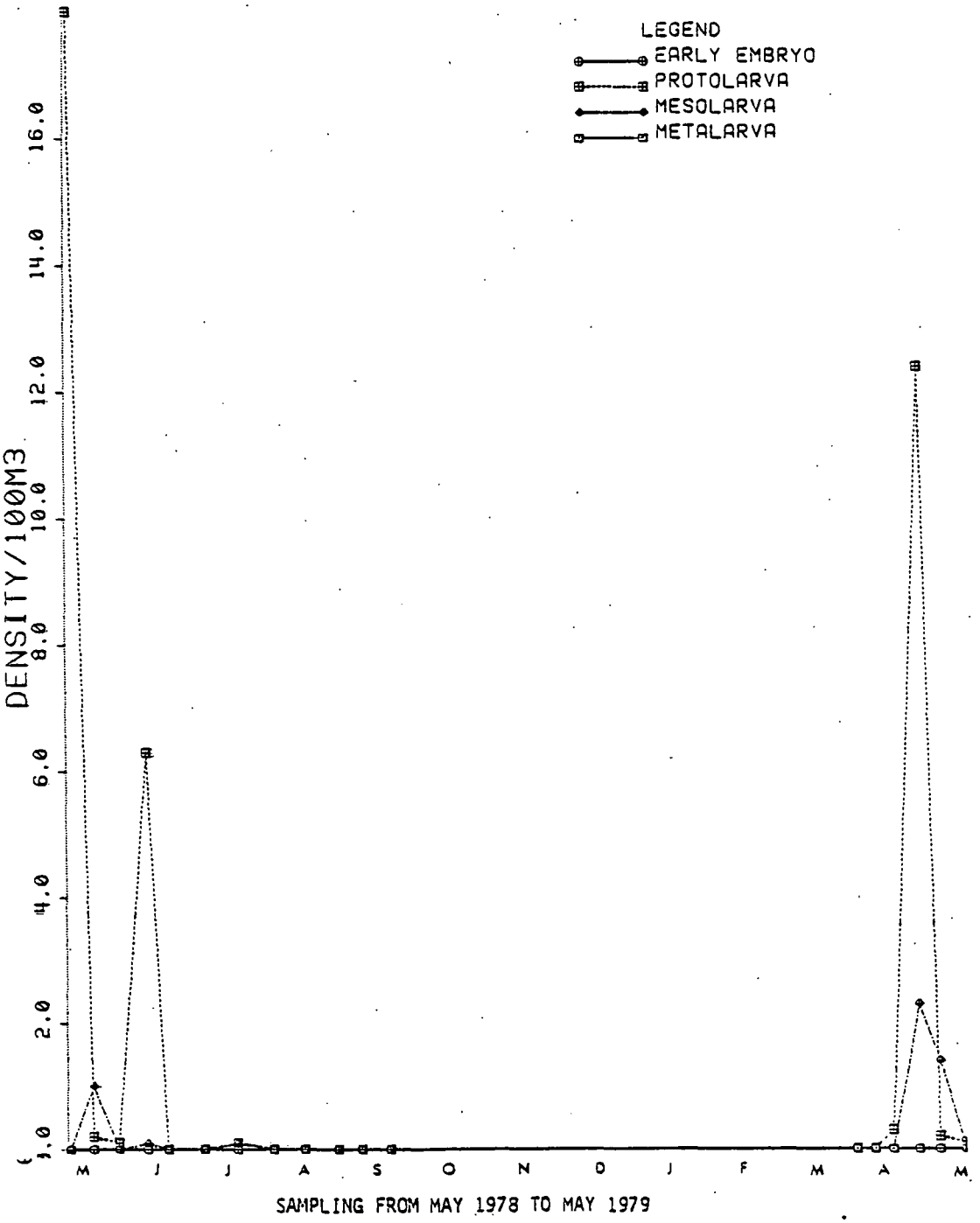
GREEN RIVER ICHTHYOPLANKTON
ABUNDANCE-ZONE 3
CARP
FIGURE 4.2.1-7



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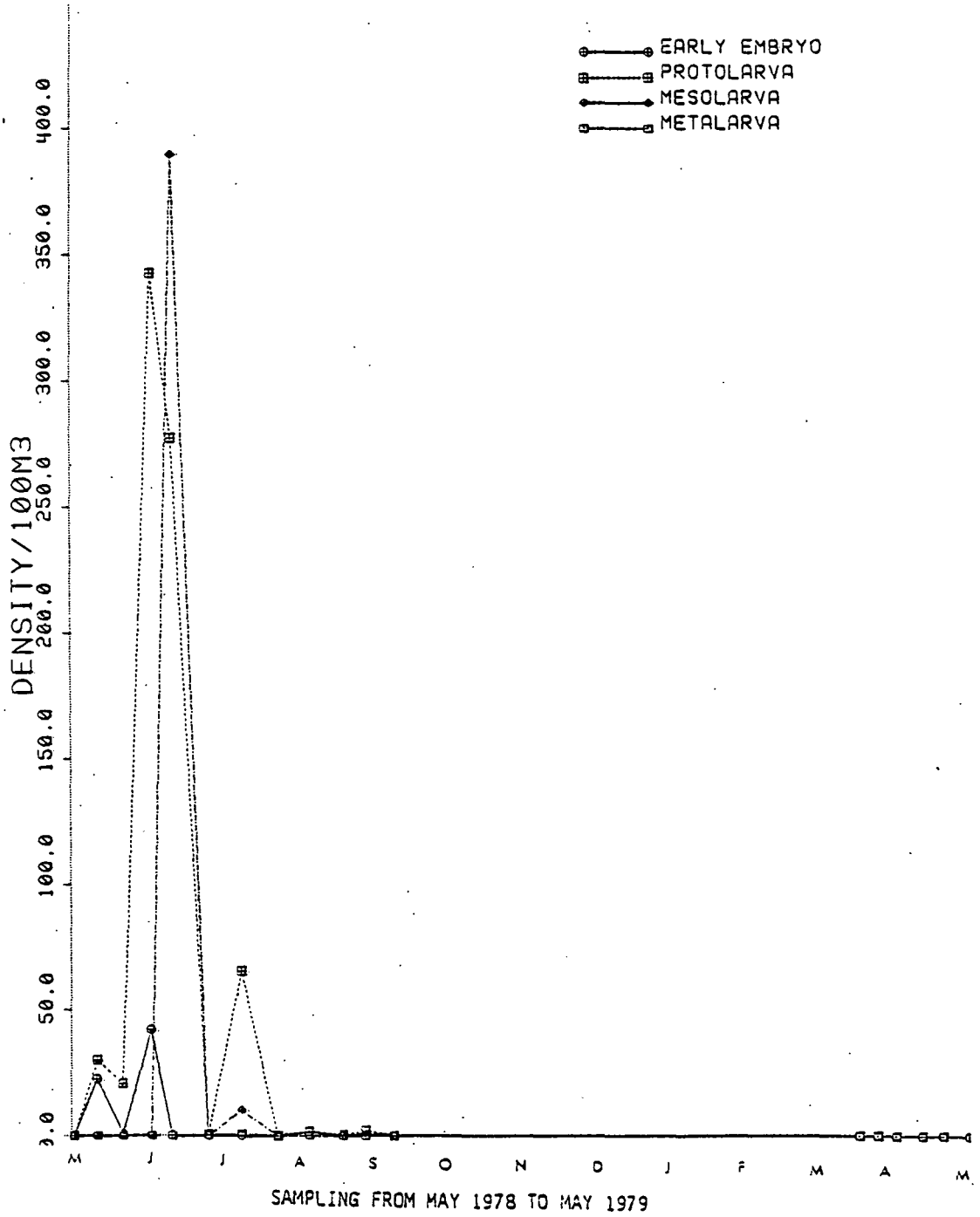
GREEN RIVER ICHTHYOPLANKTON
ABUNDANCE-ZONE 6
CARP
FIGURE 4.2.1-8



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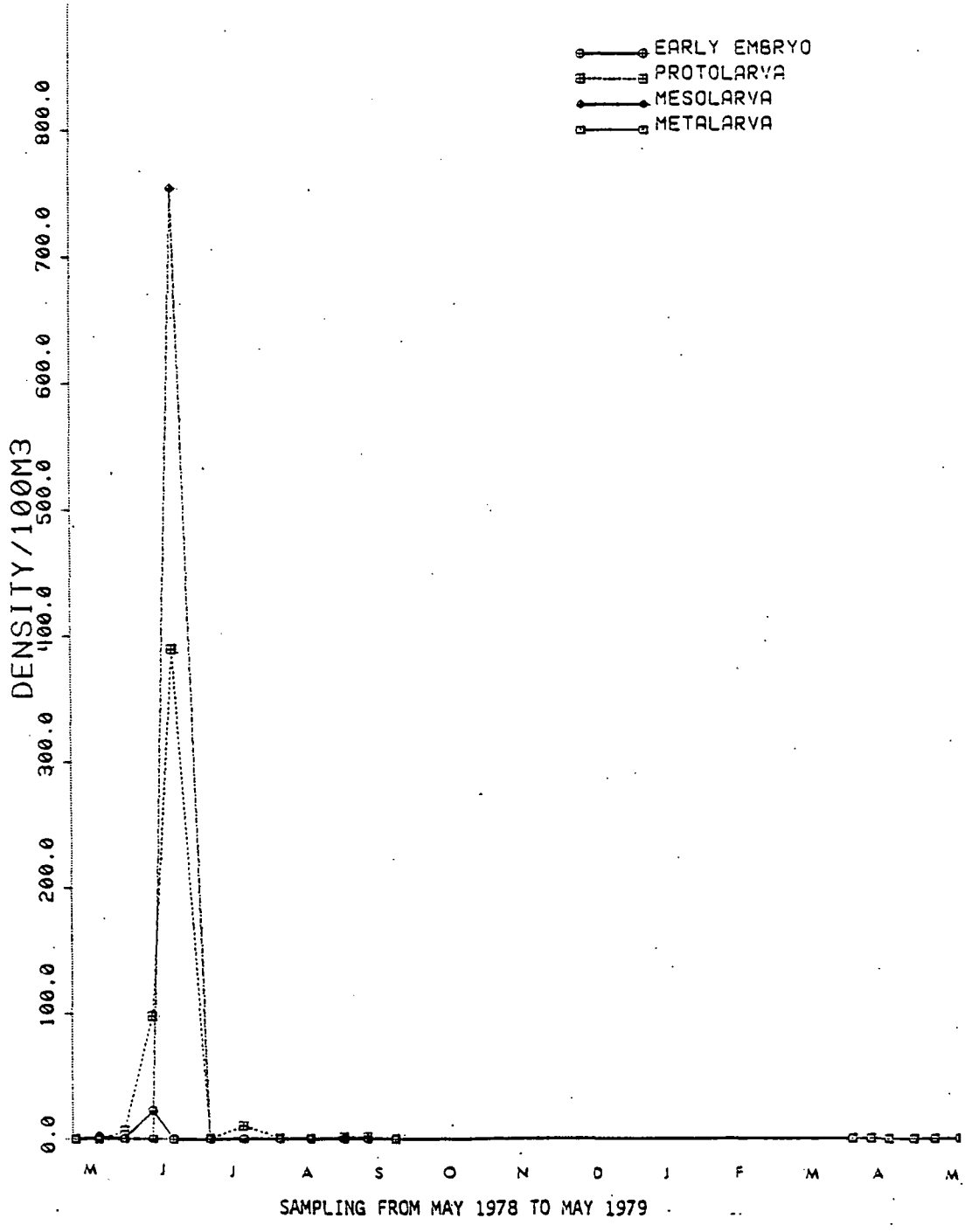
GREEN RIVER ICHTHYOPLANKTON
ABUNDANCE-ZONE 3
FRESHWATER DRUM
FIGURE 4.2.1-9



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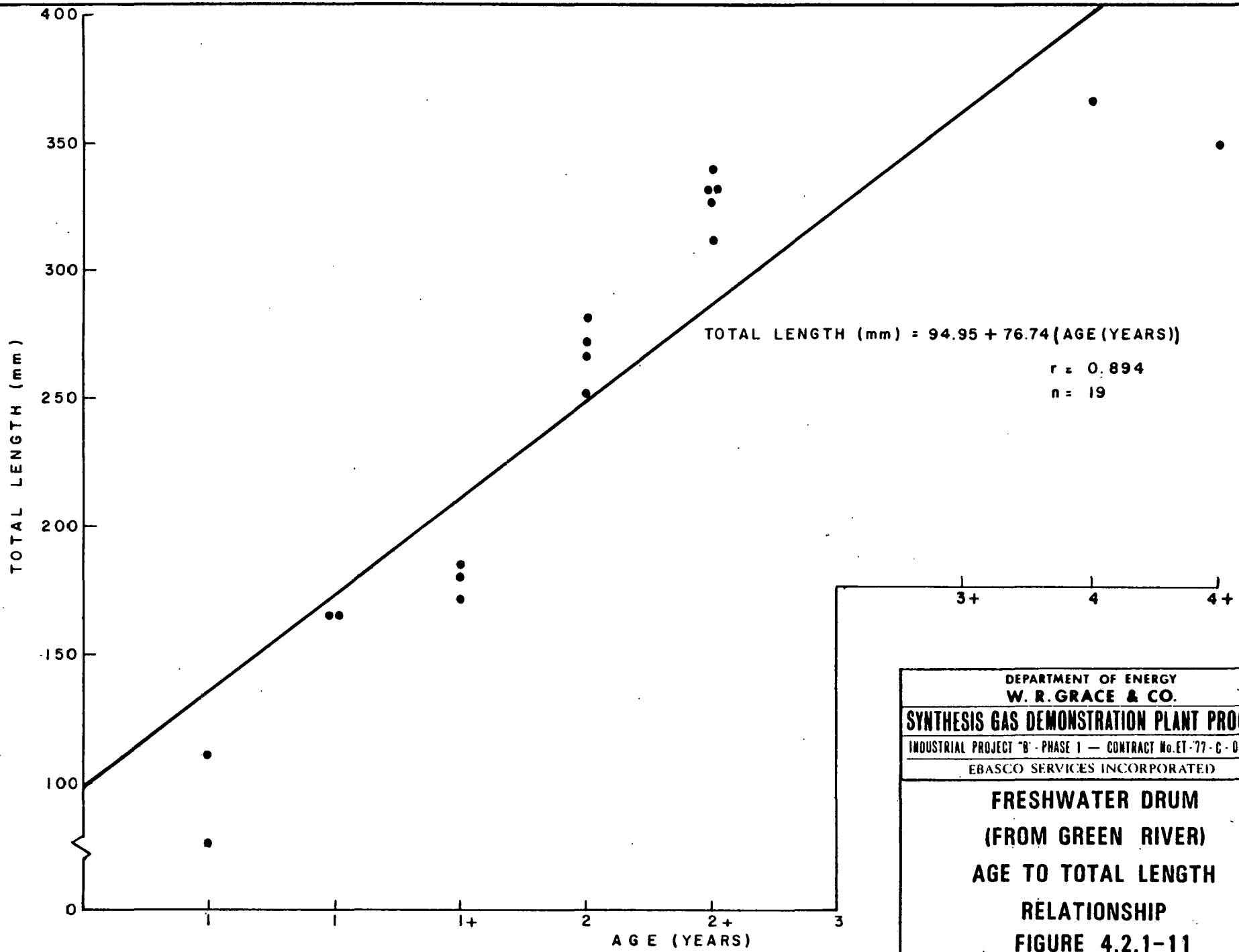
GREEN RIVER ICHTHYOPLANKTON
ABUNDANCE-ZONE 6
FRESHWATER DRUM
FIGURE 4.2.1-10



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FRESHWATER DRUM (FROM GREEN RIVER) AGE TO TOTAL LENGTH RELATIONSHIP

FIGURE 4.2.1-11

FF	FLOOD PLAIN FOREST
C	CROPLAND
FR	FENCE ROW, INTERMITTENT STREAM BORDER
S	CYPRESS SLOUGH
GR	GRASSLAND
H	CROPLAND (HAY)
UF	UPLAND FOREST
P	POND
R	RESIDENTIAL

0 1/4 1/2 3/4 1
MILE

0 200 400 600 800 1000 m.
KILOMETER

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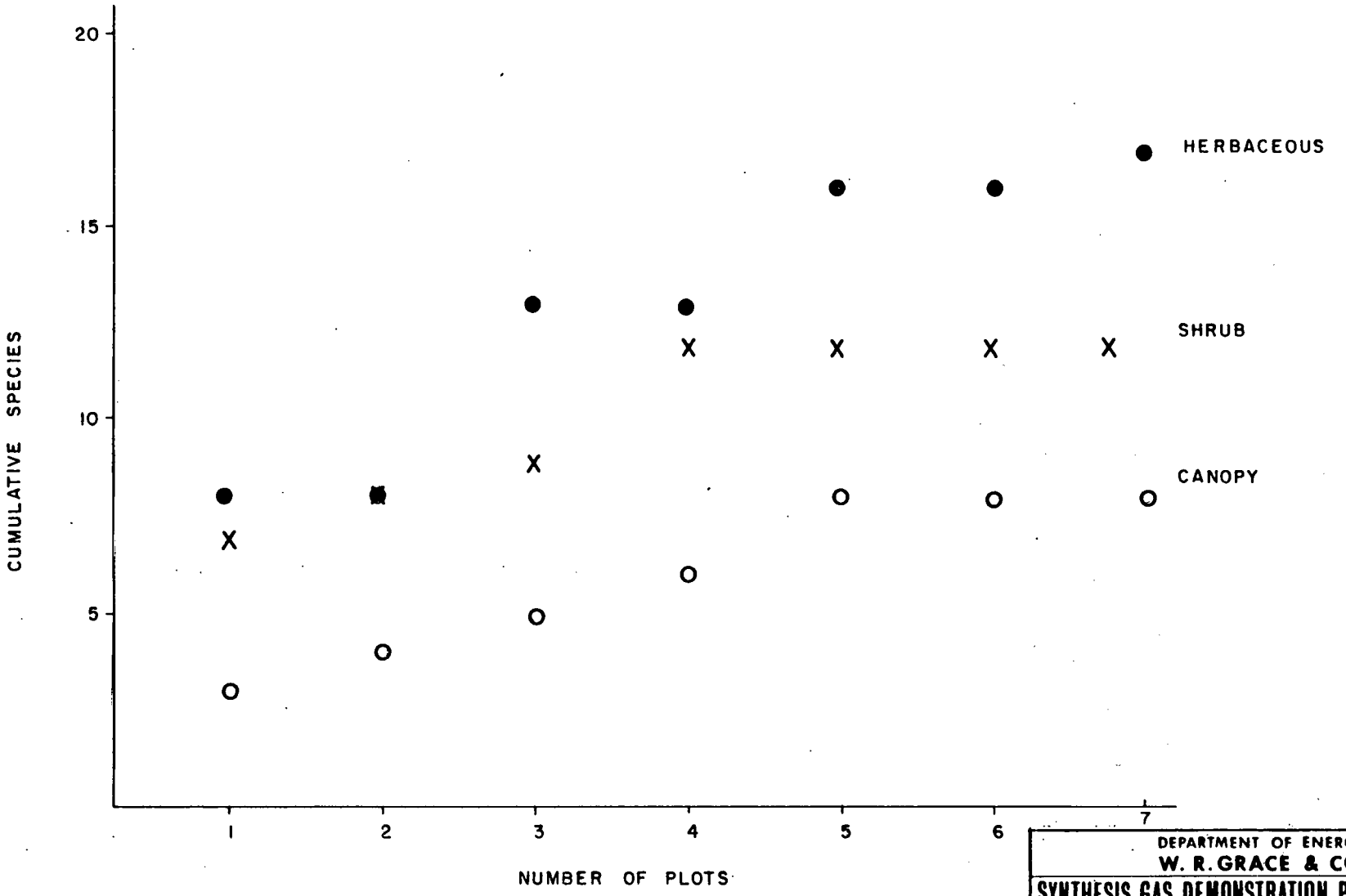
VEGETATION MAP OF BASKETT SITE

FIGURE 4.2.2-1



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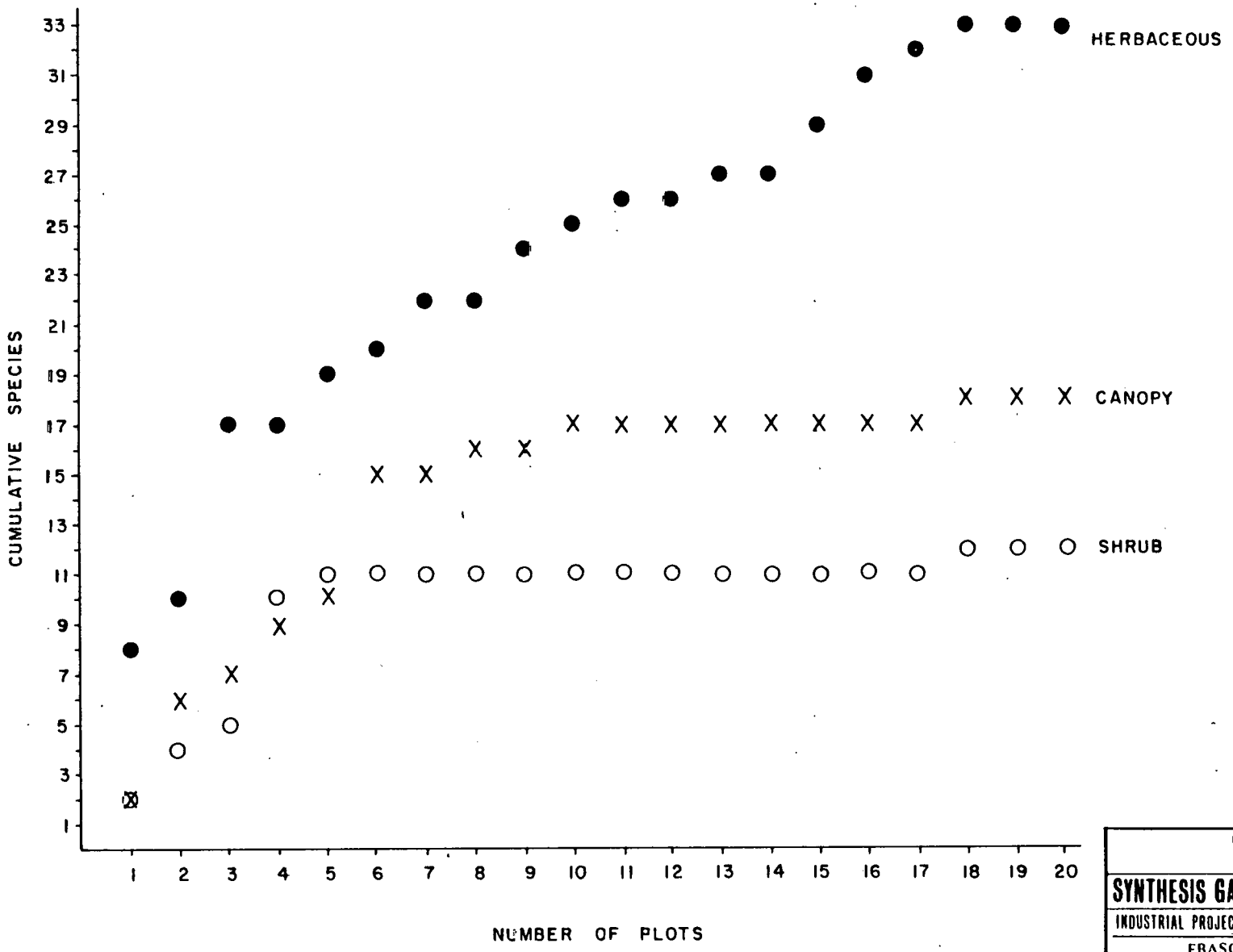
SPECIES AREA CURVES OBTAINED IN UPLAND FOREST

FIGURE 4.2.2-2



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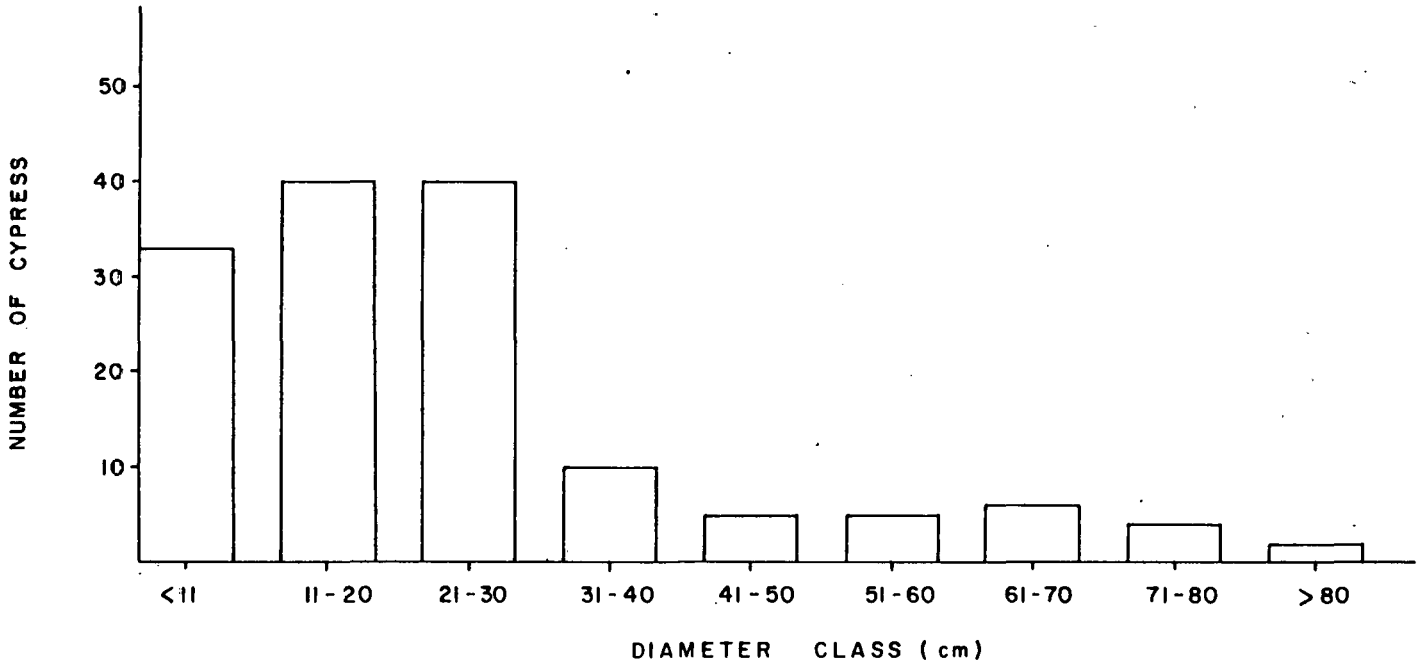
SPECIES AREA CURVES
OBTAINED IN FLOODPLAIN FOREST

FIGURE 4.2.2-3



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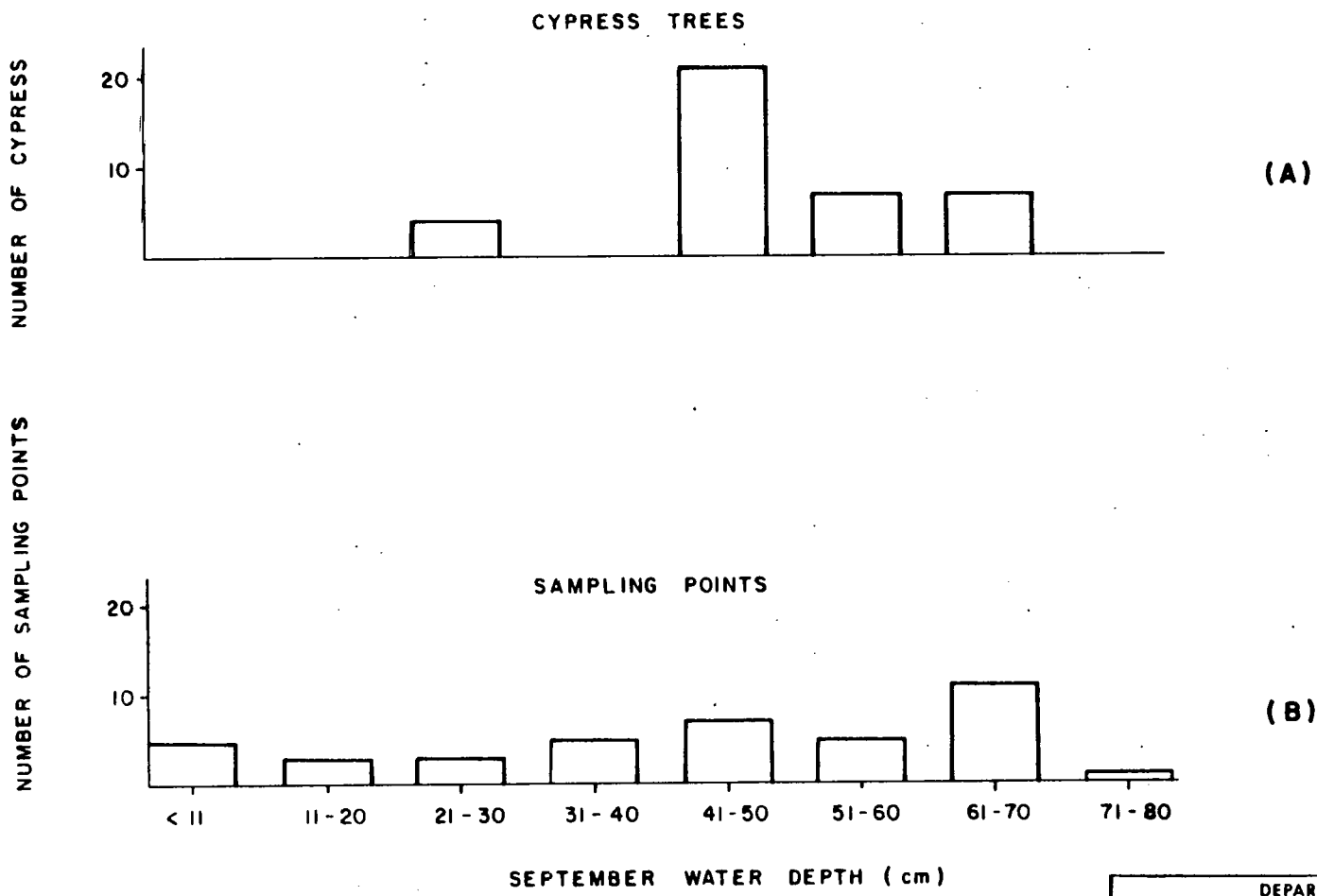
DISTRIBUTION OF CYPRESS TREES AMONG DIAMETER CLASSES

FIGURE 4.2.2-4



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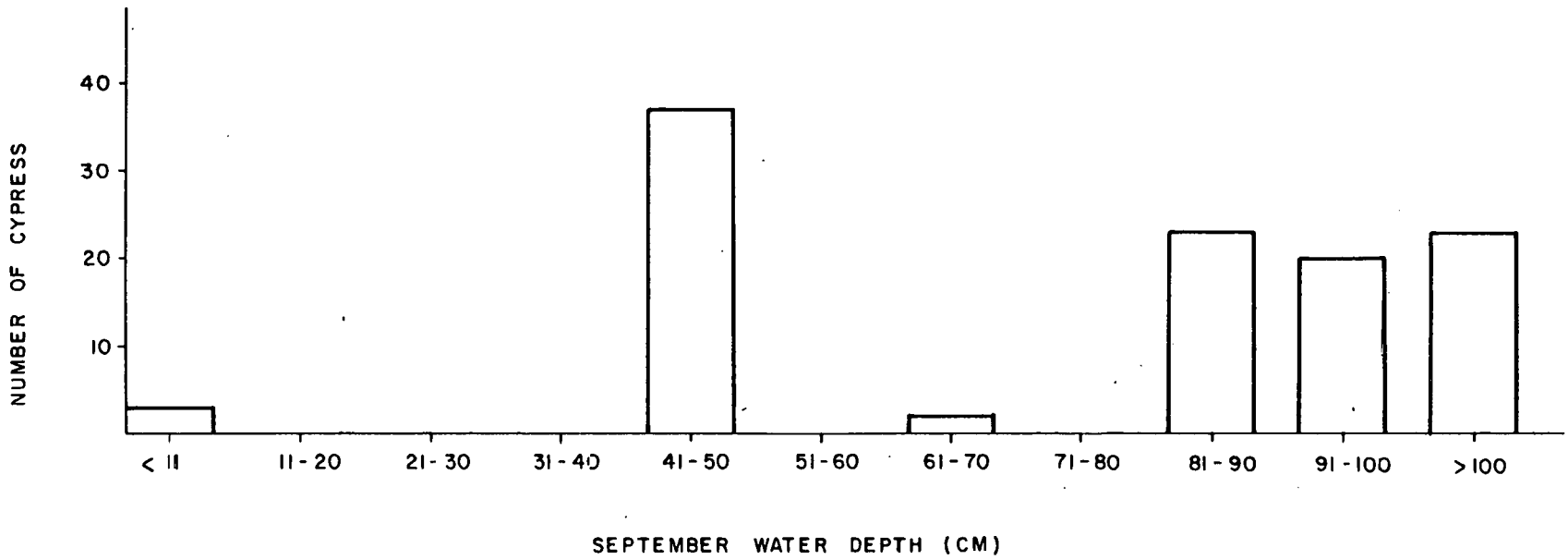
DISTRIBUTION OF (A) CYPRESS TREES AND (B) SAMPLING POINTS IN SEPTEMBER WATER DEPTH CLASSES IN CYPRESS SLOUGH (ON SITE TRANSECTS)

FIGURE 4.2.2-5



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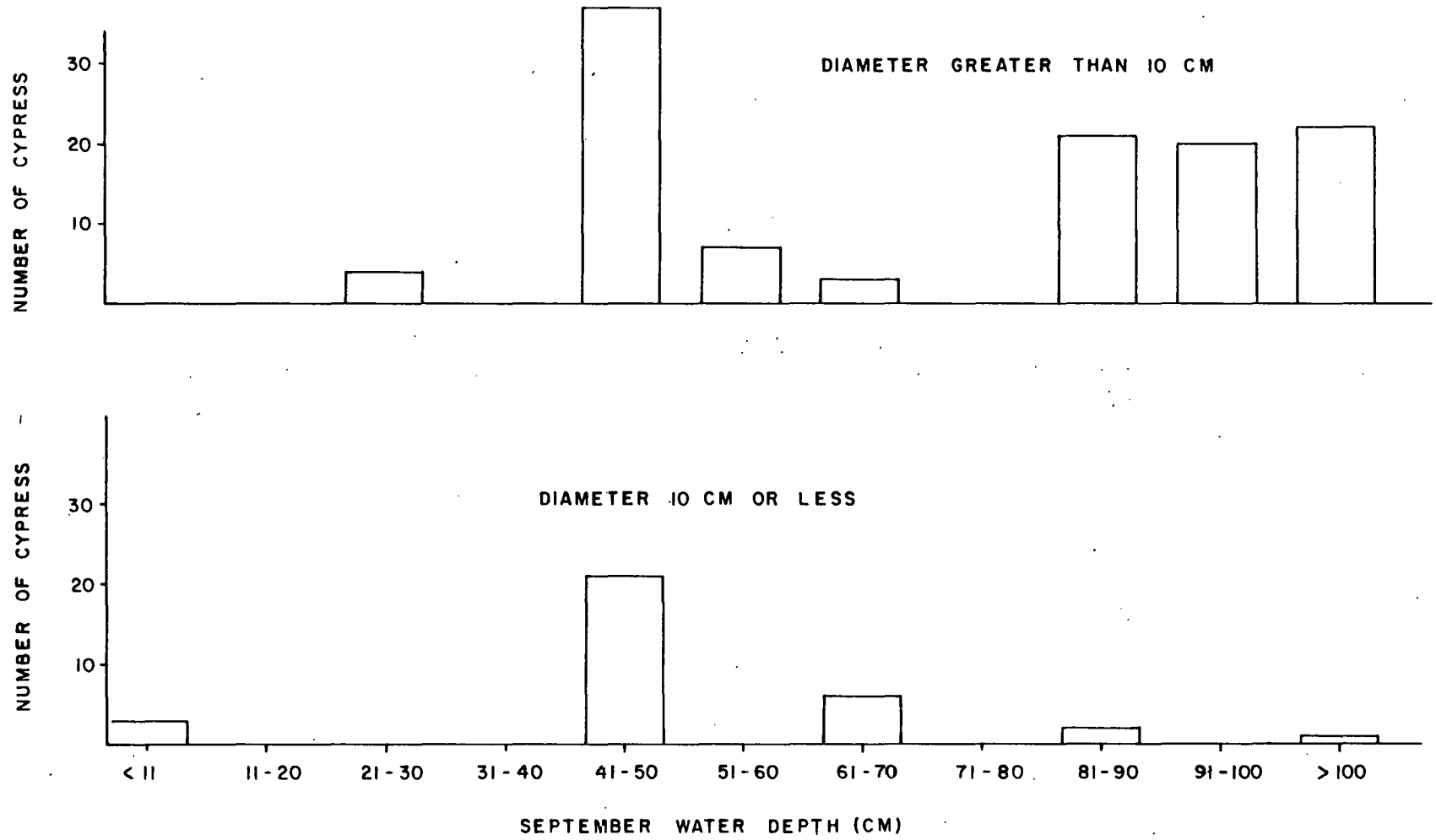
DISTRIBUTION OF CYPRESS TREES IN SEPTEMBER WATER DEPTH CLASSES IN CYPRESS SLOUGH (OFF SITE TRANSECTS)

FIGURE 4.2.2-6



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DISTRIBUTION OF CYPRESS TREES WITH (A) DIAMETER GREATER THAN 10 CM AND (B) DIAMETER EQUAL TO OR LESS THAN 10 CM IN SEPTEMBER WATER DEPTH CLASSES

FIGURE 4.2.2-7

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4.3.1 AMBIENT AIR QUALITY

4.3.1.1 Regional Air Quality

For the purpose of evaluating and devising air pollution abatement strategies, the EPA has divided the United States into Air Quality Control Regions (ACQR). The proposed Syngas Project site at Baskett, Kentucky is located in the Evansville-Owensboro-Henderson AQCR (Number 77). Table 4.3.1-1 lists the counties which make up this AQCR.

4.3.1.1.1 Air Contaminant Emission Sources

4.3.1.1.1.1 Area Sources

Emission inventory data for area sources in Henderson and Daviess Counties, Kentucky and Vanderburgh County, Indiana were obtained from a recently published EPA emissions update and projection for the Indiana Air Quality Maintenance Area[1]. The relative emission densities of area source emissions are presented in Figure 4.3.1-1 and 4.3.1-2 for particulates and sulfur dioxide.

An area source represents a collection of many small sources in a given area, which individually may be insignificant with respect to air quality, but collectively may have a significant impact on the air quality of specific area. Area source emissions include emissions from sources such as residential and commercial heating, motor vehicles, railroads, and vessels.

Figures 4.3.1-1 and 4.3.1-2 indicate that the greatest emission densities of sulfur dioxide and particulates due to area sources are in the vicinity of of the cities of Evansville (Indiana), Owensboro (Kentucky) and Henderson (Kentucky).

4.3.1.1.1.2 Point Sources

Emission data for point sources other than the proposed facility, were obtained from the Kentucky Division of Air Pollution Control (KDAPC) and the Indiana Air Pollution Control Division (IAPCD)[2,3]. Emission data included information from Henderson, Daviess, Webster, and Hancock Counties in Kentucky and Posey, Vanderburgh, Warrick and Spencer Counties in Indiana. All major point sources of sulfur dioxide and suspended particulates within the potential area of impact were considered in the analysis to demonstrate compliance with ambient air quality standards. Information was also obtained from the KDAPC and the IAPCD for major sources which have an influence on the area of impact and which commenced construction on or after January 6, 1975. This information was used in the analysis to demonstrate compliance with the allowable emissions under Prevention of Significant Deterioration (PSD) requirements. Where possible, point sources were merged using the procedures described in EPA's Guidelines for Air Quality Maintenance Planning and Analysis Volume 10 (Revised); Procedures for Evaluating Air Quality Impact of New Stationary Sources[1]. This technique was used to reduce the number of single point sources used in the modeling analysis without significantly affecting the model predictions. The emissions data for point sources of sulfur dioxide and particulates described above are presented in Tables 4.3.1-2

and 4.3.1-3 for construction commenced after January 6, 1975, and Tables 4.3.1-4 and 4.3.1-5 for construction commenced prior to that date.

4.3.1.1.2 Air Contaminant Concentrations

Air contaminant concentrations were obtained from the KDAPC air quality sampling network in Henderson County. Although the emission densities of the pollutants vary within the region, this data is useful in characterizing regional air quality. In general, the sampling stations are located in high emission density areas and consequently reflect a qualified worse-case view of the region's air quality. Figure 4.3.1-3 indicates the locations of the KDAPC air quality monitoring sites in Henderson County. A summary of measured ambient concentrations of nitrogen dioxide, hydrogen sulfide, non-methane hydrocarbons and carbon monoxide in Henderson County is presented in Table 4.3.1-6.

4.3.1.1.2.1 Sulfur Dioxide

Figure 4.3.1-4 presents a summary of annual means of sulfur dioxide concentrations in Henderson County. The figure indicates that average long-term levels are below the annual National Ambient Air Quality Standards (NAAQS) of 80 micrograms per cubic meter. Six violations of the 24-hour NAAQS of 365 micrograms per cubic meter were reported at one KDAPC sampling site (No. 4006 in Figure 4.3.1-4) in the City of Henderson from 1975 to June of 1978. Table 4.3.1-7 presents a summary of the sulfur dioxide concentrations from the KDAPC sampling sites in Henderson County. There were three sites which conducted continuous monitoring or 3-hour bubbler sampling for sulfur dioxide. There were no violations of the 3-hour NAAQS of 1300 micrograms per cubic meter reported at these sites.

4.3.1.1.2.2 Suspended Particulates

Figure 4.3.1-5 presents a summary of annual geometric means of total suspended particulates from KDAPC sampling sites in the City of Henderson (six sites) in Niagara (one site) and another in Robards (one site). Five of the six sites in the City of Henderson show annual concentration levels that exceed the annual NAAQS. The Robards site was only recently established and is located in close proximity to an aluminum plant and a coal fired power plant in Webster County. Suspended particulate levels during the most recent year of data collection at the Robards site have annual means below the NAAQS. The data from the Niagara site also indicate that levels of suspended particulates were below the annual ambient air quality standards. Niagara is located in a rural area of Henderson County, not far from the Robards site.

Table 4.3.1-8 presents a summary of the total suspended particulate concentrations reported for Henderson County. Between 1974 and mid-1978 the 24-hour secondary suspended particulate NAAQS of 150 micrograms per cubic meter has been exceeded approximately 85 times at a number of KDAPC sampling sites in the City of Henderson. From 1977 to mid-1978 Robards has experienced four violations of the 24-hour secondary suspended particulate NAAQS. Niagara has had one violation of the 24-hour secondary suspended

particulate NAAQS which occurred in 1975. From 1974 to mid-1978 there were only 2 violations of the 24-hour primary NAAQS of 260 micrograms per cubic meter for suspended particulates recorded at one of the monitoring sites in the City of Henderson which occurred in 1975 and one at Robards which occurred in 1977.

4.3.1.1.2.3 Nitrogen Dioxide

The annual average concentrations of nitrogen dioxide reported for the KDAPC sampling sites located in the City of Henderson range from 0.012 to 0.034 parts per million. This range is based on monitoring information obtained during the period from 1973 to 1977 (see Table 4.3.1-6). The levels are significantly below the annual nitrogen dioxide NAAQS of 0.05 parts per million. Most nitrogen oxides emissions in the area are from high temperature combustion sources such as automobiles and power plants.

4.3.1.1.2.4 Carbon Monoxide

The yearly one-hour maximum concentration of carbon monoxide recorded in the City of Henderson during the period from 1972 to 1977 ranged from 5.0 parts per million in 1973 to 35.5 parts per million in 1974 (see Table 4.3.1-6). During this period, there was one reported violation of the one hour carbon monoxide NAAQS of 35 parts per million. This occurred in 1974. The yearly maximum eight-hour carbon monoxide values ranged from 3.1 parts per million in 1974 to 7.5 parts per million in 1975 during the same period of record. No violations of the eight-hour carbon monoxide NAAQS of 9 parts per million were reported during this period. Excessive levels of carbon monoxide are usually associated with automobile emissions in high traffic density areas.

4.3.1.1.2.5 Ozone

During the period from 1974 to 1977 the yearly one-hour maximum concentration of ozone recorded in the City of Henderson ranged from 0.044 parts per million in 1974 to 0.257 parts per million in 1976 (see Table 4.2.1-6). During this period 298 violations of the one-hour ozone NAAQS of 0.08 parts per million were recorded. Ozone levels in excess of the NAAQS are usually attributed to photochemical reactions occurring in the lower atmosphere. Atmospheric constituents such as non-methane hydrocarbons and nitrogen oxides in the presence of sunlight take part in complex photochemical reactions which form ozone. The highest ozone concentrations usually occur during or immediately following periods of intense sunlight and very warm temperatures. Consequently, most violations of the ozone NAAQS occur during the afternoons of the warmer summer months.

4.3.1.1.2.6 Other Pollutants

The yearly maximum one-hour concentrations of hydrogen sulfide recorded during the period between 1972 to 1976 ranged from 0.0042 parts per million (1972) to 0.0090 parts per million (1974) (see Table 4.3.1-6).
There were no violations of the one-hour Kentucky Ambient Air Quality Standard (KAAQS) for hydrogen sulfide of 0.01 parts per million during this period. Hydrogen sulfide levels are usually associated with emissions from industrial processes.

The yearly maximum three-hour concentrations of non-methane hydrocarbons observed during the period from 1975 to 1976 in the City of Henderson ranged from 1.9 parts per million in 1975 to 4.7 parts per million in 1976 (see Table 4.3.1-6). There were 128 violations of the three-hour non-methane hydrocarbon NAAQS of 0.24 parts per million. The non-methane hydrocarbon NAAQS is considered to be a guide for use in devising implementation plans to achieve the ozone NAAQS. As discussed in Section 4.3.1.1.2.5, hydrocarbons are a precursor in the photochemical formation of ozone. High non-methane hydrocarbon emissions are usually associated with emissions from automobiles in areas with heavy traffic or with industrial processing plants (eg, facilities that handle large amounts of volatile organic solvents).

4.3.1.1.3 Attainment Status Summary

The Clean Air Act, as amended in 1977 (CAAA77), requires each state to determine areas where NAAQS are currently exceeded for any of the major air pollutants. These areas are designated non-attainment areas. In the vicinity of the site both the KDAPC and IAPCD have designated non-attainment areas. These areas are identified in Table 4.3.1-9[10]. The Baskett site is located in a non-attainment area for photochemical oxidants (ozone) associated with the greater metropolitan Evansville urban complex. Non-attainment areas for particulates and sulfur dioxide are approximately four to eight kilometers (2.5 to 5.0 miles) from the proposed site. These non-attainment areas are critical with respect to impacts from the proposed facility.

4.3.1.1.4 Class I Areas

The CAAA77 designated international parks, national wilderness areas, national memorial parks greater than 5,000 acres and national parks greater than 6,000 acres as Class I Areas under Prevention of Significant Deterioration (PSD) provisions. In addition, areas that had been designated as Class I Areas prior to the 1977 Clean Air Act Amendments retained their status. The maximum increase of sulfur dioxide and particulate concentrations over baseline levels in these areas is limited to very small increments under the PSD provisions of CAAA77. These PSD increments are discussed in Section 3.5.1.1.3 of this report.

There are no Class I Areas in Indiana or Illinois. The closest Class I Area to the Baskett Site is Mammouth Cave National Park, which is the only Class I Area in Kentucky. The Mammouth Cave Class I Area is located 121 kilmeters (75 miles) southeast of the Baskett Site.

4.3.1.2 Air Quality Near Site

4.3.1.2.1 Air Contaminant Emission Sources

4.3.1.2.1.1 Area Sources

The area source emission density of particulates near the Baskett site is 10 to 12 tons per year per square kilometer[1] (Figure 4.3.1-1). The emission density of sulfur dioxide is approximately 0.5 to 1.0 tons per year square kilometer[1] (Figure 4.3.1-2). These emission densities are signi-

ficantly lower than those in the vicinity of Evansville (Indiana) or Henderson (Kentucky).

Most of the area source particulate emissions in the Baskett area (approximately 95 percent) are due to fugitive dust from unpaved roads, agricultural tilling operations, paved roads, and wind erosion[1]. Most of the area source sulfur dioxide emissions in the Baskett area are due to vessels, highway vehicles, and commercial and industrial fuel combustion[1].

4.3.1.2.1.2 Point Sources

There are no major point sources in close proximity to the proposed site. Henderson Municipal Power and Light located approximately 10.5 kilometers (6.5 miles) from the proposed site and the Alcoa Aluminum plant located approximately 9.0 kilometers (5.8 miles) from the proposed site are the nearest major point sources of particulate, sulfur dioxide, nitrogen oxides, and carbon monoxide emissions. The nearest major point source of hydrocarbons is the Home Oil Terminal located in the City of Henderson approximately eight kilometers (5 miles) from the proposed site. There are a number of point sources of hydrocarbon emissions located in the Owensboro, Daviess County area which is approximately 30 kilometers (18 miles) from the proposed site.

4.3.1.2.2 Air Contaminant Concentrations

The proposed Baskett Site is in a rural area near a few small towns. No ambient air quality monitoring stations in the immediate vicinity of Baskett are available from which to establish background levels of air contaminants. However, the KDAPC have established natural background levels (levels not influenced by major local man-made sources) of particulates and sulfur dioxide from eight years of ambient air quality data at a rural monitoring site in Kentucky. These values are presented in Table 4.3.1-10 and have been used as an indication of the background levels of these pollutants in the Baskett area.

The nearest ambient air quality stations are located in the City of Henderson which is more densely populated and more industrialized than the site area. Air quality data from Henderson are not considered representative of Baskett site conditions.

The discussions that follow for each of the criteria pollutants compare factors such as emission densities, traffic patterns and industrial development for the proposed site to those in the City of Henderson. Based on this comparison and the background levels for rural areas established by KDAPC, a qualitative assessment of pollutant levels in the vicinity of the proposed site has been made.

4.3.1.2.2.1 Sulfur Dioxide

Since the emission densities of sulfur dioxide from area sources in the vicinity of the proposed site are lower than those in the City of Henderson (see Figure 4.3.1-2) and also since there are no major point sources of sulfur dioxide near the site, it is anticipated that ambient levels of sulfur dioxide in the vicinity of the proposed site will be lower than those levels

recorded in the City of Henderson. The sulfur dioxide levels recorded in the City of Henderson are generally below the NAAQS. As described in Section 4.3.1.1.2.1, only one of the five monitoring sites in the City of Henderson had any violations of the NAAQS for sulfur dioxide from 1975 to mid-1978. The typical natural background levels of sulfur dioxide for rural areas which have been established by the KDAPC are shown in Table 4.3.1-10. These levels are well below the NAAQS.

4.3.1.2.2.2 Suspended Particulates

The emission densities of particulates from area sources in the vicinity of the proposed site are lower than those in the City of Henderson (see Figure 4.3.1-1). In addition, there are no major point sources of particulates close to the proposed site. Thus, it is expected that ambient levels of particulates near the proposed site will be lower than those experienced in the City of Henderson. The suspended particulate levels in the City of Henderson are below the 24-hour primary NAAQS of 260 micrograms per cubic meter. However, most of the monitoring sites in the City of Henderson have experienced levels above the 24-hour secondary NAAQS of 150 micrograms per cubic meter. The typical natural background levels of suspended particulates established by the KDAPC are shown in Table 4.3.1-8. These levels are well below the NAAQS, and are expected to be indicative of the site area.

4.3.1.2.2.3 Nitrogen Dioxide

High ambient levels of nitrogen dioxide are usually attributed to emissions of nitrogen oxides from automobiles or large power plants. Since there are no large power plants near the proposed site and the population and traffic densities near the site are lower than those in the City of Henderson, it is expected that the ambient nitrogen dioxide levels in the vicinity of the site are lower than the levels in and near the City of Henderson. The ambient levels of nitrogen dioxide in the City of Henderson are well below the annual NAAQS of 0.05 parts per million as indicated in Table 4.3.1-6.

4.3.1.2.2.4 Carbon Monoxide

The ambient levels of carbon monoxide monitored in the City of Henderson are generally below the NAAQS. Only one violation of the one-hour NAAQS was recorded, occurring in 1974. No violation of the 8-hour NAAQS have been reported. High carbon monoxide levels are usually caused by automobile traffic. Since the population traffic densities are lower near the proposed site relative to the population and traffic densities of the City of Henderson, the carbon monoxide levels in the vicinity of the site are expected to be lower than those experienced in the City of Henderson.

4.3.1.2.2.5 Ozone

There are no monitoring sites for ozone near the proposed site and thus quantitative data regarding the levels of ozone near Baskett are not available. The meteorological conditions that cause high ozone levels usually cover a large area; thus, the recorded ozone violations in Henderson suggest that the area of the proposed site also experiences ozone levels in excess of the ambient air quality standards. As noted in Sections

4.3.1.1.2.5 and 4.3.1.1.3, all of Henderson County is designated as non-attainment for ozone.

4.3.1.2.3 Attainment Status Summary

The area in the immediate vicinity of the proposed site can be considered to be in attainment of the NAAQS for all pollutants except for photochemical oxidants (ozone). The entire County of Henderson has been designated as a non-attainment area for photochemical oxidants.

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4.3.2 METEOROLOGY

4.3.2.1 Introduction

The Baskett Site is located in Henderson County, Kentucky, approximately 11.3 km (7 miles) northeast of Henderson and 12.9 km (8 miles) southeast of Evansville, Indiana. The site is just south of the Green River with the northern portions of the site being the floodplain of the Green River. Low hills are located east, south and west of the site. Elevations at the site range from about 107 m (350 ft) to 137 m (450 ft) above mean sea level (MSL) with maximum elevations in the site vicinity being a little less than 183 m (600 ft) MSL in the Wolf Hills about 3.2 km (2 miles) northwest of the site. Maximum elevations in Hoosier National Park, about 81 km (50 miles) northeast of the site, range up to approximately 275 m (900 ft) MSL.

Prevailing winds in the site region are from the northwest during winter (January through March) and generally from the southwest and south-southwest during the rest of the year. The region is in the path of low pressure systems that move from the western Gulf region northeastward over the Mississippi and Ohio Valleys. A large part of the precipitation received in the region during the cooler part of the year results from these storms and there is considerable variation in seasonal temperature and precipitation from year-to-year, depending on the frequency of such storms.

Severe storms (tornadoes, freezing precipitation and hail) are relatively infrequent in the region but some wind damage occurs each year. Convective thunderstorms originating in maritime tropical air from the Gulf of Mexico occur in the region during the warmer months of the year.

4.3.2.2 Weather Data Sources

Meteorological data have been used in the ground level pollutant concentration calculations performed for the Air Quality Control System (AQCS) analyses, PSD Report and monitoring site studies. These data were also used to develop the descriptive climatology of the region and to calculate ground level fogging and icing frequencies, salt deposition rates and upper level plume frequencies that would result from plant cooling tower operation. These analyses require hourly meteorological data for a period of time long enough to include representative normal and extreme conditions. The data had to have been collected at a location that is representative of the proposed site. The National Weather Service Station located at Dress Regional Airport was selected for this purpose. Dress Airport is located in Evansville, Indiana 19 km (12 miles) north-northwest of the site and is considered to experience meteorlogical conditions representative of the proposed site due to its proximity to the site and a similarity of the terrain features. Upper air meteorological data were obtained from the Nashville, Tennessee Metropolitan Airport, located 217 km (135 miles) south-southwest of the site. This station is the closest upper air station to the site.

4.3.2.3 Temperature and Relative Humidity

Table 4.3.2-1 gives monthly average and extreme dry-bulb temperatures for the base periods of record[1,2]. The average monthly dry-bulb temperature ranges from 0.3°C (32.6°F) in January to 25.4°C (77.8°F) in July and the annual mean temperature is 13.2°C (56.0°F). Based on a 37-year period of record, the extreme highest and lowest temperatures recorded are 40.3°C (105°F) and -30.5°C (-23°F) respectively. As is characteristic of a continental climate, there are large seasonal temperature variations.

The wet-bulb temperature, when considered in conjunction with the dry-bulb temperature, is a measure of the moisture content of the air. June-September wet-bulb temperatures are generally used as the temperature criteria for cooling tower design purposes. Table 4.3.2-2 gives the cumulative frequency of wet-bulb temperature for each month during the summer season[3]. The cumulative frequency of wet-bulb temperatures indicate the percent of time that the temperature equals or is less than a given value. The table indicates that the wet-bulb temperatures in July are 24.4°C (76.0°F) or more, for less than ten percent of the time. In September, however, less than ten percent of the wet-bulb temperatures are 22.7°C (73°F) or more. Average wet-bulb temperatures in the area are highest in July.

Table 4.3.2-3 presents monthly relative humidity data[4]. The data indicate that there is little monthly variation in relative humidity. On an annual basis, the relative humidity is seldom less than 30 percent (two percent of the time) and most frequently (28 percent of the time) between 50 and 69 percent.

4.3.2.4 Precipitation

Table 4.3.2-4 presents monthly average and maximum precipitation[1,2]. October normally has the least and March the greatest amounts of precipitation. The average annual total precipitation is 1063.8mm (41.88 in.). The greatest precipitation to occur in a single month during the 37 year period of record was 342.9mm (13.50 in.) in January 1950.

Table 4.3.2-5 gives short-term (five minutes to 24 hours) maximum recorded rainfall for a period of record of approximately 60 years[5]. These values range from 18.8mm (0.74 in.) for a five-minute time period to 176.3mm (6.94 in.) for a 24-hour time period.

Plant design criteria utilize extreme rainfall rates expressed in terms of return periods (computed as the inverse of the probability) ranging up to 100 years. Table 4.3.2-6 presents this information for 1 year to 100 year return periods and for rainfall durations ranging from 0.5 hours to 24 hours[6]. The table indicates that 54.6mm (2.15 inches) of rain in a one-hour duration can be expected to occur once every ten years. For a one-hour duration, however, 74.9mm (2.95 in.) of rain is only expected to occur once every 100 years.

4.3.2.5 Snowfall

Snowfall varies greatly from year to year, with approximately 330.2mm (13 in.) of snow falling in the Evansville area during an average year. Snowfalls of two or more inches are infrequent and usually melt within a day or two. There are, on the average about four days per year with snowfalls of one inch or greater.

Table 4.3.2-7 gives monthly average and maximum recorded snowfall amounts and maximum snowfalls in 24-hours[1,2]. During the 37-year period of record, the maximum monthly and 24-hour snowfalls were 541.0mm (21.3 in.) and 269.2mm (10.6 in.), respectively.

4.3.2.6 Winds

The annual prevailing wind direction is south-southwest, with prevailing winds during the warmer months generally from the southwest or south-southwest and from the northwest during winter (January - March). Monthly speeds range from 10.1 kph (6.3 mph) in August to 18.4 kph (11.4 mph) in March with monthly mean wind speeds during the summer generally less than those in winter. Calm conditions have a monthly frequency that ranges from 3.5 percent in February to 13.6 percent in August. Monthly and annual wind roses for Evansville are presented in Figures 4.3.2-1 through 4.3.2-13[4].

The "fastest mile wind speed" is the passage of "one mile of wind" in the shortest period of time, usually experienced in units of miles per hour. Table 4.3.2-8 gives monthly fastest mile wind speeds for Evansville, recorded during a 38-year period of record[1,2]. The fastest mile value during the period was 59 mph, recorded in February, 1956.

Table 4.3.2-9 gives statistically derived expected recurrence intervals of fastest mile wind speeds at the Baskett Site, excluding consideration of tornadic winds[7]. These data indicate that 80 mph per hour winds can be expected to occur once every 100 years and winds with speeds of 70 mph can be expected to occur once every 25 years. It should be noted that the observed wind speeds during the past 38 years at Evansville are somewhat less than the statistically derived values. Based on the data given in Table 4.3.2-9, a wind speed of 70-75 mph can be expected to occur once during the 38 year period. As previously discussed, however, the maximum wind speed actually recorded during a 38 year period was 59 mph. Statistically derived values are based on probability and are, therefore, subject to statistical fluctuations.

The persistence of winds from a given direction is, along with the mean speed and the prevailing direction, another identifying characteristic of the wind regime at a given locale. Table 4.3.2-10 presents the maximum persistence of wind directions at Evansville during a five-year period[3]. A computer sorting procedure was used to determine the maximum number of hours during the examined period that the wind was from each of 16 wind sectors (each sector is 22.5 degrees) and also from each of 16 groups of three adjacent wind sectors (eg, NNW-N-NNW). The maximum persistence of wind direction from one sector for the examined period is 42 hours of winds from the northwest. The data indicate that, in general,

winds from the southwest and west-northwest and adjacent directions tend to be most persistent.

4.3.2.7 Fog

The seasonal and annual percent frequency of fog at Evansville (based on 17,544 observations) are as follows[8]:

	PERCENT FREQUENCY OF FOG				
	WINTER	SPRING	SUMMER	FALL	ANNUAL
Light-moderate fog	12.5	7.2	6.4	12.5	9.7
Dense fog	1.3	0.1	0.1	0.5	0.5

Dense fog is defined by the National Weather Service as fog that restricts visibility to 400 meters (0.25 mile) or less. The light to moderate class represents the remaining fog event.

4.3.2.8 Severe Weather

Severe storms, which occur infrequently in the site area, include thunderstorms, freezing precipitation (glaze) and tornadoes. Table 4.3.2-11 gives the monthly and annual frequency of freezing precipitation[9] and thunder storms[1]. About 45 thunderstorms can be expected annually in the site vicinity with June and July having the greatest thunderstorm frequency. Eighty-seven percent of the recorded thunderstorms occurred during the March - September period.

Freezing precipitation is the result of rain or drizzle falling on surfaces with temperatures below 0°C (32°F). The precipitation may be super cooled if it passes through a layer of subfreezing air just above the ground. Severe storms of this nature can create extreme travel hazards, stretch or break transmission lines and damage trees. An average of approximately three such storms per year occur in the site area, with the month of December having the highest frequency.

The geometric probability that a tornado will strike a given point in the site area is given by Thom's equation[10]:

$$P_s = \frac{Z_t}{A}$$

$$\text{and } R = \frac{1}{P_s}$$

where P_s is the geometric strike probability; Z is the mean path area of a tornado in Kentucky (2.72 km^2 (1.05 mi^2))[11]; t is the mean number of tornadoes per year in the one-degree square encompassing the site (0.9 tornadoes per year in Thom's study[10] and 1.23 tornadoes per year in a study by Pautz[12]); A is the area of a degree square at the site latitude (9821 km^2 (3792 mi^2)); and R is the return period. Thom's equations indicate that, on the average, the tornado probability for the site

area is 0.00025 to 0.00034 and that a given point in the one degree square can be expected to be affected by a tornado once in approximately 2933 to 4013 years.

4.3.2.9 Diffusion Climatology

The diffusion climatology of a region is a description of those properties of the atmosphere which determine dispersion of effluents from stacks. The dispersion characteristics of the atmosphere depend mainly on horizontal wind speed, thermal stability, mixing height and surface roughness.

Turner[13] defined a system of hourly stability classification using wind speed and estimates of radiation derived from solar attitude and measurements of cloud cover and ceiling. Turner's classifications utilize work accomplished by Pasquill[14]. Turner's stability indicators range from extremely unstable (Class 1) to extremely stable (Class 7). Table 4.3.2-12 gives a description of the Turner-Pasquill classes and the stratification of the stability classes according to weather conditions[13].

Turner's system of classifying atmospheric stability incorporates two of the atmospheric properties (wing speed and thermal stability) mentioned above. Surface roughness, another atmospheric property of interest, is closely related to the topography of the site area (discussed in Section 4.1). Mixing heights, the last property, are discussed later in this section. The terrain in the region of interest for all diffusion analyses is fairly uniform and should have no significant effect on the dispersion of air pollutants.

Table 4.3.2-13 gives the monthly and seasonal frequencies of stability classes at Evansville for the period 1960-1964[3]. Hourly meteorological data were stratified into stability classes in accordance with the aforementioned method developed by Turner. Neutral (Class D) conditions are most prevalent (47 percent annual occurence) while stable (Classes E-G) and unstable Classes A-C) conditions are less frequent (32 percent and 21 percent respectively). Table 4.3.2-14 presents the annual percent frequency of stability according to wind direction, and also gives the average wind speed for each wind direction and stability class[3].

The diffusion characteristics of a region are also affected by the mixing height, defined as the thickness of the atmospheric layer above the earth's surface within which pollutants are presumed to mix by convection[15]. In general, the higher the mixing height, the greater the dispersion potential of the atmosphere. A study by Holzworth[16] determined seasonal morning and afternoon mixing heights at Nashville, Tennessee, 217 km (135 miles) south-southeast of the Baskett Site. These data are shown in Table 4.3.2-15[16]. The annual mean mixing height is 1027 m (3370 ft). Mean morning mixing heights are lowest during the fall, 357 m (1171 ft) and mean afternoon mixing heights are highest during summer, 1874 m (6147 ft).

The National Air Pollution Potential Forecasting Program (NAPPFP) has issued forecasts of "high meteorological potential for air pollution" on a daily basis since August 4, 1960 for the eastern part of the United States

and from October 1, 1963 for the western part. The criteria used to define high meteorological potential area as follows:

1) Mixing heights 1500 m (4920 ft) or less.

2) Wind speeds 4 m sec^{-1} (8.9 mph) or less.

3) No significant precipitation anticipated in the next 24 to 36 hours.

4) The above conditions extend over an area of at least 194,000 square kilometers (75,000 square miles).

Figure 4.3.2-14 shows isopleths of the number of high potential forecast days issued by the NAPPFP through April 3, 1970 adjusted to a five-year period for comparison.[16] The analysis indicates that between 10 to 20 days of high potential were forecast in a five year period in the region of the proposed site.

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4.3.3 AMBIENT NOISE FIELD

4.3.3.1 Site Description and Noise Sensitive Land Uses

Baskett site is located in Henderson County about 9.7 km (6 mi.) east of Henderson and 32 km (20 mi.) west of Owensboro, Kentucky. The Green River forms the north-northeastern boundary of the site and Tscharner Road forms the boundary extending from the south-southwest to the east. The nearest rail line is the Louisville and Nashville Railroad, and the nearest major Highway is U.S. 60. Both run south of the site. Henderson Airport, located in Henderson, Kentucky, is about 24 km (15 mi.) away.

Baskett site is located in a sparsely populated area, where topography varys from level floodplain to gently rolling terrain. Part of the existing land is cultivated (primarily along the floodplain). The rest consists of wooded areas. The nearest residential homes are located adjacent to Tscharner and Tillman Bethel Road. Farther east-southeast of the site is the residential area of Baskett. There are some seasonal homes located near the Green River north-east of the site. The Henderson Golf and Country Club is located to the south-southwest of the site. Adjacent to the Country Club is the Green River Comprehensive Care Center. Two newly built residential homes are located at the entrance to the Country Club and near Highway U.S. 60.

The location of the noise sensitive land uses located within 15,000 ft of the site are shown in Figure 4.3.3-1.

4.3.3.2 Noise Survey at Baskett Site

A complete physical description of sound must account for its frequency spectrum and magnitude as a function of time. To simplify this description, the most common approach is to weigh the amplitudes of various frequencies by measuring the A-weighted sound levels in decibels (dB), as observed on a sound level meter. The A-weighting scale discriminates against the low frequency components of sound in a quantity proportional to the hearing ability of a person, and has been found to correlate fairly well for man's perception of sound[1]. Because environmental sound varies in time at a fixed location, a statistical approach is required to properly describe this variation. This is accomplished by providing the percent of the entire observation period each sound level in decibels is being exceeded.

The sound level exceeded 10 percent of the time, expressed as L_{10}, is often used to represent the higher-level shorter-durations of sounds. A measure of the median sound level is given by the L_{50}, which represents the level exceeded 50 percent of the time. The residual sound level is approximated by L_{90}, which is the sound level exceeded 90 percent of the time. A measure accounting for both the duration and magnitude of the sound occurring during a given period is called the equivalent A-weighted sound level (L_{eq}). This descriptor and the measures, such as L_{dn} (Day-Night average sound level), derived from it are used extensively by the Environmental Protection Agency (EPA) in formulating guidelines for community noise exposure[2].

To estimate the ambient sound field at Baskett site, a sound survey was conducted during the period of August 7-10, 1978. The ambient data collected during this survey included statistical descriptors such as L_1, L_5, L_{50} and L_{eq}, which were obtained with a GenRad Community Noise Analyser Model 1945. This instrument, which computes a statistical distribution of the measured sound levels, and at the end of the monitoring period displays that distribution in a digital form was the primary sound measuring device. Manual observations of the residuals were obtained with GenRad Precision Sound Level Meter and Analyser. These measurements provide a check on and complement the more complete data obtained by the 1945 Community Noise Analyser. Ambient sound measurements were conducted at 8 locations designated as A, B, C, D, E, F, I and II (Figure 4.3.3-2). At Locations A, B, C, D, E, and F, ambient sound data were collected for one continuous hour during daytime hours of 7 am to 10 pm and the nighttime hours of 10 pm to 7 am. At measuring locations I and II ambient data were collected for a half hour period during the daytime hours of 7 am to 10 pm.

Measurement locations A through II were selected after a careful evaluation was made of the noise sensitive land uses surrounding the site and the location of traffic arteries such as U.S. Route 60. Of greatest importance were residential homes that are located close to the site. Other considerations that were taken into account for the selection of the eight monitoring locations were the estimated outer limit of plant noise impact, and the location of various recreational areas surrounding the site. In addition to collecting ambient data in designated residential locations, an effort was made to identify the sound levels indicative of the ambient field of the rural agricultural lands between the Green River and U.S. Route 60.

Other informal observations were made during the monitoring period. These included observations of road traffic and aircraft activity in the area, land pattern use, and identification of human activities that could contribute to the ambient noise field. The non-quantitative observations supplement the physical measurement of sound and are essential to the understanding of the ambient noise field levels at Baskett site. Informal weather observations were obtained throughout the sound survey at each monitoring location, to assure that the weather was suitable for acoustic monitoring. These observations were made by using hand-held instruments, 4 to 5 feet above ground (Tables 4.3.3-1 and 4.3.3-2).

4.3.3.3 Ambient Noise Field at Baskett Site Area

The sound level data acquired by the Community Noise Analyser at the eight monitoring locations are shown in Tables 4.3.3-3 and 4.3.3-4. The residual measurements acquired by the Sound Level Meter and Analyser are presented in Tables 4.3.3-5 and 4.3.3-6. The estimated Daytime L_{eq} range between 36 dB(A) at point F (near Tillman-Bethel Road) to an L_{eq} of 59 dB(A) at point II (near Route 60).

The results shown in Table 4.3.3-4 indicate that the estimated nighttime L_{eq} range between 45 dB(A) at point B (near Green River) to an L_{eq} of 57 dB(A) at point A (near Tscharner Road).

At four monitoring locations, A, C, E and F, the nighttime L_{eq} exceeded the Daytime L_{eq} levels, whereas at points B and D the Daytime levels were higher. This increase in nighttime ambient noise levels at locations A, C, E and F could be largely attributed to the significant increase in insect noise during this period. At Point A there was an increase of 10 dB(A) above the daytime levels. At point F an increase of 20 dB(A) was experienced. At points B and D the insect noise was present at night but it was less significant than at locations A, C, E and F. The daytime man-made intrusions and river and road traffic at location B and road traffic at locations D caused the L_{eq} daytime levels to be higher than the nighttime levels. This was particularly pronounced at point B (near Green River) were the daytime levels were 11 dB(A) higher than the nighttime levels.

The physical measurement of noise and general observations, taken during the survery indicated that the daytime ambient noise field at the Baskett site area is largely composed of noise resulting from road traffic, intermittent barge traffic, and man-made intrusions such as lawn mower operation, occasional light plane and train traffic. Barking dogs, birds, and some insect noise also could be heard during daytime hours. At night there was still some intermittent noise created by rail and road traffic; however insect noise increased dramatically and had a considerable influence on the ambient noise levels.

During the monitoring period, pronounced diurnal changes in traffic pattern such as rush-hour traffic were not detected in the area surrounding the site (except along Route 60). This is not surprising since the Baskett Site is located in a rural area with a low population density. (The 1978 resident population within three miles of the site is is estimated at 1668 persons). Road traffic on the roads which lead to the site, such as Tscharner Road, was observed to be light. This confirms the latest (1973) Average Daily Traffic Count (ADT) which recorded 36 cars on this road. Because traffic is usually a mojor contributor to the diurnal fluctuations in the ambient noise levels, it is believed that the L_{eq} shown in Table 4.3.3-3 are indicative of the daytime values experienced at Baskett site during the measurement period.

The nighttime environment at time of sampling was controlled largely by an almost constant insect noise which decreased the nighttime variation of the acoustic field. Consequently, it is believed that the L_{eq} shown in Table 4.3.3-4 are indicative of the nighttime values experienced at Baskett Site during the monitoring period.

The L_{eq} shown in tables 4.3.3-3 and 4.3.3-4 have been converted in L_{dn} (Day night average sound levels), as described in the Data Appendix Section 4A.10, and have produced an estimate of L_{dn} indicative of the ambient field at Baskett Site (Table 4.3.3-7). These levels range between L_{dn} of 52 dB(A) at point C (Henderson County Country Club) and 63 dB(A) at point A near Tscharner Road).

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REFERENCES - SECTION 4.3.3

1. U S Environmental Protection Agency, 1973, Public Health and Welfare Criteria for Noise, 550/9-73-002, EPA, Washington, D C.

2. U S Environmental Protection Agency, 1974, Information on Level of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safet, 550/9-74-004, EPA, Washington, D C.

TABLE 4.3.1-1

EVANSVILLE - OWENSBORO - HENDERSON INTERSTATE
AIR QUALITY CONTROL REGION NUMBER 77

Counties in the State of Kentucky

Daviess

Hancock

Henderson

McLean

Ohio

Union

Webster

Counties in the State of Indiana

Posey

Gibson

Vanderburgh

Pike

Warrick

Dubois

Spencer

Perry

TABLE 4.3.1-2

SULFUR DIOXIDE EMISSION SOURCES THAT COMMENCED CONSTRUCTION SUBSEQUENT TO JANUARY 6, 1975

Name	Location (UTM) (East)	Location (UTM) (West)	Elevation (meters)	Stack Height (meters)	Inside Diameter (meters)	Pollutant Release Rate (kg/hr)	Mass Release Rate ($X10^4$ kg/hr)	Exit Temperature (^oF)	Permit Date
Posey County, Indiana									
General Electric Company	420.3	4,199.9	122	30	1.7	386.11	32.99	350	11-1-76
General Electric Company	420.3	4,199.9	122	6	0.6	9.03	0.81	590	9-15-77
General Electric Company	420.3	4,199.9	122	76	3.0	611.09	12.14	300	1-23-78
S I G & E - A B Brown	437.6	4,195.2	113	152	4.3	58.75	134.79	150	Not Rec'd
Spencer County, Indiana									
Indiana & Michigan Elec Co	495.9	4,196.7	119	76	3.0	13,227.09	1,334.85	300	1-23-78
Henderson County, Kentucky									
Anaconda Aluminum - FS	455.6	4,167.8	131	30	3.1	7.27	0.87	199	Not Rec'd
Anaconda Aluminum - RM-1*	455.7	4,167.9	131	15	6.0	6.91	0.22	117	Not Rec'd
Anaconda Aluminum - RM-2*	455.5	4,167.7	131	15	6.0	6.91	0.22	117	Not Rec'd
B R E C - Reid Unit 2	456.0	4,166.5	131	107	4.6	120.60	3.62	154	Not Rec'd
B R E C - Reid Unit 3	456.0	4,166.5	31	107	4.6	120.60	3.62	154	Not Rec'd

* Represents two or more stacks combined into one source for modeling purposes.

Sources: Kentucky Division of Air Pollution Control[2]
Indiana Division of Air Pollution Control[3]

TABLE 4.3.1-3

PARTICULATE EMISSION SOURCES THAT COMMENCED CONSTRUCTION SUBSEQUENT TO JANUARY 6, 1975

Name	Location (UTM) (East)	Location (UTM) (West)	Elevation (meters)	Stack Height (meters)	Inside Diameter (meters)	Pollutant Release Rate (kg/hr)	Mass Release Rate ($X10^4$ kg/hr)	Exit Temperature (°F)	Permit Date
Posey County, Indiana									
General Electric Company	420.3	4,199.9	122	30	1.7	8.36	32.99	350	11-1-76
General Electric Company	420.3	4,199.9	122	76	3.2	12.55	12.14	300	1-23-78
S I G & E - A B Brown	437.6	4,195.2	113	152	4.3	803.62	134.79	150	Not Rec'd
Warrick County, Indiana									
Alcoa Aluminum Company	464.4	4,199.5	122	6	1.1	4.25	9.85	700	3-5-76
Spencer County, Indiana									
Indiana & Michigan Elec Co	495.9	4,196.7	119	76	3.0	436.37	1,334.85	300	1-23-78
Hancock County, Kentucky									
Martin Marietta Aluminum	513.8	4,200.5	140	21	4.6	39.44	43.56	560	Not Rec'd
Henderson County, Kentucky									
Anaconda Aluminum - FS	455.6	4,167.8	131	30	3.1	131.68	0.87	199	Not Rec'd
Anaconda Aluminum - RM-1*	455.7	4,167.9	131	15	6.0	8.06	0.22	117	Not Rec'd
Anaconda Aluminum - RM-2*	455.5	4,167.7	131	15	6.0	8.06	0.22	117	Not Rec'd
B R E C Reid #2	456.0	4,166.5	131	107	4.6	1,450.80	3.62	154	Not Rec'd
B R E C Reid #3	456.0	4,166.5	131	107	4.6	1,450.80	3.62	154	

* Represents two or more stacks combined into one source for modeling purposes.

Sources: Kentucky Division of Air Pollution Control[2]
Indiana Division of Air Pollution Control[3]

TABLE 4.3.1-4

SULFUR DIOXIDE EMISSION SOURCES THAT COMMENCED CONSTRUCTION PRIOR TO JANUARY 6, 1975

Name	Location (UTM) (East)	Location (UTM) (North)	Elevation (meters)	Stack Height (meters)	Inside Diameter (meters)	Pollutant Release Rate (kg/hr)	Mass Release Rate ($X10^4$ kg/hr)	Exit Temperature (^oF)
Daviess County, Kentucky								
Field Packaging	488.2	4,181.1	116	44	2.4	129.00	1.02	330
Fleischman Distilling*	487.6	4,180.3	119	51	1.8	73.14	7.78	450
Clearmore Distilling*	492.1	4,181.0	113	22	2.7	39.34	8.29	426
Medley Distilling Co.*	487.8	4,181.0	114	38	2.0	73.72	3.25	400
Owensboro Brick & Tile*	492.4	4,179.8	125	119	1.4	10.77	4.14	122
Owensboro M U - Station 1	492.0	4,181.0	116	45	4.0	88.53	11.44	422
Owensboro M U - Elmers Station*	494.7	4,183.0	116	178	5.5	7,486.66	175.54	289
Henderson County, Kentucky								
Agrico Chemical Co.	442.8	4,184.8	113	37	1.8	11.23	4.01	240
Anaconda Aluminum*	456.0	4,167.9	128	24	2.1	223.05	42.75	219
Big Rivers Electric Co., R #1	456.0	4,166.5	134	76	3.7	1,967.40	51.19	335
Big Rivers Electric Co., RH-1	456.0	4,166.5	134	107	4.6	256.90	179.94	300
Big Rivers Electric Co., RH-2	456.0	4,166.5	134	107	4.6	256.90	179.94	300
Henderson Municipal P&L	448.0	4,188.6	119	40	2.1	883.09	8.09	330

* Represents two or more stacks combined into one source for modeling purposes.

Sources: Kentucky Division of Air Pollution Control[2]
Indiana Division of Air Pollution Control[3]

TABLE 4.3.1-4 (Cont'd)

Name	Location (UTM) (East)	Location (UTM) (North)	Elevation (meters)	Stack Height (meters)	Inside Diameter (meters)	Pollutant Release Rate (kg/hr)	Mass Release Rate ($X10^4$ kg/hr)	Exit Temperature (^oF)
Posey County, Indiana								
General Electric Co.*	420.3	4,199.9	122	74	1.1	2,531.99	3.28	550
Indiana Farm Bureau*	420.1	4,199.5	422	15	1.5	140.79	2.12	750
Indiana Farm Bureau*	420.1	4,199.5	122	50	0.9	57.17	9.27	210
J R Short Milling Co.	421.6	4,198.1	110	30	2.4	14.01	0.43	525
S I G & E - A B Brown	437.6	4,195.2	145	152	4.3	837.19	134.79	150
Vanderburgh County, Indiana								
ARKLA Industries*	451.7	4,203.6	116	46	3.7	31.54	18.20	600
ARKLA Industries*	451.7	4,203.6	116	46	3.0	30.60	18.20	400
Bernadin	447.6	4,204.4	119	123	1.2	4.77	0.24	420
Bucrus Erie Co.*	455.0	4,202.0	117	46	2.1	45.33	4.47	597
Evansville State Hospital	455.8	4,202.9	122	53	1.8	21.89	13.47	400
General Tire & Rubber*	449.7	4,204.8	104	9	0.5	14.52	0.75	400
International Steel	449.9	4,204.8	116	17	1.0	16.60	1.33	500
Mead Johnson*	447.5	4,203.2	110	30	1.8	51.75	5.06	400
NEDFE	446.0	4,205.0	137	24	1.4	8.29	0.84	460
S I Gas & Electric Co.*	446.9	4,202.1	116	76	5.1	7.57	33.89	330
Sterling Brewers*	448.9	4,203.3	107	35	1.8	38.28	1.62	500
Whirlpool*	452.9	4,208.3	116	16	1.5	84.76	9.20	500
Whirlpool*	450.2	4,205.0	116	20	1.5	37.77	6.09	500

* Represents two or more stacks combined into one source for modeling purposes.

Sources: Kentucky Division of Air Pollution Control[2]
Indiana Division of Air Pollution Control[3]

TABLE 4.3.1-4 (Cont'd)

Name	Location (UTM) (East)	Location (UTM) (North)	Elevation (meters)	Stack Height (meters)	Inside Diameter (meters)	Pollutant Release Rate (kg/hr)	Mass Release Rate ($X10^4$ kg/hr)	Exit Temperature (°F)
Warrick County, Indiana								
Alcoa Aluminum*	464.4	4,199.5	125	122	4.7	15,090.33	132.11	271
S I G & E - Co.*	471.3	4,195.6	122	152	4.4	7,216.12	18.65	300

* Represents two or more stacks combined into one source for modeling purposes.

Sources: Kentucky Division of Air Pollution Control[2]
Indiana Division of Air Pollution Control[3]

TABLE 4.3.1-5

PARTICULATE EMISSION SOURCES THAT COMMENCED CONSTRUCTION PRIOR TO JANUARY 6, 1975

Name	Location (UTM) (East)	Location (UTM) (North)	Elevation (meters)	Stack Height (meters)	Inside Diameter (meters)	Pollutant Release Rate (kg/hr)	Mass Release Rate ($X10^4$ kg/hr)	Exit Temperature (°F)
Posey County, Indiana								
GAF Corp*	419.6	4,199.7	110	16	1.1	13.12	0.73	550
General Electric Co.*	420.3	4,199.9	122	24	1.1	107.80	3.28	550
Indiana Farm Bureau*	420.1	4,199.5	122	15	1.5	6.32	2.12	750
Indiana Farm Bureau*	420.1	4,199.5	122	50	0.9	6,380.63	9.27	1,210
J R Short Milling Co.	421.6	4,198.1	110	30	2.4	3.63	0.43	525
S I G & E A B Brown	437.6	4,195.2	145	152	4.3	58.75	134.79	150
Spencer County, Indiana								
Barmet*	494.7	4,196.0	143	26	0.2	793.07	5.40	280
Vanderburgh County, Indiana								
ARKLA Industries*	451.7	4,203.6	116	46	3.7	5.49	18.20	600
ARKLA Industries*	451.7	4,203.6	116	46	3.0	4.77	18.20	400
Bell Plastics*	449.9	4,204.9	116	4	0.5	28.11	0.62	400
Mead Johnson*	447.5	4,203.2	110	30	1.8	6.75	5.06	400
S I G & E*	446.9	4,202.1	116	76	5.1	7.57	33.89	330
Sterling Brewers*	448.9	4,203.3	107	35	1.8	7.04	1.62	500
Whirlpool Corp*	452.9	4,208.3	116	16	1.5	27.38	6.09	500
Whirlpool Corp*	450.2	4,205.0	116	20	1.5	58.10	0.04	500

* Represents two or more stacks combined into one source for modeling purposes.

Sources: Kentucky Division of Air Pollution Control (2)
Indiana Division of Air Pollution Control (3)

TABLE 4.3.1-5 (Cont'd)

Name	Location (UTM) (East)	Location (UTM) (North)	Elevation (meters)	Stack Height (meters)	Inside Diameter (meters)	Pollutant Release Rate (kg/hr)	Mass Release Rate ($X10^4$ kg/hr)	Exit Temperature (°F)
Warrick County, Indiana								
Alcoa Aluminum*	464.4	4,199.5	125	122	4.7	24,618.81	132.11	271
Alcoa-Warrick*	464.4	4,199.5	125	18	0.8	54.68	2.77	385
Metzger Construction	469.8	4,211.0	137	11	0.5	21.06	3.54	200
S I G & E *	471.3	4,195.6	122	132	4.4	284.38	18.65	300
Daviess County, Kentucky								
Field Packaging Co.*	488.2	4,181.1	116	44	2.4	9.67	1.02	330
Fleischman Distributing Co.*	487.6	4,180.3	116	51	1.8	6.12	7.78	450
W R Grace*	495.9	4,184.6	115	6	0.2	3.94	0.04	199
Green River Corp*	495.2	4,183.2	116	20	1.5	7.99	25.95	86
Medley Distilling Co.*	487.8	4,181.0	115	38	2.0	4.18	3.25	400
Owensboro Brick & Tile*	487.3	4,182.2	125	17	1.4	178.31	4.14	122
OMU-Elmer Station*	494.7	4,183.0	116	178	5.5	182.25	175.54	289
Owensboro Grain Co.*	492.1	4,180.9	122	12	0.7	22.94	1.38	77
Pioneer Farm Service	492.4	4,179.8	116	21	0.5	3.45	1.16	77
Henderson County, Kentucky								
Anaconda Aluminum*	456.0	4,167.9	128	24	2.1	50.55	42.75	219
Anaconda Aluminum*	456.0	4,167.9	128	15	0.4	33.53	2.64	77
BREC Reid #1	456.0	4,166.5	134	76	3.7	1,404.60	51.19	335
BREC Reid #H-1	456.0	4,166.5	134	107	4.6	7,420.70	179.92	300
BREC Reid #H-2	456.0	4.166.5	134	107	4.6	7,420.70	179.92	300
Handson Light & Power	448.0	4,188.6	117	40	2.1	36.95	8.09	330

* Represents two or more stacks combined into one source for modeling purposes.

Sources: Kentucky Division of Air Pollution Control[2]
Indiana Division of Air Pollution Control[3]

TABLE 4.3.1-6

SUMMARY OF MEASURED AIR POLLUTANT CONCENTRATIONS IN CITY OF HENDERSON
(parts per million)

Pollutant	Averaging Period	1972	1973	1974	1975	1976	1977
Nitrogen Dioxide	Annual Arithmetic Mean	-	0.012-0.018	0.069-0.034	0.013-0.030	0.012-0.026	0.017-0.023
Hydrogen Sulfide	1 Hour Maximum	0.009	0.007	-	0.006	0.0042	-
	Second Maximum	-	-	-	0.005	0.0042	-
	# of Violations	0	0	-	0	0	-
Non-Methane Hydro-carbons	3 Hour Maximum	-	-	-	1.9	4.7	-
	Second Maximum	-	-	-	1.8	2.0	-
	# of Violations	-	-	-	63	65	-
Oxidants (Ozone)	1 Hour Maximum	-	-	0.044	0.085	0.257	0.158
	Second Maximum	-	-	-	0.081	0.188	0.149
	# of Violations	-	-	0	2	109	187
Carbon Monoxide	1 Hour Maximum	10.0	5.0-8.0	35.5	8.5	10.0	9.9
	Second Maximum	-	-	-	7.0	8.8	7.0
	# of Violations	-	0	1	0	0	0
	8 Hour Maximum	4.8	3.1-36	7.5	5.9	6.2	3.7
	Second Maximum	-	-	-	5.7	-	3.6
	# of Violations	-	-	0	0	0	0

Notes:

Range indicates the range of values from different monitoring sites

# of violations indicates the number of times the standards were exceeded.

- indicates no data available.

Source: Kentucky Division of Air Pollution Control[4-9].

TABLE 4.3.1-7

SUMMARY OF SULFUR DIOXIDE CONCENTRATIONS (ug/M^3) IN HENDERSON COUNTY

Location	Site No.	Period	No. Obs.	3-Hour Max.	3-Hour 2nd Max	3-Hour No. >1300	24-Hour Max.	24-Hour 2nd Max	24-Hour No.>365	Arithmetic Mean
Henderson	4006	1974	57	-	-	-	248.1	-	0	23.0
		1975	55	-	-	-	469.7	427.4	2	49.2
		1976	56	-	-	-	572.0	-	3	74.6
		1977	50	-	-	-	163.4	121.6	0	24.9
		7/77-6/78	2133	628.8	607.8	0	449.0	121.6	1	29.9
Henderson	4083	1974	55	-	-	-	52.4	-	0	11.2
		1975	59	-	-	-	131.7	110.2	0	17.7
		1976	53	-	-	-	125.5	-	0	20.7
		1977	42	-	-	-	70.7	43.0	0	9.7
		7/77-6/78	47	-	-	-	70.7	52.8	0	13.2
Henderson	4085	1974	57	-	-	-	176.9	-	0	28.5
		1975	59	-	-	-	159.2	154.3	0	26.4
		1976	59	-	-	-	158.3	-	0	35.2
		1977	49	-	-	-	104.0	88.0	0	23.6
		7/77-6/78	47	-	-	-	104.0	82.5	0	21.9
Henderson	4086	1974	41	-	-	-	68.8	-	0	8.1
		1975	43	-	-	-	67.5	41.8	0	12.7
		1976	51	-	-	-	114.6	-	0	25.2
		1977	52	-	-	-	100.9	96.0	0	19.0
		7/77-6/78	39	-	-	-	96.0	63.1	0	18.1
Niagara	4087	1974	56	-	-	-	100.1	-	0	16.9
		1975	57	-	-	-	55.5	46.3	0	10.0
		1976	58	-	-	-	42.1	-	0	9.4
		1977	42	-	-	-	36.3	30.6	0	-
		7/77-6/78	44	-	-	-	55.6	37.2	0	9.5
Henderson	4155	1974	6875	529.2	-	0	167.7	-	0	21.7
		1975	7681	783.4	751.9	0	330.1	227.9	0	24.0
		1976	5979	717.9	-	0	324.9	-	0	46.3
		1977	7784	476.8	372.0	0	159.8	136.2	0	43.3
		7/77-6/78	7874	476.8	374.7	0	159.8	146.7	0	44.7
Henderson	4156	1974	58	-	-	-	275.0	-	0	30.9
		1975	58	-	-	-	160.8	149.8	0	26.4
		1976	51	-	-	-	137.5	-	0	27.7
		1977	52	-	-	-	150.9	190.6	0	18.5
		7/77-6/78	41	-	-	-	33.1	26.1	0	6.8
Robards	4205	5/76-12/76	259	432.3	-	0	136.2	-	0	18.7
		1977	394	327.5	217.5	0	141.5	91.7	0	14.7
		7/77-6/78	342	217.5	180.8	0	52.4	52.7	0	-

- Indicates no data reported; Stations using 24-hour bubblers account for most 3-hour periods where no data was repoted.
Source: Kentucky Division of Air Pollution Control[5,6,7,8,9].

TABLE 4.3.1-8

SUMMARY OF TOTAL SUSPENDED PARTICULATE CONCENTRATIONS (ug/M^3) IN HENDERSON COUNTY

Location	Site No.	Period	No. Obs	24-Hour Max.	24-Hour 2nd Max	24-Hour Min	No. - 260	No. - 150	Mean Arith.	Mean Geo.
Henderson	4006	1974	54	175	-	38	0	2	90	84
		1975	45	123	-	31	0	0	72	68
		1976	57	186	-	39	0	2	87	82
		1977	52	176	-	24	0	4	83	76
		8/77-6/78	46	176	157	-	0	2	83	78
Henderson	4083	1974	55	232	-	36	0	7	105	96
		1975	58	204	-	35	0	5	93	84
		1976	53	211	-	33	0	4	90	84
		1977	41	254	-	5	0	8	107	85
		7/77-6/78	47	229	208	-	0	6	103	92
Henderson	4085	1974	53	187	-	28	0	3	70	63
		1975	58	154	-	21	0	1	62	56
		1976	60	173	-	22	0	3	75	68
		1977	53	155	-	26	0	2	73	66
		7/77-6/78	51	170	131	-	0	1	75	68
Henderson	4086	1974	44	117	-	21	0	0	64	59
		1975	40	112	-	19	0	0	54	50
		1976	42	160	-	25	0	1	65	60
		1977	49	159	-	26	0	2	73	67
		7/77-6/78	42	135	116	-	0	0	68	61
Niagara	4087	1974	53	80	-	19	0	0	43	41
		1975	53	189	-	16	0	1	49	43
		1976	51	122	-	21	0	0	50	45
		1977	45	95	-	18	0	0	46	41
		7/66-6/78	50	78	78	-	0	0	42	39
Henderson	4155	1974	57	254	-	29	0	4	103	93
		1975	51	262	-	31	1	9	102	91
		1976	53	236	-	28	0	6	95	86
		1977	51	207	-	18	0	5	97	87
		7/77-6/78	47	170	169	-	0	3	91	83
Henderson	4156	1974	57	147	-	33	0	0	81	75
		1975	51	152	-	8	0	1	74	66
		1976	48	208	-	33	0	1	83	78
		1977	57	196	-	21	0	3	85	76
		7/77-6/78	48	196	145	-	0	1	75	69
Robards	4205	5/76-12/76	29	136	-	28	0	0	65	61
		1977	53	263	-	21	1	2	60	54
		7/77-6/78	53	162	154	-	0	2	67	59

- Indicates no data reported.
Source: Kentucky Division of Air Pollution Control[5,6,7,8,9].

TABLE 4.3.1-9

NON-ATTAINMENT AREAS NEAR BASKETT, KENTUCKY

Non-Attainment Area	Pollutant	Closest Distance to Baskett Site km (miles)
Kentucky		
Daviess County	Photochemical Oxidants	16 (9.9)
Henderson County	Photochemical Oxidants	0
City of Henderson	Particulates and Sulfur Dioxide	8.9 (5.5)
City of Owensboro	Particulates and Sulfur Dioxide	30 (18.6)
Indiana		
Vanderburgh County	Particulates	4.0 (2.5)
Warrick County	Sulfur Dioxide	8.1 (5.0)

Source: CFR Title 40, Part 81,[10].

Table 4.3.1- 10

BACKGROUND CONCENTRATIONS OF SUSPENDED PARTICULATES AND SULFUR DIOXIDE

Air Pollutants	Averaging Period	Background Concentrations (ug/m^3)
Suspended Particulates	24-hour	85
	Annual Geometric Mean	35
Sulfur Dioxide	3-hour	100
	24-hour	28
	Annual Arithmetic	3

Note: Natural background (no man-made effects from nearby sources) based on 8 years of ambient air quality data at a rural site in Kentucky.

Source: Phone conversation of May 19, 1978 between G Trivedi of Kentucky, Division of Air Pollution and M Barboza of Envirosphere.

TABLE 4.3.2-1

AVERAGE AND EXTREME MONTHLY DRY BULB TEMPERATURES

EVANSVILLE, INDIANA

	Average (F)[a]			Extremes (F)[b]			
Month	Maximum	Minimum	Monthly	Record Highest	Year	Record Lowest	Year
January	41.5	23.7	32.6	76	1943	-21	1977
February	45.4	26.4	35.9	79	1962	-23	1951
March	54.6	34.0	44.3	83	1945	-9	1960
April	67.9	45.5	56.7	90	1967	24	1972
May	77.0	54.4	65.7	95	1975	28	1963
June	86.0	63.4	74.7	104	1954	41	1966
July	88.9	66.7	77.8	105	1954	47	1947
August	88.0	64.4	76.2	102	1964	46	1964
September	81.4	56.7	69.1	103	1954	31	1942
October	71.2	45.2	58.2	94	1953	21	1952
November	55.2	34.5	44.9	83	1961	-3	1950
December	44.0	26.5	35.3	75	1951	-9	1963
Annual	66.8	45.1	56.0	105	1954	-23	1951

(a) Period of record 1941-1970
(b) Period of record 1941-1977

Source: National Oceanic and Atmospheric Administration[1,2]

TABLE 4.3.2-2

SUMMER WET-BULB TEMPERATURES BY CUMULATIVE FREQUENCIES

EVANSVILLE, INDIANA

Month[a]	Cumulative Frequency (percent)[b]					
	5	10	25	50	75	90
June	55F[c]	57F	61F	67F	71F	74F
July	60	62	67	70	73	76
August	57	61	65	70	73	76
September	47	50	56	63	70	73
Summer[d]	55	57	62	67	72	75

[a] 5040-5207 observations per month

[b] Comulative frequency is defined as the percent of time that wet-bulb temperature equals or is less than the corresponding wet-bulb temperature given in the table.

[c] Temperatures rounded to nearest whole degree Farenheit (F).

[d] Average of June - September values

Source: National Oceanic and Atmospheric Administration, 1978[3]

TABLE 4.3.2-3

MONTHLY PERCENT FREQUENCY OF RELATIVE HUMIDITY
EVANSVILLE, INDIANA

Month	Relative Humidity (percent) 0-29	30-49	50-69	70-79	80-89	90-100
January	0	6	27	22	23	22
February	0	11	32	19	19	19
March	2	16	32	18	18	13
April	4	21	29	17	18	12
May	2	18	27	16	18	19
June	1	18	28	17	20	16
July	1	16	28	16	20	19
August	1	15	27	15	20	22
September	3	20	24	14	18	21
October	3	18	22	14	21	22
November	2	15	32	17	19	14
December	0	7	28	21	23	20
Annual	2	15	28	17	20	18

Source: United States Weather Bureau, 1963[4]

TABLE 4.3.2-4

AVERAGE AND MAXIMUM MONTHLY PRECIPITATION (INCHES)
EVANSVILLE, INDIANA

Month	Average	0.01 in. (Days/ Month)	Maximum Monthly[b]	Year
January	3.40	10	13.50	1950
February	3.27	9	7.25	1956
March	4.69	12	12.84	1964
April	4.06	11	7.99	1955
May	4.38	11	12.22	1961
June	3.57	10	9.30	1943
July	3.77	10	9.69	1958
August	2.95	7	8.43	1977
September	2.80	7	9.89	1945
October	2.52	7	8.83	1941
November	3.17	9	8.49	1957
December	3.30	11	7.95	1951
Annual	41.88	104	13.50	1950

(a)Period of record 1941-1970

(b)Period of record 1941-1977

Source: National Oceanic and Atmospheric Administration[1,2]

TABLE 4.3.2-5

SHORT-TERM MAXIMUM RECORDED RAINFALL
EVANSVILLE, INDIANA

Time Period	Rainfall (inches)	Date
5 minutes	0.74	May 7, 1961
10 minutes	1.02	May 7, 1961
15 minutes	1.19	August 10, 1908
30 minutes	1.96	June 26, 1943
60 minutes	2.79	July 20, 1916
2 hours	3.11	July 20, 1916
3 hours	3.41	September 20, 1924
6 hours	4.40	September 19, 1924
12 hours	4.82	October 5, 1910
24 hours	6.94	October 5, 1910

Period of record 1900-1961 for time periods 5 minutes to 12 hours. Record period 1897-1961 for 24 hour rainfall value.

Source: United States Weather Bureau, 1963[5]

TABLE 4.3.2-6

RAINFALL RATES (INCHES) FOR VARIOUS DURATIONS AND RETURN PERIODS

BASKETT SITE, KENTUCKY

Rainfall Duration (hours)	Return Period (years)[a]						
	1 Year	2 Years	5 Years	10 Years	25 Years	50 Years	100 Years
0.5	1.05	1.25	1.50	1.70	1.95	2.15	2.40
1.0	1.28	1.50	1.90	2.15	2.45	2.75	2.95
2.0	1.60	1.85	2.30	2.60	2.95	3.40	3.65
3.0	1.78	2.05	2.55	2.90	3.35	3.60	4.05
6.0	2.10	2.45	3.05	3.45	3.95	4.45	4.80
12.0	2.55	2.95	3.65	4.20	4.70	5.25	5.75
24.0	2.95	3.40	4.25	4.80	5.50	6.05	6.60

[a] Statistical projections based on a period or record of 19 years (1940-1958).

Source: United States Weather Bureau, 1961[6]

TABLE 4.3.2-7

AVERAGE AND MAXIMUM MONTHLY SNOWFALL (INCHES)

EVANSVILLE, INDIANA

Month	Average[a]	Maximum Monthly[a]	Year	24-hour Maximum[a]	Year
January	3.2	21.3	1977	8.7	1978
February	3.2	11.3	1948	8.7	1966
March	3.0	20.2	1960	10.6	1960
April	0.3	8.6	1971	8.6	1971
May	0.0	0.0		0.0	
June	0.0	0.0		0.0	
July	0.0	0.0		0.0	
August	0.0	0.0		0.0	
September	0.0	0.0		0.0	
October	T[b]	T[b]	1957	T[b]	1957
November	0.7	6.9	1958	6.9	1958
December	2.5	10.4	1973	7.0	1963
Annual	12.9	21.3	1977	10.6	1960

(a) Period of record 1941-1978
(b) Trace- Less than 0.1 inch

Source: National Oceanic and Atmospheric Administration,[1,2]

TABLE 4.3.2-8

MAXIMUM MONTHLY FASTEST MILE WIND SPEEDS

EVANSVILLE, INDIANA

Month	Speed (mph)	Direction	Year
January	47	W	1972
Feburary	59	W	1956
March	56	S	1945
April	54	NW	1958
May	55	NW	1957
June	58	NW	1958
July	53	NW	1941
August	49	NW	1963
September	49	SW	1941
October	37	S	1946
November	47	SW	1940
December	56	SW	1971
Annual	59	W	1956

Period of record is 1940-1977. Wind measurements taken at heights of 40 ft (1940-1951), 64 feet (1951-1961), and 20 feet (1961-1977).

Sources: National Oceanic and Atmospheric Administration,[1,2]

TABLE 4.3.2-9

RECURRENCE INTERVALS OF FASTEST MILE WIND SPEEDS

BASKETT SITE, KENTUCKY

Recurrence Interval (Years)	Fastest Mile Wind Speed (mph)
2	50
10	60
25	70
50	75
100	80

Values shown are statistical values based on a period of record of 21 years.

Source: Thom, 1968[7]

TABLE 4.3.2-10

MAXIMUM PERSISTENCE OF WIND DIRECTION

EVANSVILLE, INDIANA

One-Sector Wind Direction		Three-Sector Wind Direction	
Wind Direction	Max Hours	Wind Direction	Max Hours
N	15	NNW-N-NNE	37
NNE	12	N-NNE-NE	59
NE	21	NNE-NE-ENE	38
ENE	12	NE-ENE-E	50
E	22	ENE-E-ESE	41
ESE	8	E-ESE-SE	31
SE	19	ESE-SE-SSE	32
SSE	15	SE-SSE-S	62
S	28	SSE-S-SSW	56
SSW	16	S-SSW-SW	57
SW	23	SSW-SW-WSW	67
WSW	14	SW-WSW-W	45
W	20	WSW-W-WNW	41
WNW	16	W-WNW-NW	67
NW	42	WNW-NW-NNW	58
NNW	17	NW-NNW-N	58
Calm	20		

The maximum persistence of wind direction is the greatest number of consecutive hours that the wind direction was from the given direction or directions. Data are based upon 43,846 hourly observations during the 1960-1964 period.

Source: National Oceanic and Atmospheric Administration, 1978[3]

TABLE 4.3.2-11

AVERAGE OBSERVATION OF FREEZING PRECIPITATION AND THUNDERSTORMS
EVANSVILLE, INDIANA

Month	Number of Days per Month	
	Freezing Preciptiation[a]	Thunderstorms[b]
January	0.8	1
February	0.4	1
March	0.2	4
April	0.0	5
May	0.0	6
June	0.0	8
July	0.0	8
August	0.0	5
September	0.0	3
October	0.0	2
November	0.0	1
December	1.4	1
Annual	2.8	45

(a) Based on 10 year period of record (1939-1948)

Source: Quartermaster Research and Engineering Command, 1959[9]

(b) Based on 36 year period of record (1941-1976)

Source: National Oceanic and Atmospheric Administration, 1976[1]

TABLE 4.3.2-12

TURNER-PASQUILL STABILITY CLASS RELATIONSHIPS AND STRATIFICATION OF STABILITY ACCORDING TO WEATHER CONDITIONS

Turner Stability Class	Pasquill Stability Class	Stability Description
1	A	Extremely Unstable Conditions
2	B	Unstable Condition
3	C	Slightly Unstable Conditions
4	D	Neutral Condition
5	E	Slightly Stable Condition
6	F	Stable Conditions
7	G	Extremely Stable Conditions

STRATIFICATION OF TURNER-PASQUILL STABILITY ACCORDING TO WEATHER CONDITIONS

Surface Wind Speed (kts)	Daytime Conditions Incoming Radiation				Day or Night Balanced Radiation	Nighttime Conditions Outgoing Radiation	
	Strong	Moderate	Slight	Weak		Weak	Strong
0-1	A	A	B	C	D	F	G
2-3	A	B	B	C	D	F	G
4-5	A	B	C	D	D	E	F
6	B	B	C	D	D	E	F
7	B	B	C	D	D	D	E
8-9	B	C	C	D	D	D	E
10	C	C	D	D	D	D	E
11	C	C	D	D	D	D	D
12	C	D	D	D	D	D	D

Source: Turner, 1961[13]

TABLE 4.3.2-13

MONTHLY AND SEASONAL FREQUENCIES OF STABILITY CLASSES
EVANSVILLE, INDIANA

Month/ Season	No. of Observations	Percent Frequency of Stability Class[a] Unstable A	B	C	Total Unstable	Neutral D	Stable E	F	G	Total Stable
December	3,719	0.00	0.97	6.94	7.91	61.52	8.74	10.78	11.05	30.57
January	3,720	0.00	1.42	7.93	9.35	60.65	11.80	9.62	8.58	30.00
February	3,408	0.00	1.58	7.48	9.06	65.67	8.01	8.89	8.36	25.26
(Winter)	10,847	(0.00)	(1.32)	(7.45)	(8.77)	(62.61)	(9.52)	(9.76)	(9.33)	(28.61)
March	3,720	0.08	3.20	6.94	10.22	65.94	9.11	7.26	7.47	23.84
April	3,600	0.06	4.11	10.47	14.64	58.42	9.44	9.92	7.58	26.94
May	3,720	1.77	10.59	20.03	32.39	43.01	5.97	9.06	9.57	24.60
(Spring)	11,040	(0.64)	(5.97)	(12.48)	(19.08)	(55.79)	(8.17)	(8.75)	(8.21)	(25.13)
June	3,600	2.39	13.56	21.06	37.01	36.61	6.08	8.92	11.39	26.39
July	3,720	2.53	15.62	21.34	39.49	31.91	5.22	10.08	13.31	28.61
August	3,720	0.73	14.62	18.31	33.66	26.80	7.02	14.35	18.17	39.54
(Summer)	11,040	(1.88)	(14.60)	(20.23)	(36.72)	(31.77)	(6.11)	(11.12)	(14.29)	(31.51)
September	3,600	0.08	9.03	17.03	26.14	34.97	6.31	11.83	20.75	38.89
October	3,719	0.00	5.65	14.74	20.39	32.48	9.20	15.86	22.08	47.14
November	3,600	0.00	3.92	11.25	15.17	47.89	8.06	12.61	16.28	36.95
(Fall)	10,919	(0.03)	(6.20)	(14.34)	(20.57)	(38.45)	(7.86)	(13.43)	(19.70)	(40.99)
Annual	43,846	(0.64)	(7.05)	(13.65)	(21.34)	(47.05)	(7.92)	(10.78)	(12.90)	(31.60)

[a] See Table 4.3.2-12 for explanation of stability class designations. Data are based upon 43,846 hourly observations during the 1960-1964 period; values in parentheses represent seasonal or annual averages as identified.

Source: National Oceanic and Atmospheric Administration, 1978[3]

TABLE 4.3.2-14

FREQUENCY OF STABILITY CLASS BY WIND DIRECTION
EVANSVILLE, INDIANA

Direction	Percent Frequency of Stability Class[a]							
	A	B	C	D	E	F	G	Total
N	0.03	0.45	0.79	2.95	0.53	0.64	0.58	5.97
NNE	0.03	0.20	0.39	1.40	0.27	0.27	0.22	2.78
NE	0.05	0.51	0.71	2.37	0.40	0.54	0.44	5.02
ENE	0.01	0.37	0.55	1.41	0.22	0.47	0.29	3.31
E	0.05	0.61	0.77	2.38	0.34	0.49	0.28	4.93
ESE	0.02	0.34	0.50	1.15	0.17	0.23	0.14	2.55
SE	0.06	0.73	1.17	3.36	0.57	0.62	0.34	6.86
SSE	0.01	0.31	0.55	2.04	0.38	0.37	0.18	3.84
S	0.04	0.58	1.16	4.68	1.06	0.96	0.32	8.79
SSW	0.02	0.31	0.76	3.51	0.67	0.37	0.12	5.75
SW	0.03	0.73	1.47	4.29	0.89	0.63	0.26	8.31
WSW	0.03	0.30	0.60	2.10	0.29	0.31	0.16	3.79
W	0.04	0.37	0.71	3.02	0.34	0.58	0.39	5.44
WNW	0.03	0.21	0.52	3.09	0.34	0.40	0.43	5.02
NW	0.04	0.50	1.30	6.14	0.99	2.11	2.69	13.76
NNW	0.01	0.20	0.66	2.55	0.46	0.80	0.72	5.40
Calm	0.12	0.35	1.04	0.61	0.00	0.99	3.36	8.47
Total Class Freq (%)	0.64	7.05	13.65	47.05	7.92	10.78	12.90	100.00
Av Wind Speed (mph)	4.30	5.50	7.30	10.70	8.00	4.65	1.73	7.81

[a] See Table 4.3.2-13 for explanation of stability class designations. Data are based upon 43,846 hourly observations during the 1960-1964 period.

Source: National Oceanic and Atmospheric Administration, 1978[3]

TABLE 4.3.2-15

MEAN SEASONAL AND ANNUAL MORNING AND AFTERNOON MIXING HEIGHTS NASHVILLE - TENNESSEE

Season	Mixing Height (feet)[a]		
	Morning	Afternoon	Daily Average
Winter	1,847	3,683	2,765
Spring	1,988	5,848	3,918
Summer	1,446	6,147	3,797
Fall	1,171	4,831	3,001
Annual	1,614	5,126	3,370

[a] Five year (1960-1964) period of record

Source: Holzworth, 1972[16]

TABLE 4.3.3-1

INFORMAL WEATHER OBSERVATIONS AT BASKETT SITE AREA
DURING THE ACOUSTIC MEASUREMENT PERIOD
(Daytime)

Location	Description	Day	Date	Time	°F DT	°F WT	RH %	Wind Speed (mph)	Wind Direction	Clouds	Bar Press. mbar
A	At residential home near Tscharner Road	Monday	8/07/78	10:20	80	70	60	Calm		Sunny	1007
B	At seasonal home near Green River	Monday	8/07/78	11:55	79	69	60	Calm		Partly Sunny	1004
C	On the property of Henderson Golf and Country Club	Monday	8/07/78	17:10	85	66	35	0-4	N	Sunny	1001
D	Near Baskett Christian Church	Monday	8/07/78	19:00	83	69	48	Calm		Sunny	1005
E	At residential home near Tillman Bethel Road	Tuesday	8/08/78	09:50	79	72	70	Calm		Sunny	1018
F	At residential home near Tillman Bethel Road	Tuesday	8/08/78	12:00	86	74	56	2-3	S	Sunny	1013
I	At the site boundary near Tscharner Road	Thursday	8/10/78	07:45	74	71	85	2-3	SW	Sunny	1010
II	At the entrance to Henderson Golf and Country Club near Route 60	Thursday	8/10/78	08:10	79	73	74	2	SE	Sunny	1009

RH - Relative Humidity
Bar Press - Barometric Pressure
DT - Dry Bulb Temperature
WT - Wet Bulb Temperature

TABLE 4.3.3-2

INFORMAL WEATHER OBSERVATIONS AT BASKETT SITE AREA
DURING THE ACOUSTIC MEASUREMENT PERIOD
(Nighttime)

Location	Description	Day	Date	Time	°F DT	°F WT	RH %	Wind Speed (mph)	Wind Direction	Clouds	Bar Press. mbar
A	At residential home near Tscharner Road	Wednesday	8/09/78	22:00	74	70	81	Calm		Clear	1010
B	At seasonal home near Green River	Thursday	8/10/78	06:00	69	67	90	Calm		Clear	1010
C	On the property of Henderson Golf and Country Club	Wednesday	8/09/78	00:35	74	71	85	4	S	Clear	1014
D	Near Baskett Christian Church	Wednesday	8/09/78	23:15	73	70	85	Calm		Clear	1010
E	At residential home near Tillman Bethel Road	Tuesday	8/08/78	22:00	76	72	81	Calm		Clear	1014
F	At residential home near Tillman Bethel Road	Tuesday	8/08/78	23:15	76	72	81	Calm		Clear	1014

RH - Relative Humidity
Bar Press - Barometric Pressure
DT - Dry Bulb Temperature
WT - Wet Bulb Temperature

TABLE 4.3.3-3

MEASURED AMBIENT SOUND LEVELS AT BASKETT SITE AREA
AUTOMATIC OBSERVATIONS
[dB(A)]
(Daytime)

Location	Description	Day	Date	Time	$L_{0.1}$	L_1	L_2	L_5	L_{10}	L_{20}	L_{50}	L_{90}	L_{99}	L_{min}	L_{max}	L_{eq}
A	At residential home near Tscharner Road	Monday	8/07/78	10:15 11:15	64	58	56	53	50	47	42	37	34	32	66	47
B	At seasonal home near Green River	Monday	8/07/78	11:45 12:45	72	68	66	63	58	53	42	36	33	32	76	56
C	On the property of Henderson Golf and Country Club	Monday	8/07/78	17:00 18:00	55	50	47	45	43	42	40	38	37	36	62	42
D	Near Baskett Christian Church	Monday	8/07/78	18:55 19:55	77	63	60	55	52	50	47	42	39	37	84	55
E	At residential home near Tillman Bethel Road	Tuesday	8/08/78	09:35 10:35	60	54	52	49	47	44	40	37	36	35	62	44
F	At residential home near Tillman Bethel Road	Tuesday	8/08/78	11:55 12:55	48	44	43	41	38	36	33	31	30	30	53	36
I	At the site boundary near Tscharner Road	Thursday	8/10/78	07:15 07:45	63	52	50	49	48	47	45	42	41	40	64	46
II	At the entrance to Henderson Golf and Country Club, near Route 60	Thursday	8/10/78	08:05 08:35	73	72	69	65	62	59	54	48	44	43	74	59

TABLE 4.3.3-4

MEASURED AMBIENT SOUND LEVELS AT BASKETT SITE AREA

AUTOMATIC OBSERVATIONS

[dB(A)]

(Nighttime)

Location	Description	Day	Date	Time	$L_{0.1}$	L_{1}	L_{2}	L_{5}	L_{10}	L_{20}	L_{50}	L_{90}	L_{99}	L_{min}	L_{max}	L_{eq}
A	At residential home near Tscharner Road	Wednesday	8/09/78	22:00 23:00	70	66	65	64	62	58	54	43	41	41	71	57
B	At seasonal home near Green River	Thursday	8/10/78	05:55 06:55	62	51	49	47	46	46	45	42	42	41	65	45
C	On the property of Henderson Golf and Country Club	Wednesday	8/09/78	00:30 01:30	53	50	49	47	47	46	46	45	45	44	54	46
D	Near Baskett Christian Church	Wednesday	8/09/78	23:15 24:15	72	60	57	53	48	47	45	44	44	43	78	51
E	At residential home near Tillman Bethel Road	Tuesday	8/08/78	22:00 23:00	58	55	53	50	50	49	48	47	46	45	62	49
F	At residential home near Tillman Bethel Road	Tuesday	8/08/78	23:15 24:15	58	57	57	57	57	56	56	55	55	54	61	56

TABLE 4.3.3-5

MEASURED RESIDUAL SOUND LEVELS AT BASKETT SITE AREA
MANUAL OBSERVATIONS
(Daytime)

Location	Description	Day	Date	Time	dB(A)
A	At residential home near Tscharner Road	Monday	8/07/78	10:40	38
B	At seasonal home near Green River	Monday	8/07/78	12:15	36
C	On the property of Henderson Golf and Country Club	Monday	8/07/78	17:00	37
D	Near Baskett Christian Church	Monday	8/07/78	19:55	40
E	At residential home near Tillman Bethel Road	Tuesday	8/08/78	9:45	38
F	At residential home near Tillman Bethel Road	Tuesday	8/08/78	12:05	32
I	At the site boundary near Tscharner Road	Thursday	8/10/78	07:20	42
II	At the entrance to Henderson Golf and Country Club, near Route 60	Thursday	8/10/78	08:25	44

TABLE 4.3.3-6

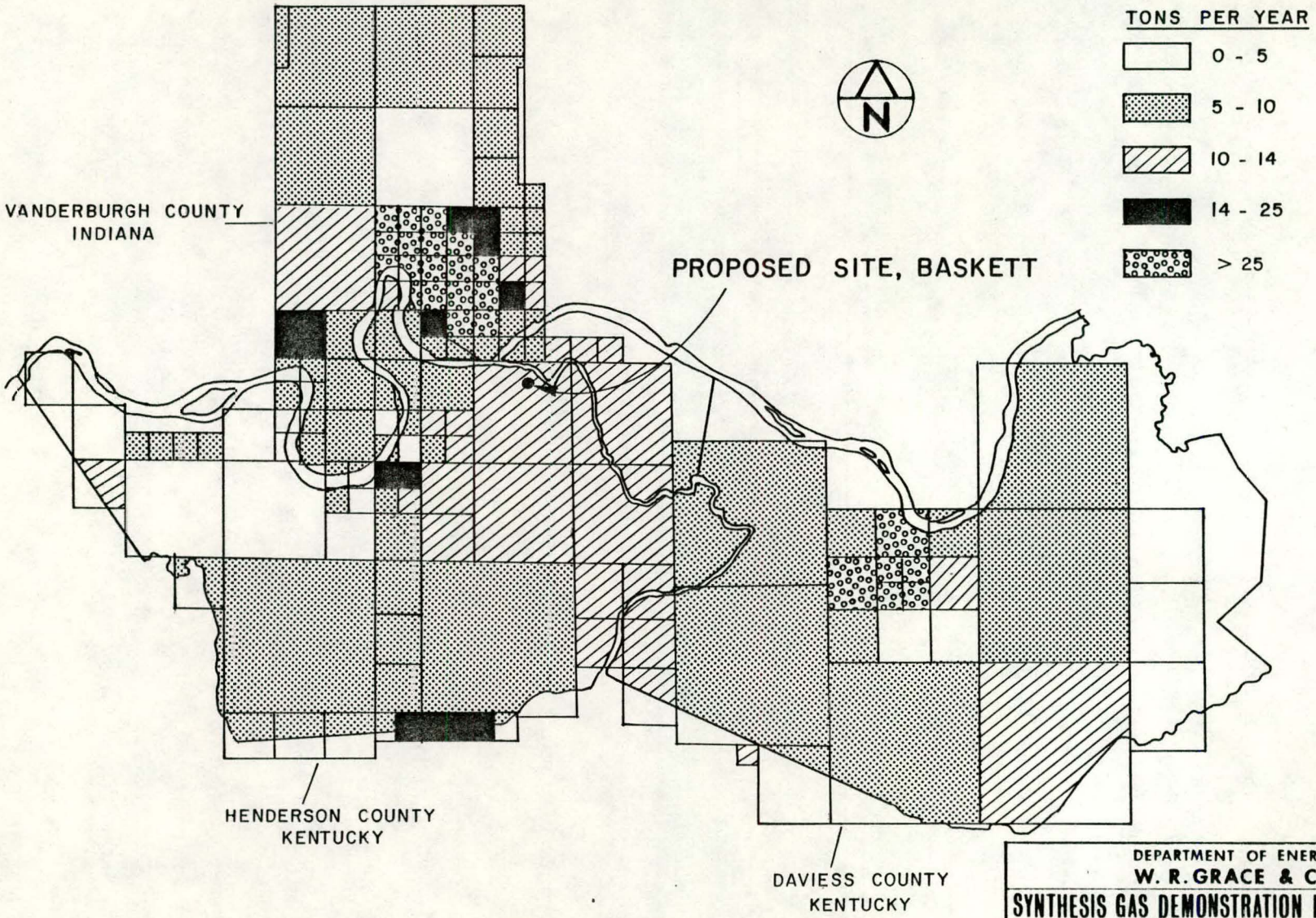
MEASURED RESIDUAL SOUND LEVELS AT BASKETT SITE AREA
MANUAL OBSERVATIONS
(Nighttime)

Location	Description	Day	Date	Time	dB(A)
A	At residential home near Tscharner Road	Wednesday	8/09/78	22:00	46
B	At seasonal home near Green River	Thursday	8/10/78	06:10	44
C	On the property of Henderson Golf and Country Club	Wednesday	8/09/78	00:30	46
D	Near Baskett Christian Church	Wednesday	8/09/78	23:45	43
E	At residential home near Tillman Bethel Road	Tuesday	8/08/78	22:00	45
F	At residential home near Tillman Bethel Road	Tuesday	8/08/78	23:45	53

TABLE 4.3.3-7

ESTIMATED SOUND LEVELS INDICATIVE OF THE AMBIENT FIELD AT BASKETT SITE

Location	Description	L_d Daytime)	L_n Nighttime)	L_{dn} (Day-night)
A	At residential home near Tscharner Road	47	57	63
B	At seasonal home near Green River	56	45	56
C	On the property of Henderson Golf and Country Club	42	46	52
D	Near Baskett Christian Church	55	51	58
E	At residential home near Tillman Bethel Road	44	49	55
F	At residential home near Tillman Bethel Road	36	56	62
I	At the site boundary near Tscharner Road	46	-	-
II	At the entrance to Henderson Golf and Country Club	59	-	-



Source: EPA, 1977 (1)

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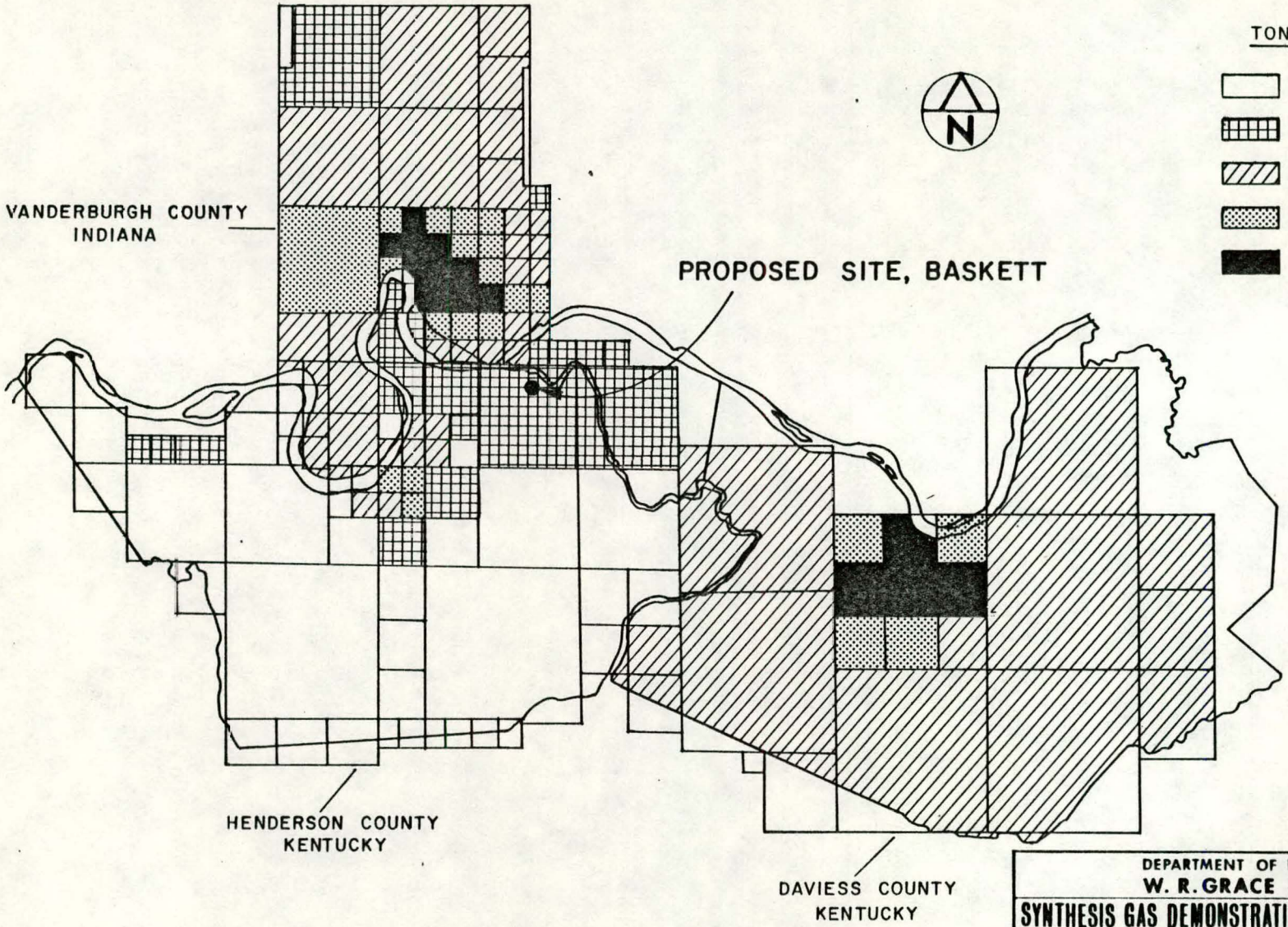
EBASCO SERVICES INCORPORATED

1974 EMISSION DENSITY OF PARTICULATES FROM AREA SOURCES IN VANDERBURGH HENDERSON AND DAVIESS COUNTIES

FIGURE 4.3.1-1



Source: EPA, 1977 (1)

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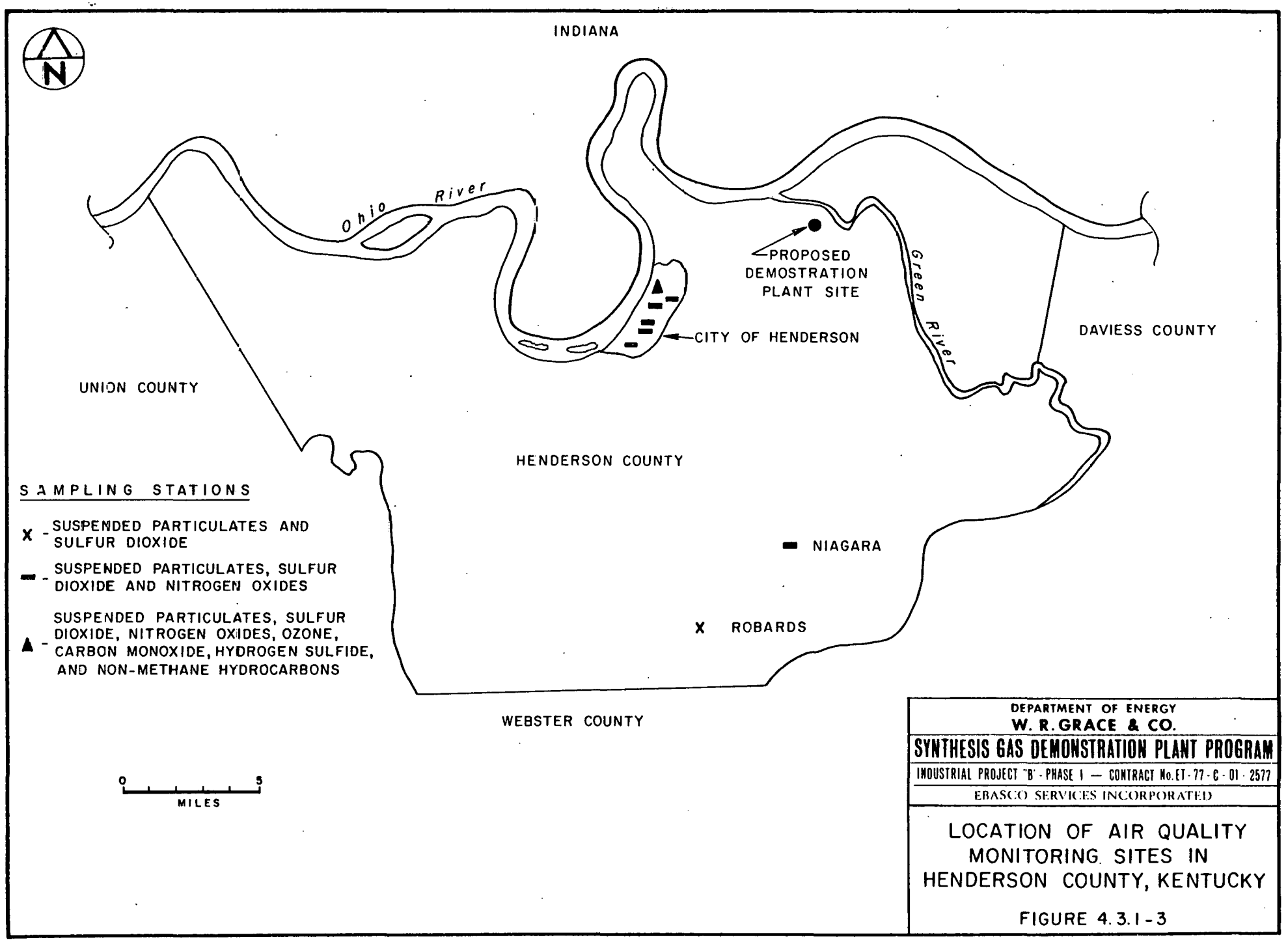
1974 EMISSION DENSITY OF SULFUR DIOXIDE FROM AREA SOURCES IN VANDERBURGH HENDERSON AND DAVIESS COUNTIES

FIGURE 4.3.1-2


INDIANA
N
Ohio River
Green River
PROPOSED DEMOSTRATION PLANT SITE
CITY OF HENDERSON
DAVIESS COUNTY
UNION COUNTY
HENDERSON COUNTY
NIAGARA
ROBARDS
WEBSTER COUNTY
SAMPLING STATIONS
X - SUSPENDED PARTICULATES AND SULFUR DIOXIDE
- SUSPENDED PARTICULATES, SULFUR DIOXIDE AND NITROGEN OXIDES
▲ - SUSPENDED PARTICULATES, SULFUR DIOXIDE, NITROGEN OXIDES, OZONE, CARBON MONOXIDE, HYDROGEN SULFIDE, AND NON-METHANE HYDROCARBONS
0
5
MILES
DEPARTMENT OF ENERGY
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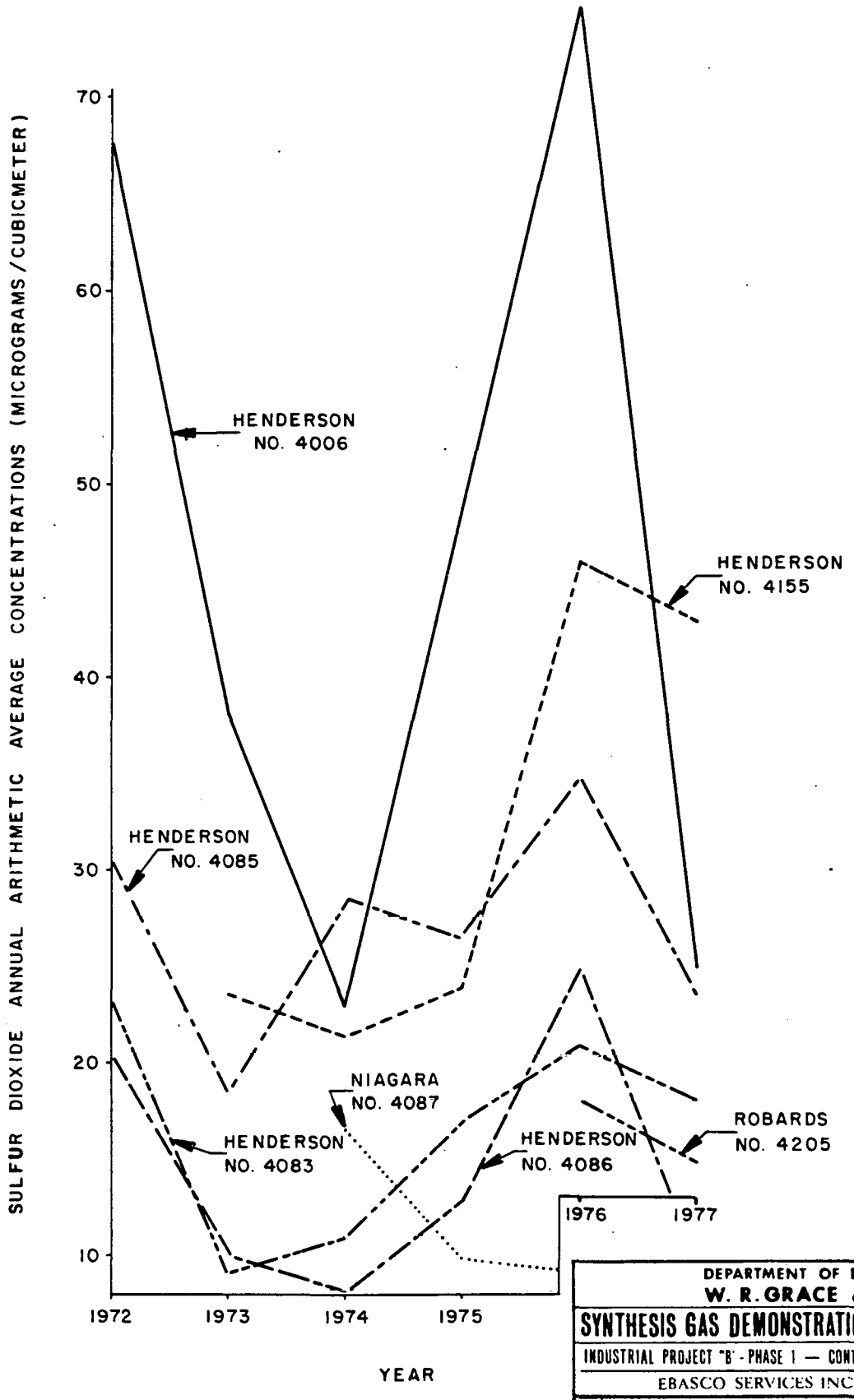
SYNTHESIS GAS DEMONSTRATION PLANT PROGRAM
INDUSTRIAL PROJECT "B" - PHASE 1 — CONTRACT No. ET-77-C-01-2577
EBASCO SERVICES INCORPORATED
LOCATION OF AIR QUALITY MONITORING SITES IN HENDERSON COUNTY, KENTUCKY
FIGURE 4.3.1-3



SOURCE : KENTUCKY DIVISION OF AIR POLLUTION CONTROL (4-9)

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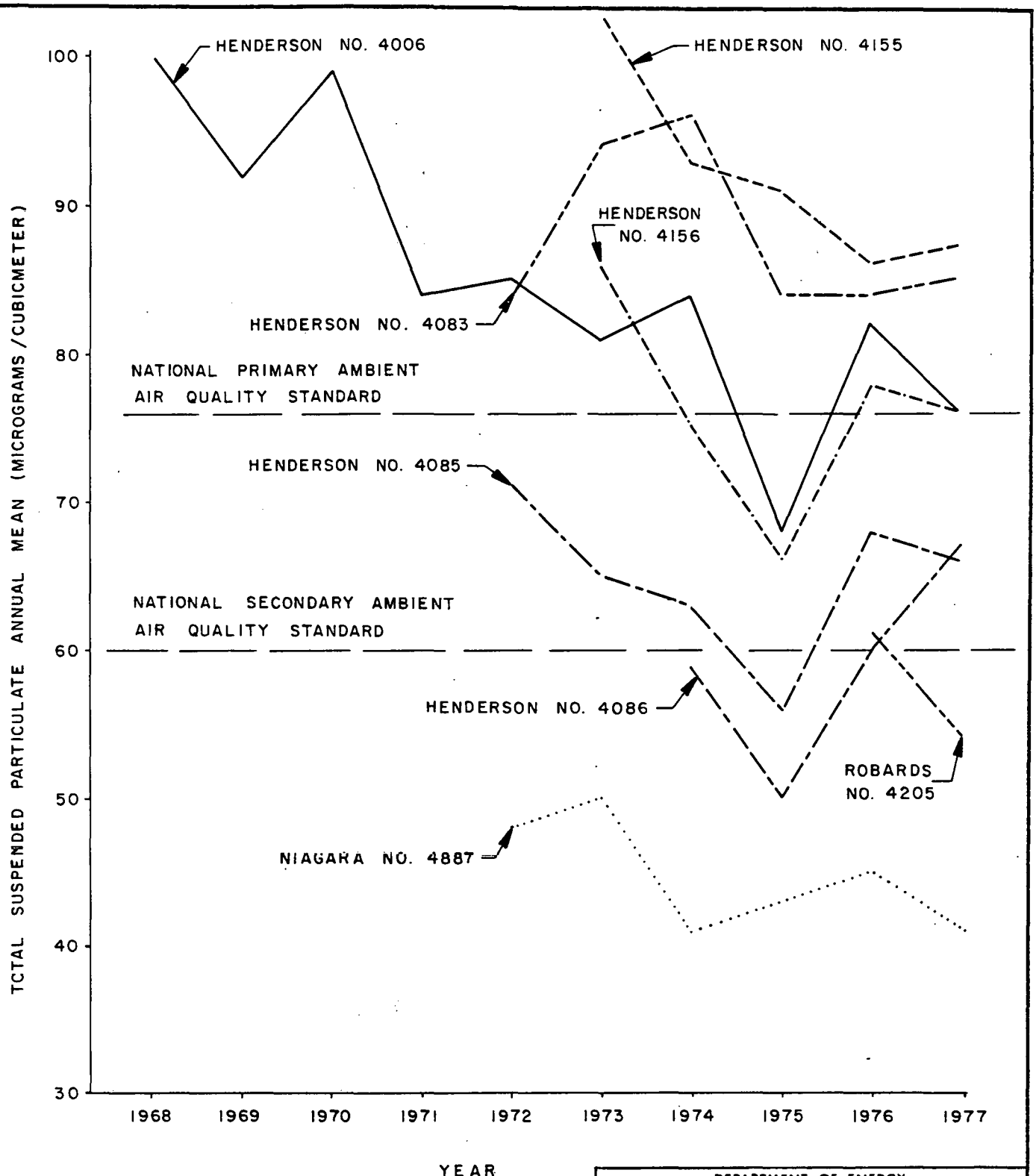
SULFUR DIOXIDE ANNUAL ARITHMETIC AVERAGE CONCENTRATIONS, HENDERSON COUNTY SITES

FIGURE 4.3.1-4



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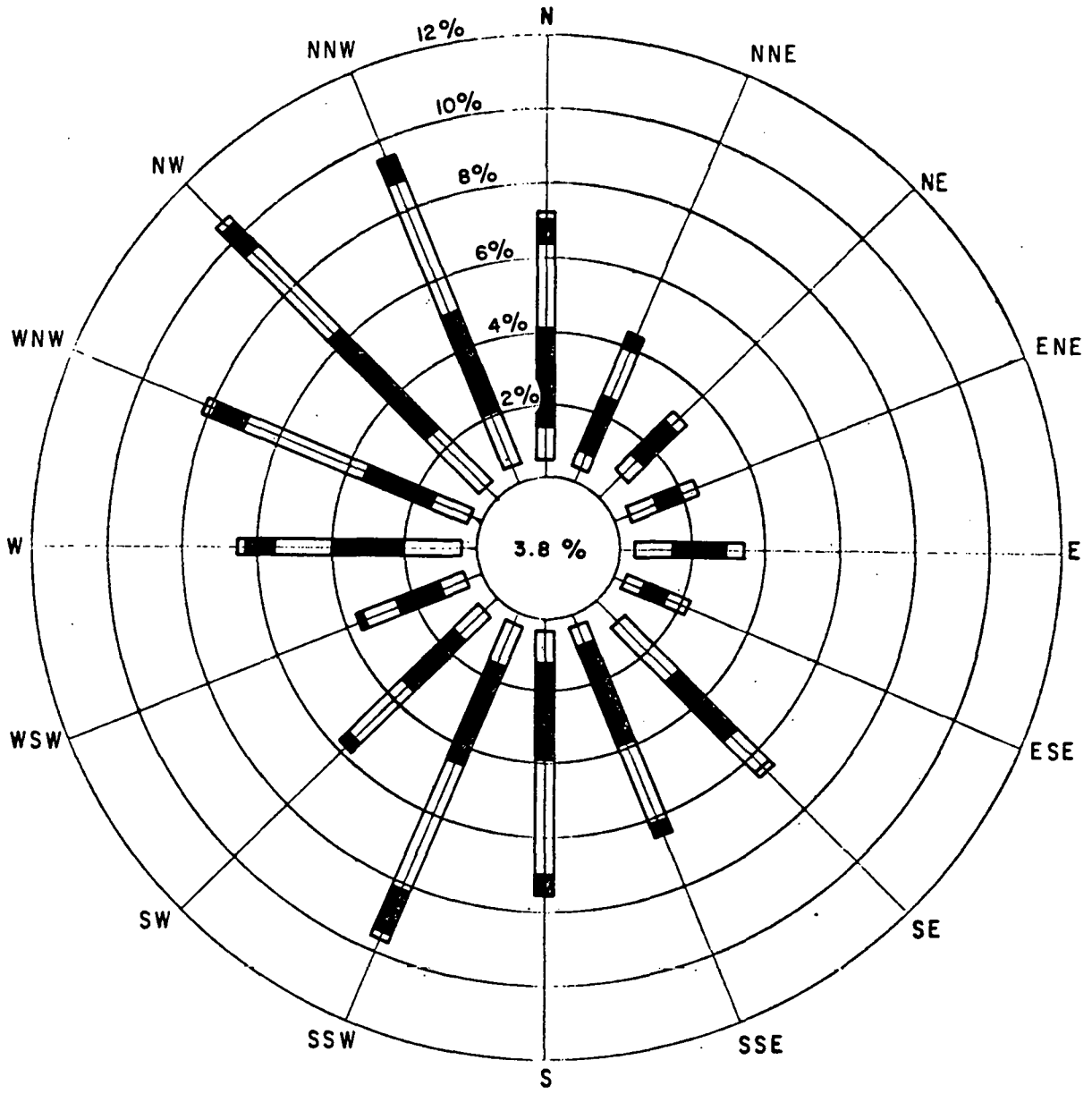
SOURCE : KENTUCKY DIVISION OF AIR POLLUTION CONTROL [4-9]

TOTAL SUSPENDED PARTICULATE ANNUAL GEOMETRIC MEANS FOR HENDERSON COUNTY SITES

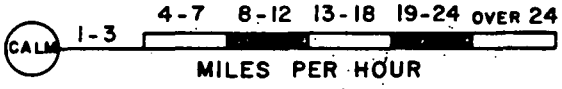
FIGURE 4.3.1-5



PERCENTAGE FREQUENCIES OF WIND DIRECTION AND SPEED:

DIRECTION	HOURLY OBSERVATIONS OF WIND SPEED (IN MILES PER HOUR)										AV. SPEED
	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	47 OVER	TOTAL	
N	.5	.9	2.6	2.4	.7	.1				7.1	11.9
NNE	.3	.7	1.6	1.3	.2					4.2	10.7
NE	.6	1.0	1.0	.3	+					2.9	7.6
ENE	.4	.9	.7	.4	+					2.4	8.0
E	.6	1.1	1.3	.6	+					3.6	8.2
ESE	.2	.7	.6	.6	+					2.1	9.1
SE	.8	2.2	2.2	1.3	.1					6.5	8.6
SSE	.3	.7	2.9	2.2	.2					6.3	11.2
S	.3	1.0	2.6	3.2	.5					7.6	12.2
SSW	.3	1.1	3.0	3.7	1.2	.2	+			9.5	13.1
SW	.6	1.1	2.0	1.6	.4	+				5.9	10.7
WSW	.4	.7	1.3	1.0	.1					3.4	10.1
W	.5	1.5	2.0	1.7	.5	.1	+			6.3	11.0
WNW	.4	1.2	2.1	3.3	.9	.2				8.1	12.6
NW	.7	2.0	3.6	3.3	1.1	.2	+			10.9	11.7
NNW	.5	1.6	3.1	3.6	.7	+				9.5	11.6
CALM	3.8									3.8	
TOTAL	11.1	18.4	32.5	30.6	6.7	.7	.1			100	10.7

Source : United States Weather Bureau , 1963 (4)



7440 OBSERVATIONS

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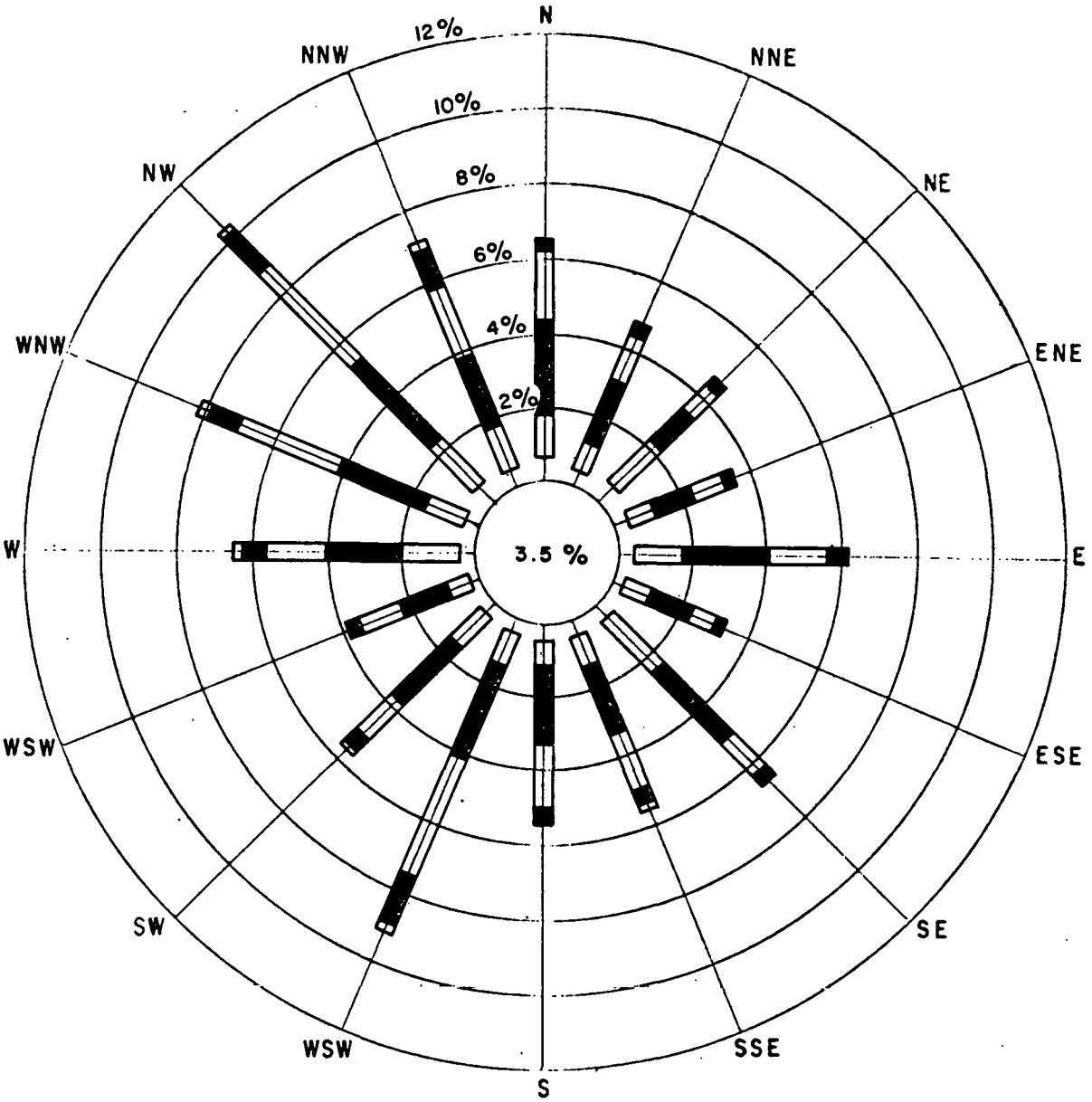
SYNTHESIS GAS DEMONSTRATION PLANT PROGRAM

INDUSTRIAL PROJECT "B" - PHASE I — CONTRACT No. ET-77-C-01-2577

EBASCO SERVICES INCORPORATED

SURFACE WIND ROSE
EVANSVILLE , INDIANA
JANUARY (1951 - 1960)

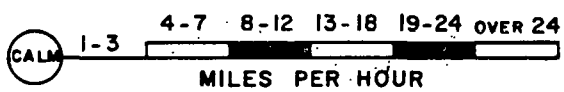
FIGURE 4.3.2-1



PERCENTAGE FREQUENCIES
B OF WIND DIRECTION AND SPEED:

DIRECTION	HOURLY OBSERVATIONS OF WIND SPEED (IN MILES PER HOUR)										AV SPEED
	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	47 OVER	TOTAL	
N	.6	1.3	2.5	1.6	.4	*				6.7	10.6
NNE	.3	.9	1.8	1.5	.2					4.6	10.9
NE	.7	1.5	1.5	.9	.1					4.7	8.7
ENE	.3	.8	1.4	.8	.1					3.4	9.6
E	.4	1.4	2.2	1.7	.3	*				6.1	10.4
ESE	.2	.9	1.3	.6	.1					3.1	9.6
SE	.6	2.1	2.6	1.3	.2	*		*		6.7	9.3
SSE	.4	.8	2.1	1.7	.4	.1				5.5	11.5
S	.4	.8	2.1	1.6	.4	*	*			5.4	11.2
SSW	.4	.9	2.8	3.2	1.5	.3	*			9.1	13.6
SW	.3	1.4	2.1	1.3	.4	.1	*			5.6	10.9
WSW	.2	.7	1.3	1.2	.4	*				3.8	11.7
W	.5	1.5	2.0	1.7	.5	.1	.1			6.4	11.0
WNW	.4	1.1	2.6	3.0	.9	.2	.1			8.2	12.7
NW	.7	1.8	2.8	3.5	1.3	.1				10.2	12.2
NNW	.4	1.4	2.1	2.0	1.0	.2				7.1	12.1
CALM	3.5									3.5	
TOTAL	10.2	19.8	33.2	27.6	8.1	1.2	.2	*		100	10.9

Source : United States Weather Bureau , 1963 (4)



6792 OBSERVATIONS

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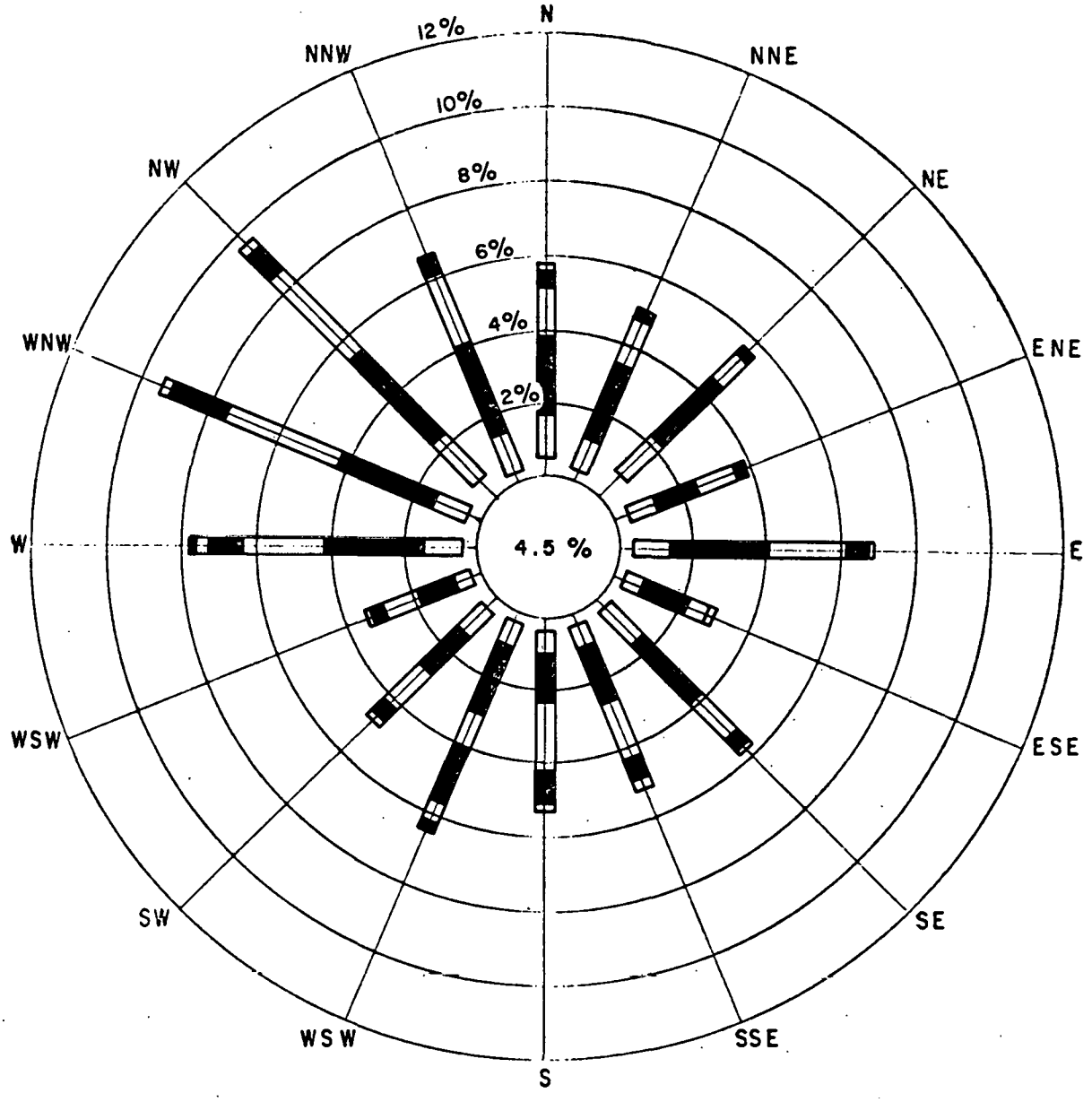
EBASCO SERVICES INCORPORATED

SURFACE WIND ROSE
EVANSVILLE , INDIANA
FEBRUARY (1951 - 1960)

FIGURE 4.3.2-2



PERCENTAGE FREQUENCIES
B OF WIND DIRECTION AND SPEED:

DIRECTION	HOURLY OBSERVATIONS OF WIND SPEED (IN MILES PER HOUR)									TOTAL	AV SPEED
	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	47 OVER		
N	.5	1.3	2.4	1.7	.3	.1				5.9	10.5
NNE	.4	.8	2.1	1.5	.1	+				4.7	10.5
NE	.8	1.4	2.2	1.0	.2	+				5.5	9.1
ENE	.3	.8	1.3	1.1	.4	+				3.8	11.3
E	.4	1.2	2.4	2.1	.8	.1				6.9	11.8
ESE	.2	.7	1.2	.7	.1	+		+		2.8	10.2
SE	.4	1.2	2.3	1.2	.3	.1	+			5.6	10.6
SSE	.2	.8	1.7	1.4	.5	.2	+			5.1	12.0
S	.2	.8	1.5	1.8	.8	.1	+			5.2	13.2
SSW	.3	.7	2.2	2.7	1.9	.3	.1			8.2	14.8
SW	.3	.9	1.7	1.4	.3	.1				4.7	11.4
WSW	.2	.5	1.2	1.1	.4	.1	+			3.4	12.9
W	.4	1.3	2.5	2.2	.8	.4	.1	+		7.7	12.7
WNW	.4	1.2	2.6	3.3	1.6	.3	+			9.4	13.6
NW	.7	1.6	3.1	3.2	.9	.1				9.7	11.6
NNW	.3	1.3	2.4	2.1	.5	+				6.6	11.3
CALM	4.5									4.5	
TOTAL	10.5	16.3	32.1	28.6	9.9	2.2	.2	+		100	11.4

Source : United States Weather Bureau , 1963 (4)

CALM 1-3 4-7 8-12 13-18 19-24 OVER 24
MILES PER HOUR

7440 OBSERVATIONS

DEPARTMENT OF ENERGY
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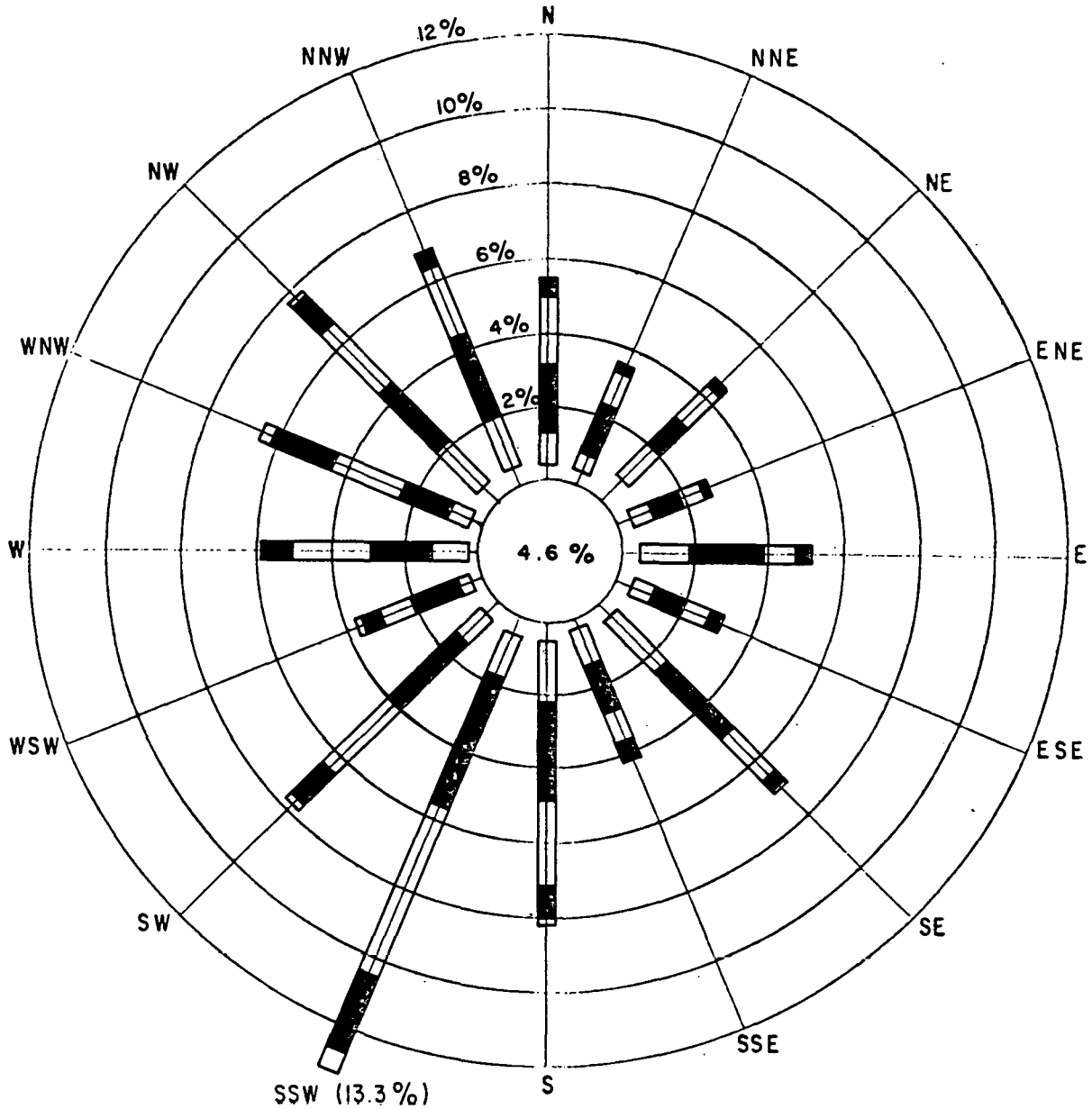
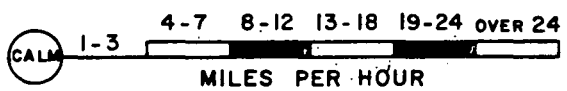
SYNTHESIS GAS DEMONSTRATION PLANT PROGRAM
INDUSTRIAL PROJECT "B" - PHASE 1 — CONTRACT No. ET-77-C-01-2577
EBASCO SERVICES INCORPORATED

SURFACE WIND ROSE
EVANSVILLE , INDIANA
MARCH (1951 - 1960)

FIGURE 4.3.2-3





7200 OBSERVATIONS

B PERCENTAGE FREQUENCIES OF WIND DIRECTION AND SPEED:

DIRECTION	HOURLY OBSERVATIONS OF WIND SPEED (IN MILES PER HOUR)												AV SPEED
	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	OVER 46	TOTAL			
N	.4	.9	2.0	1.6	.3					5.3	11.1		
NNE	.3	.6	1.4	1.1	.2					3.6	10.6		
NE	.9	1.1	1.2	1.1	.1	+				4.4	9.1		
ENE	.3	.8	.8	.7	.1					2.7	9.4		
E	.6	1.3	2.0	1.1	.3	+				5.2	9.6		
ESE	.3	.8	.9	.8	.2	+			+	3.0	10.2		
SE	.7	1.8	2.5	1.4	.4	.1	+			6.9	9.9		
SSE	.2	1.1	1.6	.9	.2	.1	+			4.1	10.7		
S	.6	1.5	2.8	2.4	.8	.1				6.1	11.6		
SSW	.4	1.4	3.7	5.1	2.1	.4	.1			13.3	13.8		
SW	.3	1.0	2.7	2.6	.9	.5				7.8	12.8		
WSW	.1	.6	1.3	1.0	.4	.1				3.6	12.3		
W	.2	1.1	1.7	2.0	.8	.2			+	6.0	13.2		
WNW	.2	.8	1.6	2.1	1.4	.5	.1			6.4	14.4		
NW	.8	1.4	2.5	2.1	.8	.1	+			7.8	11.3		
NNW	.5	1.5	2.3	2.0	.5	+	+			6.9	11.0		
CALM	4.6									4.6			
TOTAL	11.5	17.7	31.0	28.2	9.5	1.8	.2	+		100	11.2		

Source : United States Weather Bureau , 1963 (4)

DEPARTMENT OF ENERGY
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SYNTHESIS GAS DEMONSTRATION PLANT PROGRAM
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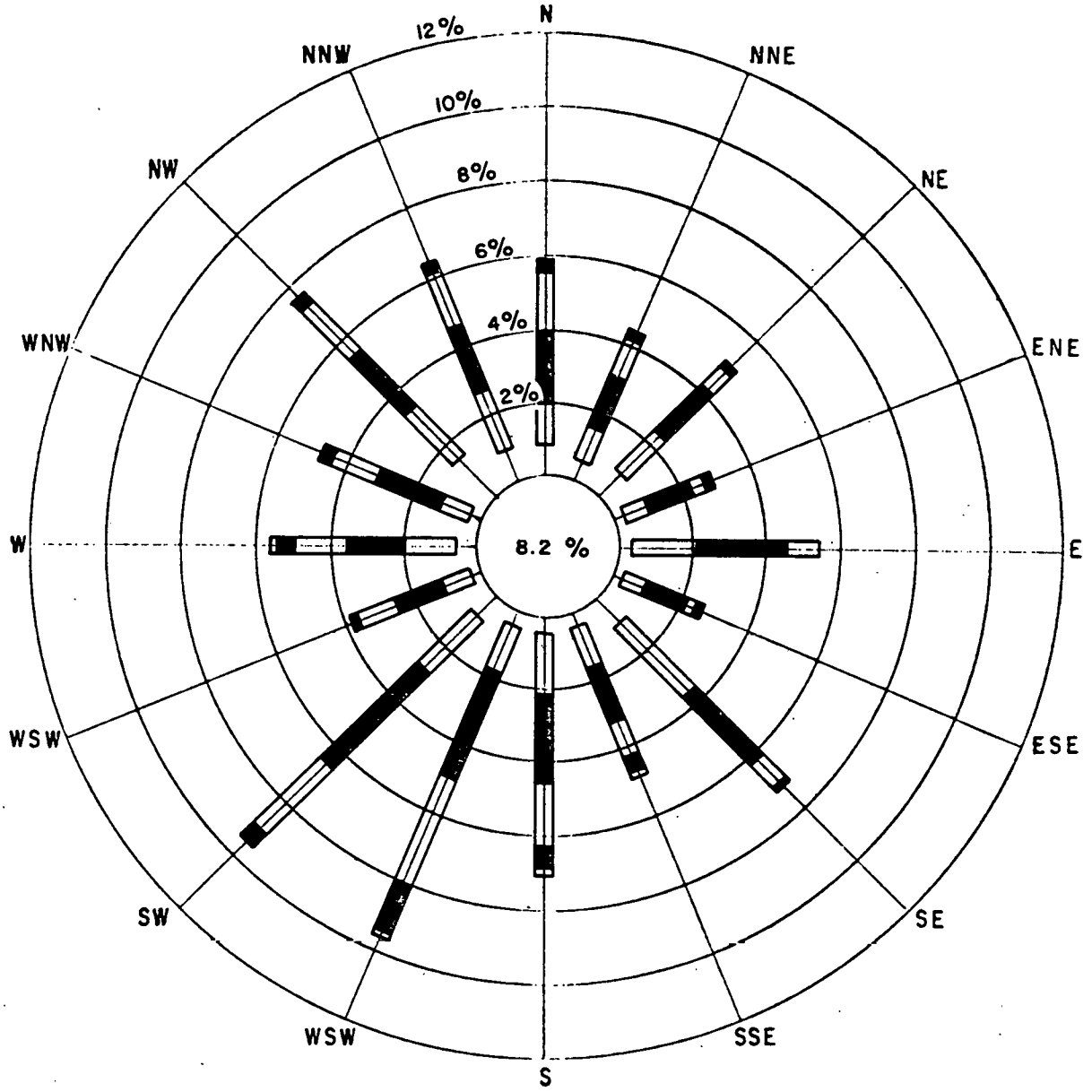
EBASCO SERVICES INCORPORATED

SURFACE WIND ROSE
EVANSVILLE , INDIANA
APRIL (1951 - 1960)

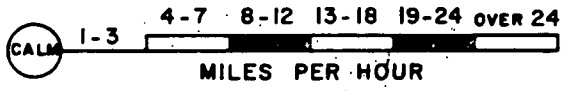
FIGURE 4.3.2-4



B PERCENTAGE FREQUENCIES OF WIND DIRECTION AND SPEED:

DIRECTION	HOURLY OBSERVATIONS OF WIND SPEED (MILES PER HOUR) 0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	47 OVER	TOTAL	AV SPEED
N	.8	1.2	1.9	1.5	.6	+				5.9	10.1
NNE	.4	1.0	1.7	1.1	.2					4.3	10.0
NE	.9	1.5	1.7	.7	.1					5.0	8.2
ENE	.3	.8	1.2	.5	.1					2.8	9.1
E	.5	1.6	2.4	.9	+					5.3	8.7
ESE	.2	.8	1.1	.3	.1					2.5	8.6
SE	1.0	2.5	2.7	.9	.1					7.2	8.0
SSE	.5	1.2	1.7	1.2	.3	.1	+			4.8	10.3
S	.7	1.5	2.5	1.7	.6	.1	+			7.0	10.6
SSW	.4	1.4	3.1	3.1	1.3	.2				9.5	12.7
SW	.8	2.0	3.6	2.5	.5	+				9.4	10.4
WSW	.2	.9	1.6	.9	.2	+				3.9	10.6
W	.7	1.3	1.7	1.2	.3	.1	+			5.3	10.0
WNW	.3	.8	2.0	1.5	.3		+			4.9	11.1
NW	1.7	1.9	2.0	1.6	.3	+	+			7.7	8.8
NNW	1.0	1.6	2.0	1.4	.1		+	+		6.3	9.1
CALM	8.2									8.2	
TOTAL	18.7	22.3	32.6	21.0	4.8	.6	.1	+		100	9.1

Source : United States Weather Bureau , 1963 (4)



7440 OBSERVATIONS

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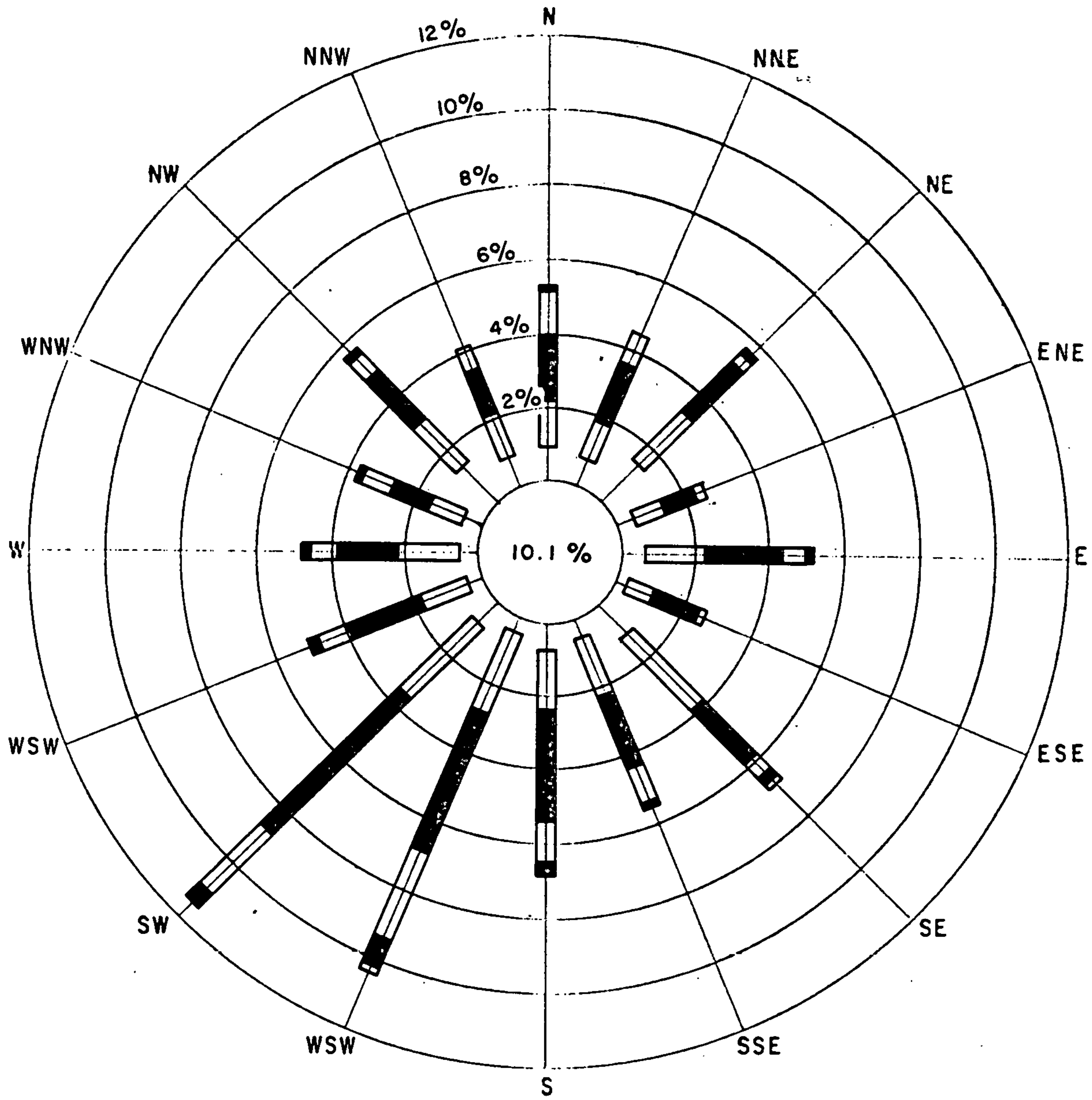
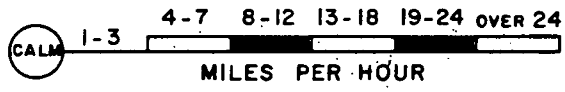
SYNTHESIS GAS DEMONSTRATION PLANT PROGRAM
INDUSTRIAL PROJECT "B" - PHASE I — CONTRACT No. ET-77-C-01-2577
EBASCO SERVICES INCORPORATED

SURFACE WIND ROSE
EVANSVILLE , INDIANA
MAY (1951-1960)

FIGURE 4.3.2-5





7200 OBSERVATIONS

B PERCENTAGE FREQUENCIES OF WIND DIRECTION AND SPEED:

DIRECTION	HOURLY OBSERVATIONS OF WIND SPEED (IN MILES PER HOUR) 0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	47 OVER	TOTAL	AV. SPEED
N	.9	1.3	1.8	1.0	.1	*				5.7	8.8
NNE	.8	1.1	1.8	.9	*	*		*		4.6	8.8
NE	1.4	2.0	1.8	.6	.1					5.8	7.1
ENE	.4	.9	.9	.3	*					2.6	8.0
E	.7	1.7	2.0	.8	.1		*			5.0	9.0
ESE	.2	.9	.9	.2	.1	*				2.4	8.4
SE	1.1	2.8	2.0	.7	.1	.1				6.7	7.8
SSE	.6	1.7	2.1	1.1	.1					5.6	9.1
S	.6	1.7	3.1	1.1	.2	*				6.9	9.2
SSW	.5	2.4	3.9	2.7	.8	.2	*			10.4	11.0
SW	.7	2.8	5.2	2.5	.4					11.5	9.9
WSW	.3	1.5	2.1	1.1	.2	*				5.1	9.7
W	.6	1.6	1.7	.7	.1					4.7	8.4
WNW	.5	.9	1.6	.8	.1	*				3.7	9.3
NW	1.3	1.8	1.7	.6	.1			*		5.6	7.4
NNW	.8	1.3	1.4	.5	*	*				4.1	7.7
CALM	10.1									10.1	
TOTAL	21.7	26.4	33.7	15.3	2.3	.4	*	*		100	8.0

Source: United States Weather Bureau, 1963 (4)

DEPARTMENT OF ENERGY
W. R. GRACE & CO.

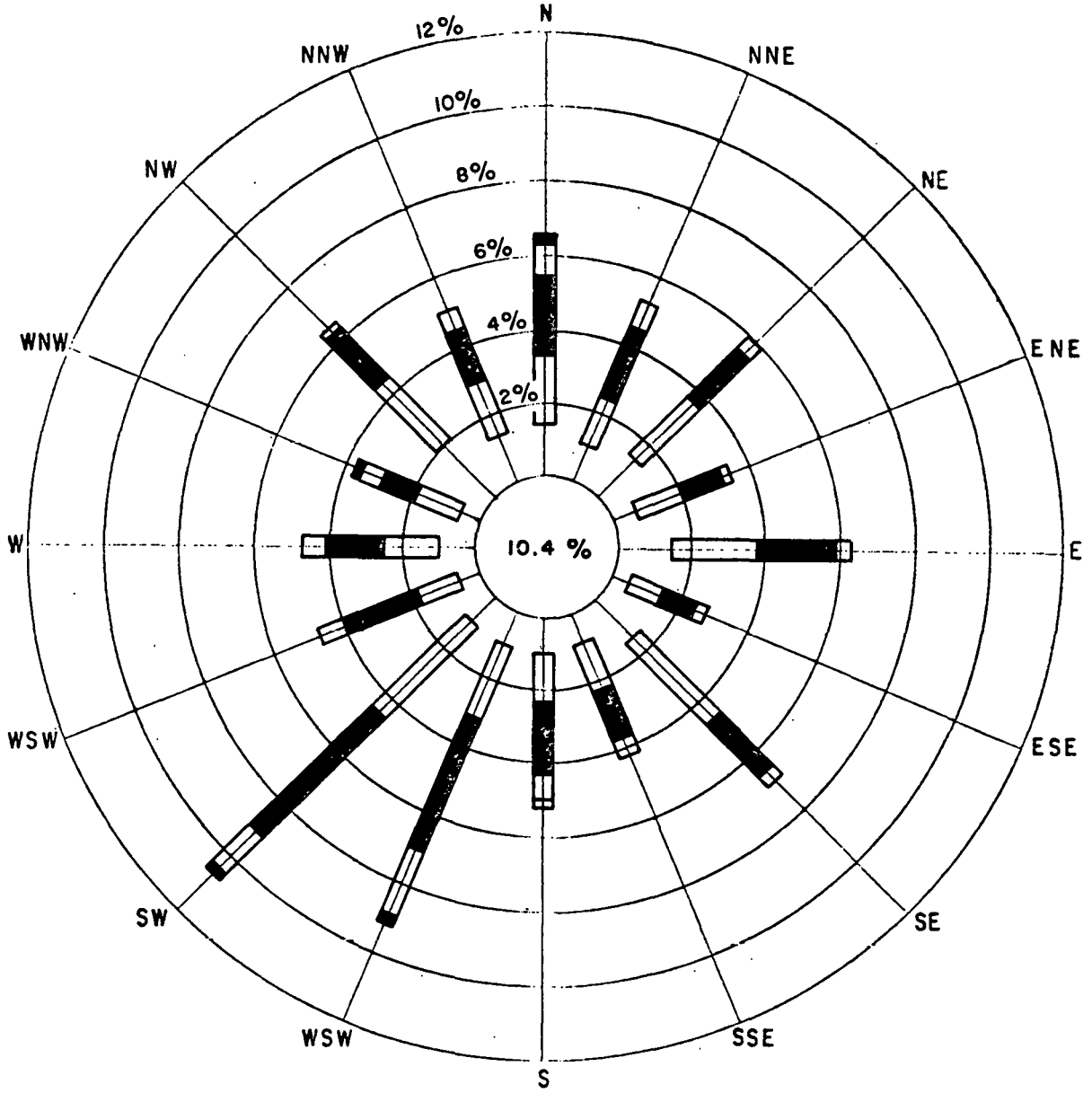
SYNTHESIS GAS DEMONSTRATION PLANT PROGRAM

INDUSTRIAL PROJECT "B" - PHASE I — CONTRACT No. ET-77-C-01-2577

EBASCO SERVICES INCORPORATED

SURFACE WIND ROSE
EVANSVILLE, INDIANA
JUNE (1951 - 1960)

FIGURE 4.3.2-6



PERCENTAGE FREQUENCIES
B OF WIND DIRECTION AND SPEED

DIRECTION	HOURLY OBSERVATIONS OF WIND SPEED (IN MILES PER HOUR)												AV SPEED
	0 - 3	4 - 7	8 - 12	13 - 18	19 - 24	25 - 31	32 - 38	39 - 46	47 OVER	TOTAL	
N	1.7	1.8	2.1	.6	.1					6.3	7.2
NNE	1.0	1.3	2.0	.8	.4					5.1	8.2
NE	1.6	2.2	1.8	.4						6.0	6.6
ENE	.7	1.4	1.1	.2						3.4	6.7
E	1.4	2.5	2.0	.4	+					6.3	6.8
ESE	.4	1.2	.6	.2						2.6	6.7
SE	1.4	3.0	2.0	.4	+					6.8	6.6
SSE	.7	1.6	1.4	.3		+				4.1	7.2
S	.9	1.6	1.7	.7	.1					5.0	8.0
SSW	.8	2.4	3.7	1.9	.3					9.1	9.5
SW	1.1	3.2	4.7	1.6	.2	+				10.8	8.9
WSW	.5	1.3	2.1	.7	+					4.6	8.8
W	1.0	1.5	1.5	.6	+			+		4.7	7.8
WNW	.7	1.2	1.0	.4	.1	+				3.5	7.6
NW	2.0	2.5	1.4	.4	.1	+				6.5	6.3
NNW	1.5	1.7	1.4	.4	+	+				5.1	6.8
CALM	10.4									10.4	
TOTAL	27.9	30.4	30.4	10.1	1.0	.1		+		100	6.8

Source : United States Weather Bureau , 1963 (4)

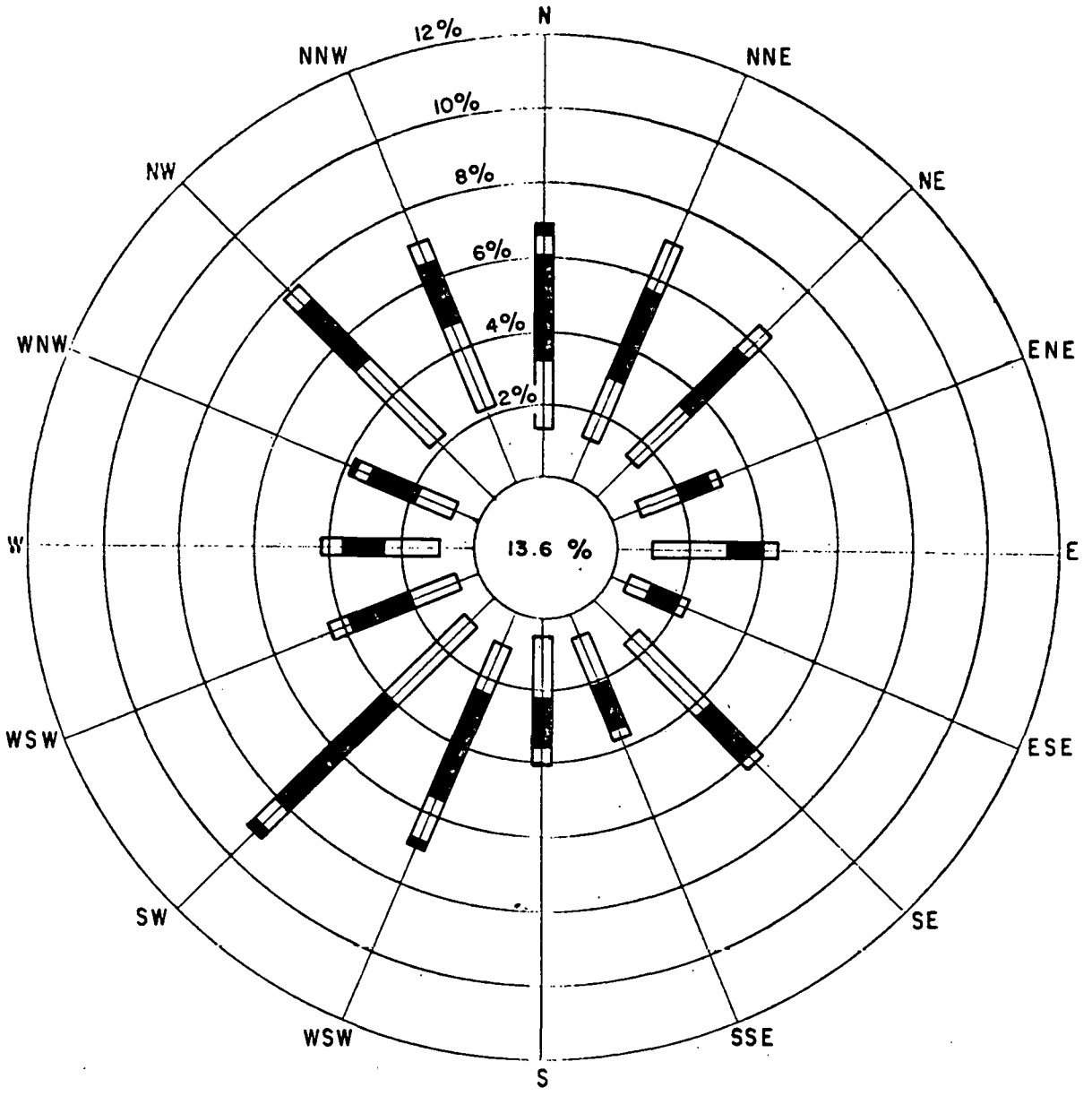
CALM 1-3 4-7 8-12 13-18 19-24 OVER 24
MILES PER HOUR

7440 OBSERVATIONS

DEPARTMENT OF ENERGY
W. R. GRACE & CO.
SYNTHESIS GAS DEMONSTRATION PLANT PROGRAM
INDUSTRIAL PROJECT "B" - PHASE 1 — CONTRACT No. ET-77-C-01-2577
EBASCO SERVICES INCORPORATED

SURFACE WIND ROSE
EVANSVILLE , INDIANA
JULY (1951 - 1960)

FIGURE 4.3.2-7



B PERCENTAGE FREQUENCIES OF WIND DIRECTION AND SPEED:

DIRECTION	HOURLY OBSERVATIONS OF WIND SPEED (IN MILES PER HOUR)											AV SPEED
	0-3	4-7	8-12	13-18	19	24	25-31	32-38	39-46	47 OVER	TOTAL	
N	1.3	2.1	2.6	.7	.1						6.8	7.8
NNE	1.3	1.7	2.8	1.2	+						7.0	8.4
NE	1.6	2.1	2.1	.6	+						6.4	7.0
ENE	.7	1.3	.9	.3	+						3.2	6.9
E	1.0	2.0	1.1	.3	+						4.3	6.3
ESE	.4	.8	.8	.1							2.1	6.8
SE	1.4	2.9	1.7	.2							6.2	6.3
SSE	.6	1.5	1.3	.6							3.7	7.5
S	.5	1.8	1.9	.3	+						4.0	7.2
SSW	.8	1.7	3.0	1.4	.1	+					6.9	9.0
SW	1.0	3.0	4.0	.8	.1						8.9	8.1
WSW	.6	1.4	1.8	.5							4.3	8.0
W	.9	1.5	1.3	.4							4.1	7.1
WNW	.7	1.2	1.3	.4	.1						3.7	7.6
NW	2.2	3.2	1.9	.5	+						7.8	6.2
NNW	2.1	2.8	1.8	.4	+						6.9	6.1
CALM	13.6										13.6	
TOTAL	30.7	30.9	29.6	8.4	.4	+					100	6.9

Source: United States Weather Bureau, 1963 (4)

CALM 1-3 4-7 8-12 13-18 19-24 OVER 24

MILES PER HOUR

7440 OBSERVATIONS

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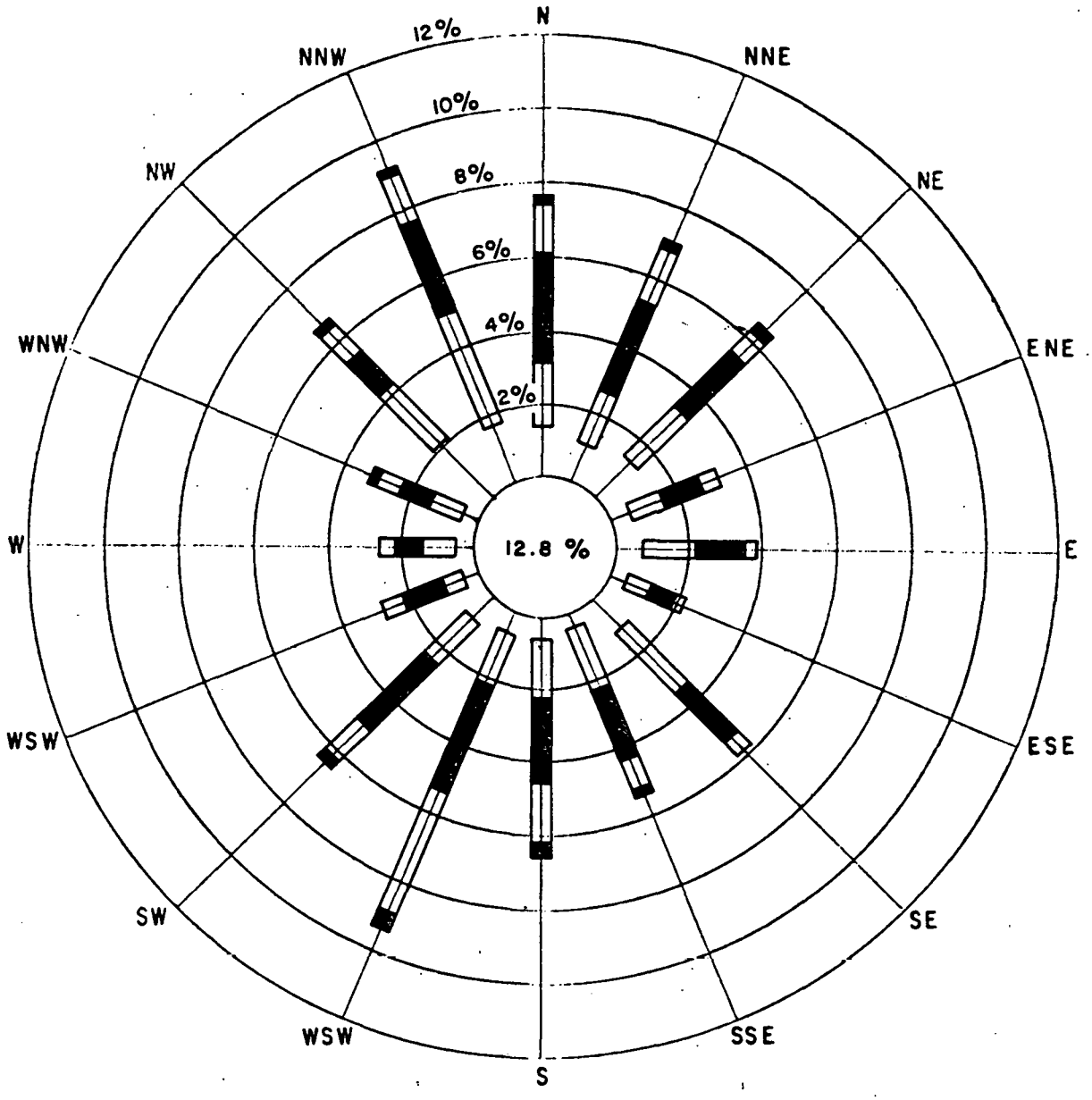
SYNTHESIS GAS DEMONSTRATION PLANT PROGRAM

INDUSTRIAL PROJECT "B" - PHASE I — CONTRACT No. ET-77-C-01-2577

EBASCO SERVICES INCORPORATED

SURFACE WIND ROSE
EVANSVILLE, INDIANA
AUGUST (1951 - 1960)

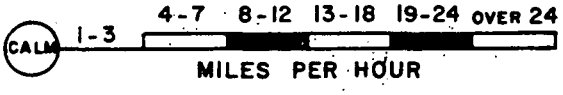
FIGURE 4.3.2-8



PERCENTAGE FREQUENCIES
B OF WIND DIRECTION AND SPEED:

DIRECTION	HOURLY OBSERVATIONS OF WIND SPEED (IN MILES PER HOUR)										AV SPEED
	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	47 OVER	TOTAL	
N	1.6	1.8	2.7	1.4	.1					7.6	8.4
NNE	1.1	1.6	2.6	1.4	.1					6.9	8.8
NE	1.4	2.0	2.2	.7	.1	+				6.3	7.5
ENE	.6	.9	1.1	.5	+					3.1	7.7
E	.8	1.4	1.3	.4	+					3.9	7.3
ESE	.4	.8	.7	.2						2.1	7.2
SE	1.1	2.4	1.9	.6	+		+			5.9	7.3
SSE	.5	1.8	2.0	.9	.1	+				5.3	8.9
S	.7	1.5	2.5	1.6	.3					6.5	9.8
SSW	.6	1.6	3.5	3.2	.5	+				9.4	11.2
SW	.9	1.6	2.6	1.2	.1					6.3	8.7
WSW	.4	.8	.9	.3	+					2.4	7.9
W	.5	.9	.7	.3	+	+				2.4	7.4
WNW	.5	.9	.9	.7	.1					3.1	9.0
NW	2.0	2.2	1.5	.8	.2	+				6.7	7.1
NNW	1.8	3.2	2.8	1.3	.1	+				9.1	7.8
CALM	12.8									12.8	
TOTAL	27.7	25.4	29.9	15.1	1.8	.1	+			100	7.4

Source: United States Weather Bureau, 1963 (4)



7200 OBSERVATIONS

DEPARTMENT OF ENERGY
W. R. GRACE & CO.

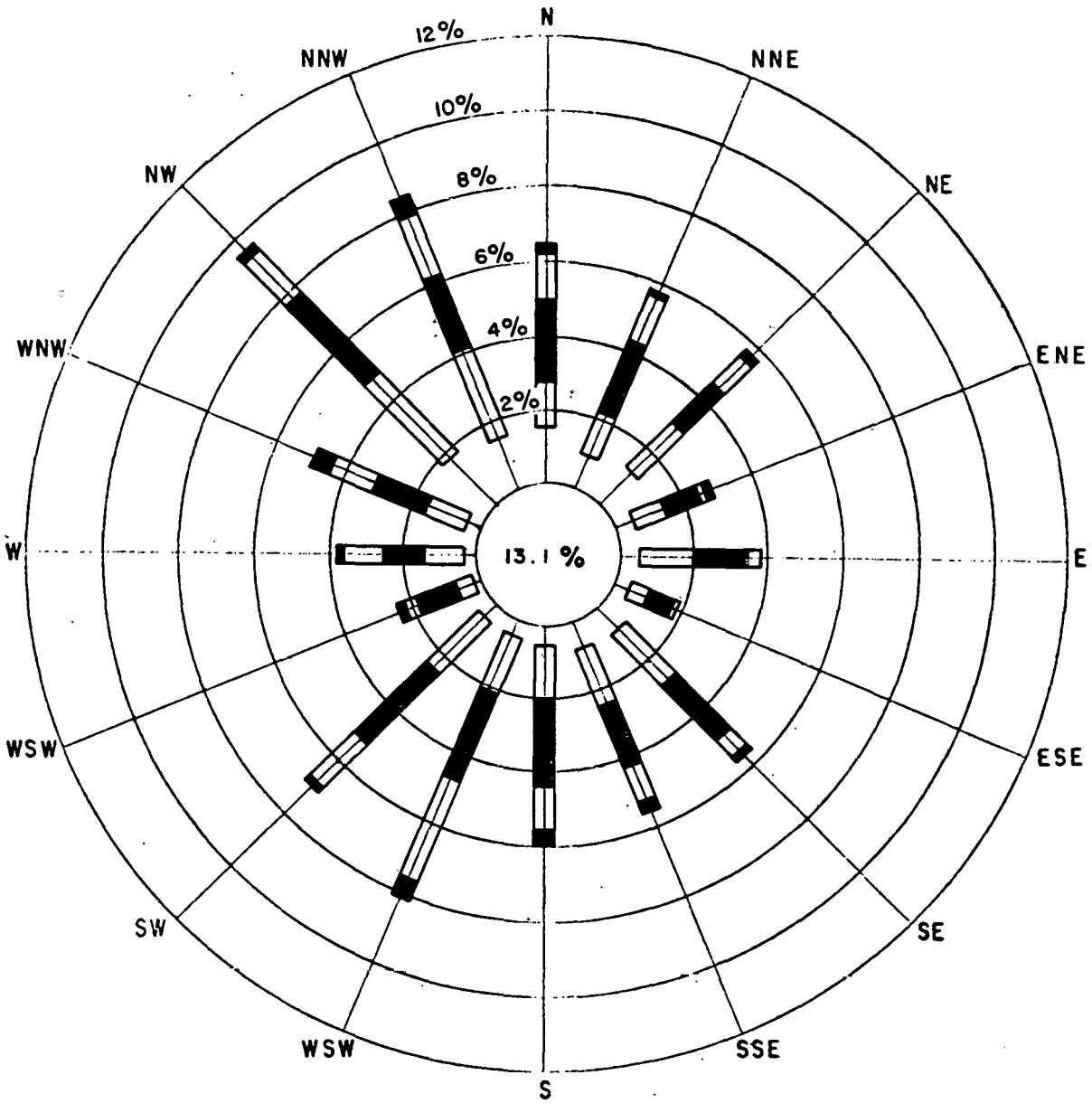
SYNTHESIS GAS DEMONSTRATION PLANT PROGRAM

INDUSTRIAL PROJECT "B" - PHASE 1 — CONTRACT No. ET-77-C-01-2577

EBASCO SERVICES INCORPORATED

SURFACE WIND ROSE
EVANSVILLE, INDIANA
SEPTEMBER (1951 - 1960)

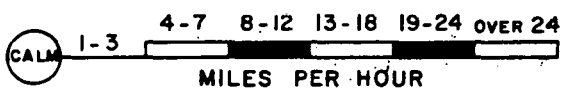
FIGURE 4.3.2-9



PERCENTAGE FREQUENCIES
B OF WIND DIRECTION AND SPEED:

DIRECTION	HOURLY OBSERVATIONS OF WIND SPEED (IN MILES PER HOUR) 0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	47 OVER	TOTAL	AV SPEED
N	1.5	1.4	2.1	1.1	.1					6.3	8.2
NNE	.9	1.3	2.2	1.5	.1	+				5.8	9.1
NE	1.3	1.7	1.7	.8	.1	+				5.7	7.6
ENE	.6	1.0	.8	.3	.1	+				2.8	7.7
E	.7	1.3	1.3	.4						3.8	7.6
ESE	.3	.6	.6	.1						1.7	7.2
SE	.9	2.0	1.9	.5	.1					5.5	7.5
SSE	.8	1.7	1.6	.9	.2	+				5.3	8.8
S	.6	1.4	2.4	1.3	.2	+				5.9	9.7
SSW	.5	1.6	2.7	2.6	.7	+				8.1	11.3
SW	.7	1.8	2.7	1.6	.2	+				7.0	9.6
WSW	.2	.6	1.1	.3	.1					2.4	9.1
W	.5	.9	1.2	.9	.2	+				3.8	9.7
WNW	.4	1.1	1.7	1.5	.3	+	+			4.9	10.7
NW	1.8	3.1	2.9	1.8	.2	+				9.8	8.3
NNW	1.5	2.6	2.3	1.6	.3	+				8.3	8.6
CALM	13.1									13.1	
TOTAL	26.3	24.1	29.4	17.2	2.8	.2	+			100	7.8

Source : United States Weather Bureau , 1963 (4)

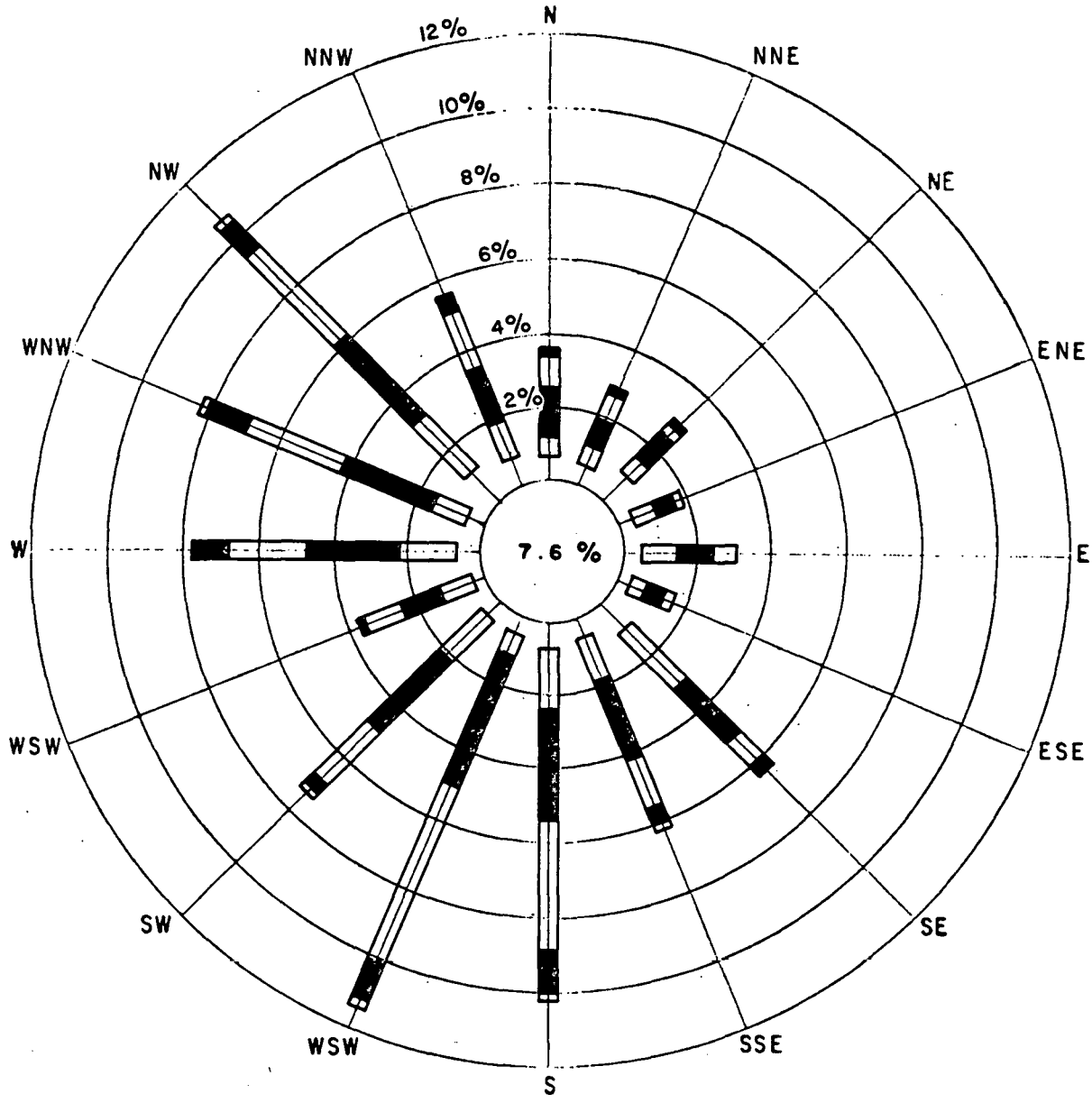


7440 OBSERVATIONS

DEPARTMENT OF ENERGY
W. R. GRACE & CO.
SYNTHESIS GAS DEMONSTRATION PLANT PROGRAM
INDUSTRIAL PROJECT "B" - PHASE 1 — CONTRACT No. ET-77-C-01-2577
EBASCO SERVICES INCORPORATED

SURFACE WIND ROSE
EVANSVILLE , INDIANA
OCTOBER (1951 - 1960)

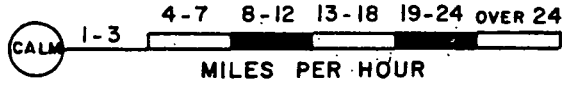
FIGURE 4.3.2-10



PERCENTAGE FREQUENCIES
B OF WIND DIRECTION AND SPEED:

DIRECTION	HOURLY OBSERVATIONS OF WIND SPEED (IN KNOTS PER HOUR) 1 - 3	4 - 7	8 - 12	13 - 18	19 - 24	25 - 31	32 - 38	39 - 46	47 OVER	TOTAL	AV SPEED
N	.4	.8	1.2	1.1	.1					3.6	9.9
NNE	.4	.6	.9	.7	.1					2.7	9.2
NE	.9	.8	.8	.3	.1					2.8	7.0
ENE	.5	.7	.5	.2	+	+				1.9	7.3
E	.6	.8	.9	.5	+					2.9	8.1
ESE	.2	.7	.4	.2	+					1.5	7.6
SE	1.0	2.2	2.1	.8	.1	+	+			6.3	8.1
SSE	.4	1.5	2.2	1.4	.5	.1				6.1	10.8
S	.7	1.7	3.3	3.2	1.1	.2				10.2	12.0
SSW	.4	1.5	4.0	4.3	1.0	.2	+	+		11.4	12.5
SW	.7	1.5	2.8	1.8	.3	.1	+			7.2	10.3
WSW	.2	1.0	1.5	.9	.2	+				3.8	10.4
W	.7	1.6	2.6	2.0	.8	+	+			7.8	11.0
WNW	.5	1.2	2.5	2.8	1.0	.1				8.1	12.5
NW	1.2	2.1	2.8	3.5	.9	.1				10.6	11.0
NNW	.8	1.1	1.7	1.5	.4	+				5.5	10.2
CALM	7.6									7.6	
TOTAL	17.1	19.6	30.1	25.3	6.6	.9	.1	+		100	9.8

Source : United States Weather Bureau , 1963 (4)



7200 OBSERVATIONS

DEPARTMENT OF ENERGY
W. R. GRACE & CO.

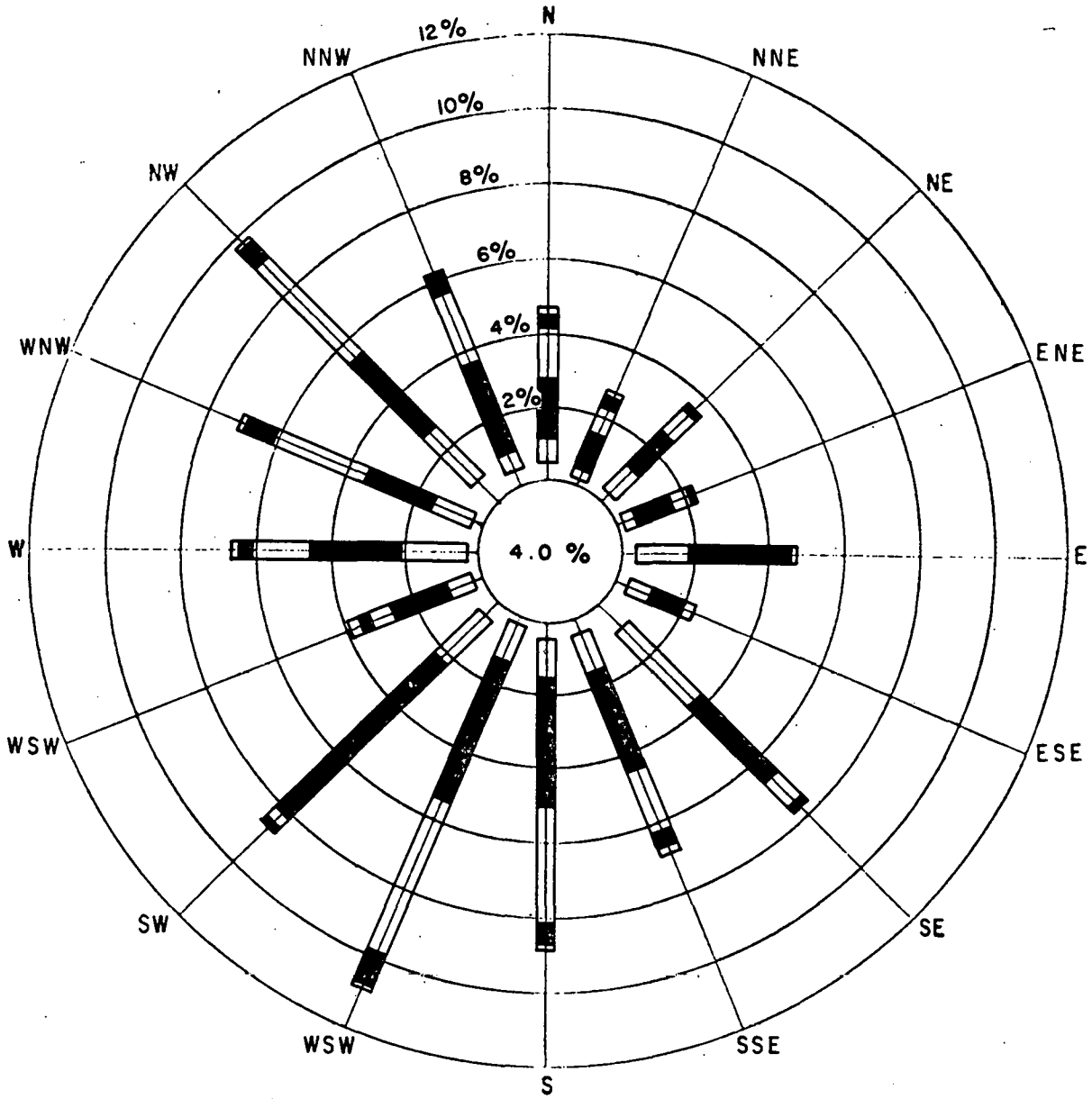
SYNTHESIS GAS DEMONSTRATION PLANT PROGRAM

INDUSTRIAL PROJECT "B" - PHASE 1 — CONTRACT No. ET-77-C-01-2577

EBASCO SERVICES INCORPORATED

SURFACE WIND ROSE
EVANSVILLE , INDIANA
NOVEMBER (1951 - 1960)

FIGURE 4.3.2-11



B PERCENTAGE FREQUENCIES OF WIND DIRECTION AND SPEED:

DIRECTION	HOURLY OBSERVATIONS OF WIND SPEED (IN MILES PER HOUR)										AV SPEED
	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	47 OVER	TOTAL	
N	.5	.7	1.7	1.3	.3	.1				4.6	10.9
NNE	.2	.5	1.0	.7	.2	.1				2.7	11.2
NE	.7	.9	1.2	.7	.1					3.5	8.6
ENE	.2	.6	1.0	.4	.2	*				2.3	9.6
E	.7	1.2	2.1	.7	.1					4.8	8.8
ESE	.4	.7	.8	.3	*					2.2	8.2
SE	.9	2.9	2.9	1.0	.2	*				7.6	8.4
SSE	.3	1.2	2.9	1.9	.3	.1				6.7	11.0
S	.5	1.2	3.5	3.0	.5	.1				8.8	11.6
SSW	.1	1.3	4.1	4.6	1.0	.1	*			11.0	13.0
SW	.5	1.7	3.8	2.1	.3	.1				8.5	10.4
WSW	.2	.8	1.6	1.1	.2	.1				3.9	10.7
W	.4	1.7	2.6	1.4	.3	.1				6.4	10.3
WNW	.2	1.1	2.3	2.5	.9	.1				7.0	12.5
NW	.9	1.8	3.0	3.4	.5	.1				9.8	11.2
NNW	.4	1.5	1.9	1.9	.3	*	*			6.2	10.7
CALM	4.0									4.0	
TOTAL	11.1	19.3	36.4	27.0	5.3	1.0	*			100	10.3

Source : United States Weather Bureau , 1963 (4)

CALM 1-3 4-7 8-12 13-18 19-24 OVER 24

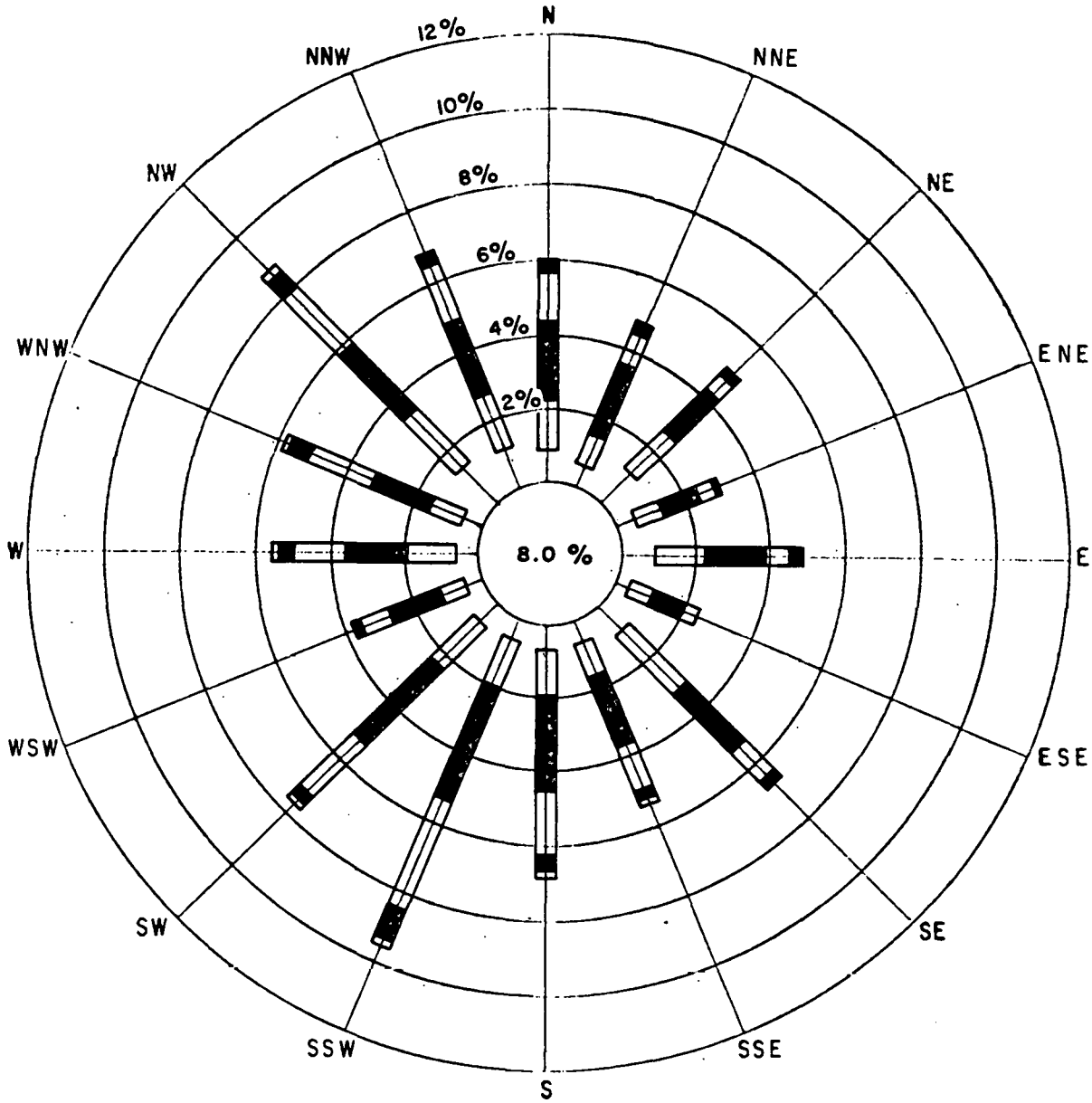
MILES PER HOUR

7440 OBSERVATIONS

DEPARTMENT OF ENERGY
W. R. GRACE & CO.
SYNTHESIS GAS DEMONSTRATION PLANT PROGRAM
INDUSTRIAL PROJECT "B" - PHASE I — CONTRACT No. ET-77-C-01-2577
EBASCO SERVICES INCORPORATED

SURFACE WIND ROSE
EVANSVILLE , INDIANA
DECEMBER (1951 - 1960)

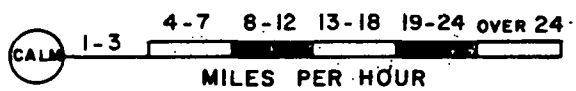
FIGURE 4.3.2-12



PERCENTAGE FREQUENCIES
B OF WIND DIRECTION AND SPEED:

DIRECTION	HOURLY OBSERVATIONS OF WIND SPEED (IN MILES PER HOUR)									AV SPEED
	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	47 OVER	TOTAL	
N	.9	1.3	2.1	1.4	.2	+				6.0	9.6
NNE	.6	1.0	1.8	1.1	.1	+		+		4.7	9.5
NE	1.1	1.5	1.6	.7	.1	+				4.9	7.8
ENE	.4	.9	1.0	.5	.1	+				2.8	8.5
E	.7	1.5	1.7	.8	.1	+	+			4.8	8.6
ESE	.3	.8	.8	.4	+	+		+		2.3	8.5
SE	.9	2.3	2.2	.9	.1	+	+	+		6.5	8.2
SSE	.5	1.3	2.0	1.2	.2	.1	+			5.2	10.1
S	.6	1.4	2.4	1.8	.4	.1	+			6.7	10.8
SSW	.5	1.5	3.3	3.2	1.0	.2	+	+		9.6	12.2
SW	.7	1.8	3.1	1.8	.3	.1	+			7.8	10.0
WSW	.3	.9	1.5	.8	.2	+	+			3.7	10.2
W	.6	1.4	1.8	1.2	.4	.1	+	+		5.4	10.4
WNW	.4	1.1	1.8	1.8	.6	.1	+			5.9	11.8
NW	1.4	2.1	2.4	2.1	.5	.1	+	+		8.6	9.7
NNW	1.0	1.8	2.1	1.6	.3	+	+	+		6.8	9.5
CALM	8.0									8.0	
TOTAL	18.8	22.6	31.7	21.2	4.9	.7	.1	+		100	9.1

Source : United States Weather Bureau , 1963 (4)



87,672 OBSERVATIONS

DEPARTMENT OF ENERGY
W. R. GRACE & CO.

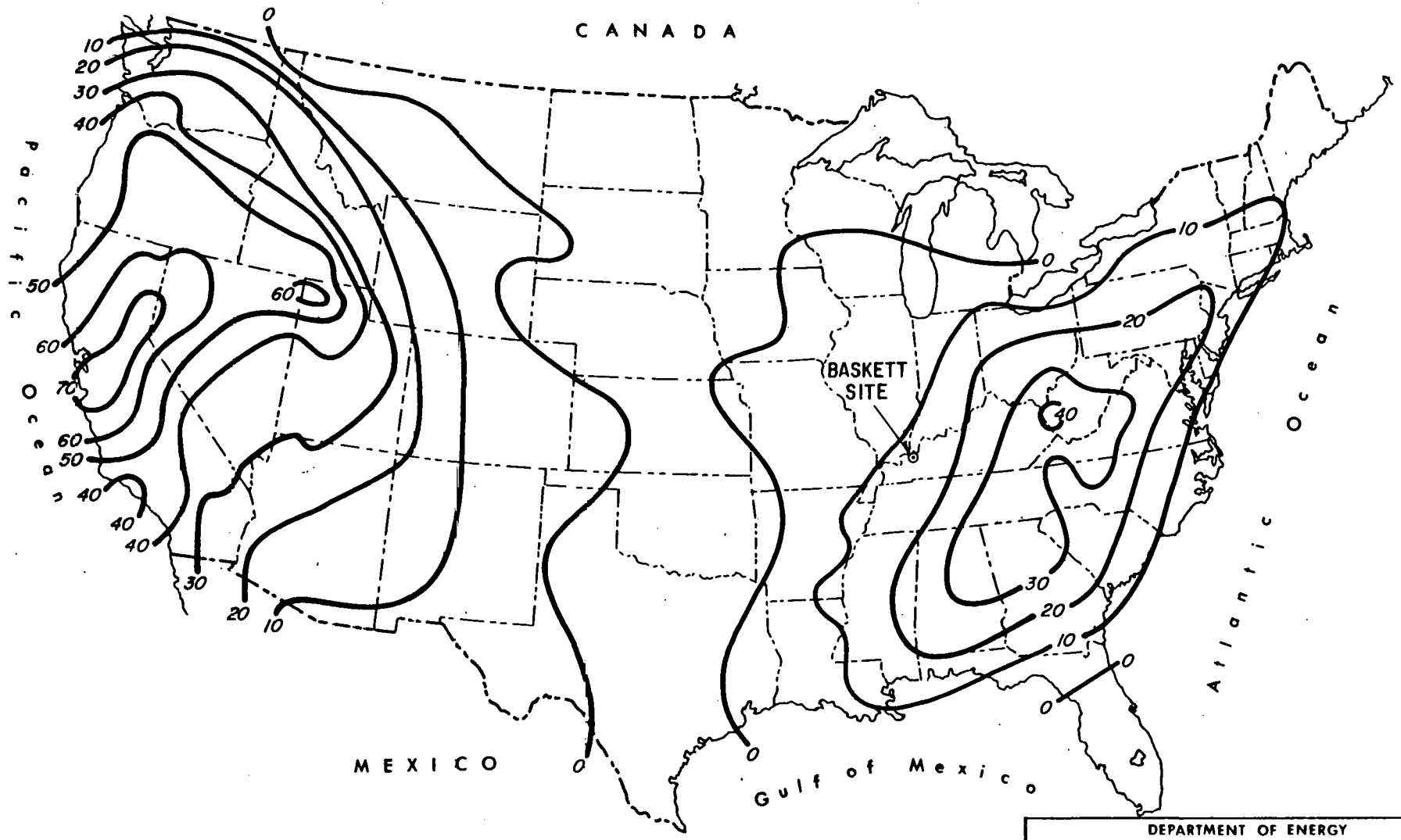
SYNTHESIS GAS DEMONSTRATION PLANT PROGRAM

INDUSTRIAL PROJECT "B" - PHASE I — CONTRACT No. ET-77-C-01-2577

EBASCO SERVICES INCORPORATED

SURFACE WIND ROSE
EVANSVILLE , INDIANA
ANNUAL (1951 - 1960)

FIGURE 4.3.2-13



SOURCE: HOLZWORTH, 1972 (16)

DEPARTMENT OF ENERGY
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SYNTHESIS GAS DEMONSTRATION PLANT PROGRAM
INDUSTRIAL PROJECT "B" - PHASE 1 — CONTRACT No. ET-77-C-01-2577
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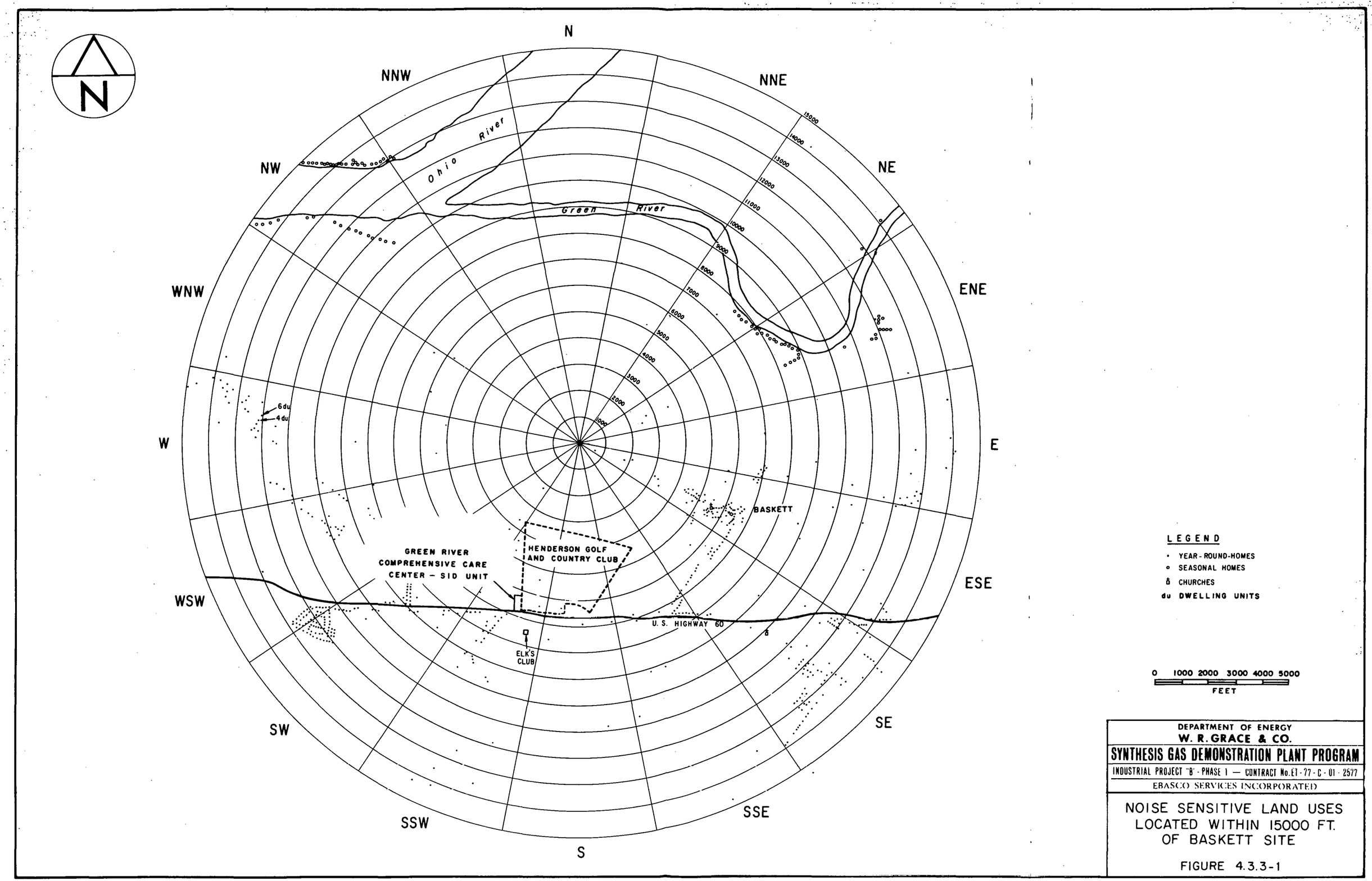
TOTAL NUMBER OF FORECAST-DAYS OF HIGH METEOROLOGICAL POTENTIAL FOR AIR POLLUTION IN A 5-YEAR PERIOD

FIGURE 4.3.2-14



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NOISE SENSITIVE LAND USES LOCATED WITHIN 15000 FT. OF BASKETT SITE

FIGURE 4.3.3-1

SEE TABLES 4.3.3-1 TO 4.3.3-7

0 2000 4000 6000 8000 10000

FEET

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SYNTHESIS GAS DEMONSTRATION PLANT PROGRAM

INDUSTRIAL PROJECT "B" - PHASE 1 — CONTRACT No. ET-77-C-01-2577

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AMBIENT SOUND MEASUREMENT LOCATIONS AT BASKETT SITE

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4.4 HYDROLOGY AND WATER QUALITY

4.4.1 SURFACE WATER HYDROLOGY

4.4.1.1 Description of Surface Water Hydrology

4.4.1.1.1 Green River

The Baskett Site is located on the Green River approximately 2 miles upstream of its confluence with the Ohio River. The Green River will serve as the source of water supply for the plant and will receive treated plant effluents.

4.4.1.1.1.1 Flow

Information pertaining to streamflow and reservoir parameters has been obtained from publications of the U.S. Geological Survey.[1] The drainage area of the Green River at the site is approximately 23,310 sq.km (9,000 sq. miles) of which about 4,070 sq. km.(1,570 sq. miles) do not contribute directly to surface runoff. The average discharge of the Green River as measured at Lock No. 2 at Calhoun, Kentucky, the nearest upstream gaging station, is 309 cu m/sec (10,920 cfs) from 45 years of record (1930-1975). The drainage area at this station is approximately 19,590 sq. km. (7,564 sq. miles) of which about 3,990 sq. km. (1,540 sq. miles) do not contribute directly to surface runoff. Based on the ratio of contributing area at the site to the contributing area at Lock and Dam No. 2 Calhoun, Kentucky (1.23), the average discharge at the Green River at the site is estimated to be about 382 cu m/sec (13,500 cfs) or about 70 percent of the average flow contributed to the Ohio River between Louisville, Kentucky and Evansville, Indiana.

Flow in the Green River at the site is regulated by upstream reservoirs on the Green, Barren, Nolin and Rough Rivers (see Figure 4.4.1-1). These reservoirs have a combined storage capacity of 577,760 x 10^3 cu m (468,390 ac-ft) available for seasonal flow regulation in addition to a combined capacity of 2,086,600-2,664,370 x 10^3 cu m (1,691,600 - 2,160,000 cu-ft) for flood control, depending on season. These reservoirs regulate approximately 36 percent of the drainage area of the Green River upstream of the site and can store approximately 5 percent of the annual average flow. Prominent parameters of these reservoirs are listed in Table 4.4.1-1, and their location relative to the site is illustrated in Figure 4.4.1-1.

When inflows are adequate, the Barren, Nolin, and Rough River Reservoirs are to release a minimum of 1.42 cu m/sec (50 cfs); and Green River Lake Reservoir is to release a minimum of 4.25 cu m/sec (150 cfs). However, releases are to be such that 11.33 cu m/sec (400 cfs) is always maintained at Livermore, about 101 km (63 miles) upstream of the mouth of the lowest flow which can be expected to occur in the Green River at the site. The Corps of Engineers, Louisville District, report no existing or future plans for modification to existing installations or construction of new facilities which would alter the present streamflow conditions at the site.

The water level in the Green River at the site, from the confluence with the Ohio River to the Spottsville Lock and Dam (River Mile 9) is controlled by Ohio River backwater created by the Uniontown Lock and Dam at Ohio River Mile 846. The normal pool elevation of the Green River at the site is 104.2 m (342 ft) MSL.[3] The water level control provided by the Uniontown Lock and Dam assures sufficient depth for intake and discharge at the plant site even under low flow conditions on the Green River. The river width in the site area varies from 121.9 to 152.4 m (400 to 500 ft). Because of the relatively short period of record since the completion of the upstream dams on the Green River, it is not possible to provide a low flow frequency analysis which adequately takes into account the reservoir effects. A flow duration curve for the Green River at Calhoun, however, is shown in Figure 4.4.1-2 to provide an indication of the range of flows which may be expected in the Green River at the site.

The U.S. Army Corps of Engineers has determined the discharges and associated water levels for the 100 year and 500 year floods on the Ohio River at the mouth of the Green River.[5] According to the Corps of Engineers, the 100 year flood discharge at the site is 26,060 cu m/sec (920,000 cfs) and the associated water level is 115.8 m (380 ft) MSL. The 500 year flood discharge is 30,580 cu m/sec (1,080,000 cfs) and the water level is 116.4 m (382 ft) MSL. Both elevations and discharges computed by the Corps of Engineers were based on the modifications afforded by the upstream reservoir program and updated to 1976.

4.4.1.1.1.2 Currents

Since both the Ohio River and Green River at the site are regulated by a system of upstream reservoirs, accurate estimation of discharge flow rates and river currents requires that the effects of these reservoirs be accounted for. The nearest gaging station which collects water resources data on a regular basis in the Green River is at the Lock and Dam No. 2 located approximately 97 km (60 miles) upstream from the site. Prior to the construction of Rough River Lake, Nolin Lake, Barren River Lake, and Green River Lake, the 1 day, 50 year low flow was 7.48 m^3/s (264 cfs) at the Lock and Dam No. 2[1]. If an estimate at the site based on drainage area is made, the corresponding 1 day, 50 year low flow will be about 9.20 m^3/s (325 cfs). At the present time, however, the Corps of Engineers operate the four reservoirs and maintain a flow of 11.33 m^3/s (400 cfs) at Livermore, just upstream of Lock and Dam No. 2. Using the 11.33 m^3/s (400 cfs) as the design low flow for the site, the average river speed at the site at low flow is about 1.5 cm/s (0.05 ft/sec). Normal pool elevation, 342 ft MSL on Sandy Hook Datum, is assumed to be maintained at all times except flood conditions. A 45 year average discharge flow rate at Lock and Dam No. 2 is 309 m^3/s (10,920 cfs).[1] An estimation of flow (based on drainage area ratios) at Lock and Dam No. 1 yields 382 m^3/s (13,500 cfs) of discharge and 46.6cm/s (1.53 ft/sec) of average river speed at the site.

Current measurements at 15 different locations near the discharge area were made in August. September, October and November 1978. Details of the field program are presented in Appendix Section 4A.8. Field data is given in Appendix 4B. The results are tabulated below:

	August (8/4/78)	September (9/5/78, 9/14/78, 9/29/78)	October (10/16/78)	November (11/4/78)
Average Speed	6.4 cm/s (0.21 fps)	10.05 cm/s (0.33 fps)	9.1 cm/s (0.30 fps)	14.0 cm/s (0.46 fps)
Average Direction	281 degrees M* (downstream)	272 degrees M (downstream)	237 degrees	M 276 degrees (downstream)

*M denotes magnetic North

During this low flow period, river velocity varied from 6.1 to 15.2 cm/s (0.2 to 0.5 fps) and flow direction was downstream towards the Ohio River confluence.

4.4.1.1.1.3 Bathymetry

A comprehensive bathymetric survey of the Green River was conducted by the US Army Corps of Engineers (COE) in 1966. Analysis of this data indicates a bowl-shaped channel in the discharge area, with slightly deeper depths towards the north bank. A pronounced V-shaped channel is indicated near the upstream property boundary. Maximum depth indicated by the COE survey is 8.3M (27.3 ft) under normal pool elevation of 342.0 ft and the corresponding average midchannel depth is approximately 7.3M (24 ft).

Analysis of site specific data also shows a similar bottom topography; a bowl-shaped channel tending to a V-shaped channel further upstream. Maximum depth obtained was 8.8m (29 ft), and average mid-channel depth is 7.6 m (25 ft). It seems (as shown in Figure 4.4.1-3) that the channel configuration at the discharge area has changed slightly over the last 12 years. It appears that the south bank has a moderate buildup of sediment deposits which tends to distort the V-shaped pattern to one with steeper sides, bringing the deeper depths closer to mid-channel. This change, however, appears minimal and can be expected over a period of years. Figure 4.4.1-4 shows detailed contours of the Green River in the site area.

4.4.1.1.2 Ohio River

The Ohio River below the confluence with the Green River has a drainage area of approximately 277,130 sq. km (107,000 sq. miles) as measured at Evansville, 12.9 km (8 miles) downstream. The average discharge for the Ohio River at Evansville from 34 years of record is 3775 cu m/sec (133,300 cfs).

Like the Green River, the Ohio River is regulated by a system of upstream navigation locks and dams. The stage-discharge relationship for the gage at Evansville also is indeterminate at low flows. The nearest upstream gage on the Ohio River is at Louisville, Kentucky. The drainage area of the Ohio River at Louisville is 236,130 sq. km (91,170 sq. miles) and the average discharge from 47 years of record is 3,231 cu m/sec (114,100 cfs). In that the drainage area at Louisville is about 85 percent of the drainage area at Evansville and the average discharge at Louisville about 85 percent of the average discharge at Evansville, the low flow parameters determined for the Ohio River at Louisville can be considered to be a conservative representation of the flow of the Ohio River in the vicinity of the site.

The low flow frequency relationship at Louisville for low flows of one-day, 7-days and 30-days is presented in Figure 4.4.1-5. The flow duration relationship for Ohio River flows at Louisville is presented in Figure 4.4.1-6.

4.4.1.1.3 On-Site Stream

Most of the drainage from the proposed plant area constitutes the headwaters of a small, un-named stream which flows northward across the floodplain into Cypress Slough. The outlet of the Slough travels a short distance from the beaver dam, at the west end of the Slough, to its confluence with another small, un-named stream which flows northward and empties into the Green River. The total drainage area upstream from the beaver dam, as delineated in Figure 4.4.1-10, is approximately 5.29 km^2 (2.02 mi^2). Of this area, 1.05 km^2 will comprise the upland plant area of the project. The east end of the plant area, amounting to 0.27 km^2, drains into the Race Creek basin to the east.

Utilizing the runoff values for the Beaverdam Creek (see Suection 4.4.1.1.4), average values for the discharge of the unnamed stream flowing into Cypress Slough can be estimated. The drainage area of the stream itself, including the future plant area, is 3.52 km^2. During the dry period of June through November, the average discharge of the stream would be 0.01 m^3/sec (0.35 cfs). In the driest month, August, the average discharge would be 0.008 m^3/sec (0.27 cfs). In comparison, the average discharge for the wet period of December through May would be 0.07 m^3/sec (2.4 cfs). In the wettest month, March, the average discharge would be 0.09 m^3/sec (3.3 cfs).

4.4.1.1.4 On-Site Water Body - Cypress Slough

Cypress Slough occupies a portion of the Green River floodplain north of the plant site. The total area of the Slough is about 33 ha (80 acres), of which 8 ha (20 acres) are on the site property. The slough is about a mile in length and 0.13 mi in average width, with the long axis parallel to the Green River. Figure 4.4.1-10 shows the location of Cypress Slough and the related drainage basin.

Cypress Slough, whose ecology is described in Subsection 4.2.2.2.2.2.6, is frequently inundated by floods on the Green River or the Ohio River. Standing water normally remains in the area year-round. The cypress population survey (Subsection 4.2.2.2.2.2.6) showed water depths of 41-80 cm (16-31 inches) in the on-site portion. The average water surface elevation measured in the Slough in the fall of 1978 was about 354.5 ft MSL. The banks of the Green River to the north of the Slough range from elevations of about 360 to 369 ft MSL, except where the un-named stream to the west of the slough cuts through the bank to discharge into the river. The level pool elevation for the Green and Ohio Rivers, controlled by the Uniontown Dam, is 342 ft MSL.

The beaver dam at the outlet of Cypress Slough is approximately 200-250 feet long. The effective crest elevation, which controls the Slough water levels, is about 354.5 ft MSL. Flood stages on the Ohio River routinely exceed this elevation in winter and spring, causing flooding of the Slough. Table 4.4.1-1A gives mean monthly flow data for the Ohio at Evansville[1].

Since the Uniontown Dam became operational, the discharges at Evansville have only been determined during flood seasons. Based on the 34 years of complete records, 1941-1974, a flow-duration curve is shown in Figure 4.1.1-11. Stage records at Dam No. 48 (downstream of Evansville) and at Dam No. 47 (10 km (6 mi) upstream from the mouth of the Green River) have been analyzed by the Corps of Engineers[11]. Durations of stages for 38 years of record (1930-1967) are available, along with adjustments to the mouth of the Green River and to include the effect of the Downtown Dam. The adjusted stage durations in per cent are shown in Figure 4.4.1-12. Additional data was provided[11] giving the number of flood crests in the historical record exceeding certain levels at the mouth of the Green River (Table 4.4.1-1B).

Cypress Slough will be flooded whenever the Ohio River stage exceeds the crest of the beaver dam at 354.5 ft MSL. According to Figure 4.4.1-12, this level is exceeded 21 percent of the time. Table 4.4.1-1B shows the breakdown by months for the duration of stages above this leve, and the number of flood crests above this level is 38 years of record. Examination of the Corps' record of flood crests showed that even in drought years, at least one flood crest exceeding 354.5 ft MSL occurred. Since the construction of the Uniontown Dam raised the level of the Ohio-Green Rivers by four feet, the annual flooding of Cypress Slough is nearly certain.

Average monthly precipitation totals[12] for the two nearest weather stations, Evansville, Indiana and Henderson, Ky, are also given in table 4.4.1-18. Based on the precipitation records at Henderson, Ky, rainfall runoff coefficients were determined for Beaverdam Creek, a gaged stream located 17 miles southwest of the site near Corydon, Kentucky. Beaverdam Creek has a drainage area of 37 km^2 (14.3 mi^2) and topography similar to that of the site area. Streamflow records were available for the years 1973-1975. Table 4.4.1-1C shows the computed runoff coefficients determined using the Henderson precipitation data. The ratio of runoff to precipitation (runoff coefficient) is seen to be very small for the months of June through November, averaging 0.09. This implies that the effects of evaporation and transportation on runoff are important during this period.

The water content of Cypress Slough is derived from winter and spring flooding on the Ohio or Green Rivers, from rainfall and runoff within the Slough drainage basin, and possibly, but not necessarily, from groundwater, as discussed in Subsection 4.4.2.1.5. Groundwater levels on either side of the Slough have been observed to be lower, in the dry season, than the Slough surface water level. Water losses consist of drainage through the beaver dam, evaporation, transpiration, and possibly, but not necessarily, groundwater seepage. Sufficient data have not yet been obtained to permit quantifying the losses.

4.4.1.1.5 On-Site Water Bodies - Farm Ponds

There are five farm ponds scattered over the site (see Figure 4.4.1-10). Their sizes range from 0.05 ha (0.11 acre) to 0.20 (0.5 acre) with depths of 1m (3 ft) to 2,1 (7 ft). These ponds are basically used for irrigation.

4.4.1.2 Surface Water Quality

4.4.1.2.1 Introduction

This section defines the water quality of the surface waters in the vicinity of the proposed plant site. These surface waters include the reaches of Ohio River and Green River near the confluence of these two rivers, the Cypress Slough and the on-site stream.

Data utilized to characterize the water quality of these surface waters were obtained from the following sources:

1) Environmental Protection Agency (EPA) STORET Data System[7]

2) Ohio River Valley Water Sanitation Commission (ORSANCO)[8,9]

3) Evansville Waterworks Department[10]

4) U S Geological Survey (USGS) - Water Resources Data for Kentucky[6]

5) 1978-79 Ebasco/Envirosphere Site-Specific Water Quality Monitoring Program

The available data from these sources in terms of sampling locations and periods of record are summarized in Table 4.4.1-2. The location of the sampling stations for the first three data sources and for the Ebasco/Envirosphere monitoring program is shown on Figures 4.4.1-8 and 4.4.1-9, respectively.

As indicated in Table 4.4.1-2, EPA STORET data generally has a longer period of record than the other sources but the data records were available only up to 1974. The other data sources have more recent data (e.g., 1976 to 1979), including, the site-specific monitoring program. For the Ohio River section between Evansville and Owensboro (River Miles 791.5 to 763.2), water quality can be evaluated by the data from EPA STORET, ORSANCO, and the Evansville Waterworks Department. For the Green River section between the proposed plant site and Sebree (River Miles 1.5 to 41.3) water quality can be evaluated by the data from EPA STORET, ORSANCO, and the site-specific monitoring program. It should be mentioned that the Sebree sampling station is considered not completely applicable to the proposed plant site. The water quality measured at this far station may not represent the water quality in the Green River near the site. However, this station is the closest one with relatively complete and consistent data for recent years. USGS data from Calhoun (River Mile 63.1) is used only for temperature comparison. For characterizing the water quality of Cypress Slough and the on-site stream, the monitoring program is the only data source.

Unlike the other data sources, the EPA STORET data system does not collect all the data by itself. Therefore, the sampling frequency and investigated water quality parameters are not uniform. Data are scattered and many gaps exist in the records. The water quality parameters measured most frequently

at Evansville, Owensboro, and Spottsville sampling stations were color, conductivity, pH, alkalinity, hardness, chloride and sulfate. In addition, dissolved oxygen (DO), 5-day biochemical oxygen demand (BOD_5), nutrient (phosphorus and nitrogen), and coliforms at Evansville and Owensboro and calcium, magnesium, sodium and potassium at Spottsville were also relatively frequently measured. The above mentioned parameters were measured with an average sampling frequency of once per one or two months. The other parameters such as turbidity, total suspended solids (TSS), total dissolved solids (TDS), and heavy metals were measured at lesser frequency, especially, heavy metals. Even at the Evansville sampling station which has the most data, the majority of the 21 investigated heavy metals were not measured more than 50 times during the record period of 17 years (1958 through 1974). For the above reasons, the EPA STORET data were used in a supplementary sense in characterization of the existing water quality of the Ohio and Green River sections near the proposed plant site.

Among the other three data sources, (not including USGS), ORSANCO has the most data. At the Evansville and Sebree sampling stations, 27 water quality parameters have been systematically measured with the sampling frequencies below:

Parameters	Frequency
TSS, sulfate, sodium, phenol, cyanide, total phosphate, total Kjeldahl nitrogen, ammonia nitrogen, nitrate, fecal coliforms, total coliforms	2 to 3 times a month
Dissolved solids, calcium, magnesium, BOD, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, zinc, silver, selenium	monthly

In addition, continuous monitoring has also been conducted at Evansville for DO, pH, temperature, and specific conductance.

The water quality data provided by Evansville Waterworks Department are monthly average values for 16 chemical and physical parameters which have been routinely monitored at Evansville Filtration Plant (River Mile 791.5). Those parameters include turbidity, hardness, alkalinity, chloride, calcium carbonate, silica, fluoride, temperature, TDS, TSS, pH, iron, manganese, sulfate, total coliforms, and fecal coliforms.

The site-specific water quality monitoring program was conducted on a quarterly basis. A total of 38 chemical and physical parameters has been either measured in the field or analyzed in the laboratory. A complete description of this monitoring program is presented in Appendix 4A.7. The raw data resulting from this monitoring program are given in Appendix 4B.

4.4.1.2.2 Water Quality of Green River Section Near Plant Site

Table 4.4.1-3 summarizes the water quality of the Green River section between the proposed plant site (River Mile 1.5) and Sebree (River Mile 41.3) based on the available water quality data from EPA STORET, ORSANCO,

and the site-specific monitoring program. The relatively complete and consistent data from ORSANCO were also summarized on monthly basis in Table 4.4.1-4 to show the seasonal variation of the water quality. As indicated in these two tables, data for the major water quality parameters of DO, temperature and TDS are limited, especially for DO. Therefore, whether temperature or TDS levels meet the Kentucky water standards for the Green River Basin navigation streams can not be accurately evaluated. For the case of DO, it can not be evaluated. Temperature data is supplemented by USGS records from Calhoun as shown in Table 4.4.1-5.

The site-specific quarterly monitoring data as presented in Tables 4B.4-1 and 4.4.1-3 were compared with historical data as shown in Tables 4.4.1-3 and 4.4.1-4. Most of the parameters measured are within the compatible ranges of historical data except arsenic, cadmium, cyanide, selenium and zinc. The measured concentrations of these five parameters show higher values than their corresponding historical values with ranges of 0.5 to 47.6 ug/l for arsenic, 2 to 40 ug/l for cadmium, 0.01 to 0.2 mg/l for cyanide, 2 to 10.3 ug/l for selenium, and 73 to 260 ug/l for zinc. Therefore, besides these five parameters, the historical data observed at Sebree Station were considered as a meaningful set of data in defining the water quality of Green River at the plant site. In the following discussion, both the site-specific monitoring data and historical data were used. For the above five parameters and other missing parameters (such as DO, sulfide and oil and grease), the site-specific monitoring data were considered representative.

The water quality of the Green River section in question is generally good except for total and fecal coliforms, iron and manganese. The water has a pH around neutral (6.8 to 8.1) and low hardness with an average of 153 mg/l. The concentrations of TDS and TSS are low with average values of 211 mg/l and 66 mg/l, respectively. Heavy metals are present normally in trace amounts. Sulfate, chloride, fluoride, cyanide, and phenols are generally in low concentrations with averages of, in order, 65 mg/l, 25 mg/l, 0.25 mg/l, 0.06 mg/l, and 7 ug/l.

The water quality summarized in Tables 4.4.1-3, 4.4.1-4 and 4.4.1-5 was compared with the Kentucky Water Standards for the Green River Basin Navigation streams and the Federal recommended drinking water standards as presented in Tables 4.4.1-6 and 4.4.1-7 respectively. The results indicated that the levels of temperature, TDS, pH, arsenic, barium, chromium, fluoride, selenium, silver, copper, nitrate, and zinc meet these standards. The concentrations of following parameters may occasionally exceed these standards:

Parameters	Concentration Average	Concentration Range	Standard Occasionally exceeded
Cadmium, ug/l	5	1 to 35	River and Drinking
Cyanide, mg/l	0.058	∠0.01 to 0.20	River
Lead, ug/l	19	6 to 75	River and Drinking
Chloride, mg/l	25	2.5 to 254	Drinking

Mercury, ug/l	1.1	0.1 to 22.5	Drinking
Sulfate, mg/l	65	26 to 260	Drinking
Fecal coliforms, Count/100 ml	538	0 to 5900	River

However, total coliforms ranging from 0 to 33,000/100 ml with an average of 2323/100 ml may frequently exceed the Kentucky river water quality standards and the Federal drinking water standards. The concentrations of iron (800 to 12400 ug/l; average 2740 ug/l) and manganese (130 to 1700 ug/l; average 352 ug/l) may always exceed the drinking water standards. From the limited monitoring data, it is difficult to judge whether the minimum 4.0 mg/l DO standard has been complied with at all the time. Based on the DO concentration of 5.7 mg/l observed in July, 1979 at a water temperature of 26.5°C (i.e., close to the maximum recorded temperature of 28°C), it is believed that most of the time, the DO concentration should be higher than 4.0 mg/l.

The levels of measured parameters fluctuate during the year. The available data indicated that most of those parameters do not have an obvious variation with season except for DO and temperature. DO concentrations observed in the winter (February) were high (11.8 to 11.9 mg/l) where as in the summer (July) concentrations were relatively low (5.7 to 5.9 mg/l). This variation is logical considering the inverse relationship between the DO concentration and the temperature of the water. The observed river water temperature in the winter was 2.0 to 2.2°C, where as in the summer the observed river water temperature was 26.3 to 26.5°C. During the spring (May) and fall (October), the observed DO and temperature levels were within the above ranges of the winter and summer measurements.

Table 4.4.1-3 presents the concentrations of 14 selected polynuclear aromatic hydrocarbon (PAH) compounds recorded as part of the winter, spring and summer portions of the on-site monitoring program. These benzene ring compounds were selected for monitoring because of the potential for their emission during the operational phase of coal conversion processes in general.[13] These compounds are not covered either by the Green River water quality standards (Table 4.4.1-6) or by Federal recommended drinking water standards (Table 4.4.1-7). The compounds are of particular concern because of their toxicity, as was reported by ORNL for coal conversion facilities[13].

Of the 14 PAH's monitored, mean values for two compounds, 2-methyl naphthalene (180 to 15 ug/l; 91 ug/l average) and pyrene (116 to 15 ug/l; 53 ug/l average) exceed 10 ug/l, while the remaining 12 averaged less than 10 ug/l. Fluoranthene concentrations (13 to 1.9 ug/l; 7.1 ug/l average) may exceed 10 ug/l occasionally.

The 14 compounds taken as a group exhibit a range of 180 to much less than 1 ug/l and a mean value of 14 ug/l. Thus, during much of the time, concentrations of the PAH's monitored in the Green River should be below 14 ug/l.

The PAH concentrations varied from one sample to the next. The concentrations of seven PAH compounds were higher in winter than in spring or summer,

and the concentrations of five compounds were higher in summer. Concentration of one compound was highest during the spring sampling period and concentrations of one compound were the same for all sampling periods. No general seasonal trend of PAH concentration could be postulated from the data.

4.4.1.2.3 Temperature

River water temperature data has been gathered over a ten year (1967 to 1976) period by USGS at the Lock and Dam No. 2 in Calhoun, Kentucky, which is upstream of the site area at River Mile 63.1[6]. Table 4.4.1-5, presents the monthly maximum, minimum and average temperatures. During the period of July through October, 1978 site specific measurements of temperature were also made. Two separate methods were employed. The first was a continuous in-situ recorder placed slightly downstream of the proposed discharge location and moored 5 ft below the water surface (see Figure 4A.8-2). The second method was biomonthly vertical profiles of the river at 15 stations. Figure 4A.8-1 gives locations of these profile stations.

It can be seen from Table 4.4.1-8 that monthly mean temperatures obtained from the site specific survey (i.e., in-situ recorder) compares well with the USGS historical data[6]. For the month of July, the mean in-situ site recorded temperature was 82.5°F and for historical data taken at Calhoun it was 82.5°F. During August the site recorded data shows a mean temperature of 82.3°F while USGS data collected Calhoun has a mean of 82.4°F. During September the mean site recorded temperature was 80°F and at Calhoun; a mean of 79.4°F was recorded. During October the mean site record temperature was 67.0°F and 69.2°F at Calhoun.

Table 4.4.1-9 shows a comparison of temperatures obtained during the vertical profile survey of August, September, October and November with mean daily values as recorded by the in-situ recorder. As can be seen, the agreement is excellent.

Data Appendix 4B.4 contains the tabulated raw data for in-situ and vertical profile measurements.

4.4.1.2.4 Water Quality of Ohio River Section Near Plant Site

Table 4.4.1-10 summarizes the water quality of the Ohio River section between Evansville, Indiana (River Mile 891.5) and Owensboro, Kentucky (River Mile 763.2), based on the available water quality data from EPA STORET, ORSANCO, and the Evansville Waterworks Department. The relatively complete and consistent data from ORSANCO were also utilized to describe the seasonal variation of water quality in Table 4.4.1-11.

The water quality of the Ohio River Section in question is considered similar to that of the Green River discussed in the previous subsection. A majority of the measured parameters have similar ranges of concentrations in both river sections. The exceptions are that in the Ohio River section, the concentrations of TSS, total Kjeldahl nitrogen, total phosphate, total coliforms, iron, copper, magnesium, and manganese are

generally higher, and in the Green River section, the concentrations of TDS, fecal coliforms, and selenium are generally higher.

The water quality summarized in Tables 4.4.1-10 and 4.4.1-11 was compared with the ORSANCO stream quality criteria for the Ohio River and the Federal recommended drinking water standards as presented in Tables 4.4.1-12 and 4.4.1-7, respectively. The results indicated that based on the data of recent years (1976-1978), the levels of temperature, pH, TDS, arsenic, barium, cadmium, chloride, copper, cyanide, fluoride, lead, nitrate, nitrogen, selenium, silver, sulfate and zinc meet these standards. The concentrations of the following parameters may occasionally exceed these standards:

Parameter	Concentration Average	Concentration Range	Standards occasionally exceeded
DO, mg/l	9.1	3.6 to 16.2	River
Phenol, ug/l	3.21	0 to 17.0	River
Total coliforms, No./100ml	4626	0 to 38,000	River and Drinking
Mercury (ug/l)	1.1	0.1 to 22.5	Drinking

The concentrations of iron (360 to 17,750 ug/l, average 4655 ug/l), and manganese (90 to 1960 ug/l, average 1030 ug/l) may always exceed the drinking water standards. However, if the EPA STORET data (prior to 1974) were included in evaluation, parameters such as arsenic, cadmium, chromium, cyanide, lead and sulfate may also occasionally exceed the ORSANCO river criteria and the Federal drinking water standards. This may indicate some improvement of the water quality in this section of the Ohio River.

The seasonal water quality summary in Table 4.4.1-11 also indicates that in addition to DO, temperature, TSS, and fecal and total coliforms, the levels of the remaining parameters fluctuate during the year without any obvious variation with season. DO has higher concentration in winter months (December to March) with monthly averages greater than 10 mg/l and lower concentration in summer and early fall months (June to October) with monthly averages of 7.0 to 8.0 mg/l. In August, the DO level could be below the minimum requirement of 4.0 mg/l. The highest temperature of 89°F could be in July and August and the lowest temperature of 32°F could be in January and February. TSS concentrations appear relatively high (monthly average, 135 to 247 mg/l) in winter and spring months (December to April) when river flows are generally high, and relatively low (monthly averages; 27 to 83 mg/l) in summer and fall months (June to November) when river flows are generally low. Fecal and total coliforms show similar trend as TSS with higher levels in winter and spring months as indicated by the following monthly averages:

Month	Fecal Coliforms Count/100 ml)	Total Coliforms Count/100 ml)
October through April	397 to 798	2,733 to 21,317
May through September	70 to 371	1405 to 2200

4.4.1.2.5 Cypress Slough Water Quality

The published water quality data do not include analyses of Cypress Slough. This information was obtained from an on-site sampling program. Water samples were collected quarterly during the period of fall 1978 through summer 1979 at the inlet and outlet of Cypress Slough. The analytical results of these samples are presented in Tables 4.4.1-13 and 4B.4-2.

A comparison of the Cypress Slough water quality at the inlet monitoring station to the water quality at the outlet monitoring station indicates no significant difference in concentrations of the measured parameters except Oil and Grease. The measured concentrations of Oil and Grease at the inlet were 0.2 to 1.6 mg/l with an average of 0.8 mg/l while at the outlet, 0.2 to 8.0 mg/l with an average of 3.7 mg/l.

Combining the inlet and the outlet water quality data should provide water quality of the Cypress Slough water. The quality of the slough water represented by the combined inlet and outlet measurements is shown in Table 4.4.1-13. The water has a pH around neutral (7.1 to 7.8). Alkalinity averages 91 mg/l. The concentration of TSS is low (Average 71 mg/l). Iron and manganese concentrations are high ranging from 0.57 to 3.7 mg/l and 0.04 to 2.73 mg/l respectively. The other heavy metals are present normally in trace amounts. Chloride, cyanide, fluoride, phenols and sulfate are in low concentrations ranging from 1.5 to 15 mg/l, 0.01 to 0.17 mg/l, 0.05 to 0.18 mg/l, 0.0005 to 0.0161 mg/l and 3 to 29 mg/l, respectively.

The measured parameters show small variation from season to season except for DO and temperature. DO concentrations range from 2.5 to 12 mg/l. In winter months DO concentrations are high (11.3 to 12 mg/l) where as in July, measured DO concentrations range from 2.6 to 4.9 mg/l. The observed water temperature in February was 1.3 to 2°C where in July it was 24.3 to 26.3^{o}C.

The Cypress Slough water quality was also compared with the Green River water quality. The concentration of the measured parameters of the slough water fall within the ranges of the Green River water quality except for DO. The minimum DO concentration observed in the slough water is 2.5 mg/l while in the Green River, the observed minimum DO concentration is 5.7 mg/l. Like the Green River, iron and manganese concentrations are also high in the slough water.

4.4.1.2.6 On-Site Stream Water Quality

As with Cypress Slough, the published water quality data do not include analyses of the on-site stream. Information was collected by the 1978-79 site-specific water quality monitoring program. The data resulting from the survey conducted between fall 1978 and summer 1979 are summarized in Table 4.4.1-14.

Based on the limited sampling program, the water quality of the on-site stream is good except for iron (0.49 to 9.25 mg/l) and manganese (0.04 to 0.25 mg/l). The pH of the water is within the neutral range (7.22 to 8.09). The concentrations of TSS ranges from 13 to 178 mg/l. Other heavy metals

are present in trace quantities ranging from a minimum of 0.0002 mg/l for mercury to a maximum of 0.145 mg/l for zinc. Ammonia, arsenic, cyanine and phenols are also present in trace quantities ranging from 0.0006 to 0.24 mg/l. Chloride (1.8 to 15 mg/l), fluoride (0.14 to 0.21 mg/l), nitrate (0.10 to 3.10 mg/l) and sulfate (11 to 30 mg/l) are generally present in low concentrations. DO concentrations range from 7.6 to 12.0 mg/l where as temperature varies from 1 to 18.8°C.

The water quality of the on-site stream was also compared with the Federal recommended drinking water standards. The results indicate that the following parameters may occasionally exceed the standards beside iron which will always exceed the standards.

Parameters	Average	Range
Cadmium (mg/l)	0.01	0.002 to 0.018
Manganese (mg/l)	0.15	0.04 to 0.25
Mercury (mg/l)	0.0035	0.0002 to 0.0057

The measured parameters show small variation of concentration from season to season except for DO and temperature.

The on-site stream water quality was also compared with the Cypress Slough water quality. The measured parameters compare favorably with that of the slough except iron, manganese and DO. Iron concentrations (0.49 to 9.25 mg/l) in the on-site stream are higher than the iron concentration (0.57 to 3.70 mg/l) of the slough. Manganese concentrations (0.04 to 0.25 mg/l) in the on-site stream are lower than the manganese concentrations (0.04 to 2.73 mg/l), of the slough. DO concentrations in the on-site stream range from 7.6 to 12 mg/l while in the slough 2.5 to 12 mg/l.

Table 4.4.1-14 presents the concentrations of selected polynuclear aromatic hydrocarbon (PAH) compounds recorded as part of the winter, spring and summer portions of the on-site monitoring program. These benzene ring compounds were selected for monitoring because of the potential for their emission during the operational phase of coal conversion processes in general.[13] These compounds would not be covered either by the Green River water quality standards (Table 4.4.1-6) or by Federal recommended drinking water standards (Table 4.4.1-7). The compounds are of particular concern because of their toxicity, as was reported by ORNL for coal conversion facilities[13].

Of the 14 PAH compounds monitored, the mean concentrations of three, 2-methyl naphthalene (0.282 to 0.102 mg/l; 0.193 mg/l average), pyrene (0.204 to 0.033 mg/l; 0.108 mg/l average) and fluoranthene (0.103 to 0.036 mg/l; 0.064 mg/l) exceeded 0.020 mg/l. The 14 compounds taken as a group exhibit a range of 0.282 to less than 0.002 mg/l and a mean concentration of 0.034 mg/l. Thus, it is expected that during much of the time, concentrations of the PAH's monitored in the on-site stream should be less than 0.034 mg/l.

While nine compounds exhibited higher concentrations in winter, than during spring or summer; two exhibited greatest concentrations in spring and two exhibited their greatest concentrations in summer. Therefore, while no published or other data are available to confirm the observation, the concentration of PAH's in general may be higher in winter than in spring or summer. This affect may be due to the release of organic materials including PAH's with ice and snow melt. These materials may have been accumulated during preceeding icy periods.[14]

The concentrations of PAH's in the on-site stream were compared with those in the Green River. Concentrations on each sampling date as well as mean concentrations for the three samples in the stream were usually higher than corresponding values in the Green River. Of the nine compounds which exhibited maximum concentrations during the winter sampling period in the on-site stream, six were also at a maximum in the Green River. This affect may be due to the relatively small flow of the on-site stream as compared to the Green River

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4.4.2 GROUNDWATER HYDROLOGY

4.4.2.1 Description of Groundwater Hydrology

4.4.2.1.1 General

Only the unconsolidated surficial sediments, the Lisman formation, and the upper sandstone member of the Carbondale formation contain fresh groundwater in the eastern half of Henderson County [1]. All aquifers below the Carbondale formation contain salty water in the general area north of the Rough Creek fault zone [2].

4.4.2.1.2 Aquifer Yields

The Ohio River alluvium is the principal aquifer in the area. Collector-type wells yield as much as 4000 gpm; vertical wells have a capacity of at least several hundred gpm[2]. In general, wells in the Ohio River Valley alluvium can be expected to yield 50 gpm from depths less than 150 ft. Gallaher and Price[7] present hydraulic conductivity (K) values for the alluvial aquifer in several locations in the Ohio River Valley in Kentucky. They give a median value of K for the Spottsville-Reed area as 51 ft/day. Alluvium in small tributary valleys yield little or no water to wells[2].

Ryder[3] indicates that alluvium along the Green River yields quantities of water suitable for domestic use. He has reported transmissivity values for the alluvium along the Green River at two locations as 90 m^2/day and 150 m^2/day and hydraulic conductivities of the streambed as 4.9×10^{-5} m/day and 1.6×10^{-3} m/day.

In the proposed project area, a layer of alluvial sand may be found in the floodplain area, and this layer thickens toward the Green River as shown in Figure 4.5.1-9. However, this alluvial aquifer does not extend to the plant site area which is located above the floodplain.

The upper sandstone member of the Carbondale formation is the most widely used bedrock aquifer in the Henderson-Spottsville area[2]. It generally yields enough water for a modern domestic supply (more than 500 gpd) to most wells and locally yields as much as 30 gpm. In areas where this aquifer is overlain by limestone, ground-water yields tend to be lower than normal because of deposition of secondary calcium carbonate, resulting in reduction of aquifer permeability. Thickness of the aquifer and the amount of clay and silt mixed with the sand also are important factors controlling water availability and yield[1]. Although the Lisman Formation (Anvil Rock Sandstone Member) commonly yields enough water for domestic use in other areas, the ground-water availability map of Maxwell and Devaul[2] (Sheet 2) indicates that the Lisman Formation is somewhat less significant as a bedrock aquifer than is the Carbondale Formation for the Henderson-Spottsville area in northeastern Henderson County. Tables 4.4.2-1 and 4.4.2-2 show the field and laboratory coefficients of premeability for the soil and bedrock at the plant site.

4.4.2.1.3 Recharge and Discharge

Harvey[1] presents water-level data from observation wells penetrating the alluvium which indicate that recharge predominates in the winter and spring, and discharge predominates through the summer and fall until November. Ryder[3] discusses a similar pattern for recharge and discharge of ground water in alluvium along the Green River. Groundwater measurements recorded for this study also indicate recharge at piezometers in all boreholes except A-1 between the last part of November and the end of December 1978, illustrating a general recharge with progression of the winter season. (See Figures 4.4.2-1 and 4.4.2-2 and Table 4.4.2-3). Recharge to the alluvium comes from rainfall percolating downward through the soil, from discharge of groundwater into the alluvium from underlying bedrock aquifers, and from river water infiltration during flood or high water stages. Water discharges from the alluvium to the river during the late spring, summer, and fall months when the water table is higher than the river level. Water is discharged through vegetation by evaporation and transpiration as well as through wells and springs and by natural groundwater gradients.

Figure 4.4.2-1 depicts weekly water levels, from July, 1978, in borings A-25 and A-27, Cypress Slough, and Ohio-Green Rivers at Evansville, Indiana. The figure clearly shows the seasonal varibility in interactions between the surface and ground waters at the site. Up to the end of November, the water level in the Slough is higher than in the borings and the groundwater levels in the borings are higher than the water level in the River. These levels indicate that the water from the Slough leaks downward to the groundwater table and the water from the Slough and the ground water discharge to the River during the same period.

The interactions between the surface waters and the ground water appear to be reversed from December until the beginning of May. During this period, the Ohio-Green rivers are generally in high water stages and water from the Rivers flows to the alluvium and the Slough as indicated by the water levels shown on Figure 4.4.2-1. This trend apparently begins to alter back to the Fall trend in May, when river levels are the lowest and water flows from the Slough and the alluvium to the River. The observed seasonal changes in the River-alluvium interactions confirm the trends reported by others. (1,3 and 4).

The groundwater levels observed in boring A-27 closely follow the River stage because of the proximity of the Green River and the boring and indicating a good connection between the ground water and surface water at that location.

Recharge of bedrock aquifers is mainly through precipitation on outcrop areas in the uplands. Water is discharged from the bedrock aquifers by leakage through wells, and by vegetation.

4.4.2.1.4 Groundwater Levels

The only information available on groundwater levels in the immediate site area comes from water level measurements taken in boreholes drilled during May and June, 1978 and from continuing weekly piezometer measurements begun on July 1, 1978. Locations of the boreholes and piezometers are shown in Figure 4.4.2-3. Table 4.4.2-3 contains a complete tabulation of water level measurements.

A water-table map, based on measurements taken during June-July, 1978, (Figure 4.4.2-2) shows that the water table generally varies with topography, except near the Green River, where it may fluctuate with river level. The water table at the site was located in the overburden during the monitoring period, except in borings A-1 and A-18, where it was several feet below the soil/rock interface. In the plant/solid waste disposal area the water table is controlled by topography. In stream valleys, depth to the water table is low, e.g., A-13 (3.5 ft), A-8 (5.2 ft), and A-3 (4.0 ft). The depth to the water table is greater near the top of steep slopes, e.g., A-1 (25.6 ft), A-19 (23.7 ft), and A-18 (23.2 ft). The water table has intermediate depths on broad slopes with low relief, e.g., A-16 (5.2 ft), A-21 (11.0 ft), and A-22 (5.2 ft). Groundwater levels on the Green River alluvial plain were within 10 feet of the land surface near the uplands and between 10 and 15 feet below the surface near the river.

Groundwater data from the area around Henderson [1] indicate that seasonal variations in the elevation of the water table correlate closely with seasonal variations in precipitation, with the water table generally being highest during the months of March and April and lowest in October and November. The effects of this seasonal variation in the immediate site area is apparent in Figure 4.4.2-4 which is a plot of water table elevations versus time from July 1978 through August 1979.

4.4.2.1.5 Groundwater Movement

The general slope of the water table in a north-south profile across the site is shown in Figure 4.4.2-5. The northward slope direction indicates that the overall direction of ground-water at the site is from the upland toward the Green River. However, local gradients towards areas of discharge such as drainage ditches and sloughs are to be expected, even though distribution of data is too limited to reveal in detail the configuration of the piezometric surface. Cypress Slough is a particular area of uncertainty with respect to slope of the water table. On the profile shown in Figure 4.4.2-5 the elevation of the water table in piezometers A-25 and A-27 suggest an essentially flat water table at an elevation between 350 and 351 feet. However, Cypress Slough contained standing water with a surface elevation of 354 feet on the date that groundwater levels shown in the profile were measured. The fact that the water table in the slough is higher than that in the piezometers on either side could possibly suggest the presence of a perched water table due to the relatively impervious sediments on the bottom of the slough. (see Table 4.4.2-4 and Figure 4.4.2-1).

Reversal of the slope of the water table near the Green River might be expected whenever the level of the Green River is higher than normal (Figure 4.4.2-1).

4.4.2.2 Groundwater Quality

The available literature data on the quality of the groundwater in and near the proposed plant site are limited. In 1962, Maxwell and Devaul[2] had summarized historical water quality data of the groundwaters in different formations in the Western Coal Field region of Kentucky during a statewide reconnaissance investigations of groundwater resources for general use. The Western Coal Field region consists of 10 counties including Henderson where the proposed plant site is located. U.S. Army Corps of Engineers had summarized some groundwater quality data in their 1975 draft environmental impact statement for a navigation project for Green River[6] based on measured groundwater quality of the public and industrial water supply wells in the 10 counties bordering the river navigation system. Radian Corporation[4] has provided some description of groundwater quality in their 1978 site evaluation study report for the Syngas Project. These literature data indicate the general groundwater quality in a broad area related to the proposed plant site. For site-specific data, a groundwater quality survey was conducted. The detailed description of sampling procedures and analytical methods is presented in Appendix 4A.

In the Radian Corporation report[4], it was indicated that the Ohio River Valley alluvial aquifer usually produces a hard to very hard calcium bicarbonate water. The hardness of water produced near Henderson ranges from about 30 mg/l to more than 560 mg/l (as $CaCO_3$). The hardness commonly exceeds 250 mg/l. The total dissolved solids (TDS) content ranges from 280 to 700 mg/l and commonly exceeds 460 mg/l. The iron concentrations, ranging from 0.17 to 13 mg/l, are high as compared to the recommended maximum level of 0.3 mg/l for drinking water (See Table 4.4.1-7). The average iron content of several water samples from the alluvium was 2.45 mg/l. Few specific chemical analyses were reported on the water quality of the bedrock aquifiers underlying the alluvium. The water in those aquifiers below the upper sandstone member of the Carbondale Formation is highly mineralized.

In the vicinity of the proposed plant site, the interface between fresh and saline water is believed to occur at a depth of about 200 to 300 feet[5]. Water samples from the Tradewater Formation and Caseyville Sandstone showed chloride contents of over 8,000 and 15,000 mg/l, respectively. In the deeper Devonian strata, one water sample from an oil test well had a TDS content of 166,000 mg/l and a chloride content of 103,000 mg/l.

The groundwater quality data presented in the U.S. Army Corps of Engineers environmental impact statement[6] for a navigation project in Daviess and Henderson Counties near the proposed plant site are summarized in Table 4.4.2-5. The values of the water quality parameters in this table reflect the general groundwater quality described by Radian Corporation[4]. The groundwater is generally a hard calcium bicarbonate water.

The measured carbonate hardness ranged from 36 to 350 mg/l (as $CaCO_3$) in the shallow wells (less than 300 feet) and from 2,300 to 18,000 mg/l (as $CaCO_3$) in the deep wells (greater than 1,300 feet). Water from the deep

wells is highly mineralized with a TDS content of 41,900 to 113,000 mg/l. The concentrations of iron, manganese, chloride, and TDS in the deep well water generally exceed the recommended drinking water standards (See Table 4.4.1-7), especially for chloride and TDS. The water from the shallow wells generally meets the recommended drinking water standards except for iron and manganese. Their concentrations in the measured raw water ranged from 0.33 to 2.8 mg/l and from 0.07 to 0.69 mg/l, respectively. One shallow well water sample also indicated a high TDS content of 510 mg/l which exceeds the recommended drinking water standard of 500 mg/l.

Table 4.4.2-6 presents the groundwater water quality data summarized by Maxwell and Devaul[2] in 1962 for the different formations in the Western Coal Field region of Kentucky. As indicated in this table, the groundwater in this region is soft to moderately hard. Water from the alluvium is generally of the calcium bicarbonate type, while water in the shallow bedrock aquifers are generally of the sodium bicarbonate or the calcium bicarbonate type. At greater depths the calcium bicarbonate water becomes less common, and water usually is more highly mineralized. Water from the alluvium is suitable for domestic use. Except for iron concentrations (ranging from 0.1 to 26 mg/l), the concentrations of the other measured parameters in the alluvium are generally within the limits of the recommended drinking water standards (See Table 4.4.1-7). In the bedrock aquifiers, the concentrations of iron, sulfate, chloride, and dissolved solids can exceed the recommended drinking water standards, especially in the deep bedrock aquifiers. The water from the deep bedrock aquifiers becomes saline and is too highly mineralized for domestic use. The water quality as described by the parameters in Table 4.4.2-6 is generally in agreement with the findings discussed in References 4 and 6.

Table 4.4.2-7 summarizes the water quality for the groundwater withdrawn from the two on-site observation wells (i.e., Stations A-11 and A-18). The depths of these two wells are approximately 24 feet and 40 feet, respectively and they are in the alluvial aquifier. Based on the values given in the table, these two well waters generally meet the recommended drinking water standards except for iron, manganese, mercury, selenium and dissolved solid (as indicated by specific conductance). The measured ranges of concentrations of these parameters are as follows:

Parameter	Measured range
Iron, mg/l	1.67 - 7.60
Manganese, mg/l	0.09 - 1.80
Mercury, mg/l	∠0.0002 - 0.0041
Selenium, mg/l	∠0.002 - 0.14
Specific Conductance, umhos/cm	820 - 990

Comparing the water quality data in Table 4.4.2-7 with those water quality data from the shallow wells and alluvium aquifier presented in Tables 4.4.2-5 and -6, it can be recognized that the majority of the parameters have compatible ranges of concentrations except chloride. The on-site well

water appears to have relatively low concentration of chloride (<0.02 to 0.85 mg/l).

Table 4.4.2-7 presents the concentrations of 14 selected polynuclear aromatic hydrocarbon (PAH) compounds recorded as part of the summer portion of the on-site monitoring program. These benzene ring compounds were selected for their emission during the operational phase of coal conversion processes in general[8]. These compounds are not covered by either the Green River water quality standards (Table 4.4.1-6) or by Federal public drinking water standards (Table 4.4.1-7). The compounds are of particular concern because of their toxicity, as reported by ORNL for coal conversion facilities[8].

Of the 14 PAH's reported for the summer sample, 2-methyl naphthalene showed the highest concentration, 3.3 ug/l; while the concentrations of the remaining 13 PAH compounds were less than 1.0 ug/l. The average concentration for the 14 compounds was less than 0.8 ug/l.

No data representative of seasonal trends were obtained.

The results of the groundwater PAH analyses were compared with those for the Green River and on-site stream. PAH concentrations in the groundwater were consistently lower than corresponding values reported in either surface water. The average PAH concentration in the groundwater was one order of magnitude less than the average concentration obtained in the Green River. Of the 14 PAH's, the groundwater analyses also showed maximum concentrations of 2-methyl naphthalene, similar to the surface water analyses.

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TABLE 4.4.1-1

REGULATING RESERVOIRS UPSTREAM OF THE BASKETT SITE

RESERVOIR - Location	DRAINAGE AREA Sq. Km	(Sq. mi.)	STORAGE 10^3 cu m	(ac-ft)	DATE OF CLOSURE mo/yr
Barren River Lake near Finney, Ky.	2435	(940)	234,860	(190,400)	3/64
Nolin River Lake near Kyrock, Ky.	1821	(703)	131,120	(106,300)	3/63
Green River Lake near Campbellsville, Ky.	1766	(682)	100,530	(81,500)	2/69
Rough River Lake near Falls of Rough, Ky.	1176	(454)*	111,250	(90,190)	10/59

* Of which 285 sq.km (110 sq.mi.) do not contribute directly to surface runoff.

Source: U.S. Geological Survey, 1975[1]

TABLE 4.4.1-1A

MEAN MONTHLY FLOW DATA

OHIO RIVER AT EVANSVILLE, INDIANA

WATER YEAR*	Q, 10^3 CFS											
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT
1978	-	-	293	220	182	361	215	257	-	-	-	-
77	-	-	-	-	-	303	235	-	-	-	-	-
76	-	-	157	276	308	198	-	-	-	-	-	-
75	-	95	220	288	369	482	318	238	-	-	-	-
74	40	121	229	424	198	278	263	142	197	69	47	127
73	62	215	394	162	207	276	313	268	154	93	48	25
72	41	41	139	232	235	385	402	194	98	143	63	30
71	56	134	189	183	288	269	90	195	71	60	64	78
70	23	57	82	147	274	189	318	192	70	44	41	35
69	27	65	111	164	221	82	193	123	59	82	64	25
68	48	69	190	111	169	237	236	188	207	35	59	21
67	41	75	180	86	128	415	176	338	54	65	46	20
66	43	42	43	136	269	126	148	254	26	24	28	27
65	28	29	137	204	215	259	323	93	30	29	14	44
64	10	21	37	88	98	540	263	107	45	23	21	14
63	34	102	74	110	100	526	169	65	65	28	24	14
62	27	57	155	199	195	472	299	67	54	42	19	21
61	17	34	36	98	141	447	308	342	155	81	73	21
60	41	67	193	208	222	166	237	106	108	78	32	28
59	30	44	65	230	309	179	189	136	57	38	32	18
58	22	112	239	165	158	169	249	353	96	179	174	52
57	29	36	147	170	379	161	340	144	77	63	15	19
56	36	69	52	32	445	427	310	177	145	96	109	56
55	87	47	95	174	251	577	181	113	61	46	31	13
54	8	10	24	73	66	144	159	112	51	43	43	27
53	11	20	60	161	162	235	191	209	89	36	20	11
52	14	84	283	355	365	309	230	168	73	29	22	15
51	48	149	308	342	406	364	283	135	102	58	20	24
50	24	43	168	476	518	229	238	170	192	106	58	130
49	23	77	237	305	409	257	199	104	74	68	44	27
48	18	44	55	100	258	308	493	159	65	65	50	19
47	18	30	66	264	158	119	262	223	183	72	61	40
46	81	115	129	218	248	244	102	160	208	55	33	13
45	35	26	73	242	189	633	241	195	138	42	39	53
44	13	29	23	53	94	334	317	151	64	19	19	27
43	54	138	173	351	218	377	240	220	131	57	57	16
42	17	39	57	81	161	247	202	91	86	79	90	35
41	14	43	87	132	83	99	111	32	109	72	31	25

*Water year begins Oct. 1 of preceding calendar year.

Source: USGS, 1976[1].

TABLE 4.4.1-1B

HYDROLOGIC CONDITIONS
AFFECTING CYPRESS SLOUGH

Month	Average Flood Days[1]	Historical Flood Peaks[2]	Avg Rainfall, Evansville, Ind (in.) (1877-date)	Avg Rainfall, Henderson, Ky (in.) (1914-date)
Jan	11.0	24	3.4	4.6
Feb	13.6	16	3.3	3.2
Mar	18.5	22	4.7	5.4
Apr	17.4	19	4.1	4.3
May	7.8	15	4.4	4.2
Jun	2.2	9	3.6	3.8
Jul	0.6	2	3.8	3.6
Aug	0.7	1	3.0	3.4
Sep	0.2	1	2.8	3.1
Oct	0.1	1	2.5	3.0
Nov	1.0	4	3.2	3.7
Dec	4.9	10	3.3	3.8

Notes:

1. 1930-1967 Record. Average days per month estimated Ohio River stage at mouth of Green River exceeded 354.5 ft MSL. Adjusted for present conditions.
2. 1930-1967 Record. Total number of historical flood peaks estimated to have exceeded 354.5 ft MSL, NGVD, at mouth of Green River.

Sources: Curry, 1979[11], NOAA, 1977[12].

TABLE 4.4.1-1C

AVERAGE RUNOFF FROM AVERAGE PRECIPITATION
BEAVERDAM CREEK NEAR CORYDON, KY

Month	Average Precipitation Inches	Runoff Inches	Runoff Coefficient
Jan	4.6	2.58	0.56
Feb	3.2	1.76	0.55
Mar	5.4	2.76	0.51
Apr	4.3	1.50	0.35
May	4.2	1.39	0.33
June	3.8	0.26	0.07
July	3.6	0.24	0.07
Aug	3.4	0.23	0.07
Sept	3.1	0.30	0.10
Oct	3.0	0.28	0.09
Nov	3.7	0.44	0.12
Dec	3.8	2.11	0.56

Source: USQS, 1976[1].

TABLE 4.4.1-2

AVAILABLE DATA FOR WATER QUALITY CHARACTERIZATION

Surface Water	Location of Sampling Station	* Mile Point	Period of Record: EPA STORET	ORSANCO	Evansville Waterworks Dept.	USGS	Monitoring Program
Ohio	Evansville, In.	791.5	1958-1974	1969-1978	1974-1977		
	Owensboro, Ky.	763.2	1968-1974				
Green	Sebree, Ky.,	41.3		1976-1978			
	Spottsville, Ky.	9.0	1956-1974				
	Baskett Site, Ky.	1.5					1978-1979
	Calhoun, Ky.	63.1				1967-1976	
Cypress Slough	Inlet and Outlet	On-Off-site					1978-1979
On-site Stream	See Fig 4.4.1-2	On-site					1978-1979

* The mile point for Ohio River is defined as the distance in miles from its head waters at Pittsburgh, Pennsylvania. The Green River mile point is measured from its confluence with the Ohio River.

TABLE 4.4.1-3

GREEN RIVER WATER QUALITY
Concentrations, mg/l*

Parameters	Spottsville, Ky. (RM 9.0) STORET Data (1956-1974)			Sebree, Ky. (RM 41.3) ORSANCO Data (1976-1978)			Plant Site (RM 1.5) Monitoring Data (1978-1979)		
	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min
Biological Oxygen Demand (5-day)				35	.65	.5	5.8	∠ 2.8	∠ 1.0
Dissolved Oxygen							11.9	8.9	5.7
Total Dissolved Solids	290	195.8	82	476	211	119			
Total Suspended Solids	170	59.8	13	262	61	10	135	66	31
Temperature (deg C)	31	16.7	4				26.5	15.0	2.0
pH (Unit)	8.1	7.3	6.8				8.10	7.34	6.18
Bicarbonate (As $CACO_3$)							275.6	107.7	51.8
Ammonia Nitrogen				.69	.096	.01	0.19	∠ 0.1	∠ 0.05
Total Kjeldahl Nitrogen				2.9	.44	.03			
Total Phosphorus	.06	.03	0	1.01	.21	.02	0.52	0.20	0.08
Fecal Coliform (Count/100 ml)				5,900	538	0			
Total Coliform (Count/100 ml)				33,000	2,323	0			
Nitrate - Nitrogen	2.0	1.43	.99	1.24	.80	.03	3.75	1.63	0.6
Carbonate (As $CACO_3$)							0	0	0
Alkalinity (As $CACO_3$)	119	79	44.0	88	57	30	275.6	107.7	51.8
Aluminum	.10	.10	.10						
Arsenic (μg/l)				∠10	∠ 10	∠10	47.6	∠ 19.6	∠ 0.5
Barium (μg/l)				∠300	∠192	40	330	∠ 150	∠ 50
Cadmium (μg/l)				∠ 5	4.2	∠ 1	40	∠ 12	∠ 2
Calcium	62.	36.3	18.0	125	45	24	70	38	19
Chloride	254.	24.2	2.5	22	12.8	5.3	7.5	5.4	2.5

TABLE 4.4.1-3 (Cont'd)

Parameters	Spottsville, Ky. (RM 9.0) STORET Data (1956-1974)			Sebree, Ky. (RM 41.3) ORSANCO Data (1976-1978)			Plant Site (RM 1.5) Monitoring Data (1978-1979)		
	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min
Chromium (μg/l)				30	24.5	0	40	14	< 2.5
Copper (μg/l)				50	25.1	3	80	< 30	< 2.0
Cyanide				< .01	< .01	< .01	0.20	< 0.06	< 0.01
Cyanide A							< 0.1	< 0.1	< 0.1
Total Organic Carbon				4.6	4.3	2.6	7.5	4.8	1.5
Fluoride	.50	.18	0	0.9	.25	0.1	0.18	0.13	0.07
Total Hardness				270	153	89			
Lead (μg/l)				75	18.7	6	50	< 30	10
Magnesium	18	7.8	3.0	25	10.4	60	14.4	9.5	6.24
Manganese (μg/l)	550	60	0	1,700	351.7	130	1,000	250	30
Mercury (μg/l)				22.5	1.07	.1	6.9	< 3.8	< 0.2
Nickel (μg/l)				< 100	< 75.7	6	80	< 28	< 4
Potassium	4.1	1.7	0.3	1.9	1.8	1.7			
Phenol (μg/l)				17	2.77	0	19.8	< 6.9	< 0.5
Selenium (μg/l)				< 25	< 5	< 5	10.3	< 3.9	< 2
Silver (μg/l)				< 30	< 30	< 30	17	< 6.5	< 5
Silicon Dioxide	17.0	9.1	4.9	6.7	6.4	5.9			
Sodium	132	16.1	2.0	18	10	3.8			
Sulfate	107	40.7	10	260	65.3	26	97	59	30
Sulfide							0.10	< 0.02	< 0.008
Zinc (μg/l)				130	44	20	260	138	73
Iron (μg/l)	1,300	50	0	12,400	2,740	800	7,700	3,420	1,650

TABLE 4.4.1-3 (Cont'd)

Parameters	Spottsville, Ky. (RM 9.0) STORET Data (1956-1974)			Sebree, Ky. (RM 41.3) ORSANCO Data (1976-1978)			Plant Site (RM 1.5) Monitoring Data (1978-1979)		
	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min
Oil and Grease							4.8	1.9	0.50
Specific Conduc. (umhos/cm.)	1,080	321.8	132				390	322.5	240
Polynuclear Aromatic Hydrocarbons (PAH's)									
2-Methyl naphthalene (ug/l)							180	91	15
Fluoranthene (ug/l)							13	7.1	1.9
Pyrene (ug/l)							116	53	15
Chrysene (ug/l)							10	5	2
Benzo(a)anthracene (ug/l)							10	5	2
Benzo(c)phenanthrene (ug/l)							<10	<5	2
Benzo(j)fluoranthene (ug/l)							14	6	<0.5
Benzo(b)fluoranthene (ug/l)							13	7	<3
Benzo(a)pyrene (ug/l)							0.8	0.6	0.5
Dibenz(a,c)anthracene (ug/l)							4	2	0.2
Dibenz(a,h)anthracene (ug/l)							15	<6	0.5
Benzo(g,h,i)perylene (ug/l)							1	<1	<<1
o-Phenylene pyrene (ug/l)							<5	2	<<1
2-Methyl fluoranthene (ug/l)							<2	<2	<2

* Unless otherwise specified

Sources: EPA STORET[7], ORSANCO[8] and Ebasco/Envirosphere Field Observations.

TABLE 4.4.1-4

SEASONAL WATER QUALITY, GREEN RIVER, RIVER MILE 41.3, SEBREE, KENTUCKY

Parameter	Units	January			February			March			April		
		Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min
Biological Oxygen Demand (5-day)	mg/1	3.5	2.3	0.9	3.5	1.7	0.8	1.4	1.4	1.4	3.2	2.9	2.2
Total Dissolved Solids	mg/1	220	165	119	215	194	160	171	154	137	25.0	237	151
Total Suspended Solids	mg/1	262	115	15	77	51	17	230	70	37	189	83	11
Ammonia-Nitrogen	mg/1	0.1	<0.07	<0.05	0.34	<0.18	<0.05	0.66	0.11	0.02	0.18	0.10	0.05
Total Kjeldahl Nitrogen	mg/1	1.0	0.57	0.21	1.8	0.63	0.20	0.80	0.45	0.25	2.9	0.20	0.03
Nitrate Nitrogen	mg/1	1.1	0.83	0.54	1.24	0.94	0.51	1.10	0.80	0.25	1.02	0.78	0.63
Total Phosphate	mg/1	0.50	0.21	0.06	0.35	<0.19	<0.05	0.28	<0.11	<0.05	0.43	0.15	<0.05
Fecal Coliform Bacteria	Count/100 ml	980	393	100	640	305	10	1,300	355	90	3,600	795	0
Total Coliform Bacteria	Count/100 ml	4,200	1,799	100	3,200	1,323	0	1,500	825	400	8,700	2,823	600
Alkalinity	mg/1	88	80	71	38	34	30	-	-	-	-	-	-
Arsenic	ug/1	<10	<10	<10	-	-	-	-	-	-	<10	<10	<10
Barium	ug/1	<200	<147	40	<200	<167	100	<200	<200	<200	<200	<200	<200
Cadmium	ug/1	<5.0	<5.0	<5.0	<5	<3.6	1.0	<5	<5	<5	<5	<3.6	1.0
Calcium	mg/1	59	36	25	52	38	24	40	34	30	51	41	33
Chloride	mg/1	5.8	5.5	5.3	22	20	19	-	-	-	-	-	-
Chromium	ug/1	<30	<23	<10	<30	<23	10	<30	<30	<30	<30	<23	<10
Copper	ug/1	<30	<21	3	50	<30	10	<30	<30	<30	70	<35	6
Cyanide	mg/1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Organic Carbon	mg/1	4.6	3.9	2.6	4.6	4.6	4.5	-	-	-	-	-	-
Fluoride	mg/1	0.9	0.4	0.1	0.1	0.1	0.1	-	-	-	-	-	-
Total Hardness	mg/1	130	123	120	110	100	89	-	-	-	170	143	120
Iron	ug/1	14,300	5,590	870	12,400	5,040	820	2,960	2,960	2,960	8,100	3,983	1,150
Lead	ug/1	36	<18	7	45	35	27	<5	<5	<5	15	12	6
Magnesium	mg/1	11.0	8.3	6.8	11.0	9.0	7.0	10.0	7.7	6.0	17.0	12.8	8.0
Manganese	ug/1	720	360	130	780	477	310	320	320	320	610	447	260
Mercury	ug/1	<0.5	<0.33	0.0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	22.5	<7.8	<0.2
Nickel	ug/1	<100	<70	10	<100	<71	12	<100	<100	<100	<100	<71	13
Potassium	mg/1	1.8	1.8	1.7	1.9	1.8	1.8	-	-	-	-	-	-
Phenol	ug/1	4	<2.3	1	4	<1.6	0.0	10.0	<4	<2.0	17	<4.5	<2.0
Selenium	ug/1	<5	<5	<5	-	-	-	-	-	-	<5	<5	<5
Silver	ug/1	<30	<30	<30	-	-	-	-	-	-	<30	<30	<30
Silicon Dioxide	mg/1	6.7	6.6	6.5	6.5	6.2	5.9	-	-	-	-	-	-
Sodium	mg/1	9.0	5.8	3.8	18	<11	<5	6.0	6.0	6.0	10	7.5	4.6
Sulfate	mg/1	60	39	26	79	58	26	64	59	53	118	74	49
Zinc	ug/1	130	<67	<30	110	67	30	<30	<30	<30	80	<47	30

Source: ORSANCO (1976-1978) [9]

TABLE 4.4.1-4 (Cont'd)

SEASONAL WATER QUALITY, GREEN RIVER, MP 41.3 - SEBREE, KENTUCKY[1]

Parameter	Units	May			June			July			August		
		Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min
Biological Oxygen Demand (5-day)	mg/1	2.0	1.3	0.5	1.6	1.6	1.6	-	-	-	1.7	1.4	1.0
Total Dissolved Solids	mg/1	300	236	173	251	231	182	-	-	-	246	210	160
Total Suspended Solids	mg/1	92	54	15	95	44	24	-	-	-	168	65	10
Ammonia-Nitrogen	mg/1	0.18	0.13	0.05	0.10	0.06	0.03	-	-	-	0.69	0.12	0.01
Total Kjeldahl Nitrogen	mg/1	0.87	0.49	0.27	0.51	0.36	0.20	-	-	-	0.7	0.39	0.2
Nitrate Nitrogen	mg/1	0.90	0.90	0.89	1.02	0.82	0.03	-	-	-	1.1	0.92	0.56
Total Phosphate	mg/1	0.19	0.10	0.04	0.17	0.09	0.02	-	-	-	0.63	0.43	0.03
Fecal Coliform Bacteria	Count/100 ml	620	89	40	200	140	0	360	140	20	1,700	715	10
Total Coliform Bacteria	Count/100 ml	2,600	2,334	200	3,400	1,325	500	900	400	100	4,800	2,575	100
Alkalinity	mg/1	-	-	-	-	-	-	-	-	-	-	-	-
Arsenic	ug/1	-	-	-	-	-	-	-	-	-	-	-	-
Barium	ug/1	<300	<250	<200	<200	<200	<200	-	-	-	<200	<200	<200
Cadmium	ug/1	<5	<2.5	<1	<5	<3	1.0	-	-	-	<5	<5	<5
Calcium	mg/1	56	47	36	63	46	38	-	-	-	50	41	31
Chloride	mg/1	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	ug/1	<30	<15	0.0	<30	<20	<10	-	-	-	<30	<25	20
Copper	ug/1	<30	<18	5	<30	<18	5	-	-	-	<30	<18	6
Cyanide	mg/1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	-	<0.01	<0.01	<0.01
Total Organic Carbon	mg/1	-	-	-	-	-	-	-	-	-	-	-	-
Fluoride	mg/1	-	-	-	-	-	-	-	-	-	-	-	-
Total Hardness	mg/1	210	205	200	150	137	130	-	-	-	160	145	130
Iron	ug/1	3,280	2,030	780	1,700	1,690	1,680	-	-	-	1,570	1,535	1,500
Lead	ug/1	15	15	14	12	12	12	-	-	-	25	23	20
Magnesium	mg/1	16.0	12	7.0	12.0	10	7.1	-	-	-	12	9.8	7.0
Manganese	ug/1	390	305	220	370	270	170	-	-	-	310	255	200
Mercury	ug/1	<0.5	<0.3	0.1	<0.5	<0.3	0.1	-	-	-	<0.5	<0.2	0.1
Nickel	ug/1	<100	<53	6	<100	<54	8	-	-	-	<100	<54	8
Potassium	mg/1	-	-	-	-	-	-	-	-	-	-	-	-
Phenol	ug/1	10	<2	1	4	<2	1	-	-	-	3	<1.8	0
Selenium	ug/1	-	-	-	-	-	-	-	-	-	-	-	-
Silver	ug/1	-	-	-	-	-	-	-	-	-	-	-	-
Silicon Dioxide	mg/1	-	-	-	-	-	-	-	-	-	-	-	-
Sodium	mg/1	12	10	7	10	10	9	-	-	-	11	8.8	6.5
Sulfate	mg/1	120	83	39	89	66	36	-	-	-	83	62	34
Zinc	ug/1	40	30	20	30	30	30	-	-	-	50	45	40

Source: ORSANCO (1976-1978)[9]

TABLE 4.4.1-4 (Cont'd)

SEASONAL WATER QUALITY, GREEN RIVER, RIVER MILE 41.3, SEBREE, KENTUCKY

Parameter	Units	September			October			November			December		
		Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min
Biological Oxygen Demand (5-day)	mg/1	2.2	1.7	1.2	2.5	1.7	0.7	0.7	0.7	0.7	3.2	1.7	0.1
Total Dissolved Solids	mg/1	476	312	229	217	190	154	258	201	167	213	187	158
Total Suspended Solids	mg/1	69	35	18	58	30	12	106	79	16	78	43	17
Ammonia-Nitrogen	mg/1	0.11	0.07	0.01	0.06	<0.06	0.05	0.10	0.08	<0.05	0.11	0.08	<0.05
Total Kjeldahl Nitrogen	mg/1	0.9	0.5	0.3	0.6	0.4	0.2	0.7	0.4	0.2	1.2	0.4	<0.1
Nitrate Nitrogen	mg/1	0.9	0.8	0.68	0.73	0.63	0.52	0.99	0.56	0.33	1.17	0.82	0.46
Total Phosphate	mg/1	0.32	0.28	0.02	1.01	0.22	0.03	0.40	0.2	0.09	0.63	0.27	0.05
Fecal Coliform Bacteria	Count/100 ml	210	160	100	160	110	10	5,900	1,074	0	660	192	40
Total Coliform Bacteria	Count/100 ml	3,100	2,167	1,700	1,500	1,300	700	33,000	6,550	0	20,000	4,459	200
Alkalinity	mg/1	-	-	-	-	-	-	-	-	-	-	-	-
Arsenic	ug/1	-	-	-	<10	<10	<10	-	-	-	-	-	-
Barium	ug/1	<200	<150	100	<200	<200	<200	<200	<200	<200	<200	<200	<200
Cadmium	ug/1	<5	<3	2	<5	<5	<5	<5	<5	<5	<5	<5	<5
Calcium	mg/1	65	53	42	54	47	37	56	45	39	125	67	41
Chloride	mg/1	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	ug/1	<30	<20	<10	<30	<30	<30	<30	<30	<30	<30	<30	<30
Copper	ug/1	<30	<16	4	<30	<30	<30	<30	<30	<30	<30	<30	<30
Cyanide	mg/1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Organic Carbon	mg/1	-	-	-	-	-	-	-	-	-	-	-	-
Fluoride	mg/1	-	-	-	-	-	-	-	-	-	-	-	-
Total Hardness	mg/1	270	220	170	-	-	-	-	-	-	-	-	-
Iron	ug/1	1,900	1,450	800	1,440	1,835	600	3,070	1,830	590	3,720	2,195	670
Lead	ug/1	75	43	9	<10	8	6	18	<14	10	29	21	13
Magnesium	mg/1	25	16	11.0	12	10	8.0	12	9	6.0	13	10	7.0
Manganese	ug/1	1,700	610	180	220	215	210	260	250	240	410	330	250
Mercury	ug/1	<0.5	<0.35	0.1	<0.5	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Nickel	ug/1	<100	<60	8	<100	<100	<100	<100	<100	<100	<100	<100	<100
Potassium	mg/1	-	-	-	-	-	-	-	-	-	-	-	-
Phenol	ug/1	3	<1.3	0	4	<3.0	<2	<2	<2.0	<2	16	<6.0	<2
Selenium	ug/1	-	-	-	<5	<5	<5	-	-	-	-	-	-
Silver	ug/1	-	-	-	<30	<30	<30	-	-	-	-	-	-
Silicon Dioxide	mg/1	-	-	-	-	-	-	-	-	-	-	-	-
Sodium	mg/1	17	15	12	13	9.0	5.0	11	11	11	6	6	6
Sulfate	mg/1	260	121	78	74	58	41	52	42	35	76	56	30
Zinc	ug/1	60	<40	<30	<30	<30	<30	110	70	30	<30	<30	<30

Source: ORSANCO (1976-1978)[9]

TABLE 4.4.1-5

GREEN RIVER TEMPERATURE DATA (1967-1976)

Month	Green River Temperature (oF)		
	Average	Maximum	Minimum
January	42.3	53.6	32.9
February	44	51.8	39.2
March	50	59.0	42.8
April	58.7	71.6	49.1
May	67.8	74.3	59.9
June	74.5	85.1	60.8
July	82.5	87.8	73.4
August	82.4	88.7	68
September	79.4	87.8	64.4
October	69.2	78.8	59
November	57.3	69.8	58.2
December	48	53.6	41.9

Source: USGS, 1977[6]

TABLE 4.4.1-6

BRIEF SUMMARY OF KENTUCKY WATER STANDARDS FOR THE GREEN RIVER BASIN NAVIGATION STREAMS

Parameter	Applicable Standard
Temperature (^{o}C)	31.6 maximum ($89^{o}F$)
Dissolved solids (mg/l)	500 maximum
pH (units)	6.0 - 9.0
Dissolved oxygen (mg/l)	5.0 average (not $<$ 4.0)
Threshold odor (number)	$<$ 3.0
Total coliforms (count/100 ml)	1,000 average (not 2,400)
Fecal coliforms (count/100 ml)	200 mean, 400 maximum May-October 1,000 mean, 2,000 maximum November-April
Toxic Chemicals	(mg/l)
Arsenic	0.05
Barium	1.00
Cadmium	0.01
Chromium (Cr_6)	0.05
Cyanide	0.025
Fluoride	1.00
Lead	0.05
Selenium	0.01
Silver	0.05

TABLE 4.4.1-7

STANDARDS FOR RAW GROUNDWATER AND SURFACE WATER FOR PUBLIC DRINKING WATER SUPPLY

Parameter	Suggested Limit That Should Not Be Exceeded	
Physical	(a)	(b)
Color		15 color units
pH		6.5-8.5
Odor		3 threshold odor numbers
Turbidity	1 unit	
Inorganic		
Arsenic	0.05 mg/l	
Barium	1.0 mg/l	
Cadmium	0.01 mg/l	
Chloride		250 mg/l
Chromium	0.05 mg/l	
Copper		1.0 mg/l
Fluoride	1.4-2.4 mg/l	
Iron		0.3 mg/l
Lead	0.05 mg/l	
Maganese		0.05 mg/l
Mercury	0.002 mg/l	
Nitrate (as N)	10.0 mg/l	
Selenium	0.01 mg/l	
Silver	0.05 mg/l	
Sulfate		250 mg/l
Hydrogen Sulfide		0.5 mg/l
Total Dissolved Solids		500 mg/l
Zinc		5.0 mg/l
Organic		
Alkyl benzene sulfonate		0.5 mg/l
Chlorinated hydrocarbons		
Endrin	0.0002 mg/l	
Lindane	0.004 mg/l	
Methozychlor	0.1 mg/l	
Toxaphene	0.005 mg/l	
Chlorophenoxys		
2,4-D	0.1 mg/l	
2,4 5-tp Silvex	0.1 mg/l	
Microbiological containment	One coliform bacterium per 100 ml as the mean of all samples per month.	

(a) National Interim Primary Drinking Water Regulations
(b) National Secondary Drinking Water Regulations

TABLE 4.4.1-8

COMPARISON OF IN-SITU RECORDED TEMPERATURE WITH HISTORICAL DATA FOR LOW RIVER FLOW PERIOD

Month	Temperature oF In-Situ Recorded	Historical* Data	Remarks
July	81.14	73.4	Minimum
	85.5	87.8	Maximum
	82.5	82.5	Mean
August	79.0	68.0	Minimum
	84.9	88.7	Maximum
	82.3	82.4	Mean
September	76.8	64.4	Minimum
	62.8	87.8	Maximum
	80.0	79.4	Mean
October	60.4	59.0	Minimum
	75.9	78.8	Maximum
	67.0	69.2	Mean

* At Calhoun, Kentucky

Sources: In-situ Recorded - Ebasco/Envirosphere Field Observations, 1978.

Historical - USGS, 1977[6]

TABLE 4.4.1-9

COMPARISON OF MOORED IN-SITU RECORDED TEMPERATURE WITH TEMPERATURES OBTAINED FROM VERTICAL PROFILE SURVEY

Date	Temperature	
	In-Situ Recorded	Vertical Profile
August 4, 1978	81.86	81.5
September 5, 1978	79.5	79.7
September 14, 1978	80.06	79.7
September 29, 1978	77.0	77.0
October 16, 1978	65.5	64.5
November 6, 1978	N/A*	62.2

* In-situ Recorder removed Nov. 1, 1978.

TABLE 4.4.1-10

OHIO RIVER WATER QUALITY

Parameter	Units	Evansville, Indiana (MP 791.5) STORET Data (1958-1974) Max	Mean	Min	ORSANCO Data (1976-1978) Max	Mean	Min	Evansville Water Dept (1974-1977)* Max	Mean	Min	Owensboro, Ky (MP 763.2) STORET Data (1968-1974) Max	Mean	Min
Biological Oxygen Demand (5 day)	mg/l	8.4	2.6	0.3	6.2	2.4	1.0	-	-	-	4.4	1.6	0.6
Dissolved Oxygen	mg/l	14.7	9.1	0.9	16.2	9.1	3.6	-	-	-	11.0	7.6	4.8
Total Dissolved Solids	mg/l	342	269	206	200	179	162	319	103.7	18	150	32	2
Total Suspended Solids	mg/l	716	104	0.0	614	149	5	-	-	-	80	23	2
Temperature	°C	31.2	18.0	0.0	31.6	16.1	0	30	18.2	4	30	22	5
pH		-	-	-	8.8	7.4	6.6	7.9	7.7	7.5	8.1	7.6	7.2
Specific Conductance	umhos/cm	-	-	-	610	350	140	-	-	-	-	-	-
Ammonia-Nitrogen	mg/l	30	0.4	0.0	0.93	0.19	0	-	-	-	0.55	0.12	0.01
Total Kjeldahl Nitrogen	mg/l	-	-	-	3.2	0.79	0.1	-	-	-	-	-	-
Total Phosphate	mg/l	2.0	0.21	0.01	3.85	0.30	0.05	1.79	.71	.22	0.28	0.14	0.08
Fecal Coliform	Count/100 ml	8,000	752	10	3,500	407	0	1,123	389.0	6.25	49,000	3,993	20
Nitrate-Nitrogen	mg/l	-	-	-	1.9	1.2	0.53	-	-	-	-	-	-
Alkalinity	mg/l	130	67	24	66	60	50	90	67.6	52	85	65	34
Aluminum	mg/l	3.9	0.41	0.01	-	-	-	-	-	-	-	-	-
Arsenic	ug/l	65	47	22	-	10	-	-	-	-	0.01	0.01	0.01
Barium	ug/l	121	58	17	300	190	0	-	-	-	-	-	-
Boron	mg/l	0.19	0.10	0.04	-	-	-	-	-	-	-	-	-
Cadmium	ug/l	24	5	1	5	4	0	-	-	-	5	2	1
Calcium	mg/l	62	45	30	37	34	30	57.6	40.9	30.4	56	48	36
Chloride	mg/l	106	29	7	22	18	14	38	25.5	14	57	33	15
Chromium	ug/l	100	31	2	40	25	0	-	-	-	50	35	30
Copper	ug/l	120	34	4	250	49	7	-	-	-	50	42	20
Cobalt	mg/l	0.02	0.012	0.002	-	-	-	-	-	-	-	-	-
Cyanide	mg/l	6	3	0.01	0.02	0.01	0	-	-	-	0.01	0.01	0.01
Total Organic Carbon	mg/l	16	5.8	1.2	8.8	5.9	4.0	-	-	-	7.8	5.1	3.1
Fluoride	mg/l	0.51	0.24	0.12	0.3	0.2	0.1	-	-	-	0.39	0.27	0.14
Total Hardness	mg/l	-	-	-	130	120	110	195	131.2	99	-	-	-
Iron	ug/l	7,800	1,750	5.0	17,750	4,655	360	2,700	1,100	1,700	790	431	300
Lead	ug/l	140	15	5	49	16.7	5	-	-	-	11	10	10
Magnesium	mg/l	15	11.2	1.1	500	173	8.2	-	-	-	14	12.1	9.5
Manganese	ug/l	600	180	0.6	1,330	424	90	1,960	1,030	220	160	81	25
Mercury	ug/l	160	8	0.2	0.5	0.4	0.0	-	-	-	1.0	0.5	0.3
Molybdenum	mg/l	0.08	0.031	0.005	-	-	-	-	-	-	-	-	-
Nickel	ug/l	100	56	2	100	82	0	-	-	-	100	100	100
Potassium	mg/l	4.8	3.5	2.1	2.2	2.1	2.0	-	-	-	-	-	-
Phenol	ug/l	0.5	0.3	0.1	17	3.21	0	-	-	-	0.5	0.5	0.5
Selenium	ug/l	10	3	0.01	-	5	-	-	-	-	4	3	2
Silver	ug/l	50	6	0.1	30	26.3	0	-	-	-	3	2	2
Silicon Dioxide	mg/l	-	-	-	6.6	6.3	6.0	6.8	4.58	1.2	-	-	-
Sodium	mg/l	38.9	20.2	7.7	34	18.5	9.3	-	-	-	30	23.1	11.5
Sulfate	mg/l	310	95	35	131	67.5	15	128	80.9	58	65	31	20
Zinc	ug/l	390	59	10	260	64.1	20	-	-	-	65	31	20

Note: Data presented under the title "Evansville Water Department" were based on monthly average values provided by the source.

Sources: ORSANCO,[9] STORET,[7] and Evansville Water Department.

TABLE 4.4.1-11

SEASONAL WATER QUALITY, OHIO RIVER, RIVER MILE 791.5, EVANSVILLE, INDIANA

Parameter	Units	January			February			March			April		
		Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max
Dissolved Oxygen	mg/l	11.3	12.4	14.0	10.3	12.3	15.0	8.8	10.8	13.2	7.3	9.5	12.8
Temperature	°F	32	39	49	32	41	50	36	50	56	48	56	68
pH		7.0	7.4	8.3	6.9	7.4	7.7	6.6	7.3	8.2	6.7	7.3	8.3
Specific Conductance	umhos/cm	140	292	380	250	332	500	220	288	560	200	292	360
Biological Oxygen Demand (5-day)	mg/l	1.4	2.6	3.5	1	2.6	4.7	1.4	1.4	1.4	1.5	2.8	4.0
Total Dissolved Solids	mg/l	162	169	182	178	189	200	-	-	-	-	-	-
Total Suspended Solids	mg/l	7	175	254	<10	135	306	68	201	447	15	247	500
Ammonia-Nitrogen	mg/l	0.14	0.26	0.59	0.20	0.37	0.93	0.13	0.33	0.71	0.02	0.12	0.17
Total Kjeldahl Nitrogen	mg/l	0.6	0.73	1.0	0.4	1.32	3.2	0.9	1.3	2.3	0.38	0.8	1.2
Nitrate Nitrogen	mg/l	1.76	1.11	1.46	0.53	0.97	1.36	1.07	1.22	1.34	1.07	1.09	1.25
Total Phosphorous	mg/l	<0.05	0.30	0.48	<0.05	<0.18	0.53	<0.05	<0.24	0.50	0.06	0.42	0.87
Fecal Coliform Bacteria	Count/100 ml	20	397	1,480	0	730	2,720	20	450	1,300	0.0	460	800
Total Coliform Bacteria	Count/100 ml	400	3,783	7,400	700	2,733	7,000	500	3,100	19,000	2,800	5,633	11,200
Alkalinity	mg/l	59	63	66	50	57	64	-	-	-	-	-	-
Arsenic	ug/l	<10	<10	<10	-	-	-	-	-	-	<10	<10	<10
Barium	ug/l	<200	<200	<200	70	<157	<200	<200	<200	200	0.0	<200	<200
Cadmium	ug/l	<5	<5	<5	1	<3.7	<5	0	<3.3	<5	0.0	<2.5	<5.0
Calcium	mg/l	32	34	36	30	34	37	-	-	-	-	-	-
Chloride	mg/l	14	15	16	17	20	22	-	-	-	-	-	-
Chromium	ug/l	<30	<30	<30	10	<23	<30	0	<23	40	<10	<20	<30
Copper	ug/l	<30	<43	70	12	<25	<30	<30	<51	70	<30	<32	33
Cyanide	mg/l	0	<0.01	<0.01	0	<0.01	<0.01	0	<0.01	<0.02	0	<0.01	<0.01
Total Organic Carbon	mg/l	4.0	6.2	8.8	4	5.5	7	-	-	-	-	-	-
Fluoride	mg/l	0.1	0.2	0.3	0.1	0.1	0.1	-	-	-	-	-	-
Total Hardness	mg/l	110	120	130	110	120	130	-	-	-	-	-	-
Iron	ug/l	4,780	6,053	8,600	360	1,967	3,200	3,560	9,803	17,750	5,200	6,450	7,700
Lead	ug/l	14	14.7	16	<10	<13.7	17	6	25.3	40	12	14	16
Magnesium	mg/l	8.2	8.7	9.1	8.4	8.9	9.3	500	500	500	-	-	-
Manganese	ug/l	540	940	1,140	190	227	250	190	733	1,140	210	285	360
Mercury	ug/l	<0.5	<0.5	<0.5	0	<0.37	<0.5	0.2	<0.43	<0.5	0.1	<0.3	<0.5
Nickel	ug/l	<100	<100	<100	10	<70	<100	<100	<100	<100	10	<55	<100
Potassium	mg/l	2.0	2.0	2.1	2.0	2.11	2.2	-	-	-	-	-	-
Phenol	ug/l	0	<3.5	3	<2	<2.3	4	0.0	3.8	11	0.0	4	15
Selenium	ug/l	<5	<5	<5	-	-	-	-	-	-	<5	<5	<5
Silver	ug/l	0.0	<15	<30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	<15	<30
Silicon Dioxide	ug/l	6.1	6.3	6.6	6.0	6.2	6.4	-	-	-	-	-	-
Sodium	mg/l	11	16	20	12	17	24	9.3	18	27	11	12	13
Sulfate	mg/l	52	64	80	46	67	84	15	66	96	49	66	79
Zinc	ug/l	90	91.7	95	<30	<33	40	60	136.7	260	40	60	80

Source: ORSANCO Data during the period of 1973 through 1977.[9] Dissolved oxygen, temperature, pH and specific conductance were continuously monitored. The remaining parameters were measured by grab samples.

TABLE 4.4.1-11 (Cont'd)

SEASONAL WATER QUALITY, OHIO RIVER, RIVER MILE 791.5, EVANSVILLE, INDIANA

Parameter	Units	May			June			July			August		
		Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max
Dissolved Oxygen	mg/1	5.6	8.8	16.2	4.8	7.0	9.8	5.0	7.1	10.1	3.6	6.9	11.4
Temperature	°F	59	67	80	66	76	83	74	82	89	78	82	87
pH		6.7	7.4	8.8	6.7	7.2	8.4	6.8	7.6	8.7	6.7	7.4	8.6
Specific Conductance	umhos/cm	240	330	610	230	342	560	300	390	580	300	408	560
Biological Oxygen Demand (5-day)	mg/1	2.3	4.3	6.2	1.1	1.1	1.1	-	-	-	1.2	1.2	1.2
Total Dissolved Solids	mg/1	-	-	-	236	236	236	-	-	-	-	-	-
Total Suspended Solids	mg/1	16	105	291	11	66	152	-	-	-	5	38	191
Ammonia-Nitrogen	mg/1	0.4	0.14	0.31	0.06	0.11	0.19	-	-	-	0.0	0.04	0.07
Total Kjeldahl Nitrogen	mg/1	0.3	0.6	0.91	0.2	0.54	0.77	-	-	-	0.3	0.48	0.58
Nitrate Nitrogen	mg/1	0.85	1.07	1.19	0.84	1.21	1.4	-	-	-	1.03	1.26	1.4
Total Phosphorous	mg/1	0.11	0.23	0.47	0.08	0.14	0.21	-	-	-	<0.05	0.11	0.23
Fecal Coliform Bacteria	Count/100 ml	20	345	580	40	371	720	0	70	120	20	225	480
Total Coliform Bacteria	Count/100 ml	700	2,200	4,000	200	2,188	3,900	0	1,405	2,800	200	1,425	3,600
Alkalinity	mg/1	-	-	-	-	-	-	-	-	-	-	-	-
Arsenic	ug/1	-	-	-	-	-	-	-	-	-	-	-	-
Barium	ug/1	90	<145	<200	60	<130	<200	0.0	0.0	0.0	<200	<250	300
Cadmium	ug/1	1	<3	<5	0.0	<2.5	<5	0.0	0.0	0.0	2	<3.5	<5
Calcium	mg/1	-	-	-	-	-	-	-	-	-	-	-	-
Chloride	mg/1	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	ug/1	10	<20	<30	10	<20	<30	20	20	20	20	<25	<30
Copper	ug/1	27	54	80	10	25	40	7	7	7	9	30	50
Cyanide	mg/1	0.0	<0.01	<0.01	0	<0.01	<0.01	-	-	-	0	<0.01	<0.01
Total Organic Carbon	mg/1	-	-	-	-	-	-	-	-	-	-	-	-
Fluoride	mg/1	-	-	-	-	-	-	-	-	-	-	-	-
Total Hardness	mg/1	-	-	-	-	-	-	-	-	-	-	-	-
Iron	ug/1	3,900	7,450	11,000	920	2,310	3,700	1,800	1,800	1,800	530	595	660
Lead	ug/1	7	22	37	7	10	13	12	12	12	7	12	16
Magnesium	mg/1	-	-	-	-	-	-	-	-	-	-	-	-
Manganese	ug/1	370	640	910	120	170	220	160	160	160	90	105	120
Mercury	ug/1	0.2	<0.4	<0.5	0.2	<0.4	<0.5	0.1	0.1	0.1	0.2	<0.4	<0.5
Nickel	ug/1	36	<68	<100	12	<56	<100	0.0	0.0	0.0	2	<51	<100
Potassium	mg/1	-	-	-	-	-	-	-	-	-	-	-	-
Phenol	ug/1	1	<2.0	3	0	<1.0	3	-	-	-	0	<1.3	2
Selenium	ug/1	-	-	-	-	-	-	-	-	-	-	-	-
Silver	ug/1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Silicon Dioxide	ug/1	-	-	-	-	-	-	-	-	-	-	-	-
Sodium	mg/1	15	16	17	18	22	23	-	-	-	26	28	30
Sulfate	mg/1	69	84	105	73	84	98	-	-	-	73	92	131
Zinc	ug/1	50	75	100	<30	<35	40	40	40	40	20	30	40

Source: ORSANCO Data during the period of 1973 through 1977.[9] Dissolved oxygen, temperature, pH and specific conductance were continuously monitored. The remaining parameters were measured by grab samples.

TABLE 4.4.1-11 (Cont'd)

SEASONAL WATER QUALITY, OHIO RIVER, RIVER MILE 791.5, EVANSVILLE, INDIANA

Parameter	Units	September			October			November			December		
		Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max
Dissolved Oxygen	mg/1	4.1	6.8	10.5	5.5	8.0	11.5	6.8	9.0	11.3	8.7	11.4	13.7
Temperature	°F	67	77	86	54	65	77	42	54	64	35	42	49
pH		6.9	7.5	8.7	7.0	7.4	8.5	7.1	7.5	8.3	7.1	7.5	8.1
Specific Conductance	umhos/cm	290	392	590	280	393	560	250	390	610	270	348	450
Biological Oxygen Demand (5-day)	mg/1	1.2	1.5	1.7	1.7	1.9	2.1	2.3	2.3	2.3	3.7	3.7	3.7
Total Dissolved Solids	mg/1	-	-	-	-	-	-	-	-	-	-	-	-
Total Suspended Solids	mg/1	19	27	33	29	83	147	46	62	105	26	190	614
Ammonia-Nitrogen	mg/1	0.01	0.04	0.08	0.06	0.08	0.19	<0.05	<0.09	0.11	0.13	0.28	0.38
Total Kjeldahl Nitrogen	mg/1	0.1	0.44	0.66	0.1	0.42	0.7	0.4	0.47	0.5	0.6	0.85	1.4
Nitrate Nitrogen	mg/1	0.86	1.08	1.2	1.02	1.23	1.43	0.89	0.97	1.13	0.79	1.22	1.89
Total Phosphorous	mg/1	<0.05	0.14	0.23	<0.05	0.30	0.46	0.17	0.31	0.78	0.06	1.3	3.85
Fecal Coliform Bacteria	Count/100 ml	0	73	90	70	427	1,000	240	798	3,500	80	627	1,400
Total Coliform Bacteria	Count/100 ml	700	1,700	4,000	1,400	10,067	29,000	100	3,067	5,800	2,800	21,317	38,000
Alkalinity	mg/1	-	-	-	-	-	-	-	-	-	-	-	-
Arsenic	ug/1	-	-	-	<10	<10	<10	-	-	-	-	-	-
Barium	ug/1	0.0	<100	<200	<200	<200	<200	<200	<200	<200	<200	<200	200
Cadmium	ug/1	0.0	<4.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Calcium	mg/1	-	-	-	-	-	-	-	-	-	-	-	-
Chloride	mg/1	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	ug/1	<10	<23	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30
Copper	ug/1	10	65	90	60	155	250	60	75	90	30	55	80
Cyanide	mg/1	0.0	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Total Organic Carbon	mg/1	-	-	-	-	-	-	-	-	-	-	-	-
Fluoride	mg/1	-	-	-	-	-	-	-	-	-	-	-	-
Total Hardness	mg/1	-	-	-	-	-	-	-	-	-	-	-	-
Iron	ug/1	720	1,130	1,800	2,160	5,805	9,450	3,150	3,285	3,420	1,430	7,015	12,600
Lead	ug/1	8	19	49	9	17	25	<10	<25	40	21	21	21
Magnesium	mg/1	-	-	-	-	-	-	-	-	-	-	-	-
Manganese	ug/1	100	128	160	150	465	780	180	190	200	170	665	1,160
Mercury	ug/1	0	<0.4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Nickel	ug/1	9	<55	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Potassium	mg/1	-	-	-	-	-	-	-	-	-	-	-	-
Phenol	ug/1	0.0	<1.2	<2	<2	<2.0	<2	<2	<3.3	5	<2.0	<7.0	17
Selenium	ug/1	-	-	-	<5	<5	<5	-	-	-	-	-	-
Silver	ug/1	-	-	-	<30	<30	<30	-	-	-	-	-	-
Silicon Dioxide	ug/1	-	-	-	-	-	-	-	-	-	-	-	-
Sodium	mg/1	20	21	21	23	29	34	15	17	19	14	16	17
Sulfate	mg/1	75	79	83	70	79	95	67	69	76	48	62	77
Zinc	ug/1	20	27	30	<30	<55	80	60	70	80	50	85	120

Source: ORSANCO Data during the period of 1973 through 1977.[9] Dissolved oxygen, temperature, pH and specific conductance were continuously monitored. The remaining parameters were measured by grab samples.

TABLE 4.4.1-12

ORSANCO STREAM QUALITY CRITERIA FOR THE OHIO RIVER

Parameter	Criteria
Dissolved Oxygen (mg/l)	5.0 daily average (not <4.0)
Stream Max Temperature (^{o}F)	Monthly maximum not to exceed 50-Jan, 50-Feb, 60-Mar, 70-Apr, 80-May, 87-June, 89-July, 89-Aug, 87-Sept, 78-Oct, 70-Nov, 57-Dec
pH (units)	6-9
Dissolved Solids (mg/l)	500 monthly average (maximum <750)
Fecal Coliform (Count/100 ml)	Recreation: 200 (max monthly geometric mean) 400 (<10% samples, during recreational season) Water Supply: 2,000 (max monthly geometric mean) Both based on at least five samples per month.

Chemical Constituents: shall not exceed the following

Arsenic	50ug/l
Barium	1,000 ug/l
Cadmium	10 ug/l
Chloride	250 mg/l
Chromium (hexavalent)	50 ug/l
Copper	0.1 x 96 hr LC50
Cyanide	25 ug/l
Fluoride	1.0 mg/l
Lead (dissolved)	50 ug/l
Mercury	0.2 ug/l*
Nitrate-N+ Nitrite-N	10 mg/l
Nitrite-N	1.0 mg/l
Phenol	10 ug/l
Selenium	10 ug/l
Silver	50 ug/l
Sulfate	250 mg/l
Zinc	0.01 x 96 hr LC50

* Total body burden of any aquatic species shall not exceed 0.5 ug/gram

TABLE 4.4.1-13

WATER QUALITY, CYPRESS SLOUGH, INLET AND OUTLET

Concentration, mg/l*

Parameter	Inlet			Outlet			Combined		
	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min
Ammonia (as N)	0.24	<0.13	<0.05	0.13	<0.09	<0.05	0.24	<0.11	<0.05
Arsenic (total)	0.0266	<0.0130	<0.0005	0.0228	0.0137	0.0064	0.0266	<0.0133	<0.0005
Barium (total)	0.11	0.09	0.05	0.12	<0.08	<0.05	0.12	<0.08	<0.05
Bicarbonate (as $CaCO_3$)	115.6	87.4	59.2	115.6	94.7	62.9	115.6	91.1	59.2
BOD_5	11.9	<4.6	0.9	8.1	3.5	1.3	11.9	<4.1	0.9
Cadmium (total)	0.0045	<0.003	<0.002	0.0075	<0.003	<0.002	0.0075	<0.003	<0.002
Calcium (total)	42.5	31	15.0	45.0	33	25.0	45.0	32	15.0
Carbonate (as $CaCO_3$))	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chloride	5.0	3.4	2.0	15.0	5.6	1.5	15.0	4.5	1.5
Chlorine (total res.)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chromium (hexavalent)	0.021	<0.007	<0.0025	0.022	0.008	<0.0025	0.022	<0.008	<0.0025
Chromium (total)	0.030	0.020	0.010	0.040	0.017	0.003	0.040	0.019	0.003
COD	93	64	32	100	63	43	100	64	32
Copper (total)	0.09	<0.03	<0.002	0.06	<0.03	<0.002	0.09	<0.003	<0.002
Cyanide	0.08	0.04	<0.01	0.17	0.08	0.03	0.17	0.06	<0.01
Cyanide A	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
DO*	11.3	6.2	2.5	12.0	5.8	2.6	12.0	6.0	2.5
Fluoride	0.18	0.13	0.06	0.17	0.13	0.05	0.18	0.13	0.05
Iron (total)	3.70	2.45	1.80	2.84	2.07	0.57	3.70	2.26	0.57
Lead (total)	0.05	<0.03	<0.02	0.05	0.03	<0.02	0.05	<0.03	<0.02
Magnesium (total)	9.3	7.0	5.25	29.5	12.3	5.25	29.5	9.6	5.25
Manganese (total)	2.73	1.19	0.11	2.63	1.48	0.04	2.73	1.34	0.04
Mercury (total)	0.0047	0.0039	0.0032	0.0054	0.0040	0.0025	0.0054	0.0039	0.0025
Nickel (total)	0.035	<0.012	<0.004	0.013	<0.007	<0.004	0.035	0.009	<0.004
Nitrate (as N)	1.75	1.11	0.70	1.25	1.09	0.80	1.75	1.10	0.70
Oil and Grease	1.6	<0.8	<0.2	8.0	3.7	<0.2	8.0	2.3	<0.2
pH*, units	7.77	7.34	7.14	7.74	7.42	7.22	7.77	7.38	7.14
Phenol	0.0068	<0.0033	<0.0005	0.0161	0.0064	<0.0005	0.0161	0.0048	<0.0005
Phosphorus	0.45	0.26	0.09	0.30	0.21	0.09	0.45	0.23	0.09
Selenium (total)	0.0063	<0.004	<0.002	0.007	0.003	<0.002	0.007	0.004	<0.002
Silver (total)	1.613	0.409	<0.005	0.088	0.030	<0.005	1.613	0.219	<0.005
Specific Conductance, umhos/cm	300	259	210	270	255	240	300	257	210
Sulfate	29	20	6	28.3	18	3	29	19	3
Sulfide	<0.008	<0.008	<0.008	0.03	<0.01	<0.008	0.03	<0.01	<0.008
Temperature*, C	24.3	14.4	1.3	26.3	14.6	2.0	26.3	14.5	1.3
TOC	13.7	6.9	1.1	16.9	8.2	1.2	16.9	7.5	1.1
TSS	92	63	42	132	80	52	132	71	42
Zinc (total)	0.200	0.098	0.030	0.250	0.086	0.015	0.250	0.092	0.015

* Unless otherwise specified.

TABLE 4.4.1-14

ON-SITE STREAM WATER QUALITY

Parameter	Concentration* (mg/l)		
	Max	Mean	Min
Ammonia (as N)	0.24	∠ 0.15	∠ 0.05
Arsenic (total)	0.0213	0.0113	0.0016
Barium (total)	0.24	∠ 0.14	∠ 0.05
Bicarbonate (as $CaCO_3$)	190.8	136.5	37.0
BOD_5	19.0	∠ 5.5	∠ 1.0
Cadmium (total)	0.0180	∠ 0.010	∠ 0.002
Calcium (total)	125	54	27.5
Carbonate (as $CaCO_3$)	0.0	0.0	0.0
Chloride	15.0	7.6	1.8
Chlorine (total res.)	∠ 0.2	∠ 0.2	∠ 0.02
Chomium, (Hexavalent)	0.006	∠ 0.003	∠ 0.0025
Chromium, (Total)	0.018	0.007	0.003
COD	180	70	21
Copper (total)	∠ 0.018	∠ 0.006	∠ 0.002
Cyanide	0.15	0.09	0.05
Cyanide A	∠ 0.1	∠ 0.1	∠ 0.1
DO	12.0	9.4	7.6
Fluoride	0.21	0.18	0.14
Iron (total)	9.25	4.6	0.49
Lead (total)	0.05	∠ 0.03	∠ 0.02

TABLE 4.4.1-14 (Cont'd)

Parameter	Concentration* (mg/l)		
	Max	Mean	Min
Magnesium (total)	23.45	17.6	5.25
Manganese (total)	0.25	0.15	0.04
Mercury (total)	0.0057	<0.0035	<0.0002
Nickel (total)	0.110	<0.042	<0.004
Nitrate (as N)	3.10	1.78	0.10
Oil & Grease	1.3	<0.8	<0.2
pH, units	8.09	7.58	7.22
Phenol	0.0068	0.0042	0.0006
Phosphorous (total)	0.33	0.21	0.09
Selenium (total)	0.0110	<0.004	<0.002
Silver (total)	0.025	<0.010	<0.005
Specific Conductance, umhos/cm	490	282	129
Sulfate	30	24	11
Sulfide	0.06	<0.021	<0.008
Temperature, ^{o}C	18.8	11.8	1.0
TOC	33.4	11.2	2.4
TSS	178	84	13
Zinc (Total)	0.145	0.096	0.015
Polynuclear Aromatic Hydrocarbons (PAH's)			
2-Methyl naphthalene	0.282	0.193	0.102
Fluoranthene	0.103	0.064	0.036
Pyrene	0.204	0.108	0.033

TABLE 4.4.1-14 (Cont'd)

	Concentration* (mg/l)		
	Max	Mean	Min
Polynuclear Aromatic Hydrocarbons (PAH's)			
Chrysene	0.029	0.014	0.0045
Benzo(a)anthracene	0.025	0.012	0.0045
Benzo(c)phenanthrene	0.025	<0.012	0.0045
Benzo(j)fluoranthene	0.023	<0.014	<0.005
Benzo(b)fluoranthene	0.027	0.017	<0.005
Benzo(a)pyrene	0.017	0.009	0.004
Dibenz(a,c)anthracene	0.021	0.009	0.002
Dibenz(a,h)anthracene	0.0089	0.007	0.006
Benzo(g,h,i)perylene	0.0095	0.005	0.003
o-Phenylene pyrene	<0.005	0.004	0.003
2-Methyl fluoranthene	<0.002	<0.002	<0.002

*Unless otherwise specified.

TABLE 4.4.2-1

SOIL AND BEDROCK FIELD PERMEABILITY

Boring	Permeability Test #, Type	Coefficient of Permeability, K (cm/sec)	Type of Material Tested, depth (feet)
A-8	WT1, Falling Head	9.9×10^{-6}	Soil - clayey SILT, 3.0
	WT2, Falling Head	4.3×10^{-6}	Soil - clayey SILT, 8.0
	WT3, Falling Head	2.6×10^{-6}	Soil - clayey SILT, 13.0
	WT4, Falling Head	1.5×10^{-6}	Bedrock - highly weathered SHALE, 18.0
A-29	WT1, Falling Head	1.1×10^{-5}	Soil - clayey SILT, 3.5
	WT2, Falling Head	2.9×10^{-6}	Soil - clayey SILT, 8.5
	WT3, Falling Head	1.4×10^{-6}	Bedrock - highly weathered
A-30	WT1, Falling Head	2.4×10^{-5}	Soil - clayey SILT, 5.5
	WT2, Falling Head	0.0 (no take)	Soil - clayey SILT, 10.5
	WT3, Falling Head	4.7×10^{-4}	Soil - clayey SILT, 15.5
	WT4, Packer Test (8 min @ 50 psi)	0.0 (no take)	Bedrock - slightly weathered to fresh CLAYSTONE and COAL with thin layers of sandstone and siltstone, 30.0 to 64.0

TABLE 4.4.2-2

SUMMARY OF LABORATORY

PERMEABILITY TESTS

A. UNDISTURBED OVERBURDEN MATERIAL

Boring No.	Depth, ft.	Natural Moisture Content, %	Dry Density, PCF	Coefficient of Permeability
A2	13.5 - 15.6	12.5	127.4	8.39×10^{-7} cm/sec

B. RECOMPACTED OVERBURDEN MATERIAL

Boring No.	Depth, ft.	Optimum Moisture Content, %	Max. Dry Density (ASTM D1557), PCF	Coefficient of Permeability
A2	1.5 - 7.0	14.4	113.0	7.16×10^{-6} cm/sec
A11	6.0 - 8.0	14.5	113.0	1.74×10^{-5} cm/sec
A29	4.0 - 7.0	13.6	114.6	3.22×10^{-5} cm/sec

TABLE 4.4.2–3
VARIATION OF WATER TABLE ELEVATIONS
(BASED ON PIEZOMETER MEASUREMENTS FROM JULY 1, 1978 TO AUG. 17, 1979)

DATE	WATER TABLE ELEVATIONS IN FEET[1] (a)	(b)	(c)	(d)	(e)	(f)
07–01–78	455.97	375.29	398.20	408.73	353.01	353.02
07–08–78	454.84	375.79	398.62	408.45	353.17	354.54
07–15–78	453.97	375.71	398.53	407.40	352.64	352.68
07–22–78	453.59	375.58	398.59	406.48	352.32	351.98
07–29–78	453.59	375.38	398.28	406.19	352.01	351.77
08–05–78	453.59	375.25	398.20	405.69	351.93	352.43
08–12–78	453.63	375.04	397.87	405.15	351.80	353.20
08–19–78	<453.55[2]	374.79	397.37	404.73	350.72	349.72
08–26–78	453.63	374.75	396.70	404.36	351.59	349.06
09–02–78	453.73	374.50	396.37	404.19	351.49	352.25
09–09–78	<453.59[2]	374.29	395.95	403.98	351.30	349.72
09–16–78	<453.59[2]	374.21	395.78	403.77	351.26	349.62
09–23–78	<453.59[2]	373.96	395.37	403.48	351.13	349.97
09–30–78	453.72	373.75	395.12	403.27	351.05	350.47
10–07–78	453.67	373.62	394.95	403.07	350.88	350.39
10–14–78	<453.59[2]	373.50	394.62	402.82	350.84	350.54
10–21–78	<453.59[2]	373.29	394.58	402.65	350.80	351.39
10–28–78	<453.59[2]	373.25	394.37[3]	401.40[3]	350.64	350.27
11–04–78	453.63	373.08	394.58	402.19	350.59	349.98
11–11–78	<453.59[2]	372.79	394.66	402.19	350.55	349.72
11–18–78	<453.59[2]	372.88	396.41	402.44	350.47	351.60
11–24–78	<453.59[2]	372.83	397.53	402.57	350.43	351.89
12–02–78	<453.47[2]	373.38	400.91	403.36	350.69	356.64
12–08–78	<453.47[2]	376.21	406.91	404.44	N. A.	N. A.
12–16–78	<453.47[2]	376.67	403.78	405.98	N. A.	N. A.
12–22–78	<453.47[2]	377.21	403.78[4]	404.52[4]	N. A.	365.60
12–30–78	<453.47[2]	376.83	402.70	406.82	361.05	N. A.

DATE	WATER TABLE ELEVATIONS IN FEET[1] (a)	(b)	(c)	(d)	(e)	(f)
01–06–79	<453.47[2]	377.50	404.32	408.07	N. A.	N. A.
01–13–79	453.47	376.92	403.37	408.86	N. A.	N. A.
01–20–79	453.47	376.79	406.58	409.44	362.51	366.35
01–27–79	453.59	377.17	405.16	410.44	N. A.	N. A.
02–03–79	453.51	376.92	403.87	410.73	N. A.	N. A.
02–10–79	453.51	376.58	402.87	410.90	358.26	360.10
02–19–79	453.51	376.66	403.95	410.98	355.93	362.02
02–23–79	453.38	377.50	405.95	411.40	N. A.	N. A.
03–03–79	454.63	379.04	405.41	412.23	N. A.	N. A.
03–10–79	455.22	378.17	404.58	412.86	N. A.	N. A.
03–17–79	455.34	377.66	403.74	412.78	N. A.	N. A.
03–24–79	456.80	379.75	405.99	413.32	363.64	366.27
03–31–79	457.05	379.83	406.70	413.65	361.26	366.56
04–06–79	458.09	378.50	405.20	414.44	N. A.	N. A.
04–13–79	460.88	378.17	405.53	414.32	N. A.	N. A.
04–20–79	460.97	378.50	405.87	415.49	370.93	N. A.
04–27–79	462.13	378.50	406.00	415.65	368.68	366.85
05–04–79	463.38	377.33	403.28	415.46	359.87	364.56
05–11–79	463.13	377.46	403.28	415.32	358.72	362.10
05–18–79	462.80	377.04	403.87	415.23	356.30	361.50
05–25–79	462.80	376.71	403.25	415.11	355.47	360.31
06–03–79	461.63	376.13	401.37	414.36	356.39	359.50
06–10–79	461.30	376.13	402.75	414.23	357.30	360.50
06–17–79	460.22	375.75	402.00	413.73	DAMAGED	359.02
06–27–79	458.68	375.50	401.33	412.86	AND	358.77
					LOST	
07–03–79	458.05	375.17	400.87	412.40	↓	358.27
07–11–79	457.18	375.21	400.28	411.90	↓	357.64
07–18–79	457.01	375.38	400.24	411.90	↓	358.89
07–24–79	456.93	375.69	400.03	411.82	↓	358.85
07–31–79	457.63	376.33	401.28	412.19	↓	359.85
08–03–79	457.38	376.08	401.20	412.07	↓	359.68
08–10–79	457.63	375.83	401.49	412.36	↓	359.10
08–17–79	457.05	375.75	400.41	411.90	↓	358.27

[1] *Columns (a) through (f) denote the following boreholes:*
- *(a) Borehole A–1, ground surface elev. 479.2 ft., reference point elev. 480.30 ft.*
- *(b) Borehole A–9, ground surface elev. 380.9 ft., reference pt. elev. 384.00 ft.*
- *(c) Borehole A–11, ground surface elev. 407.7 ft., reference pt. elev. 411.20 ft.*
- *(d) Borehole A–18, ground surface elev. 428.9 ft., reference pt. elev. 430.90 ft.*
- *(e) Borehole A–25, ground surface elev. 369.3 ft., reference pt. elev. 373.26 ft.*
- *(f) Borehole A–27, ground surface elev. 366.6 ft., reference pt. elev. 370.10 ft.*

[2] *Piezometer dry when measurement taken.*

[3] *Water withdrawn from piezometer for analysis two days prior to measurement; water table recovery may have been incomplete when measured.*

[4] *Piezometer pumped dry for water sampling on previous day; water table recovery may have been incomplete when measured.*

TABLE 4.4.2–4

VARIATION OF WATER LEVEL ELEVATIONS IN CYPRESS SLOUGH AND THE OHIO-GREEN RIVERS

DATE	WATER ELEVATION IN FEET[1] (a)[2]	(b)
07–01–78	345.54	N. R.[3]
07–08–78	348.34	N. R.
07–15–78	343.74	N. R.
07–22–78	342.44	N. R.
07–29–78	342.84	N. R.
08–05–78	343.84	N. R.
08–12–78	346.84	N. R.
08–19–78	344.14	N. R.
08–26–78	343.04	N. R.
09–02–78	347.94	354.57
09–09–78	342.94	354.41
09–16–78	341.74	354.49
09–23–78	341.84	354.41
09–30–78	341.84	354.22
10–07–78	342.94	354.41
10–14–78	344.24	354.41
10–21–78	343.24	354.32
10–28–78	344.74	354.41
11–04–78	342.54	354.32
11–11–78	342.30	354.32
11–18–78	346.23	354.70[4]
11–24–78	342.90	354.70
12–02–78	348.59	355.16[4]
12–08–78	365.77	N. A.[5]
12–16–78	373.46	N. A.
12–22–78	359.76	N. A.
12–30–78	356.64	N. A.

DATE	WATER ELEVATION IN FEET[1] (a)[2]	(b)
01–06–79	367.51	N. A.
01–13–79	364.54	N. A.
01–20–79	357.14	N. A.
01–27–79	368.54	N. A.
02–03–79	354.44	N. A.
02–10–79	345.64	356.66
02–19–79	353.24	356.66
02–23–79	356.44	N. A.
03–03–79	372.44	N. A.
03–10–79	371.04	N. A.
03–17–79	–	N. A.
03–24–79	352.24	357.16
03–31–79	355.24	358.99
04–06–79	368.14	N. A.
04–13–79	365.34	N. A.
04–20–79	364.14	N. A.
04–27–79	349.64	358.82
05–04–79	347.44	357.74
05–11–79	349.84	356.99
05–18–79	349.94	356.49
05–25–79	344.94	356.32
06–03–79	350.04	356.41
06–10–79	354.74	356.66
06–17–79	344.64	356.16
06–27–79	350.84	356.24
07–03–79	344.54	356.16
07–11–79	343.94	356.16
07–18–79	344.04	356.24
07–24–79	343.84	356.24
07–31–79	357.24	356.49
08–03–79	353.54	356.57
08–10–79	344.04	356.41
08–17–79	344.84	356.32

[1] *Levels in Cypress Slough measured by marker pipe located at N = 573,829.08, E = 1,501,335.23. Elevation of top of marker pipe is 359.24 feet. Levels in the Ohio-Green Rivers measured by gauge (elevation 328.64 feet above MSL) located in Evansville, Indiana. Letter (a) denotes data from the Ohio-Green Rivers; (b) denotes data from the slough.*

[2] *Levels of the Ohio-Green Rivers indicate stage determined by U. S. Weather Bureau personnel at 6:00 a.m. on each date shown.*

[3] *The abbreviation, "N. R.", in column indicates no reading was taken since the marker pipe was installed in the slough between 08–26–78 and 09–02–78 when the first reading was taken.*

[4] *Obvious surface water recharge of slough noted through drainage ditch on south side of slough on this date.*

[5] *The abbreviation, "N. A.", in column indicates marker pipe not accessible due to flooding by Green River on that date.*

Table 4.4.2-5

TYPICAL PUBLIC AND INDUSTRIAL GROUNDWATER QUALITY FOR DAVIESS AND HENDERSON COUNTIES WHICH BORDER THE GREEN RIVER NAVIGATION SYSTEM

Well No.	Name of County and City	Location	Date of Collection	Type of Water	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Chemical Analyses (results in milligrams per liter except as noted) Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved Solids (residue at 180°C)	Hardness as $CaCO_3$ Ca, Mg	Hardness as $CaCO_3$ Non-Carbonate	Specific Conductance (micromhos at 25°C)	pH (Unit)
Drinking Standard[b/]					--	0.3	0.05	--	--	--	--	--	--	250	250	1.4 – 2.4	10 (as N)	500	--	--	--	6.5 – 8.5
1	Daviess County																					
	Owensboro Municipal Utilities Population served, 58,800 (includes southeast Daviess Co. Water District)	Groundwater 23 wells-374636N870535 90-130 ft	9/23/69 7/10/69	R F	11 --	0.86 0.01	0.69 Nil	61 18.0	13 17.01	21 --	3.3 --	144 20	0 16	81 65	39 24.0	0.4 1.2	1.8 0.22	321 190	206 36	88 79	505 --	7.4 9.0
2	Owensboro Daviess County Concrete Co.	Groundwater 2 wells-374902N870221 (both wells) 36 ft	5/22/68	R	22	0.33	0.15	52	24	13	0.6	274	0	20	9.0	0.4	3.1	268	228	4	470	7.7
3	Owensboro Texas Gas Transmission Corp.	Groundwater Well-374401N870723 230 ft, 8 in. Well-374405N870720 200 ft	5/22/68	R	31	2.8	0.20	83	29	29	0.7	444	0	4.0	10	0.2	1.4	406	326	0	706	7.4
4	Whitesville Municipal Water Works Population served, 1,000	Groundwater 4 wells-374108N865257 158-300 ft	8/6/64	F	--	0.48	0.05	63.6	0.24	--	--	356	Nil	228	23	0.9	0.01	720	160	Nil	--	7.9
5[a/]	Old Stanley Distillery	Groundwater Well-374918N871422 122 ft	10/10/72	--	--	1.70	0.07	48.0	8.3	4.4	0.8	182	0	7.8	4.0	0.4	0.45	173	150	6.0	300	7.2
6[a/]	Zog No. 3 Bowling	Groundwater Oil well-373807N872524 2,380 ft	8/15/72	--	--	1.30	1.20	4,800.0	1,500.0	32,000.0	260.0	182	0	2.30	6,200	3.3	--	113,000	18,000	18,000	117,000	6.5
7[a/]	White and Vickery 3 Marshall	Groundwater Oil well-374729N871036 1,372 ft	5/2/73	--	0.7	2.8	1.50	520	240	15,000	36	58	0	0	24,000	0.9	--	41,900	2,300	2,200	56,000	6.5
8[a/]	McBride/S. J. Alvey	Groundwater Oil well-373725N872051 2,229 ft	5/2/73	--	2.3	0.6	2.4	2,800	660	31,000	99	106	0	3,000	54,000	1.7	--	98,000	9,700	9,600	106,000	6.7
9	Henderson County Henderson Audubon State Park	Groundwater well-375308N873348 72 ft Well-375309N873345 66 ft	8/17/62	F	-	0.22	Nil	99.2	29.65	-	-	350	0	54	10.0	0.2	1.42	510	350	20	--	7.3

Legend: R = Raw water; F = Filtered water

a) EPA

b) National Interim Primary and Secondary Drinking Water Regulations

Source: U S Corps of Engineers[5]

TABLE 4.4.2-6

WATER QUALITY OF GROUNDWATERS IN DIFFERENT FORMATIONS
IN THE WESTERN COAL FIELD REGION OF KENTUCKY

Geologic unit	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness as $CaCO_3$		Specific conductance at 25° C (micromhos)	pH
														Total	Noncarbonate		
Quaternary alluvium:																	
Determinations	28	28	28	28	21	21	28	28	28	28	28	28	28	28	28	28	28
Maximum	22	26	152	50	88	5.7	639	------	155	81	.6	9	691	564	209	1,060	8.0
Average	15	4.3	78	29	18	1.3	342	0	46	11	.2	5.2	380	312	44	636	------
Minimum	3.7	.1	41	5.8	3.8	.5	104	------	8	2.1	.0	.0	174	126	0	289	6.4
Henshaw formation:																	
Determinations	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2
Maximum	31	7.6	115	67	47	9.0	442	------	272	16	------	1.3	790	564	------	1,060	6.9
Average	24	4.8	95	47	38	5.0	348	0	205	9.8	.1	.7	608	429	200	850	------
Minimum	16	2.0	74	27	28	1.0	254	------	137	3.5	------	.1	425	294	------	610	6.7
Lisman formation:																	
Determinations	15	15	15	15	11	11	15	15	15	15	15	15	15	15	12	15	15
Maximum	32	6.9	128	61	909	33	1,010	30	1,450	830	1.5	115	2,990	530	146	3,810	8.2
Average	18	2.0	50	25	253	5.3	457	3.8	171	83	.5	20	805	221	17	1,240	------
Minimum	5.1	.09	1.6	.5	6.2	.6	46	0	.7	2.5	0	.1	86	6	0	110	6.6
Carbondale formation:																	
Determinations	9	9	9	9	2	2	9	9	9	9	9	9	9	9	8	9	9
Maximum	31	4.4	112	73	39	3.6	824	41	156	42	1.0	29	742	580	20	1,200	8.2
Average	14	1.2	56	24	34	3.4	510	7	28	16	.5	7.8	501	236	3	825	------
Minimum	4.0	.20	10	2.4	28	3.2	177	0	1.0	2.4	.2	.0	197	35	0	325	7.0
Tradewater formation:																	
Determinations	17	17	17	17	17	17	17	17	17	17	15	15	17	16	11	17	17
Maximum	37	16	208	190	6,350	64	1,660	30	1,740	8,680	7.7	6.4	17,300	1,300	531	24,700	8.4
Average	21	1.9	36	25	740	6.9	461	5.6	268	809	1.1	.8	2,150	166	57	3,180	------
Minimum	5.3	.05	1.0	.3	7.3	.6	44	0	.3	2.9	.1	.0	89	4	0	259	6.1
Caseyville sandstone:																	
Determinations	8	8	8	8	7	7	8	8	8	8	8	8	8	8	8	8	8
Maximum	22	37	52	11	278	3.2	615	9.8	43	173	1.3	5.7	668	175	31	1,100	8.7
Average	14	5.9	14	5	146	1.7	312	3.5	20	40	.5	1.0	387	56	10	637	------
Minimum	9.6	.08	.8	.2	4.4	.8	58	0	1.3	2.2	0	0	112	3	0	186	6.5
Upper Mississippian:																	
Determinations	5	6	6	6	6	6	6	6	6	6	3	3	6	3	3	6	4
Maximum	14	4.6	2,750	1,030	36,400	3,530	432	16	3,180	63,000	1.5	.2	83,800	830	475	88,000	7.9
Average	11	1.7	570	244	12,320	612	297	3	1,220	19,600	1.2	.2	28,000	300	156	34,800	------
Minimum	8.7	.08	6.9	2.9	4.9	.7	38	0	.2	11	.1	.1	324	31	0	96	5.9

Note: Unless otherwise specified, all the dissolved constituents given in ppm.

Source: Maxwell, 1962[4].

TABLE 4.4.2-7

SITE SPECIFIC MONITORING PROGRAM OBSERVATION WELLS A-11 AND A-18

Concentration, mg/l*

ameter	Well A-11 Max	Well A-11 Mean	Well A-11 Min	Well A-18
onia (as N)	1.48	∠0.41	∠0.05	0.99
enic (total)	0.046	∠0.017	∠0.0005	0.062
lum (total)	∠0.02	∠0.1	∠0.05	0.25
arbonate (as $CaCO_3$)	425.5	415	386.9	935
nium (total)	0.0320	∠0.015	∠0.002	∠0.002
cium total)	220	130	62.5	138
bonate (as $CaCO^3$)	0.0	0.0	0.0	0.0
oride	0.85	∠0.4	∠0.2	0.45
orine (total res.)	∠0.2	∠0.2	∠0.2	∠0.2
omium (hexavalent)	0.005	0.003	0.002	∠0.0025
omium (total)	0.072	0.039	0.006	∠0.0025
	35	24	11	18
per (total)	0.04	0.03	0.01	0.027
nide	0.10	∠0.05	0.03	0.04
nide A	∠0.1	∠0.1	∠0.1	∠0.1
oride	0.89	0.33	0.09	0.48
n (total)	7.60	3.64	1.67	5.50
d (total)	0.09	∠0.04	∠0.02	∠0.02
nesium (total)	122	73	54	85
ganese (total)	0.89	0.33	0.09	1.80
cury (total)	0.0041	0.0021	∠0.0002	0.0018
cel (total)	0.035	∠0.018	∠0.004	0.055
rate (as N)	7.66	4.8	3.5	0.5
units	6.89	7.23	7.52	7.22
ols	0.0315	∠0.0091	∠0.0005	∠0.0005
phorus (total)	0.22	0.14	0.06	0.17
nium (total)	0.10	∠0.04	∠0.002	1.140
er (total)	0.016	∠0.008	∠0.005	0.027
ific Conductance, umhos/cm	990	963	940	820
ate	42	35	29	12
ide	∠0.008	∠0.008	∠0.008	∠0.008
erature* °C	15.8	11.7	8.0	11.9
	3.8	2.8	1.8	9.5
(total)	0.442	0.223	0.080	0.872

less otherwise specified.

TABLE 4.4.2-7 (Cont'd)

Parameter	Well A-11 July 20, 1979
Polynuclear Aromatic Hydrocarbons	
2-Methyl naphthalene	0.0033
Fluoranthene	<0.0001
Pyrene	0.0007
Chrysene	<0.0003
Benzo(a)anthracene	<0.0008
Benzo(c)phenanthrene	<0.0008
Benzo(j)fluoranthene	<0.0008
Benzo(b)fluoranthene	<0.0008
Benzo(a)pyrene	<0.0004
Dibenz(a,c)anthracene	<0.0006
Dibenz(a,h)anthracene	<0.0007
Benzo(g,h,i)perylene	<0.0009
o-Phenylene pyrene	<0.0006
2-Methyl fluoranthene	<0.0001

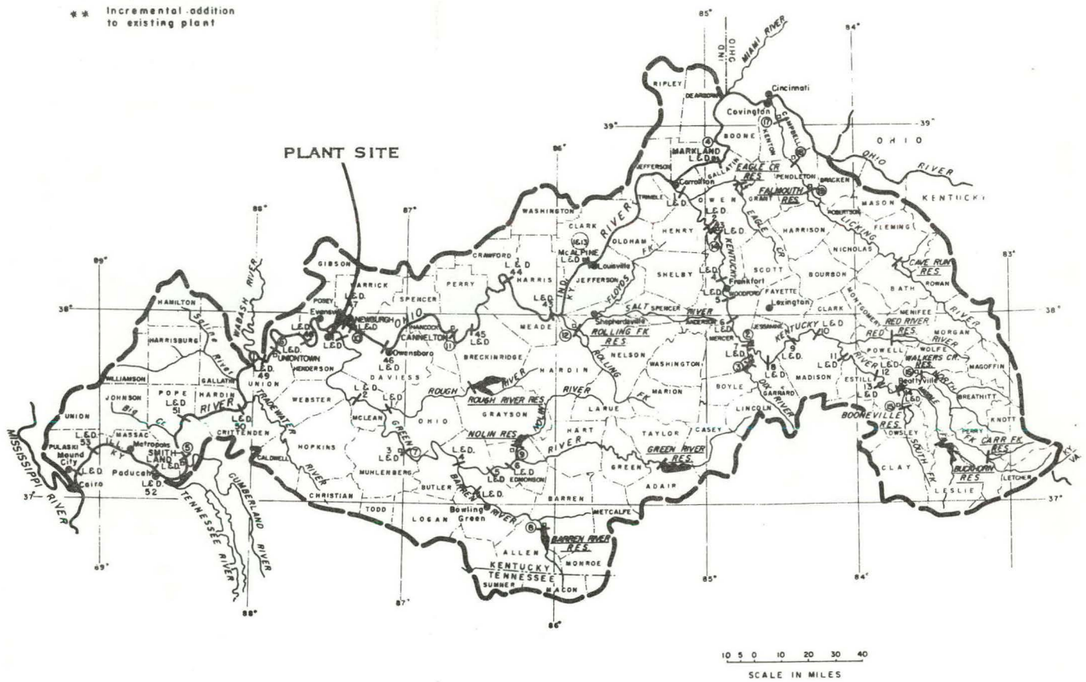
* Unless otherwise specified

KEY TO
HYDROELECTRIC PROJECTS

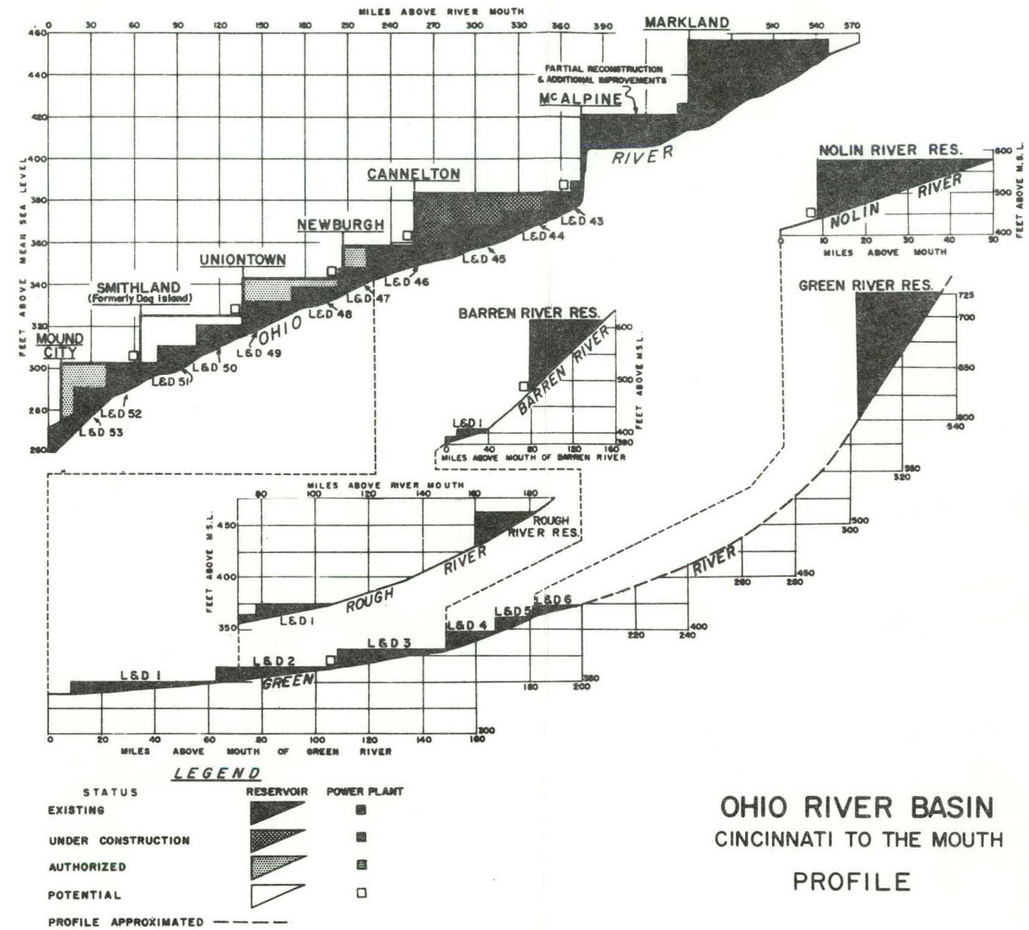
1 OHIO FALLS
2 LOCK No. 7
3 DIX RIVER
4 MARKLAND *
5 SMITHLAND
6 UNIONTOWN
7 ROCHESTER
8 BARREN RIVER RES.
9 NOLIN RIVER RES.
10 NEWBURGH
11 CANNELTON
12 ROLLING FK. RES.
13 OHIO FALLS **
14 LOCK No. 3
15 BOONEVILLE
16 FINCASTLE
17 POOLS CREEK
18 BOSTON STATION
19 FALMOUTH

* Under Construction

** Incremental addition to existing plant



OHIO RIVER BASIN .
CINCINNATI TO THE MOUTH
PLAN



OHIO RIVER BASIN
CINCINNATI TO THE MOUTH
PROFILE

SOURCE: MODIFIED AFTER FEDERAL POWER COMMISSION, 1966 (4)

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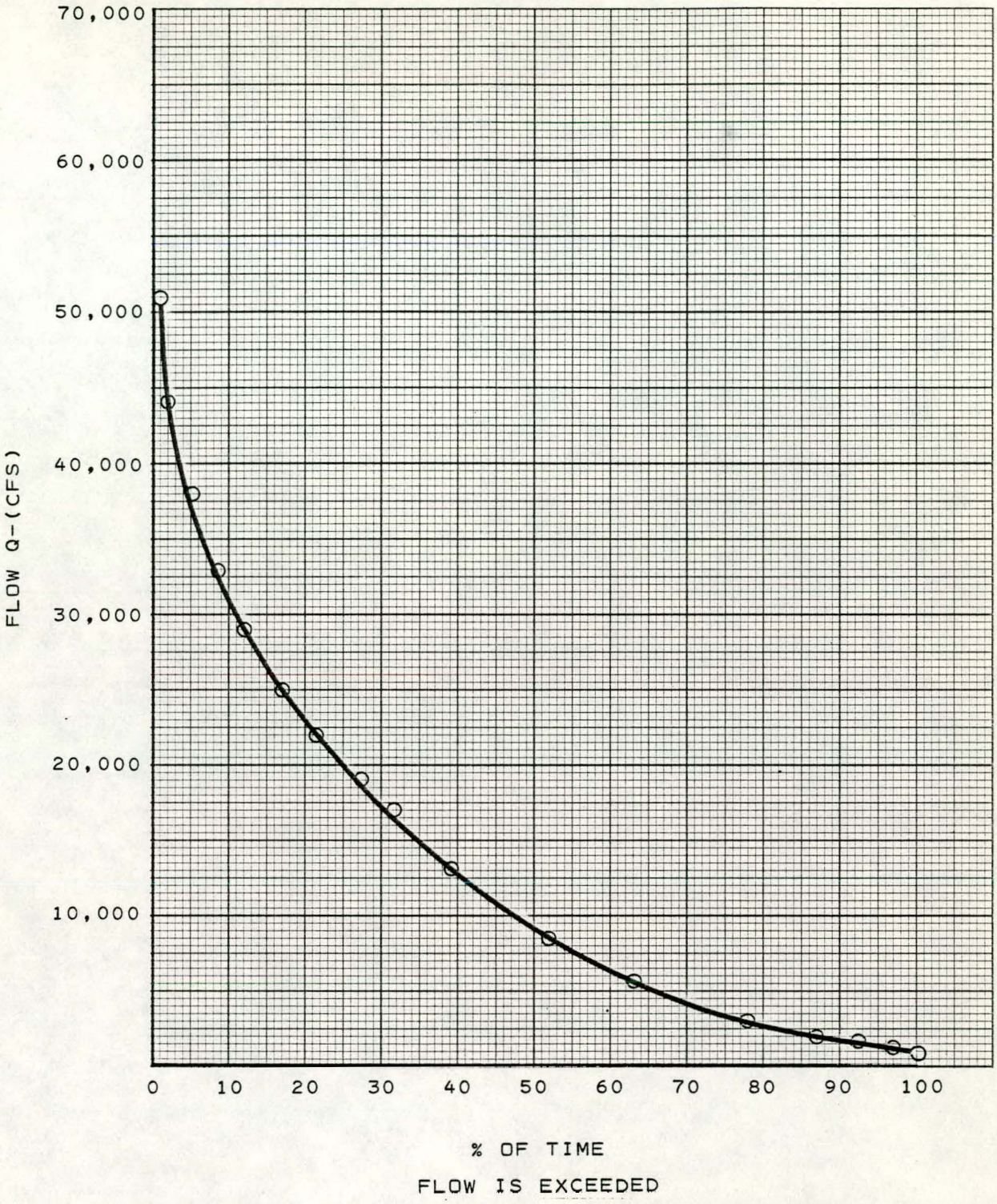
INDUSTRIAL PROJECT "B" - PHASE 1 — CONTRACT No. ET-77-C-01-2577
EBASCO SERVICES INCORPORATED

WATER RESOURCES
DEVELOPMENT
IN THE SITE REGION

FIGURE 4.4.1-1



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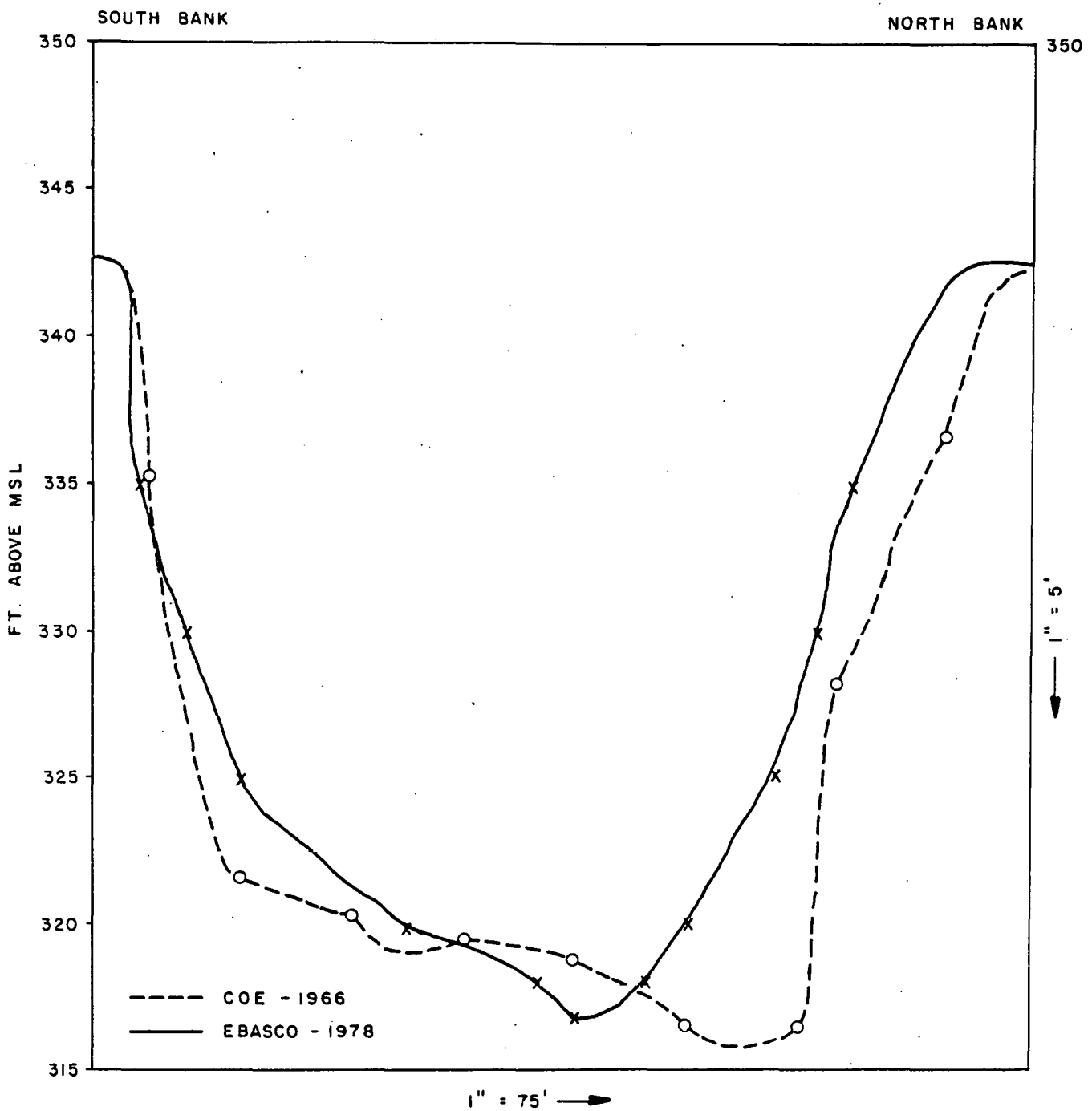
INDUSTRIAL PROJECT "B" - PHASE 1 — CONTRACT No. ET-77-C-01-2577

EBASCO SERVICES INCORPORATED

FLOW DURATION CURVE
GREEN RIVER AT LOCK 2
AT CALHOUN, KY

FIGURE 4.4. 1-2



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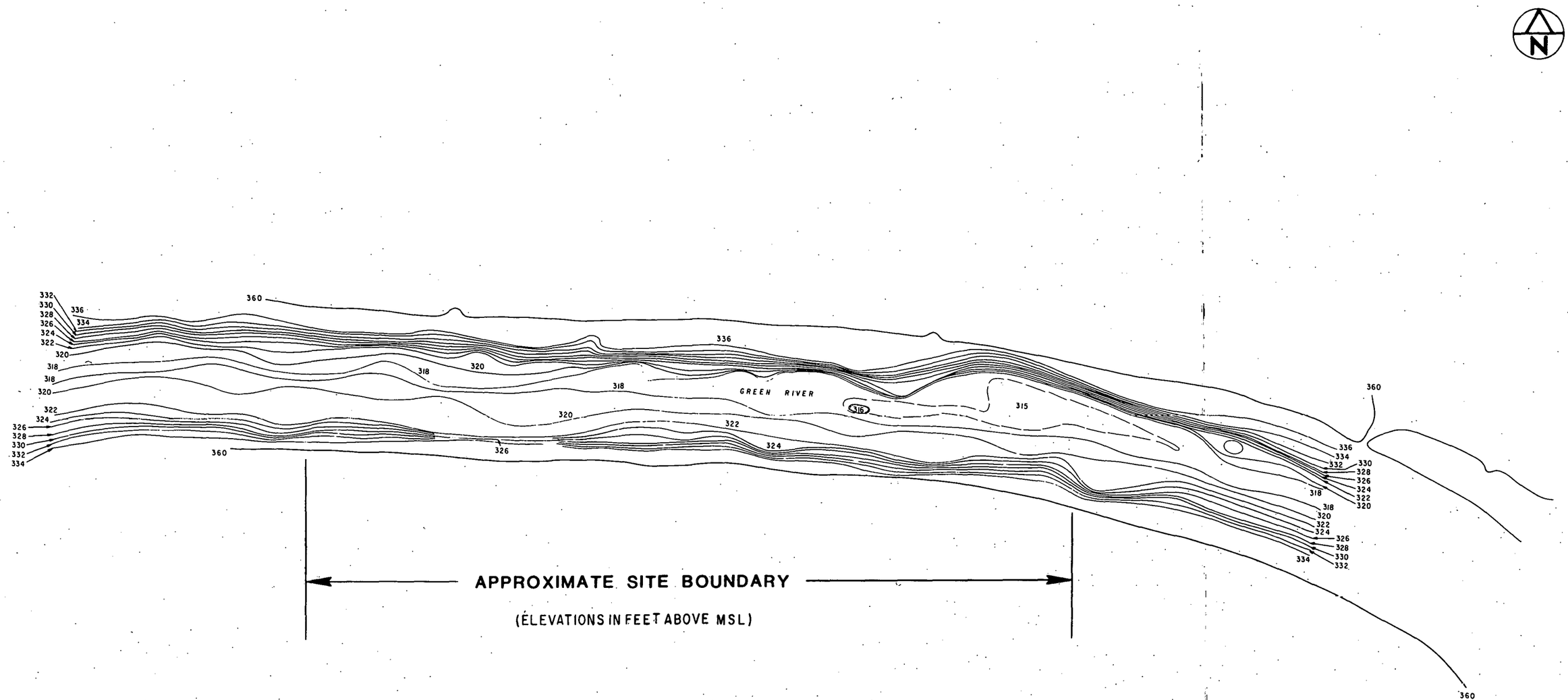
COMPARISON OF CROSS - SECTIONS AT PROPOSED DISCHARGE AREA

FIGURE 4.4.1-3



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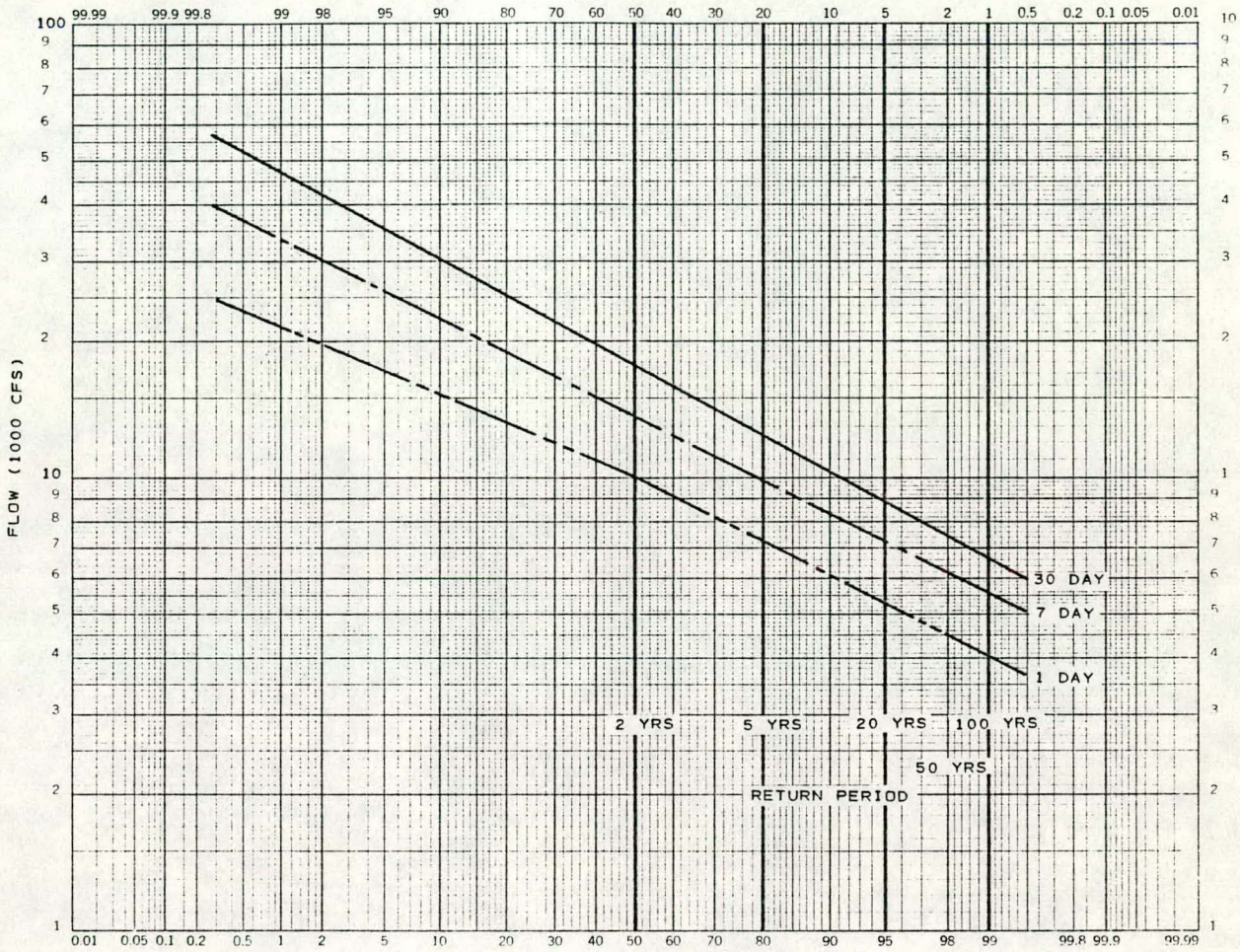
BATHYMETRIC CONTOUR MAP
GREEN RIVER-BASKETT SITE

FIGURE 4.4.1 4



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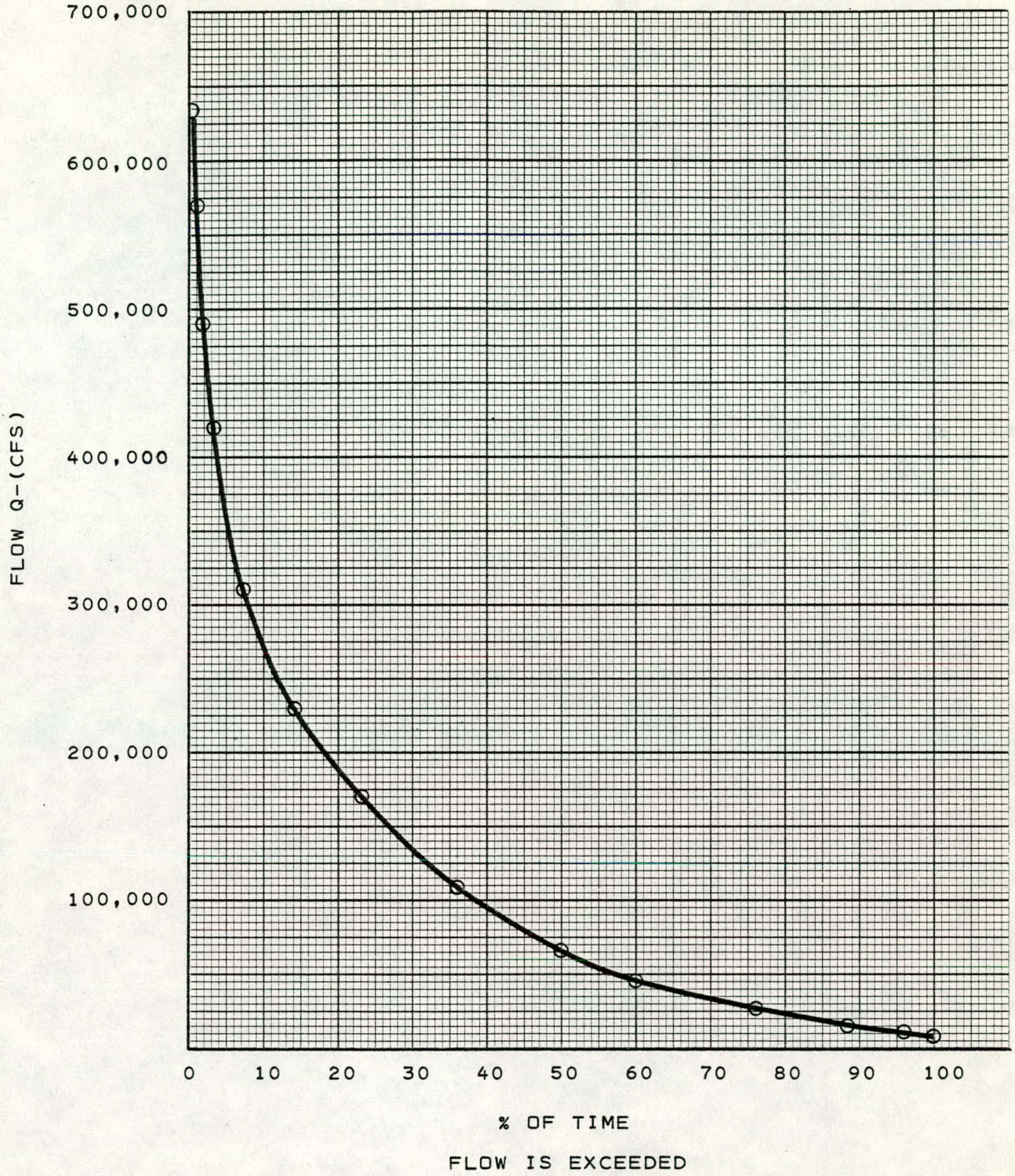
LOW FLOW FREQUENCY
FOR OHIO RIVER AT
LOUISVILLE, KY

FIGURE 4.4.1-5



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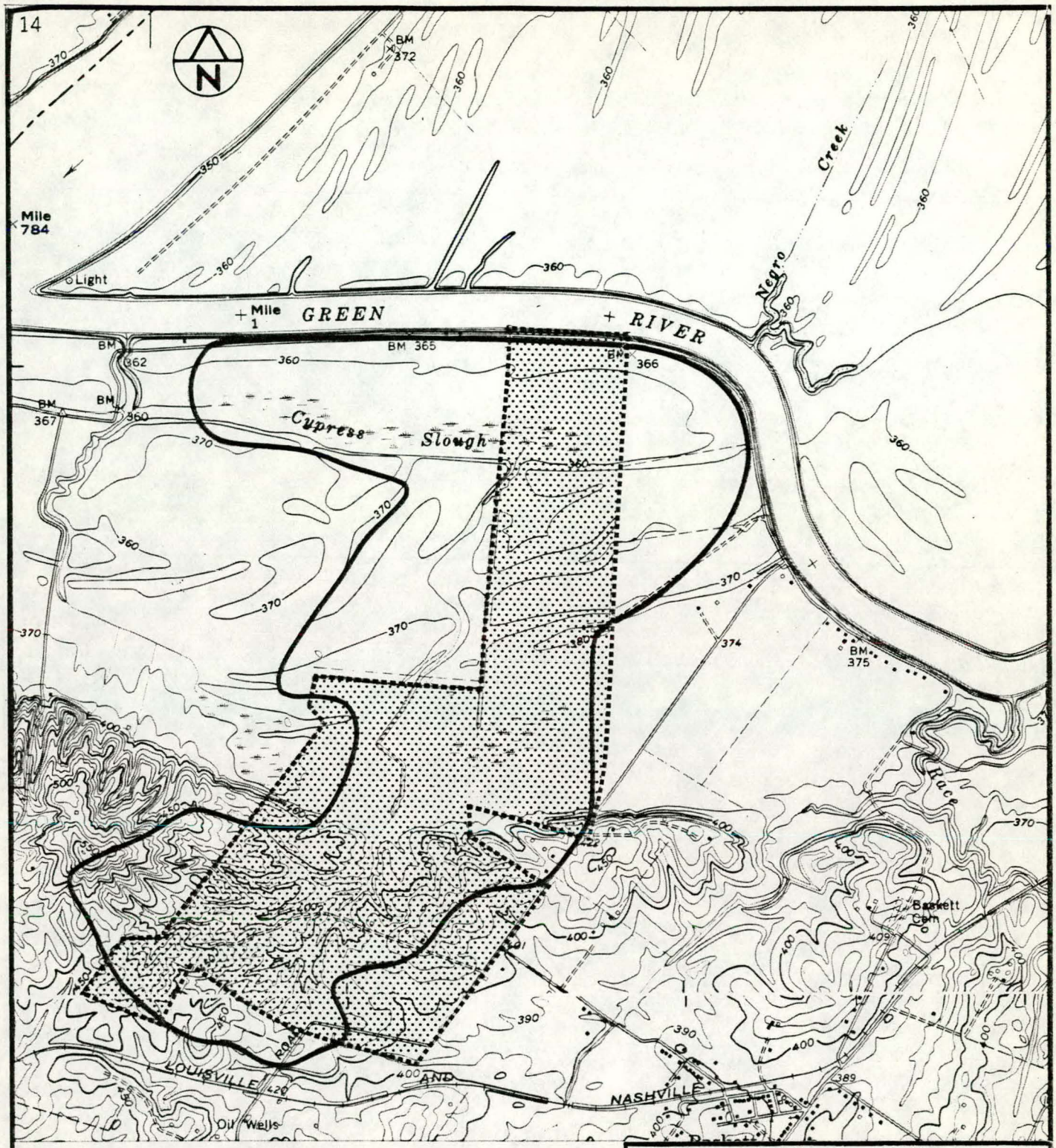
FLOW DURATION CURVE

OHIO RIVER AT LOUISVILLE, KY

FIGURE 4.4.1-6



LEGEND

PROJECT SITE AREA

DRAINAGE BASIN BOUNDARY

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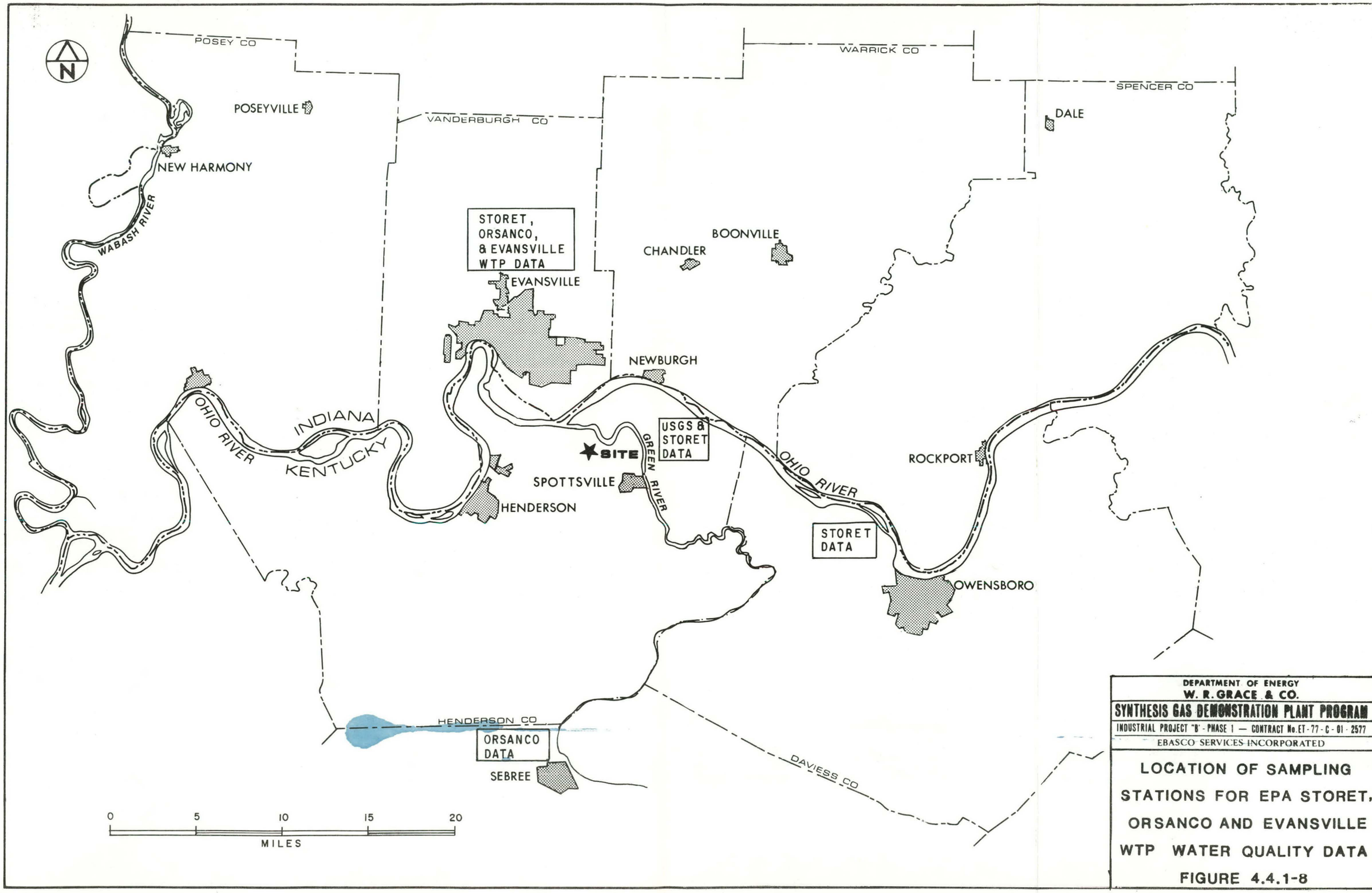
CYPRESS SLOUGH
DRAINAGE BASIN

FIGURE 4.4.1-7


N
POSEY CO
WARRICK CO
SPENCER CO
VANDERBURGH CO
POSEYVILLE
DALE
NEW HARMONY
WABASH RIVER
STORET, ORSANCO, & EVANSVILLE WTP DATA
BOONVILLE
CHANDLER
EVANSVILLE
NEWBURGH
INDIANA
OHIO RIVER
KENTUCKY
USGS & STORET DATA
SITE
GREEN RIVER
OHIO RIVER
ROCKPORT
SPOTTSVILLE
HENDERSON
STORET DATA
OWENSBORO
HENDERSON CO
ORSANCO DATA
SEBREE
DAVIESS CO
0
5
10
15
20
MILES
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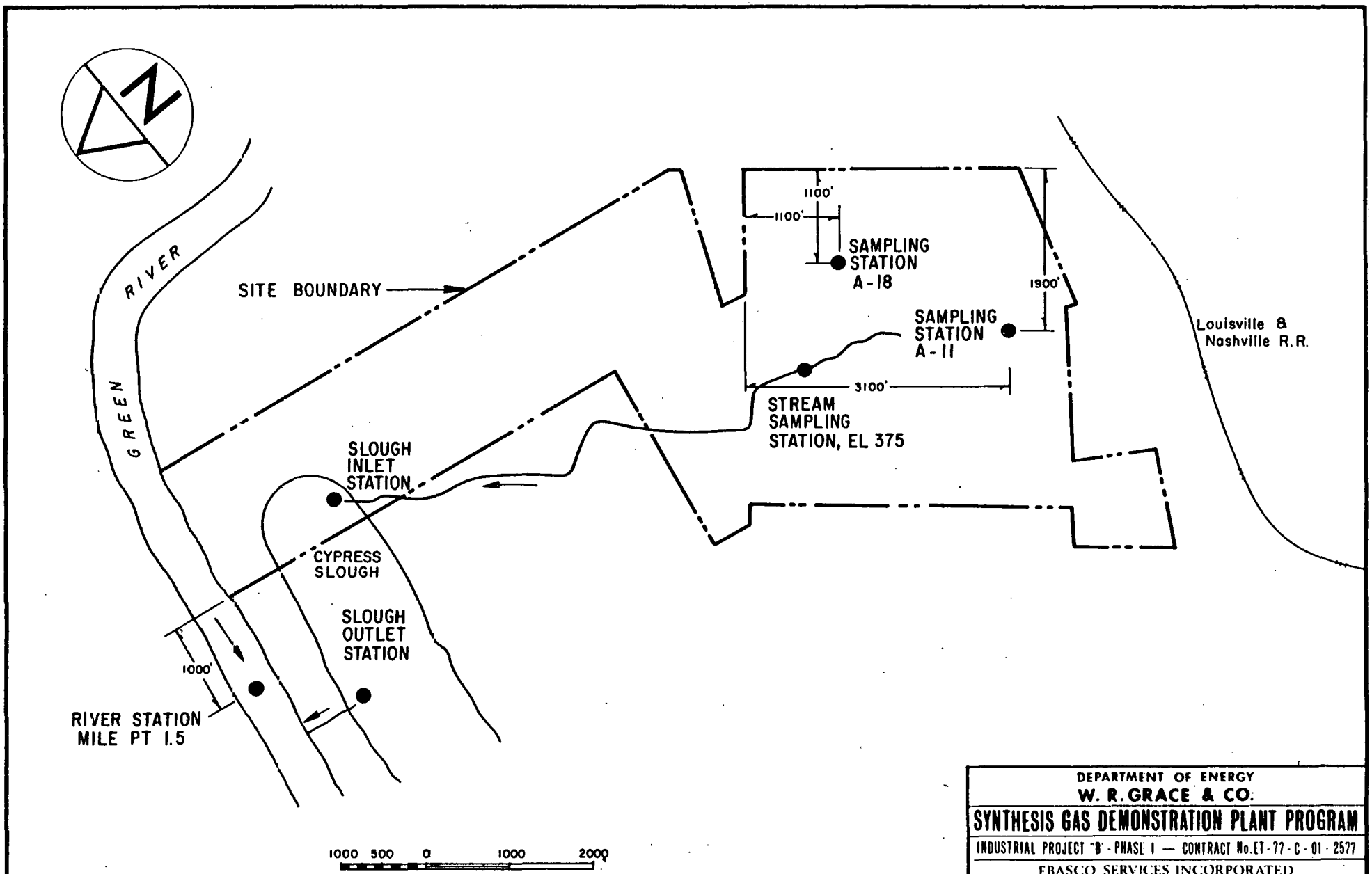
EBASCO SERVICES INCORPORATED
LOCATION OF SAMPLING STATIONS FOR EPA STORET, ORSANCO AND EVANSVILLE WTP WATER QUALITY DATA
FIGURE 4.4.1-8



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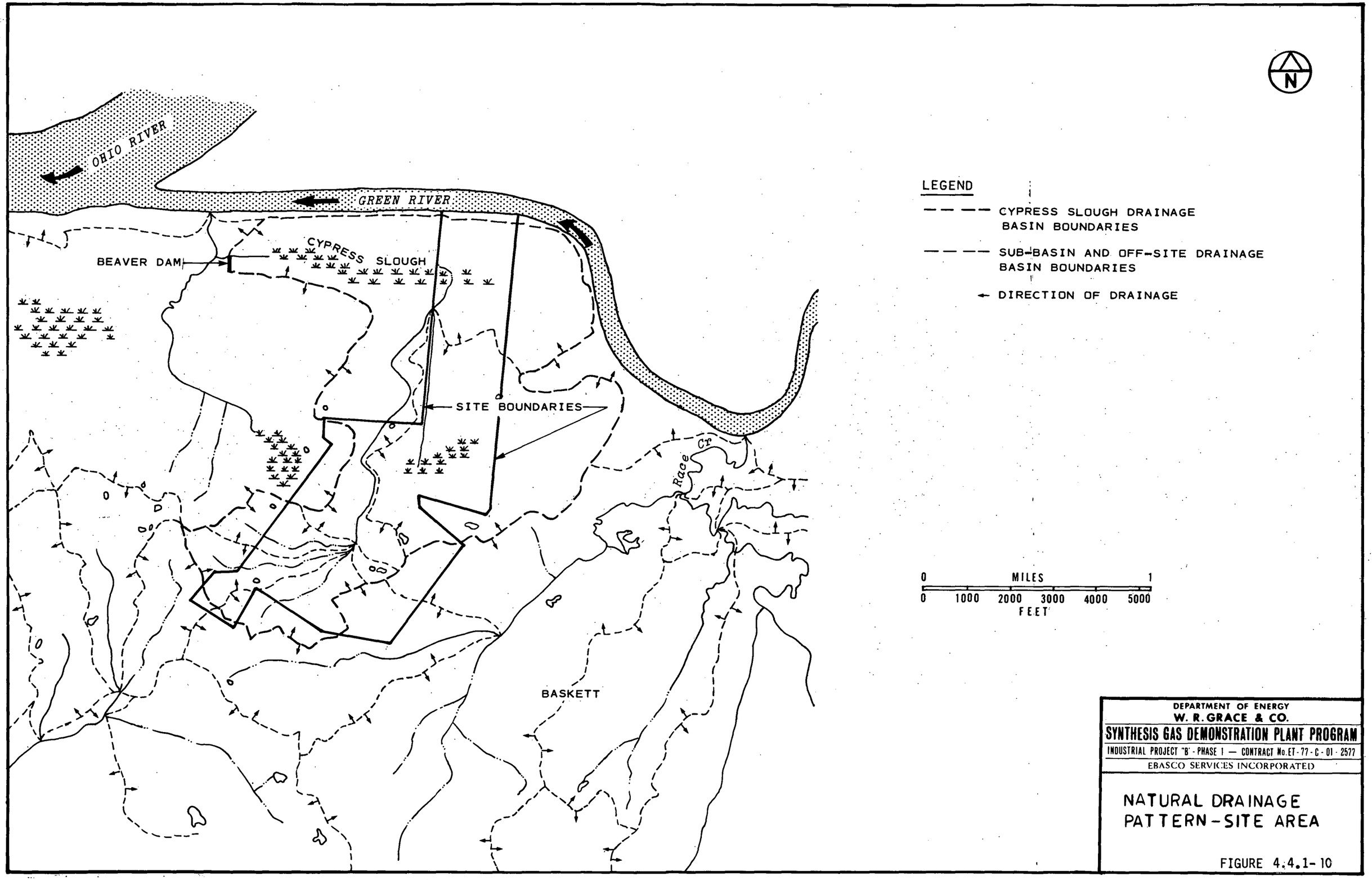
WATER QUALITY SAMPLING STATION LOCATION PLAN

FIGURE 4.4.1-9


N
OHIO RIVER
GREEN RIVER
CYPRESS SLOUGH
BEAVER DAM
SITE BOUNDARIES
Race Cr
BASKETT
LEGEND
CYPRESS SLOUGH DRAINAGE BASIN BOUNDARIES
SUB-BASIN AND OFF-SITE DRAINAGE BASIN BOUNDARIES
DIRECTION OF DRAINAGE
0 MILES 1
0 1000 2000 3000 4000 5000
FEET
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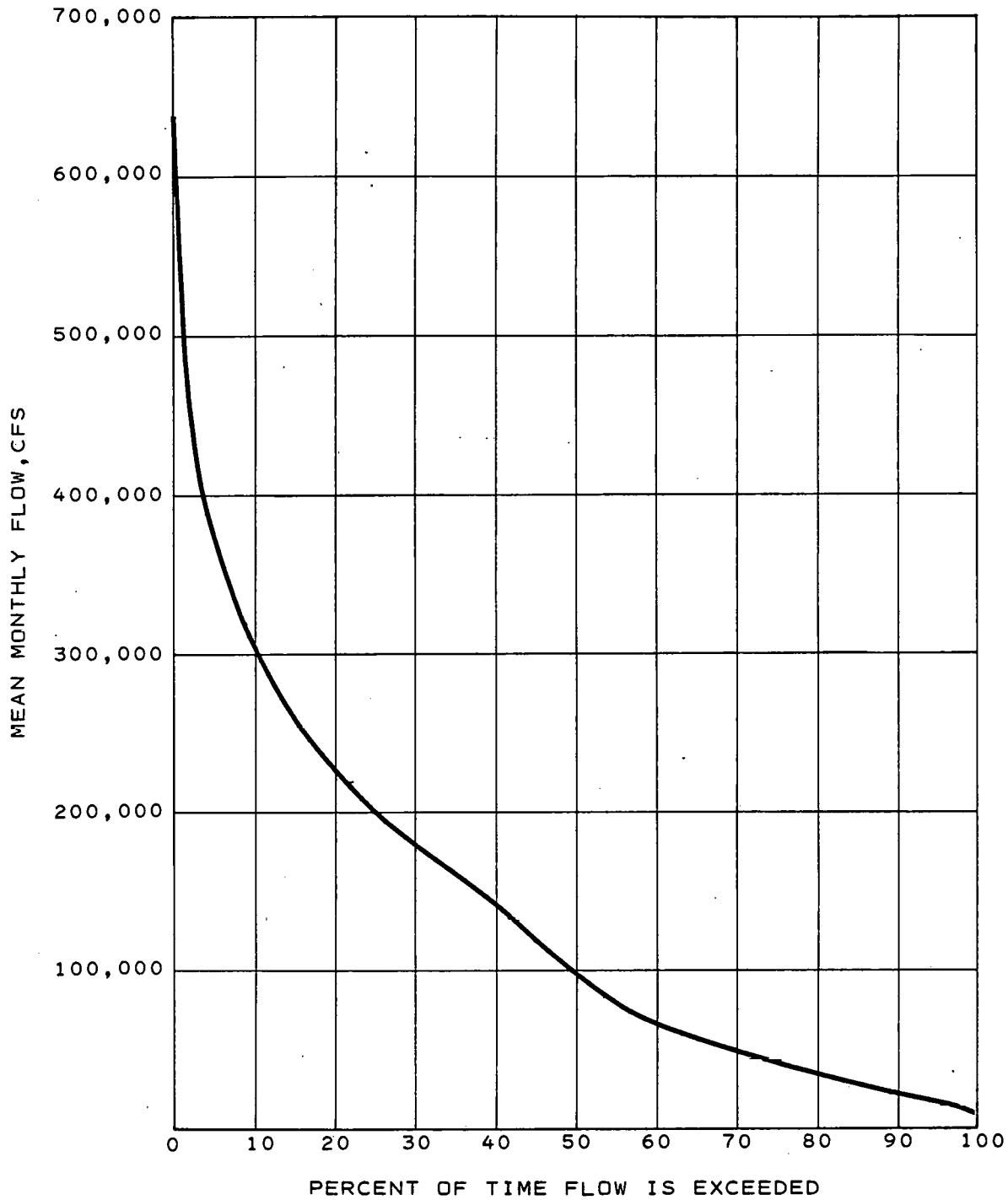
NATURAL DRAINAGE PATTERN-SITE AREA
FIGURE 4.4.1-10



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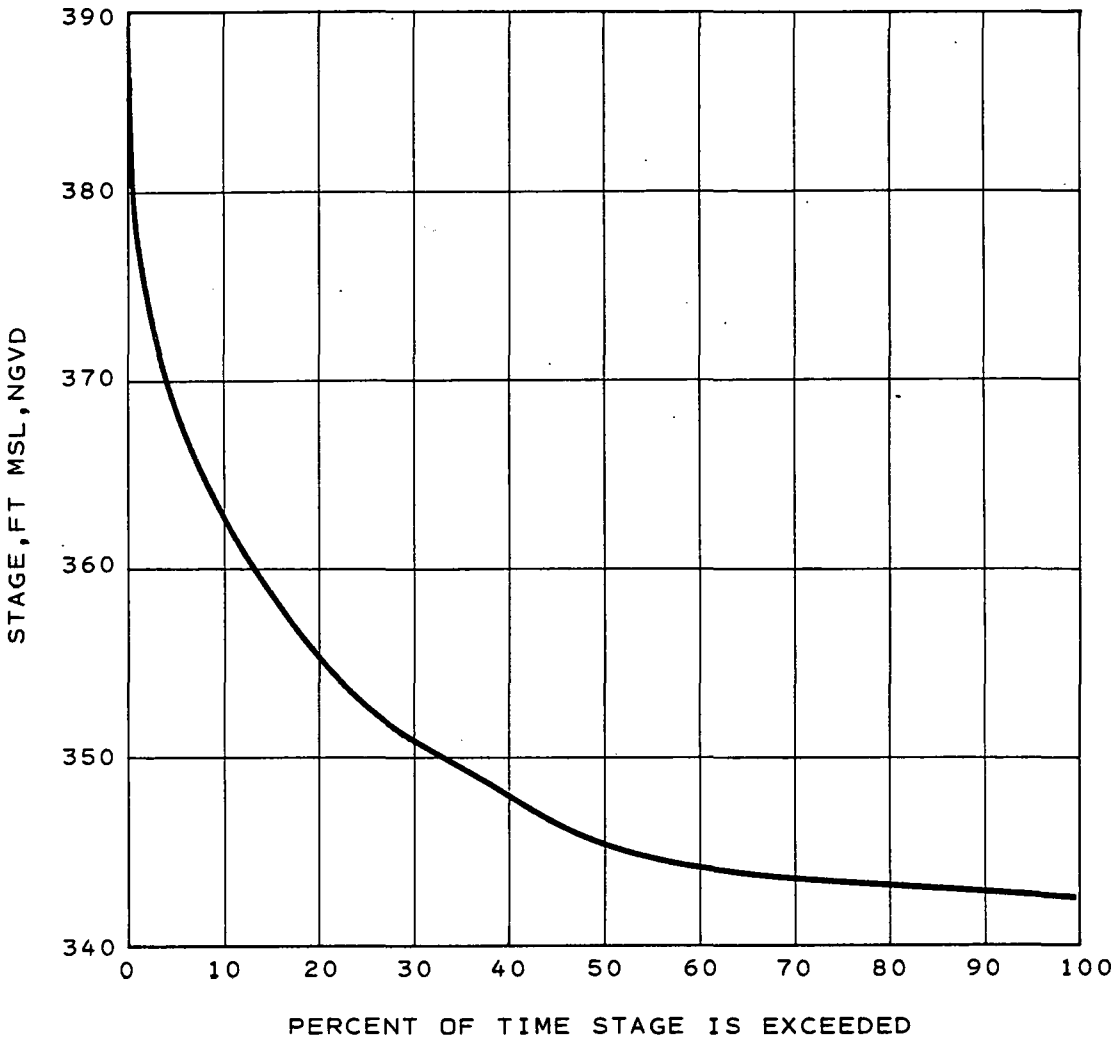
FLOW DURATION CURVE
OHIO RIVER AT
EVANSVILLE, INDIANA

FIGURE 4.4.1-11



NOTE: INCLUDES EFFECT OF UNIONTOWN DAM

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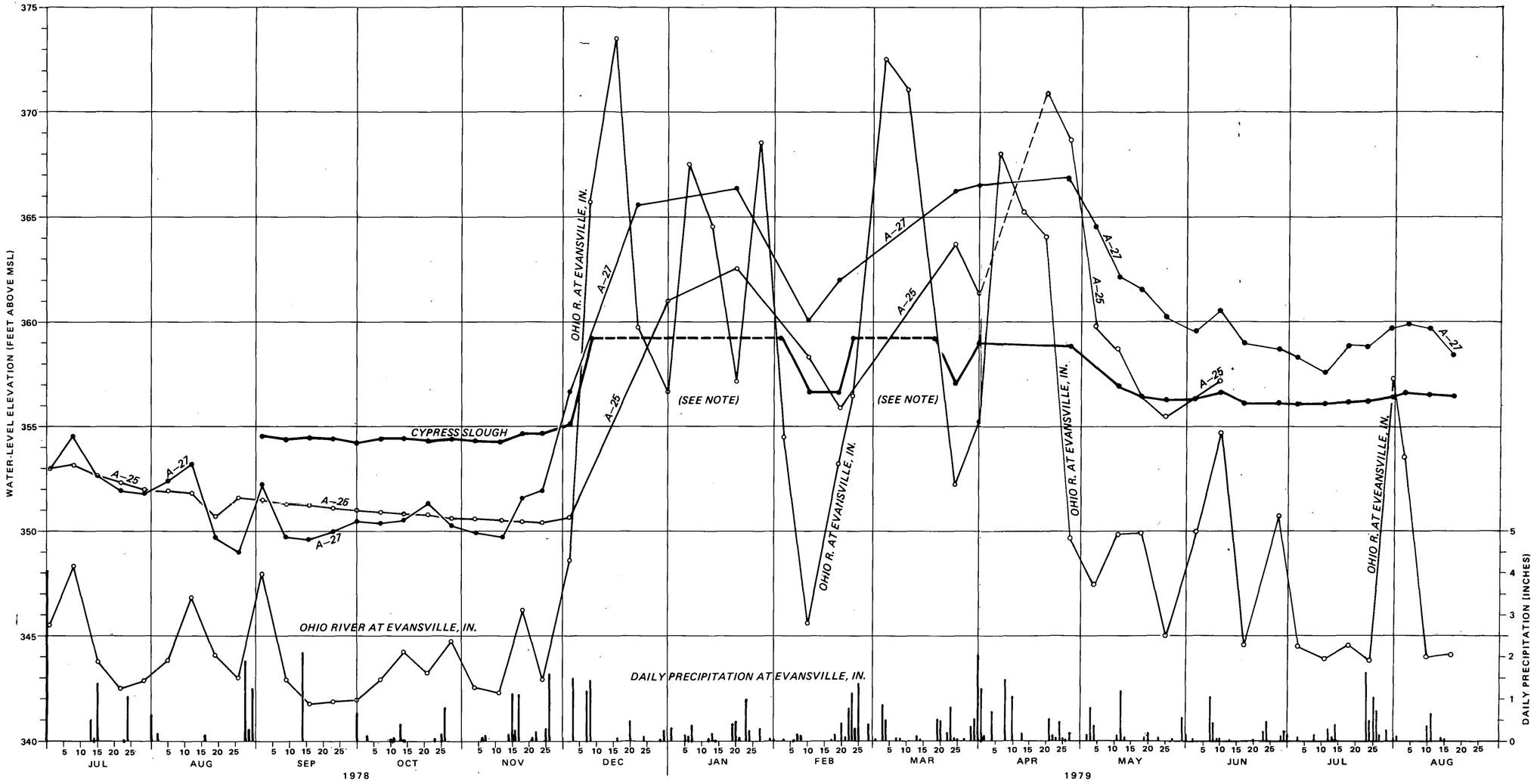
STAGE DURATION CURVE
OHIO RIVER AT
MOUTH OF GREEN RIVER

FIGURE 4.4.1-12



NOTE: Dashed line indicates that water level is above the reference point.

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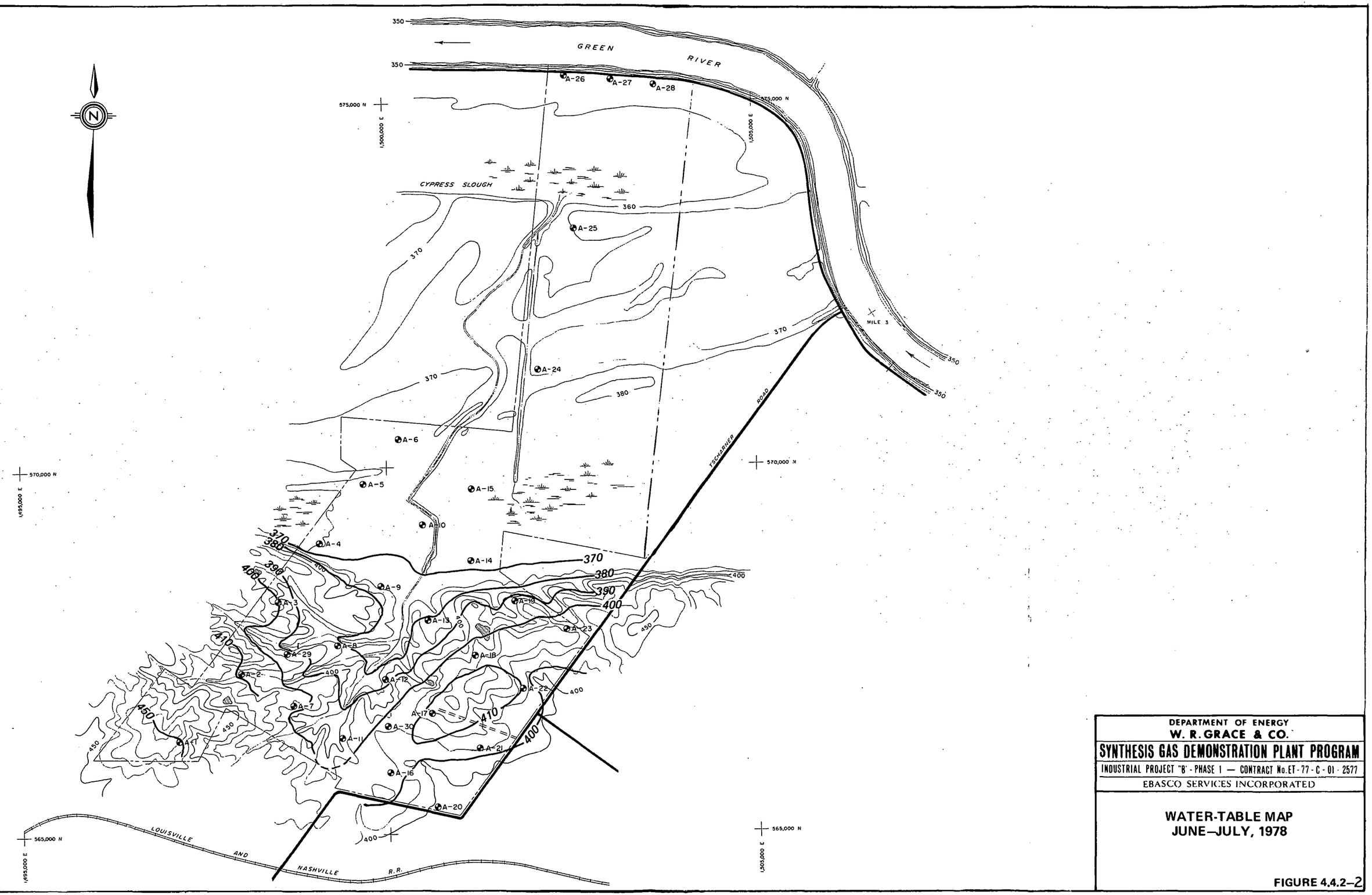
PLOTS OF WATER LEVELS IN PIEZOMETERS, CYPRESS SLOUGH AND OHIO RIVER

FIGURE 4.4.2–1



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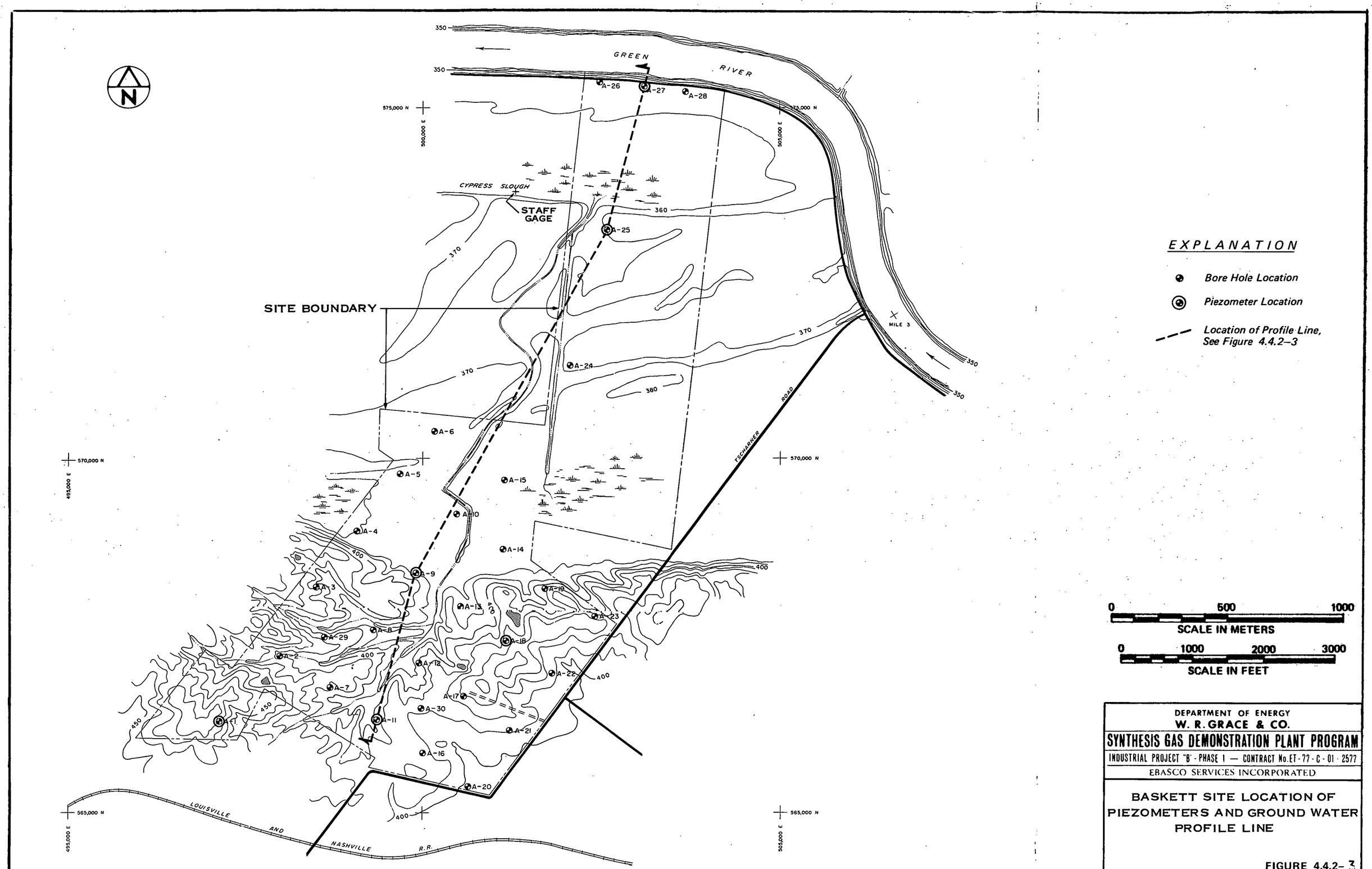
WATER-TABLE MAP
JUNE–JULY, 1978

FIGURE 4.4.2–2


N
GREEN RIVER
CYPRESS SLOUGH
STAFF GAGE
SITE BOUNDARY
MILE 3
TSCHARNER ROAD
LOUISVILLE AND NASHVILLE R.R.
575,000 N
570,000 N
565,000 N
500,000 E
505,000 E
495,000 E
A-26
A-27
A-28
A-25
A-24
A-6
A-5
A-15
A-10
A-4
A-14
A-9
A-3
A-13
A-19
A-23
A-29
A-8
A-18
A-2
A-12
A-22
A-7
A-17
A-30
A-1
A-11
A-21
A-16
A-20
350
360
370
380
400
450
EXPLANATION
Bore Hole Location
Piezometer Location
Location of Profile Line, See Figure 4.4.2–3
0 500 1000
SCALE IN METERS
0 1000 2000 3000
SCALE IN FEET
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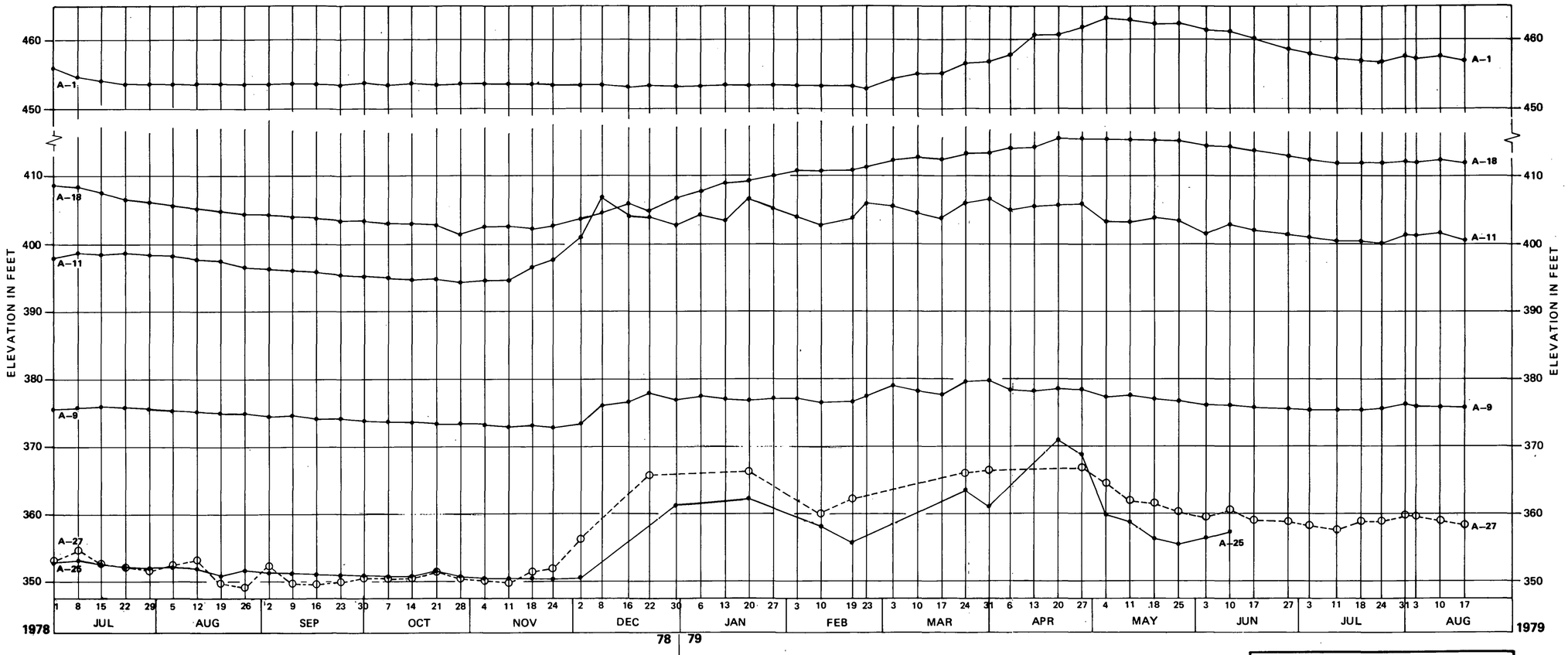
BASKETT SITE LOCATION OF PIEZOMETERS AND GROUND WATER PROFILE LINE
FIGURE 4.4.2-3



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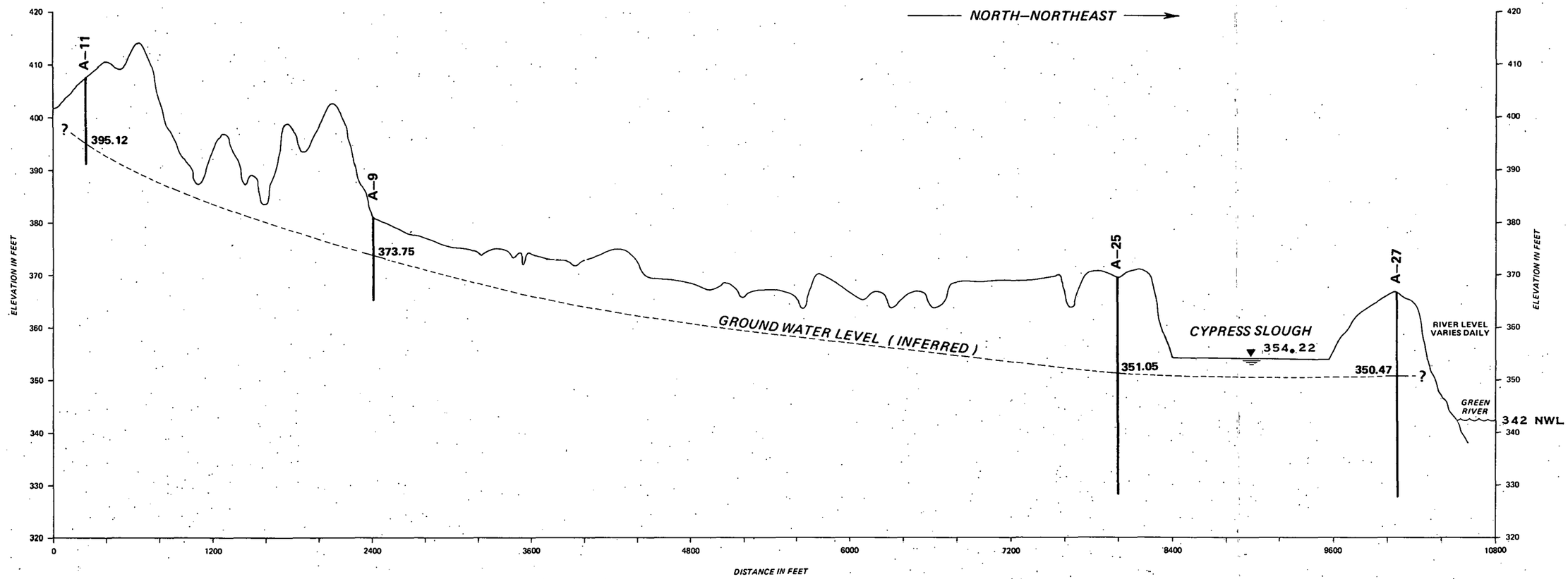
PLOT OF GROUND WATER LEVELS VERSUS TIME

FIGURE 4.4.2–4



NOTE:
- Vertical exaggeration = 40 X
- Profile location on Figure 4.4.2–1

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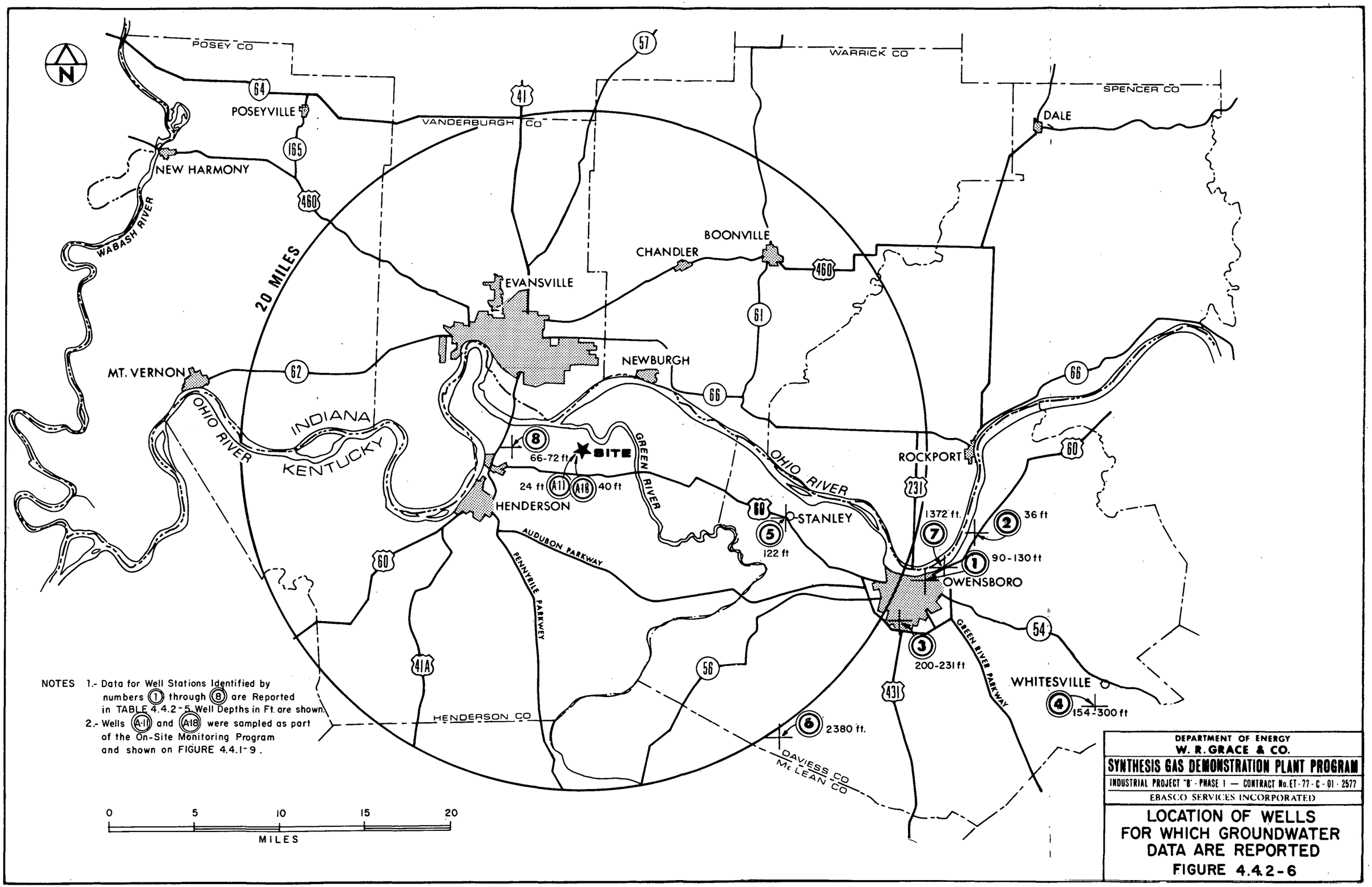
TOPOGRAPHIC PROFILE SHOWING ELEVATIONS OF WATER TABLE ON 9/30/78

FIGURE 4.4.2–5



NOTES 1.- Data for Well Stations Identified by numbers (1) through (8) are Reported in TABLE 4.4.2-5. Well Depths in Ft. are shown.
2.- Wells (A-11) and (A18) were sampled as part of the On-Site Monitoring Program and shown on FIGURE 4.4.1-9.

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LOCATION OF WELLS FOR WHICH GROUNDWATER DATA ARE REPORTED

FIGURE 4.4.2-6

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4.5 GEOLOGY AND SOILS

4.5.1 GEOLOGY

4.5.1.1 Physiography

The Baskett Site is located in Kentucky's Western Coal Field physiographic region, a part of the Interior Low Plateau physiographic province[1]. The Western Coal Field (Figure 4.5.1-1) is the southern part of a large synclinal basin in which Pennsylvanian strata are the outcropping bedrock formations. This region, together with adjoining areas of Illinois and Indiana, is also referred to as the Shawnee Hills Section[3].

The region is characterized by dissected uplands with rolling to hilly interstream areas and narrow V-shaped stream valleys in the eastern and southern parts, where as much as 350 ft of relief are present. In the northern and western parts, broad alluviated valleys are common and relief is more subdued. Maximum relief in the Evansville-Henderson-Spottsville area is 250 ft, the difference in elevation between the normal water level of the Ohio River and the Green River (342 ft MSL) and the highest point in the Wolf Hills northeast of Henderson.

At the confluence of the Ohio and Green Rivers, the Ohio River valley is an alluvial plain about 6 miles wide. Elevations on the alluvial plain range from 350 to slightly over 380 ft MSL, but large areas of the plain lie between 350 and 360 ft MSL. Elevations above 360 ft MSL on the plain are most common on low narrow ridges which probably represent point bar deposits or natural levees. Ray[4] has described similar ridges related to point bar deposits (i.e., meander scrolls) on the Ohio River floodplain east of the site near Owensboro, Kentucky. Drainage is largely through shallow creeks and sloughs directly into the Ohio or Green River. In several places near the proposed site, small creeks flowing off the south valley wall disappear into marshy swales after flowing onto the alluvial plain.

The larger tributary valleys in the Henderson-Spottsville area are partly filled with alluvium and lake sediments, resulting in wide, flat valley floors for some distance back from the valley mouths. The elevation of the flat portions range from around 380 ft MSL at the valley mouths to 400 ft MSL in the upper reaches of the tributary valleys. Much of the natural drainage has been channeled into drainage ditches.

The dissected upland in the area between Henderson and the Green River is represented by steep bluffs overlooking the Ohio and Green River valleys and by low hills rising 50 to 100 ft above the flat tributary valley floors. The bluffs rise abruptly above the Ohio valley floor, with elevations increasing as much as 200 ft over horizontal distances as short as 700 ft. Highest elevations are in the Wolf Hills northeast of Henderson, where the maximum elevation is 588 ft MSL. Elsewhere, few hilltops exceed 550 ft MSL in elevation; most are between 450 and 500 ft MSL with gentle slopes. Small ponds are common on the lower slopes.

4.5.1.2 Regional Stratigraphy

The area between Henderson and Spottsville is underlain to a depth of several thousand feet by Paleozoic strata ranging in age from Cambrian to late Pennsylvanian. These strata are underlain by Precambrian rocks whose lithologic nature is largely unknown, because they lie below the depth of deepest drilling in the area. However, the Precambrian basement in this area is inferred to be part of a vast terrane of granite and rhyolite that underlies neighboring areas to the east, north and west[5]. The uppermost Paleozoic rocks are largely covered by alluvium in the valleys of the Ohio River and its tributaries and by loess in the dissected uplands. The distribution of alluvium and bedrock surface formations beneath the loess is shown in Figure 4.5.1-2. A generalized section of geologic formations exposed or present in the subsurface in the Henderson-Spottsville area is given in Table 4.5.1-1.

The Pennsylvanian Carbondale formation is the oldest rock unit exposed in the Henderson-Spottsville area. The middle and upper portions crop out in the bluffs along the Green River from the vicinity of Spottsville southward as shown in Figure 4.5.1-2[6]. The formation consists largely of shale with sandstone members in its upper and lower portions. The No. 9 coal bed in the upper part of the Carbondale has an average thickness of 4 ft and is the source of most, if not all, of the coal mined in Henderson County.

Only the lower third of the Lisman formation is recognized in the Henderson-Spottsville area [7]. It consists of shales and sandy shales with one sandstone and two limestone members which, because of erosion, are not everywhere present in the area. Exposures of the formation are mostly scattered outcrops of sandstone, shale, and sandy shale in the banks of creeks rising in the bluffs along the Ohio and Green Rivers. The Providence limestone and the Anvil Rock sandstone members form the basal part of the formation. The Anvil Rock member is a coarse-to fine-grained, cross-bedded channel sandstone grading into shale laterally.

In the upland areas, the Lisman formation is largely hidden by a cover of loess, the thickness of which ranges from 2 or 3 ft to as much as 50 ft in the bluffs near the Ohio River but is commonly 10 to 15 ft thick. The loess is generally buff to yellow-brown in color and consists mainly of clayey silt and silty clay. Where the loess is thickest, the basal part is commonly calcareous[8].

The valleys of the Ohio and Green Rivers and their tributaries contain thick deposits of unconsolidated alluvium, mainly Pleistocene in age. In the Ohio River Valley, where the land surface is relatively flat, the thickness of the alluvium is governed primarily by the altitude of the underlying bedrock surface. Near the confluence of the Ohio and Green Rivers in the Henderson-Baskett area, alluvium is typically 90 to 100 ft thick where it fills old river channels[7]. A maximum thickness of as much as 180 ft is found in the area of confluence where topographic highs on the land surface are above former river channels[9]. Ryder[10] indicates that alluvium in the Green River Valley away from the site area also may exceed 100 feet in thickness. Thickness of alluvium, consisting of sand, silt, gravel, and clay in the valley mouths of tributary streams

(other than the Green River), is commonly 70 to 80 ft. The alluvium in the Ohio River Valley generally becomes coarser and contains increasing amounts of gravel with depth. Ohio River alluvium also tends to be finer grained near the valley margins, where it contains a mixture of the finer materials deposited by the river and silt, clay, and fine sand brought in by the tributaries. The alluvium of the tributary valleys is largely clay and silt with some fine sand and small amounts of gravel[7].

4.5.1.3 Regional Structure

The proposed site is located in the southeastern part of the Illinois Basin (Figure 4.5.1-3), a broad downwarp in the Precambrian basement surface filled with a succession of Paleozoic strata more than 8000 ft thick. Downwarping began in early Paleozoic time, but the main period of progressive subsidence was during the Mississippian and Pennsylvanian periods when more than 4000 ft of sediment were deposited.

The regional dips of the strata underlying the Henderson-Spottsville area are westward toward the center of the Illinois Basin. The dip decreases with decreasing age of the strata, ranging from 31 ft/mi for the Barlow limestone, a marker bed in the Upper Mississippian strata, to 10 ft/mi for the No. 9 coal seam, a Middle Pennsylvanian marker horizon which lies within 150 ft of the land surface[7].

The Pennsylvanian and Mississippian strata in the area have been mildly warped by post-Pennsylvanian deformation, creating minor anticlines plunging generally toward the north or south[7].

Structural relief on the Mississippian formations is 500 to 550 ft [8]. Folds in Pennsylvanian strata tend to be broader than corresponding ones in Mississippian strata[8].

There is no surficial evidence of faulting within 10 mi of the proposed site. However, as can be seen on Figure 4.5.1-3, the proposed site is 19 mi north of the Rough Creek fault zone, an east-west zone of major disturbance, and 14 mi northwest of a zone of prominent northeast-trending faults lying between the Ohio River and the Rough Creek fault zone. Another set of northeast-trending faults is located approximately 25 mi west of the proposed site, near the confluence of the Wabash and the Ohio Rivers. The latter fault set, together with the Wabash Valley faults further west (Figure 4.5.1-3), form the northern part of a broad belt of northeast-trending faults which Heyl and others[13] refer to as the New Madrid fault zone. As described by Heyl and others, the fault zone extends from near Vincennes, Illinois southwestward beneath the Mississippi embayment to New Madrid, Missouri and beyond.

The northeast-trending faults southeast of the proposed site also may be related to the New Madrid fault zone. These faults are located on the southeastern margin of the northeast-trending magnetic high shown on aeromagnetic maps published by Lidiak and Zeitz[14]. According to Lidiak and Zeitz, this magnetic high "parallels and in part coincides with the eastern part of the broad northeast-trending New Madrid fault zone and may represent a structure in the basement that is associated with this faulting". The fact that the proposed site is located on the northwest flank of this

same magnetic high suggest a possible continuity of geologic structure between the site and the New Madrid fault zone.

The identification of active faults in the Upper Mississippi Valley region is complicated by the fact that no evidence of tectonic surface ruptures related to historical or other Holocene earthquakes has been found, with the possible exception of the 1811-1812 earthquakes near New Madrid, Missouri[14,15,16]. Extensive efforts to identify recent deformation related to faults have so far been unsuccessful [15,17,18]; such efforts are continuing however[19].

Practically all evidence for active faulting in the Upper Mississippi Valley region is based on historical seismic activity. The New Madrid fault zone coincides with a northeast-trending belt of relatively high seismic activity (Figure 4.5.1-4), with most persistent activity associated with the portion of the zone underlying the Mississippi Embayment in the vicinity of New Madrid, Missouri. Historical seismic activity in this area includes three major shocks of devasting intensity which were part of an earthquake series beginning in December 1811 and continuing into 1813. The nature of seismic activity in the Upper Mississippi Valley region prior to the 1960's is poorly known because of lack of sufficient instrumental data. Instrumental data since the early 1960's indicate that recent seismic activity is related, in part, to northeast and northwest trends that more or less parallel, but do not necessarily coincide with, known faults, and in part, to a predominantly northerly trend that is poorly represented by known faulting.

The recently established microearthquake network in the Upper Mississippi embayment has identified several linear, seismically active zones corresponding presumably to seismically active faults[20]. The most prominent of these zones trend N40°E. Two of these zones, one extending northeast from the vicinity of New Madrid, Missouri, and another extending southwest from the vicinity of Reelfoot Lake in Tennessee, are particularly well established by epicenter distribution. Other trends of epicenters with a NW-SE orientation have also been identified. Stauder and others [20] cite several lines of evidence which indicate to them that the New Madrid seismic zone is probably a seismic regime distinct from that of the Wabash Valley, raising the possibility that there is little liklihood of an 1811-1812 type seismic event extending along a continuous fault zone from New Madrid into Illinois and the Wabash Valley.

The question of whether the New Madrid Fault Zone is structurally and seismically continuous from the Upper Mississippi embayment region to the Wabash Valley area cannot be settled on the basis of information available at present. However, a 5-year program of study now being undertaken by the United States Geological Services, including a planned seismograph array in the Wabash Valley area [19], may provide sufficient data for a conclusive answer.

4.5.1.4 Seismic History

Epicenters of earthquakes of Modified Mercalli (MM) Intensity V or greater located within a 100-mile radius of Baskett are shown in Figure 4.5.1-5 and listed in chronological order in Table 4.5.1-2. An explanation of

the Modified Mercalli Intensity Scale is included in Table 4.5.1-3.

Only a few of the earthquakes with epicenters shown in Figure 4.5.1-5 are known to have had damaging effects in the Evansville-Henderson-Baskett area. According to Coffman and van Hake[21] the earthquake on July 26, 1891 frightened people in churches and caused property damage in Evansville, but they give no details of the type of damage. In 1925 there were several earthquakes centered in the vicinity of Evansville or Henderson. The first of these, on April 26, resulted in broken crockery in Evansville [25]. Another earthquake on September 2 caused a church steeple to sway, displaced bricks of a few old buildings in Evansville, and triggered landslides in Henderson[26]. The September 2 earthquake was followed by two Intensity IV shocks on September 20[27]. The most recent earthquake to cause damage in the area was the south central Illinois earthquake of November 9, 1968. Henderson experienced Intensity VII from this earthquake; four or five chimneys toppled on old houses, two old buildings cracked, and the City Building sustained considerable masonry damage[27].

The most severe earthquakes to affect the Henderson-Baskett area were located around New Madrid, Missouri, nearly 150 miles from the proposed site. These were the three major shocks of the 1811-1812 earthquake series, which were felt over an area of at least two million square miles. According to Coffman and von Hake, all three of these earthquakes were of Modified Mercalli Intensity XII [21]. There is little data available in the scientific literature regarding the extent of damage caused by these shocks in the potential site area, although Fuller[28] states that the December 30, 1811 shock overturned nearly every chimney in Henderson County. A generalized isoseismal map for the December 16, 1811 shock, published by Nuttli[29] and reproduced in Figure 4.5.1-6, indicates that the intensity was VII - VIII in the proposed site area.

On the seismic risk map published in the 1976 Uniform Building Code[30], (Figure 4.5.1-7), the site location occurs close to the boundary of Zone 3 - Zone 2. The risk map in the Uniform Building Code (UBC) is adopted from Algermissen[31] with some change for the western United States. For the central and eastern United States, the map was adopted without change.

By taking into account new data and more recent studies than were available at the time of Algermissen's study[31], the conclusion presented in this report is that seismic risk Zone 2 provides an appropriate design basis for the site region for the following reasons:

1. In the last paragraph on page 20, Algermissen[31] stated: "In areas where the relations between seismicity and geologic structure are not clear or where only limited geologic information is available, the risk zones are based on the distribution of MM intensities and strain release. In all cases, the size and shape of the zones have been heavily influenced by the historical distribution of intensities (Figure 1)." This situation appears to be the case for the region around the site under consideration. According to Figure 1 in Algermissen [31], the site location occurs inside the maximum MM intensity VIII region. This intensity distribution is evidently related to the 1811-12 New Madrid earthquake series.

Nuttli[29] carried out a detailed and thorough study of the New Madrid earthquake of December 16, 1811 and published an isoseismal map. On this map, the site is located between intensity VII and VIII contours, and the site intensity may be interpolated at 7 3/4. Accordingly, the site should be considered outside the UBC Zone 3, which corresponds to intensity VIII and higher of the MM scale.

2. According to Figure 5 of Nuttli[32], the site is located near the southeast boundary of seismic region 2a. Nuttli[32] assigned body wave magnitude 6.2 for the design earthquake for region 2. This corresponds to an epicentral intensity of 7.8 according to Gutenberg and Richter's[33] relation:

$$M = 1 + 2/3\ I_o$$

where M is magnitude and I_o is epicentral intensity.

3. St. Louis University, under a grant from the U.S. Geological Survey, established a microearthquake network in the New Madrid seismic zone to analyze the seismic characteristics of the region. From the spatial distribution of hypocenters located during the first 21 months of operation, Stauder and others[20] identified the existence of linear seismically active zones, corresponding presumably to seismically active faults. One of these trends, N40°E, parallels the axis of the Mississippi embayment. The other is parallel to and possibly related to the crest of the Pascola arch which joins the Ozark uplift to the Nashville dome. At present there appears no suggestion that these strongly localized trends continue north beyond latitude 37°N. The latitude of the Syngas Project site is 37° 53'N. It may be interpreted, therefore, that the zone of major damage (Zone 3) does not extend into the site area.

4. The site is located north of the Rough Creek fault zone, whereas the New Madrid seismic zone is located south of this east-west trending fault zone. The region immediately south of the Rough Creek fault zone is severely fractured. Thus a major structural discontinuity separates the site region from the New Madrid seismic zone, which in turn may suggest that the Zone 3 boundary should not extend north of the Rough Creek fault zone.

5. A recent fault map compiled by Howard and others[34] of the US Geological Survey delineated the Central Mississippi Valley as a distinct tectonic unit. The site is located outside the Central Mississippi Valley region. In a gross sense, the boundary for UBC Zone 3 is close to the Central Mississippi Valley boundary. This would imply that if the UBC seismic risk zone map were to be refined by considering the fault map compiled by Howard and others[34], the site would be located in Zone 2 rather than Zone 3.

4.5.1.5 Site Geology

The proposed plant and solid waste disposal area is covered predominantly by unconsolidated Pleistocene loess deposits of the Illinoian and Wisconsin Glacial stages[27]. The floodplain of the Green River is predominantly alluvium with small areas of loess. Directly underlying the unconsolidated sediment cover are Paleozoic siltstones, claystones, shales, coal seams, and some limestone and sandstone units. Figures 4.5.1-9 and 4.5.1-10 illustrate the on-site stratigraphic relationships of the loess, river sands and Paleozoic bedrock. Locations of borings drilled in the site are shown in Figure 4.5.1-8.

4.5.1.5.1 Quaternary Sedimentary Cover

4.5.1.5.1.1 Loess Deposits

Soils in the area proposed for the location of the plant, above the flood plain of the Green River, are predominantly Pleistocene loess deposits of the Illinoian and Wisconsin Glacial Stages [35]. They are poorly compacted and weakly indurated but do exhibit some cohesion.

Loess existing at the site consists of clayey silts and silty clays. The clays and silts encountered are generally of medium to stiff consistency (visual field classification) and of low plasticity (Liquid limit $<37\%$ and Plasticity Index $<13\%$ based on laboratory results obtained for this project and presented in Appendix 4B.7 of this report). The loess deposits locally contain fine sand. Results of field permeability tests of the clayey silts in the plant/solid waste disposal area indicate values less than 10^{-5} cm/sec as determined by falling head tests in boreholes A-8, A-29, and A-30. (Figure 4.5.1-8 locates all borings. Procedures used and data collected during field permeability testing are shown in Appendix 4A.6 and 4B.7). Thickness of the loess in the upland plant and ash pond area ranges from a minimum of 9.0 ft to a maximum of 50.0 ft and averages 20-25 ft, as determined by borings and seismic refraction. The existing overburden surface appears to follow bedrock topography.

4.5.1.5.1.2 Alluvial Deposits

Alluvial deposits consisting of interlayered silts, clays, silty-clayey sands, and clean medium to fine sands make up much of the sediment cover of the Green River floodplain. Generally, the upper parts of the alluvial deposits are composed largely of clays and silts while the lower portions consist mainly of sands or coarser alluvium (Figure 4.5.1-9 and 4.5.1-10). This sequence found in the Baskett area is similar to that noted more regionally along the Green River by Ryder[10]. The alluvium is interbedded with some thin, discontinuous loess deposits. The alluvial sequence on the floodplain increases in thickness toward the Green River, from 27.6 ft in boring A-6 near the southern fringe to 58.0 ft in boring A-26 at the water front (Figure 4.5.1-8). Sand and thin pebble units (less than 2 in thick) occur in the northeast corner of the plant and solid waste disposal area, directly overlying Paleozoic Bedrock, with thicknesses of 11.5 ft and 8.5 ft recorded.

Silts and clays interlayered with the sands are indistinguishable in the

field from the silts and clays of the plant and solid waste disposal area loess, though many are certainly fluvial deposits.

Refusal of the drive sampler is reached very abruptly near the top of the bedrock on the floodplain, indicating a shallow weathered zone.

4.5.1.5.2 Paleozoic Bedrock

Bedrock in the site area consists of flat-lying interbedded siltstones, claystones, shales, coal seams, and some limestone and sandstone units. Bedrock in the plant and solid waste disposal area consists of Upper Pennsylvanian siltstones and claystones, with occasional coal seams and associated overclay and underclay (Figure 4.5.1-9). Nearer the Green River, Lower Pennsylvanian limestones and sandstones are found beneath the siltstones and claystones of the Upper Pennsylvanian Lisman Formation. Elevation contours on the top of bedrock are included as Figure 4.5.1-13.

In general, the upper 5 to 10 ft of claystone and siltstone in the plant and solid waste disposal area are severely weathered. Shaley partings are prominent in the highly weathered claystone. Brown weathering stains are also apparent on these predominantly grey claystones. The claystones, shales, siltstones, and limestones in this area are characterized by gradational contacts and lateral facies changes. Iron-cemented concretions are common throughout these units. Permeabilities of the highly weathered shale and siltstone bedrock underlying the loess in the plant area were determined to be approximately 1.5×10^{-6} cm/sec through falling head field permeability tests (borings A-8, A-29). A packer test in the relatively fresh bedrock beneath the plant area (boring A-30) indicated a permeability of zero. (Procedures used and data collected during field permeability testing are included in Appendix 4A.6 and 4B.7).

Claystones in the area are of moderate hardness and moderate strength. The more highly weathered claystones exhibit shaley fissility, but all of the claystones break into 0.25 to 0.75 in partings after drying. The siltstones are generally massive and some contain fine sand. They are hard, strong, and are better indurated than the claystones. The overclays and underclays associated with coal beds are soft and plastic and often contain carbonaceous fragments. Limestone and sandstone units up to 5 in thick are associated with some of the overclays, especially those which occur with the lower No. 12 coal bed. A columnar section in Johnson[35] also indicates that limestone overlies the No. 12 coal bed. Some shale units containing lignite fragments are also found interbedded with the clays. The thick limestone units found generally between elevation 300 and 350 ft MSL are massive, very hard, and very strong. These limestone units contain abundant calcareous fossil shell fragments. The massive sandstone unit found beneath the limestone units in hole A-28 may correspond to the Mississippian sandstone unit of the USGS stratigraphic section[35] (Appendix 4B.7 includes logs for all borings).

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TABLE 4.5.1-1

GENERALIZED SECTION OF GEOLOGIC STRATA EXPOSED OR PRESENT IN SUBSURFACE IN THE EASTERN PART OF HENDERSON COUNTY, KENTUCKY

SYSTEM	SERIES	GROUP	FORMATION	THICKNESS IN FEET	CHARACTER
Quaternary	Recent and Pleistocene		Valley alluvium and loess	0–50	Loess – silt and some fine-grained sand; mantles uplands.
				0–145	Ohio Valley alluvium – sand and gravel overlain by silt and clay.
				0–80	Tributary valley alluvium – principally silt and clay.
Quaternary and Tertiary (?)	Pleistocene and Pliocene (?)		Chert gravel	0–11	Sandy gravel with pebbles of chert and quartz in scattered, patchy deposits.
Pennsylvanian	Upper Pennsylvanian	McLeansboro	Lisman Formation	0–300	Shale, sandstone, coal, and several thin limestone beds; includes Anvil Rock sandstone and Providence limestone members and No. 12 and No. 13 coal beds in lower portion.
	Middle Pennsylvanian		Carbondale Formation	300–400	Shale, coal beds, several thin limestone beds, and a prominent white medium-grained sandstone (20 to 100 feet thick).
	Lower and Middle Pennsylvanian	Pottsville	Tradewater Formation	450–550	Mainly shale with coal seams, and a thin persistent limestone bed. Several sandstones usually present.
			Caseyville Sandstone	500–600	Massive sandstones, medium-grained, pebbly; a few beds of shale, coal, and limestone.
Mississippian	Upper Mississippian	Chester	(a)	800–1000	Sandstone beds alternating with limestone or shale.
		Meramec	(b)	860	Mainly limestones, oolitic in upper part, dolomitic in lower part.
	Lower Mississippian	Osage	Undifferentiated	650	Limestones and shales.
Devonian			Undifferentiated	1100	Limestone overlain by several hundred feet of black shale
Silurian			Undifferentiated	400	Massive dolomitic limestone.
Ordovician			Undifferentiated	1600	Massive dolomitic limestone with some siltstone, shale, and sandstone.
Cambrian			Undifferentiated	700+	Massive dolomitic limestone.

Source: Harvey *(1956, Table 2).*[7]

a *In order from youngest to oldest: Kinkaid limestone, Degonia sandstone, Clore limestone, Palestine sandstone, Menard limestone, Waltersburg sandstone, Vienna limestone, Tar Springs sandstone, Glen Dean limestone, Hardinsburg sandstone, Golconda formation, Cypress sandstone, Paint Creek shale, Bethel sandstone, Renault formation, Aux Vases sandstone (Harvey, 1956, p. 46).*[7]

b *In order from youngest to oldest: Ste. Genevieve limestone, St. Louis limestone, Spergen (Salem of local usage) limestone, Warsaw (Harrodsburg of local usage) limestone (Harvey, 1956, p. 45).*[7]

TABLE 4.5.1-2

CHRONOLOGICAL LIST OF EARTHQUAKES WITH INTENSITY ≥ MM V WITHIN 100 MILES OF PROPOSED SITE.

No.	Year	Date	Locality	N lat.	W. long.	Area (sq. mi)	Intensity (epicenter)
1	1827	Aug. 6	New Albany, Ind.	38.3	85.8		VI
2	1827	Aug. 7	New Albany, Ind.	38.3	85.8		VI
3	1876	Sept. 25	Wabash River	38.5	87.7	60,000	VI
4	1887	Feb. 6	Vincennes, Ind.	38.7	87.5	75,000	VI
5	1891	July 26	Evansville, Ind.	37.9	87.5		VI
6	1899	Apr. 29	Southwestern Ind.	38.5	87.0	40,000	VI-VIII
7	1906	May 11	Southwestern Ind.	38.5	87.2	800	V
8	1906	May 21	Flora, Ill.	38.5	88.5		V
9	1909	Sept. 22	South-central Ind.	38.7	86.5	4,000	V
10	1909	Sept. 27	Wabash River	39.0	87.6	30,000	VII
11	1909	Oct. 23	Wabash River	39.0	87.7	8,000	V
12	1919	May 25	Southwestern Ind.	38.5	87.5	18,000	V
13	1922	Mar. 22	Southeastern Ill.	37.3	88.6	25,000	V
14	1925	Apr. 26	Evansville, Ind.	38.0	87.5	100,000	V
15	1925	Sept. 2	Henderson, Ky.	37.8	87.6	75,000	V-VI
16	1931	Jan. 5	Southwestern Ind.	39.0	87.0	500	V
17	1957	Mar. 26	Paducah, Ky.	37.0	88.4		V
18	1958	Nov. 7	Wabash River	38.4	87.9	33,000	VI
19	1962	June 26	Southeastern Ill.	37.7	88.5		V
20	1963	Aug. 2	Illinois-Kentucky border	37.0	88.8		V

TABLE 4.5.1-2 (CONT'D)

No.	Year	Date	Locality	N. lat.	W. long.	Area (sq.mi)	Intensity (epicenter
21	1968	Nov. 9	Southcentral Ill.	38.0	88.5	580,000	VII
22[a]	1974	Apr. 3	Southeastern Ill.	38.6	88.1	243,000	VI
23[b]	1976	Apr. 15	Madisonville, Ky.	37.4	87.3		V

Source: Coffman and von Hake (21) unless otherwise noted.

See Figure 4.5.1-5 for epicenter locations.

[a]Data from Coffman and Stover (22).

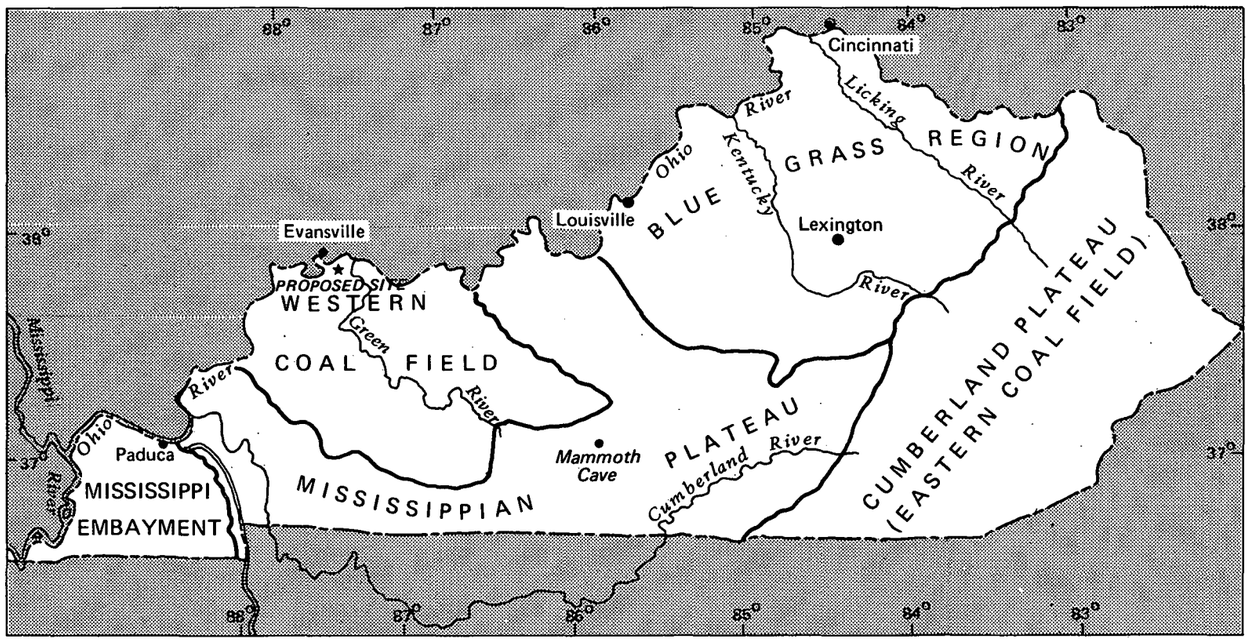
[b]Data from Simon and others (23).

TABLE 4.5.1-3

MODIFIED MERCALLI INTENSITY SCALE

I - Not felt except by a very few under especially favorable circumstances.
II - Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.
III - Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration like passing truck. Duration estimated.
IV - During the day felt indoors by many; outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls make creaking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
V - Felt by nearly everyone; many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbances of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop.
VI - Felt by all; many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight.
VII - Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motor cars.
VIII - Damage slight in specially designed structures; considerable in ordinary substantial buildings, with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Disturbs persons driving motor cars.
IX - Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.
X - Some well-built, wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed over banks.
XI - Few, if any, (masonry) structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.
XII - Damage total. Waves seen on ground surfaces. Lines of sight and level distorted. Objects thrown upward into the air.

Source: Modified after Derecho and Fintel, 1974 (24)



SOURCE: AFTER LOBECK, 1932 (2)

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PHYSIOGRAPHIC REGIONS OF KENTUCKY

FIGURE 4.5.1–1

EXPLANATION

QUATERNARY

Qal — Alluvium

PENNSYLVANIAN

Henderson County

IPl — Lisman formation

IPc — Carbondale formation

Contact

SOURCE: MAP FROM MAXWELL AND DEVAUL (6)

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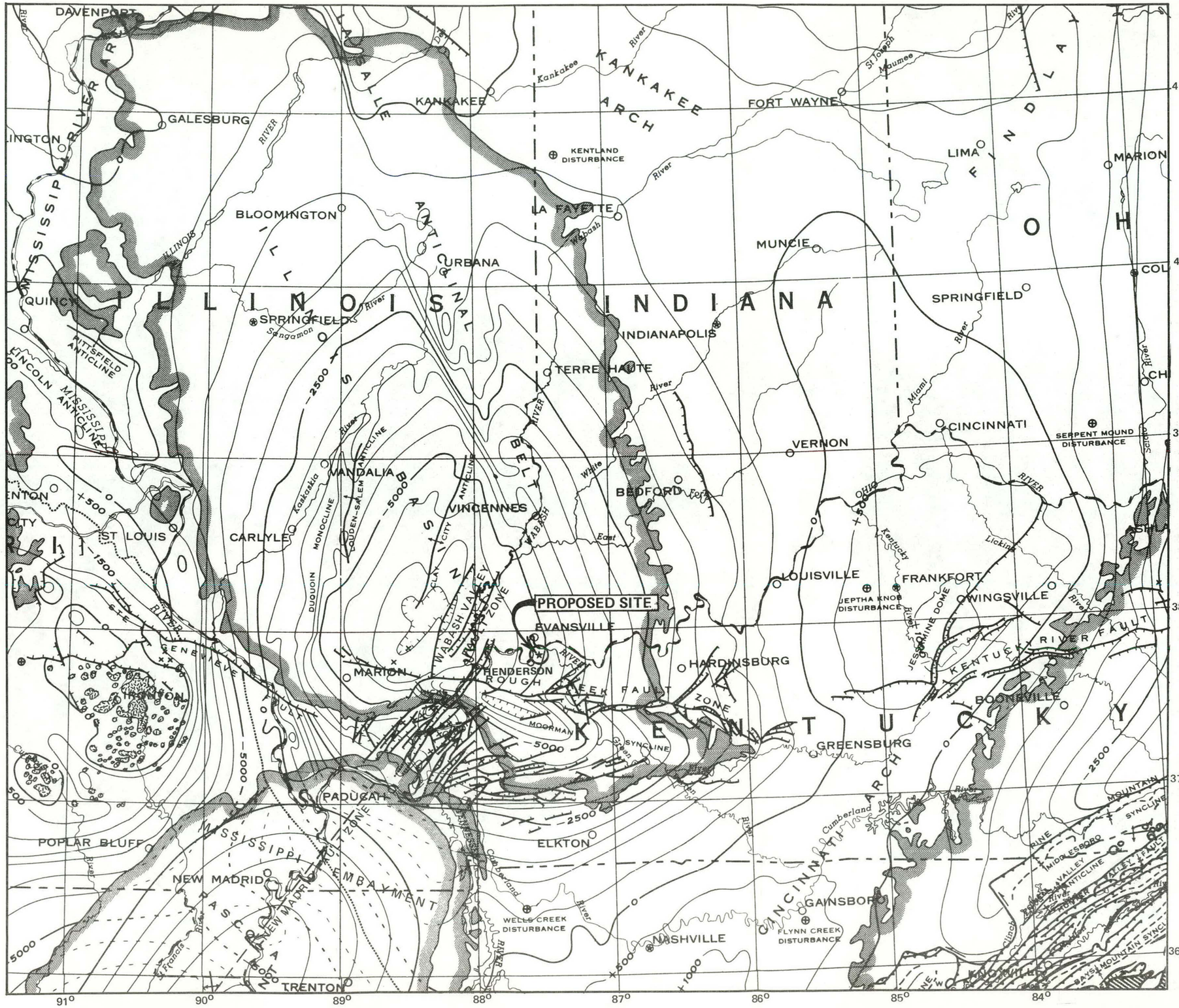
GEOLOGIC MAP OF EASTERN PART OF HENDERSON COUNTY, KENTUCKY

FIGURE 4.5.1–2



EXPLANATION

Normal fault, hachures on down–thrown side

Anticline

Structural contour line

Division between contours drawn on Ordovician Fernvale – Trenton beds (NE) and Pre Cambrian Rocks (SW)

Border of sedimentary basin

SOURCES: ADOPTED FROM U.S. GEOLOGICAL SURVEY (11) AND AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS AND HADLEY AND DEVINE (12)

0 20 40 60 80 100
SCALE IN KILOMETERS

0 50 100
SCALE IN MILES

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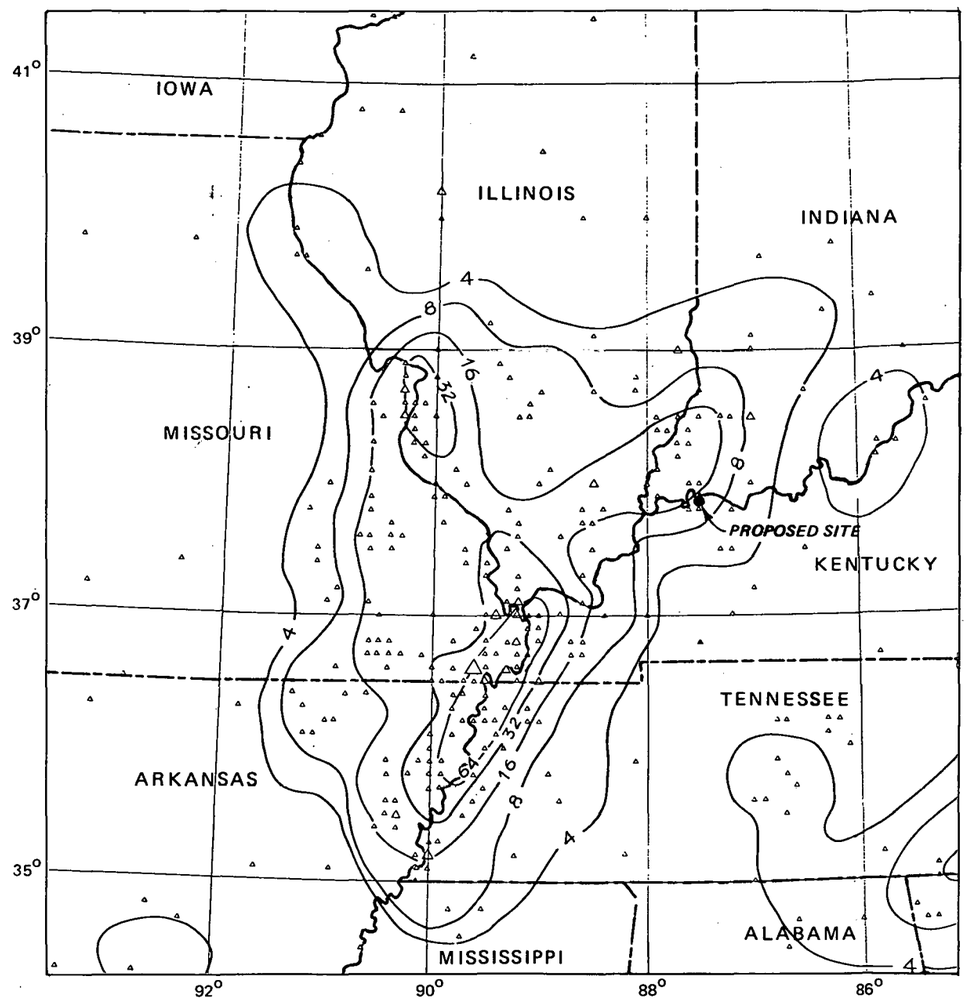
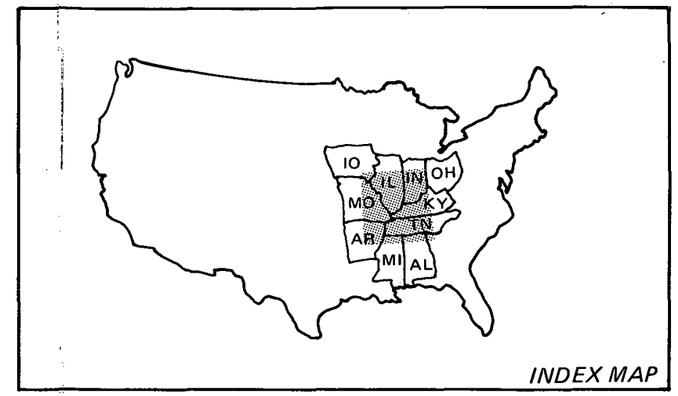
MAJOR STRUCTURAL FEATURES IN THE UPPER MISSISSIPPI – OHIO RIVER VALLEY AREA

FIGURE 4.5.1–3





EXPLANATION

Modified Mercalli Intensity

III to VI

VII

VIII

IX to X

XII

The center of each triangular symbol indicates the epicentral location of one or more seismic events, plotted to the nearest 0.1 degree of latitude and longitude. The intensity shown is maximum Modified Mercalli (MM) intensity in the epicentral area of the largest event at the plotted location. Most locations are based on observations of intensity rather than on instrumental records.

— 8 —

Seismic frequency contour representing the areal distribution of earthquake epicenters with epicentral intensity of MM III and greater, as indicated by the total number of epicenters per $10^4 km^2$, during the period 1800–1972.

SOURCE: MAP FROM HADLEY AND DEVINE (1974) (12)

NOTE: THE CONTOURS PROVIDE ONLY GUIDELINES FOR ESTIMATING REGIONAL SEISMICITY AND DO NOT PRECISELY LOCATE SEISMIC BOUNDAIRES

0 50 100 150 200
SCALE IN KILOMETERS

0 50 100 150 200
SCALE IN MILES

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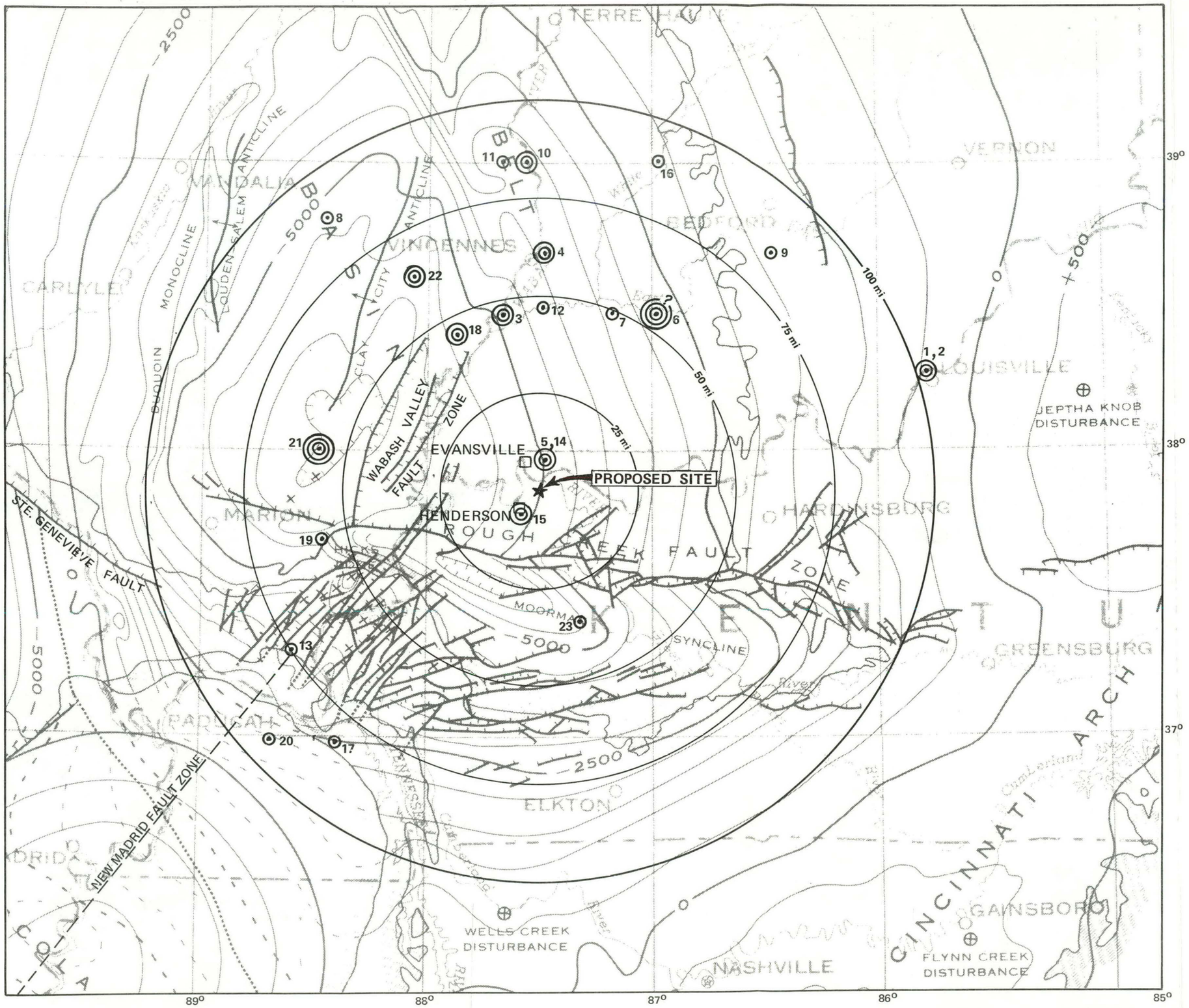
SEISMICITY OF THE UPPER MISSISSIPPI – OHIO RIVER VALLEY AREA (1800–1972)

FIGURE 4.5.1–4



EXPLANATION

- Earthquake, intensity V
- Earthquake, intensity VI
- Earthquake, intensity VII
- Earthquake, intensity VI – VII
- Chronological number shown in Table 4.5.1–2
- Normal fault, hachures on downthrown side
- Anticline

NOTES:
- See Table 4.5.1–2 for sources of data on earthquakes
- Tectonic features from Hadley & Devine (1974) (12)
- All intensities based on modified Mercalli Scale. See Table 4.5.1–3

0 20 40 60 80 100
SCALE IN KILOMETERS

0 25 50 75
SCALE IN MILES

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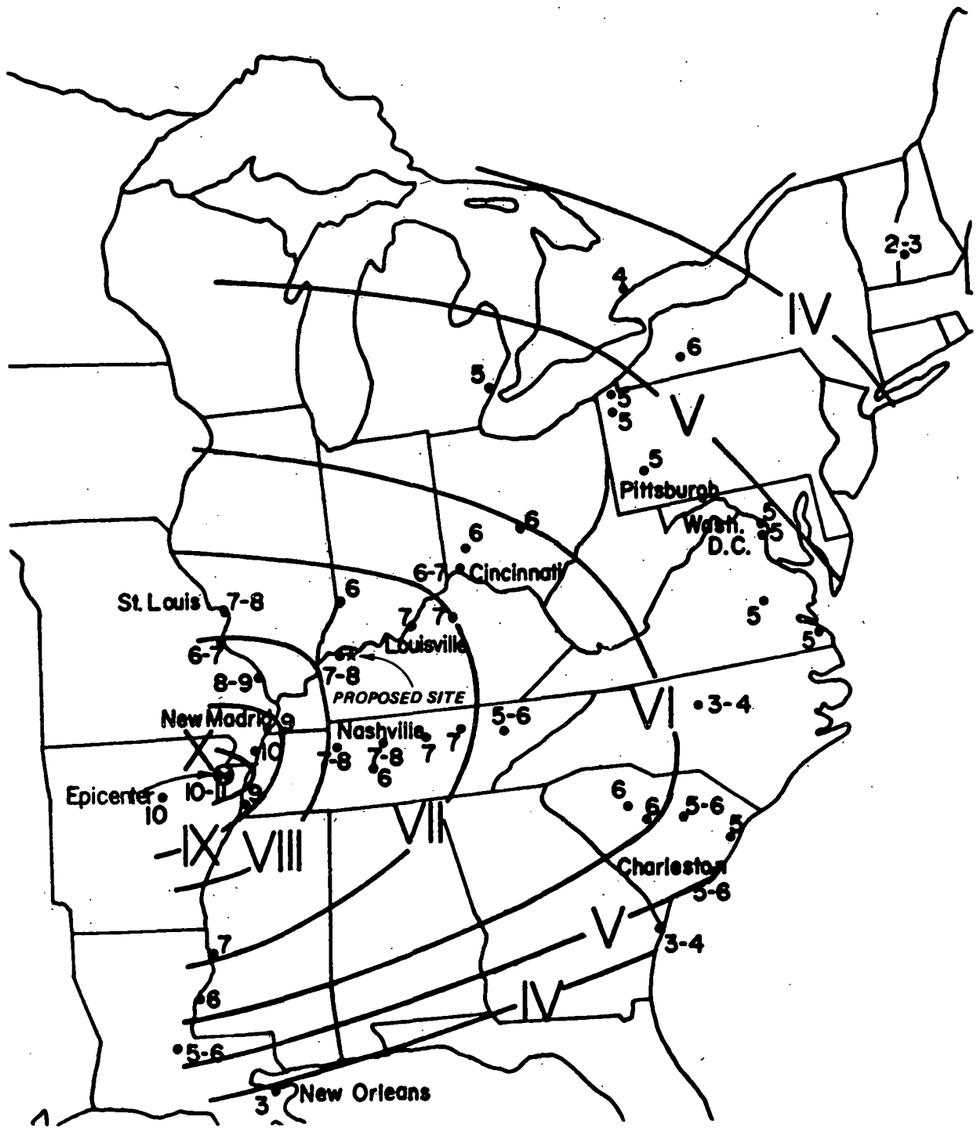
EPICENTERS OF EARTHQUAKES WITH INTENSITY ≥ MM V AND MAJOR FAULTS WITHIN 100 mi. OF PROPOSED SITE

FIGURE 4.5.1–5



EXPLANATION

VI — *Outer limit of Modified Mercalli intensity indicated by Roman numeral*

5 ● *Modified Mercalli intensity value for individual locality*

SOURCE: MAP TAKEN FROM NUTTLI (29)

0 100 200 300 400 500
SCALE IN MILES

0 200 400 600 800
SCALE IN KILOMETERS

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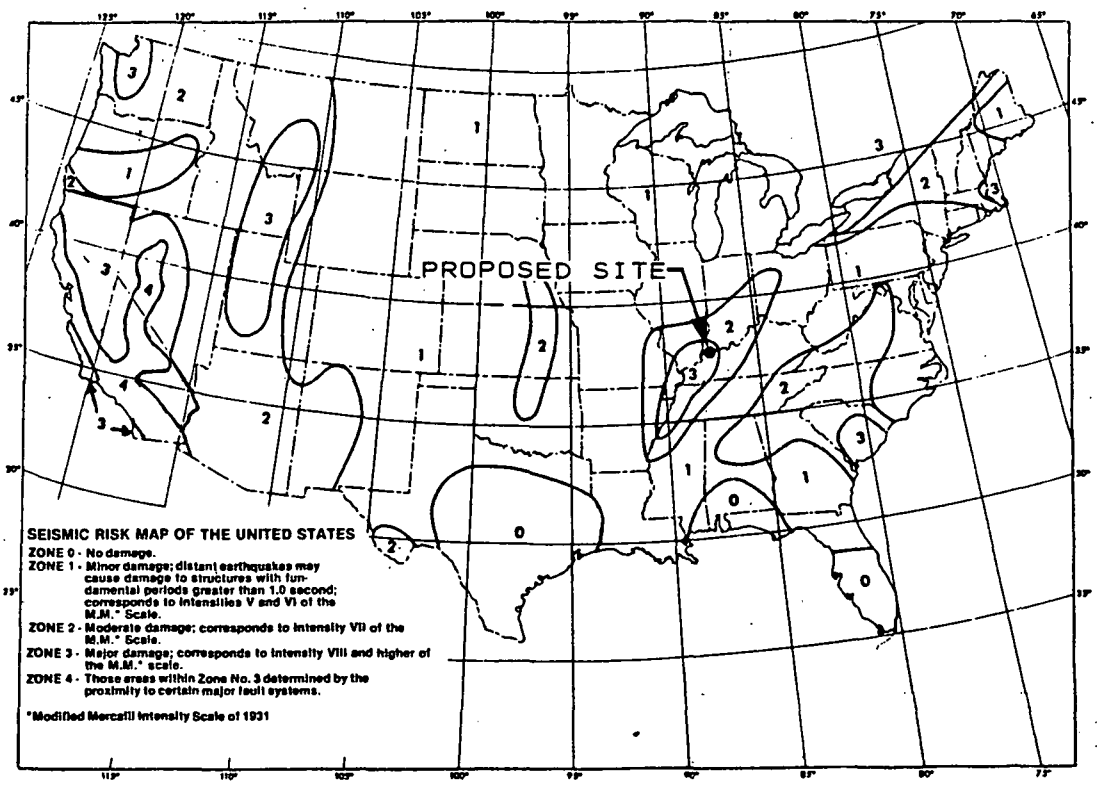
GENERALIZED INTENSITY MAP OF THE NEW MADRID EARTHQUAKE OF DECEMBER 16, 1811

FIGURE 4.5.1–6



SOURCE: UNIFORM BUILDING CODE, 1976 (30)

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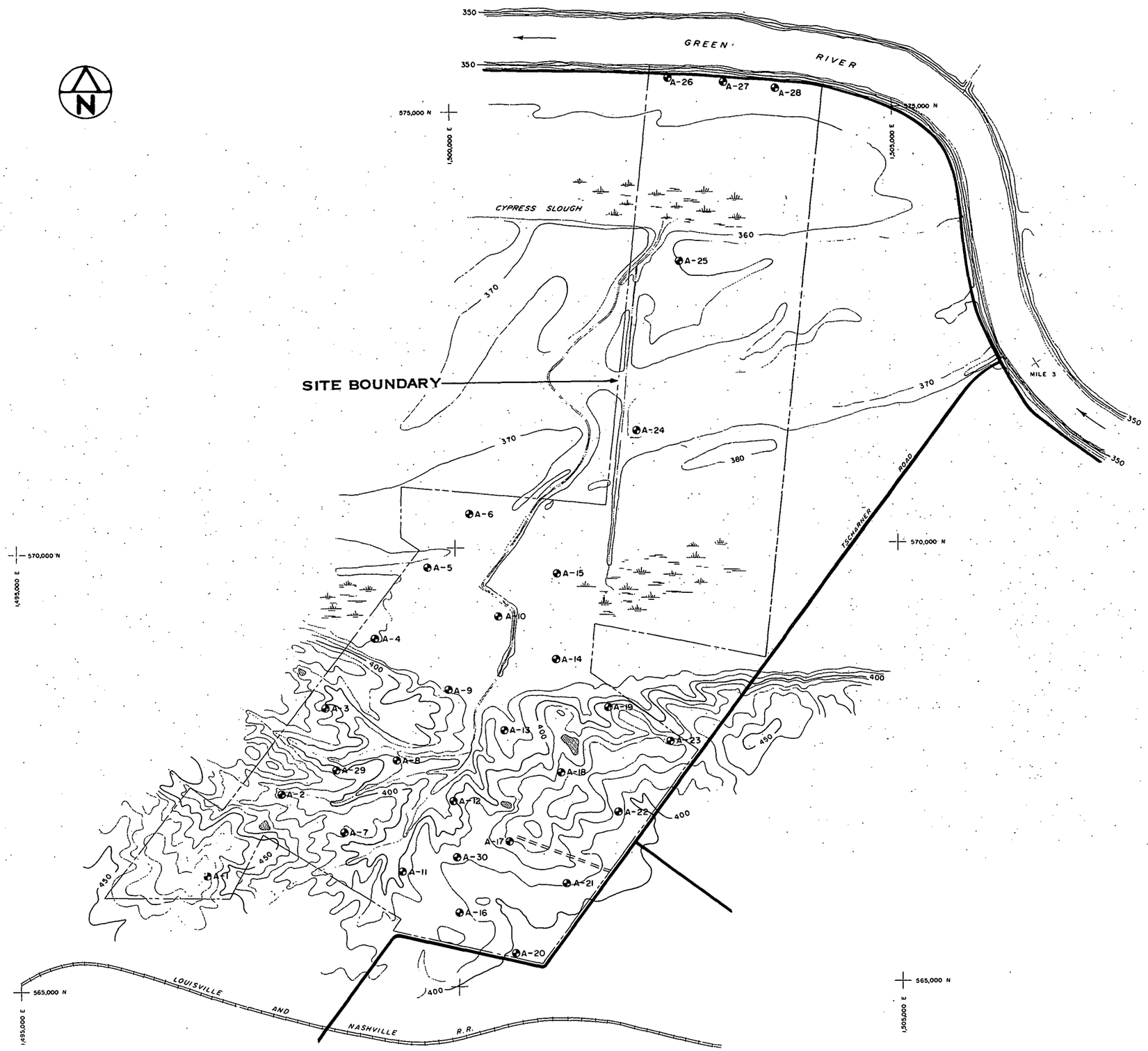
SEISMIC RISK MAP FOR THE CONTERMINOUS UNITED STATES

FIGURE 4.5.1–7



EXPLANATION

Bore Hole Location

BORING SCHEDULE			
BORING NO.	BORING COORDINATES NORTH	BORING COORDINATES EAST	TOTAL BORING DEPTH (FT.)
A-1	566295.96	1497132.31	114.0
A-2	567204.63	1497977.27	35.8
A-3	568187.47	1498505.46	39.8
A-4	568991.95	1499099.83	27.9
A-5	569796.24	1499694.07	48.7
A-6	570439.49	1500169.31	32.6
A-7	566788.87	1498715.46	50.0
A-8	567593.23	1499309.75	26.5
A-9	568397.72	1499904.12	39.4
A-10	569201.82	1500498.21	33.7
A-11	566313.48	1499358.89	24.2
A-12	567117.85	1499953.18	48.5
A-13	567922.14	1500547.41	44.8
A-14	568726.43	1501141.65	43.6
A-15	569700.75	1501169.19	48.3
A-16	565838.10	1500002.33	44.7
A-17	566642.46	1500596.61	90.8
A-18	567446.87	1501190.69	100.0
A-19	568163.80	1501722.20	38.9
A-20	565362.71	1500645.76	33.5
A-21	566167.19	1501239.89	49.5
A-22	566971.49	1501834.12	49.5
A-23	567774.91	1502429.53	44.3
A-24	571310.93	1502098.72	34.7
A-25	573252.14	1502580.19	71.2
A-26	575336.28	1502484.98	79.0
A-27	575273.26	1503081.71	92.6
A-28	575210.41	1503678.51	71.2
A-29	567488.20	1498610.48	20.0
A-30	566478.01	1499977.78	64.4
TOTAL			1542.1

0 500 1000
SCALE IN METERS

0 1000 2000 3000
SCALE IN FEET

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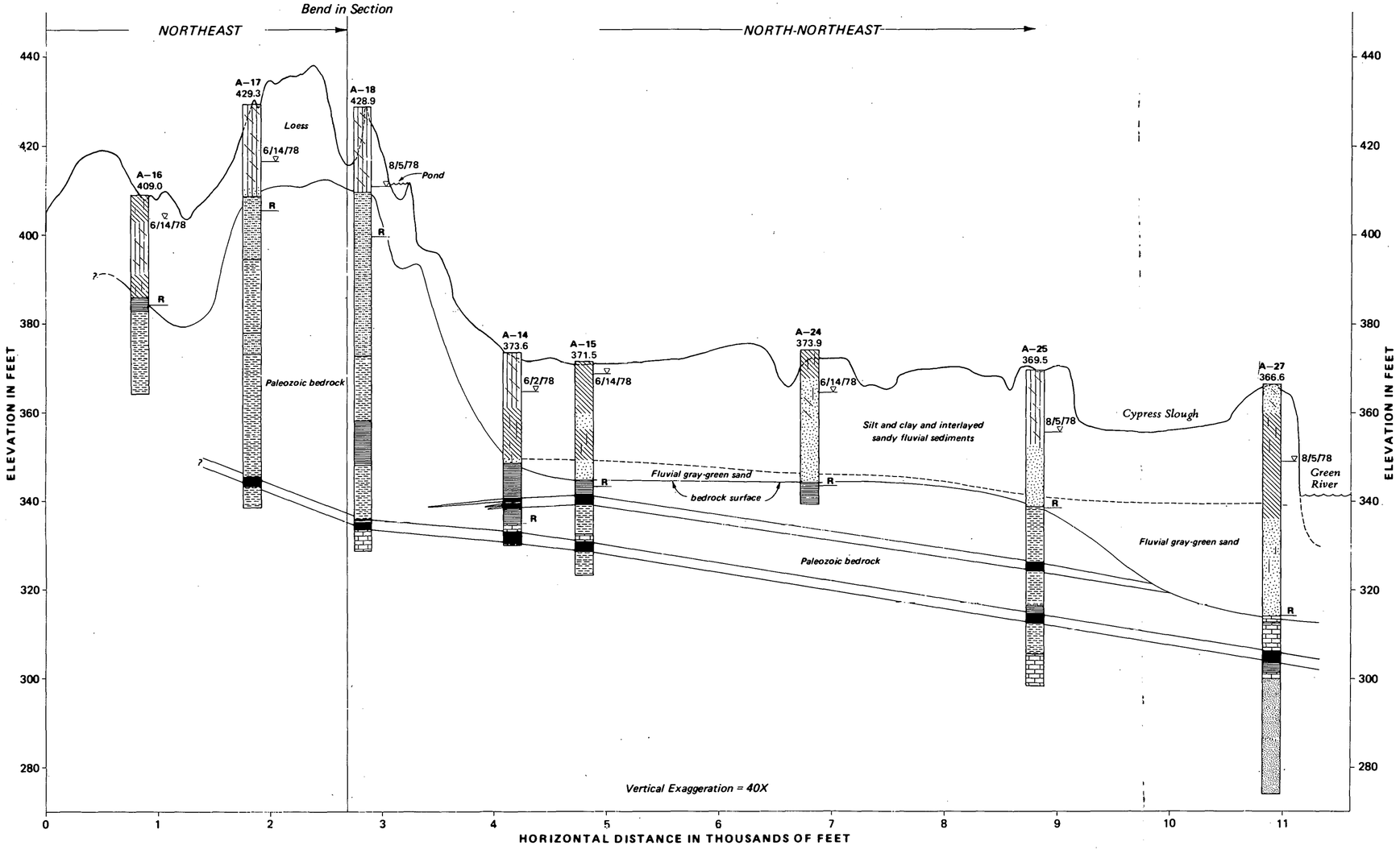
EBASCO SERVICES INCORPORATED

BASKETT SITE
BORING LOCATION MAP

FIGURE 4.5.1-8



EXPLANATION

- Sand
- Silt
- Clayey Silt
- Clay
- Silty Clay
- Limestone
- Siltstone
- Claystone
- Shale
- Sandstone
- Coal

A-27 366.6 Boring number and elevation in feet

Contact, dashed where approximate

6/14/78 Ground water level and date of observation

R Split spoon or auger refusal

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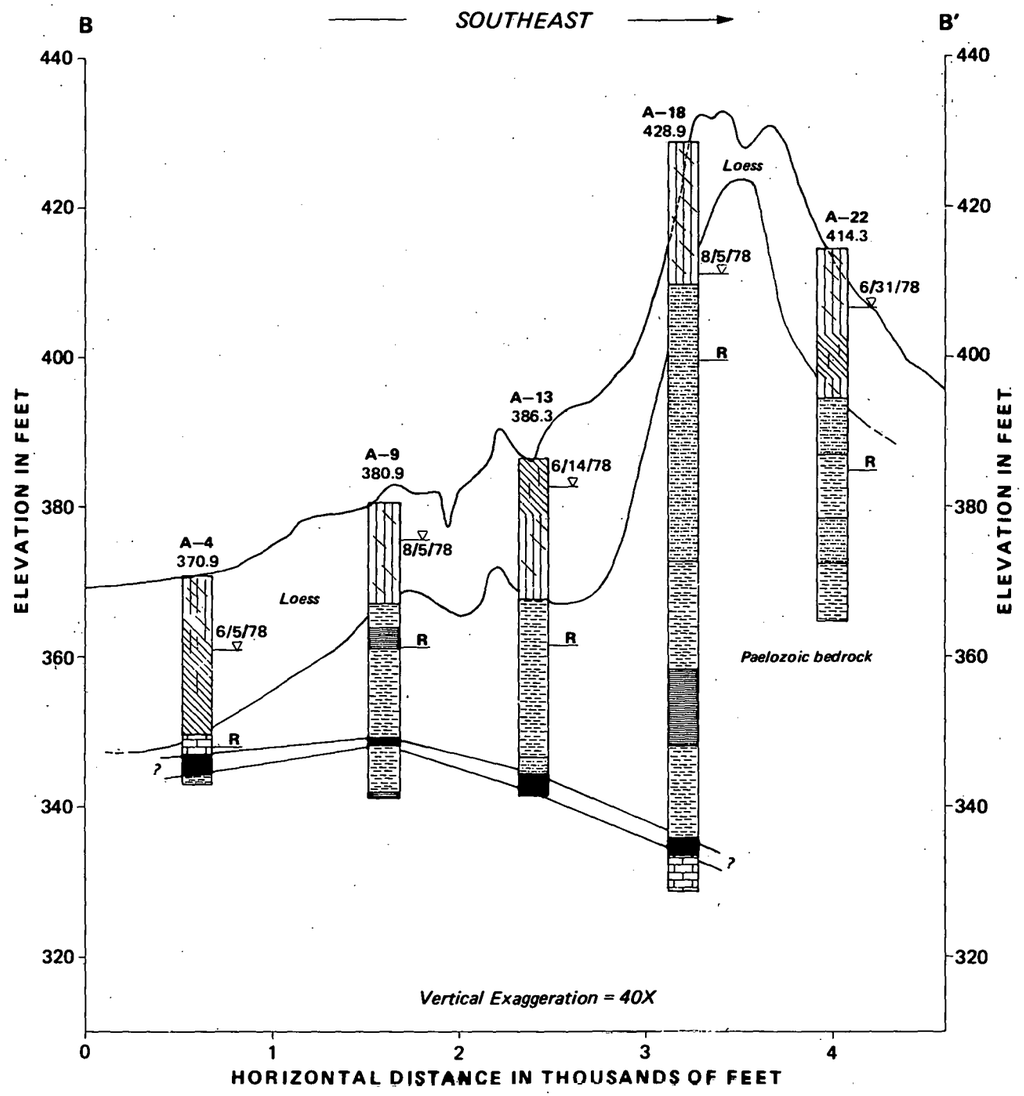
EBASCO SERVICES INCORPORATED

BASKETT SITE
CROSS SECTION A - A

FIGURE 4.5.1-9



EXPLANATION

- Sand
- Silt
- Clayey Silt
- Clay
- Silty Clay
- Limestone
- Siltstone
- Claystone
- Shale
- Sandstone
- Coal

A–27 / 366.6 Boring number and elevation in feet

Contact, dashed where approximate

6/14/78 Ground water level and date of observation

R Split spoon or auger refusal

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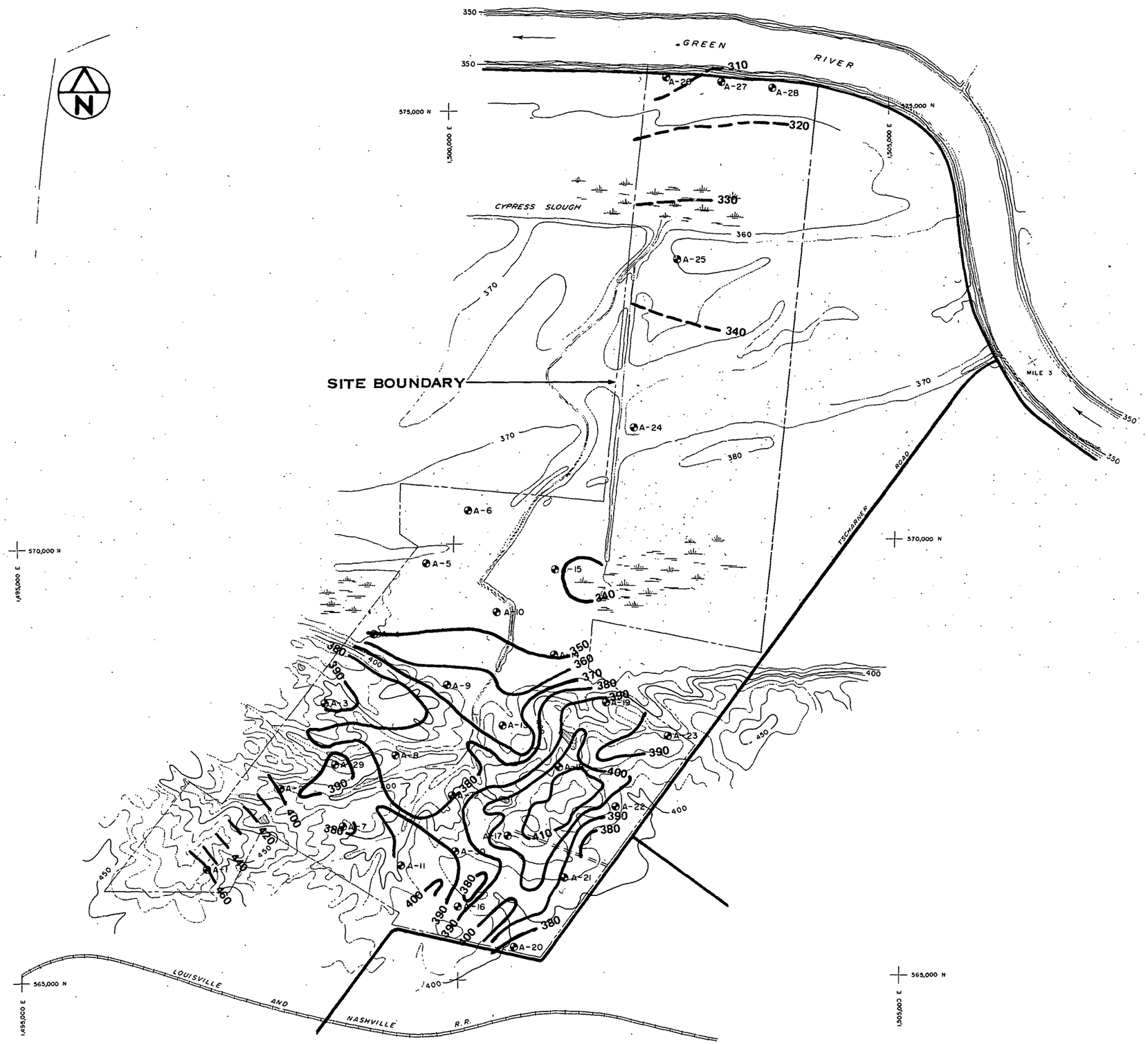
BASKETT SITE
CROSS SECTION B - B'

FIGURE 4.5.1-10



EXPLANATION

300 — Elevation contour of top of Bedrock, in feet (MSL)

0 500 1000
SCALE IN METERS

0 1000 2000 3000
SCALE IN FEET

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BASKETT SITE
BEDROCK CONTOUR MAP

FIGURE 4.5.1-11

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4.6.1 REGIONAL ECONOMY

4.6.1.1 Introduction

This section examines the economy of the delineated regional study area. The study area consists of six counties including Henderson and Daviess Counties in Kentucky and Vanderburgh, Spencer, Posey and Warrick Counties in Indiana. (See Figure 4.1.2-1). The section first presents a regional overview of both the regional and national employment for the years 1967 to 1977. Both regional and national comparison for earnings and unemployment were also investigated. The section then presents an evaluation of employment levels for the specific industrial sectors within the region, in cognizance of the national trends for the time period 1967 to 1977, and an identification of the basic and non-basic sectors within the regional economy.

4.6.1.2 Regional Overview

The regional and national employment for the time period of 1967 to 1977, is presented in Tables 4.6.1-1 to -4. As can be seen in these tables, the region in 1967 had a total employment level of 125,837[(1)(2)(3)] which climbed to a 1977 level of 161,474[(3)(4)(5)] resulting in a rate of change of 1.283 ("Rate of change" is a ratio measure of 1977 employment levels to 1967 employment levels that allows the analyst to gauge the magnitude of change that has occured during a specific time period for a specific industrial sector. The interpretation of the rate of change is as follows: >1.000, a growing sector; = 1.000, a stable sector; and <1.000, a declining sector). During this same 10 year period national employment rose from 69.7 million to 85.4 million[(6)] exhibiting a rate of change of 1.225. On comparing the study region to the nation for this time period, the region expanded its total employment base at a rate slightly greater (1.283 to 1.225) than that of the nation as a whole. In terms of individual counties within the region, Warrick County displayed the highest rate of change, 1.717, primarily due to increases in mining and service type industries while the counties having the larger employment concentrations (Vanderburgh and Daviess) had the lowest rates of change in their employment levels, Venderburgh 1.252 and Daviess 1.146. The rate of change for Henderson County during this period was 1.407.

For 1967 and 1977 (Tables 4.6.1-1 and 4.6.1-2), Vanderburgh County had the highest concentration of employment. In 1967 employment in Vanderburgh County numbered 67,897[(1)(2)(3)], about 54.0 percent of all regional employment while in 1977 the level rose to 84,989[(3)(4)(5)], however the total share of regional employment declined slightly to 52.6 percent. Both in 1967, and in 1977, Daviess County had the second highest employment concentration. In 1967 the employment level was 29,069[(1)(2)(3)], accounting for 23.1 percent of the regional total, while in 1977 the employment level reached 33,320[(3)(4)(5)], however the Daviess County total share of the region's employment base declined to 20.6 percent. The remaining four counties in the region showed increases in their shares of the region's employment, indicating a slight shift in employment concentrations to the less populated areas. These four counties - Spencer, Posey and Warrick in Indiana and Henderson in Kentucky had a combined 1967 employment level of 28,871[(1)(2)(3)] or 22.9 percent of the region's employment. In 1977, these

four counties had a combined employment level of 43,165[3][4][5] or 26.7 percent share of the region's employment.

Unemployment trends for both the region and the nation for the years 1974 to 1977 are presented in Table 4.6.1-6. During this period the national unemployment rate increased from 5.6[16] percent in 1974, to 8.5[16] percent the following year, and began dropping slightly to 7.7[16] percent in 1976 and 7.0[16] percent in 1977. In comparison to these national unemployment trends, the counties within the region for this period, have consistently exhibited unemployment rates below the national norm, except for the recession year of 1975.

The average gross weekly earnings of regional and national workers for the years 1967 and 1977 are presented in Table 4.6.1-5. In 1967, the national average gross weekly earnings for an employed preson was $127.37[12] while the average for the region under study was $116.66[8][10], about 8.4 percent below the national average. Only Warrick ($144.03)[8] and Posey ($130.00)[8] Counties exhibited a weekly average which was above the national level. Even Vanderburgh County, with its high degree of manufacturing employment, had a weekly average of $123.20[8] in 1967 which was 3.2 percent below the national level. Henderson County's weekly average ($89.44)[10] was 29.7 percent below the national level.

By 1977, the national gross average weekly earnings increased to $215.82[13] while the region's average increased to $210.91[9][11], (2.5% behind the national level). Warrick County's average, $321.68[9], was almost 50 percent above the national level due to an increase in mining activity in this county. Posey County in 1977 exhibited an earning average 11.1 percent above the national average ($239.91), because of the increase in white collar employment (services and wholesale trade) within the county. The average gross weekly earnings in Vanderburgh, Spencer, Handerson and Daviess Counties ranged from 5 percent to 20 percent below the national average.

4.6.1.3 Sector Analysis

The sector analysis consisted of evaluating the employment levels of specific industrial sectors within the region and comparing them to the national trends. The sectors which comprise the employment base of the study region are as follows: Agriculture; Mining; Construction; Manufacturing; Transportation, Communications and Public Utilities; Wholesale and Retail Trade; Finance, Insurance and Real Estate; Service; and Government. Throughout this analysis, data from Tables 4.6.1-1 to 4.6.1-4 are utilized. All 1967 regional employment data is presented in Table 4.6.1-1, with 1977 regional employment data presented in Table 4.6.1-2. The national employment data for both 1967 and 1977 are presented in Table 4.6.1-3, while regional and national rates of change are presented in Table 4.6.1-4.

4.6.1.3.1 Agriculture

In 1967, agricultural employment in the region numbered 19,474[1][2][3] or 15.5 percent of the region's total employment. By 1977, agricultural employment increased to 20,531[3][4][5], but its share of the region's total employment decreased to 12.7 percent. The comparison of the regional to national employment trends indicates that from 1967 to 1977 national

agricultural employment declined from 3.8 to 3.2 million workers[6] displaying a rate of change of .844. However, the region, with a rate of change 1.054, exhibited a small increase. In the study region agriculture employment constituted a sizeable share of the overall regional total for both 1967 (15.5%) and 1977 (12.7%) in comparison to national levels where agricultural employment only comprised a very small proportion of the total national level. In 1967, national agricultural employment only accounted for about 5.5 percent of nation's total employment, and by 1977 it decreased to 3.8 percent. This indicates that agriculture constitutes an important part of the region's overall economic base, and probably has a significant effect on unemployment rates and average gross weekly earnings which are below national levels.

4.6.1.3.2 Mining

Except for Warrick County, mining employment in the region accounted for a small proportion of the total employment in 1967 as well as 1977. While mining employment for the region was 2,412[1][2] or 1.9 percent of the region's employment in 1967 and 2,958[4][5] and 1.8 percent in 1977, Warrick County's mining employment more than doubled from 529[1] to 1,307[4] during the period to where it constituted about 11 percent of Warrick's County total employment in 1977.

National mining employment in 1967 was 613,000[6], or 0.9 percent of the total national employment. By 1977 employment rose to 831,000[6] or 1.0 percent of all national employment. Except for Warrick County, where mining is an important factor in that county's overall economic base, the remainder of the region generally followed the national mining trends. The 1967-77 rate of change (1.56) in national mining employment was only slightly higher than that experienced in the region (1.226).

4.6.1.3.3 Construction

Construction employment within the region from 1967 to 1977 generally follows the national trends. Both the region and the nation displayed growth in this sector. The regional construction employment increased from 5,671[1][2][3] to 7,970[3][4][5] while the national employment increased from 3.2 million to 3.8 million[6]. Share of total employment in both cases was about 4.5 percent. The only major difference is the rate of the expansion of the two employment bases. The region had experienced an expansion or rate of change of 1.417, while the national rate of change was only 1.198.

4.6.1.3.4 Manufacturing

The manufacturing sector is one of the dominant employment sectors within the region. In 1967, the employment level in this sector was 46,337[1][2], or 36.8 percent of all regional employment. This level in 1977 had declined to 43,420[4][5] or 26.9 percent of the region's employment. In comparison, the national manufacturing trends increased from 19.4 million in 1967 to 19.5 million in 1977[6] and accounted for about 27.9 percent of all national employment in 1967 and 22.9 percent in 1977. This indicates that the manufacturing sector plays a more significant role within the region than manufacturing plays within the nation. The major concentrations of manufacturing

employment within the region during 1977 were in Vanderburgh County which accounted for 56.0 percent (24,327 employees)[4] and in Daviess County which contained 16.8 percent (7,303 employees)[5] of the total manufacturing employment.

As shown in Table 4.6.1-7, the machinery metal products and equipment sector (Standard Industrial Classification-SIC 35 and 36) generated almost 28 percent of the region's manufacturing employment in 1977. The second most important industrial sector during 1977, was primary and fabricated metals (SIC 33 and 34), which accounted for about 22.6 percent of the region's manufacturing base. The other major industrial sector in 1977 was chemical, petroleum, coal and rubber products (SIC 28, 29, and 30), which comprised 18.0 percent of the region's total manufacturing base. These three industrial sectors accounted for 69 percent of all manufacturing employment within the region in 1977, while the remaining industrial sectors (Table 4.6.1-7) accounted for about 31 percent of the total manufacturing employment base.

The national employment trends from 1967 to 1977 for these three major industrial components are shown in Table 4.6.1-8. During this period these components exhibited, on a national level, a combined rate of change of 1.049. More specifically, the chemical, petroleum and rubber products sector, machinery products sector, and primary and fabricated metals sector had a rate of change of 1.142, 1.049 and .989 respectively. The remaining components of the region's manufacturing employment base, which made up about 31 percent of the total manufacturing employment had a combined rate of change of .973. The region's major components in 1977, exhibited national growth tendencies (a combined rate of change of 1.049), while the minor components of the region's manufacturing base displayed a declining pattern (combined rate of change .973).

4.6.1.3.5 Transportation, Communications and Public Utilities

The regional and national employment trends for the Transportation, Communications and Public Utilities (TCPU) sector for 1967 to 1977 are similar to those previously discussed in the Construction sector description. From 1967 to 1977 both the region and the nation expanded their employment levels 5,645[1][2] to 6,949[4][5] and 4.3 million to 4.6 million[6] respectively, as illustrated by the rate of change, 1.231 to 1.077. The region exhibited a greater degree of expansion in its TCPU employment base with the TCPU's share of the region total employment averaging between 4.3 percent to 4.5 percent, below the national norm of 6.1 percent in 1967 and 5.4 percent in 1977.

Since the TCPU sector consists of various types of services, both public and private, the main catalyst for growth in this sector is population expansion, particularly in undeveloped areas. During the analysis period, the region experienced about a 4.8 percent[20] growth in its population, which most likely accounts for the expansion in this sector.

4.6.1.3.6 Wholesale and Retail Trade

The wholesale and retail trade sector in the region made sizeable gains in its employment base from 1967 to 1977. In 1967, wholesale and retail trade

employment was 22,569[1][2] and by 1977 it increased to 34,027[4][5]. The resulting rate of change of 1.508 is considerably above the national rate of change of 1.344. With this dramatic increase, wholesale and retail employment also became a more significant employment sector within the region. The share of regional employment attributed to wholesale and retail trade increased from 17.9 percent in 1967 to 21.1 percent in 1977, which closely approached the national norm of 21.4 percent for 1977. During 1977, this sector in Vanderburgh County comprised about 60 percent of all wholesale and retail employment within the region, indicating that Evansville/Vanderburgh County is the focal point for wholesale and retail activity within the region.

4.6.1.3.7 Finance, Insurance and Real Estate

The Finance, Insurance and Real Estate (FIRE) employment sector for the region experienced an employment expansion slightly above the national level. In 1967, FIRE had an employment of 3,469[1][2] and by 1977 it reached 4,929[4][5], resulting in an employment rate of change of 1.421 compared to the national rate of 1.398. Even with this increase the FIRE sector is minor within the overall region, because this sector accounted for only 2.8 and 3.1 percent of the regional total in 1967 and 1977 respectively. These percentages were below the national norm of FIRE employment, which was 4.6 and 5.3 percent in 1967 and 1977, respectively.

4.6.1.3.8 Service

For the study period, the Service sector had the largest increase in employment. In 1967, Service employment in the region numbered 6,637[1][2][3], with about 63 percent of this employment being in Vanderburgh County. By 1977, it increased to 23,395[3][4][5]. This resulted in an expansion or rate of change of 3.706. The catalyst of this jump was a dramatic increase in health service employment within Vanderburgh County, where 7,499 (50%)[18] of the county's 15,061[3][4] service employees were in health services. This increase in health service employment was brought about by an expansion in health care facilities within the Evansville area. As a result, the service employment sector's share of the total regional employment climbed from 5.3 percent to 14.5 percent in 1977, making it an important segment in the region's overall economy.

The Service sector nationally in 1967 had 10.1 million employees and by 1977 this level had increased to 15.3 million[6]. This mounted to a rate of change of 1.518. The Service sector in 1967 was 14.5 percent of all national employment, and in 1977 it was 18.0 percent, which was above the regional level of 14.5 percent.

4.6.1.3.9 Government

The regional Government sector has shown modest increase in its employment base; in 1967 the regional employment sector was 13,623[1][2][3] and contributed to about 10.8 percent of all regional employment. By 1977, it increased to 17,295[3][4][5] or 10.7 percent of the regional total. Much of the increase resulted from Federally funded Comprehensive Employment

Training Act (CETA) programs.[18]. Both the expansion or rate of change and share of total employment in this sector lagged behind national trends. Between 1967 and 1977, the national government employment rate of change was 1.333 (11.4 million to 15.2 million)[6], in comparison to the regional rate of change of 1.270. The governmental sector's share of overall employment on the national level was substantially above the regional level. For example in 1967 it comprised 16.4 percent of all national employment while in 1977 it rose to 17.8 percent.

4.6.1.4 Basic/Non-Basic Sector Analysis

The purpose of this analysis is to identify the employment levels of the basic (exporting) and non-basic (importing) sectors within the regional economy, along with the multiplier effects which occur as a result of an increase in basic employment. Table 4.6.1-9 illustrates the level of basic and non-basic employment within the region for 1977.

In 1977, the region had a total employment base of 161,474 jobs[3][4][5]. Of this total, 74,879 people[3][4][5] were engaged in basic employment and 86,595 people[3][4][5] were involved in non-basic employment. The multiplier effect involved in the region is 1.6789[21] which indicates that for every one new basic job in the region, there will be an additional 1.6789 secondary (indirect and income-induced) jobs generated in support of that basic job.

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21. Employment Multiplier Based Upon a Model Developed by the University of Illinois (See Appendix 5A) incorporating 1972 County Business Patterns (U S Department of Commerce).

4.6.2 DEMOGRAPHY AND SETTLEMENT PATTERNS

4.6.2.1 Introduction

This section examines the specific demographic and settlement characteristics for twenty, three and sixty miles around the proposed site. The twenty mile radius was utilized because it allowed a detailed discussion of the existing and projected population levels, as well as the pertinent demographic characteristics, of all or major portions of the six counties that comprise the study area. The three mile radius around the site has been studied separately to provide an examination of the immediate population that may be effected by the proposed plant. The final radius, sixty miles around the proposed plant, is presented since this coincides with the air quality impact study area.

4.6.2.2 Twenty-Mile Study Area

4.6.2.2.1 Present Population

The aggregate 1976 population for all six counties as shown in Table 4.6.2-1 was 355,100 persons. Of this aggregate population, 33.5 percent resided in the Kentucky counties of Henderson and Daviess, and the remainder in the Indiana counties of Posey, Spencer, Vanderburgh, and Warrick. Vanderburgh County had the largest share of 1976 area-wide population, with 45.6 percent of the total, or 161,800 persons. The next largest was Daviess County, with 23.0 percent of the total, or 81,700 persons. Spencer County had the smallest share of population, with 4.9 percent, or 17,500 persons. Henderson County, in which the plant site is located, had 10.5 percent of the area-wide population in 1976, or 37,200 persons[1].

The May 1977 population estimates for population centers containing over 1,000 persons in 1975 within the six-county region are listed in Table 4.6.2-2. The largest concentration of population, found in the City of Evansville, in Vanderburgh County, Indiana was estimated to be 133,566 persons in 1975. This figure represents a 3.7 percent decline from the 1970 population, and is most likely due to a migration to nearby rural, unincorporated areas. Owensboro, in Daviess County, Kentucky, is the next largest population center in the six-county study area. Its 1975 population was estimated at 50,788, a 0.9 percent increase over its 1970 population 50,329. The City of Henderson, in Henderson County, is the only other population center of over 10,000 persons within the six-county area. In 1975 its population was estimated at 22,832 persons, a 0.6 percent decline from its 1970 population of 22,976[2]. Henderson and Evansville are approximately equidistant from the project site at about six air miles. In highway distance, Henderson is approximately 8 miles west of the site and Evansville about 14 miles to the northwest.

The six-county area as a whole represented approximately 0.16 percent of the 1976 national population of 215.1 million persons[3]. The Kentucky portion in 1976 was approximately 3.5 percent of Kentucky's population, and the Indiana portion represented about 4.4 percent of Indiana's population.

A more precise count of the number of persons within 20 miles of the plant site can be obtained by disaggregating the counties into their constituent

census Enumeration Districts (E.D.'s) and counting those with centers falling within the 20-mile radius. Using this method, a 1970 population of 246,301 persons is indicated within 20 miles of the plant; the 1960 count for this study area was 234,677 persons[4].

4.6.2.2.1.1 Age, Sex, and Race Structure

Age, sex, and race were analyzed in the 20-mile region using data from the 1960 and the 1970 Census of Population[5]. For the characteristics as shown in Table 4.6.2-3, the distribution of selected characteristics within the region was similar to distributions of the same characteristics in the National and state-wide populations. As of 1970, males represented 47.9 percent of the 20-mile regional population, and females, 52.1 percent. Nationally, these distributions were 49.3 and 50.7 percent[6]. The state-wide male and female distributions were 48.7 and 51.3 percent in Indiana, and 49.0 and 51.0 percent in Kentucky.

In 1970 the national black population represented approximately 11.1 percent of the total population. Both Kentucky and Indiana had a smaller percentage of blacks than the national average. Within the six-county area, the 1970 black population was 5.1 percent of the total.

Age-specific groups in the area-wide population followed patterns similar to those found in the nation and in the two states. On a national level, persons under five years of age made up a smaller percentage of the population in 1970 (8.3 percent) than in 1960 (11.1 percent). This pattern is followed in both the area-wide and state-wide distributions for this age group. Persons five to eighteen years old (the school-age population) made up approximately 24.4 percent of the area-wide 1970 population, while nationally and state-wide they constituted about 26 percent of the population. The state and area-wide percentage for this age group has decreased slightly (about 2.0 percent, on the average) since 1960, while the national percentage had increased by 1.0 percentage point. The working-age group, ages 19-64, made up the largest segment of the population, slightly higher than 50 percent. In the area-wide population, 19-64 year olds have been a relatively stable group, comprising 52.2 percent of the population in 1960 and 52.6 percent in 1970. In both Indiana and Kentucky, the percentage represented by this group grew by about 0.4 percentage point from 1960 to 1970. In the nation this percentage increased from 54.1 percent to 55.8 percent. Persons older than 65 years accounted for approximately 10 percent of the population at the national, statewide, and areawide levels[5], [6] in both 1960 and 1970.

4.6.2.2.2 Population Projections

Average annual rates of population change for the six-county area between 1960-2000 are shown in Table 4.6.2-4. For comparison purposes, this table also provides these rates of change for the three-mile and sixty-mile study areas, the states, and the nation.

Between 1960 and 1970 the entire six-county area grew at an average rate of 0.7 percent per year, as compared to 1.1 percent per year for Indiana, 0.6 percent per year for Kentucky, and 1.3 percent per year for the nation as a whole. The six-county area grew by only 0.2 percent per year between 1970

and 1976, as compared to 0.3 percent, 1.1 percent, and 1.0 percent per year for Indiana, Kentucky, and the nation, respectively. The fastest growing county in this six-county area was Warrick County, Indiana, which showed a 1.7 percent average annual increase between 1960 and 1970, and a 3.6 percent average annual increase between 1970 and 1976. The county with the slowest annual growth rate was Vanderburgh County, Indiana, which grew only 0.2 percent annually in the 1960-1970 period and then declined by 0.7 percent annually between 1970 and 1976. Henderson County showed a 0.7 percent average annual increase between 1970 and 1976[1].

From 1976 to 1980 the six-county area is projected to grow by 2.8 percent from 355,100 to 365,200, or at an average annual growth rate of 0.7 percent. Warrick is expected to be the fastest growing county, increasing by 4.3 percent per year during the 1976-1980 period. The County's population growth reflects the ongoing addition of approximately 500 dwelling units per year. Residential development in Warrick is taking place primarily in Ohio Township (in the southwest portion of the County) and is expected to continue at its current rate[7].

Posey County, Indiana, is expected to show a 2.4 percent annual increase in population between 1976-1980. Growth is currently taking place primarily in the eastern part of the County[8]. The 1976-1980 population increase for Spencer County, Indiana, is expected to be 1.7 percent per year, with the principal center of residential development being the new town of Santa Claus[9]. Vanderburgh County, Indiana is the only county in this area that is expected to experience a decline (0.9 percent annually) in population during this time period. However, some residential development is taking place in the periphery of Evansville.

Daviess County, Kentucky, is projected to show a slow annual rate of 0.4 percent growth between 1976-1980[10]. Henderson County, Kentucky is also projected to have a slow population growth rate for that same period[10]. However, the U S Census population estimate for 1976 (37,200 persons) proved to be slightly higher than the State estimate for 1980 (37,061), indicating a higher actual growth rate for Henderson County. Therefore, the State Demographer [11] prepared a new preliminary estimate for 1980 (see Table 4.6.2-5). The revised estimates by the State Demographer, which are based upon projections made by the Green River Area Development District, indicate a 1.6 percent increase for Daviess and 2.4 percent increase for Henderson between 1976-1980[11]. Residential development for Daviess County is taking place primarily to the east and south of the City of Owensboro[12]. In Henderson County new developments are occurring to the west of the City of Henderson and along U S Route 60, the main east-west highway in the County.

As shown in Table 4.6.2-1, during the 1980-2000 period, the six-county area is projected to grow by about 13.4 percent to 414,000 persons. Warrick County should increase its population by 90 percent, and Posey County by 32.2 percent. Spencer is expected to grow by 21 percent, while Vanderburgh will continue its population decline, by as much as by 9.2 percent between 1980 and 2000.

For Daviess and Henderson Counties, the assumption has been made, based upon the State's revised projections, that a 0.6 percent annual population

increase will be taking place in the 1980-2000 period. This would bring the Daviess County population to 93,800 by 2000. Table 4.6.2-5 gives the original State population projections as compared to the revised projections for Henderson County. Henderson County population is expected to grow from a total of 38,100 persons in 1980 to 42,900 persons in 2000.

Cumulative percent population increases from 1960 to 2000 for each of the six counties are represented in Figure 4.6.2-1. Warrick County's increase will approach 250 percent, and Vanderburgh's net decline will be about 12.9 percent.

4.6.2.3 Three-Mile Area

The 1978 resident population within three miles is estimated at 1668 persons, and the 1978 seasonal population at 294. The basis for population estimates within this area was a dwelling unit count taken from aerial photography flown in October 1975[13]. This dwelling unit count was verified and updated in the field[14] and is therefore representative of the 1978 population. A population estimate was obtained by utilizing a factor of 3.16 persons per dwelling unit, as derived from the Evansville SMSA 1970 Census of Population and Housing[15]. This factor is applicable to both permanent resident and seasonal population in the area[16].

Population projections to the year 2000 for the area within three miles of the plant are given in Table 4.6.2-6. Only resident population, which occurs exclusively within the Henderson County portion of this area, has been projected. Examination of the locations of proposed subdivisions in Henderson County has indicated that about 20 percent of the County's growth is taking place within this three-mile radius[17]. Application of this percentage factor to the population within the study area yields an annual growth rate of 2.5 percent. This rate of increase was therefore incorporated as the basis for projecting the population, and by year 2000, the population within the area is expected to grow to 2,872 persons.

4.6.2.4 Sixty-Mile Area

As shown in Figure 4.1.3-1, there are a total of 31 counties within this radius which encompass parts of the states of Kentucky, Indiana, and Illinois. The 1970 to 2000 populations by county are presented in Table 4.6.2-7. The combined total population for all 31 counties as estimated for 1976 is 819,400. By the year 2000 this population is expected to grow to 956,995, an increase of 16.8 percent, reflecting an average annual growth rate of about 0.7 percent.

The latest population estimates for major population centers (over 10,000 persons) within the sixty-mile radius are shown in Table 4.6.2-8. The largest concentration of population occurs in Evansville, Indiana, with an estimated 1975 population of 133,566. As stated earlier, Evansville is located about 14 highway miles from the proposed site. Owensboro, Kentucky, is the next largest population center, located about 22 highway miles to the east of the proposed site, Owensboro's population was estimated at 50,788 for 1975[18].

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19) Indiana University, Division of Research, May 1976, Indiana Population Projections, Bloomington, Indiana.

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21) State of Illinois, Bureau of Budget, September 1977, Illinois Population Projection , 1970 - 2025, Springfield, Illinois.

4.6.3 SERVICES AND INFRASTRUCTURE

4.6.3.1 Introduction

This section examines the current (1978) levels and capacities of specific services within the City and County of Henderson. Based upon the results of a preliminary analysis of Ebasco/Envirosphere's construction worker model, (Appendix 5A) it was determined that any major new population increases generated by the construction of the Syngas Plant, would be in Henderson County, and most likely within the City of Henderson. The other counties in the region, particularly Vanderburgh and Daviess would show no appreciable population increases. This indicates that any major impacts on services and infrastructure will primarily be in Henderson County and City.

4.6.3.2 Existing Services

4.6.3.2.1 Education

The current (1978-79) levels and capacities of the various public and private elementary, secondary and post-secondary schools in Henderson County are shown in Table 4.6.3-1. The current enrollment (1978-79) of students for the Henderson county school system is 8434[1]. This is a decrease from an enrollment level of 8,498[2] students in 1977-78. For the 1978-79 school year, the elementary schools in the City have a total enrollment of 2,552 students, with a maximum capacity of 2,651 students[1]. The elementary schools in the remainder of the county currently have a total enrollment of 1,771 students with a maximum capacity for 1,822[1]. In the junior high schools (North and South), the current total enrollment is 2,074 with a total capacity for 2,168 students,[1]. The high school (Henderson County High School) has a current enrollment of 2,005 students with an estimated capacity for 2,105 students[1]. In total, the county school system (elementary, junior high and high school) has the ability to absorb an additional 345 students[1] based upon current enrollment statistics. The current student/teacher ratio is 25.1 to 1, which is slightly below the County Board of Education Standard of 26.0 to 1[30].

In Henderson County, there are two other educational institutions: the Holy Name School, which is a private Catholic elementary school in the City of Henderson with a 1978-79 enrollment of 447 students and the ability to expand to 500 students[3]; and the Henderson County Community College, a two-year junior college, with a total enrollment of 802[4] students.

4.6.3.2.2 Health

The various health facilities the Henderson County, particularly hospitals and health care centers are examined in this subsection.

4.6.3.2.2.1 Hospitals

The evaluation of hospital services, for both Henderson County and City, was primarily confined to the examination of the utilization (occupancy) and capacity of Community Methodist Hospital in the City of Henderson.

There is one other hospital in Community Methodist's service area, Union County Hospital (40 beds) in Morganfield, but it is assumed that the new population residing in Henderson County and City will go to Community Methodist Hospital, if hospitalization is required. The service area for Community Methodist Hospital encompasses Henderson, Webster and Union Counties and has a current (1978) population of 67,362[5].

At the present, Community Methodist Hospital has just completed an 18 bed addition, bringing its total bed level to 209 beds, and has 47 doctors on the staff[6]. The hospital is projecting a 60 bed addition around 1981[6]. The current (1978) estimated utilization of Community Methodist Hospital is about 63,826 patient days[7]. It has a current capacity of 76,285 patient days[7]. This usage results in an about 84% utilization rate (see Table 4.6.3-2). The projected utilization rates, as shown in Table 4.6.3-2 for Community Methodist Hospital, indicate that the hospital has excess capacity and can absorb some additional growth.

4.6.3.2.2.2 Health Department

The Henderson County Health Department's primary purpose is to provide preventive medicine through various types of clinics. At the present, it serves about 18,825 people with a capacity to handle about 22,000, indicating a utilization rate of 85.5 percent.[8] Currently the county health program does have the ability to absorb additional 3,175 people and based upon county health officials' estimates, the health center will maintain excess capacity into the mid-1980's[8].

4.6.3.2.3 Protective Services

This subsection examines the present levels of service attributed to both police and fire departments in Henderson County.

4.6.3.2.3.1 Police

The police enforcement in the region is provided by the City of Henderson Police Department and the Henderson County Sheriff's department. The service area for the city police department is the city limits, while the County Sheriff's Department's main responsibility is patrolling the unincorporated and rural areas (e.g., Baskett) of the county.

In fiscal year 1978, the Police Department had a total of 56 full-time employees (45 operational and 11 supportive). Based upon the City's present population of 22,800, the current service standard for police services is 2.46 full-time employees per 1000 population. In comparison to a national standard developed for the southern region of the United States, a city with a population between 10,000 to 24,999, should exhibit a service standard of 2.01 full-time police department employees per 1000 population. In October, 1978, the City of Henderson had an excess capacity of 10 full-time police employees.

The County Sheriff's Department at present has a staff that includes 12 deputies and a sheriff. The 1978 service population for the Sheriff's

Department is 14,850 and it is estimated that the present staffing levels could serve an additional 7,500 people before the department would have to increase staff[12].

4.6.3.2.3.2 Fire

With the exception of the City of Henderson, all fire protection within the County is provided by volunteer departments. The Henderson City Fire Department's 1978 manpower and equipment levels are presented in Table 4.6.3-3. Based upon this information and the location of the fire stations, the department is able to respond to a fire alarm within three minutes and the first-due equipment has the potential fire flow of 1,000 to 1,500 gallons per minute.[13] The response time indicates that the locations of the fire stations are about one (1) mile away from any potential fire zones within the City.[14]

The equipment levels for the volunteer departments are listed in Table 4.6.3-4. In most cases these departments have one station and two (2) pumpers each with a fire flow capacity of 500 gallons per minute.[13]

4.6.3.2.4 Water and Sewer

This subsection examines the current (1978) water and sewer systems in Henderson City and County.

4.6.3.2.4.1 Water

The Municipal Water and Sewer Department (See Table 4.6.3-5) serves the City of Henderson and the Henderson County Water District serves parts of Henderson County. About 8.0 percent of the City's total daily usage is purchased by the county users[15]. Currently the City has a usage of 4.6 million gallons per day (gpd), with a capacity for 6 million gpd[15], while the County comsumes about 400,000 gpd and has a capacity for 666,000 gpd[16]. The total overall daily usage of water for both the City and County is about 5 million gpd. It is projected that the city water system may have to be expanded by 1980 or 1981[15]. Currently there are about 21,600 residential users of the city water system and about 7,020 residential users relying on the county water system indicating that about 76 percent (28,620) of the total County's population (1978-37,650) utilizes one of the two water systems.[17] The remaining population (9,030) derive their water through individual wells.[17]

4.6.3.2.4.2 Sewer

The only sewer system within the County, is in the City of Henderson provided by the Municipal Water and Sewer Department (see Table 4.6.3-5). The system has a current daily usage of 4.9 million gpd with a capacity of 7.5 million gpd[15]. It is projected that capacity may have to be expanded by 1980 or 1981. The estimated level of residential users of the sewer system is about 21,600[17], with the remaining residential population utilizing septic tanks.

4.6.3.2.5 Housing

This subsection examines the current housing stock Henderson County. A housing survey, conducted in 1977-78 by the Henderson City-County Planning Commission for its comprehensive plan, identified (Table 4.6.3-6) a total housing stock of 14,194 units in the county[18]. Of the total units in the county, 13,807 were occupied during the 1977-78 indicating only 387 units (2.7%) were vacant in the county[18]. During this housing survey, 2,002 units were categorized as substandard[18].

In 1977-78, 9,368 or 66% of the total housing stock was owner-occupied with the remaining 4,826 (34%) being rental units.[18] Of the total number of owner-occupied units (9,368), 9,256 were inhabited resulting in a vacancy rate of 1.2%[18]. The survey also identified 1,321 owner-occupied units as substandard[18]. The examination of rental units showed that of the total number (4,826), 4,551 units were occupied resulting in vacancy rate of 5.7%,[18] which is a greater vacancy rate than for the owner-occupied units. The survey identified 681 rental units as substandard[18].

4.6.3.2.6 Highways

This subsection examines the various highways that may be impacted by the proposed plant. The first part of this subsection will identify and analyze the primary highways which lead to the site. The primary highways are identified as the major throughfares which gives the site access to the major populations centers and to other major throughfares, including all roads and highways that go from the major thoroughfare to the site. The second part examines all the secondary highways. The secondary highways are usually major thoroughfares which connect from a population center to the primary major thoroughfare. Based upon these definitions the following highways have been categorized:

1) <u>Primary Highways</u>

   - US 60 (Between Henderson and Owensboro) (giving access to site via Tscharner Road and Dr. Hodge Road)

2) <u>Secondary Highways</u>

   - US 41 (Between Henderson and Evansville)
   - Pennyrile Parkway and US 41 (Between Henderson and Webster County Line)
   - US 60 (Between Henderson and Union County Line)
   - Audubon Parkway (Between Henderson and Owensboro)

4.6.3.2.6.1 Primary Highway

The major highways that gives the site access to the region is US 60, which runs between Henderson and Owensboro, and is shown in Figure

4.6.3-1. This road, which is classified as a major collector[32], is a two lane, free access road with a high-type surface having a gross load limit of 80,000 pounds.

A review of average daily traffic (ADT) data for the years 1971, 1973 and 1977, shown in Table 4.6.3-7, indicates a decline in traffic levels the further east one travels from Henderson. For example, Watson Lane, which is the closest point to the City monitored along US 60, had a 1977 ADT of 9,575, while ADT's at Spottsville further east along US 60 had a count in 1977 of 4,280[19].

Growth in ADT for US 60 from 1971 to 1977 indicates a greater average annual increases at points closer to Henderson (6.5 percent Watson Lane) than at points which are further east of the City (4.0 percent at Spottsville). The closest point to Tscharner Road with available data was Country Club Road, with an ADT in 1973 of 4,469 and 5,860 in 1977. This resulted in an annual average increase of 7.8 percent. This increase (1973-77) is slightly greater than that measured for US 60 between 1971 to 1977[19].

The primary roads which lead into the site are Tscharner Road from US 60 and Dr. Hodge Road from Baskett (Figure 4.6.3-1). Both roads according to the latest (1973) ADT, are used lightly. Tscharner Road had an ADT of 36, while Dr. Hodge Road at Tscharner Road had an ADT of 148[19].

Tscharner Road, a two lane highway, and Dr. Hodge Road, which leads into Tscharner Road, have a low type surface comprised mostly of low grade bituminous materials. Tscharner Road becomes gravel slightly north of Dr. Hodge Road.

4.6.3.2.6.2 Secondary Highways

Secondary highways are shown in Figure 4.6.3-2. The US 41, a four lane divided highway, is designated as a principal arterial[32]. It runs north from Henderson to Evansville with "limited access" going to "controlled access" near the city. The capacity limit, like all the highways discussed in this secondary highway subsection, is 80,000 gross pounds. The ADT's for US 41, (Table 4.6.3-8) show an average annual growth in traffic levels from 1971 to 1977 to be 4.7 percent. The 1977 traffic levels were high along US 41, especially in the vicinity of Watson Lane where the count was 38,461 and at the US 60 interchange where the count was 37,480[19].

Another secondary highway is the Pennyrile Parkway/US 41 which runs south between Henderson and Webster County. The Pennyrile Parkway and US 41 run parallel to each other with the Pennyrile being a four (4) lane divided highway. The examination of ADT's for 1971 to 1977 (Table 4.6.3-8) indicate a substantial growth in traffic levels where the Pennyrile and US 41 merge near Van Wyck Road. The 1971 level of 12,975 increased to 20,522 in 1977 amounting to an average annual increase of 9.7 percent. At a point further south along the Parkway near the Henderson County High School, which has much lower ADT going from 5,130 to 6,904 between 1971 to 1977, for an annual average increase of 5.8 percent[19].

US 60 runs west from Henderson to Union County and is classified as a minor arterial[32]. This highway shows a relatively high traffic level for the year 1977 (Table 4.6.3-8) ranging from ADT of 14,020 at Community Drive to an ADT of 23,536 at Second Street[19]. Except for Community Drive, all the other points where ADT's were recorded for US 60, are in an area which can be considered urban, being in downtown Henderson.

Another secondary highway is the Audubon Parkway which runs in a roughly easterly direction from Henderson to Owenboro. This thoroughfare is relatively new, and is a divided highway which has been classified as a principal arterial. An estimated ADT for the Audubon Parkway made by the Southwestern Indiana and Kentucky Regional Council of Governments in 1976 was 1,100 cars per day[31] indicating a lightly used highway.

4.6.3.3 Fiscal Analysis

4.6.3.3.1 Introduction

This section examines the 1977-78 fiscal structure of the City of Henderson and Henderson County. These governmental units would be responsible for providing public services to any immigrant population resulting from the impact of the proposed plant. In this section revenue source classified as "own" source revenues are raised by the locality itself and utilized in the support of public (governmental) services. These own source revenues consist of taxes, and charges and miscellaneous revenues. Taxes usually include real property, personal property, and franchise taxes, while charges and miscellaneous revenues are normally generated by fees and permit revenue, fines, forfeitures, and penalites. The first part of this section will discuss the various own source revenues, while the second part will analyze the expenditure patterns for the public service functions provided during fiscal year 1978.

4.6.3.3.2 Revenue Sources

The revenue sources for the City of Henderson are given in Table 4.6.3-9. For fiscal 1977-78, the City generated $2,946,716[20] in locally raised revenues, with the major contribution from taxes and franchises. During this period taxes and franchises generated about 55.1 percent ($1,622,239) of the City's total revenue, with the property tax being the largest single source[20]. The property tax yielded $907,395 (less deductions for police, fire and municipal workers pension fund) and comprised about 30.8 percent of all locally raised revenue[20]. The levy was generated from a total assessed valuation for Henderson during fiscal year 1978 of $222,900,655 (real and personal property)[21]. The valuation is based upon a 100 percent of market value assessment. The City has an effective tax rate of .53/$100 of assessed valuation[21].

The second largest revenue category for the City during fiscal year 1978 was generated by user fees which amounted to $480,785, and 16.3 percent of the total raised revenue[20]. The single biggest source was from refuse fees from residential users, totaling about $258,200 which accounted for 53.7 percent of all user fees and 8.8 percent of all locally raised revenues[20]. "Other revenues" was the third largest revenue category for the city, accounting for $441,719 and 14.9 percent of all locally raised rev-

enue.[20] The other revenues and miscellaneous revenues, which include fines and forfeitures, licenses and permits, rents and concessions, and sale of municipal property accounted for about $401,973 or 13.6 percent of the total revenue raised locally.[20]

Also during fiscal year 1978 the City received about $3,939,928 in intergovernmental transfers and utility fund revenues, as shown in Table 4.6.3-10[20]. These funds are not classified as own source revenues because they are based upon a transfer (grant) from a higher governmental jurisdiction or a sale of a utility, and are earmarked for a specific purpose.

In fiscal 1971-1972, the City raised in own source revenues a total of $2,069,813. Of this amount, 54.9 percent ($1,135,998) was generated by taxing mechanisms, while the remaining 45.1 percent ($933,815) was derived from charges and miscellaneous revenues.[22] In fiscal 1977-78, the revenue system was very similar with 55.1 percent in fiscal year 1978 coming from taxing mechanisms, and the remaining revenues coming from charges and miscellaneous sources. The property tax in fiscal year 1978 comprised about 30.8 percent of all locally raised revenues, in fiscal year 1972 this proportion was 27.2 percent[22] indicating a small increase in the reliance upon the property tax.

The major share of own source revenues in fiscal year for municipalities in the nation were generated by taxing mechanisms. More specifically, 72.5 percent of all own source revenues were generated by various taxing powers, while only 27.5 were derived from charges and miscellaneous sources. The property tax during this period accounted for 46.6 percent of all own source revenues on a national scale[23]. Based upon this general comparison, it can be stated that the City of Henderson is not as heavily dependent on taxing mechanisms, and specifically the property tax, as are the rest of the nation's municipalities.

The revenue sources for Henderson County during fiscal year 1978, reported in Table 4.6.3-11, show a revenue generation of $1,233,921.01[25]. The major revenue categories for this county were taxes and franchises, which accounted for $751,921.01[25] or about 60.9 percent of all raised revenues. The major source, within this category was the property tax, which generated $562,656.34 (less deductions) in revenue accounting for about 45.6 percent of the County's total raised revenue. This indicates a greater reliance by the County on the property tax than the City[24]. Like the City, Henderson County's assessed valuation is based upon 100% market value. During fiscal year 1978 the County has a total assessed valuation (real property and personal property) of $432,658,065 and an effective tax rate of $.14/$100 of assessed valuation[24].

The second largest revenue category, "other revenues", accounted for $413,800 or 33.5 percent of the county's total raised revenue[25]. The main sources were derived from a revenue surplus from the previous year ($168,400) and excess fees ($120,000) which totaled $288,400 and contributed to about 23.4 percent of the total county revenue sources[25]. The "other revenue" categories; fines and forfeitures, licenses and permits, and rents and concessions accounted for about $68,200 in raised revenue, and amounted to about 5.5 percent of the County's total raised revenue[25]. Also like the City, Henderson County received about $484,348.22 in intergovernmental transfers,

as shown in Table 4.6.3-12[25].

In fiscal year 1972, Henderson County generated $721,000 in own source revenues. Of this total about 86.5 percent ($623,000) came from taxes, while the remaining proportion, 13.5 percent ($98,000) was generated by charges and miscellaneous revenues[26]. The counties on a national scale, however, generated about 73.5 percent[23] of all own source revenues by some kind of taxing mechanism. This indicates that Henderson County during fiscal year 1972 had a greater dependance on taxing mechanisms than counties nationally. By fiscal year 1978, taxes still remained an important source of revenue for the county, but the overall share declined to 60.9 percent, with other revenues, specifically from surpluses and excess fees, contributing about 33.5 percent of all own source revenues[25]. Even though the County still has a heavy dependance upon the various taxing mechanisms, especially the property tax which comprised about 45.6 percent of all locally raised revenue in fiscal year 1978,[24] the County has been able to shift some of the burden to other revenue sources.

In Henderson County there are three other governmental units, in addition to the State, which utilize the property tax as a revenue source to support their services. These three taxing districts - county school system, county health department, and library have specific effective tax rates which are applied to the total county assessed valuation (real and personal property) to derive revenue. During fiscal year 1978, the county school system generated $1,012,762 (less deductions) in property tax revenue, which was about 10 percent of the system's revenue source[27]. During this period the county health department derived $86,531 and the library received $129,797 in property tax revenue.

The state property tax incorporates two different effective tax rates, one for real property and one for personal property. The state property tax rates, and the effective rates for the other taxing districts are given in Table 4.6.3-13, along with the applicable assessed valuation of both Henderson County and City for fiscal year 1977-78.

4.6.3.3.3 Expenditure Patterns

The expenditure of own source revenues for public service functions of the City of Henderson during fiscal year 1978 are presented in Table 4.6.3-14. As can be seen in this Table, the City expended about $1,091,741 or 37.5 percent of its total revenue sources ($2,907,773) on Public Safety while General Administration consumed about $1,026,503 (35.3 percent) of the total revenues[20]. The General Administration function includes $564,445[20], classified as non-departmental, and is primarily made up of statutory expenditures for social security, hospitalization insurances, workman's compensation and pension funds. The Public Works function absorbed about $344,838, about 12 percent of the available revenue, while both the Recreation and Education, and General Services utilized $444,691, about 15.3 percent of the total own source revenues.[20].

The evaluation of historical expenditure patterns for the City, indicates an increase in expenditure level from $2,070,259 in fiscal year 1972[22] to $2,907,773 in fiscal year 1978[20]. The only appreciable shift in expenditures from fiscal year 1972 to fiscal year 1978 occurred in the Public

Works function. The Public Works function consumed about 24.2 percent ($500,362) of all expenditures during fiscal year 1972[22]. By fiscal year 1978 this percentage, however, had declined to 11.8 percent ($343,838)[20] due to the shift of street maintenance activities to a separate City public way fund (Table 4.6.3.-10). Both the General Administration and Public Safety functions had a slight increase in their shares of the City's overall expenditures from fiscal year 1972 to fiscal year 1978. The General Administration function absorbed 30.7 percent ($634,585)[22] of the City's total expenditures, and by fiscal year 1978 increased the percentage to 35.5 percent ($1,026,503)[20], while the Public Safety function went from 31.7 percent ($657,243)[22] to 37.5 percent ($1,901,741)[20] for the same period. The other public service functions (Recreation and Education, and General Services) remained unchanged in their share of the total City expenditure during this period.

The Henderson County expenditure pattern of own source revenues during fiscal 1977-78 for public service functions is given in Table 4.6.3-15. The primary services rendered by the county government are in the areas of Public Works (maintenance of county highways) and General Administration. In fiscal year 1978, $564,012.95 or 45.7 percent of the total available revenue ($1,233,921.11) was expended on the Public Works function, while General Administration consumed $423,932.09 in revenues, or 34.4 percent of the County's total own source revenues[28]. This expenditure pattern during fiscal year 1978 closely coincides with the expenditure patterns in fiscal year 1972, which included $222,000 for highways and $220,000 for general administration[26].

The County in fiscal year 1978 expended about $76,900 on the Health and Welfare, and Recreation and Education service functions, which absorbed about 6.3 percent of the available revenue[28]. The County, during fiscal year 1978, paid about $112,876.07 in debt service for both the courthouse and jailhouse bond or about 9.1 percent of the available own source revenues[28]. The courthouse bond issue is for $400,000 and started in 1964 and will paid in full by 1989. By fiscal year 1978, $375,429.10 has been paid on this bond [28]. The jailhouse bond was issued in 1973 for $375,000 and will be concluded in 1987. By the end of the fiscal year 1978, about $209,000 has been paid[28]. As of fiscal year 1978, the country had about $7,878,161 in remaining in debt capacity[25][28][29].

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REFERENCES - SECTION 4.6.3

1) Henderson County Board of Education, Enrollment October 1978, Henderson, Kentucky

2) Henderson County Board of Education, Enrollment September 1977, Henderson, Kentucky.

3) Holy Name School, Enrollment September 1978, Henderson, Kentucky.

4) Newspaper Enterprise Association, 1978 World Almanac, New York, New York.

5) Service Area Population Based Upon Ebasco/Envirosphere's Projections, October 1978.

6) Community Methodist Hospital, November 1976, Certificate of Need (Exhibit F), Henderson, Kentucky.

7) Patient Days For Hospital Utilization and Capacity Based Upon Ebasco/Envirosphere Projections, October 1978.

8) B R Staples, Henderson County Health Department to R Winley, Ebasco/Envirosphere, Local Facilities Questionnaire, February 15, 1978.

9) City of Henderson, June 1977, Annual Budget 1977-78, Henderson, Kentucky.

10) Population Based Upon Ebasco/Envirosphere Projections.

11) Rutgers University Center for Urban Policy Research, 1978, Fiscal Impact Handbook, New Brunswick, New Jersey.

12) C West, Henderson County Sheriff, to R Winley, Ebasco/Envirosphere, Local Facilities Questionnaire, February 14, 1978.

13) C Trodglen, Fire Chief, City of Henderson to G Willant, Ebasco/Envirosphere, Personal Communication, April 25, 1978.

14) American Insurance Association, Engineering and Safety Service, 1975, Fire Department Station and Companies - Location, Distribution and Response - Special Interest Bulletin No 176, New York, New York.

15) Mr Stolz, City of Henderson Water Department to J Marchetti, Ebasco/Envirosphere, Personal Communication, October 29, 1978.

16) Mr Frey, Henderson County Water Department, to J Marchetti, Ebasco/Envirosphere, Personal Communication, October 29, 1978.

17) User Population Based Upon Ebasco/Envirosphere Estimate from City and County Water Departments, October 29, 1978.

18) Henderson City-County Planning Commission, March 1978, 701 Comprehensive Planning Assistance Housing and Land-Use Study, Henderson, Kentucky

19) B Schryock, Kentucky Department of Transportation, Bureau of Highways, to H Maggied, Ebasco/Envirosphere, Personal Communication, September 20, 1978.

20) City of Henderson, June 1978 Annual Budget 1978-79, Henderson, Kentucky

21) W D Wilson, Finance Director, City of Henderson, to J Marchetti, Ebasco/Envirosphere, Personal Communication, October 23, 1978.

22) City of Henderson, June 1971 Annual Budget 1971-1972, Henderson, Kentucky

23) U S Department of Commerce, 1972 Census of Governments, Volume 4, Number 5 (Governmental Finances), Washington, D.C.

24) Henderson County Treasurer, June 1977 Estimated Receipts from Tax Levies (Fiscal 1977-78), Henderson, Kentucky

25) Henderson County Treasurer, June 1977, Estimated Receipts from All Sources (Fiscal 1977-78), Henderson, Kentucky

26) U.S. Department of Commerce, 1972 Census of Governments, Volume 4, Number 3 (Finances of County Governments), Washington, D.C.

27) Henderson County Board of Education, June 1978, Annual Financial Report (Fiscal 1977-78), Henderson, Kentucky

28) Henderson County Treasurer, June 1978, Summary Analysis of Appropriations, Henderson, Kentucky

29) Based upon State law, maximum capacity of bonded debt is 2 percent of total assessed valuation (real and personal property).

30) W W Rideout, Superintendent - Henderson County Schools, to J Marchetti, Ebasco/Envirosphere, Personal Communication, November 3, 1978.

31) Southwestern Indiana and Kentucky Regional Council of Governments, June 1976, (Regional-Thoroughfare Inventory, Evansville, Indiana

32) Green River Area Development District, June 1977, Functional Classification of the Green River Area Development District Highway Network, Owensboro, Kentucky.

REFERENCE - SECTION 4.6.3 (Cont'd)

33) S Posey, Henderson County Tax Assessor, to J Marchetti, Ebasco/Envirosphere, Personal Communication, October 17, 1978.

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4.6.4 COMMUNITY ATTITUDES

The purpose of this section is to summarize the perceived actual or potential concerns of the community with the development of the Baskett site for the Syngas Plant.

Descriptions of community attitudes were drawn from two sources: (1) informal discussions with community leaders and planning agencies during the land use and socioeconomic studies and (2) pertinent articles in the local newspapers.

4.6.4.1 Informal Discussions

Local people who expressed an opinion about the plant included the following:

Judge A G Pritchett, Henderson County Administrator

Richard Brown, City Manager, City of Henderson

Andrew Furedy, Planner, Southwestern Indiana and Kentucky Regional Council of Governments

George Russell, Director, Green River Area Development District

Robert Crawford, Jr, Executive Vice-President, Henderson-Audubon Chamber of Commerce

Rudy Higginbotham, U S Soil Conservation Service, Henderson, Ky

Michael Bouvier, Green River Area Development District

Ted Clarke, Director, Henderson City-County Planning Commission

Mrs Raleigh, Secretary, Holy Name Catholic Church, Henderson, Ky

Rudy Felty, Farm Bureau, Henderson, Ky

In general, the majority of the people contacted are in favor of the plant but with some reservations. They realize that it could be of economic benefit to the region by increasing employment; increasing the local tax base and by creating a market for the coal of the region. In addition, many feel that there is a real national energy crisis and this plant is a means of helping to solve this problem.

Based on these facts most people favor installation of the plant. However, just as these people realize there are economic benefits associated with the plant, they realize there are environmental effects. It is these effects or the lack of knowledge of these effects which cause these people to have reservations in their opinions of the plant. The major concerns focus on: air quality impacts; solid waste problems; and infrastructural problems, e.g. the cost of upgrading access roads to the site.

Other impacts such as the influx of immigrant workers to the area and the loss of prime farmland were not perceived as major problems. The majority felt that the community could plan to service the immigrant workers adequately and that the amount of farmland to be eliminated by the plant is small enough such that the tradeoff is considered worthwhile.

The general consensus of opinion, therefore, was that no one (either those spoken to or the general public) could formulate an unqualified opinion until they were better informed about how the plant works, and its potential impacts. A few people mentioned that they really had no opinion because they had not heard that much about the plant.

4.6.4.2 Newspaper Articles

To obtain an idea of potential concerns which the community might have, once more information on the plant is made public, local newspapers were researched for recent articles pertaining to environmental issues or presenting adverse public reactions to other projects in the region. The investigation revealed the following:

1) There has been controversy over the air pollution caused by Barmet aluminum recycling plant in Rockport, Indiana which is charged with violating Federal and state air pollution laws[1,2,3]. Rockport, Indiana is 23.5 miles to the east of the proposed site, however, it is possible that the extremely poor press which this company has received in the local papers could have repercussions on community attitudes toward the Syngas Plant.

   The City of Henderson, Henderson County, Vanderburgh County and Warrick County have all been designated as air quality non-attainment areas for specific pollutants (for further discussion of this see Chapter 4.3.1). This has drawn mixed public reaction. Some people are concerned that these designations will affect the economic potential of the area for industrial growth[4]. Others temper enthusiasm for growth with concern for the impacts of pollution in the area and are outspoken on the subject. This group includes Drs. J Barnes, H Dunn and T Zeller at Indiana State University at Evansville (ISUE)[5,6].

   Dr. Zeller conducted weekly seminars at ISUE during the 1978-79 school year on energy and the environment. He also served as technical advisor to the ISUE Continuing Education Office program entitled "Pollution Education Update" conducted from February to July 1979[5] which included local televised programs on pollution issues.

   Another critic is Dr. Richard Wham of Henderson who, at the initiation of the Syngas site studies, quoted a 1975 Federal Energy Research and Development Administration Report as saying that "pollutants from coal gasification plants could be harmful and possibly cause cancer and other

respiratory diseases even though emission controls are enforced"[7]. The conclusion which can be drawn is that area people are aware of potential air pollution hazards and that this environmental aspect will be very important to the public when the subject of the Coal Gasification Plant arises.

2) In Union County (the county to the west of Henderson County) there has been strong opposition to the building of a four-unit coal-fired generating plant by Big Rivers Electric Corp; a TVA coal washing plant; a coal handling dock; and a 90 acre strip mining operation. Opposition centers around pollution and the loss of farmland[8,9,10]. No such attitudes seem to be prevalent in Henderson County as yet, but the possibility of such opposition cannot be ignored. It is pertinent to note that both Henderson and Vanderburgh Counties have bans against strip mining[6].

3) In Georgetown, Kentucky, there were heated debates over the construction of a proposed gasification plant[11,12] in conjunction with an industrial park. The plant would have utilized 1.5 tons of coal per hour producing approximately 205,000 cubic feet of low-Btu gas per hour (for comparison, the gasifiers of the Syngas Project will use approximately 2,000 tons of coal per day). The plant was to be located in Georgetown which is in the Bluegrass Region, one of the most scenic regions in Kentucky. Citizens of the town were "concerned about air and water pollution, transportation and disposal of hazardous wastes, and the problems associated with growth"[12]. Opponents to the project, as Concerned Citizens, Inc, were successful in their well-organized opposition to both the gasification plant and the industrial park; the Department of Energy withdrew support from the gasifier and developers have shelved plans for the project.

The Henderson County situation would appear to be different from the Georgetown Region in terms of the presence and acceptance of industry, the current unemployment rate, the not particularly celebrated scenic value of the region (i.e., this is not the Blue Grass Region), and apparent community acceptance of the project at this time. However, the concerns expressed at the Georgetown meeting should not be dismissed as not occurring in Henderson. As the limited number of informal discussions revealed, the community, while in favor of the plant, is still wary. It may become vocal about similar issues as it becomes more informed.

4.6.4.3 Summary

In summary, the primary concerns surrounding the proposed plant center on air quality, solid waste and infrastructural issues. There might be some problems associated with e.g., the influx of construction workers and the alienation of farmland but these are not perceived as major concerns of the community at this time.

The most frequently voiced opinion about the project is that the general public has not been informed about how the plant operates and what environmental effects it will have. People are very much aware of the economic benefits the plant will have in the region, but their lack of knowledge of plant operations and effects qualifies any positive attitudes they might have. Until the public becomes more informed, primarily through the documents, hearings and news media coverage associated with the preparation of the DOE Environmental Impact Statement (EIS), it will not be possible to give a more definitive representation of community attitudes towards the proposed facility as the attitudes will be developing throughout the EIS procedure.

References - Section 4.6.4

1 Evansville Press, "Rockport Residents Want Some Fresh Air", Evansville, Indiana, June 3, 1978.

2 The Sunday Courier and Press, "Recycling Plant Spews Pollution", Evansville, Indiana, June 18, 1978.

3 Evansville Press, "Barmet Case Is Moved From Small Claims Court", Evansville, Indiana, August 16, 1979.

4 The Gleaner, "City, County Face Common Crises", Henderson, Kentucky, July 9, 1979.

5 Evansville Press, "Their Method: Science; Their Message: Pollution Kills", Evansville, Indiana, February 3, 1979.

6 Evansville Press, "Anti-pollution Forces are Chief Critics of Coal", Evansville, Indiana, March 15, 1979.

7 The Gleaner, "Gas Plant Site Study Begins Today", Henderson Kentucky, March 27, 1979.

8 The Gleaner, "Industrial Growth Worries Union County" Henderson, Kentucky, June 24, 1978.

9 The Gleaner, "Union County Votes Against Big Rivers", Henderson, Kentucky, June 29, 1978.

10 The Gleaner, "Land Committee Blasts the Corps", Henderson, Kentucky, July 22, 1978.

11 The Gleaner, "Coal-Gas Battle Predicted", Henderson, Kentucky, May 23, 1978.

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4.6.5 HISTORIC, CULTURAL, AND NATURAL FEATURES

The following is a discussion of known historic, cultural and natural features which are in the general vicinity of the proposed site. This includes sites which are on or nominated to the National Register of Historic Places, the National Register of Natural Landmarks, and any state and local listings. In addition, results are presented from a cultural resources survey conducted at and in the vicinity of the Baskett Site.

4.6.5.1 Historic and Cultural Features

4.6.5.1.1 National Register of Historic Places

No historic or cultural site on, or nominated to, the National Register of Historic Places is located on the Baskett Site.

At present, only one site in Henderson County is on the National Register of Historic Places. This is the Barret House, which is located at 204 East Elm Street in the city of Henderson. Henderson is approximately 8 highway miles southwest of the Baskett Site. Three additional locations in Henderson are presently nominated to, or are in the process of being nominated to, the National Register of Historic Places. They are the Downtown Henderson Historic District, St Paul's Episcopal Church, and the Youngblood House.

4.6.5.1.2 Kentucky Heritage Commission Survey of Historical Sites

No site listed in the Kentucky Heritage Commission, Survey of Historical Sites in Kentucky[1] is located on the Baskett Site. All sites in Henderson County of interest to the Kentucky Heritage Commission are located in the City of Henderson.

4.6.5.1.3 Other Historic and Cultural Sites

The cultural resources survey[2] performed at the Baskett Site under the direction of Dr M B Collins, Principal Investigator, Department of Anthropology, University of Kentucky, located 36 sites with two more adjacent to the site boundaries. The locations of these sites are shown in Figure 4.6.5-1. Of the 38 sites, 27 contained predominantly prehistoric material, such as lithic artifacts and debris or ceramic potsherds, and 11 contained only historic material; such as ceramic or glass sherds, metal fragments or brick. All sites are summarized in Appendix 4B.3. Four sites have been recommended by the cultural resource investigators for future work if they are to be affected by project activity. These sites are described in the following discussion.

Site 15He80 contains material from both prehistoric and historic occupations. It is likely that some prehistoric lithic material may pertain to the Paleo-Indian period, the earliest period (12000 - 8000 BP) of known human occupation in the region. The historic material consists of domestic artifacts concentrated in a midden area. The ratio of ceramic to glass fragments suggests to the investigators that the site may be older than the other circa-early-20th-century historic sites located in the area.

Site 15He98 was located by back hoe testing of the flood plain. Two features, identified as hearths, were located in alluvial deposits at depths of approximately two and three meters below the current ground surface. While no cultural material was recovered from, or in association with, either feature, the possibility remains that sealed cultural deposits are present which pertain to the occupations that constructed the hearths on the contemporary ground surface.

Site 15HeH5 represents the current location of one complete and four fragmentary cemetery headstones. It is inferred from plow marks on the stones that this location is not the original location of the cemetery from which these stones came. The complete headstone records the death of one Eliza M Graham in 1848.

Site 15HeH10, the Aubrey Williams Home and Farm, has both potential archeological and architectural significance. Early maps suggest the presence of pre-20th century dwellings in the vicinity. Prehistoric material may also be present. The structures on-site consist of a one-story, "L" -shaped house with a porch, five outbuildings, and four barns. The house was built, according to informants, in 1904, and it has been remodeled. Close inspection of the house reveals that the original house was built on a solid brick foundation with wooden siding. Today, the structure exhibits an asbestos shingle roof, aluminum siding, and an independently roofed front porch built of brick. A local informant described the current siding as being aluminum over stucco over weatherboard. County Property Assessment Form photographs show the house to be formerly tin-roofed. According to the informant, brick from the Siiss Brickyard of Baskett, Kentucky, in operation circa-1890-1920, was used to construct the Williams House.

Five outbuildings are found on the site. The one located directly behind the Williams House is a rectangular structure measuring approximately 6.5 x 8.5 meters. It seems to be presently used for storage. The second outbuilding is a storage shed with a lean-to type roof sloping from front to rear. It is rectangular in plan. The third and fourth outbuildings are both gable-roofed tractor sheds. One of these has a lean-to addition on one side made of weatherboard. The fifth structure is a simple woodframe structure with upright pole supports, a slightly sloped gabled roof and earthen floor.

Four barns are located on this site. One barn may be described as a "tobacco" barn type. Its structure is similar to the transverse-crib barn, but it contains a ventilator roof as a distinctive feature. Additions have been made to both sides of the central structure, and the whole barn is tin-roofed. The second barn is a single-crib structure with a wing shed on one side. The roof is tin, and some cement is used in the foundation. The other two barns are both transverse-crib barns. Additions have been added to both sides of one of these barns while only a one-side addition has been made to the other. Both structures are presently used for housing tractors and other storage.

The barns and outbuildings seem to be similar to those common throughout Kentucky. The house is of interest for several reasons:

1) It was built during a period of local economic growth and prosperity. Therefore, historically, the house can be seen as a unique remaining example of structures which were utilizing brick from the Siss Brickyard in Baskett, Kentucky. It provides historical evidence which relates to the economic systems which operated in the Baskett area during the late 1800's and early 1900's.

2) The house is also a surviving example of construction analogous to other turn-of-the-century domestic structures found archeologically on the Baskett Site. Since the archeological sites contain brick, as does the Williams House, it may be inferred that the archeological sites also had economic ties with businesses in Baskett.

3) The style of the house is not readily classifiable within the typology of folk architecture presented in Montell and Morse[3]. The study of folk architecture by Montell and Morse is by no means exhaustive; anthropologically, the house structure may add information concerning folk structures of the early 20th century.

4.6.5.2 Natural Features

4.6.5.2.1 National Register of Natural Landmarks

No natural feature listed on the National Registry of Natural Landmarks is located on the Baskett Site. The Henderson Sloughs in Henderson and Union Counties, which are on the Registry, are some 16 km (10 miles) to the southeast of the Baskett site. The Henderson Sloughs are described in Section 4.2.2.2.2.3.2.

4.6.5.2.2 State Nature Preserves

Portions of Audubon State Park, the adjacent Wolf Hills and on-site and off-site portions of the Cypress Slough are presently under consideration by the Kentucky Nature Preserve Commission for designation as a Kentucky Nature Preserve. (See Sections 4.1.2.4 and 4.2.2 for descriptions of the Audubon State Park and the Cypress Slough.)

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1. Kentucky Heritage Commission, 1971, Survey of Historic Sites In Kentucky, KHC, Frankfort, Kentucky.

2. Robinson K W, S D Smith, and M B Collins, 1978. A Cultural Resources Survey and Limited Subsurface Reconnaissance of the Proposed Synthesis Gas Demonstration Plant Area, Baskett, Henderson County, Kentucky, on file with the Museum of Anthropology, University of Kentucky, Lexington, Kentucky.

3. Montell W.L. and M.L. Morse, 1976, Kentucky Folk Architecture, University Press of Kentucky, Lexington, Kentucky.

TABLE 4.6.1-1

REGIONAL EMPLOYMENT - 1967

Sector	COUNTY						Total
	Vanderburgh	Spencer	Posey	Warrick	Henderson	Daviess	
Agriculture	6,210	2,014	1,838	1,787	2,661	4,964	19,474 (.155)
Mining	551	31	161	529	476	664	2,412 (.019)
Construction	2,992	14	794	158	432	1,281	5,671 (.045)
Manufacturing	27,749	304	1,676	2,699	3,653	10,256	46,337 (.368)
TCPU	3,121	53	57	243	512	1,659	5,645 (.045)
W/R Trade	14,264	546	780	545	1,896	4,538	22,569 (.179)
FIRE	2,330	47	92	99	238	663	3,469 (.028)
Services	4,190	70	139	167	498	1,573	6,637 (.053)
Government	6,490	737	824	783	1,318	3,471	13,623 (.108)
Total	67,897 (.540)	3,816 (.030)	6,361 (.051)	7,010 (.056)	11,684 (.093)	29,069 (.231)	125,837 (1.000)

Notes: 1. Numbers in parenthesis represent proportions of the total.
2. Definitions - TCPU is for Transportation, Communications and Public Utilities; W/R Trade is for Wholesale and Retail Trade and FIRE is for Finance, Insurance and Real Estate.

Sources: Indiana Employment Security Division,(1) Kentucky Department of Human Resources,(2) and US Department of Commerce(3)

TABLE 4.6.1-2

REGIONAL EMPLOYMENT - 1977

Sector	COUNTY						
	Vanderburgh	Spencer	Posey	Warrick	Henderson	Daviess	Total
Agriculture	6,500	2,150	1,968	1,900	2,813	5,200	20,531 (.127)
Mining	414	128	94	1,307	428	587	2,958 (.018)
Construction	4,233	167	614	545	649	1,762	7,970 (.049)
Manufacturing	24,327	984	2,647	3,813	4,346	7,303	43,420 (.269)
TCPU	3,563	140	203	449	650	1,944	6,949 (.043)
W/R Trade	20,266	942	1,392	1,564	3,167	6,696	34,027 (.211)
FIRE	2,898	133	152	251	386	1,109	4,929 (.031)
Services	15,061	449	489	975	2,447	3,974	23,395 (.145)
Government	7,727	890	1,152	1,233	1,548	4,745	17,295 (.107)
Total	84,989 (.526)	5,983 (.037)	8,711 (.054)	12,037 (.075)	16,434 (.102)	33,320 (.206)	161,474 (1.000)

Notes: 1. Numbers in parenthesis represent proportions of the total.
2. Definitions - TCPU is for Transportation, Communications and Public Utilities; W/R Trade is for Wholesale and Retail Trade and FIRE is for Finance, Insurance and Real Estate.

Sources: Indiana Employment Security Division,[4] Kentucky Department of of Human Resources,[5] and US Department of Commerce[3]

TABLE 4.6.1-3

NATIONAL EMPLOYMENT 1967 & 1977
(000)

Sector	1967	1977
Agricultural	3,844 (.055)	3,244 (.038)
Mining	613 (.009)	831 (.010)
Construction	3,208 (.046)	3,844 (.045)
Manufacturing	19,447 (.279)	19,554 (.229)
TCPU	4,261 (.061	4,589 (.054)
W/R Trade	13,606 (.195)	18,292 (.214)
FIRE	3,225 (.046)	4,508 (.053)
Services	10,099 (.145)	15,333 (.180)
Government	11,398 (.164)	15,190 (.178)
Total	69,701 (1.000)	85,385 (1.000)

Notes: 1. Numbers in parenthesis represent proportions of the total.
2. Definitions - TCPU is for Transportation, Communications and Public Utilities; W/R Trade is for Wholesale and Retail Trade and FIRE is for Finance, Insurance and Real Estate.

Source: US Department of Labor[6]

TABLE 4.6.1-4

REGIONAL AND NATIONAL RATES OF CHANGE AND AVERAGE ANNUAL PERCENTAGE CHANGES IN EMPLOYMENT BY SECTOR

1967 to 1977

Sector	Rates of Change		Average Annual Percent	
	Regional	National	Regional	National
Agricultural	1.054	.844	.54%	-1.56%
Mining	1.226	1.356	2.26	3.56
Construction	1.418	1.198	4.18	1.98
Manufacturing	.937	1.006	-.63	.06
TCPU	1.231	1.077	2.31	.77
W/R Trade	1.508	1.344	5.08	3.44
FIRE	1.421	1.398	4.21	3.98
Services	3.706	1.518	27.06	5.18
Government	1.270	1.333	2.70	3.33
Total	1.283	1.225	2.83	2.25

Note: Definitions - TCPU is for Transportation, Communications and Public Utilities; W/R Trade is for Wholesale and Retail Trade and FIRE is for Finance, Insurance and Real Estate.

Source: Ebasco/Envirosphere Company[7]

TABLE 4.6.1-5

REGIONAL AND NATIONAL AVERAGE WEEKLY EARNINGS

1967 AND 1977

Area	1967	1977
National	$127.37	$215.82
Region - 6 Counties	116.66	210.91
Vanderburgh	123.20	205.04
Spencer	87.89	172.06
Posey	130.00	239.91
Warrick	144.03	321.68
Henderson	89.44	188.51
Daviess	102.63	193.81

Notes: 1. The regional average was computed by weights being assigned to each county.

2. Earnings include both supervisory and non-supervisory workers.

Sources: Indiana Employment Security Division,[8,9] Kentucky Department of Human Resources,[10,11] US Department of Labor[12,13]

TABLE 4.6.1-6

REGIONAL AND NATIONAL UNEMPLOYMENT TRENDS

1974 TO 1977

Area	1974	1975	1976	1977
National	5.6%	8.5%	7.7%	7.0%
Region - 6 Counties				
Vanderburgh	4.3	7.0	5.2	5.0
Spencer	5.5	8.8	6.2	6.0
Posey	5.8	9.5	7.0	6.8
Warrick	3.0	4.9	3.5	3.4
Henderson	5.5	8.6	5.4	4.7
Daviess	5.2	8.9	6.8	4.8

Sources: Indiana Employment Security Division,[14] Kentucky Department of Human Resources,[15] US Department of Labor,[6,16]

TABLE 4.6.1-7

REGIONAL MANUFACTURING EMPLOYMENT

(1977)

Industry	COUNTY						Total
	Vanderburgh	Spencer	Posey	Warrick	Henderson	Daviess	
Food and Kindred	2,033	62	192	17	56	1,485	3,845 (.089)
Tobacco	-	-	-	-	-	977	977 (.022)
Clothing, Textiles & Leather	832	-	17	80	243	17	1,189 (.027)
Lumber & Furniture	1,793	100	22	95	615	447	3,072 (.071)
Printing, Publishing & Paper	1,985	16	45	25	219	184	2,474 (.057)
Chemicals, Petroleum, Coal & rubber	5,335	45	1,406	16	493	522	7,817 (.180)
Stone, Clay & Glass	449	135	24	62	73	250	993 (.023)
Primary & Fabricated Metals	3,314	290	898	3,245	1,422	634	9,803 (.226)
Machinery Metal Products & Equipment	7,807	300	34	249	951	2,785	12,126 (.279)
Other	779	36	9	24	274	2	1,124 (.026)
Total	24,327 (.560)	984 (.022)	2,647 (.061)	3,813 (.088)	4,346 (.100)	7,303 (.168)	43,420 (1.000)

Note: The number in parenthesis represent proportions of the total.

Sources: Indiana Employment Security Division[17] and Kentucky Department of Human Resources[18]

TABLE 4.6.1-8

NATIONAL MANUFACTURING EMPLOYMENT - 1967 TO 1977

(000)

Industry	1967	1977	Rate of Change
Food and Kindred	1,786.3	1,720.6	.963
Tobacco	86.5	70.0	.809
Clothing, Textiles & Leather	2,707.2	2,533.8	.934
Lumber & Furniture	1,052.2	1,152.3	1.095
Printing, Publishing & Paper	1,726.9	1,807.8	1.047
Chemicals, Petroleum, Coal & Rubber	1,700.7	1,942.1	1.142
Stone, Clay & Glass	628.3	652.4	1.038
Primary & Fabricated Metals	2,685.2	2,654.6	.989
Machinery Metal Products & Equipment	3,928.5	4,122.4	1.049
Other	3,144.9	2,898.5	.922
Total	19,446.7	19,554.5	1.001

Note: Numbers in parenthesis represent proportions of the total.

Sources: US Department of Labor[16,19]

TABLE 4.6.1-9

BASIC AND NON-BASIC EMPLOYMENT

IN THE REGION

(1977)

Sector	Basic Employment	Non-Basic Employment
Agricultural	20,531	
Mining	2,958	
Construction	7,970	
Manufacturing	43,420	
TCPU		6,949
W/R Trade		34,027
FIRE		4,929
Services		23,395
Government		17,295
Total	74,879	86,595

Notes:

1. The identification of basic/non-basic employment was done with the use of location quotients.

2. Definitions - TCPU is for Transportation, Communications and Public Utilities; W/R Trade is for Wholesale and Retail Trade, and FIRE is for Finance, Insurance and Real Estate.

Sources: Indiana Employment Security Division,(4) Kentucky Department of Human Resources(5) and US Department of Commerce(3)

TABLE 4.6.2-1

POPULATION OF SIX-COUNTY AREA, 1960-2000

State	County	1960	1970	1976	1980	1983	1985	1990	1995	2000
Kentucky	Daviess	70,588	79,486	81,700	83,000	84,200	85,000	88,000	91,100	93,800
	Henderson	33,519	36,031	37,200	38,100	38,800	39,300	40,400	41,700	42,900
Indiana	Posey	19,214	21,740	22,300	24,500	25,520	26,200	28,100	30,300	32,400
	Spencer	16,074	17,134	17,500	18,700	19,240	19,600	20,600	21,500	22,600
	Vanderburgh	165,794	168,772	161,800	159,900	158,100	156,900	153,400	149,100	144,400
	Warrick	23,577	27,972	34,600	41,000	45,560	48,600	57,000	66,700	77,900
Total Six-County Area		328,766	351,135	355,100	365,200	371,420	375,600	387,500	400,400	414,000

Source: U S Department of Commerce [1][5], University of Louisville[10] and Indiana University[19]

TABLE 4.6.2-2

CENTERS OF POPULATION OVER 1,000 IN SIX-COUNTY AREA
POPULATION CHANGE, 1970-1975

County	City or Town	1970	Estimated 1975	Percent Change
Kentucky				
Daviess	Owensboro	50,329	50,788	0.9
Henderson	Henderson	22,976	22,832	-0.6
Indiana				
Posey	Mt Vernon	6,770	7,136	5.4
	Poseyville	1,035	1,096	5.9
Spencer	Dale	1,113	1,161	4.3
	Rockport	2,565	2,205	-14.0
Vanderburgh	Evansville	138,764	133,566	-3.7
Warrick	Boonville	5,736	5,475	-4.6
	Chandler	2,032	2,252	10.8
	Newburgh	2,302	3,211	39.5

Source: US Department of Commerce[2]

TABLE 4.6.2-3

NATIONAL, STATEWIDE, AND SIX COUNTY AREA DEMOGRAPHIC PROFILE OF SELECTED DEMOGRAPHIC CHARACTERISTICS

1960-1970

	U S A		Kentucky		Indiana		Six County Area	
	1960	1970	1960	1970	1960	1970	1960	1970
Total	179,323,175	203,235,298	3,038,156	3,218,706	4,662,498	5,193,669	328,766	351,135
Population								
% Males	49.7	49.3	49.6	49.0	49.3	48.7	49.4	47.9
% Females	50.3	50.7	50.4	51.0	50.7	51.3	50.6	52.1
% Black	10.5	11.1	7.1	7.4	5.9	7.2	4.9	5.1
% Under 5	11.1	8.3	11.3	8.4	11.6	8.7	11.4	8.2
% 5-18	25.0	26.0	29.1	26.2	27.1	26.7	26.4	24.4
% 19-64	54.1	55.8	50.0	54.9	51.8	55.1	52.2	52.6
% Over 65	9.8	9.9	9.6	10.5	9.5	9.5	10.0	10.8
1960-1970 Population Change, %	13.3		5.9		11.4		6.8	
Average Annual Population Growth, %	1.3		.6		1.1		.7	

Sources: U S Department of Commerce(5)(6)

TABLE 4.6.2-4

AVERAGE ANNUAL RATES OF POPULATION CHANGE, 1960-2000

State	County	1960-1970	1970-1976	1976-1980	1980-1990	1990-2000
Kentucky	Daviess	+1.2%	+0.5%	+0.4%	+0.6%	+0.6%
	Henderson	+0.7%	+0.5%	+0.6%	+0.6%	+0.6%
Indiana	Posey	+1.2%	+0.4%	+2.4%	+1.4%	+1.4%
	Spencer	+0.6%	+0.4%	+1.7%	+1.0%	+0.9%
	Vanderburgh	+0.2%	-0.7%	-0.9%	-0.4%	-0.6%
	Warrick	+1.7%	+3.6%	+4.3%	+3.3%	+3.2%
Total Six-County Area		+0.7%	+0.2%	+0.7%	+0.6%	+0.7%
Area within 3 miles of Plant		N A	N A	+2.5%*	+2.5%	+2.5%
60-mile area		N A	+0.5%	+0.7%	+0.7%	+0.6%
Indiana		+1.1%	+0.3%	+1.3%	+0.9%	+0.8%
Kentucky		+0.6%	+1.1%	+0.7%	+1.0%	+0.9%
United States		+1.3%	+1.0%	+0.8%	+0.9%	+0.7%

*1978-1980

N A = Not Available

Sources: See Tables 4.6.2-1,-3,-5,-6,and -7

TABLE 4.6.2-5

POPULATION OF HENDERSON COUNTY, 1970-2000

U S Census Count, 1970 = 36,031

U S Census Estimate, 1976 = 37,200

Projection Year	State of Kentucky Projections[10]	Projections Based upon 0.6% Annual Increase
1980	37,061	38,100[11][b]
1983	37,323[a]	38,800
1985	37,846	39,300
1990	38,917	40,400
1995	39,951	41,700
2000	40,780	42,900

Notes:

(a) Straight-line interpolation of 1980 and 1985 State projections

(b) All numbers rounded to nearest 100.

Source: University of Louisville[10] and Sparr[11]

TABLE 4.6.2-6

POPULATION PROJECTIONS

1978-2000

AREA WITHIN 3 MILES OF THE PLANT

Year	Population within 3 Miles of Plant
1978	1,668
1980	1,752
1983	1,887
1985	1,983
1990	2,243
1995	2,538
2000	2,872

Source: Ebasco/Envirosphere Company (14)(20)

TABLE 4.6.2-7

POPULATION OF COUNTIES WITHIN 60 MILES OF PROJECT, 1970-2000

County	1970	Estimated 1976	1980	1990	2000
Illinois					
Edwards	7,090	7,700	7,826	8,082	7,865
Gallatin	7,418	6,800	7,080	6,938	6,972
Hamilton	8,665	8,400	8,399	8,958	9,473
Hardin	4,914	5,200	5,373	5,492	5,511
Lawrence	17,522	17,600	19,524	19,925	18,879
Saline	25,721	27,200	27,197	27,363	27,926
Wabash	12,841	13,700	14,111	14,926	15,139
Wayne	17,004	17,300	17,564	18,489	18,324
White	17,312	17,200	16,098	17,783	17,401
Subtotal	118,487	121,100	123,172	127,956	127,490
Indiana					
Daviess	26,602	25,800	27,200	27,600	27,500
Dubois	30,934	32,200	33,300	36,500	39,500
Gibson	30,444	30,900	32,800	34,700	36,400
Knox	41,546	40,600	40,200	38,500	36,600
Perry	19,075	18,700	19,200	19,700	20,200
Pike	12,281	12,300	12,100	11,900	11,900
Posey	21,740	22,300	24,500	28,100	32,400
Spencer	17,134	17,500	18,700	20,600	22,600
Vanderburgh	168,772	161,800	159,900	153,400	144,400
Warrick	27,972	34,600	41,000	57,000	77,900
Subtotal	396,500	396,700	408,900	428,000	449,400
Kentucky					
Breckenridge	14,789	15,800	15,326	16,525	17,725
Caldwell	13,179	12,900	13,297	13,408	13,627
Crittenden	8,493	9,000	9,408	10,572	11,883
Daviess	79,486	81,700	83,000	88,000	93,800
Hancock	7,080	7,200	7,555	8,161	8,783
Henderson	36,031	37,200	38,100	40,400	42,900
Hopkins	38,167	44,100	46,662	56,074	65,513
McLean	9,062	10,400	11,058	13,214	15,422
Muhlenberg	27,537	31,100	32,316	37,634	42,902
Ohio	18,790	20,700	21,128	24,571	28,413
Union	15,882	17,000	16,895	18,571	20,372
Webster	13,282	14,500	14,696	16,655	18,765
Subtotal	281,778	301,600	309,441	343,785	380,105
Total	796,765	819,400	841,513	899,741	956,995

Sources: University of Louisville[10], Indiana University[19], State of Illinois[21], Sparr[11] and US Department of Commerce[2]

TABLE 4.6.2-8

POPULATION OF CITIES WITH OVER 10,000 POPULATION WITHIN A 60 MILE RADIUS

State	County	City	Population July 1,1975	Population 1970 Census	Percent Change
Indiana	Daviess	Washington	10,835	11,358	-4.6
	Dubois	Jasper	10,287	8,641	+19.0
	Knox	Vincennes	19,375	20,969	-7.6
	Vanderburgh	Evansville	133,566	138,764	-3.7
Kentucky	Daviess	Owensboro	50,788	50,329	+0.9
	Henderson	Henderson	22,832	22,976	-0.6

Source: U S Department of Commerce [18]

TABLE 4.6.3-1

HENDERSON COUNTY SCHOOLS
1978-79

School	Enrollment	Capacity	% Of Capacity
City of Henderson (Elementary)			
Central	380	393	96.5
East Heights	650	673	96.5
Jefferson	270	276	97.7
Seventh Street	312	322	96.8
South Heights	303	312	97.1
Bend Gate	637	675	96.4
Remainder of County (Elementary)			
Cairo	229	236	97.0
Corydin	208	212	98.3
Hebbardsville	227	285	97.0
Niagara	247	254	96.9
Robards	208	214	96.9
Smith Mills	219	224	97.9
Spottsville	383	397	96.4
North Junior High	1,002	1,046	95.6
South Junior High	1,072	1,122	95.5
Henderson County High School	2,005	2,105	95.0
Special Education - Barrett Center	32	33	97.2
Totals:	8,434	8,769	96.2

Source: Henderson County Board of Education(1)

TABLE 4.6.3-2

COMMUNITY METHODIST HOSPITAL

Year	Service Area Population	Service Capacity (In Patient Days)	Utilization (In Patient Days)	Utilization Rate
1978	67,362	76,285	63,826	83.7%
1979	67,894	76,285	63,565	83.3
1980	68,417	76,285	63,283	82.9
1981	68,889	98,367	76,837	78.1
1982	69,361	98,367	78,072	79.4

Notes: 1. Service area population is based upon Ebasco/Envirosphere estimate of Henderson, Union and Webster Counties population.

2. The 1978 to 1980 service capacities and utilization data are based upon a 209 bed facility and from 1981 to 1982 are based upon a 269 bed facility.

Sources: Community Methodist Hospital[6] and Ebasco/Envirosphere Company[5][7]

TABLE 4.6.3-3

CITY OF HENDERSON FIRE DEPARTMENT
(1978)

Municipality	Stations	Equipment
Henderson	4	3 Pumpers @ 1000 gpm each 1 Pumper @ 1500 gpm each 1-95 ft ladder truck 1 Standby pumper @ 500 gpm

Notes:

1. The term gpm stands for gallon per minute (fire flow).
2. The four stations include three(3) substations and one (1) main firehouse
3. The current (1978) personnel are 51 firemen and 5 service personnel (fiscal 1978).
4. Fire station locations are as follows: (1) Downtown Henderson; (2) East end of the City (US 41); (3) North end of the City (1700 block of N Green); and (4) South end of the city (US 41A)

Source: City of Henderson Fire Department [13]

TABLE 4.6.3-4

HENDERSON COUNTY VOLUNTEER FIRE DEPARTMENT
(1978)

Municipality	Stations	Equipment
Baskett	1	2 Pumpers @ 500 gpm each
Corydon	2	3 Pumpers @ 750 gpm each
Niagara	1	2 Pumpers @ 500 gpm each
Read	1	2 Pumpers @ 500 gpm each
Robards	1	1 Pumper @ 500 gpm 1 Pumper @ 400 gpm 1 Tanker @ 1500 gallons
Smith Mills	1	2 Pumpers @ 750 gpm each 1 Tanker @ 1200 gpm

Note: The term gpm stands for gallons per minute (fire flow).

Source: City of Henderson Fire Department[13]

TABLE 4.6.3-5

WATER AND SEWER FOR HENDERSON CITY AND COUNTY
(In Millions of Gallons Per Day)

Government	Water			Sewer		
	Capacity	Usage	No. of Users	Capacity	Usage	No.of Users
Henderson City	6.0	4.6	21,600	7.5	4.9	21,600
Henderson County	.666	.400	7,020	N/A	N/A	N/A

Notes: 1. The number of users represents the Ebasco/Envirosphere estimated residental populations utilizing the systems.

2. The County has no sewer system, utilizes septic tanks.

3. The County consumes about 400,000 gallons per day of City water, resulting in a total usage of 5 million gallons per day.

Sources: City of Henderson Water Department[15] and Henderson County Water Department[16]

TABLE 4.6.3-6

HENDERSON COUNTY HOUSING DATA
(1977-78)

Tenure	Total Housing Stock	Occupied Units	Vacant	Vacancy Rate	Substandard
Owner-Occupied	9,368	9,256	112	1.2%	1,321
Rented	4,826	4,551	275	5.7%	681
TOTAL	14,194	13,807	387	2.7%	2,002

Source: Henderson City-County Planning Commission[18]

TABLE 4.6.3-7

AVERAGE DAILY TRAFFIC FOR US 60
(1971 to 1977)

Point	1971	1973	1977
Watson Lane	6,902	-	9,575
Wathen Road	5,295	5,463	-
County Club Road (Race Creek)	-	4,469	5,860
East of Rucker Road	3,739	4,020	-
Spottsville	3,513	4,056	4,280

Notes: 1. See Figure 4.6.3-1 for 1977 ADT locations.

2. The dash (-) represents no count taken at that point for the indicated year.

Source: Kentucky Department of Transportation[19]

TABLE 4.6.3-8

AVERAGE DAILY TRAFFIC FOR SECONDARY HIGHWAYS
(1971 to 1977)

Highways and Points	1971	1977
US 41		
@ US 60 Interchange	26,008	37,480
@ Watson Lane	26,675	38,461
Pennyrile Parkway/US 41		
@ Van Wych Road	12,975	20,522
@ Henderson County High School	5,130	6,904
US 60		
@ Harding Avenue	18,500	22,885
@ Second Street	19,060	23,536
@ Fair Street	-	19,283
@ Community Drive	-	14,020

Notes:
1. See Figure 4.6.3-2 for 1977 ADT locations.
2. The dash (-) represents no count taken at that point for the indicated year.
3. No counts have been taken for the Audubon Parkway.

Source: Kentucky Department of Transportation[19]

TABLE 4.6.3-9

CITY OF HENDERSON REVENUE SOURCES
(1977-78)

Revenue Category	Revenue Level	
Taxes and Franchises	$ 1,622,229	(.551)
Property Tax (Real and Personal)	907,395	
Delinquent Property Tax	27,871	
Penalty and Interest	7,200	
Franchise Tax	80,671	
Bank Shares	14,277	
Insurance Tax	141,939	
In Lieu of Tax-Housing Commission	23,886	
In Lieu of Tax-Electric	79,000	
In Lieu of Tax-Gas	300,000	
In Lieu of Tax-Water	40,000	
User Fees	480,785	(.163)
Bus Fares	16,900	
Parking Meter Collections	31,000	
Refuse Fees-Residential	258,200	
Refuse Fees-Commercial	103,836	
Landfill Fees	29,311	
Delinquent Tax Collection Fees	751	
Appeal Board Fees	732	
Swimming Pool Fees	12,839	
Golf Course Fees	7,819	
Police Court Fees	19,400	
Fines and Forfeitures	152,553	(.052)
Police Court Fines	77,600	
Parking Meter Fines	18,265	
Base Court Fees	46,688	
Transfer from Police Court	10,000	
License and Permits	171,062	(.058)
Privilege Licenses	129,761	
Liquor and Beer Licenses	14,634	
Building Permits	20,467	
Electrical Permits	16,200	
Rents and Concessions	37,588	(.012)
Parking Lots	10,373	
Rent-Municipal Center	4,800	
Other Rentals	5,115	
Concessions-Municipal Facilities	9,800	
Rent-Municipal Lands	7,500	

TABLE 4.6.3-9 (Cont'd)

CITY OF HENDERSON REVENUE SOURCES
(1977-78)

Revenue Category	Revenue Level	
Sale of Municipal Property	$ 40,770	(.014)
Cemetery Spaces	10,770	
Grave Openings	19,105	
Other Cemetery Services	8,209	
Photostatic Service	2,686	
Other Revenues	441,719	(.149)
Interest Income	32,057	
Recreational Activities	11,516	
Governmental Service Charge Water	99,000	
Governmental Service Charge - Electricity	125,000	
Governmental Service Charge - Gas	106,000	
Governmental Service Charge - Other	20,000	
Insurance Recoveries	1,046	
Unclassified	471,000	
Total	$2,946,716	(1.000)

Note: Numbers in parenthesis represent the proportion a specific category is of the total sum.

Source: City of Henderson[20]

TABLE 4.6.3-10

CITY OF HENDERSON INTERGOVERNMENTAL TRANSFERS/UTILITY FUNDS
(1977-78)

Revenue Category	Revenue Level
Public Way Improvements	$ 449,130
Public Utility Fund	2,884,917
Revenue Sharing Trust Fund	605,881
Total	$3,939,928

Notes:

1. Public Way Improvements derived from vehicle licenses ($132,500), State-Municipal Aid ($248,500) subsidy-general fund ($63,130), and miscellaneous ($5,000).

2. Public Utility Fund derived primarily from gas sales.

3. Revenue Sharing Trust Fund derived from Federal Revenue Sharing ($493,585), interest on income ($30,000) and a carry-over surplus ($82,296).

Source: City of Henderson[20]

TABLE 4.6.3-11

HENDERSON COUNTY REVENUE SOURCES
(1977-78)

Revenue Category	Revenue Level	
Taxes & Franchises	$ 751,921.01	(.609)
Property Tax (Real and Personal	562,656.34	
Bank Shares	13,977.06	
Franchise Companies	45,303.40	
Argicultural Products	7,565.64	
Unmined Coal	2,098.57	
Oil Production	78,720.00	
Deliquent Tax Receipts	4,000.00	
Property Transfer Tax	35,000.00	
Legal Process Tax	1,400.00	
Forest Fire Fund	1,200.00	
Fines & Forefitures	4,000.00	(.003)
Licenses & Permits	60,000.00	(.049)
Truck License Distribution	51,000.00	
Liquor Package Licenses	6,000.00	
Motor Vehicle Operators Licenses	3,000.00	
Rents & Commissions	4,200.00	(.003)
Leases - Sand and Gravel	4,200.00	
Other Revenues	413,800.00	(.335)
Interest on Reports	20,000.00	
Insurance Refund	4,000.00	
Public Defender Program	7,000.00	
Election Expense Refund	5,400.00	
Refunds	87,000.00	
Work Release Program	2,000.00	
Surplus from Previous Year	168,400.00	
Excess Fees	120,000.00	
Total	$1,233,921.01	(1.000)

Note: Number in parenthesis represent the proportion a specific category is of the total sum.

Sources: Henderson County Treasurer[24][25]

TABLE 4.6.3-12

HENDERSON COUNTY INTERGOVERNMENTAL TRANSFERS
(1977-78)

Revenue Category		Revenue Level
Federal Revenue Sharing		$434,348.22
CETA		50,000.00
	Total	$484,348.22

Note: CETA represents the Comprehensive Employment Training Act.

Source: Henderson County Treasurer[28]

TABLE 4.6.3-13

EFFECTIVE TAX RATES AND APPLICABLE VALUATIONS
(1977-78)

Taxing District	Effective Tax Rates Real	Effective Tax Rates Personal	Applicable Valuations
City of Henderson	.53	.53	$222,900,655
Henderson County	.14	.14	432,658,065
State (Kentucky)	.315	.45	432,658,065
County School District	.392	.392	432,658,065
Library	.03	.03	432,658,065
County Health	.02	.02	432,658,065

Notes: 1. Effective tax rates are in cents per $100 of assessed valuation.

2. Applicable Valuation includes both the total assessed valuations for real and personal property.

Sources: City of Henderson[21] and Henderson County[33]

TABLE 4.6.3-14

CITY OF HENDERSON EXPENDITURES
(1977-78)

Public Service Function	Expenditure Level	
General Administration	$ 1,026,503	(.353)
Mayor and City Commission	25,815	
General Administration	43,841	
Legal	15,786	
City Clerk	11,442	
Police Court	15,180	
Finance	58,886	
Computer Facilities	105,605	
Customer Services	167,563	
Non-Departmental	564,445	
Public Safety	1,091,741	(.375)
Police	480,370	
Fire	554,560	
Code Enforcement	40,816	
Traffic Control	15,995	
Public Works	344,838	(.118)
Public Works Administration	26,961	
Sanitation-Collection	154,564	
Sanitation-Disposal	52,853	
Central Garage	83,180	
Engineering	27,280	
Recreation and Education	231,421	(.080)
Park and Recreation	137,803	
Golf	12,288	
Cemeteries	52,530	
Municipal Park	28,800	
General Services	213,270	(.073)
Personnel	42,238	
Purchasing and Stores	1,020	
Municipal Facilities	97,026	
Parking System	20,197	
Public Transportation	52,807	

Note: Numbers in parenthesis represent the proportion a specific category is of the total sum.

Source: City of Henderson[20]

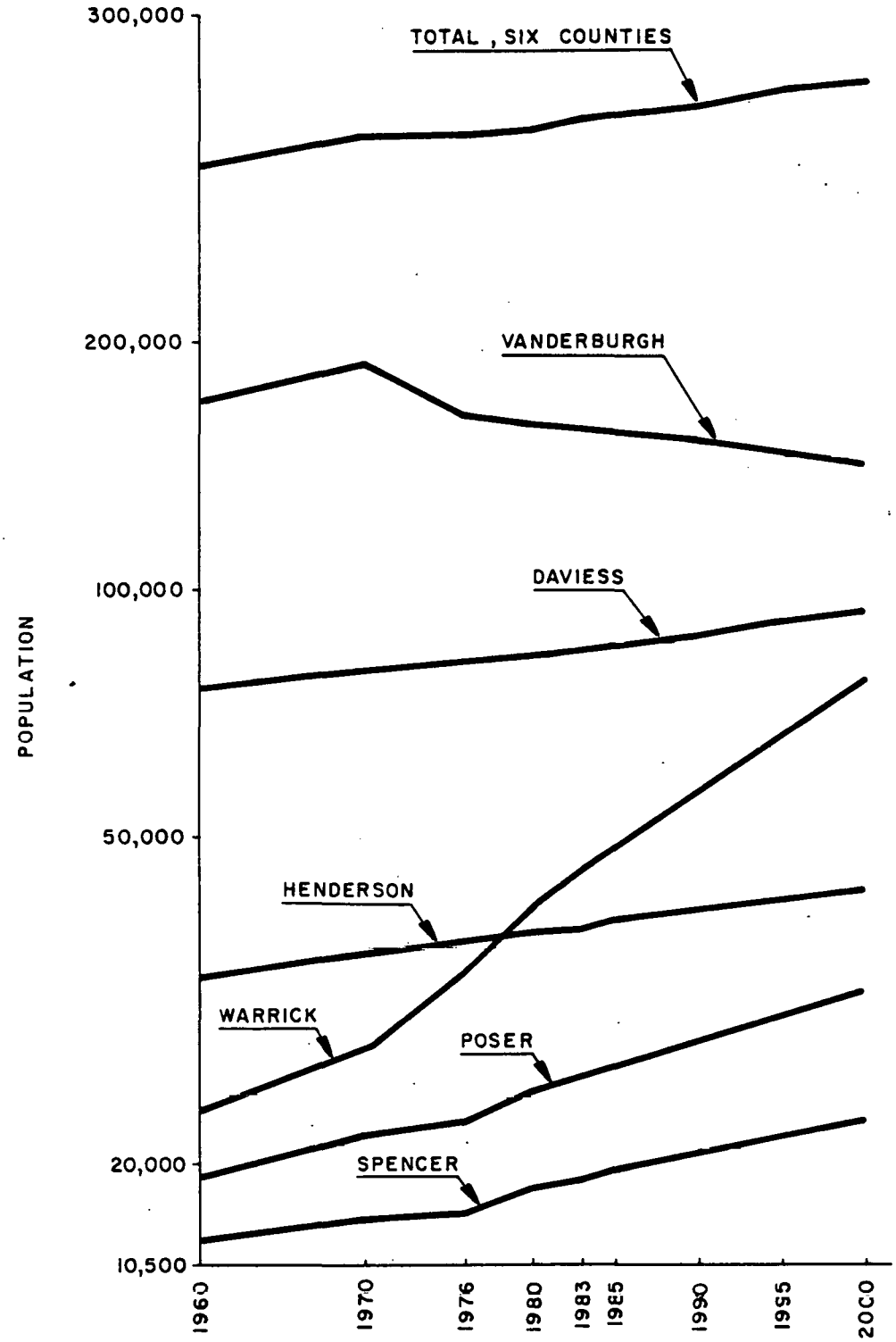
TABLE 4.6.3-15

HENDERSON COUNTY EXPENDITURES
(1977-78)

Public Service Function	Expenditure Level	
General Administration	$ 423,932.09	(.344)
General Government	306,501.00	
Miscellaneous - General Fund	117,431.09	
Public Safety	56,200.00	(.046)
Protection to Persons and Property	55,000.00	
Forest Fire Protection	1,200.00	
Public Works	564,012.95	(.457)
Highways	534,687.95	
Health and Sanitation	29,325.00	
Health and Welfare	35,400.00	(.029)
Recreation and Education	41,500.00	(.034)
Debt Service	112,876.07	(.091)
Courthouse Bond	25,665.00	
Jail Bond	67,211.07	
Interest Income	20,000.00	

Note: Numbers in parenthesis represent the proportion a specific category is of the total sum.

Source: Henderson County Treasurer[28]

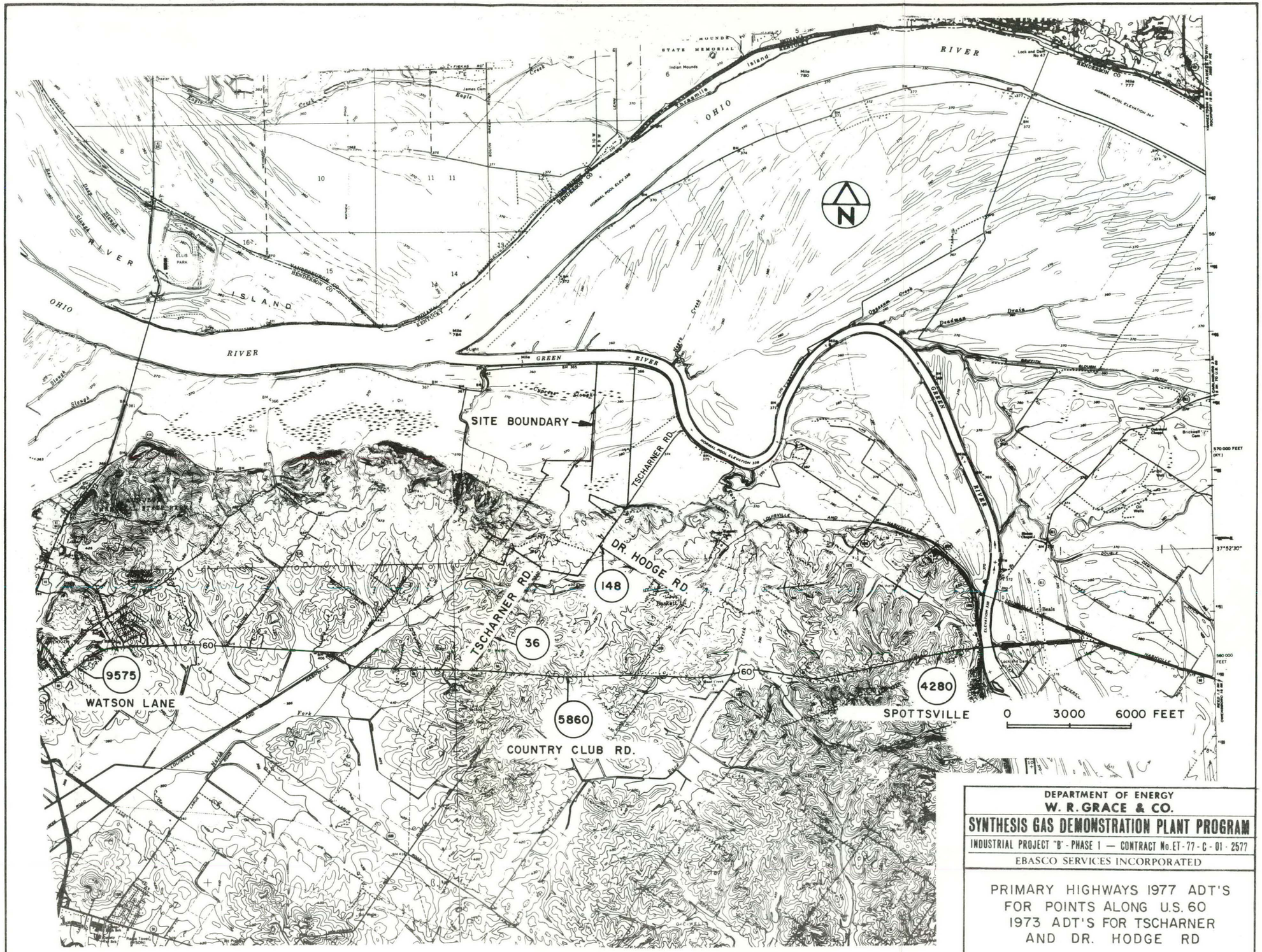


SOURCE: FROM TABLE 4.6.2 - 1

DEPARTMENT OF ENERGY
W. R. GRACE & CO.
SYNTHESIS GAS DEMONSTRATION PLANT PROGRAM
INDUSTRIAL PROJECT "B" - PHASE I — CONTRACT No. ET-77-C-01-2577
EBASCO SERVICES INCORPORATED

SIX - COUNTY
POPULATION GROWTH,
1960 - 2000

FIGURE 4.6.2-1



SEE TABLE 4.6.3-7

DEPARTMENT OF ENERGY
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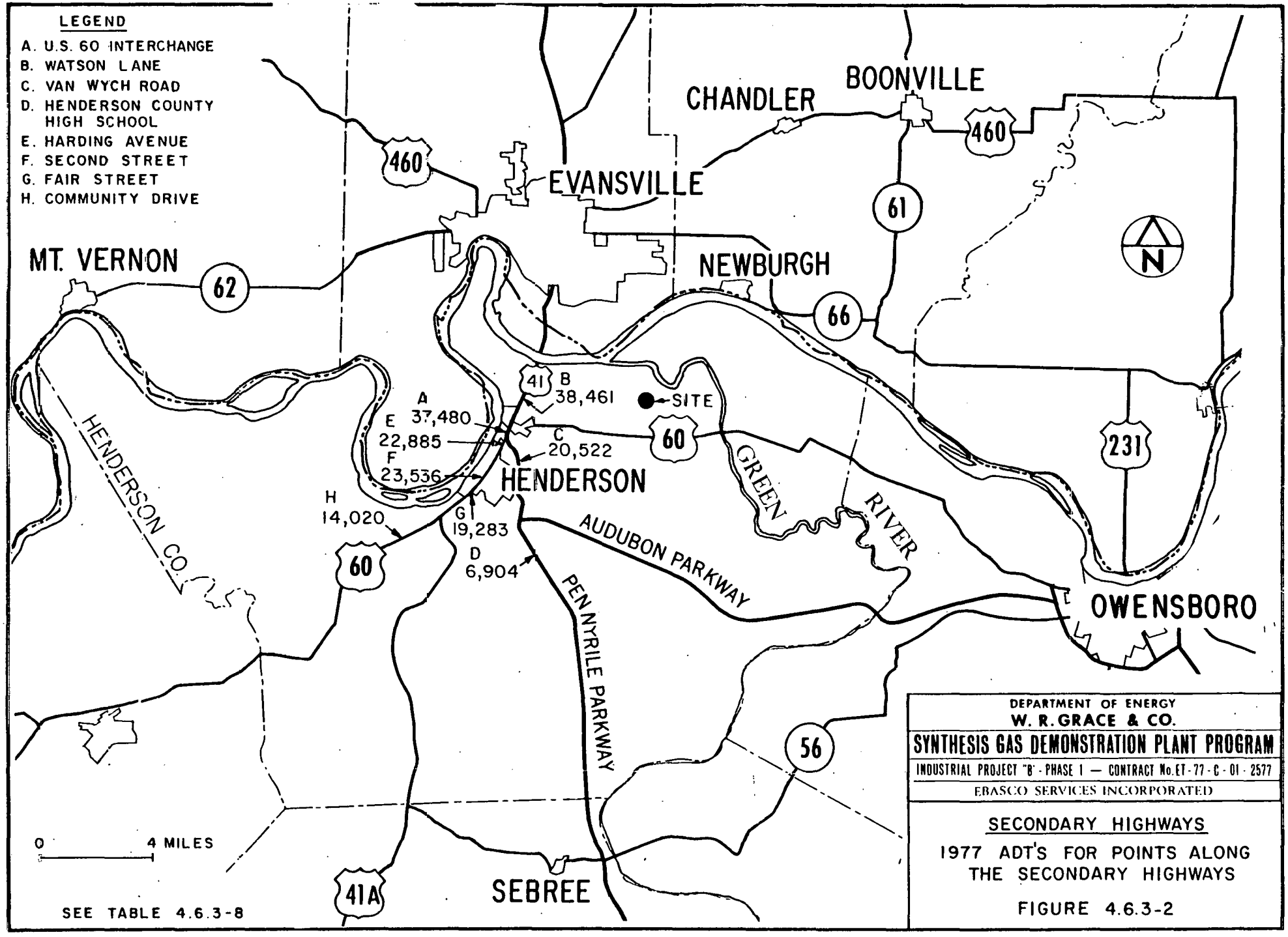
PRIMARY HIGHWAYS 1977 ADT'S FOR POINTS ALONG U.S. 60 1973 ADT'S FOR TSCHARNER AND DR. HODGE RD

FIGURE 4.6.3-1


LEGEND
A. U.S. 60 INTERCHANGE
B. WATSON LANE
C. VAN WYCH ROAD
D. HENDERSON COUNTY HIGH SCHOOL
E. HARDING AVENUE
F. SECOND STREET
G. FAIR STREET
H. COMMUNITY DRIVE
MT. VERNON
EVANSVILLE
CHANDLER
BOONVILLE
NEWBURGH
HENDERSON
HENDERSON CO.
OWENSBORO
SEBREE
SITE
GREEN RIVER
AUDUBON PARKWAY
PENNYRILE PARKWAY
A 37,480
B 38,461
C 20,522
D 6,904
E 22,885
F 23,536
G 19,283
H 14,020
62
460
41
60
61
66
231
56
41A
N
0 4 MILES
SEE TABLE 4.6.3-8
DEPARTMENT OF ENERGY
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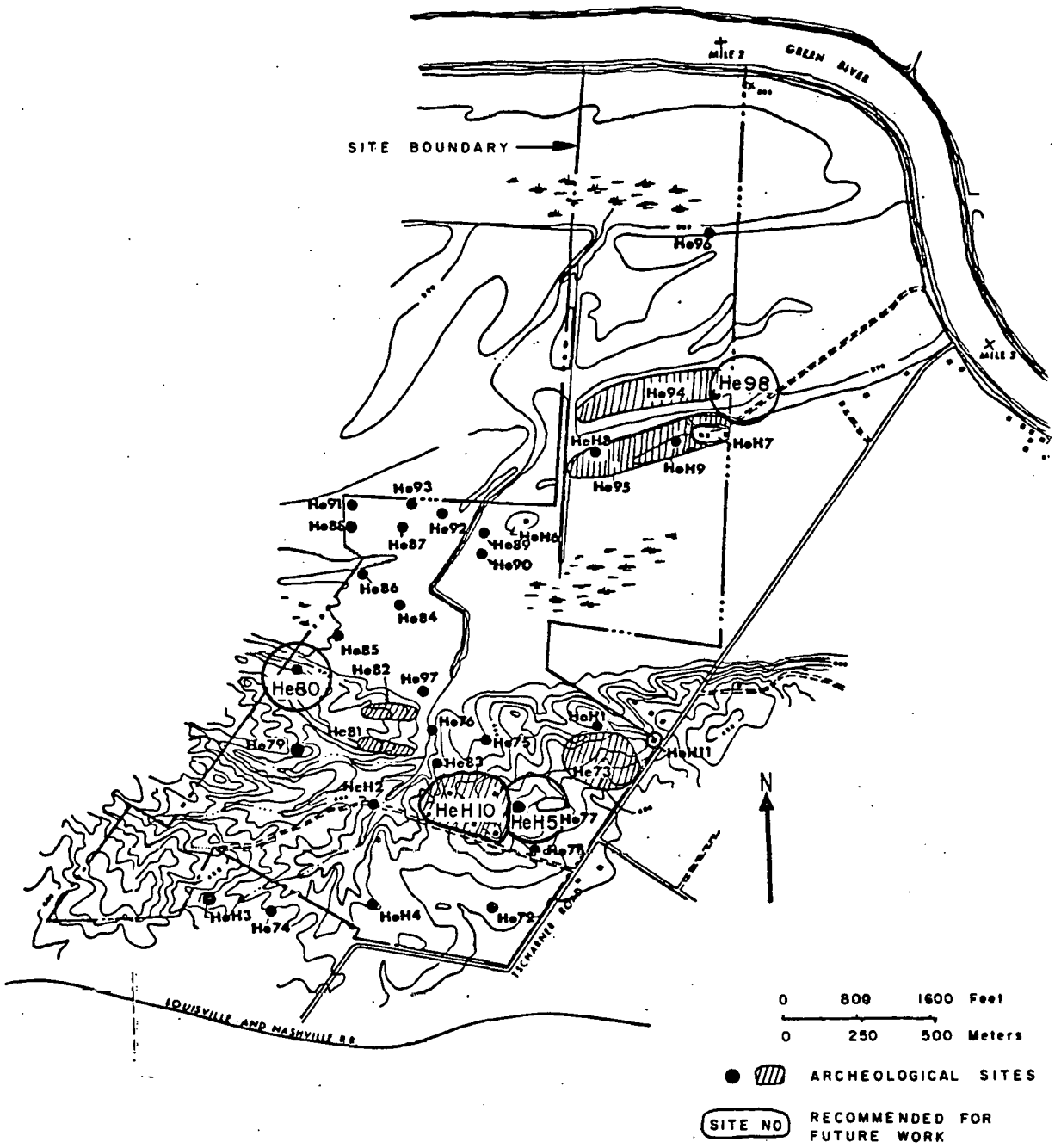
INDUSTRIAL PROJECT "B" - PHASE 1 — CONTRACT No. ET-77-C-01-2577
EBASCO SERVICES INCORPORATED
SECONDARY HIGHWAYS
1977 ADT'S FOR POINTS ALONG THE SECONDARY HIGHWAYS
FIGURE 4.6.3-2



Source : Robinson , et al , 1978

Note : All Sites Are To Be Prefixed By 15 Which Signifies Kentucky, e.g. 15He3, 15He74, etc.

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INDUSTRIAL PROJECT "B" - PHASE 1 — CONTRACT No. ET-77-C-01-2577
EBASCO SERVICES INCORPORATED

LOCATION OF CULTURAL RESOURCES SITES IN THE PROJECT AREA

FIGURE 4.6.5-1

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APPENDIX 4A - MONITORING METHODOLOGY

4A.1 INTRODUCTION

This appendix describes the methodologies and equipment which were employed for gathering site specific data for Aquatic Ecology, Terrestrial Ecology, Land Use and Socioeconomics, Cultural Resources, Geology and Geohydrology, Water Quality, Hydrographics, Air Quality and Meteorology, and Noise. This site specific data was used in describing the existing environmental conditions presented in the Synthesis Gas Demonstration Project Environmental Report, Chapter 4; Characterization of the Existing Environment Likely to be Affected by the Proposed Action.

All programs, except for Air Quality and Meteorology, will be concluded prior to the issuance of the Final Environmental Report. Air Quality and Meteorology will conclude in March, 1980.

4A.2 AQUATIC ECOLOGY

4A.2.1 INTRODUCTION

A baseline study was made of on-site water bodies and the Green River adjacent to and up-river from the site. The on-site bodies include a stream, five farm ponds, and Cypress Slough. The objective of the aquatic field sampling program was to gather data necessary for describing the population and community structure of the aquatic systems. The data were used in part as a basis for determining potential impact on the systems affected by construction and operation of the Synthesis Gas Demonstration Project. Depending on the particular aquatic system being investigated, qualitative and/or quantitative evaluations were made.

For each trophic level, samples were collected in triplicate with the exception of phytoplankton and adult fish. The Green River was sampled at selected locations and specific times (Tables 4A.2-1 to 4A.2-5). Sampling locations were identified and described as River Zones. Zone 1 through 3 were adjacent to the proposed site and Zones 4 through 6 were approximately 1.7 km (1 mile) up river of the site (Figures 4A.2-1 and-2). The up river zones were selected as controls for future possible monitoring and to aid in describing the existing biota. Shore and channel zones were differentiated by water depth. Location of sampling points within zones was done randomly, using a grid system. Sampling was conducted at these points, which were designated by order of selection, unless such activity was precluded by parked barges. If this occurred, the next possible location was sampled. If the entire zone was occupied by barges, sampling of course could not be done. Details of the sampling and laboratory work, by trophic category, are presented in the following sections.

4A.2.2 PHYTOPLANKTON

4A.2.2.1 Field Data Collection

4A.2.2.1.1 Green River

One liter (0.26 gal) whole water samples were collected quarterly from Zones 1, 2, 3 and 5 (Table 4A.2-1 and Figures 4A.2-1 and-2). In 1978 spring and summer quarters, surface samples were collected using a 1 liter (0.26 gal) graduated cylinder. In 1978 fall and winter quarters and 1979 spring quarter composite samples were made from Van Dorn sampler grabs at surface, mid- and bottom water levels. Samples were preserved in Lugol's solution[1].

4A.2.2.1.2 Ponds

One liter (0.26 gal) whole water samples were collected during the 1978 spring quarter from three on-site farm ponds (Table 4A.2-1, Figure 4A.2-3). Samples were taken from nearshore and central areas of each pond, at just below surface with a 1 liter (0.26 gal) graduated cylinder.

4A.2.2.1.3 Cypress Slough

One liter (0.26 gal) whole water samples were collected using a Van Dorn sampler during the 1978 fall and 1979 spring quarters (Table 4A.2-1). Two locations, one on-site at the eastern end of the slough (Location 2) and the other west of the proposed site,(Location 1) were selected for biological sampling (Figure 4A.2-3). Location 1 (CS-1, Figure 4A.2-3) yielded a composite sample representing three depths whereas Location 2 (CS-2, Figure 4A.2-3) could only be sampled at the surface due to the shallowness of the water column.

4A.2.2.2 Laboratory Analysis

Subsamples were taken from a well-mixed one-liter (0.26 gal) phytoplankton sample using a wide bore pipette. Depending upon the density of organisms within the subsample, it was placed in either a 25 ml (0.75 oz) or 50 ml (1.5 oz) sedimentation chamber and allowed to settle for at least 72 hours. The size of each subsample was determined by the relative phytoplankton concentration in the sample, such that sufficient numbers of organisms would be present to produce unbiased estimates of organism density, while ensuring laboratory efficiency. At least two chamber diameters were examined with a Nikon Model MS inverted microscope. Organisms, principally blue-green and green algae, were identified and enumerated under magnifications ranging from 100X to 400X. Ocular reticles in 100 graduations were used for cell measurement purposes. Additional chamber diameters were examined until at least 100 cells and/or chains of the most numerous forms were counted.

To facilitate identification of diatoms, additional subsamples were mounted on slides using Hyrax medium as outlined by Weber[2]. A Foerst centrifuge was used to concentrate the diatoms. Relative abundances were determined from Whipple field counts.

Data reduction comprised a determination of numbers of organisms per unit liter, and their relative abundances.

4A.2.3 MICROZOOPLANKTON

4A.2.3.1 Field Data Collection

4A.2.3.1.1 Green River

Day subsurface samples (15 cm (6 in.) below surface) were collected from Zones 1, 2, 3 and 5 and night subsurface and bottom samples (30 cm, (1 ft) above substrate) were collected from Zones 2 and 3 to determine possible divrnal diel variations (Figures 4A.2-1&2). Collections were made during all 1978 sampling quarters (Table 4A.2-2). Two Jabsco gasoline pumps with Briggs and Stratton 2-1/2 hp engines were used to obtain the samples.

Incurrent hoses were lowered to the desired depth and excurrent hoses were placed in 0.5m, 76 u mesh plankton nets. The nets were suspended from the boat so that the discharges from the hoses would be buffered by the surrounding water. Prior to each sampling the pumps were calibrated by determining the time it took to fill a 45 liter (12 gal) container. This rate was then used to determine the pumping time for 1514 liters (400 gal).

After the desired volume of water was filtered the pumps were again calibrated. The nets were thoroughly washed and the sample retrieved in the cod end bucket. Three samples were collected from each depth and preserved in 5 percent formalin buffered with borax.

Plankton nets with 0.5m (76 u) mesh were also towed for various distances and times to determine the comparability between the tow and pump samples. A flow meter was secured within the net opening to determine the volume filtered. After retrieval the nets were washed and the samples preserved as above.

4A.2.3.1.2 Ponds

Samples were collected from three on-site farm ponds during the 1978 spring quarter (Table 4A.2-2, Figure 4A.2-3). Triplicate surface samples were taken in both the nearshore and central areas of each pond. Samples were collected by means of the pump system previously described, and were preserved with buffered 5 percent formalin. The volume of water filtered ranged from 190 liters (50 gal) to 378 liters (100 gal). Variation was due to differences in algal growth and detrital load among ponds.

4A.2.3.1.3 Cypress Slough

Samples were collected only from Location One (CS-1, Figure 4A.2-3) since Location Two (CS-2, Figure 4A.2-3) did not have sufficient water depth. Collections occurred during 1978 fall and 1979 spring quarters (Table 4A.2-2) and were made by towing a 0.5 m (76 u) mesh plankton net. The net was towed, by hand, from the shore. Tows were short and nonquantifiable due to high turbidity and towing difficulty, caused primarily by dense shore vegetation. Samples were preserved with buffered 5 percent formalin.

4A.2.3.2 Laboratory Analysis

Microzooplankton samples, both pump and net tows, were subsampled with a Folsom Plankton splitter. Samples were split to provide subsamples which were estimated to contain approximately 200-400 organisms. Subsamples were allowed to settle for at least one hour, after which excess water was decanted. Decanting was performed with a Pasteur pipette, one end of which was upturned and covered by a 0.5 m (76 u) mesh net, while the other end was coupled to Tygon tubing. A siphon was then set up to draw off excess water. This method ensured that organisms in the subsample were not lost during the decanting process. Organisms remaining in the concentrate were rinsed into a 10 ml (0.3 oz) Ward Counting Wheel. The Ward Counting Wheel was placed under a Wild M-5 dissecting microscope with 6X to 50X objectives with 10X oculars. All organisms were identified to the lowest possible taxonomic level. Organisms requiring higher magnification or dissection for taxonomic verification were placed in a Sedgwick-Rafter counting chamber or on a glass slide and examined under a Nikon phase compound microscope. Subsamples were examined as described above until at least 50 of the most numerous taxa of cladocerans or copepods were counted. The entire sample was examined if the subsample contained less than the prescribed organism quota.

4A.2.4 BENTHOS

4A.2.4.1 Macroinvertebrates

4A.2.4.1.1 Field Data Collection

4A.2.4.1.1.1 Green River

Samples were collected from Zones 1, 2, 3 and 5 (Figures 4A.2-1&2) using a petite ponar grab. Samples were collected from Zones 1,3 and 6; Zones 1,2, 3 and 5; and Zones 1 and 5 during the 1978 spring, summer and winter quarters, respectively, and were preserved in buffered 10 percent formalin. Live samples were collected during the 1978 fall and 1979 spring quarters from Zones 2 and 3, and Zones 1 and 3, respectively for biomass determinations. All zones were sampled in triplicate with one of the three samples being also analyzed for sediment composition. Preserved samples were placed in buffered 10 percent formalin. Those samples not used for sediment analysis were strained through a U S Standard No. 35 sieve (520 u mesh) prior to shipment to the laboratory subcontractor.

4A.2.4.1.1.2 Ponds

Samples were taken during the 1978 spring quarter (Table 4A.2-3). Three samples each were collected from both the nearshore and central areas of three on-site ponds with a petite ponar grab (Figure 4A.2-3). Two samples from each set of triplicates were strained through a U S Standard No. 35 sieve (520 u mesh). The third sample was left intact for particle size determinations. All samples were preserved in buffered 10 percent formalin.

4A.2.4.1.1.3 Streams

During the 1978 spring quarter drift nets were used to sample the four stream stations. Sampling began at 0600 hrs and thereafter at 6 hr intervals the samples were retrieved and the nets reset for total sampling time of 24 hrs. Surber nets were used to sample for benthic macroinvertebrates. Sampling occurred twice during the 24 hr period at each of the four stations. All samples were preserved in buffered 10 percent formalin.

Samples to be analyzed only for sediment composition were taken during the 1979 spring quarter (Table 4A.2-3). These were collected from each of the four stations (Figure 4A.2-3). Sample were preserved in buffered 10 percent formalin

4A.2.4.1.1.4 Cypress Slough

Collections were made with the petite ponar grab during the 1978 fall and 1979 spring quarters (Table 4A.2-3). Triplicate samples were taken from Locations 1 during the 1978 fall quarter and Location 1 and 2 during the 1979 spring quarter (Figure 4A,2-3). Two of each set if triplicates were strained through a U S Standard No. 35 sieve (520 u mesh). The third sample was left intact for particle size determinations. All samples were preserved in buffered 10 percent formalin.

4A.2.4.1.2 Laboratory Analysis

Ponar grab samples were placed in transparent, gridded culture dishes and sorted using Wild M-5 binocular dissecting microscopes. If these prewashed samples contained much clay or silt, they were placed in a U S Standard No. 35 sieve (520 u mesh) and washed by a stream of water passed through a fine spray nozzle. The organisms found were sorted into major groups of organisms (e g, oligochaetes, molluscs, chironomids) and placed into vials containing 80 percent ethanol and glycerin for later identification and enumeration. All forms were identified to the lowest taxonomic level possible with the aid of dissecting and compound microscopes. Live benthic samples were immediately sorted, and organisms were identified to the lowest possible taxonomic level and enumerated, as described above. Subsequently, they were prepared for biomass determinations using the following ash-free, dry weight procedure. Organims, by taxonomic category, were rinsed with distilled water, dried to a constant weight on a preweighed and preased aluminum dish at 60°C in a laboratory drying oven. Following the weight determination on a Sartorius analytical balance, sensitive to 0.1 mg, organisms were ashed at 425°C in a Thermolyne muffle furnace. After cooling to room temperature in a dessicator, each sample was weighed again. All weighings of taxonomic categories were recorded. One sample from each set of live triplicate samples had a 25 gm sediment subsample removed prior to initial washing for particle size analysis using the methods described below. Live organisms from this subsample were sorted prior to particle size treatment and included in the identification, enumeration and biomass determination process described above.

The method for sediment analysis followed Buchanan[3]. Approximately 100 gm (3.6oz) of wet sample was placed into a 1 liter (0.26 gal) beaker. Distilled water was carefully added until the beaker was full, then the beaker was placed in a 100°C oven for four hours. The beaker was removed, all clear liquid siphoned off, and the process repeated a second time then oven dried at 100°C. Approximately 25 gm (0.9 oz) of the dried sample was weighed (nearest 0.1 mg) on a Sartorius analytical balance. It was placed into a plastic blender cup, along with 200 ml (6.0oz) of $(NaPO_3)_6$ solution and mixed for three minutes followed by ultra-sonification to insure complete separation of particles. This material was washed into an evaporating dish with distilled water and dried in an oven at 100°C. Each dry sample was sorted through the following U S Standard sieve series while stacked on a mechanical shaker to provide the following information as per the Wentworth scale.

U S Std Sieve No.	Particle Name	Particle Size Retained
10	Gravel	2000 u
18	Very Coarse Sand	1000 u - 2000
35	Coarse Sand	500 u - 1000
60	Medium Sand	250 u - 500
120	Fine Sand	125 u - 250
230	Very Fine Sand	62 u - 125
-	Silt and Clay	less than 62 u

The fraction collected on each screen was accurately weighed with a Sartorius analytical balance.

All invertebrates collected by drift and surber nets were identified to the lowest possible taxa. Samples were sorted and stored in 80 percent ethanol with glycerin added to prevent dessication.

4A.2.4.2 Macrophytes

4A.2.4.2.1 Field Observations

During the initial field operation of each sampling quarter visual examinations of nearshore and shoreline areas within Zones 1, 3 and 6 (Green River) and stations 1 and 2 (Cypress Slough). The on-site farm ponds and streams were examined for macrophytes during the 1978 and 1979 spring quarters.

4A.2.4.3 Mussels

4A.2.4.3.1 Field Data Collection

Brailing was accomplished in Zones 2 and 5 during the 1978 spring quarter and in Zones 1, 2, 3 and 5 during the 1978 fall and 1979 spring quarters (Table 4A.2-1, Figures 4A.2-1,-2). In most cases the entire zone was brailed.

The brail consists of a six-foot long, two by four bar with a bridle attached. From this bar are attached 41 cm (16-inch chains) spaced 5 cm (2 inches) apart. At the end of each chain are four, four, four-prong "crowfoot" hooks. The tips of the hooks are melted forming a small ball.

The brail was lowered over the bow of the boat at the up-river end of each zone. The boat was put in reverse at speeds which would allow only the "crowfeet" to drag on the bottom. In theory, when one of the wire tips enter between partially open mussel valves, the valves close and the ball prevents the wire from slipping out. The mussels thus caught would be removed after the brail was hauled back into the boat.

4A.2.5 ICHTHYOPLANKTON AND MACROZOOPLANKTON

4A.2.5.1 Field Data Collection

4A.2.5.1.1 Green River

Table 4A.2-1 lists the collection dates and locations (Figures 4A.2-1 and 4A.2-2) of the day and night subsurface and day bottom collections. Night sampling commenced 1 hour after sunset. Occasionally exclusion from Zones 1 and 3 due to parked barges precluded sampling in these areas.

Triplicate samples were collected by towing a 1 m (3.3 ft) mouth diameter plankton net (560 u mesh) the entire length of the zone or for 6 minutes. A TSK flowmeter was secured within each net to determine the volume of water filtered. After completion of the tow, the net was thoroughly washed

and the sample collected in the cod end bucket. The sample was carefully placed in the appropriately labeled container and preserved with buffered 10 percent formalin. Only those samples collected during the designated quarterly sampling period were analyzed for both icthyoplankton and macrozooplankton, those subsurface samples to be analyzed for ichthyoplankton only were usually collected from Zones 3 and 6 at 10-15 day intervals from May through September 1978 and from late March through mid-May, 1979 through September 1978 and from late March through mid-May, 1979 (Table 4A.2-4).

4A.2.5.1.2 Cypress Slough

Ichythyoplankton samples were collected from Location 1 (CS-1, Figure 4A.2-3) during the 1978 Fall and 1979 spring quarters (Table 4A.2-4 Figure 4A.2-3). Location 2 (CS-2, Figure 4A.2-3) did not have adequate water depth for sampling.

During the 1978 fall quarter a one meter (3 ft) mouth diameter plankton net (560 u mesh) was towed from shore. This resulted in a dredging of the bottom sediments since the water depth was about 1 m (3.3 ft). Collections were thereafter, performed by lowering the 1 m (3.3 ft) net to the bottom from a small boat, waiting 5 minutes, and retrieving the net to the surface. This process was repeated several times, at different locations, and the contents of each net pooled to form one sample. The net was thoroughly washed after each retrieval and the sample collected from the cod-end bucket and preserved with buffered 10 percent formalin.

4A.2.5.2 Laboratory Analysis

Samples were sorted for ichthyoplankton (eggs and larvae) and macrozooplankton, using transparent gridded culture dishes placed under dissecting microscopes. All macrozooplankters, fish eggs and larvae were placed in vials and preserved with 5 percent buffered formalin. Macrozooplankton were identified to the lowest possible taxonomic level and enumerated. Dissecting and compound microscopes were used for identification. Ichthyoplankters were identified to species and developmental stage when possible and enumerated.

Samples analyzed for ichthyoplankton only were processed in the same manner except that the macrozooplankton were not sorted and identified.

4A.2.6 FISH

4A.2.6.1 Field Data Collection

4A.2.6.1.1 Green River

4A.2.6.1.1.1 Gill Nets

Experimental monofiliment gill nets 1.8 m (6 ft) x 38 m (125 ft) consisting of five 7.6 m (25 ft) long panels of 1.3; (1/2); 2.5; (1); 3.9; (1-1/2); 5.1; (2) and 6.4 cm (2-1/2 in.) square mesh were used. Three nets were set in both Zones 3 and 6 during the 1978 spring, summer, fall and 1979

spring quarters. The leadcore bottom lined nets were anchored perpendicular to the shoreline. After four hours of fishing the nets were retrieved. Nets were set during the day and night hours. Upon completion of each set, fish were removed from the net, identified to species, measured for length and weight, sexed and examined for the presence of external parasites. Determination of sex was limited to observation of external physical characteristics. Scales for age determination were removed from representative important species to permit age and growth analyses. Selected individuals of each species were preserved in 10 percent formalin buffered with borax. These preserved fish are maintained as part of the Ebasco reference collection.

4A.2.6.1.1.2 Seine

A 2.4 x 15.2 m (8x50 ft) beach seine with a 2.4 x 2.4 x 2.4 m (8x8x8 ft) bag was used to collect fish in the Green River. The main part of the seine was constructed of 12.7 mm^2 (1/2 in^2) number 9 twine with the bag of 6.4 mm^2 (1/4 in^2) number 63 twine. Areas of river bank selected for seining were completely or almost completely clear of garbage, fallen trees and heavy terrestrial plant growth. River banks in the areas seined typically had 60° slopes with water depths greater than one meter no more than two meters our from shore. Because of this steep dropoff it was necessary to utilize a boat when seining.

The prodcedure consisted of placing one person, holding an end of the seine on shore. The net was also anchored with a line to a tree or other convenient point. The boat with the bulk of the net piled into the bow was then backed down moving directly offshore. When half the net was out the boat was turned parallel with the bank letting out the remaining half of the seine plus about 8 m (25 ft) of line. Enough power was applied through the boat engine to bring the bow of the boat back to shore. On completing this placement, the boat anchor was quickly throuwn on shore, the boat operator jumped on shore and pulled the seine up on the river bank. Care was taken to avoid snags, and to insure that the net lead line retained contact with the river bottom and the float line was not pulled under. Captured fish were initially placed in water filled buckets. As soon as possible they were identified, weighed and measured for length. Those specimens not preserved were placed back into the river.

4A.2.6.1.1.3 Hoop Nets

Hoop nets 4.9 m (16 ft) long, constructed with four 76 cm (30 inch) diameter hoops, and a net throat diameter of 20 cm (8 in) were used in sampling. These nets were covered with 1.3 cm (0.5 in) square mesh netting and included a 15 m (50 ft) long, 91 cm (3 ft) high lead net. Depending on river conditions one or two nets were anchored, with the lead net set towards and pendicular to the shoreline, in Zones 3 and 6 (Figure 4A.2-1-2). Sampling was made quarterly except for the 1978 winter period (Table 4A.2-1). Initially the nets were set for four hours. However, due to inadequate catches this was later increased to 24 hours. Upon retrieval of the net fish were removed and treated as described earlier.

4A.2.6.1.1.4 Otter Trawl

A 3 m (10 ft) wide mourth otter trawl with 30 cm x 51 cm (12 in x 20 in) trawl boards and 3.8 cm (1.5 in) square mesh body and cod end was used to sample for fish.

Two trawl tows per zone covering the entire length of the zone were made quarterly in Zones 1, 2, 3 and 6 (Table 4A.2-1, Figures 4A.2.-1,-2). Parked barges in Zones 1 and 3 occasionally precluded sampling. Captured fish were treated as described earlier.

4A.2.6.1.1.5 Electrofishing

A 3.5 kW gasoline generator produced 220 volts, ac, 60 Hz, single phase electricity. The generator was connected to a Coffelt model VVP-15 variable voltage pulsator. Since the Green River conductivity ranged from 200-300 micromhos per cubic centimeter during sampling periods the electroshocker was set for DC at 450-500 volts with a 60 percent pulse width at 120 pulses per second. Two booms were extended about 1.5 m (5 ft) out from the bow. On the end of each boom 76 cm (30 inch) diameter aluminum rings supported 6 anode electrodes each. These anodes transmitted the electrical energy into the water.

Two persons operated the boat shocker. One was stationed on the bow and controlled the electrical current through a foot pedal safety switch. The second person operating the boat, regulated the pulsator to produce the optimum electrical fishing field. Those fish affected by the electrical field would surface and be collected off the bow by dip-netting. Water visibility rarely exceeding 15 cm (6 in.) restricted collecting efficiency of fish coming up to the surface. Captured fish were held in containers onboard the boat and at convenient intervals processed as described earlier. Table 4A.2-1 and Figures 4A.2-1,-2 give the dates and locations of sampling.

4A.2.6.1.1.6 Minnow Traps

Six galvanized iron minnow traps were used to collect small fish along the shoreline during the 1978 summer quarter. These traps were normally placed in 0.3m to 2m (1 ft to 6 ft) water depth and fished for at least 24 hours.

4A.2.6.1.2 Ponds

4A.2.6.1.2.1 Seine

Two seines one 1.2 m x 4.6 m (4 ft x 15 ft) the other 1.2 m x 1.8 m (4 ft x 6 ft) consisting of 6 mm (24 in) mesh netting were used in the 1979 spring sampling period (Table 4A.2-1). Nets were fished by two individuals wading out into the pond. Though most ponds were shallow with water depth normally less than 1 m (3.3 ft), the soft mud bottom, consisting of mud depths exceeding 0.6 m (2 ft), frequently limited seining access of some pond areas (Figure 4A.2-3).

4A.2.6.1.2.2 Electrofishing

A Coffett Model Type VII battery operated backpack electrofishing unit was used to sample for pond fish during the 1979 spring quarter (Table 4A.2-1). This unit was operated by two persons with waders or from a boat, capturing the affected fish with the dip nets functioning as anodes. Shocking was done along the shore and center of each pond (Figure 4A.2-3).

4A.2.6.1.3 Streams

Backpack electrofishing techniques, previously described, were used to obtain fish. Approximately 200 m (656 ft) of stream length at each station was sampled in the 1979 spring quarter (Table 4A.2-1, Figure 4A.2-3).

4A.2.6.1.4 Cypress Slough

4A.2.6.1.4.1 Seine

These nets were used as previously described. Considerable vegetation essentially obscured shoreline suitable for beaching a seine. Because of this, modification of seining techniques was necessary. This included picking up of the leadline prior to reaching the true shore and using firecrackers thrown in the water to stun fish immediately prior to seining an area. Both slough locations were sampled during 1978 fall and 1979 spring quarters (Table 4A.2-1, Figure 4A.2-3). Location 2 (CS-2, Figure 4A.2-3) was also sampled during the 1978 summer quarter.

4A.2.6.1.4.2 Electrofishing

The backpack shocker described above was used in the slough. Location 2 (CS-2, Figure 4A.2-3) was sampled during the summer quarter. Both locations were sampled during the 1978 Fall and 1979 Spring quarters (Table 4A.2-1, Figure 4A.2-3).

4A.2.6.1.4.3 Minnow Traps

Traps, previously described, were deployed during the 1979 summer quarter.

4A.2.6.2 Laboratory Analysis

Impressions in plastic of the scales from sampled fish were examined for age determination. Two independent age determinations were made for each fish. Those fishes not identified in the field were identified using keys of Kentucky and Ohio River fish. Keys used included those of Trautman[4] Moore[5], Whitaker[6], Eddy[7], and Clay[8]. A dissecting microscope was used when necessary for fish identification.

4A.2.7 LABORATORY ANALYSIS INFORMATION

Laboratory analysis of organisms collected by the aquatic ecological field program were identified by Ebasco/Envirosphere staff ecologists and by Lockhead Center for Marine Research, (Lockhead) under contract to Ebasco.

4A.2.7.1 Macroinvertebrates

Organisms collected by drift and surber net techniques were identified by Lockhead. As a control to these identifications, voucher specimens were identified by Dr Dana Abell, University of California at Davis.

Key used in identification included:

1) Pennak, R W, 1953, Fresh-Water Invertebrates of the United States, The Ronald Press Co, New York.

2) Ward, H B and G C Whipple, 1959, Freshwater Biology, W T Edmondson (ed), John Wiley and Sons, New York.

3) Usinger, R L, 1956, Aquatic Insects of California, University of California Press, Berkeley, California.

4) Mason, W T, Jr, 1973, An Introduction to the Identification of Chirnonomid Larvae, Environmental Protection Agency (EPA), Cincinnati (Analytic Quality Control Lab), Ohio.

5) Merrit, E and K Cummins, 1978, An Introduction to the Aquatic Insects of North America, Kendall/Hunt, Dubuque, Iowa.

6) Holsinger, J R, 1976 The Freshwater Amphipod Crustaceans (Gammaridae) of North America. EPA, Water Pollution Control Research Series 18050 ELD04/72, Cincinnati, Ohio.

7) Williams, W D, 1976, Freshwater Isopods (Asellidae) of North America, EPA, Water Pollution Control Research Series 18050 ELDO 5/7, Cincinnati, Ohio.

4A.2.7.2 Phytoplankton

Identification of phytoplanktonic organisms was by Lockhead. Taxon verification was performd by Dr C Goldman of the University of California at Davis.

Keys usd in identification included:

1) Patrick, R and C W Reimer, 1966, The Diatoms of the United States, Vol 1 (13), The Academy of Natural Sciences of Philadelphia, Pennsylvania

2) Bourrelly, P, 1968, 1970, 1972, Les Algues D'eau douce, Tomes I, II, III, Editions N Boulee et Cie, Paris, France.

3) Huber-Pestatozzi, G, 1938-1972, Das Phytoplankton des Siisswassers, Di Leennengewasser von Prof. Dr August Thienemann, E Schewiezerbartsche Verlagesbuchnandling, Stuttart, Germany.

4) Prescott, G W 1961, Algae of the Western Great Lakes Area, Wm C Brown Co, Dubuque, Iowa.

4A.2.7.3 Microzooplankton

Identification of microzooplanktonic organisms was by Lockhead, with taxon identification performed by inhouse staff members with expertise in zooplankton biology.

Key used in identification included:

1) Ahlstrom, E H, 1940, A Revision of the Rotatorian Genera Brachionus and Platyias with Description of One New Species and Two New Varieties, Bulletin, American Museum of Natural History, Vol LXXVII pp 143 - 184 & plates.

2) Ahlstrom, E H 1943, A Revision of the Rotatorian Genus Keratella with Descriptions of Three New Species and Five New Varieties, Bulletin, American Museum of Natural History Vol LXXX, pp 411 - 457 & plates.

3) Brooks, J L 1957, The Systematics of North American Daphina, Memoirs of the Connecticut Academy of Arts and Sciences, Vol 13, Yale University Press, New Haven.

4) Deevey, E S and G B Deevey, 1971, The American Species of Eubosmina Seligo (Crustacea, Ciadocera), Limnology and Oceanology 16(2), 201-218.

5) Pennak, R W, 1953, Fresh-Water Invertebrates of the United States, The Ronald Press Co, New York.

6) Pennak, R W, 1963, Species Identification of the Fresh Water Cyclopiod Copepods of the United States. Transactions of the Amrican Microscopical Society, 82:353-359.

7) Ward, H B and G C Whipple, 1959, Freshwater Biology, Second edition, W T Edmondson (ed), John Wiley and Sons, Inc, New York.

4A.3 TERRESTRIAL ECOLOGY

4A.3.1 INTRODUCTION

The primary objectives of the terrestrial field program were to document the occurrence, distribution, and relative abundance of important components of the flora and fauna (e.g., unique, rare, endangered, or economically important species) on and in the immediate vicinity of the Baskett Site. Consultation with individuals having regional expertise and literature review supplemented field work throughout the program. Terrestrial faunal surveys were conducted throughout the year to allow a biological assessment of the site on a seasonal basis. Vegetation surveys were conducted during the growing season. All terrestrial surveys were scheduled to coincide with optimum sampling conditions, as determined through discussions with local authorities or from the literature.

4A.3.2 VEGETATION SAMPLING

Vegetation field studies were performed by two plant ecologists during May 8-12, June 26-30, and September 18-27, 1978. Assistance in field identification of plants was provided during the spring sampling by T T Westfall, a local naturalist familiar with the site area, and during the fall sampling by M Medley, a staff member of the Kentucky Nature Preserve Commission.

Major vegetative cover types were delineated with the aid of 1978 black and white aerial photographs (approximate scale, 1:6965) and ground reconnaissance. Quantitative data were collected from each of the four natural vegetation communities identified on site: upland forest, flood plain forest, grassland, and Cypress Slough. Two sampling transects were located in each community type. Because the site includes several stands of upland forest and grassland, representative stands of these two community types were selected for sampling. The upland forest stand selected is one of the largest stands on site, and appeared less disturbed than the other stands. The location of sampling transects is depicted in Figure 4A.3-1, and sampling frequency in Table 4A.3-1.

Canopy data were recorded from 10m by 10m (33 ft by 33 ft) quadrats spaced at 40m (132 ft) intervals along the upland forest and flood plain forest transects. Canopy trees were defined as those of diameter of 5 cm (2 in.) or greater at 137 cm (4.5 ft) height. Diameter and species were recorded for each canopy tree located within a quadrat. Seven quadrats were sampled in the upland forest community, and twenty in the more extensive flood plain forest. The adequacy of sample size was evaluated through construction of species-area curves. These are graphs of the numbers of species observed versus the number of plots sampled[9], and are presented in Section 4.2.2.2.

Shrub and herbaceous vegetation data were obtained in the forest transects from 2 m by 4 m (6.6 ft by 13.2 ft) and 1 m by 1 m (3.3 ft by 3.3 ft) subplots nested in a designated corner of the 10 m by 10 m (33 ft by 33 ft) plots. Within the 2 m by 4 m (6.6 ft by 13.2 ft) shrub subplot, percent cover class was estimated for each woody species with foliage occurring at a stratum of 50-200 cm (1.6 ft-6.6 ft). Within the 1 m by 1 m (3.3 ft by

3.3 ft) herbaceous subplot, percent cover class was estimated for each woody species less than 50 cm (1.6 ft) tall and each herbaceous species. Cover classes utilized were less than 6 percent, 6-25 percent, 26-50 percent, 51-75 percent, and 76-100 percent[9]. In the herbaceous stratum, the smallest class was further divided into less-than-1 percent, and 1-5 percent.

The grassland community supported neither shrub nor canopy strata, and was sampled by ten 1 m by 1 m (3.3 ft by 3.3 ft) plots. These plots were evenly spaced along two transects which traversed two small grassland areas. Percent cover class was estimated for each species occurring in a plot.

The sampling methodology applied to Cypress Slough was modified to maximize information on the sparsely distributed cypress, and to minimize the time expended traversing the extremely dense shrub stratum. Two transects were established traversing the slough, and measured as accurately as possible with a meter tape into approximate 10 m (33 ft) intervals. The following data were recorded during June for each 10 m (33 ft) segment: number of stems of woody plants less than 5 cm (2 in) diameter which occur within 50 cm (1.6 ft) of either side of the transect; diameter and species of trees greater than 5 cm (2 in) diameter which occur within 2 m (6.6 ft) of either side of the transect; and approximate water depth. Transects in the slough were sampled again in September to provide additional data on cypress tree distribution. In this effort, estimates of cypress tree diameter (above trunk swelling) class were obtained for an area 24.4 m (80 ft) on either side of a transect. The diameter of each cypress tree was estimated from measurement of the distance from observer to tree (measured with a range-height finder), and view width of tree trunk as observed through calipers held at a known distance from the eye. From the similar triangles formed, tree diameter was calculated as follows:

$$\text{Tree diameter} = \frac{\text{(view width) (tree distance)}}{\text{caliper distance from eye.}}$$

Cypress tree diameter measurements were also obtained during September along two additional transects located across the off-site portion of the slough (see Figure 4A.3-1). In these two off-site transects, diameter classes were estimated for those cypress trees within 24.4 m (80 ft) east of the transect line.

In addition to the quantitative sampling, small wood lots on the site were systematically traversed (see Figure 4A.3-1). The dominant species in these areas were noted. Small wood lots were also investigated for the presence of rare and/or endangered species.

Voucher specimens were retained for all species where identification was considered questionable or of particular importance. Specimens of questionable identity were sent to Dr E T Browne of Memphis State University for identification and/or verification.

4A.3.3 FAUNAL SAMPLING

4A.3.3.1 Mammals

Mammal surveys were conducted in major habitat types throughout the year (Table 4A.3-1), to determine the habitat use by both large and small mammals on the Site. Nocturnal surveys, using a portable 100,000-candle power spotlight, were used to locate animals during the spring, summer, and fall (Figure 4A.3-2). Live trapping (Figure 4A.3-2) was conducted during the fall, to determine the relative abundance of small mammals. Over 1100 trapnights of effort were expended. General observations were used during all seasons to establish the occurrence of mammals in all major habitat types on the site. Efforts were particularly directed to determine whether the swamp rabbit, meadow-jumping mouse, southeastern shrew, all rare in Kentucky, and the Indiana bat, on the Federal Endangered Species List, occur on the Site. Aerial surveys provided information on the occurrence of larger mammals on the site during the spring, fall, and winter. Pit trapping (Figure 4A.3-2), conducted for reptiles and amphibians, also provided information on small mammals, particularly those difficult to capture in live traps (e.g., meadow-jumping mice and various shrews). Mist-netting was performed over open water bodies in an attempt to capture bats.

4A.3.3.2 Birds

Major habitat types were surveyed for birds during all seasons (Table 4A.3-1) to determine their use. Aerial waterfowl surveys were conducted during the spring, fall, and winter, to determine the relative importance of the Site to waterfowl in the region. Breeding bird surveys, consisting of circular plots[10], modified belt transects[11], and waterfowl brood counts, were conducted during the summer (Figure 4A.3-2) to identify critical breeding habitats on the Site, and to obtain waterfowl production data comparable to the nearby Henderson Sloughs Wildlife Management Area. General observations were used at all seasons to supplement quantitative assessments of habitat importance to avifauna.

4A.3.3.3 Reptiles and Amphibians

Because several species of reptiles and amphibians are considered rare in Kentucky and may occur on the Site, a series of pit traps was established in appropriate habitats during the spring (Figure 4A.3-2), and checked for captures during the spring, summer, and fall seasons. General observations and searches of any likely habitats supplemented pit trapping data. Netting and seining of aquatic habitats were conducted to obtain larvae and adult specimens for identification.

4A.4 LAND USE/SOCIOECONOMIC MONITORING APPENDIX

4A.4.1 INTRODUCTION

The land use/socioeconomic monitoring effort was divided into three major areas:

1) Land Use Analysis

2) Socioeconomic Analysis

3) Esthetic Analysis

The purpose of these studies was to outline baseline conditions in the site area in order to evaluate the impacts associated with plant construction and operation.

4A.4.2 LAND USE ANALYSIS

The land use analysis was conducted within a three, twenty and sixty mile radius of the site.

The three-mile survey was performed by stereoscopic analysis of 1974-1975 1:24,000 scale USGS aerial photographs of Henderson County. "Windshield" surveys were conducted to gather additional data to update and clarify the aerial photographs.

Aerial photographs and field checks were used to determine the location and population of dwelling units within three miles of the site. Additional data on current and projected development activity, land use plans and zoning regulations was obtained from the Henderson City-County Planning Commission, the Henderson County Tax Valuation Administrator, and other local and state agencies. Information on agricultural activity and prime farmlands was collected from the Henderson County Agricultural Agent and the Henderson County Soil Conservation Service. Data on local water use was obtained from the Henderson County Water District.

The generalized survey of existing and future land uses within twenty miles of the site was performed by analyzing land use maps and land use plans available through local and regional planning agencies such as the Southwestern Indiana and Kentucky Regional Council of Governments (SI and KRCOG) in Evansville, Indiana, and the Green River Area Development District (GRADD) in Owensboro, Kentucky. Recreation information for the twenty-mile radius was obtained from state outdoor recreation agencies in Kentucky and Indiana. Information on major planned industrial, residential, commercial and recereational development was obtained by contacting the SI and KRCOG and GRADD.

The land use survey within sixty miles of the site specifically gave consideration to the land uses which may be sensitive from the standpoint of air quality impact. The survey included major urban areas, large parks or or recreation areas, Indian reservations, wildlife preserves, or other significant natural or cultural resources. This was a generalized analysis with emphasis on identifying only the most significant features. Information for the sixty-mile area was obtained by contacting appropriate State and Federal agencies and by using 1:250,000 scale USGS maps.

4A.4.3 SOCIOECONOMICS

4A.4.3.1 Demographics

The demographic study surveyed existing and projected population growth and analyzed pertinent demographic characteristics for areas of 3, 20 and 60 mile radii around the site. Data for the baseline demographic data were obtained from the following sources:

- U.S. Department of Commerce, Bureau of the Census (1970 and 1977).

- State population projections for Indiana, Kentucky and Illinois obtained from Indiana University, Division of Research, School of Business, "Indiana Population Projections," Indianapolis, May, 1976.

University of Louisville, Urban Studies Center, Population Research Unit, How Many Kentuckians' Population Forcasts, 1970-2020

State of Illinois, Bureau of Budget, Illinois Population Projections, Revised, 1977, 1970-2025, Springfield, Illinois, September, 1977

- Dwelling unit counts from U.S. Soil Conservation Service Aerial photography for Henderson County flown in October of 1974 and 1975.

- Field observations, April 1978

- Discussions with local and regional planners such as

  1) Henderson City-County Planning Commission, Henderson, Kentucky

  2) Southwestern Indiana and Kentucky Regional Council of Governments, Evansville, Indiana

  3) Green River Area Development District, Owensboro, Kentucky

The number of immigrant construction workers coming to the region of the site was estimated using a multiple regression model developed by Envirosphere. The input required for these models include the 1970 population and construction employment for the counties within the study area, peak construction employment at the site and construction employment at competing projects in the area of the site for the peak years of construction at the Synthesis Gas Demonstration plant site. Information for the regression model was obtained from the following:

- 1970 U.S. Department of Commerce Census for the number of Construction Employees within 2 hrs of the site and for the 1970 population of counties within 90 minutes of the site.

- Power Engineering, New Generating Plants, May 1978 for data on projects competing for construction labor

- Information obtained from local planners, and Chambers of Commerce in the study region, for data on projects competing for construction labor.

Competing projects which were investigated include:

- Central Illinois Public Service, Newton 2, Newton, Illinois

- Southern Indiana Gas & Electric Company, A/B Brown Unit 2, West Franklin, Indiana

- Big Rivers Electric Corporation, Plans for 600 mw unit

- Kentucky Utilities, plan for a 750 mw unit in Lewisport, Kentucky

- Ebasco Services, Labor Survey, July, 1978

4A.4.3.2 Description of the Regional Economy

The regional economy was described for a six-county area within a twenty-mile radius of the site. The counties included Henderson and Daviess Counties in Kentucky, and Vanderburgh, Posey, Warrick and Spencer Counties in Indiana. Descriptive material was obtained from: (1) employment and earnings data available through the U S Department of Commerce, Bureau of Economic Analysis (BEA); (2) employment data from the state employment security offices in Indiana and Kentucky; (3) employment and sales data from the Dunn and Bradstreet files on individual firms; and (4) information contained in the U S Census of Mineral Industries, Manufacturers, Retail and Wholesale Trade, and Agriculture. Additional information gathered in the land use analyses was also used in the description of the regional economy.

Projections of economics activity by major sectors was based upon information provided by the BEA, and by regional and local planners. Studies such as the Regional Economic Base Study by the SI and KRCG were also used.

4A.4.3.3 Infrastructure

Based on a survey of the employment in the area and the results of a construction worker model run for this project (model described in Appendix 5A), it was determined that the impact on the infrastructure from construction worker influx would be felt primarily in Henderson County. The analysis showed that the resultant population increase due to project construction was estimated to be slightly more than 1% in Henderson County and less than 0.1% in Vanderburgh and Daviess Counties. Therefore, a survey of the infrastructure was limited to only Henderson County.

The infrastructure survey included a study of housing, schools, hospitals, protective services (fire and police), water and sewer facilities, and transportation networks. The majority of the data for schools, hospitals, protective services, and water and sewer facilities was collected by contacting the officials of the appropriate services in the County. Additional data was obtained from the Henderson City/County Planning Commission. Housing availability was estimated by using US Census data. Additional personal contacts with local planners, realtors and developers were made to determine the vacancy rates in housing types likely to be used by immigrant construction workers. Data on capacities and adequacy standards for facilities, services and infrastructure were obtained from the appropriate agencies.

Data on highways was obtained from the Kentucky Department of Highways. Information on existing rail service was obtained from the Louisville and Nashville Railroad. Data on barge traffic on the Ohio and Green Rivers was tabulated from information supplied by the U S Army Corps of Engineers.

4A.4.3.4 Tax Base

Information on the existing tax structure was obtained from the Henderson County Tax Evaluator. Data collected included historic and projected information on assessed valuation, bonding capacity, *ad valorem* tax rates, and revenues.

4A.4.4 ESTHETIC/VISUAL ANALYSIS

The esthetic analysis and visual impact assessment for the Baskett Site was performed by viewshed analysis. Areas from which the plant could possibly be seen were identified through the use of USGS maps, photographs taken by Project Team members, and through field surveys. The location of sensitive land uses within each viewshed was determined. Consideration was given to such uses as recreational sites, residential areas, scenic highways or waterways, wildlife refuges, parks and playgrounds and areas from which scenic views are available. Information on these areas was obtained from local officials and Project Team field surveys.

4A.5 CULTURAL RESOURCES

4A.5.1 INTRODUCTION

The University of Kentucky, through Dr M B Collins, Principal Investigator, Department of Anthropology, under contract to Ebasco Services Incorporated, performed a cultural resources survey of the Baskett Site. Field work, performed in late May and early June 1978, consisted of surface reconnaissance of the entire site area and limited subsurface back-hoe testing in the flood plain area. This field work and a literature and records search located a total of 38 cultural resource sites on or immediately adjacent to the Baskett Site[12]. All material recovered from the cultural resources survey is curated with the Museum of Anthropology, University of Kentucky, Lexington.

4A.5.2 SURFACE RECONNAISSANCE METHODS

Basic foot survey methods were utilized in the surface reconnaissance survey phase of the Baskett Site survey. Two individuals (a survey team) covered the area by placing themselves from 5 to 20 meters (16.4 ft to 65.6 ft) apart while traversing the ground (Figure 4A.5-1). Generally, certain well delineated fields or sections were surveyed as units and the intervening areas (usually wooded field boundaries) were then examined.

Surveillance of the ground was aided by two factors. First, much of the area to be surveyed was utilized as farmland, and most of the fields were plowed and/or cleared of vegetation. Secondly, since the survey was performed in early spring, vegetation and crops had not yet had time to flourish and cover the ground. Figure 4A.5-2 gives the approximate location and percentage of various ground covers and conditions.

Plowed and tilled fields generally provided excellent ground visibility, although some low-lying areas, over which water had flooded, often were covered with a very thin silt deposit which might have covered artifactual material. The area nearest the river exhibited this condition. Little subsurface reconnaissance (coring or shovel-testing) was performed in cleared and plowed field where ground visibility was good, unless surface materials were encountered.

Visibility was not as good in other areas such as standing wheat fields, hay fields, or wooded areas. Here, the paired surveyors covered the areas in the fashion illustrated in Figure 4A.5-1, although the paths were much more irregular. Efforts were made to provide a view of the ground by placing shovel tests and core samples along the paths of the surveyors. In wooded areas and hay fields, one-by-one meter "spots" were cleared to observe the soils, and shovel tests were normally dug in these cleared areas. Any exposed area such as road beds, trails, washouts, and stream banks was also investigated. While there is less likelihood of finding archeological sites in these densely vegetated areas than in the plowed fields, it is felt that the survey procedure utilized in this survey provided adequate coverage of the entire Baskett Site.

With the exception of two wetland areas, the foot survey portion of this reconnaissance attempted 100 percent coverage of the project area. These

two wetland areas are shown in Figure 4A.5-2. Together, these areas consisted of approximately 60 acres (24.3 ha), no more than 7.5 percent of the total project area. During the weeks that surveyors were in the fields, the Cypress Slough area had several feet of standing water in it. No attempt was made to survey this area although banks and edges of the slough were closely inspected. The water in this area was slowly receding during the time of the field effort was in progress. It may be possible to traverse the area at other times of the year, however, mud and silt deposits, as well as dense vegetation would probably mask any archeological sites that might be located in the slough. It is felt that little or no archeological information was lost by avoiding the slough. Likewise, the southern-most wetland areas offered similar conditions although the water was shallower and the area smaller. The surveyors made one pass through this marsh area, and decided that visibility and maneuverability were so poor that coverage of the areas was useless.

In the event that evidence of past human activity, sites, were encountered through surface finds of artifacts, core samples and/or shovel tests were placed in the area to attempt to detect any subsurface archeological deposits. Shovel testing consisted of digging a hole approximately 40 cm (1.3 ft) in diameter to a depth of no greater than 75 cm (2.5 ft). The soil profiles and excavated fill were then examined for cultural evidence. Coring allowed the surveyors to sample subsurface areas up to one meter (3.3 ft) below the surface. These samples provided a limited but useful view of upper soil deposits.

The approximate horizontal extent of any site was also delineated. Information on the location, flora, topography, and cultural remains were recorded. Photographs augmented the data collection. Artifacts found on each site were bagged and labeled.

Surface reconnaissance methods included the architectural description of standing structures located on the Baskett Site. The description included size, function, current condition, materials of construction, and a typological classification of the "style" of a structure. Additional information for the one domestic structure on site was obtained from County Tax Assessment Form photographs and other public records.

4A.5.3 SUBSURFACE BACK-HOE TESTING METHODS

In order to adequately assess the Baskett Site, it was deemed necessary to sample the subsurface deposits of the alluvial flood plain. Back-hoe testing has, in recent years, been recognized as an efficient way to quickly sample for deeply-buried archeological sites. To sample the Baskett Site, 21 back-hoe test trenches were placed in the flood plain area, and one trench was placed at the edge of the bluffs (Figure 4A.5-3). Test trenches were excavated to the water table or the maximum depth of the back-hoe arm [4 meters (13.1 ft)]. Trenches were generally 6 to 10 meters (19.7 to 32.8 ft) in length and 60 cm (2 ft) in width. In the wetter areas where the trench walls were unstable and often collapsed, trenches were shortened to 5 meters (16.4 ft) and widened to approximately 120 cm (3.94 ft). Each test trench was inspected for cultural materials or deposits, and soil profiles were mapped.

4A.5.4 HISTORICAL RESEARCH METHODS

Extensive searches through archival materials at the University of Kentucky, Henderson Library, and at the Henderson County Court House, plus interviews with local residents and historians provided valuable, although fragmentary, information on the historical significance of the Baskett Site in a regional context. In understanding the Euro-American settlement of the Baskett Site, the Deed and Will Books on file at the Henderson County Courthouse were invaluable references.

4A.6 GEOLOGY AND GEOHYDROLOGY

4A.6.1 INTRODUCTION

Geological investigations undertaken for the proposed Syngas Plant in northwestern Kentucky defined the regional setting of the site area, assessed the general foundation conditions at the site, and evaluated the site's geological suitability. Investigations included both a review of existing pertinent literature and preliminary field studies in the site area.

The literature review, designed to establish the regional framework of the site area, defined the physiographic, geologic and geohydrologic settings and the seismic history. Field studies encompassed geological reconnaissance, exploratory drilling, a seismic refraction survey, preliminary groundwater studies, and air photo analysis.

4A.6.2 EXPLORATORY DRILLING

Except where topography, trees, or water required minor relocations, the borings were drilled on a grid with 800 to 1000-ft spacing and on a line with 2000-ft spacing to the Green River. Thirty borings, totaling 1542 linear feet, were drilled. The borings were completed by ATEC Associates, Inc. using two truck-mounted drilled rigs, a Mobile B-50 and CME 55. Standard penetration tests using a 1-3/8-in. I.D. split spoon sampler were performed in soils and weathered rock at 5.0-ft intervals down to the depth of refusal (100 blows per 1-ft penetration). Hollow-stem augers were advanced to the top of each drive-sample inverval. Rock coring was initiated upon split spoon or auger refusal. NX double-wall core barrels with diamond drill bits were used for rock coring. Falling head permeability tests were performed in soil, and packer tests were performed in bedrock. These tests were performed in accordance with standards established by the Bureau of Reclamation. Logs of all borings are included in Appendix 4B.6.

Piezometers were installed in borings A-1, A-9, A-11, A-18, A-25, and A-27. The piezometers, consisting of 3-in PVC pipe, were capped at their base and the bottom portion slotted (4-6 slots per foot) over a 10-ft length. They were lowered to the test depth through the augers. The borings were backfilled with sand to approximately 6-ft from the surface after the augers were removed. The remainder of each boring was filled with soil and sealed with a bentonite cap.

4A.6.3 SEISMIC REFRACTION SURVEY

A seismic refraction survey was carried out in the area proposed for the location of the plant and ash ponds. The primary purpose of the survey was to provide approximate depths to the top of bedrock at locations between borings. The survey was also used to supplement borehole data related to the engineering properties of the soil and rock.

Equipment for the seismic investigations consisted of a portable Nimbus ES-1200 12-channel, battery-operated seismograph, 12 geophones, connecting cables, an 8-lb sledgehammer with impact-sensing switch, and a striking plate. The seismograph stacks and enhances signals from repeated hammer

blows and produces a permanent seismogram on photographic paper. Thirty-four 12-geophone spreads, totaling 3850 linear ft, were surveyed.

Seismograms were interpreted to determine the depth of the contact between the base of the unconsolidated Quaternary deposits (loess and alluvium) and the top of the Paleozoic rock units. The intercept-time method was used to calculate the depth below the shot end of each spread. In addition, the true velocities of the P-waves through the soil and rock were calculated for each spread by computing the harmonic mean of the apparent velocities at both shot points of a spread. Time-distance plots are included in the project Site Confirmation Report[13].

4A.6.4 GROUND-WATER INVESTIGATIONS

Preliminary ground-water studies were conducted at the proposed site to determine in-situ permeabilities of the Quaternary sediments and Paleozoic bedrock, as well as to initiate monitoring of ground-water level to acquire baseline ground-water data. Six piezometers were installed and three falling-head tests and a single packer test were conducted. Weekly water-level readings are currently being taken at each of the piezometers. Equipment and methods used in gathering preliminary data on the ground-water system of the site are described in Section 4A.6.2, Exploratory Drilling.

4A.6.5 AIR PHOTO ANALYSIS

A photogeology study was made for a 10-mile radius about the site area, mainly to identify linear features which could be the surface expressions of geologic structures and to review the geomorphology of the region. The photographs studied were 9 x 9 in, black and white, 1:24,000-scale format flown during 1974 and 1975. Monoscopic and stereoscopic viewing techniques were used in the analysis, and interpretation was made using standard photogeology techniques.

4A.7 WATER QUALITY MONITORING PROGRAM

4A.7.1 INTRODUCTION

This section describes the water quality monitoring program conducted to gather site-specific water quality data necessary for the environmental assessment of the Syngas Plant at the Baskett, Kentucky site on the Green River. The field work and certain analyses were undertaken by National Laboratories Inc, Evansville, Indiana. Analysis of polycyclic aromatic hydrocarbons (PAH's) was under the direction of Dr Paul Goodley, Department of Geology and Chemistry, Murray State College, Murray, Kentucky.

A quarterly surface water and groundwater quality monitoring program including field sampling and laboratory analyses was undertaken to establish seasonal water quality for the period of Fall, 1978 through Summer, 1979. PAH's were sampled in the Green River and the on-site stream during winter, spring and summer sampling events.

4A.7.2 PROGRAM DESCRIPTION

4A.7.2.1 Monitoring Stations

Four (4) surface water and two (2) groundwater sampling stations are shown in Figure 4A.7-1. For the Green River, the sampling program was conducted at mid-stream, mid-depth at River Mile 1.5. Samples were also collected from the Cypress Slough, near the inlet of the on-site stream and near the Slough outlet to the Green River. The on-site stream was sampled at approximately elevation 375 MSL, in the vicinity of the sharpest slope of the surrounding terrain.

During the initial sampling period in Fall 1978, surface water sampling stations were established in the field and their locations were marked by means of survey marking stakes and flags. Stakes were located on high ground wherever possible to avoid submergence at times of high water level (e.g., spring flood).

The on-site stream station is located at the confluence of two tributaries. Since the stream bed was dry during the initial sampling event, the Cypress Slough inlet station was tentatively established by visual observation of the ground contours, and markers established by members of the Ebasco/ Envirosphere aquatic ecology field program during Spring, 1978.

Groundwater was sampled initially (Fall 1978) at two locations on-site, utilizing observation wells A-11 and A-18 placed previously during the site soils investigations. The groundwater sample was withdrawn from the groundwater contained in the alluvial acquifer above bed rock, the terminus of borings. The depth for observation well A-11 was approximately 7.3 m (24 ft) and approximately 12.2 m (40 ft) for A-18. Sampling of A-11 continued for the Winter, Spring and Summer quarters.

4A.7.2.2 Sampling and Monitoring Schedule

The water quality monitoring program for the Green River, the Cypress Slough, on-site stream and groundwater was executed from Fall, 1978 through

Summer, 1979. Table 4A.7-1 shows the water quality sampling schedule in that period. The Green River Station water was monitored twice per quarter on two consecutive days. Other surface water stations (Cypress Slough and the on-site stream) were monitored once per quarter. One groundwater station, Station A-11, was monitored once per quarter.

4A.7.2.3 Parameters Selected for Monitoring Program

Water quality parameters selected for monitoring both surface water and groundwater program are shown in Table 4A.7-2. Among these parameters, pH, temperature, dissolved oxygen (DO) and specific conductance were measured on-site. The remaining parameters were analyzed in the laboratories.

The parameters were selected based on the consideration of (1) Kentucky Water Quality Criteria, (2) US EPA Effluent Limitations for relevant point source industrial discharges, (3) information necessary for assessing project impacts on the site ecosystems[12], (4) potential discharges from coal gasification processes in general[18], and (5) data required for designing plant water treatment systems. Table 4A.7-3 summarizes the bases for parameter selection.

4A.7.2.4 Sampling Procedure

The sampling procedures described in this section include the techniques and methods used for sample collection, identification, preservation, transportation and storage.

At the time of sample collection, all relevant field notes were taken to describe the sampling conditions. These notes included weather and visual observations.

Sampling equipment for each station is summarized in Table 4A.7-4. Surface water samples from the Green River Station were collected using a boat to approach the mid-stream mid-depth station. The boat was anchored and sampling commenced after about five minutes to permit the boat-induced wave to stabilize.

Samples were withdrawn by means of a hand-operated positive displacement diaphragm pump. Those samples which required elimination of entrained air were sampled by means of displacement-type BOD sampler. Rigid PVC piping, of adequate length positioned by hand at mid-depth, was used as the pump suction. The chain which lowered the BOD sampler was depth-calibrated to ensure repeatability of sampling location. The The pump was purged with approximately two liters of river water prior to collection of any sample. The BOD sampler was of self purging design in that water entered the sample bottle inside the sampler by means of a tube, filled the bottle, and was displaced twice in filling the vented container. The polycyclic aromatic hydrocarbon (PAH) sampler was a brass Kemmerer bottle which was submerged to the desired depth and then filled.

When water depth was shallow, surface water samples from the Cypress Slough stations were withdrawn in the area of the inlet and discharged by inverting sample containers at mid-depth and slowly displacing the contained air.

When water depths were high, samples were withdrawn by a pump or a BOD sampler, lowered into the water from a boat.

Surface water samples from the on-site stream were collected using the same techniques as described for the Slough except the brass Kemmerer bottle was used for PAH samples.

Groundwater sampling was carried out using a 2 liter submersible sampler fabricated by the analytical laboratory. Three days prior to the sampling date, the well was pumped dry once a day using the hand-operated pump, in order to purge standing water from the well.

The individual sample bottles were identified as to sample point and preservative method.

Table 4A.7-5 summarizes the techniques applied for the preservation of samples. These methods conform to EPA recommended practice[2] or analytic subcontractor requirements. Chemical preservatives, inorganic acids, were premeasured into sample containers to facilitate field work. Samples requiring cooling were transported to the laboratory in insulated portable storage containers packed with ice or precooled commercial gel packets. Upon arrival at the laboratory of the field collection subcontractor, National Laboratories, the samples were transferred to a utility refrigerator for temporary or long-term storage, or, in the case of the PAH samples, immediately packed for air shipment to Murray State College.

For parameters other than PAH's, transportation of samples between sampling stations and laboratory was always completed within four hours of sample collection. For the winter and summer sampling events, PAH samples were air shipped to the Murray State College Laboratory within 24 hours of sampling. For the spring sampling, PAH samples were shipped by bus to the college.

4A.7.2.5 Field Measurements

Field measurements were conducted to determine values for DO, temperature, pH and specific conductance. During the Fall, 1978 sampling period, specific conductance was measured at the laboratory. At each sampling station, in-situ measurements of these parameters were conducted immediately upon sample withdrawal, using one liter or three liter volumes. Values were recorded immediately. The DO meter was adjusted to compensate for the temperature of the sample. The pH meter was calibrated using prepared pH standards of 4.0 and 10.0 prior to each analysis.

The apparatus used for field analyses is summarized in Table 4A.7-6. A complete description of the field apparatus follows.

Thermometer - Calibrated in degrees Centigrade, 0.0 to 100.0 in one degree intervals. Steel case, mercury indicator, manufactured by Weksler Instruments Corp., Freeport, New York.

pH Meter - Calibrated in hundredths of pH units. Manufactured by Beckman Instruments; Model G, Serial No. 149218.

Dissolved Oxygen Meter - Calibrated in tenths of a mg/l dissolved oxygen. Manufactured by Yellow Springs Instrument Company, Yellow Springs, Ohio; Model 51B, Serial No. 6164.

Conductivity Meter - Calibrated in micromhos/centimeter. Manufactured by Hach Chemical Company, Ames, Iowa; Model DR/EL-2, Serial No. 801784.

4A.7.2.6 Laboratory Analyses

Laboratory analyses were performed by National Laboratories to determine values for the non-PAH parameters by the methods given in Table 4A.7-7. These analyses were performed according to standard methods[15,16]. Values were recorded on laboratory data sheets, which appear in Appendix 4B.

Analytic instruments used in these laboratory analyses are described as follows:

Spectrophotometer - Model Spectronic 100, Serial Number 9453 TD, manufactured by Bausch and Lomb, Rochester, New York.

Atomic Absorption Spectrophotometer - Gerald Ashe Model 82-500 with Mark I Anacomp and Speedomax W recorder. Recorder manufactured by Leeds & Northrup Company. Unit has been modified by replacement of the original burner with a laminar flow assembly, and by replacement of gas control panel to accommodate more and different gases.

Total Organic Carbon Analyzer - Beckman Instruments, Model 905.

Laboratory pH Meter - Corning Laboratories, Incorporated, Cedar Falls, Iowa, and equipped with an Orion 094268 specific ion electrode and a 476002 (13-9) single contact reference electrode for fluoride analyses.

Amperometric Titrator - milliamp meter with a resistance branch circuit constructed by the analyst for total residual chlorine.

The PAH samples were analyzed at Murray State College using:

High Pressure Liquid Chromatography, with fluorescent and ultra-violet detection - Waters Associates, Model 440; Model 420C Flourimeter; Model 440 UV Detector; Infotronics Model CRS-104 GC Integrator.

Gas Chromatography - Hewlitt Packard Gas Chromatograph Model 5840A

Mass Spectrometry (computerized) - Hewlitt Packard Model 5985A GCMS Computer

4A.7.2.7 Quality Control/Quality Assurance

The quality of the field sampling work was assured through the presence of Ebasco personnel in the field, in a supervisory and observatory capacity, during the initial sampling event.

The quality of National Laboratories' analytic work was assured through the implementation of quality control and assurance procedures. These procedures are:

1) Analysis of one standard with each set of samples.

2) Analysis of reagent blanks on a routine schedule.

3) For those analytic procedures such as atomic absorption spectrometry, which have multiple variables, a complete calibration curve was prepared for each set.

4) Standards for any parameter which may be unstable or may be adsorbed onto surfaces of containers were freshly prepared for each sample set.

Techniques designed to eliminate erroneous results from the data set include:

1) Review of analytic results, in view of the origin of the sample, to determine if results are within the anticipated range. Should an analysis appear to yield results which diverge from expected range, the laboratory procedure was repeated.

2) Where feasible, the results of in-situ analyses were rechecked using laboratory methods, as with dissolved oxygen.

4A.8 HYDROLOGY

4A.8.1 INTRODUCTION

This section provides the sampling methodology used in gathering the flow characteristics of the Green River, the receiving water body for the Syngas Plant.

Sampling parameters of the Green River included in-situ temperature measurement, vertical profiles of current speed, current direction and temperature at specified depths of near bottom, mid-depth and near surface, and detailed bathymetry of the river in an area 1500 ft upstream and downstream of the discharge location. Sampling locations are shown in Figure 4A.8-1. Sampling schedules are given in Table 4A.8-1.

Field sampling was performed utilizing standard sampling procedures. The equipment was operated as outlined in vendor manuals. The description in this section, therefore, is limited only to the type of equipment used and the data analysis.

4A.8.2 VERTICAL PROFILES

4A.8.2.1 Equipment and Methodology

Vertical profiles of the Green River were made with an Endeco 110 Profiling Current Meter. Five (5) predetermined lines, where profiles were made, are shown in Figure 4A.8-1. Three (3) stations were sampled on each line. Measurements of current speed and direction, temperature and depth were made at each station. The measurements were made by anchoring the survey vessel, and lowering the profiling current meter over the side to the specified depth. When barge traffic on the river was too heavy to allow sampling at the regular locations, profile locations at the river bank area were moved to deeper sections of the river but along the same line.

4A.8.2.2 Analysis

Vertical profile data gathered during the field study was tabulated. Tabulated data was analyzed to determine maximum, minimum and average characteristics and for comparison with available historical data.

4A.8.3 IN-SITU TEMPERATURE MONITORING

4A.8.3.1 Equipment and Methodology

In-situ temperature measurements of the Green River, utilizing an Endeco Type 109 Thermograph, were made for a period of three months starting in July, 1978.

Temperature measurements were made at a moored location approximately 500 ft downstream of the proposed discharge location. The temperature recorder was mounted on the mooring as shown in Figure 4A.8-2. Temperature was recorded at hourly intervals, over a one month period for 3 months. At the end of each month, film packs of data were retrieved and sent to the vendor for development and analysis. When data was retrieved, a second film unit was

put in to provide uninterrupted data acquisition. A history of sampling periods is given in Table 4A.8-1.

4A8.3.2 Analysis

Analysis of in-situ temperature data was made initially by the vendor from the film packs of data sent directly from the field. The vendor developed and provided Ebasco with printouts of hourly and mean temperatures on a daily basis. Ebasco then compared historical records and vertical profiles obtained in the field with this data.

4A.8.4 BATHYMETRY

4A.8.4.1 Equipment and Methodology

Detailed bathymetry measurements were made utilizing a Raytheon DE-719B fathometer and a Motorola Mini-Ranger III for positioning. Operation and calibration procedures were carried out according to vendor specifications.

Bathymetry data was recorded by making lateral crossings of the river and recording depth and position simultaneously. Once the area of interest was covered, tie-lines were run up and down stream to provide further data cross checks.

4A.8.4.2 Analysis

A detailed contour map was prepared by plotting depth at known locations from recorded data. All depths are referenced to Mean Sea Level and include river stage corrections. In addition, cross-sections at appropriate areas were constructed.

4A.9 AIR QUALITY AND METEOROLOGY

4A.9.1 INTRODUCTION

The air quality in the vicinity of the Syngas Site has been characterized based on data collected by the Division of Air Pollution Control (KDAPC) of the Kentucky Department for Natural Resources and Environmental Protection. In general, the KDAPC data was collected in urbanized areas where emission densities of the pollutants of interest are greater than corresponding emission densities near the proposed site; therefore, a qualitative assessment of emission densities and other factors that affect air quality was necessary to properly characterize the air quality near the proposed site.

To supplement the qualitative assessment of air quality of the proposed site, mobilization for an on-site air quality monitoring program was initiated in late 1978. The collection phase of the program began in March 1979 and continued through a full annual cycle.

Meteorological data from the National Weather Service Station at the Evansville Dress Regional Airport was used to provide a climatological description of the proposed site. This data provided representative climatology for the site area, however, on-site monitoring of wind speed and direction was incorporated into the monitoring program to determine if terrain or other local effects modify the nature and distribution of the wind at the site. The data was also to be used in quality control of the monitored air quality data.

Monitoring methods and equipment met EPA Reference Methods or equivalency requirements where applicable. Table 4A.9-1 lists the pollutants monitored and the methods and equipment used. The equipment was housed in a temperature-controlled trailer. Analyzer outputs were continuously recorded on strip-chart records. Zero and span cycles were automatically activated on a daily basis.

The expected location of the area of maximum air pollutant concentration increase due to the operation of the proposed plant was investigated by mathematical modeling of plant emissions with representative meteorological data. The area of maximum impact from combined existing and proposed emission sources was investigated. Monitoring was conducted in the area where these investigations indicate the greatest impact would occur.

Reports describing the monitoring activities, and summarizing the data collected were prepared on a quarterly basis. These quarterly reports tabulated and summarized data in a format acceptable to the State of Kentucky Division of Air Pollution Control and EPA.

4A.9.2 CONTINUOUS AIR QUALITY MONITORING

Continuous ambient monitoring was conducted for sulfur dioxide, carbon monoxide, nitrogen oxides (NO_x) and photochemical oxidants (ozone) as indicated by a review of both legal and technical requirements. Estimates of emissions of criteria pollutants from the proposed plant indicate that it will be a major source with respect to these criteria pollutants.

Henderson County has been designated as a non-attainment area for photochem-

ical oxidants (ozone). Various atmospheric reactions involving nitrogen oxides (NO_x), hydrocarbons, and sunlight are associated with the formation of photochemical oxidants. Since the NO_x and hydrocarbon emissions from the plant were expected to be significant, continuous monitoring for photochemical oxidants was included in the monitoring program.

Although potential atmospheric emissions of ammonia exist only during emergency venting and the handling of the ammonia product, and controls and procedures have been established to prevent such emissions, the potential emissions are significant before the controls are implemented. Consequently, continuous monitoring of ammonia was included in the air quality monitoring program.

4A.9.3 PARTICULATE SAMPLING AND ANALYSIS

Total suspended particulates (TSP) were monitored using high volume samplers. Gravimetric analysis was performed on the high volume sampler filters to determine total suspended particulates concentrations. Additional laboratory analysis was performed on the particulate matter collected on the high volume sampler filters to determine concentrations of total organic and inorganic fractions and sulfates. Specific filters were selected (ie, those with higher loadings) for these additional analyses. This information provided some indication of background levels of these materials. Data on the total organic and inorganic fractions provided an indication of the origin of the collected suspended particulate matter and the amounts attributable to natural sources, such as fugitive dusts from agricultural tilling operations or dirt roads.

Laboratory analyses also determined the concentrations of certain trace elements and polycyclic aromatic hydrocarbons (PAH's) (See Table 4A.9-2). This information provided some indication of the background levels of these substances.

4A.9.4 METEOROLOGICAL MONITORING

The meteorological program consisted of continuous monitoring of wind speed and direction. These measurements were made from a 10-meter tower as is standard meteorological practice.

4A.10 NOISE

4A.10.1 INTRODUCTION

A sound survey was conducted during the period of August 7-10, 1978, to describe the ambient sound field at the Basket Site.

4A.10.2 MONITORING PROCEDURE

The ambient sound survey included both the collection of statistical data such as L_1, L_5, L_{90} and "Leq" descriptors which were obtained with a GenRad 1945 Community Noise Analyzer, and manual observations of the residual sound level measured with a GenRad 1933 Precision Sound Level Meter and Analyzer.

Ambient sound measurements were conducted at 8 locations designated as A, B, C, D, E, F, and I and II (Figure 4A.10-1). Location A is at a residential home near Tscharner Road. Location B is at a seasonal home near Green River. Location C is on the property of Henderson Golf and Country Club. Location D is near the Baskett Christian Church. Locations E and F are at residential homes near Tillman Bethel Road. Location I is at the site boundary near Tscharner Road and location II is at the entrance to Henderson Golf and Country Club. At locations A, B, C, D, E and F ambient data were collected for one continuous hour both during daytime hours (7:00 to 22:00) and nighttime hours (22:00 to 7:00). At locations I and II, ambient data were collected for only half an hour period during daytime hours (7:00 to 22:00).

The one half hour and one hour noise monitoring was performed with a GenRad Community Noise Analyzer Model 1945 which was the primary sound measuring device employed for this survey. This instrument is a self-contained battery powered sound monitoring device, which obtains 8191 samples and 16382 samples of the A-weighted level for half an hour and one hour of monitoring, respectively. It computes a statistical distribution of such sound levels, and at end of the monitoring period it displays that distribution in a digital form.

At all eight monitoring locations, brief sampling measurements were made by the technique of observing the residual A-weighted sound level. This procedure is a classic observation method which has been in use for a number of years prior to the introduction of equipment for more detailed statistical studies. In this procedure, the observer uses both his ears and a sound level meter which is normally set on the "slow" scale. He listens for the absence of discrete identifiable sounds, such as passing vehicles or planes. At the brief moment when such sounds are absent, he reads the minimum indication. It has been shown[17], that residuals observed by the brief-sampling technique, are approximately equal to the L_{90} value which is obtained by a statistical analysis of the ambient field at that location. This provides a check on, and complements, the more complete data displayed by the Community Noise Analyzer.

All residual measurements were obtained with a GenRad 1933 Precision Sound Level Meter and Analyzer, which meets the requirements of ANSI S1.4-1971 for Type 1 Sound Level Meters.

Both the 1945 Community Noise Analyzer and the 1933 Precision Sound Level Meter were equipped with a microphone wind screen to reduce wind effects. Calibration of the sound instruments was performed at each monitoring location with a GenRad Field Calibrator Type 1562-A, prior to and immediately after the measurement period.

All eight monitoring locations were selected after an evaluation of the noise sensitive land uses surrounding the site and the location of traffic arteries such as U.S. Route 60. Of greatest importance were residential homes that are located close to the site and consequently are in a potential noise impact zone. Other considerations given to the selection of the monitoring locations were the estimated outer limit of plant noise impact, and the location of various recreational areas surrounding the site. In addition to gathering ambient data at specific residential locations, an effort was made to sample the sound levels indicative of the ambient field of the rural agricultural land stretching between the Green River and U.S. Route 60.

Numerous other informal observations were made during the monitoring period, such as observing railway, road traffic and aircraft activity in the area, observations of land pattern use and topography, and identification of human activities that could contribute to the ambient noise field. These observations complement the physical measurement of sound and are essential to the understanding of the ambient noise levels at Baskett Site.

Informal weather observations were obtained throughout the measurement period, at each monitoring location, to assure that the weather was suitable for acoustic monitoring. These observations were made by using hand-held instruments 4 to 5 feet above ground level.

Wind on the microphone produces a noise which is mainly of low frequency. The noise may seriously upset the measurement, particularly for high wind speeds, since the noise increases with wind speed.

During the acoustic monitoring period the recorded wind speed was low (between 0-4 mph), which made the weather conducive to environmental noise measurements.

A relative humidity in excess of 90% could affect the sensitivity of the electret type microphone which was used in this survey. Hence, no ambient noise measurements were made during relative humidities greater than 90%.

The output of the 1562 calibrator varies somewhat with pressure, and a correction should be made when the atmospheric pressure is significantly different from 1013 millibars. The range of barometric pressures that were recorded at the time of the survey were such (1001-1018 millibars) that this type of correction was not necessary.

4A.10.3 MONITORING EQUIPMENT

The monitoring equipment utilized at Baskett site consisted of the following equipment:

1) GenRad Community Noise Analyzer Model 1945, Serial no. 154

2) GenRad Precision Sound Level Meter and Analyzer Model 1933, Serial no. 620.

3) GenRad Field Calibrator Type 1562-A, Serial no. 8710

4) Bendix Psychrometer, Model 566

5) Lambrecht Anemometer, Model WP3

6) Bruel & Kjaer Barometer

4A.10.3.1 Description Of GenRad 1945 Community Noise Analyzer

The 1945 Community Noise Analyzer is a complete self-contained instrument used to monitor noise and to calculate and display a varity of exceedance levels (L%), as well as the equivalent level (Leq) or the day-night level L_{dn}. This instrument is basically a sound level meter with several choices of weighting followed by a memory, digital processor and a numerical display. Weighted sound-level, L exceedance levels, and Leq or L_{dn} levels can be digitally displayed. The analyzer operates over a dynamic range from 23 to 120 dB without switching. All data can be stored in a digital memory.

The A- and C- weighting frequency networks meet ANSI S1.4 - 1971 Type 1 and IEC - 179 - 1965 requirements. The 1945 also features a true root mean square detector with both "fast" and "slow" time constants.

Up to three sequential measurements runs can be preselected, with durations from 1/2 hour to 24 hours. This instrument can be programmed with the initial starting time; the second and third runs automatically follow in sequence.

The instrument is normally powered by self-contained batteries or it can be operated from an external 12-V power supply or automotive battery.

4A.10.3.2 Description Of The GenRad 1933 Precision Sound Level Meter And Analyzer

The 1933 Precision Sound Level Meter and Analyzer is a portable sound analyzer with an impulse precision sound-level meter and an octave band spectrum analyzer. It includes A, B and C weighting characteristics and ten octave band filters with band center frequencies ranging from 31.5 Hz to 16 KHz. It has an additional flat frequency response extending from 5 Hz to 100 KHz. This instrument meets ANSI S1.4-1971 Type 1 and IEC 179-1965 requirements for Precision Sound-Level Meters.

During the sound survey, the 1933 Analyzer was fitted with a 1/2 inch electret condenser microphone with a flat random incidence response.

APPENDIX 4 A MONITORING METHODOLOGY

REFERENCES

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TABLE 4A.2-1

AQUATIC ECOLOGY SAMPLING SCHEME - PHYTOPLANKTON

	Sample			
Water Body	Location	Collection Method	Replication	Dates
Green River	Zones 1,2,3 & 5	Whole Water	1	26 May 1978
Green River	Zones 1,2,3 & 5	Whole Water	1	11 July 1978
Green River	Zones 1,2,3 & 5	Whole Water	1	12 September 1978
Green River	Zones 1,2,3 & 5	Whole Water	1	22 January 1979
Green River	Zones 1,2,3 & 5	Whole Water	1	8 May 1979
Cypress Slough	1 & 2	Whole Water	1	9 September 1978
Cypress Slough	1 & 2	Whole Water	1	24 May 1979
Ponds	1,2 & 3 (near shore & center)	Whole Water	1	24 May 1978

TABLE 4A.2-2

AQUATIC ECOLOGY SAMPLING SCHEME - MICROZOOPLANKTON

Water Body	Sample Location	Sample Collection Method	Sample Replication	Sample Dates
Green River				
(1) Day	Zones 1,2,3 & 5	Pump (76 u)	3	26 May 1978
Day	Zones 1,2,3 & 5	Pump (76 u)	3	11 July 1978
Day	Zones 1,2,3 & 5	Pump (76 u)	3	12 September 1978
Day	Zones 1,2,3 & 5	Pump (76 u)	3	22 January 1979
(2) Diel Migration (surface & bottom)	Zones 2 & 3	Pump (76 u)	3	26 May 1978
	Zones 2 & 3	Pump (76 u)	3	11 July 1978
	Zones 2 & 3	Pump (76 u)	3	12 September 1978
(3) Net Pump Comparison	Zones 2 & 5	Net Tow (76 u)	1-3	26 May 1978
	Zones 2 & 5	Net Tow (76 u)	1-3	11 July 1978
	Zones 2 & 5	New Tow (76 u)	1-3	12 September 1978
	Zone 5	Net Tow (76 u)	1-2	22 January 1979*
Cypress Slough	1 & 2	Net Tow (76 u)	3	9 September 1978
Cypress Slough	1	Net Tow (76 u)	3	24 May 1979
Ponds	1,2 & 3 (near-shore & center)	Pump (76 u)	3	24 May 1978

* Not analyzed

TABLE 4A.2-3

AQUATIC ECOLOGY SAMPLING SCHEME - BENTHOS

Water Body	Sample			
	Location	Collection Method	Replication	Dates
Green River				
(1) Macroinvertebrates				
(i) Preserved (Identification & Enumeration)	Zones 1,3 & 6	Ponar	2	19 May 1978
	Zones 1,2,3 & 5	Ponar	2	13 July 1978
	Zones 1 & 5	Ponar	3	25 September 1978
(ii) Preserved (Identification, Enumeration & Sediment)	Zones 1,2,3 & 5	Ponar	1	13 July 1978
(iii) Live (Identification, Enumeration & Biomass)	Zones 2 & 3	Ponar	2	25 September 1978
	Zone 1	Ponar	3	5 May 1979
	Zone 3	Ponar	2	5 May 1979
(iv) Live (Identification, Enumeration, Biomass & Sediment)	Zones 2 & 3	Ponar	1	25 September 1978
	Zone 3	Ponar	1	5 May 1979
(2) Mussels	Zones 1,2,3 & 5	Brail Tow	3	23 June 1978
Mussels	Zones 1,2,3 & 5	Brail Tow	3	6 September 1978
Mussels	Zones 1,2,3 & 5	Brail Tow	3	23 May 1979
(3) Macrophytes	Zones 1,3 & 6	Observed	1	26 May 1978
Macrophytes	Zones 1,3 & 6	Observed	1	11 June 1978
Macrophytes	Zones 1,3 & 6	Observed	1	12 September 1978
Macrophytes	Zones 1,3 & 6	Observed		23 May 1979
Cypress Slough				
(1) Macroinvertebrates				
(i) Preserved (Identification & Enumeration)	1 & 2	Ponar	2	9 September 1978
	1 & 2	Ponar	2	24 May 1979
(ii) Preserved (Sediment)	1 & 2	Ponar	1	24 May 1979
(2) Macrophytes	1 & 2	Observed	-	16 July 1978
Macrophytes	1 & 2	Observed	-	9 September 1978
Macrophytes	1 & 2	Observed	-	24 May 1979

TABLE 4A.2-3 (Cont'd)

AQUATIC ECOLOGY SAMPLING SCHEME - BENTHOS (Cont'd)

Water Body	Sample			
	Location	Collection Method	Replication	Dates
Ponds				
(1) Macroinvertebrates				
(i) Identification & Enumeration	Ponds 1,2 & 3 (near-shore & center)	Ponar	2	24 May 1978
(2) Macrophytes	Ponds 1,2 & 3	Observed	-	24 May 1978 20 May 1979
Streams				
(1) Macroinvertebrates	Stations 1,2,3 & 4	Drift Nets	4	20-21 May 1978
Macroinvertebrates	Stations 1,2,3 & 4	Surber Nets	2	10-21 May 1978
(2) Macrophytes	Stations 1,2,3 & 4	Observed	1	20 May 1978
Macrophytes	Stations 1,2,3 & 4	Observed	1	19 May 1979

TABLE 4A.2-4

AQUATIC ECOLOGY SAMPLING SCHEME - ICHTHYOPLANKTON AND MACROZOOPLANKTON

Water Body	Sample: Location	Sample: Collection Method	Sample: Replication	Sample: Dates
Green River		-ICHTHYOPLANKTON AND MACROZOOPLANKTON		
(1) Day (Surface)	Zones 2 & 5	Net Tow (560 u)	3	18 May 1978
	Zones 1,3 & 6	Stationary Net	2	19 May 1978
	Zones 2,3 & 6	Net Tow (560 u)	3	12 July 1978
	Zones 1,2,3 & 6	Net Tow (560 u)	3	5 September 1978
	Zones 2 & 6	Net Tow (560 u)	3	19 January 1979*
	Zones 1,2,3 & 6	Net Tow (560 u)	3	Spring 1979
(2) Diurnal Migration (Surface)	Zone 2	Net Tow (560 u)	3	18 May 1978
	Zones 3 & 6	Net Tow (560 u)		12 July 1978
	Zones 3 & 6	Net Tow (560 u)		5 September 1978
	Zone 6	Net Tow (560 u)	3	19 January 1979
Cypress Slough				
Day (Surface)	1	Oblique Tow (560 u)	3	24 May 1979
		- Ichthyoplankton (only) -		
Green River				
Day (Surface, Except **)	Zone 3	Stationary Net	2	28 May 1978
Day	Zone 6	Net Tow (560 u)	3	28 May 1978
Day	Zones 3 & 6	Net Tow (560 u)	3	8 June 1978
Day	Zones 3 & 6	Net Tow (560 u)	3	28 June 1978
Day	Zones 3 & 6	Net Tow (560 u)	3	26 July 1978
Day	Zones 3 & 6	Net Tow (560 u)	3	9 August 1978
Day	Zones 3 & 6	Net Tow (560 u)	3	22 August 1978
Day	Zones 3 & 6	Net Tow (560 u)	3	14 September 1978
Day	Zones 3 & 6	Net Tow (560 u)	3	25 September 1978
Day	Zones 3 & 6	Net Tow (560 u)	3	28 March 1979
Day	Zones 3 & 6	Net Tow (560 u)	3	7 April 1979
Day**	Zone 3	Net Tow (560 u)	3	7 April 1979
Day	Zones 3 & 6	Net Tow (560 u)	3	14 April 1979
Day**	Zone 3	Net Tow (560 u)	3	14 April 1979
Day	Zones 3 & 6	Net Tow (560 u)	3	27 April 1979
Day**	Zone 3	Net Tow (560 u)	3	27 April 1979
Day	Zones 3 & 6	Net Tow (560 u)	3	6 May 1979
Night	Zones 3 & 6	Net Tow (560 u)	3	6 May 1979
Day	Zones 1,2,3 & 6	Net Tow (560 u)	3	18 May 1979
Cypress Slough				
Day	1	Oblique Tow (560 u)	1 (composite)	9 September 1978

* Not analyzed ** Bottom

TABLE 4A.2-5

AQUATIC ECOLOGY SAMPLING SCHEME - FISH

Water Body	Sample Location	Sample Collection Method	Sample Replication	Sample Dates
Green River	Zone 6	Gill Nets (Day)	1	9 June 1978
Green River	Zones 3 & 6	(Day & Night)	3	21 June 1978
Green River	Zones 3 & 6	(Day & Night)	3	14 July 1978
Green River	Zones 3 & 6	(Day & Night)	3	7 September 1978
Green River	Zones 3 & 6	(Night & Day)	3	21 May 1979
Green River	Zone 6	(Day)	1	17 February 1979
Green River	Zone 6	Hoop Nets (1 h Night Set)	1	9 June 1978
Green River	Zones 3 & 6	Hoop Nets (3 h Day Set)	2	22 June 1978
Green River	Zones 3 & 6	Hoop Nets (8 h Night Set)	2	14 July 1978
Green River	Zones 3 & 6	Hoop Nets (24 h Set)	2	7 September 1978
Green River	Zone 6	Hoop Nets (24 h Set)	1	17 February 1979
Green River	Zones 3 & 6	Hoop Nets (24 h Set)	2	17-18 May 1979
Green River	Zones 3 & 6	Seine	2	6 September 1978
Green River	Zones 3 & 6	Seine	2	21,23 May 1979
Green River	Zones 1,2,3 & 6	Electrofishing	1	11 September 1978
Green River	Zones 1,2,3 & 6	Electrofishing	1	23 May 1979
Green River	Zones 2 & 6	Trawls	2	26 June 1978
Green River	Zone 1	Trawls	2	14 July 1978
Green River	Zones 2,3 & 6	Trawls	2	6 September 1978
Green River	Zones 1,2,3 & 6	Trawls	2	23 May 1979
Green River	Zones 3 & 6	Minnow Traps	3	24 June 1978
Cypress Slough	Location 1	Electrofishing	1	9 September 1978
Cypress Slough	Location 1	Electrofishing	1	24 May 1979
Cypress Slough	Location 2	Seine	2	16 July 1978
Cypress Slough	Location 1	Seine	2	9 September 1978
Cypress Slough	Locations 1 & 2	Seine	2	24 May 1979
Cypress Slough	Location 1	Minnow Traps	3	19 September 1978
Pond	Ponds 2a,2b & 3	Seine	2	25,26 April 1979
Pond	Pond 1	Seine	2	20 May 1979
Pond	Ponds 2a & 3	Electrofishing	1	26 April 1979
Pond	Pond 1	Electrofishing	1	20 May 1979

TABLE 4A.3-1

TERRESTRIAL ECOLOGY - WORK SCHEDULE

Element	1978									1979		
	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
VEGETATION												
Quantitative Surveys												
Herbaceous Stratum		X	X			X						
Shrub Stratum		X	X									
Canopy Stratum			X			X						
Qualitative Surveys		X	X			X						
MAMMALS												
Qualitative Surveys	X	X	X	X		X				X		
Live Trapping						X						
Spotlight Survey		X	X	X		X						
Mist-Netting		X	X			X						
Pit Traps		X	X	X	X	X						
Aerial Survey	X					X				X		
BIRDS												
Qualitative Surveys	X	X	X	X		X				X		
Breeding Bird Surveys			X									
Aerial Survey	X					X				X		
Brood Count		X	X									
Kentucky Fish and Wildlife Flights							X	X	X	X	X	X
REPTILES AND AMPHIBIANS												
Qualitative Surveys	X	X	X	X		X						
Pit Trapping		X	X	X	X	X						

TABLE 4A.7-1

SEASONAL WATER QUALITY SAMPLING SCHEDULE

Sample Period	Date	Sampling Stations*					
		Green River Station	Cypress Slough Inlet Station	Cypress Slough Outlet Station	Stream Sampling Station	Groundwater Stations A-11	Groundwater Stations A-18
Fall	October 26, 1978	X			X		
	October 27, 1978	X	X	X		X	X
	December 21, 1978					X	X
Winter	January 25, 1979					X	
	February 1, 1979	X	X	X			
	February 2, 1979	X			X		
Spring	May 3, 1979	X	X	X		X	
	May 4, 1979	X			X		
Summer	July 19, 1979	X	X	X			
	July 20, 1979	X			X	X	

* See Figure 4A.7-1 for location of sampling stations

TABLE 4A.7-2

SELECTED WATER QUALITY PARAMETERS FOR MONITORING SURFACE WATER AND GROUNDWATER

Parameter	Surface Water	Groundwater
Ammonia as N	X	X
Arsenic	X	X
Barium	X	X
Bicarbonate	X	X
BOD_5	X	
Cadmium	X	X
Calcium	X	X
Carbonate	X	X
Chloride	X	X
Chlorine	X	X
Chromium, Hexavalent	X	X
Chromium, Total	X	X
COD	X	X
Copper	X	X
Cyanide	X	X
Cyanide A	X	X
DO*	X	
Fluoride	X	X
Iron	X	X
Lead	X	X
Magnesium	X	X
Maganese	X	X
Mercury	X	X
Nickel	X	X
Nitrate	X	X
Oil & Grease	X	
pH*		
Phenol	X	X
Phosphorous	X	X
Selenium	X	X
Silver	X	X
Specific Conductance*	X	X
Sulfate	X	X
Sulfide	X	X
Temperature*	X	X
TOC	X	X
TSS	X	
Zinc	X	X

TABLE 4A.7-2 (Cont'd)

Parameter	Surface Water	Groundwater
Polycyclic Aromatic Hydrocarbons (PAH's)**		
2-Methyl naphthalene	X	X
Fluoranthene	X	X
2-Methyl fluoranthene	X	X
Pyrene	X	X
Benzo (c) phenanthrene	X	X
Benz (a) anthracene	X	X
Chrysene	X	X
Benzo (b) fluoranthene	X	X
Benzo (j) fluoranthene	X	X
Benzo (a) pyrene	X	X
O-Phenylene pyrene	X	X
Dibenz (a,c) anthracene	X	X
Dibenz (a,h) anthracene	X	X
Benzo (ghi) perylene	X	X

* Asterisk indicates field analyses.

** For Green River and on-site stream

TABLE 4A.7-3

WATER QUALITY PARAMETERS VS. SELECTION CRITERIA

Parameter	Kentucky Water Quality Standards	POINT SOURCE EFFLUENT LIMITATIONS						
		Coal Storage	Coking	Petroleum Refining	Steam Electric Power Generating	Ammonia	Coal Gasification Technology	Other
Ammonia as N			X	X		X	X	
Arsenic	X							
Barium	X							X
Bicarbonate								
BOD_5				X				
Cadmium	X							
Calcium								X
Carbonate								X
Chloride								X
Chlorine					X			
Chromium, Hexavalent	X			X				
Chromium, Total				X	X			
COD				X				
Copper								X
Cyanide	X		X	X			X	
Cyanide A			X	X				
DO	X							
Fluoride	X							
Iron		X			X			
Lead	X							

TABLE 4A.7-3 (Cont'd)

WATER QUALITY PARAMETERS VS. SELECTION CRITERIA

Parameter	Kentucky Water Quality Standards	POINT SOURCE EFFLUENT LIMITATIONS					Coal Gasification Technology	Other
		Coal Storage	Coking	Petroleum Refining	Steam Electric Power Generating	Ammonia		
Magnesium								X
Manganese		X						
Mercury								X
Nickel								X
Nitrate								X
Oil & Grease	X		X	X	X		X	
pH	X	X	X	X	X	X	X	
Phenol			X	X				
Phosphorous					X			
Selenium	X							
Silver	X							
Sulfate								X
Sulfide			X	X				
Temperature								X
TDS	X							X
TOC								X
TSS		X	X	X	X			
Zinc					X			
Polycyclic Aromatic Hydrocarbons							X	

TABLE 4A.7-4

WATER QUALITY SAMPLING EQUIPMENT LIST

Location	Apparatus	Collection Method
Green River	Hand-operated diaphragm pump and rigid PVC suction piping to required depth	Pumping
	BOD sampler, bronze and brass construction	Submerge, purge, retrieve
	PAH sampler, brass Kemmerer sampling bottle	Submerge, retrieve
Cypress Slough	Sample containers same as Green River	Submergence
On-Site Stream	Sample containers same as Green River	Submergence
Groundwater	Custom fabricated 2 liter sampling container, pvc, rubber and glass construction.	Containers filled from 2 liter sampler.

TABLE 4A.7-5

RECOMMENDATION FOR SAMPLING AND PRESERVATION OF SAMPLES ACCORDING TO MEASUREMENT

Measurement (1)	Volume Required (ml)	Container	Preservative	Holding Time (6)
Alkalinity	100	P, G (2)	Cool, 4°C	24 Hrs
Arsenic	100	P, G	HNO_3, to pH < 2	6 Mos
BOD	1,000	P, G	Cool, 4°C	6 Hrs (3)
COD	50	P, G	H_2SO_4 to pH < 2	7 Days
Chloride	50	P, G	None Required	7 Days
Chlorine Req	50	P, G	Det. on Site	No holding
Cyanides	500	P, G	Cool, 4°C NaOH to pH 12	24 Hrs
Dissolved Oxygen -				
Probe	300	G only	Det on site	No Holding
Winkler	300	G only	Fix on site	4-8 Hours
Fluoride	300	P, G	Cool, 4°C	7 Days
Metals -				
Dissolved	200	P, G	Filter on Site HNO_3 to pH < 2	6 Mos
Suspended			Filter on Site	6 Mos
Total	100		HNO_3 to pH < 2	6 Mos

TABLE 4A.7-5 (Cont'd)

RECOMMENDATION FOR SAMPLING AND PRESERVATION OF SAMPLES ACCORDING TO MEASUREMENT

Measurement	Volume Required (ml)	Container	Preservative	Holding Time[6]
Mercury -				
Total	100	P, G	HNO_3 to pH < 2	38 Days (Glass) 13 Days (Hard Plastic)
Nitrogen -				
Ammonia	400	P, G	Cool, 4°C H_2SO_4 to pH < 2	24 Hrs[4]
Nitrate	100	P, G	Cool, 4°C H_2SO_4 to pH < 2	24 Hrs[4]
Oil & Grease	1,000	G Only	Cool, 4°C H_2SO_4 to pH < 2	24 Hrs
Organic Carbon	25	P, G	Cool, 4°C H_2SO_4 to pH < 2	24 Hrs
pH	25	P, G	Cool, 4°C Det on site	6 Hrs[3]
Phenolics	500	G only	Cool, 4°C H_3PO_4 to pH < 4 1.0 g $CuSO_4$/l	24 Hrs
Phosphorus -				
Total	50	P, G	Cool, 4°C	7 Days
Residue -				
Non-Filterable (TSS)	100	P, G	Cool, 4°C	7 Days

TABLE 4A.7-5 (Cont'd)

RECOMMENDATION FOR SAMPLING AND PRESERVATION OF SAMPLES ACCORDING TO MEASUREMENT

Measurement	Volume Required (ml)	Container	Preservative	Holding Time[6]
Selenium	50	P, G	HNO_3 to pH < 2	6 Mos
Specific Conductance	100	P, G	Cool, 4°C	24 Hrs[5]
Sulfate	50	P, G	Cool, 4°C	7 Days
Sulfide	50	P, G	2 ml zinc acetate	24 Hrs
Temperature	1,000	P, G	Det on site	No Holding
15 Polycyclic Aromatic Hydrocarbons	3,000	G only	15 ml chloroform Cooled No uv light	1 Mo

(1) More specific instructions for preservation and sampling are found with each procedure as detailed in EPA-625/6-74-003. A general discussion on sampling water and industrial wastewater may be found in ASTM, Part 23, p 72-91 (1973).

(2) Plastic or Glass

(3) If samples cannot be returned to the laboratory in less than 6 hours and holding time exceeds this limit, the final reported data should indicate the actual holding time.

(4) Mercuric chloride may be used as an alternate preservative at a concentration of 40 mg/l, especially if a longer holding time is required. However, the use of mercuric chloride is discouraged whenever possible.

(5) If the sample is stabilized by cooling, it should be warmed to 25°C for reading, or temperature correction made and results reported at 25 °C.

(6) It has been shown that samples properly preserved may be held for extended periods beyond the recommended holding time.

Sources: "Methods for Chemical Analysis of Water and Wastes", EPA-625/6-74-003, USEPA, Office of Technology Transfer, 1974,

and for PAH's, Dr Paul Goodley, Department of Chemistry and Geology, Murray State College, Murray, Kentucky.

TABLE 4A.7-6

APPARATUS USED FOR FIELD ANALYSES

Parameter	Apparatus
Water Temperature	Thermometer, Weksler Co.
pH	pH Meter, Beckman, Model G
DO	Dissolved Oxygen Analyzer YSI, Model 51B
Specific Conductance	Conductivity Meter Hach Chemical, Model DR/EL-2

TABLE 4A.7-7

METHODS OF WATER QUALITY ANALYSIS

Parameter & Units	Method	Detection Limits mg/liter*	Reference Std Methods[15]
BOD_5 Day mg/liter	Modified Winkler and Probe method	0.5	P543,sec507
Total Suspended (Non-filterable) Solids, mg/liter	Glass Fiber Filtration 103-105°C	0.1	P94,sec208D
Ammonia (as N) mg/liter	Distillation-Nesslerization	0.05	P410,sec418A& P412,sec418B
Cyanide mg/liter	Distillation-Silver Nitrate Titration	0.01	P367,sec413B& P369,sec413C
Oil and Grease mg/liter	Partition-Gravimetric Method Distillation-	0.2	P515,sec502A
Phenols mg/liter	Colorimetric, 4-AAP	0.0005	P576,sec510A& P577,sec510B
Alkalinity (as $CaCO_3$) mg/liter	Titrimetric to pH 4.5 or Automated, Methyl Orange	0.5	P278,sec403
Chemical Oxygen Demand (COD) mg/liter	Dichromate Reflux	0.6	P550,sec508
Chloride mg/liter	Mercuric Nitrate or Automated Colorimetric-Ferric Thiocyanate	0.2	P304,sec408B
Fluoride mg/liter	Electrode	0.0005	P391,sec414B
Chlorine-Total Residual mg/liter	Amperometric Titration	0.2	P322,sec409C
Nitrate (as N) mg/liter	Brucine Sulfate	0.05	P427,sec419D
Total phosphorus (as P) mg/liter	Digestion Ascorbic Acid Reduction	0.02	P476,sec425C(3)& P481,sec425F
Total Organic Carbon (TOC)	Combustion-Infrared Method	1.0	P532,sec505
Sulfate (as SO_4) mg/liter	Turbidimetric	1.0	P496,sec427C

TABLE 4A.7-7 (Cont'd)

METHODS OF ANALYSIS

Parameter & Units	Method	Detection limits mg/liter*	References Std Methods(15)
Sulfide (as S) mg/liter	Titrimetric Iodide Method	0.008	P505,sec428D P369,sec413C& P376,sec413F
Cyanide A mg/liter	Titrimetric-Calcium Hypochlorite	0.1	
Arsenic-Total mg/liter	Atomic Absorption Spectrophotometer	0.0005	P156,sec301A(VII)
Cadmium-Total mg/liter	Atomic Absorption Spectrophotometer	0.002	P148,sec301A(II)
Chromium-Total mg/liter	Atomic Absorption Spectrophotometer	0.0025	P148,sec301A(II)
Copper-Total mg/liter	Atomic Absorption Spectrophotometer	0.002	P148,sec301A(II)
Iron-Total mg/liter	Atomic Absorption Spectrophotometer	0.02	P148,sec301A(II)
Lead-Total mg/liter	Atomic Absorption Spectrophotometer	0.02	P148,sec301A(II)
Silver-Total mg/liter	Atomic Absorption Spectrophotometer	0.005	P148,sec301A(II)
Manganese-Total mg/liter	Atomic Absorption Spectrophotometer	0.01	P148,sec301A(II)
Nickel-Total mg/liter	Atomic Absorption Spectrophotometer	0.004	P148,sec301A(II)
Selenium-Total mg/liter	Atomic Absorption Spectrophotometer	0.002	P159,sec301A(VII)
Zinc-Total mg/liter	Atomic Absorption Spectrophotometer	0.005	P148,sec301A(II)
Barium-Total mg/liter	Atomic Absorption Spectrophotometer	0.05	P142,sec301A(IV)
Calcium-total mg/liter	Atomic Absorption Spectrophotometer	0.01	P148,sec301A(II)
Chromium-Hexavalent mg/liter	Colorimetric	0.0025	P192,sec307A
Magnesium-Total mg/liter	Atomic Absorption Spectrophotometer	0.01	P148,sec301A(II)
Mercury-Total mg/liter	Flameless Atomic Absorption Procedure	0.0002	P156,sec301A(IV)
Specific Conductance micromhos/cm at 25°C	Wheatstone Bridge	0.1	P71,sec205
pH, units	Electrode	0.02	P460,sec424

0 2000 4000 6000 8000 10000

FEET

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AMBIENT SOUND MEASUREMENT LOCATIONS AT BASKETT SITE

FIGURE 4A.10-1

TABLE 4A.7-7 (Cont'd)

METHODS OF ANALYSIS

Parameter & Units	Method	Detection limits mg/liter*	Reference Std Methods (15)
Dissolved O_2, mg/liter	Azide Modification	0.2	P443,sec422B& P450,sec422F
Temperature, ^oC	Thermometer	0.5^o	P125,sec212
2-Methyl naphthalene	High Pressure Liquid Chromotography, Gas Chromotography (to confirm), Mass Spectrometry (to confirm)	70×10^{-12} grams	Dr.P.C. Goodley Murray State Univ.
Fluoranthene	High Pressure Liquid Chromotography, Gas Chromotography (to confirm), Mass Spectrometry (to confirm)	19×10^{-12} grams	Dr.P.C. Goodley Murray State Univ.
Pyrene	High Pressure Liquid Chromotography, Gas Chromotography (to confirm), Mass Spectrometry (to confirm)	106×10^{-12} grams	Dr.P.C. Goodley Murray State Univ.
Chrysene	High Pressure Liquid Chromotography, Gas Chromotography (to confirm), Mass Spectrometry (to confirm)	47×10^{-12} grams	Dr.P.C Cooley Murray State Univ.
Benzo(a)anthracene	High Pressure Liquid Chromotography, Gas Chromotography (to confirm), Mass Spectrometry (to confirm)	70×10^{-12} grams	Dr.P.C. Goodley Murray State Univ.
Benzo(c)phenanthrene	High Pressure Liquid Chromotography, Gas Chromotography (to confirm), Mass Spectrometry (to confirm)	75×10^{-12} grams	Dr.P.C. Goodley Murray State Univ.
Benzo(j)fluoranthene	High Pressure Liquid Chromotography, Gas Chromotography (to confirm), Mass Spectrometry (to confirm)	140×10^{-12} grams	Dr.P.C. Goodley Murray State Univ.
Benzo(b)fluoranthene	High Pressure Liquid Chromotography, Gas Chromotography (to confirm), Mass Spectrometry (to confirm)	130×10^{-12} grams	Dr.P.C. Goodley Murray State Univ.
Benzo(a)pyrene	High Pressure Liquid Chromotography, Gas Chromotography (to confirm), Mass Spectrometry (to confirm)	69×10^{-12} grams	Dr.P.C. Goodley Murray State Univ.
Dibenz(a,c)anthrancene	High Pressure Liquid Chromotography, Gas Chromotography (to confirm), Mass Spectrometry (to confirm)	100×10^{-12} grams	Dr.P.C. Goodley Murray State Univ.

TABLE 4A.7-7 (Cont'd)

METHODS OF ANALYSIS

Parameter & Units	Method	Detection limits mg/liter*	Reference Std Methods (15)
Dibenz(a,h)anthracene	High Pressure Liquid Chromotography, Gas Chromotography (to confirm), Mass Spectrometry (to confirm)	233×10^{-12} grams	Dr.P.C. Goodley Murray State Univ.
Benzo(g,h,i)perylene	High Pressure Liquid Chromotography, Gas Chromotography (to confirm), Mass Spectrometry (to confirm),	163×10^{-12} grams	Dr.P.C. Goodley Murray State Univ.
o-Phenylene pyrene	High Pressure Liquid Chromotography, Gas Chromotography (to confirm), Mass Spectrometry (to confirm)	100×10^{-12} grams	Dr.P.C. Goodley Murray State Univ.
2-Methyl fluoranthene	High Pressure Liquid Chromotography, Gas Chromotography (to confirm), Mass Spectrometry (to confirm)	10×10^{-12} grams	Dr.P.C. Goodley Murray State Univ.

*Unless otherwise specified

TABLE 4A.8-1

HYDROGRAPHICS SAMPLING CHRONOLOGY

Description	Location	Date
Vertical Profiling	Lines 1-5	04 Aug, 5 Sept, 14 Sept,
Endeco 110 PCM	(See Figure 4A.8-1)	29 Sept, 16 Oct, 2 Nov 1978
In-situ Temperature		
Endeco 109	Discharge Area	25 Jul - 29 Aug 1978
		29 Aug - 29 Sept 1978
		29 Sept- Nov 1978
Bathymetry	Site Area	22 Sept 1978
Raytheon DE-719B		
Motorola Mini-Ranger III		

TABLE 4A.9-1

AIR QUALITY MONITORING METHODS AND EQUIPMENT

PARAMETER	MANUFACTURER	MODEL	METHOD	EPA REFERENCE OR EQUIVALENT METHOD
Sulfur Dioxide	Thermo Electron Corporation	TECO Model 43 TECO Model 143	Pulsed Fluorescent	YES (1) YES (2)
Suspended Particulates	General Metals Work	Model GMWL-2000 Hi-Vol Sampler	Hi-Vol Sampler/ Gravimetric	YES (2)
	Kurz Instruments	Model 310 Hi-Vol Constant Flow Controller		NO (3)
Nitrogen Oxides	Monitor Labs, Inc	Model 8440E $NO-NO_x$ Analyser Model 8500 Calibrator	Chemiluminescent Permeation/Gas Phase Titration	YES (1) YES (2)
Ozone	Dasibi Environmental AID Incorporated	Model 1003-AH Ozone Model 565 Ozone Calibrator	Ultraviolet Absorption UV Irradiation	YES (1) YES (2)
Carbon Monoxide	Bendix, Environmental and Process Instr.	Model 8501-5CA CO Analyzer	Non-dispersive Infrared	YES (1)
Ammonia	CEA Instruments, Inc	CEA 555 Ammonia Analyser	Colorimetric, Modified Berthelot/ Sodium Salicylate	NO (3)
Wind Speed/ Direction	Climatronics Corp	F-460 Wind Speed/ Direction System	Photo-chopper Potentiometer	YES (4)
Recorders	Esterline Angus	Model L1102S/Model MS401C/Model 411BB Model No. 882 Servo Recorder	Potentiometer Potentiometer	NO (3)
Calibration	Monitor Labs, Inc	Model 8530-6	Clock Timer/Remote Contact Closer Commands	NO (3)

(1) List of Designated Reference and Equivalent Methods, U.S. EPA, Office of Research and Development, Environmental Monitoring.

(2) Title 40, Code of Federal Regulations, Part 50 National Primary and Secondary Ambient Air Quality Standards, Federal Register Volume 36, Pg 22384, November 25, 1971 as amended October 5, 1978.

(3) No applicable EPA Designated Reference or Equivalent Methods.

(4) U.S. Environmental Protection Agency, May 1978, Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD), EPA-450/2-78-019, Research Triangle Park, North Carolina.

TABLE 4A.9-2

AIR QUALITY MONITORING PROGRAM

TRACE ELEMENTS AND POLYCYCLIC AROMATIC HYDROCARBONS MONITORED

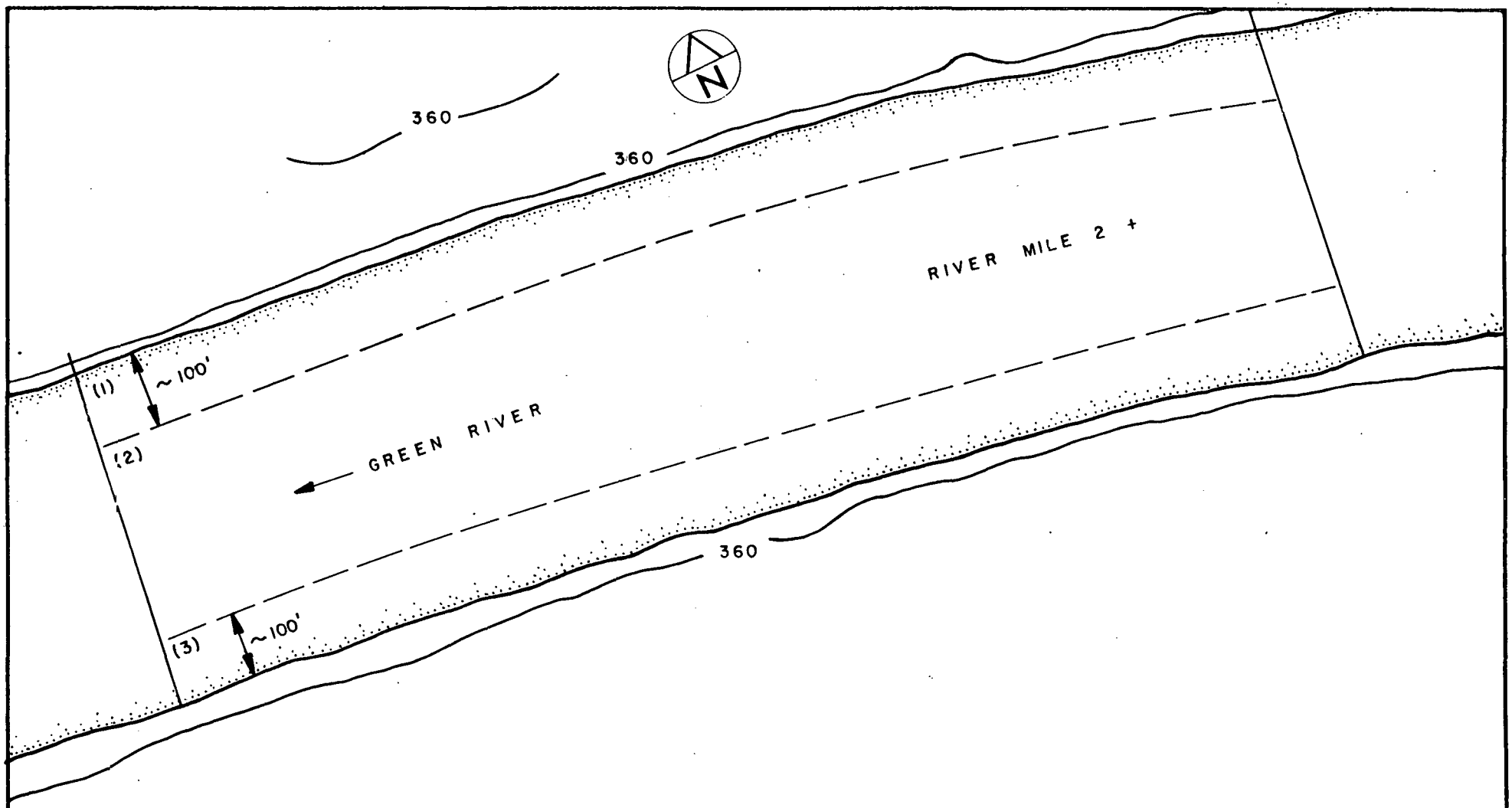
Trace Elements

Arsenic
Beryllium
Cadmium
Chromium
Cobalt
Iron
Mercury
Lead
Manganese
Nickel
Titanium
Vanadium
Zinc

Polycyclic Aromatic Hydrocarbons*

2-Methyl naphthalene
Fluoranthene
2-Methyl fluoranthene
Pyrene
Benzo (c) phenanthrene
Benz (a) anthracene
5-Methyl Chrysene
Chrycene
Benzo (b) fluoranthene
Benzo (j) fluoranthene
Benzo (a) pyrene
o-Phenylene pyrene
Dibenz (a,c) anthracene
Dibenz (a,h) anthracene
Benzo (ghi) perylene

* Salk and DeCicco[14].



0 500' ft

SCALE

( ) = ZONE NUMBER

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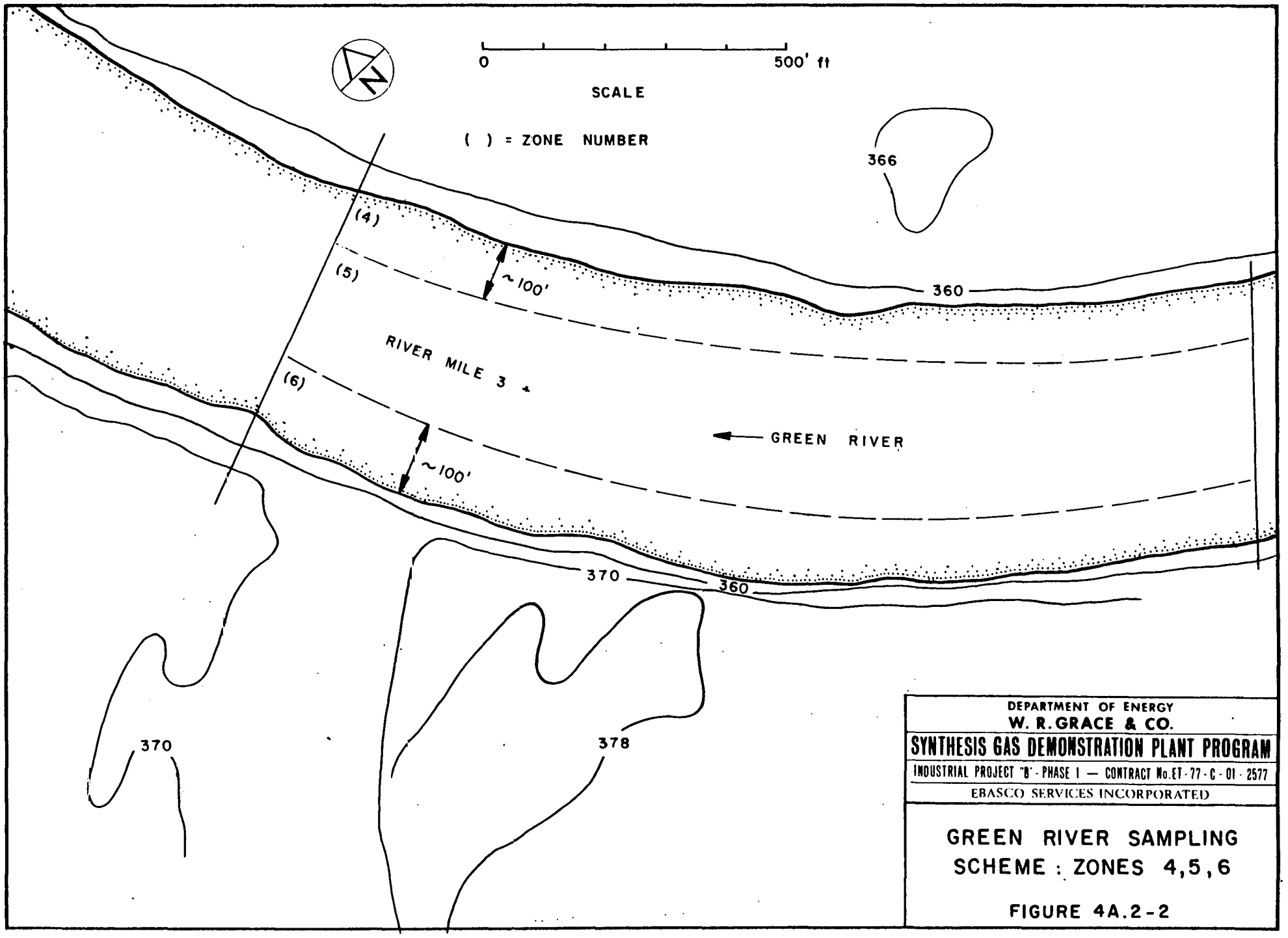
GREEN RIVER SAMPLING SCHEME : ZONES 1,2,3

FIGURE 4A.2-1



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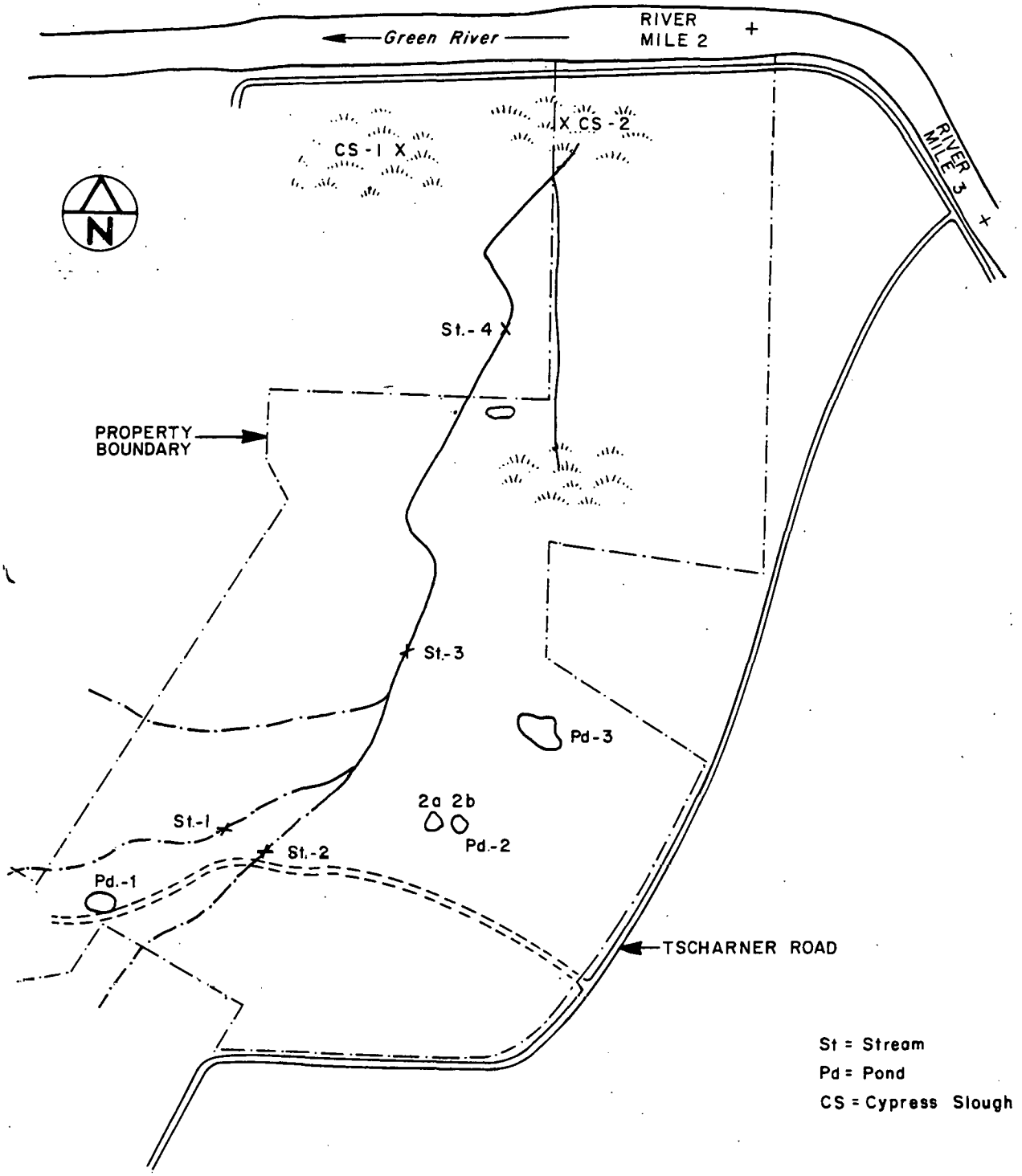
GREEN RIVER SAMPLING SCHEME : ZONES 4,5,6

FIGURE 4A.2-2



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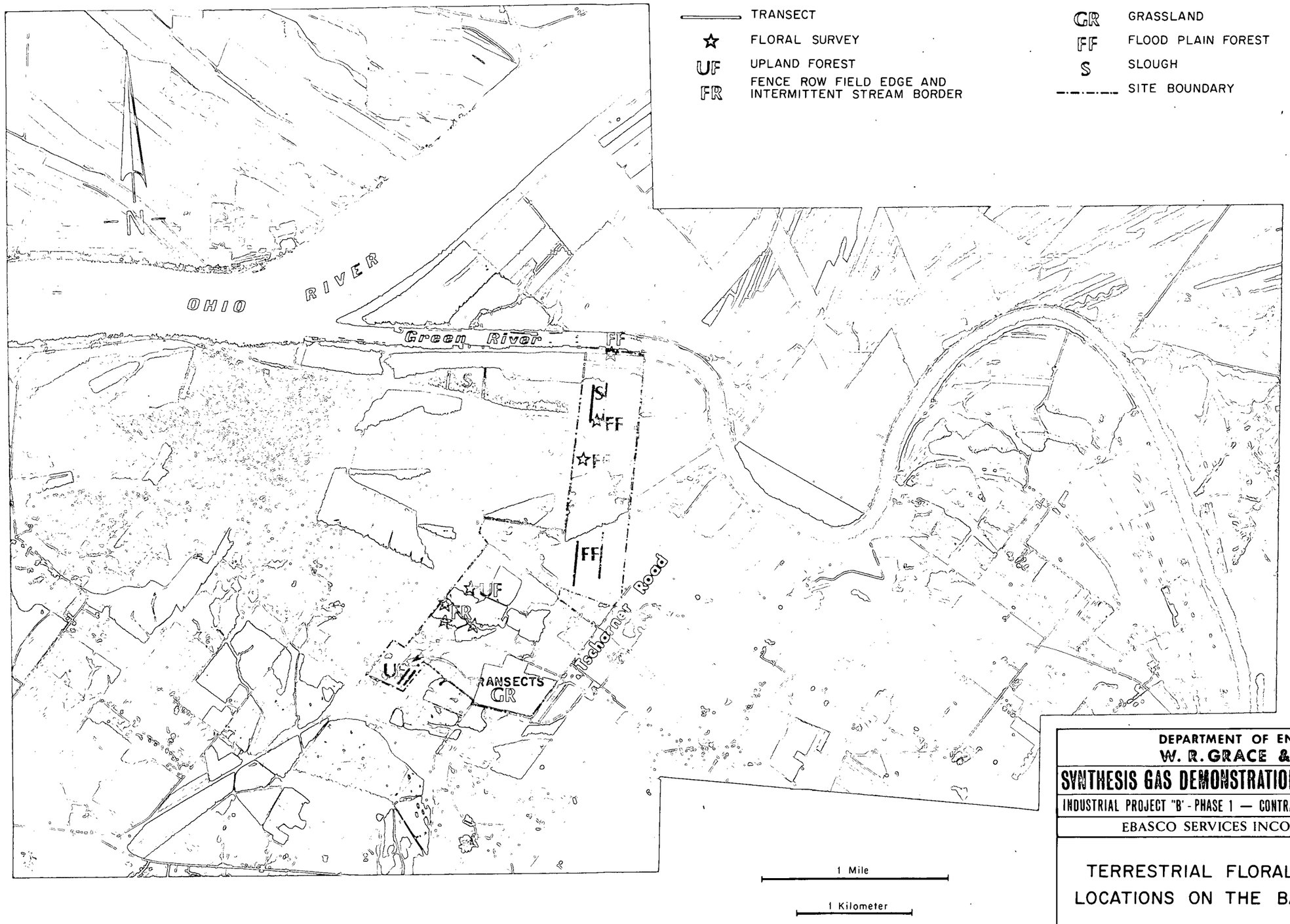
STREAM, POND, AND CYPRESS SLOUGH STATIONS

FIGURE 4A.2-3



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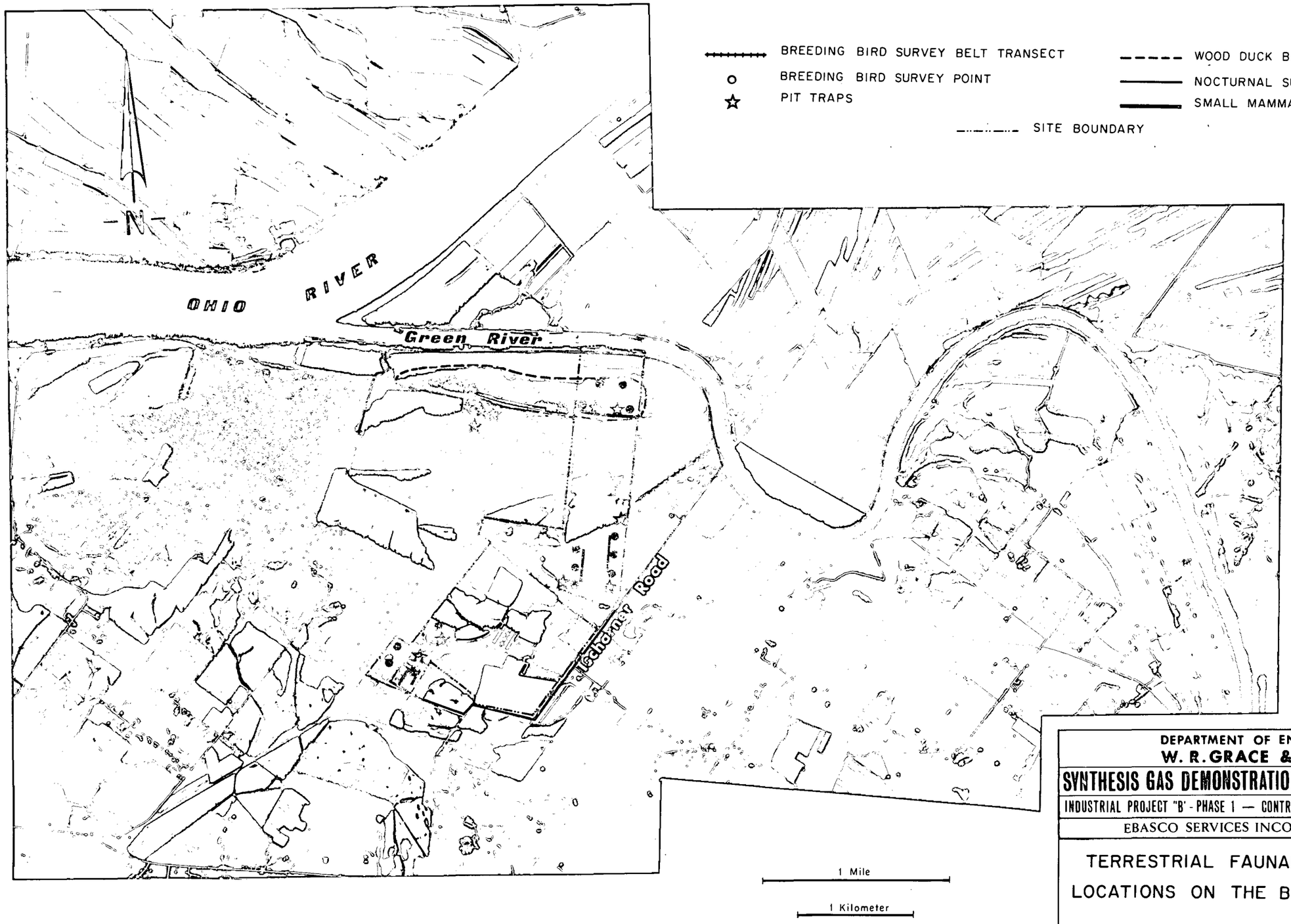
TERRESTRIAL FLORAL SAMPLING LOCATIONS ON THE BASKETT SITE

FIGURE 4A.3-1



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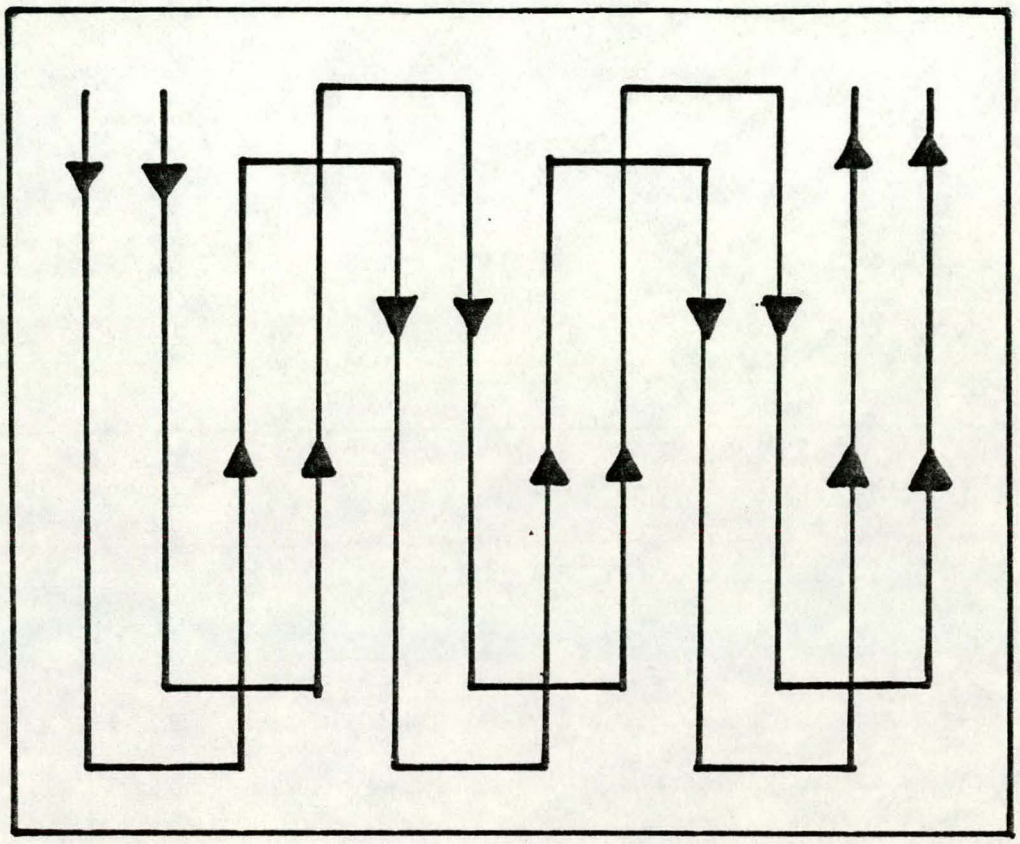
TERRESTRIAL FAUNAL SAMPLING LOCATIONS ON THE BASKETT SITE

FIGURE 4A.3-2



Source : Robinson , et al , 1978 [12]

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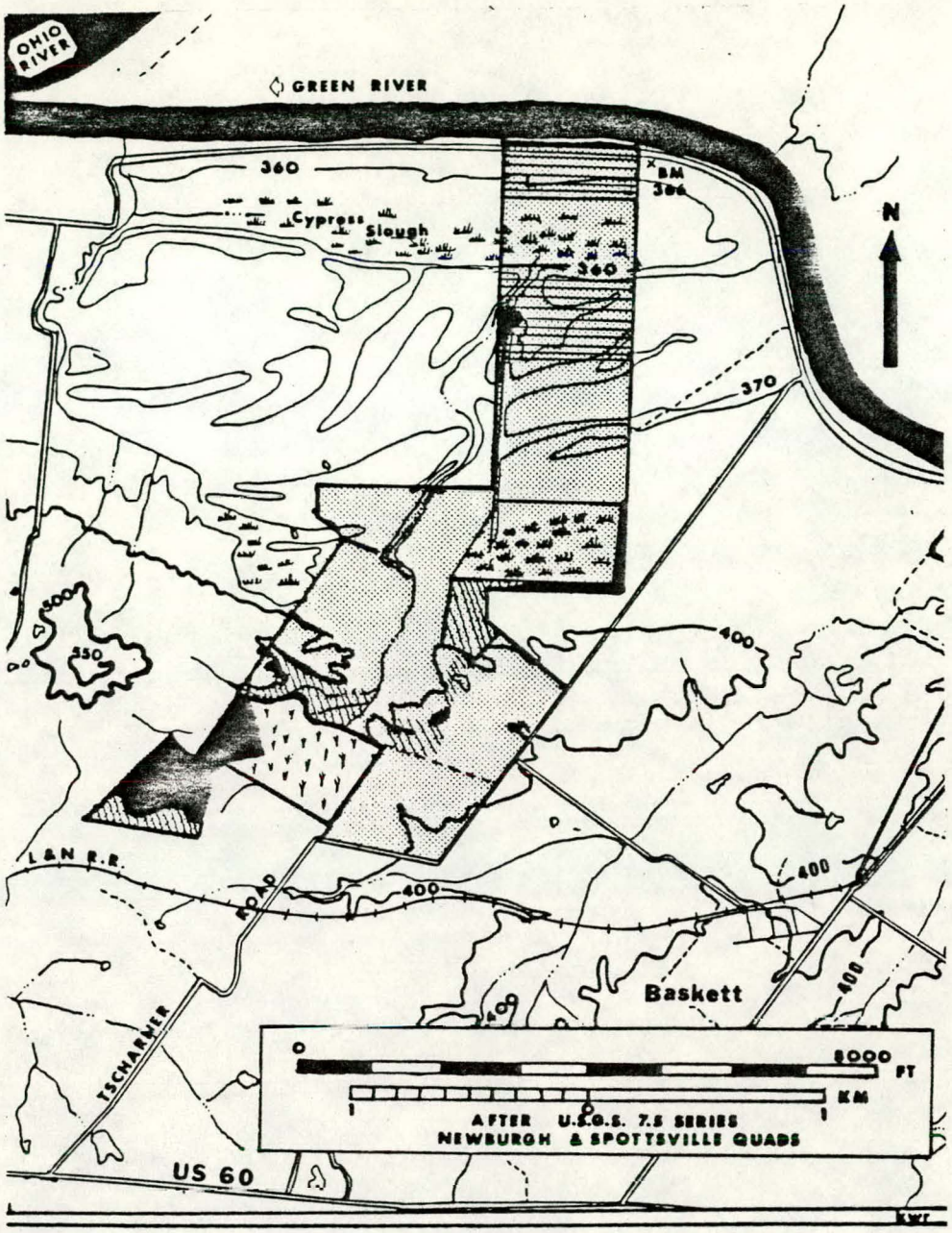
TYPICAL CULTURAL RESOURCE PEDESTRIAN SURVEY PATH IN BOUNDED AREA

FIGURE 4A.5-1



Wooded

Wheat Field

Plowed, but covered in silty wash

Grass or Hay

Slough

Plowed

Source : Robinson , et al , 1978 (12)

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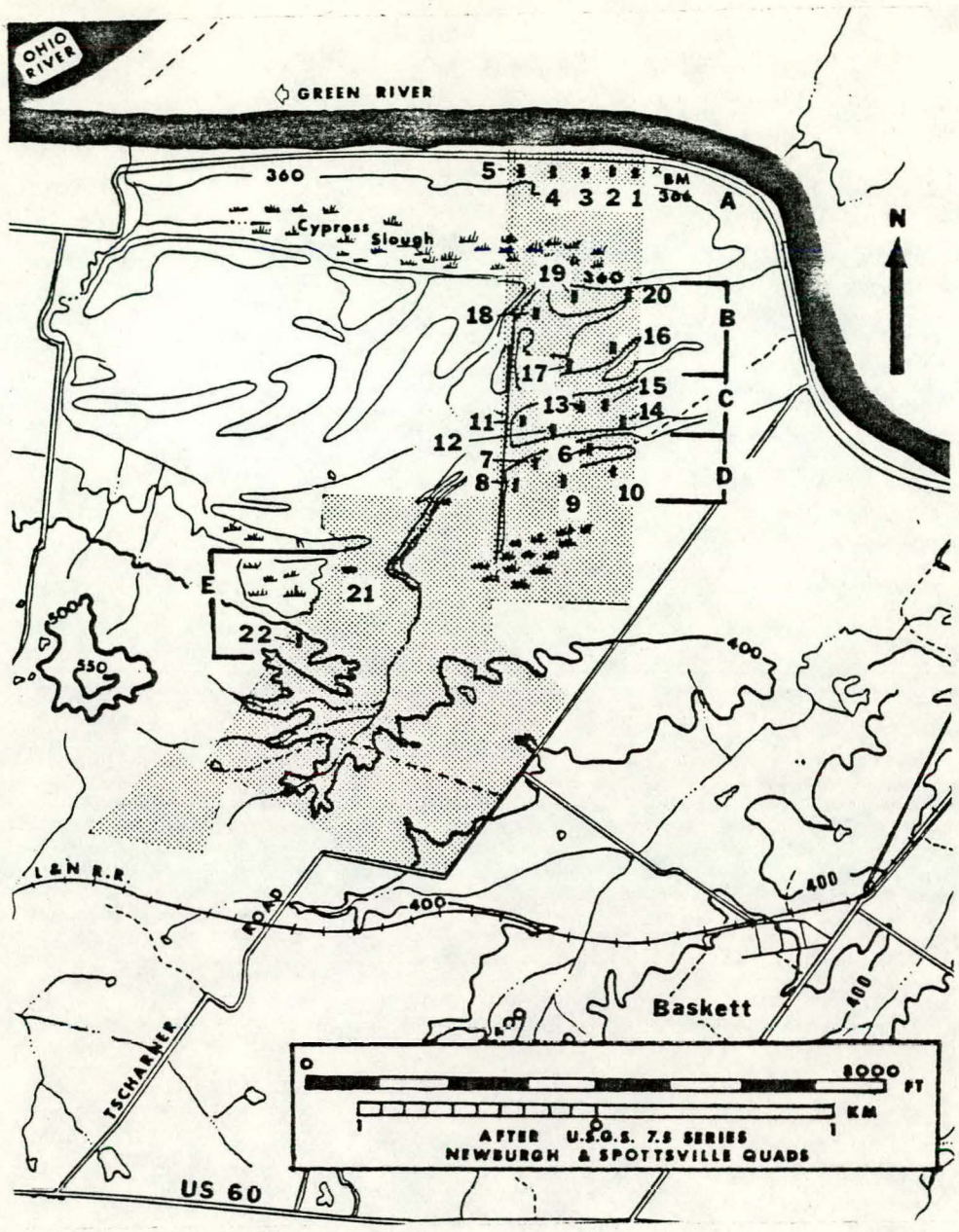
GROUND COVER OF PROJECT AREA DURING CULTURAL RESOURCE SURVEY

FIGURE 4A.5-2



Source : Robinson , et al , 1978 (12)

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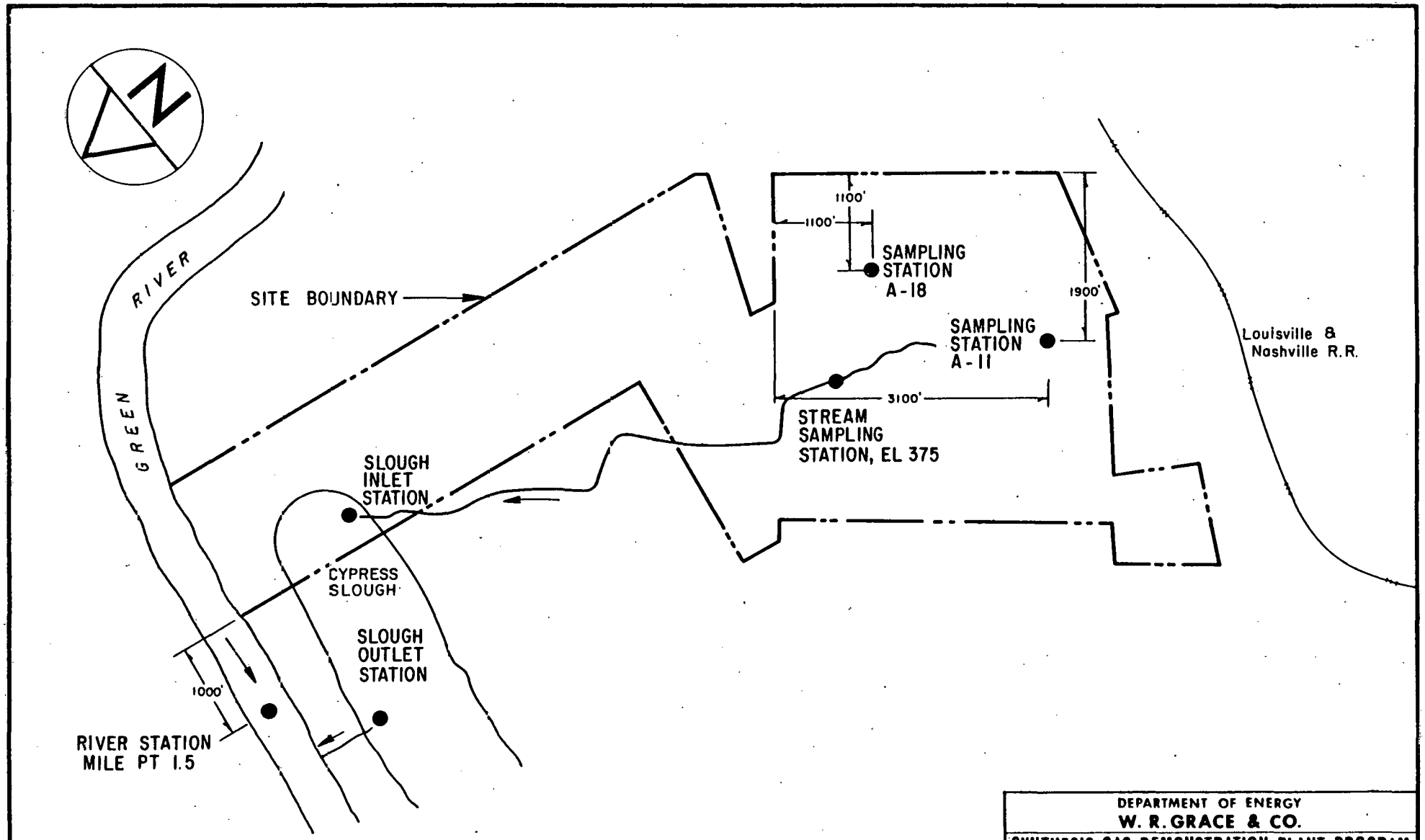
LOCATION OF BACKHOE TRENCHES DURING CULTURAL RESOURCE SURVEY

FIGURE 4A.5-3



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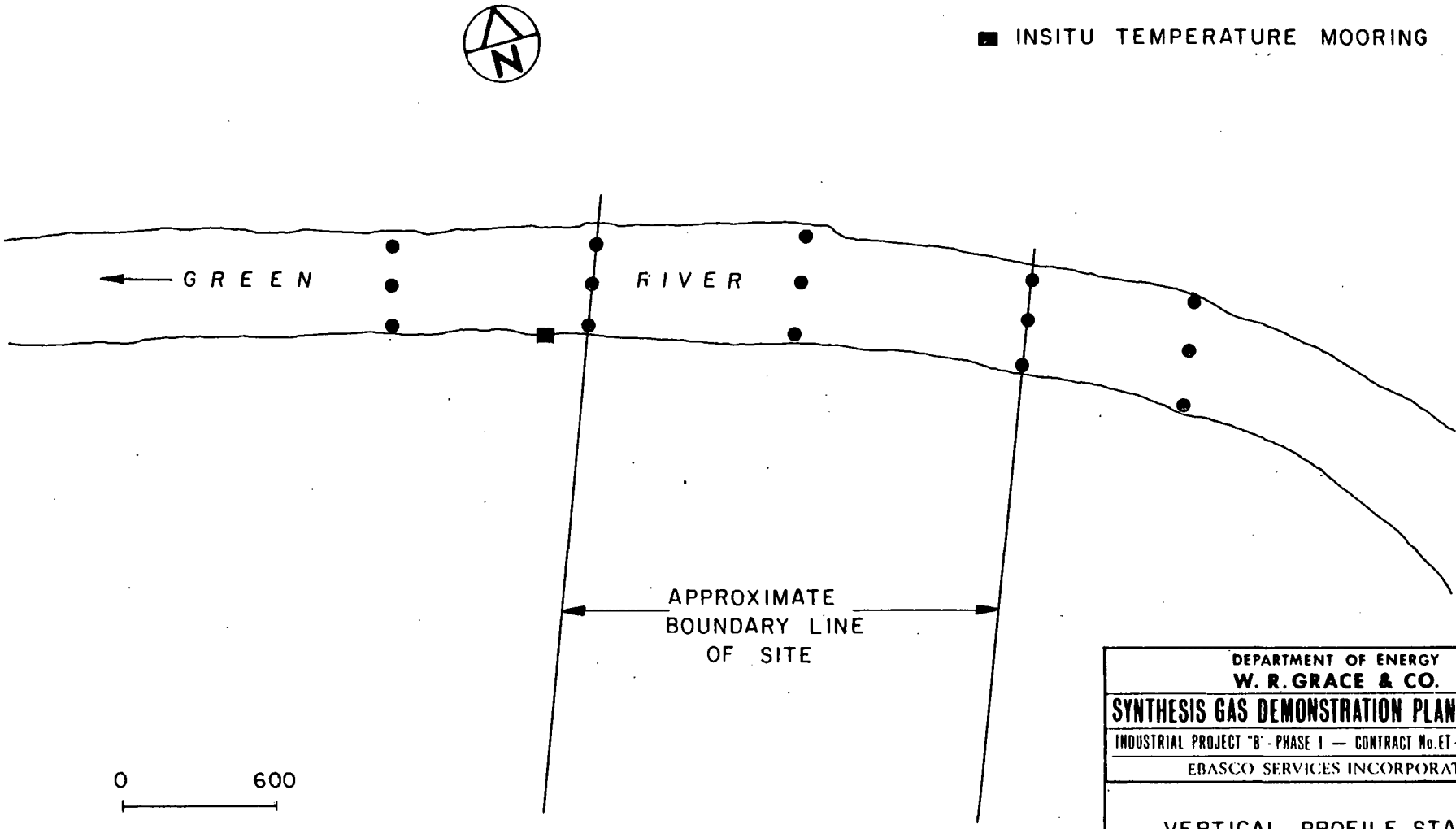
WATER QUALITY SAMPLING STATION LOCATION PLAN

FIGURE 4A.7-1



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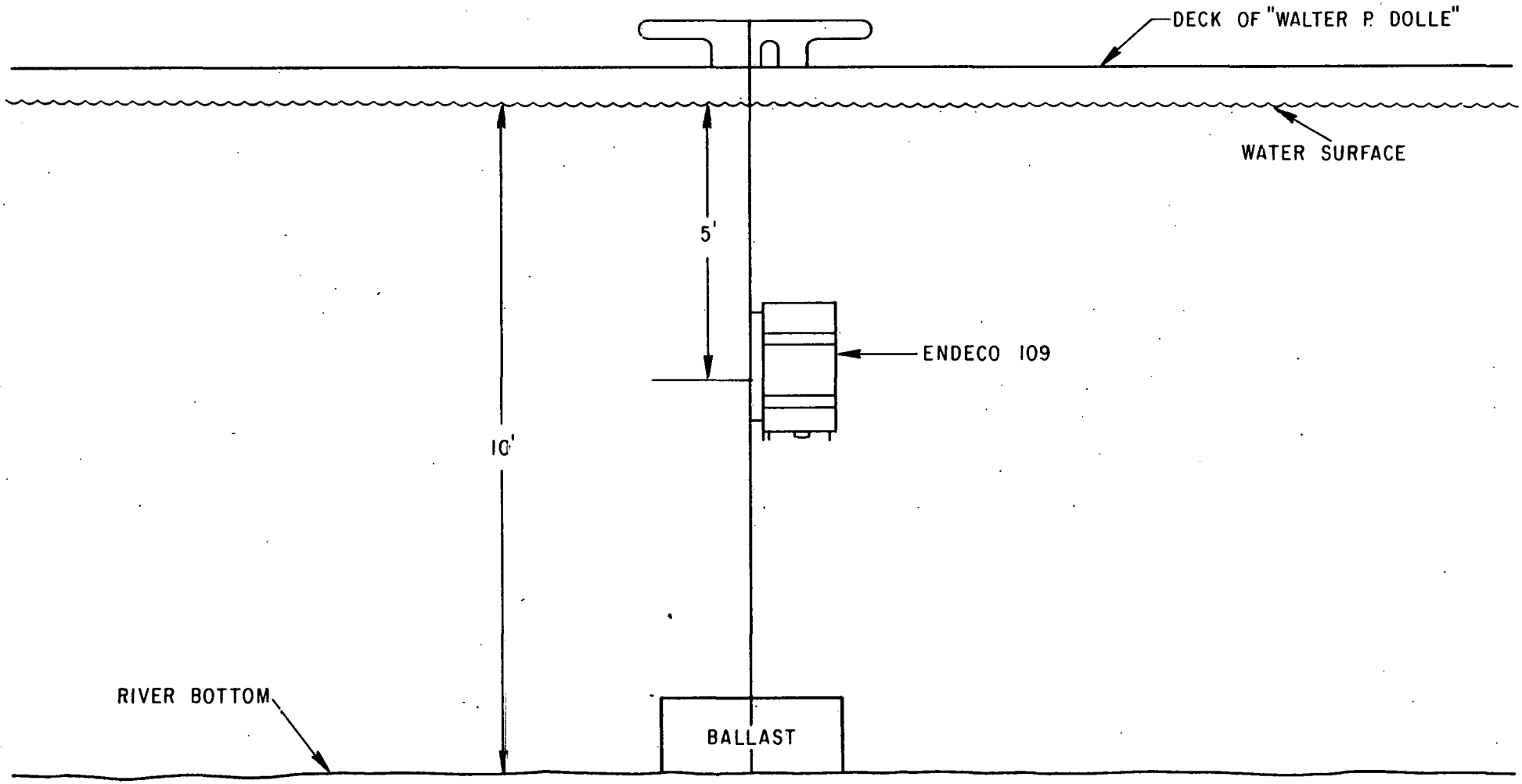
VERTICAL PROFILE STATION
AND INSITU TEMPERATURE
RECORDER LOCATIONS

FIGURE 4A.8-1



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MOORING CONFIGURATION
FOR ENDECO 109 THERMOGRAPH

FIGURE 4A.8-2

TABLE 3.8.1-2 (Cont'd)

Source	Solid Waste	Control Strategy	Ultimate Disposal
Miscellaneous	Water Pretreatment Sludge	To Clarifier Sludge Pit	On-site
Miscellaneous	Floor Drainage Treatment Solids	Oil taken off-site by contractor; sludge removed to Clarifier Sludge Pit	Off-site/On-site
Miscellaneous	Plant Refuse	Trucked Off-site	Off-site
Miscellaneous	Sanitary Waste Treatment Sludge	Trucked Off-site	Off-site
Miscellaneous	Chromium Removal Treatment Sludge	Co-disposal with evaporator residue or returned to vendor for metal recovery.	On-site/Off-site