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ANALYTICAL STUDIES FOR ASSESSING THE IMPACT OF SANITARY SEWAGE FACILITIES OF DELAWARE CO., OHIO

FINAL REPORT
UNDER U.S. EPA CONTRACT NO. 68-01-2853

24 October 1975

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M. Lewis
J. Cuneo
G. Shea
D. Wagaman
J. Whang

Performed for:

U. S. ENVIRONMENTAL PROTECTION AGENCY
Region V
230 South Dearborn Street
Chicago, Ill. 60604

By:

ENVIRO CONTROL, INC.
Environmental Studies Group
1530 East Jefferson Street
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ENVIRONMENTAL PROTECTION AGENCY

FOREWORD

This is the final report submitted under U.S. Environmental Protection Agency Contract No. 68-01-2853 calling for "Analytical Studies for Assessing the Impact of Sanitary Sewage Facilities of Delaware County, Ohio." The objectives of this study are:

- To determine the most cost-effective and environmentally compatible site and size for the proposed facility
- To evaluate the primary and secondary effects of the proposed interceptor system
- To develop mitigative measures to ameliorate adverse effects of the project.

The specific tasks undertaken in pursuit of these objectives are as follows:

- Investigation of the possibility and cost-effectiveness of regionalization of the proposed service area in Delaware County with Franklin County or the City of Delaware
- Identification of additional environmentally compatible treatment plant sites with suitable size and engineering characteristics
- Exploration of the possibility of a managerial framework, whereby regionalization across county lines could be effected and the determination of the way in which such a framework might be related to alternate site possibilities and to the proposed expansion of the Columbus interceptor systems into other portions of Delaware County
- Determination of the relationship of all existing and proposed treatment plant sites to other land uses with particular reference to residential land, parkland, and valuable natural areas
- Assessment of the impact of the interceptors, treatment facility, and discharge location on the degradation of the State Scenic River segment
- Investigation of anticipated biological impacts on stream life from the proposed interceptor construction and sewage effluent, including any adverse impacts on rare or endangered species

- Comparison of the proposed phasing of interceptors with existing areas of waste treatment problems

- Examination of population projections and the secondary growth effects of the proposed interceptor system, including a consideration of the effect of the proposed project upon size of population, rate of growth, and geographical patterns of growth

- Discussion of potential mitigative measures for any adverse effects of this project, including:

  - Interceptor stream crossings in terms of numbers of crossings and construction techniques

  - Treatment plant outfall locations

  - Odor and noise control methods at the treatment plant

  - Visual amenity of the treatment facility and its surroundings at all levels of expansion

  - Dechlorination of effluent to lessen impact upon aquatic life and odors

- Preparation of draft and final reports.

The material is presented in a format and style suitable for incorporation in EPA's environmental impact statement for wastewater treatment facilities for southern Delaware County. The correspondence between the outline of EPA's "Manual for Preparation of Environmental Impact Statements for Wastewater Treatment Works, Facilities Plans and 208 Areawide Waste Treatment Management Plans" and that of the present report is indicated below:

Report		Manual	
I.	A and B	II.	B.10
II.	A-L	III.	B.3.b.
III.	A-D	V.	B.1, 3, 4, 5, 6

Consideration of other important alternative approaches to wastewater management, such as those called for in Sections III.B.3.a, c, d of the Manual, was not included in the scope of this study.

This work was performed by Messrs. John T. Cuneo, Martin H. Lewis, and G. Bradford Shea, Dr. James S. Whang, and Messrs. David H. Wagaman and Kenneth A. Wood, Jr., under the direction of Dr. Louis C. Peltier, Project Director, and Dr. Alex Hershaft, Director of Environmental Studies at Enviro Control. Martha Krecklow deserves much credit for patient and flawless typing of the voluminous and diverse manuscripts. The gracious cooperation of numerous officials of Delaware and Franklin Counties, the City of Columbus, the City of Delaware, the Ohio Environmental Protection Agency, and the consulting engineering firm of Burgess and Niple, Ltd., is gratefully acknowledged.

TABLE OF CONTENTS

List of Figures

LIST OF TABLES

I. ENVIRONMENT WITHOUT PROPOSED ACTION

This chapter contains background information on population and economic conditions of the study area for the evaluation of secondary growth impacts resulting from the proposed action. These impacts are then evaluated on pages 245-259.

A. POPULATION AND ECONOMIC PROJECTIONS

A large number of population, economic, and land use projections are evaluated in this section, and only a few are found reasonably accurate. The material is presented in the form of overview of population and economic projections for the area, discussion of the methodology used to evaluate the projections, description of each projection evaluated, evaluation of the projections, and presentation of the best projections.

1. Overview

Significant future economic and population growth can be expected in the project area if the no-action alternative is selected. Reasonably accurate projections of population in the project area are 22,500 for 1980; 32,000 for 1985; 39,900 for 1990; and 61,300 for 2000. These can be compared to a highly accurate estimate of 13,196 on July 1, 1973. No projections were found which predicted future economic growth in either Delaware County or the project area. However, the 1972 OBERS Projections (U.S. Water Resources Council, April 1974) provide a reasonably accurate view of future economic and population growth in a region consisting of Franklin, Pickaway, and Delaware Counties. These projections predict large future increases in regional earnings in service, manufacturing, and governmental sectors.

Projections are simply current guesses about future conditions. Three major factors influence the probable accuracy of any such guess about the future. These factors are the assumptions made, the methodology used, and the quality of the current and historical data used.

Assumptions are explicit statements which define which past, current, or probable future conditions influence a projection. A methodology is the procedure by which basic data and assumptions are combined to project future conditions. The quality of data is primarily determined by how current and detailed they are, as well as by how descriptive they are of the quantity being projected.

Three major types of projections are available for Delaware County, its townships, and the variously defined regions surrounding the City of Columbus. These projections are for land use, economic development, and population. The most important aspects of these three types of projections is that their predicted results are highly interdependent, because predicted changes in one category will directly influence changes in each of the other two categories.

2. Description of Projections

The name, source, and description of each evaluated projection are listed in Tables 1 through 3. Each description contains a summary of the assumptions made, the methodology used, and the type of data base.

3. Evaluation of the Projections

There are a considerable number of relatively recent population, economic, and land use projections which could be useful in the prediction of future population in the proposed project area. Because each of these projections predicts different results, each projection needs to be evaluated to ascertain its probable accuracy. The procedure used in this evaluation eliminates those projections which are probably least accurate. First, each projection is analyzed in terms of the appropriateness of its methodology and the quality of its data base. Those projections which have inappropriate methodologies or are based on low quality data are eliminated. The remaining methodologies are then evaluated to determine how reasonable their basic assumptions are. The result of the entire evaluation procedure is to isolate and use the best projections to develop a reasonably accurate representation of the future.

TABLE 1. Population Projections

Name and Source of Projection	Type of Projection	Area Coverage	Time Coverage	Major Assumptions	Major Data Inputs	Methodology
Population Estimates and Projections, Series P-25, No. 580, U.S. Bureau of the Census, May 1975.	Population	Counties, incorporated places, townships, and other governmental units	1970 actuals 1973 estimates	• Migration can be estimated accurately from changes of residence noted on individual income tax forms	• State vital statistics records • Individual income tax return data	• Projections are calculated from natural increases and migration
Population Projection, Columbus SMSA, Columbus Area Chamber of Commerce, Research Department, September 1974	Population	Delaware, Fairfield, Franklin, Madison, Pickaway Counties; City of Columbus	1970 actuals 1975, 1980, 1990, and 2000 projections	• Based strongly on a dynamic demographic model developed by Battele Columbus Laboratories	• Historic data	• Growth rates of export industries, fertility, and migration are each varied to arrive at 8 different projections
1972 OBERS Projections Volume 5, Series E, U.S. Water Resources Council, April 1974	Population	Columbus SMSA (Delaware, Franklin and Pickaway Counties)	1970, 1971 actuals 1980, 1985, 1990, 2000, 2020 projections	• Workers will migrate to areas of economic activity and away from areas of relatively slow growth or decline	• Predicted future changes in employment (to predict migration) • U.S. Census data from 1930, 1940, 1950, 1960, and 1970	• Projections are calculated from natural increases and migration
Population Projections, Delaware County Regional Planning Commission, July 1973	Population	Delaware County and each of its townships	1940, 1950, 1960, 1970 actuals 1980, 1990, 2000 projections	• Estimates of the establishment of some sewage in most portions of the project area by 1980	• Plans for development • Past trends • Buidling permits	• Judgmental decisions based on detailed personal knowledge of the area

TABLE 1 (continued)

Name and Source of Projection	Type of Projection	Area Coverage	Time Coverage	Major Assumptions	Major Data Inputs	Methodology
Expanding the Regional Plan, Mid-Ohio Regional Planning Commission, June 1972	Population	Franklin County and adjacent townships (those in Delaware County are Concord, Liberty, Orange, Berkshire, Genoa, and Harlem Townships)	1960, 1970 actuals 1975, 1980, 1985, 1990 projections	• Townships surrounding and adjacent to Franklin County will be tied to its economic growth and thus to its population growth	• Employment projections • Historic trends	• No concise statement of methodology is made in Expanding the Regional Plan
Delaware County, Ohio Comprehensive Water and Sewer Development Plan, Finkbeiner, Pettis, and Strout, 1969	Population	Delaware County and each of its townships	1950, 1960 actuals 1965 estimates 1970, 1975, 1990, 1985, and 1990 projections	• The projection made is purposefully somewhat optimistic • Established communities, good highway access, a full range of utilities, and amenities are major attractors of population growth	• Building permit records • Historic population trends • Surveys of services, utilities, and amenities offered in each township	• The projections for Delaware County are derived by comparison of its population trends with regional and statewide trends • Projected population growth within townships is allocated from the total projected population of Delaware County on the basis of sources, utilities, and amenities.
The Columbus Area Economy, Structure and Growth, 1950 to 1985, Bureau of Business Research, the Ohio State University, early 1960's	Population • Population • Labor force	Franklin County	1950, 1960 actuals 1965, 1970, 1980, and 1985 projections	• Predicted change in the employment structure is the chief determinant of the future size and composition of population	• Past population trends • Projected economic growth	• Age, sex, and race distributions are projected as components • A number of independent projection techniques are used, including ones based on past population trends, projected economic growth, and projected labor force participation

TABLE 2. Economic Projections

Name and Source of Projection	Type of Projection	Area Coverage	Time Coverage	Major Assumptions	Major Data Inputs	Methodology
Population Estimates and Projections, Series P-25, No. 580, U.S. Bureau of the Census, May 1975	Economic (as measured by per-capita income)	Counties, incorporated places, areas, townships and other governmental units	1969 actuals 1972 estimates	• Estimates are based on total money income	• 1970 Census income and related data • 1969 and 1972 federal income tax returns • State and county money income estimates prepared by the Bureau of Economic Analysis	• Is reflective of corrections to census data and changes in income, population, and geographic boundaries
Expanding the Regional Plan, Mid-Ohio Regional Planning Commission, June 1972	Economic (as measured by housing demand and distribution of employment by industrial type)	Franklin County and surrounding townships (those in Delaware County were Concord, Liberty, Orange, Berkshire, Genoa, and Harlem Townships)	Employment: 1960, 1970 actuals; 1980, 1990 projections Housing demand: 1970 to 1980 estimates Distribution of employment by industrial type: 1950, 1965 actuals; 1985 projections	• Increases in automation will slow the rate of employment increases in manufacturing industries • The economic base will diversify • Local industries will increase their proportional share of employment and economic growth • Basic non-commodity and local industries will continue to dominate the economic base	• Data and supporting projections from The Columbus Area Economy: Structure and Growth, 1950 to 1985	• The methodology is not sufficiently explained; although it appears to be based strongly on methodology developed in The Columbus Area Economy: Structure and Growth 1950 to 1985
The Columbus Area Economy, Structure and Growth, 1950 to 1985, The Ohio State University, Bureau of Business Research, early 1960's	Economic (as measured by employment, value added, income, trade, and housing)	Franklin County	1950, 1960 actuals 1965, 1970, 1975, 1980, and 1985 projections	• Change in employment structure is the chief determinant of the future size and composition of local population • Future (through 1985) net commuter inflow into Franklin County from adjacent counties will remain at the same proportion as that existing in 1960	• Historic trends • An input-output economic base study of Franklin County	• Use of historic trends • Use of a strong interrelationship of employment and economic projections to projections of trade, income, and housing

TABLE 2 (continued)

Name and Source of Projection	Type of Projection	Area Coverage	Time Coverage	Major Assumptions	Major Data Inputs	Methodology
1972 OBERS Projections, Volume 5, Series E, U.S. Water Resources Council, April 1974	Economic (as measured by employment, personal income, and earnings by industry)	Columbus SMSA (Delaware, Franklin, and Pickaway Counties)	1970, 1971 actuals 1985, 1990, 2000, and 2020 projections	• Most factors which have in the past influenced shifts in regional "export" industry location will continue to do so in the future • Personal income and measures of employment are used as measures of the gross regional product	• Historic trends of numerous indicator variables • National and regional projections • In some cases, interviews with persons having local expert knowledge	• "Shift-share" technique used for basic (export) industries • Cobb-Douglas and Spillman type functions used for agricultural industries • Location quotients used for local service and residentiary industries

TABLE 3. Land Use Projections

Name and Source of Projection	Type of Projection	Area Coverage	Time Coverage	Major Assumptions	Major Data Inputs	Methodology
The Mid-Ohio Region Housing Market Outlook 1970-1980, Mid-Ohio Regional Planning Commission, March 1971	Land Use • Housing	Franklin County and adjacent townships in other counties	1960, 1970 actuals 1980 projections	• Growth of employment opportunities determines in large part net increases in population • Growth of employment opportunities may be accurately estimated by using economic base study techniques	• Economic base data • Projected employment data • Household characteristics	• Employment is used to project population • Population and trends in household characteristics are used to project housing demand

Those economic projections which depend on an economic base methodology are prone to error. "The Economic Base of the Metropolis", a detailed article by Hans Blumenfeld in the 1955 issue of the Journal of the American Institute of Planners (pp. 114-132) provides substantive criticism of the use of economic base studies as a projection tool (Appendix H). Because of this objection, economic projections in Expanding The Regional Plan and The Columbus Area Economy, Structure and Growth, 1950 to 1985 are each rejected. The 1972 OBERS Projections makes use of some economic base methodologies; however, substantial use of other methodologies as independent checks on accuracy helps maximize the probable accuracy of the projections. All the economic projections are based on accurate data. However, since The Columbus Area Economy, Structure and Growth, 1950 to 1985 was published in the early 1960's, its data inputs do not totally reflect recent trends.

Some population projections depend strongly upon future employment figures projected by economic base studies. Expanding the Regional Plan appears to do this, and economic base studies are definitely the basis of a number of population projections in The Columbus Area Economy, Structure and Growth, 1950 to 1985. Past population trends, however, are used as the basis of some population projections in The Columbus Area Economy, Structure and Growth, 1950 to 1985. These trends are based on pre-1970 data and do not totally reflect current conditions. The Delaware County Ohio Comprehensive Water and Sewer Development Plan has an excellent methodology, but is based on data which is not current. Population Projection, Columbus SMSA is based on current data, but the methodology is based partially on economic base study techniques. Because the accuracy of these economic base techniques is probably low, the population projections derived from them are also probably inaccurate.

There is only one actual land use projection examined that would provide information relevant to the project. This is The Mid-Ohio Region Housing Market Outlook 1970-1980. Other studies only provide information about current land use trends or present recommended concepts for the future distribution of land use. Information on factors affecting the geographic distribution of land use are used below (pages 14-33) to develop projections of geographical patterns of area growth. The methodology for The Mid-Ohio Region Housing Market Outlook 1970-1980 uses population projections as a major base in the prediction of housing variables. However, these population projections are based primarily on an economic base study. Because there is considerable doubt as to the validity of projecting population on that type of study, doubt must be cast on the probable accuracy of the predicted housing variables.

An analysis of the methodology and data inputs of the available projections serves to reduce a large number of projections to a small number. The basis for the evaluative criterion of the accuracy of this small number of screened projections is provided by the explicit assumptions on which each projective technique is based.

Three population projections need further evaluation. One, Population Estimates and Projections, does not predict future populations. Instead, it estimates population change between April 1, 1970 actuals, as determined by the Census of Population, and July 1, 1973 estimates. A primary assumption is that the migration component of population change in an area can be accurately determined from changes in residence noted on individual income tax forms. This assumption seems reasonable. Its accuracy depends on the accurate projections of the conditions which lead to migration. The 1973 estimates form the most highly accurate documented estimates of recent population changes. Caution should be used, though, in interpreting these estimates. The Columbus Area Chamber of Commerce believes that certain local economic indicators point to somewhat more population growth than is indicated by the July 1, 1973 estimates (Thomas, private communication, 1975).

The 1972 OBERS Projections assumes that population migrates to areas of economic activity and away from areas of less economic activity. This assumption is reasonable; therefore, the 1972 OBERS Projections probably forms the most accurate of existing projections of regional (Delaware, Franklin, and Pickaway Counties) population change. Population Projections was developed by the Delaware County Regional Planning Commission. It assumes establishment of central sewage service in the project area by 1978 and is based on detailed, current, and ongoing knowledge of development in Delaware County. This knowledge of local development maximizes the probable accuracy of the population projections for Delaware County and each of its townships. However, it should be noted that long-term projections for small populations, such as those in each township, are highly prone to error. This error is lowered by grouping the townships into an approximation of the total project area.

Two economic projections need further evaluation. Population Estimates and Projections estimates per capita income as of July 1, 1974. It is based on the accuracy of federal income tax returns, so its estimates of income are reasonable. The 1972 OBERS Projections is based on factors which have influenced past regional economic change. These factors form a reasonable basis for regional economic projections.

The one land use projection was discarded because it uses an economic base study as a primary tool for projecting housing demand. A discussion of geographic trends on pages 14-33 will, however, shed some light on the amounts of probable future growth of different types of land use.

4. Best Projections

The evaluation in the preceding section yields several economic and population projections which project future trends in a reliable manner. The economic projections are Population Estimates and Projections and the 1972 OBERS Projections. The population projections are Population Estimates and Projections, Population Projections, and the 1972 OBERS Projections. Tables 4 and 5 and Figures 1 and 2 describe the projected information. Table 6, as a comparison, lists the population projections made in the facilities plan (Burgess and Niple, Ltd., 1974).

TABLE 4. Anticipated Public Sewer Service Assumed in the Projections

Township	1975	1980	1985	1990
Berlin				partial sewering
Concord		partial sewering		
Delaware	city already sewered			
Genoa		very little sewering	partial sewering	
Liberty		partial sewering		
Orange		partial sewering		

Sources. Adapted from U.S. Bureau of the Census, 1975; Delaware County Regional Planning Commission, 1973

TABLE 5. Population Projections by Townships

Township	1970	1975	1980	1985	1990	1995	2000
Berlin	1,412	1,778	2,134	2,661	3,459	NA	7,784
Concord	2,732	3,412	4,094	5,119	7,501	9,754	12,631
Genoa	3,096	3,735	4,296	5,155	6,444	7,734	9,394
Liberty	2,625	3,353	6,073	7,773	9,716	12,145	14,575
Orange	1,902	2,174	5,924	11,324	12,824	14,748	16,951
Total	11,767	14,452	22,521	32,032	39,944	NA	61,341
Delaware	16,928	18,621	20,483	22,020	23,674	24,854	26,097
Total	28,695	33,073	43,004	54,052	63,618	NA	87,438
Delaware County	42,908	NA	75,695	NA	112,010	NA	148,434

Source: U.S. Bureau of the Census, 1970; Delaware County Regional Planning Commission, 1973

TABLE 6. Population Projections as Estimated in the Facilities Plan

Townships	1980	1990
Berlin	2,100	3,500
Concord	4,170	6,356
Genoa	4,722	7,144
Liberty	4,014	5,731
Orange	2,899	4,417

Source: Burgess and Niple, Ltd., 1974

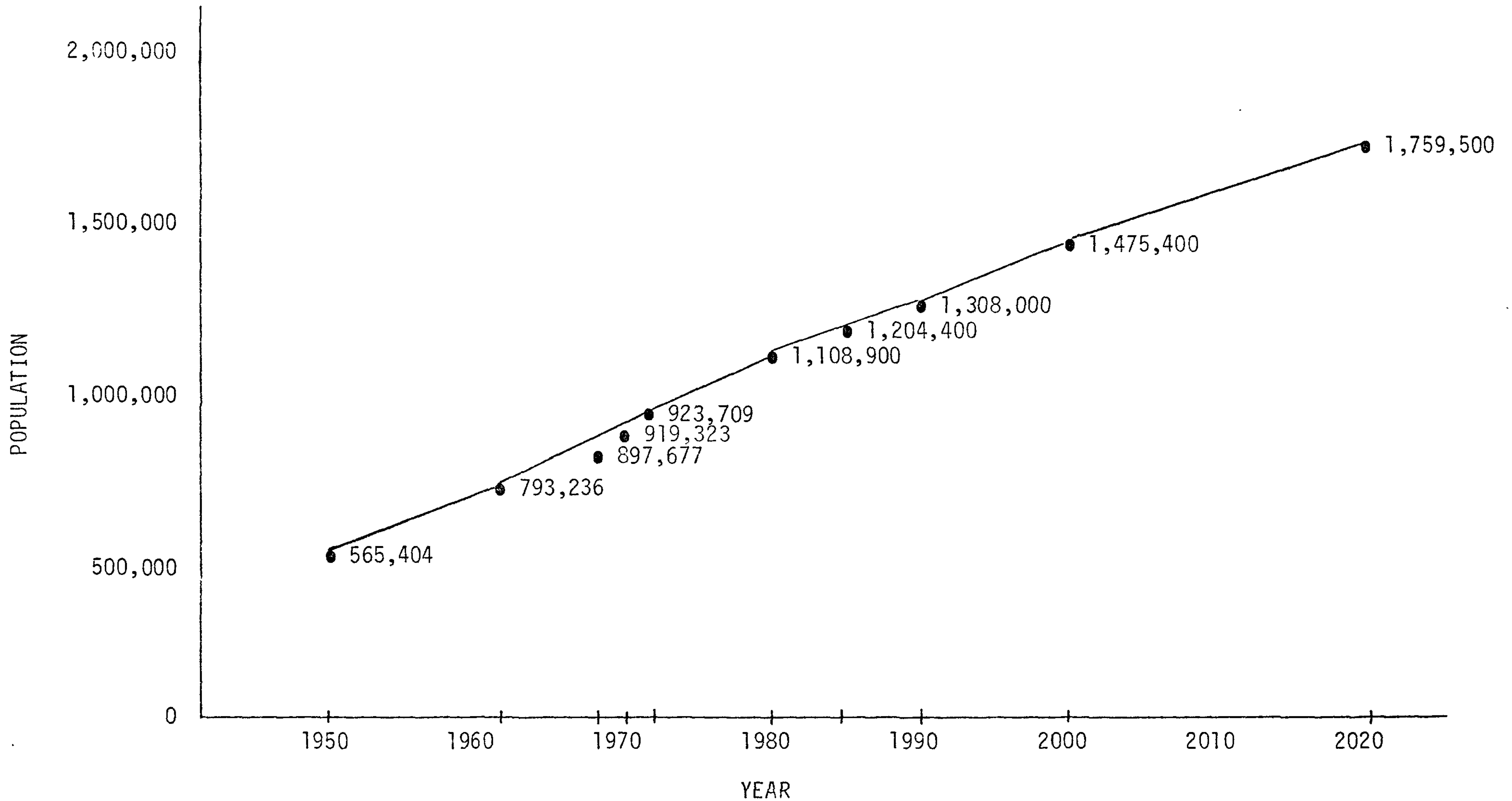

Figure 1. Population Projections for a Region Composed of Franklin, Delaware, and Pickaway Counties

Source: Adapted from U.S. Water Resources Council, 1974

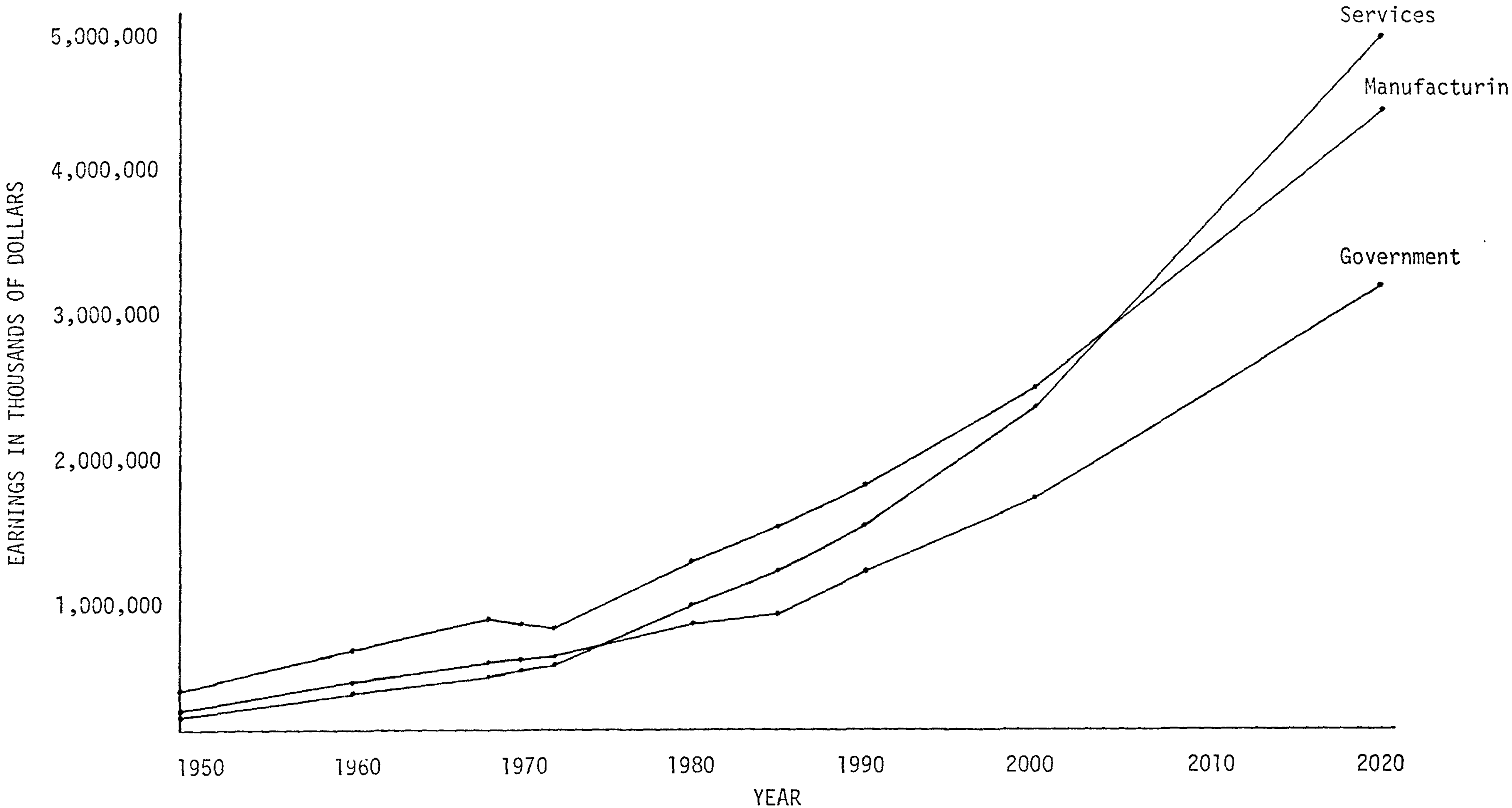

Figure 2. Increase of Earnings in the Region Composed of Franklin, Delaware, and Pickaway Counties in thousands of 1967 dollars

Source: Adapted from U.S. Water Resources Council, 1974

The two economic and three population projections provide a baseline which can be used to estimate the socio-economic environment without the proposed action. The value of this baseline is influenced strongly by the length of the period of projection and the probable accuracy of each of the five projections on which it is based. Generally, the longer the period of projection, the more uncertain the results; therefore, the probable accuracy of each of the projections varies. The regional economic and population projections in the 1972 OBERS Projections are expected to be highly accurate. The 1973 population and economic estimates presented in Population Estimates and Projections are also expected to be accurate. The Columbus Area Chamber of Commerce maintains, though, that certain economic indicators point to greater regional population growth than is estimated by this method. Population Projections can be expected to be fairly accurate because it is based on detailed, current, and ongoing knowledge of development in Delaware County. A factor which hinders its use as a projection of population without sewering is that it assumes sewering in most portions of the project area in the near future. However, considerable future development can be expected in the project area even if a public wastewater treatment system is not implemented (see pages 14-33).

The populations projected for each township differ from those projected in The Sanitary Sewerage Facilities Plan for South-Central Delaware County, Ohio (Burgess and Niple, Ltd., 1974). Projections for most townships are higher than those projected in the facilities plan. Table 6 lists the facilities plan's projections and Figure 3 displays the service area. A comparison of Table 5 with Table 6 shows that the projections of population in 1980 and 1990 for Liberty and Orange Townships are considerably higher than those of the facilities plan. The differences between the two sets of projections for Berlin, Concord, and Genoa Townships are much more moderate. The high rates of growth projected by this study for Liberty and Orange Townships are not only supported by the best available population projection, but are also further substantiated by a detailed analysis of land use trends (see pages 14-33).

According to calculations based on the population projections in Table 4 the population that would be served by the proposed sewerage system would be 11,421 by 1985 and 28,591 by 1995. Assuming a waste generation rate of 100 gallons per capita per day and assuming infiltration allowance of

1,260 gallons per day per inch diameter per mile of pipe, the waste flow would average 2.47 mgd by 1985 and 5.76 mgd by 1995. These waste flows would be safely within the design capacity of the proposed sewerage system of 6 mgd with peak capacity of 9 mgd.

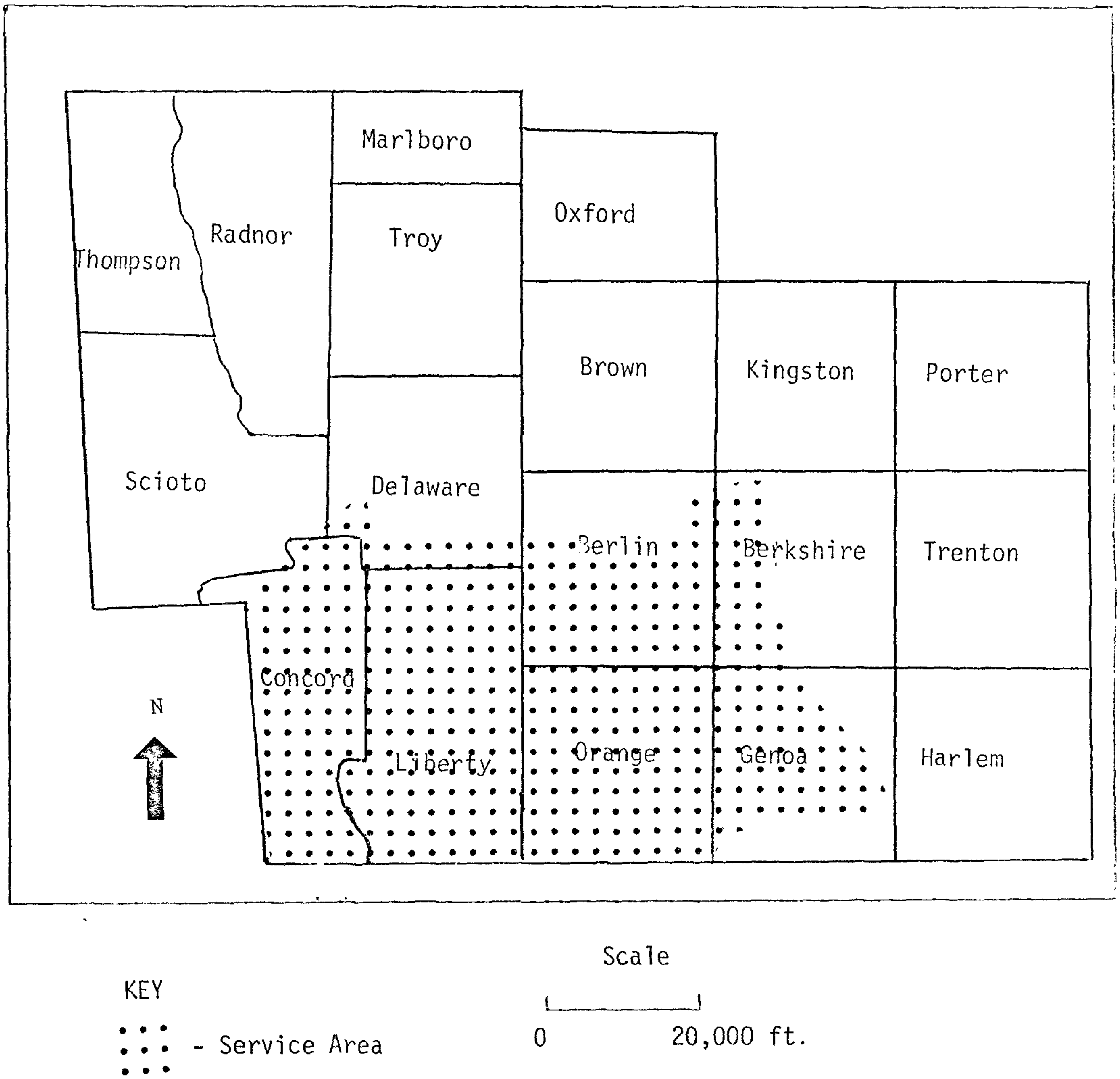

Figure 3. Facilities Plan Service Area

Source: Adapted from Surveys Unlimited, 1973

Private Communication

Thomas, James, Director of Research, Columbus Area Chamber of Commerce, 29 July 1975

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B. FUTURE GROWTH AND DEVELOPMENT

Growth and future development in any area is determined by a large number of interacting factors, including population growth, accessibility, employment opportunity, recreational opportunity, intervening or competing opportunities, land values, and the total pattern of power, gas, sewer, and transportation lines. These factors must be evaluated in both a regional and local context before an accurate projection can be made of the project area's probable future growth and development. The following section presents an overview of the probable growth and development in the proposed project area, followed by a discussion of the future growth and development in both a regional context and in the proposed project area.

1. Overview

Growth of population and industry has been occurring, to a large extent, north of the center of Columbus. This trend has influenced growth in the project area in the past and can be expected to have an expanding influence in the future. Other major factors enhancing growth potential in the project area are its excellent arterial and feeder system of highways, its large tracts of relatively inexpensive, level land, its easy access to major centers of employment, and its excellent recreation amenities. Poor waste assimilative capacities of the soil in most of the project area, combined with the lack of sewering, is the major impediment to future development. However, private package systems and septic fields are capable, if public sewering is not implemented, of accommodating significant amounts of development.

Most future development in the project area can be expected to be residential. However, rising costs of land in Franklin County and Columbus combined with the availability in the project area of large, level and comparatively inexpensive tracts of land near railroads and major highways will encourage significant future industrial development. Commercial development within the project area will be primarily neighborhood-oriented. The highest rates of residential and commercial development can be expected in Orange and Liberty Townships. Most development in Concord Township will be residential and most of this will occur in the Shawnee Hills-Dublin area. In Liberty Township considerable amounts of residential development will occur around Powell and some industrial development will occur along U.S. 23 and the Chesapeake and Ohio Railroad. Several portions of Orange Township will experience considerable residential development, while land adjacent to the Penn Central Railroad has a potential for industrial development. Some scattered areas of residential development may be expected in Berlin Township. Strict zoning regulations in Genoa Township, if continued, would limit development to moderate amounts of residential and industrial uses.

2. Regional Context

The discussion of growth in a regional context sets a framework for understanding growth and development in the project area. For the purposes of this report, Columbus is viewed as being the regional nucleus of Franklin, Delaware, Fairfield, Licking, Madison, Pickaway, and Union Counties. Factors determining growth and development in the Columbus region influence local growth and development in each of these counties.

The Columbus region has an excellent potential for future growth and development. As Figure 2 indicates, high regional growth is projected for services, manufacturing and government in Franklin, Delaware, and Pickaway Counties. Several factors provide the Columbus region with an excellent potential for future growth and development. Columbus is excellently located with respect to consumer markets. It is within 600 miles of 60 percent of the nation's markets and is thus attractive to industries with national markets. Columbus also has a major airport, Port Columbus International Airport, and is serviced by three trunk railroads, one of which, Penn Central, is considerably improving its present facilities. Columbus is also located at the intersection of Interstate Highways 70 and 71, providing rapid automobile and truck access in all directions.

The Ohio State University and several other accredited colleges and universities are located in Columbus, attracting major education-related resources into the region. The state capital and numerous state and federal administrative organizations provide large amounts of stable employment, while the headquarters of numerous bank holding companies, insurance companies, and savings and loan associations provide substantial amounts of investment capital. Columbus also has a diversity of research and development activities, including the Columbus Laboratories of Battelle Memorial Institute, The Ohio State University, and Ashland Chemical Company. It is evident that Columbus has a diverse employment base with a well-educated labor force, thereby minimizing the severe fluctuations in employment that are common to more industrially-based regions.

There are other factors which provide Columbus with an excellent potential for future growth and development. There are numerous activity-oriented recreation facilities in Franklin County and nature-oriented recreation facilities within the other counties. Columbus's generally level topography and subsoils are suitable for construction of buildings so that costs for building factories, distribution facilities, and transportation arteries are minimized. Finally, deposits of coarse sands, gravel, and limestone support a significant quarrying industry.

Although Columbus has considerable potential for future growth and development, there are major factors which inhibit growth in the Columbus region. These include lack of deposits of minerals, coal, oil, clays, gas, or other deposits to support most basic processing industries and an insufficient water supply to support industrial development which requires substantial amounts of water, such as steel making, paper mills, and large chemical industries. In addition, Columbus is in competition with other lake-basin centers in the attraction of industry.

A number of special factors determine the location of growth and development within the Columbus region. Of particular relevance to this environmental impact analysis is the determination of those factors which most influence growth and development in the ring of counties, including Delaware County, surrounding the metropolitan nucleus of Columbus and Franklin Counties. The major growth-oriented purposes that these outlying areas serve are for low density housing, inexpensive land for industrial development, and recreational land. The major factors in determining to what extent each outlying county serves various growth-oriented purposes are: (1) accessibility to major areas of employment; (2) accessibility to residential services; (3) provision of sewer, water, gas, and electricity; (4) quality and regional scarcity of recreational resources; (5) directions of growth within Columbus and Franklin Counties; and (6) the availability of sizable tracts of low cost land which does not require costly modification to make it suitable for development.

When Delaware County is analyzed in terms of the above factors, a picture of strong potential for growth emerges. The northern portions of Columbus have the most desirable centers of employment and excellent highway arterials making the southern portions of Delaware County very accessible to these desirable areas of employment. These highway arterials also give easy and rapid access from the southern portions of Delaware County to residential services in the City of Delaware, Westerville, and downtown Columbus. In addition, Delaware County has widespread provision of water, gas, and electricity services and large surpluses in facilities for most of those recreational activities for which there are insufficient facilities in the rest of the region. Finally, growth in Franklin County is occurring primarily to the north toward Delaware County and, to a lesser extent, to the east and southeast as numerous large tracts of land suitable for residential subdivisions or industrial activities are presently being held for speculative purposes.

3. Project Area

The following discussion of growth and development within the project area is divided into two parts. The first part is concerned with evaluating land use, population, and socio-economic trends which influence the project area as a whole. The second part is concerned with evaluating growth and development within each township in the project area.

Information gained from various population, land use, and socio-economic trends helps define aspects of growth and development in the project area. Population trends show that population growth is occurring at an increasingly high rate. Land use trends show that there are large concentrations of both speculative land tracts in Liberty and Orange Townships and recent residential development in

Concord, Genoa, and Liberty Townships. Since 1964 there have been more housing starts in the project area than in the much larger area comprising the rest of the county. The average value of new housing units constructed in the project area from 1964 to 1972 well exceeds the average value of all units constructed in Delaware County during the same period. Land use trends also reveal that significant amounts of farmland have been converted to other uses. Socio-economic trends show that significant decreases have occurred recently in farm populations, and that an increasing percentage of workers are commuting to Franklin County.

A wavelike outward growth of population density from metropolitan core areas has been described by Hans Blumenfeld (1954) in "The Tidal Wave of Metropolitan Expansion." This type of theoretical basis is valuable in explaining the significance of past trends in population growth from the expansion of Columbus toward and into Delaware County. Blumenfeld's theory is supported by considerable empirical evidence. The theory postulates that zones around a metropolis, from the center outward, go through subsequent stages of slow growth, rapid growth, a leveling off, and a decrease. Data in Table 7 describe historic changes in population density in each township in Delaware County. Figure 4 illustrates two important aspects of population growth in the approximate project area. The first and most obvious aspect is that the density of population is growing at a greater amount per year in the project area (curve 2) than in the rest of Delaware County (curve 1). Since 1930, the population growth in the project area has followed part of Blumenfeld's theory, changing from a stage of slow growth into a stage of increasingly rapid growth. Within Delaware County, two zones of population growth that correspond to Blumenfeld's concepts are the project area, and that portion of Delaware County outside of the project area and excluding the City of Delaware, Delaware Township, and Harlem Township. Exclusions are made to the second zone because the City of Delaware and Delaware Township have grown as a central place and Harlem Township lies in the same growth zone as those townships in the project area.

Curve 2 represents zone 1, while curve 3 represents zone 2. In this light, curve 2 represents the historic growth rate of a zone which is influenced by Columbus. Curve 3 represents the historic growth rate of a zone that is one step further removed from growth influences in Columbus.

TABLE 7. Historical Population Data, Delaware County

Governmental Unit	Area in sq. miles	Population per Square Mile*						Percent Change per year in Population			
		1930	1940	1950	1960	1970	1973	1940-1950	1950-1960	1960-1970	1970-1973
Berkshire Twp.	24.8	75.7	77.3	85.8	107.3	125.3	140.6	.2	1.1	1,7	3.0
Berlin Twp.	26.5	36.3	34.3	36.2	43.2	53.3	54.5	.6	1.9	2.3	.6
Brown Twp.	25.8	33.8	33.9	38.4	36.1	36.8	37.7	1.3	-.6	.2	.6
Concord Twp.	24.7	59.8	63.0	66.0	88.8	127.9	135.4	.5	2.9	3.0	1.6
Delaware Twp.	25.3	379.0	395.0	508.9	589.8	669.1	763.6	2.9	1.6	1.3	3.5
Genoa Twp.	24.9	38.5	41.4	45.2	89.0	126.3	161.0	.9	5.8	4.2	6.9
Harlem Twp.	27.0	31.3	33.4	33.9	42.4	56.6	57.9	.2	2.4	3.4	.6
Kingston Twp.	24.1	19.4	19.4	19.4	21.1	23.5	24.1	0	.9	1.2	.6
Liberty Twp.	34.2	40.5	41.7	49.3	61.4	87.7	100.8	1.8	2.4	2.5	3.7
Marlboro Twp.	11.9	28.2	28.9	20.4	22.7	18.4	18.8	2.9	.2	-1.1	.6
Orange Twp.	26.0	37.0	40.0	42.8	59.0	73.2	70.4	.7	3.8	2.4	-1.0
Oxford Twp.	20.1	66.1	64.8	67.2	77.2	86.7	94.2	.4	1.5	1.2	2.2
Porter Twp.	25.9	22.0	21.9	25.3	27.6	28.7	29.4	1.5	.9	.4	.6
Radnor Twp.	30.7	33.5	33.7	31.1	32.4	31.4	32.2	-.8	.4	-.3	.6
Scioto Twp.	35.8	39.8	38.5	36.4	44.2	55.8	56.6	-.5	2.1	.1	.4
Thompson Twp.	19.7	26.4	24.0	22.2	22.7	24.9	25.5	-.7	.3	1.0	.6
Trenton Twp.	26.7	30.2	34.1	34.1	37.2	47.2	48.3	0	.9	2.7	.6
Troy Twp.	25.0	24.5	26.2	21.1	32.4	39.6	40.4	-1.9	4.5	2.9	.6
Total County	459	56.7	58.3	66.0	80.3	93.5	102.5	1.3	1.9	1.9	2.4

* - Population data for 1930, 1940, 1950, 1960 and 1970 is as of April 1; data for 1973 is as of July 1

Source: Adapted from U.S. Bureau of Census Publications

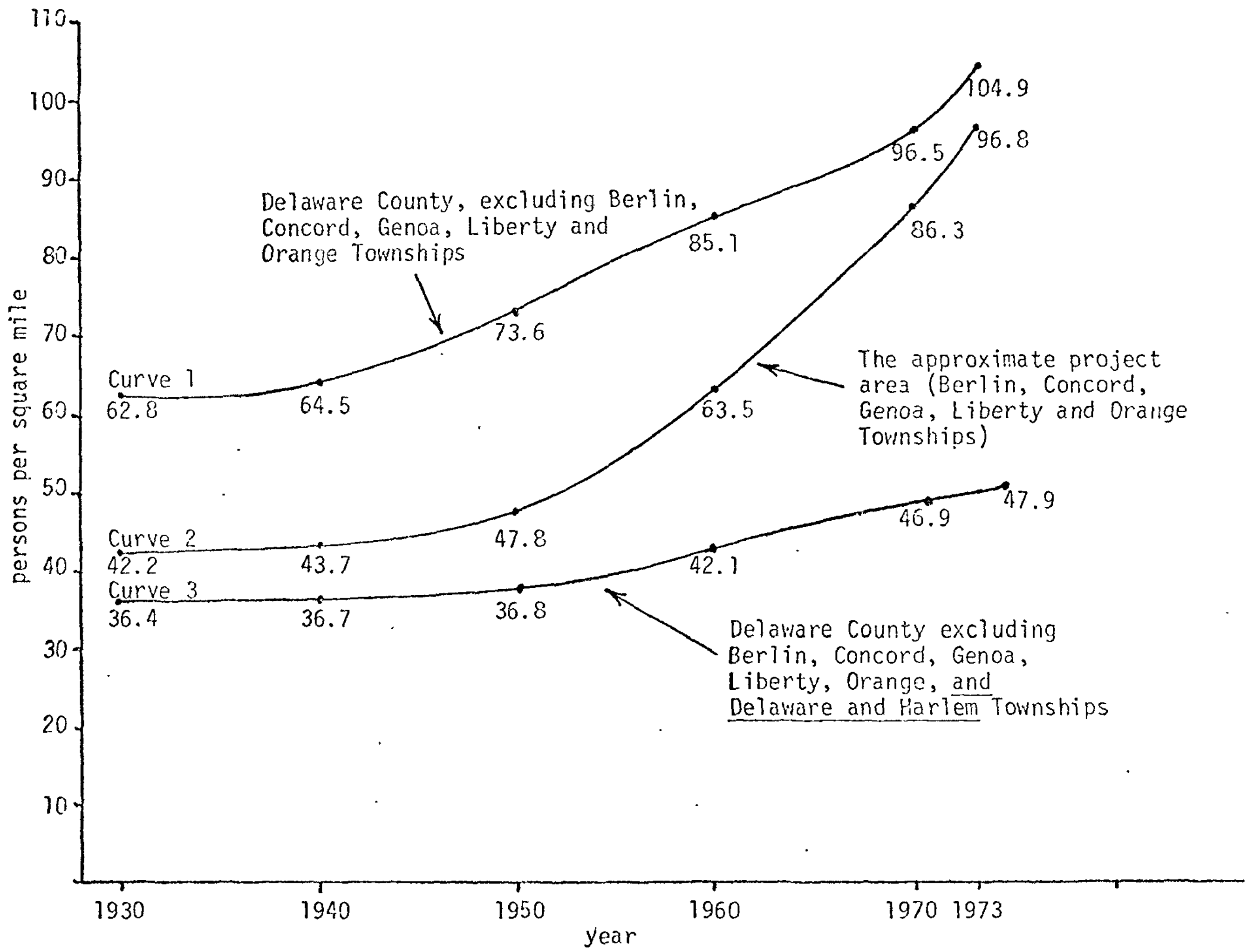


Figure 4. Growth of Population in the Approximate Project Service Area and in Other Portions of Delaware County

Source: Enviro Control, Inc., 1975

Curve 3 is representative of a zone still in a stage of slow growth. Curve 2, describing the project area, is representative of a zone in an increasingly high rate of growth. Figure 5 suggests that those townships in the growth zone just inside of Franklin County and adjacent to the project area are undergoing even higher rates of growth recently than most of those in the project area. In conclusion, those townships just south of the project area have been undergoing high rates of growth; those located in the project area are probably due for substantial growth in the near future.

Land use and socio-economic trends help evaluate what structure the predicted increasingly rapid future population gains will take. One of the more significant land use trends is the acquisition of large amounts of speculative land holdings in the southern half of Delaware County. The amount and location of this speculative land in Delaware County serves as a valuable indicator of the location of future development and the pressure for that development. This speculative land, as shown in the map in Figure 6 and in Table 8, is strongly concentrated in Liberty and Orange Townships. Discussion of potential development in these two townships (see Appendix A) emphasizes large amounts of residential development. The large size of the speculative tracts also suggests their potential for development into residential subdivisions and planned unit developments. Northern Franklin County has few large tracts of land available at prices low enough to encourage such development. Demand for larger and less expensive tracts of land shifts much of the potential for this type of development into southern Delaware County.

Currently, many of the potential developers of these speculative areas are relatively inactive. Two reasons explain this inactivity. One reason lies in the current national economic problems, even though Columbus has fared better than most metropolitan areas. In addition, many developers are waiting to see if public sewering will become a reality in the near future. Public sewering would save the developers considerable costs as opposed to investments in package systems for each subdivision. A land use trend that typically reflects large amounts of speculative land is a decrease in farm orientation. Tables 9 and 10 illustrate a striking reduction in the farm population and a large increase in the amount of farmland changed to other land uses.

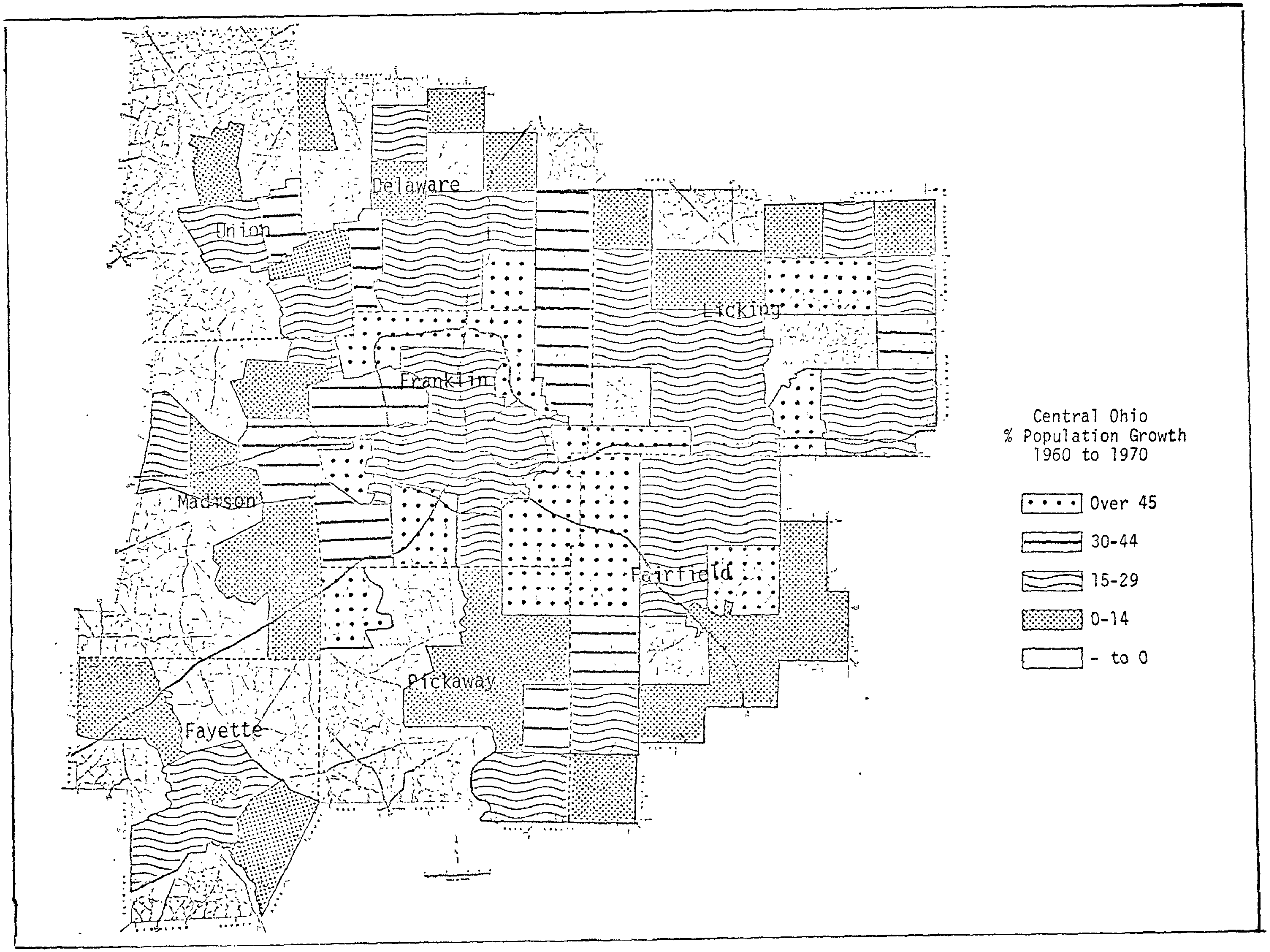
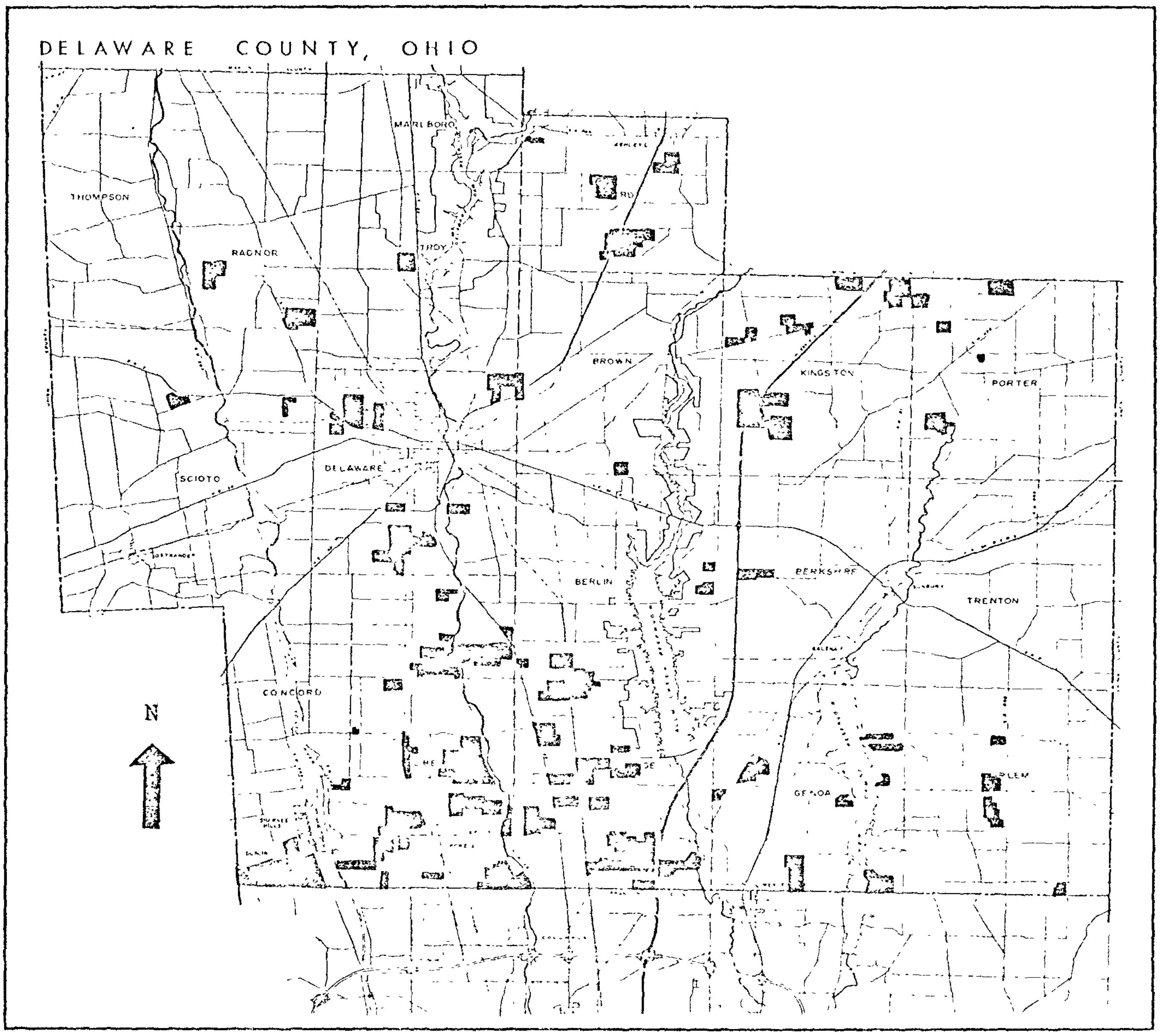


Figure 5. Population Growth in Central Ohio, 1960 to 1970

Source: Columbus Area Chamber of Commerce



Scale

KEY:

▒ - Speculative areas   0 10,000 ft.

Figure 6. Speculative Land in Delaware County

Source: Surveys Unlimited, 1973

TABLE 8. Land Development Characteristics

Political Jurisdiction	Plotted Sub-division Lots	Speculative Holdings (acres)
Berlin Township	109	578
Concord Township	299	1,003
Genoa Township	1,025	762
Liberty Township	579	2,705
Orange Township	341	2,382
Total for Berlin, Concord, Genoa, Liberty, and Orange Townships	2,353	7,430
Total for Delaware County	3,407	12,707
Total for Berlin, Concord, Genoa, Liberty, and Orange Townships* / Total for Delaware County	69%	58%

*Land area of Berlin, Concord, Genoa, Liberty, and Orange Townships / Total land area of Delaware County = 136.3 sq. miles / 459 sq. miles = 30%

Percentage of the total area of Berlin, Concord, Genoa, Liberty, and Orange Townships which is speculative = 11.6 sq. miles / 136.3 sq. miles = 8.5%

Sources: Adapted from Surveys Unlimited, 1973;
Bureau of the Census, 1967

TABLE 9. Percentage of Land in Farms

County	1959	1969	Percent of Farmland changed to other uses
Delaware	83.6	74.0	9.6
Fairfield	82.7	75.9	6.8
Licking	73.3	64.6	8.7
Madison	93.5	96.3	2.8 farmland gained
Pickaway	94.5	96.7	2.2 farmland gained
Union	90.8	89.1	1.7
Franklin	57.8	46.8	11.0

Source: U.S. Bureau of the Census, 1962, 1972

TABLE 10. Change in Farm Population, Columbus Area

County	1970 Totals	Per Cent Change 1960 - 1970
Delaware	3,669	-42.4
Fairfield	4,166	-43.7
Licking	5,200	-40.7
Madison	4,936	-16.9
Pickaway	3,900	-34.2
Union	4,179	-35.6
Franklin	3,387	-37.2

Source: U.S. Bureau of the Census, 1962, 1972

A land use trend which is an indicator of types of residential development is the average value of recently built residential units. Table 11 shows data describing the average values of dwelling units constructed between 1964 and 1972. These data show that the most recent construction of residential units has been concentrated in Concord, Genoa, and Liberty Townships. The average value of new units constructed in the project area from 1964 to 1972 has well exceeded the average value of all units constructed in Delaware County during the same period. The average value of the new units has also well exceeded the average value of existing owner-occupied units in 1970 in either Franklin or Delaware Counties. The trend in new home construction in the project area is to build fairly expensive housing.

A land use factor which describes the distribution and amounts of residential development is historic data on housing starts. Numbers of housing starts by year and by township are listed in Table 12. The most important information conveyed by the data on housing starts is that more homes were started in the project area than in the much larger area covering the rest of the county. Also, housing starts per year slowed after 1972. This decrease in housing production in the project area after 1972 reflects national economic conditions and waiting on the part of potential subdivision developers for the resolution of public sewering issues. Each of these factors is temporary.

The inexpensive large tracts of land in the project area can be expected to be especially attractive to developers who want to economically provide a large amount of land per dwelling. This can be accomplished either by dividing land into large-lot single-family residences or by providing considerable public space around apartments or clustered single-family homes. The ability to economically obtain a large amount of land per dwelling, along with the recreation and natural amenities it implies, makes development attractive in the project area. Higher land costs in Franklin County make similar development there more expensive and hence less attractive.

Current demand for residential development is indicated by the strong demand for year-round homes whose location satisfies both vacation needs and easy accessibility to year-round employment. Seasonal vacation homes are generally constructed in those areas located within several hours highway travel from major metropolitan areas and have considerable

TABLE 11. New Construction

Political Jurisdiction	New Units Constructed 1964* - 1972	Average Value Per Unit Constructed in $
Berlin Township	96	18,525
Concord Township	203	24,165
Delaware Township	120	19,663
Genoa Township	325	25,536
Liberty Township	232	28,644
Orange Township	142	24,137
Total (or average) of Berlin, Concord, Delaware, Genoa, Liberty and Orange Townships	1,118	24,513
Total for Delaware County	1,793	19,704
Total (or average) of Berlin, Concord, Delaware, Genoa, Liberty and Orange Townships / Total (or average) of Delaware County	62%	124%

* Records started in October 1964

Source: Surveys Unlimited, 1973; U.S. Bureau of the Census, 1970

TABLE 12. Number of New Housing Starts, Delaware County

Political Jurisdiction	'65	'66	'67	'68	'69	'70	'71	'72	'73	'74	(4 mo) '75	Total
Berlin Twp.	14	3	4	10	7	10	16	30	22	5	2	123
Concord Twp.	13	11	16	20	21	29	47	46	30	23	3	259
Genoa Twp.	46	43	42	39	36	35	50	31	32	23	7	384
Liberty Twp.	27	27	18	15	23	25	48	48	24	21	5	281
Orange Twp.	17	12	15	21	17	21	18	17	11	5	1	155
Total for Berlin, Concord, Genoa, Liberty, and Orange Twps.	117	96	95	105	104	120	179	172	119	77	18	1,202
Total for Delaware County	179	158	154	175	191	224	328	364	285	170	41	2,269
Total for remaining Townships in Delaware County	62	62	59	70	87	104	149	192	166	93	23	1,067

Source: Surveys Unlimited, 1973; Delaware Regional Planning Commission, 1975 recreational amenities. The project area exhibits both of these characteristics. However, because the project area is within commuting distance of Columbus, there is a strong tendency for people to combine their needs for a vacation home with their needs for a year-round residence. It is possible to live in the project area, commute to Columbus, and still have a house that is located in a high quality vacation environment. Thus, serving vacation needs in a year-round residence appears to be a major factor in the location decision of many current residences in the project area. These types of homes are located in areas near the Scioto and Olentangy Rivers, and, to a lesser extent, near Alum Creek.

Residential development is currently constrained by a strict septic tank ordinance. Although there is currently no actual building ban, a septic tank ordinance affects development by demanding the use of central sewering systems in all but the smallest subdivisions and increasing the total cost of homes serviced by septic fields. Septic fields are prohibited in any subdivision containing more than 4 lots. This regulation requires provision of public sewers or private package systems to any subdivision of more than 4 lots. This requirement increases the total cost of new homes serviced by septic fields because of two factors. First, each septic field must be built on a lot covering a minimum of one net acre. Second, there are special requirements in each septic system for 2 tanks and drains to protect against limited drainage caused by high groundwater table levels.

Strict zoning in Genoa Township and floodplain zoning provisions in Liberty and Concord Townships are the only current major zoning constraints to development in the project area. Zoning throughout the project area varies from township to township. However, in most areas it is flexible enough to provide for a wide range of types of development. Most of the zoning regulations have provisions which would allow high density developments such as PUD's, townhouses, and apartment buildings. However, at present, Genoa Township alone provides for a minimum residential lot size of one acre. Liberty and Concord Townships have rudimentary floodplain zoning provisions which restrict development in floodplains.

Trends in accessibility affect patterns of commercial, residential, and industrial development. Descriptions of each township in the project area (Appendix A) emphasize that current accessibility is excellent throughout most of the project area. Improvements are being built along U.S. Route 23 and State Route 315, and there are plans for the construction in the project area of at least one interchange with Interstate 71. These are trends toward improving the already excellent accessibility.

A major socio-economic trend is the rapidly increasing percentage of workers commuting to another county, shown in Table 13:

TABLE 13. Percentage of Workers Commuting to Another County

County	1960	1970
Delaware	26.8	39.4
Fairfield	18.1	25.6
Licking	14.3	16.2
Madison	34.1	42.1
Pickaway	28.2	36.0
Union	22.3	25.7
Franklin	2.4	2.6

Source: U.S. Bureau of the Census, 1967, 1972

This changing commuter orientation is toward Franklin County and, because of the close proximity of the project area to Franklin County, a large proportion of these out-of-county commuters live in the project area. The other major area of employment generation for residents of Delaware County is Delaware Township. Data on industries and employment as shown in Table 14 indicate that most of Delaware County's industries are located in Delaware Township. Although these industries are important employers of residents in the project area, their relative importance appears to be declining in relation to the importance of employment centers in Franklin County.

An analysis of patterns of growth and development can be brought into the most detailed focus through consideration of these patterns at

TABLE 14. Industries and Employment, Delaware County, Mid-1973

Name of Company	Location	Number of Employees
Abex Corp. Denison Div.	Delaware	202
American Can Co.	"	61
Correct Mfg. Co.	"	86
Delco Screw Products Co.	"	95
General Castings Co.	"	98
Grief Bros. Corp.	"	50
Hughes Keenan Corp.	"	85
J. G. Castings Co.	"	322
Nestle Co.	Sunbury	216
Nippert Co.	Delaware	257
North Electric Co. (Research)	Liberty	405
P.P.G. Ind. Paint Plant	Delaware	380
Pennwalt Corp.	"	46
R.B. Powers Co.	Ashley	40
Ranco Inc.	Delaware	1500
Searles Lab.	Powell	100
Sunray (Glenwood) Range Co.	Delaware	418
Swan Rubber Div.	Orange	100
Trus Joist Corp.	Delaware	80
Valves & Presses	Berlin	40
Whiteside Inc.	Delaware	44
Western Auto Dist. Center	"	140
	(will expand to 300 or more)	
Galena Tile & Shale	Galena	120

Source: The Delaware County Regional Planning Commission, 1973 a level of detail which deals with townships and portions of townships. Analysis in such detail is essential to the choice of both the proper location and sizing of sewer interceptors and the proper phasing of sewer construction. A detailed analysis of factors affecting localized development patterns is summarized in Appendix A. The most important part of the analysis in Appendix A is the projection of probable localized patterns of growth and development.

Most growth and development will be residential. However, moderate amounts of industrial development can be expected in some areas and small amounts of neighborhood commercial development can be expected near areas of major residential growth. Rising land costs in the project area will preclude any significant development of new recreation areas. Major expected areas of residential growth and development are:

- Along U.S. Route 23
- Along State Route 315
- Around the interchange of U.S. Route 36 with Interstate 71
- Shawnee Hills, Dublin, and the village of Powell
- Around the proposed interchange of Interstate 71 with Lewis Center and Big Walnut Roads
- Northwest of the intersection of U.S. Route 23 and Powell Road.

Major expected areas of industrial growth and development are along or near the Chesapeake and Ohio Railroad, the Penn Central Railroad, U.S. Route 23, the interchange of U.S. Route 36 with Interstate 71, and the proposed interchange of Interstate 71 with Lewis Center and Big Walnut Roads. Commercial growth and development is expected to be oriented primarily to neighborhood needs. As such, some small commercial enterprises can be expected to locate near areas of growth and development.

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II. ALTERNATIVES

This chapter presents the results of an investigation of local and regional alternatives for the location and implementation of the proposed Delaware County wastewater treatment facility. It provides the expansion of the Burgess and Niple, Ltd. Facilities Plan that is necessary for the presentation of an Environmental Impact Statement.

A. INTRODUCTION

This section provides an introduction to the scope and constraints of the analysis of local and regional sites. The analysis covers engineering, land use, environmental, biological, and institutional considerations.

1. Description of Alternatives

There exist a number of possible local and regional alternatives to the proposed action. The ones discussed here are all alternatives which have been suggested by local and regional officials, engineers involved in the wastewater management of the project, and other interested parties. In cases where the recommendation was vague, it was necessary to make value judgments as to the best possible location compatible with the suggestion.

The local alternatives are discussed first. These comprise 13 possible plant sites located on three of the major four basins in Delaware County. These basins are those of the Olentangy River, Scioto River, and Alum Creek. These sites, along with regional sites and pertinent existing treatment plants, are presented in Table 15.

TABLE 15. Proposed Alternative Sites and Major Existing Plants in Delaware and Franklin Counties

Site Code	Basin	Site Description	Elevation, in ft above msl	Eventual Avg. Capac. in mgd	Source
OR1	Olentangy	S. of I-270 in Franklin Co. along channelized section	850	6.00	Dr. Stein, 1974
OR2	Olentangy	W. of Ohio 315, N. of I-270 in Franklin Co.	860	6.00	Enviro Control, 1975
OR3	Olentangy	W. bank, 1 mile S. of Powell Rd.	775	6.00	Burgess and Niple, 1970
OR4	Olentangy	E. bank, 0.25 mile S. of Powell Rd.	775	6.00	Burgess and Niple, 1970
OR5	Olentangy	E. bank, 0.1 mile N. of Powell Rd.	775	6.00	Burgess and Niple, 1970
OR6	Olentangy	S. of Powell adjacent to C&O tracks and county line	910	6.00	Burgess and Niple, 1970
OR7	Olentangy	W. of river near Powell	890	6.00	Mr. Hutchins, 1975
OR8	Olentangy	E. bank, Jct. of Chapman and Winter Rds.	835	6.00	Burgess and Niple, 1970
OR9	Olentangy	E. bank, Jct. of Bean-Oiler and Chapman Rds.	835	6.00	Burgess and Niple, 1970
OR10	Olentangy	W. bank, 4000 ft. S. of Stratford	825	6.00	Burgess and Niple, 1970
OR11	Olentangy	S. end of Cherry St., Delaware	860	2.50	Existing Plant
AC1	Alum Creek	near Powell Rd. and Alum Creek	825	6.00	Burgess and Niple
AC2	Alum Creek	0.5 mile S. of Jct. Ohio 84, Ohio 10 near Killborne	920	1.25	Finkbeiner & Co., 1969
SR1	Scioto	at southern Franklin Co. line	680	60.0-120.0	Existing Plant
SR2	Scioto	at I-270 and Frank Road-Franklin Co.	700	100.0	Existing Plant
SR3	Scioto	0.5 mile S. of Ohio 198 bridge over Scioto near Radnor	910	0.50	Finkbeiner & Co., 1969

The geographical locations of the local sites are shown on the map in Figure 7. Each site has been given a site code. The first two letters in the code denote the river basin (SR denotes Scioto River) and the number that follows is assigned on a general south to north basis in each basin. Existing plants which form a part of regional alternatives are also designated according to this scheme. Locations of regional sites are shown in Figure 8.

The local alternatives are discussed on pages 69-124. These alternatives are grouped into geographic areas such that many site characteristics within each group are similar. This facilitates selection of the best alternatives, since one site can be selected from each group based on the relative merits within the group. This procedure serves to reduce the number of sites which must be compared in the final selection process. There are four groups on the Olentangy River and one on Alum Creek.

The regional alternatives involve construction or use of facilities other than the one proposed. Merger of the service area with Delaware City and/or Columbus might require construction of new facilities, or either augmentation or increased use of existing ones. In many instances a number of related possibilities which would involve different systems specifications and routing are possible for a given regionalization plan. These are discussed on pages 125-181. A different regionalization concept, the conservancy district, is presented on pages 182-184.

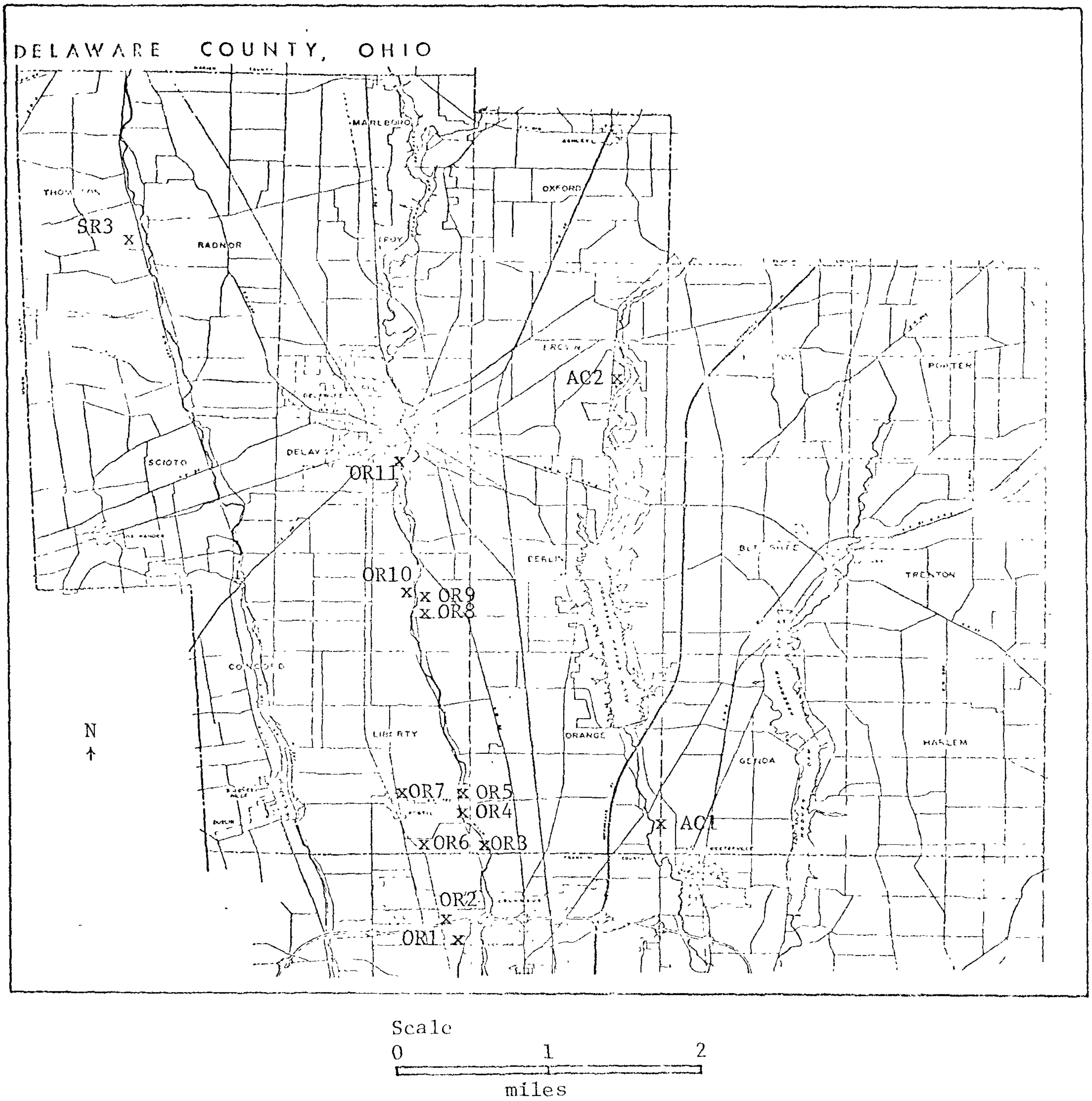
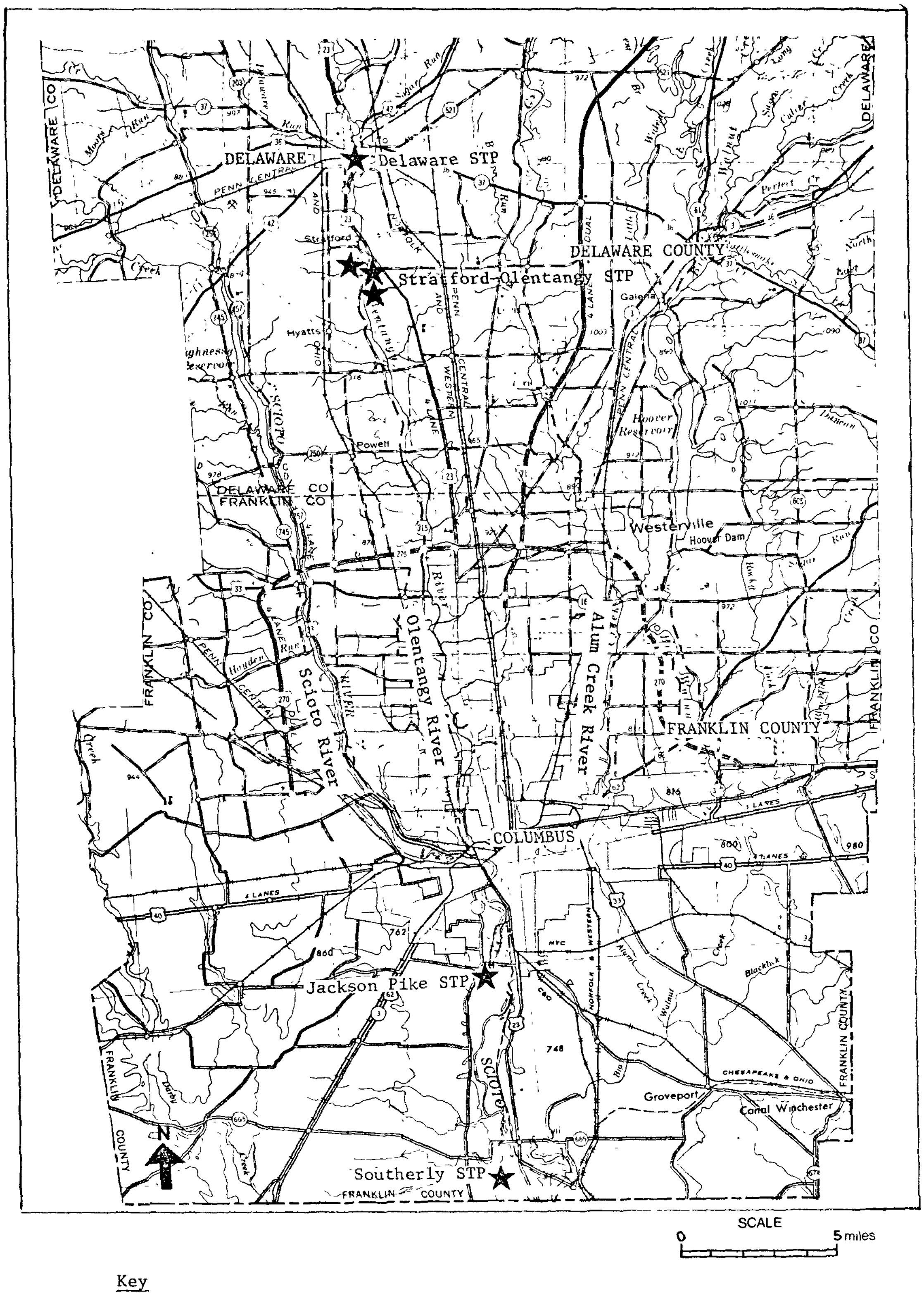


Figure 7. Local Alternative Treatment Plant Sites

Source: Enviro Control, Inc., 1975



Key

Regional Plant Site ★

Figure 8. Regional Alternative Treatment Plant Sites

Source: Enviro Control, Inc., 1975

2. Scope of Analysis

The scope in this chapter includes the analysis of many local and regional alternatives. Insofar as it is intended to define promising alternatives rather than to exhaustively investigate each alternative, the analysis is much less detailed than would be necessary in a facilities plan. Any conclusions drawn concerning engineering, land use, environmental effects or biological considerations are based on all available data but are not based on a complete on-site investigation involving actual soil sampling, water quality monitoring or other factors necessary to a complete facilities plan.

The scope of analysis is different for the local and regional alternatives. Local alternatives are first investigated according to the relative merits of the sites within the group. These merits include considerations of:

- Engineering
- Cost
- Land Use
- Aesthetics
- Water Quality
- Biological Impact
- Institutional Problems.

Following comparative evaluation within each group, one site is selected for further consideration. This selected site is then evaluated in a broader and more in-depth context for all of the points mentioned above. This in-depth analysis is designed to facilitate the comparison with other selected sites and with regional alternatives in the summary, pages 185-194.

Regional alternatives are presented mainly in terms of engineering and cost components. Environmental impacts are discussed, but in-depth analysis of land use and biological impacts is beyond the scope of this report. Institutional, legal, and political problems in implementing each regional scheme are also presented.

Pages 185-194 summarize both regional alternatives and local alternatives that have been selected within each geographical area. The most feasible alternatives are then recommended for further investigation, if they so merit. The recommendations must be made on the basis of data that are readily available due to limitations of scope. In certain cases data are missing or unreliable, but could be obtained through a more in-depth study of particular alternatives.

3. Engineering Considerations

This section concerns the engineering aspects of all alternatives. The objective of this task is to identify the engineering problems and difficulties of each alternative so that each alternative is given a fair judgment on its engineering feasibility. Many factors are involved. Before these factors are discussed, the differentiation of the local alternatives and the regional alternatives are addressed in terms of the scope of the work.

It is assumed that the engineering study of local alternatives is limited primarily to the STP sites and the additional sewer and pumping requirements for conveying the sewage from the collection point to the proposed sites. Because the volume of wastewater to be treated would be constant for all local alternative sites, the difference between any two local alternatives would be determined primarily by their system requirements between the sites and the sewage collection point shown in Figure 9.

On the other hand, the regional alternatives could have their own alternative sewage collection systems and sewage treatment facilities and the volume of wastewater to be treated would vary between alternatives. As limited by the scope of work, only three regional alternatives are considered in this report. Subalternatives within each regional alternative are also discussed, as appropriate. A description of the system configuration, the construction phases, the available facilities, and system requirements for the regional alternatives are discussed in the pertinent sections of this chapter.

The parameters considered in the evaluation of the local alternatives are:

- Pumping facilities requirements in the context of topographical characteristics of the site
- Structural requirements for flood damage control as related to the site location, if it is in a floodway
- Sewer requirements as a function of site location with respect to the collection point of the sewer network
- Outfall pipe and construction in the context of outfall location
- Excavation and grading requirement related to subsurface conditions and slope of the site
- Modification of buildings as required by limited land availability
- Additional river, highway, or railroad crossings as a function of site location.

Additional pumping facilities and force mains might be needed for a given alternative site due to its higher elevation and longer distance as compared to the sewage collection point indicated in

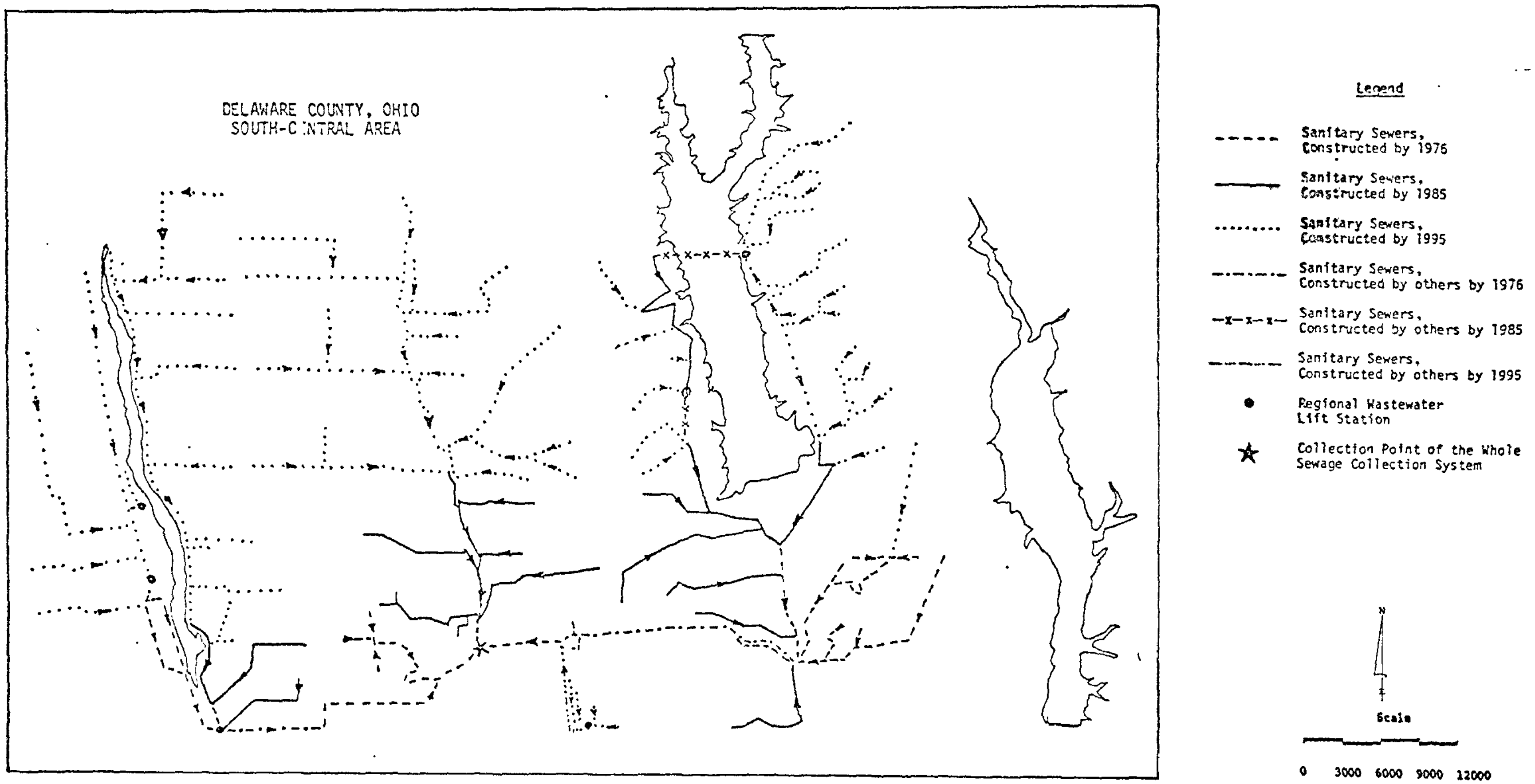


Figure 9. Basic Plan for Sanitary Sewerage Facilities

Source: Burgess and Niple, Ltd., 1974; Enviro Contro., Inc., 1975 the basic plan in Figure 9. Sites located within the zone of encroachment of floodways would need to have their building floors and road surfaces elevated above flood level and would require different foundation, building materials, and design to reduce flood damage. The distance between the site and the collection point of the sewer system determines the length and the size of the sewer trunk lines. Some alternative sites might require additional outfall pipe and outfall work to alleviate environmental impacts and to avoid hydrological and geological constraints. Stony subsurface conditions, such as indurated limestone deposits, and steep surface slope tend to increase the excavation and preparation work of a given site. Land availability would dictate the building configuration. Sites with limited available land might require that the plant be housed in a multi-level structure which would pose some engineering difficulty and increase construction costs. Site location might, in some instances, require extra river, railroad, or highway crossings of sewers as compared to the basic plan shown in Figure 9. Such crossings are quite expensive, especially when deep boring or tunneling must be employed to avoid disturbance of aquatic ecosystems.

All of the above criteria are used to evaluate the engineering feasibility of a given alternative. However, the engineering involved in the reduction of odor, noise, and residual chlorine problems is not considered as an evaluative criterion, because all local alternatives would be equally involved. They are discussed separately on pages 264-272 and 281-294. In the latter discussion, alternative stabilization and/or disinfection treatment of effluent, such as ozonation, denetrification, and dechlorination of effluent by aeration, sulfur dioxide addition, and activated carbon adsorption are considered.

The criteria used in the evaluation of the regional alternatives are essentially the same as those for the local alternatives. The major difference is that, in the regional alternatives emphasis is placed on the system configuration, available facilities and interceptor network, and the system requirements. Therefore, such factors, as requirements for flood abatement, excavation work and building modification, lose significance in the evaluation of the regional alternatives. For example, uniform soil conditions are assumed to be applicable to the whole region so that trenching and excavation for a linear foot of sewer of a given diameter would be the same throughout the whole area.

For each regional alternative, the hydraulic capacity and level of sewage treatment of existing facilities and interceptors are estimated. In this context, the system requirements include the expansion of existing treatment facilities and interceptor sewers, or construction of a new wastewater treatment plant, its collection system and pumping facilities. An inventory of these requirements is used for cost-effectiveness analysis. This analysis is presented on pages 129-134, 153-160, and 170-177 for the three regional alternatives, respectively.

The Facilities Plan developed by Burgess and Niple, Ltd. (1974), is used with some modification as the basic plan for comparative evaluation of the engineering feasibility of all alternatives. It is shown in Figures 9 and 10. Figure 9 presents the sewage collection

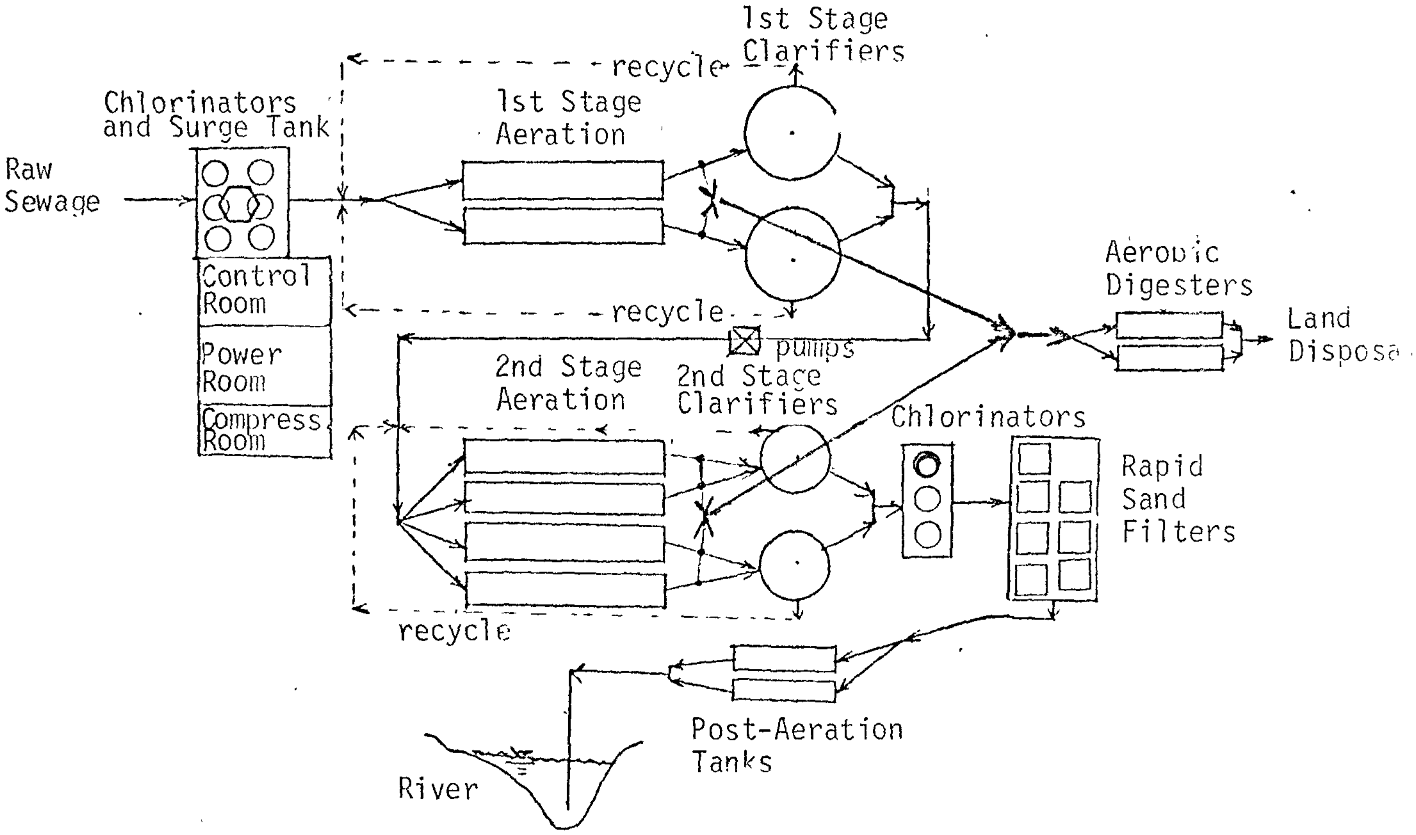


Figure 10. Diagram of the Proposed Sewage Treatment Plant

Source: Enviro Control, Inc., 1975

system; Figure 10 shows the major components of the proposed new sewage treatment plant.

The sewage collection system is designed to take full advantage of the natural drainage patterns so that minimum pumping facilities would be required. The whole system is divided into three major subsystems, each representing a river basin. They are the Scioto River in the west, the Olentangy River at the middle, and the Alum Creek in the east. Sewage from the Scioto Basin and Alum Creek is proposed to be transmitted to the collection point at Olentangy River and Powell Road, by lift stations, force main, and gravity flow sewer trunks.

The construction of the collection system is planned in three phases to be built over a period of 20 years. Interceptors that would be installed in each phase are indicated in Figure 9. This phasing scheme remains essentially the same as that proposed in the Facility Plan. One change is recommended to provide sewerage service to Powell Township in the first phase (page 219). The total footage of sewer pipes of a given size for a given phase of construction is given in Table 16.

The new STP would remain unchanged for all local alternative sites in terms of capacity and the level of treatment. The new STP would consist of prechlorination, two-stage extended aeration with clarification, rapid sand filtration, post-chlorination, and post aeration. Sludge would receive aerobic digestion. For the ultimate treatment

TABLE 16. Pipe Requirements for the Basic Interceptor Sewer Network

	Pipe Diameter in in	Length of Pipe in ft		
		Phase 1	Phase 2	Phase 3
Gravity Flow Sewer	8	5,400	0	0
	10	7,100	0	87,400
	12	5,600	67,000	98,400
	15	17,500	13,500	98,400
	18	35,000	24,000	70,400
	20	8,000	0	0
	21	10,500	38,300	9,000
	24	2,500	4,300	4,000
	27	12,000	0	3,000
	30	10,000	0	3,500
	33	2,500	0	7,900
	36	34,100	16,500	0
	42	6,500	0	0
Force Main	10	1,400	0	0
	16	12,300	2,500	0
	18	17,000	0	0
	20	8,600	0	0

Source: Enviro Control, Inc., 1975

capacity of 6 mgd with peak load of 9 mgd, the system components are shown in Table 17.

TABLE 17. System Components for the Proposed Sewage Treatment Plant

System Component	# Units	Unit Dimensions
Chlorinator	9	500 lb/day
Aerators: 1st stage	2	12 x 14.5 x 200 ft
Aerators: 2nd stage	4	12 x 14.5 x 200 ft
Aerobic Digesters	2	12 x 14.5 x 125 ft
Circular Clarifiers: 1st stage	2	12 x 100 ft (dia.)
Circular Clarifiers: 2nd stage	2	12 x 80 ft (dia.)
Rapid Sand Filters	7	10 x 40 x 50 ft
Post Aerators	2	10 x 12 x 100 ft

Source: Enviro Control, Inc., 1975

The phasing of the construction of the new sewage treatment plant would be concurrent with the interceptor phasing and would also take place in three stages. The average capacities of the sewage treatment plant would initially be 1.5 mgd and would have capacities of 3 mgd, and 6 mgd at the end of the 10th and 20th years after the plant becomes operational. The expansion of the major components of the proposed plant would be proportional to the designed sewage flows in three stages, except those in the category of land acquisition. Enough land would be acquired initially to accommodate the final capacity of the proposed plant.

Some basic assumptions are necessary for the formulation of the aforementioned evaluative criteria. They are:

- Equal level of wastewater treatment for both local and regional alternatives
- Extensive use of local topographical features to reduce pumping requirements
- Same construction scheme and schedule for all alternatives
- Construction scheme and schedule as a function of the temporal and spatial sewerage needs in the area

The first assumption is needed so that all alternatives are compared on the same scale. The areawide interceptor sewer network is designed in order to make the best use of topographical features. Thus, gravity flow sewers instead of force main and the accompanying pumping facilities are used to reduce long run power consumption and maintenance costs. The same construction scheme and the same schedule are assumed for all alternatives so that the intermediate and final goals of the proposed project can be achieved by all alternatives. The construction scheme and schedule are assumed to be the sole functions of the temporal and spatial sewerage needs in the area, and not to be influenced by other factors, such as inclement weather conditions, engineering difficulties, or shortage of energy and materials.

The Powell Road-Olentangy plant site, site OR3, is used as a representative case to demonstrate the costs of the proposed project, because this alternative has the identical sewer network as the new sewage treatment plant described in the preceding basic plan. The approach taken for the cost-effectiveness analysis is discussed further on pages 129-130. The results of the analysis are shown in Tables 18 and 19. Table 18 gives the construction costs and the operation and maintenance costs of the proposed plant. Table 19 presents the construction costs of the interceptor sewer network and its annual operation and maintenance costs. Combining Tables 18 and 19, and using the 6 1/8 percent discount rate recommended by the Water Resources Council (1975), the present worth and the equivalent annual cost of the proposed project are $25,479,000 and $2,017,000 respectively.

4. Land Use Considerations

Land use is considered in this report in the analysis of all local alternative plans. The areas of principal concern are:

- Current land use at site
- Current land use in vicinity
- Primary impacts of plant
- Secondary impacts of plant
- Primary impacts of sewers and outfall pipe
- Secondary impacts of sewers and outfall pipe.

A primary factor in considering the geographic scope of analysis for each alternative is that the eventual service area of each of the alternatives is identical. Figure 3 on page 12 illustrates the geographic extent of the project service area. Not only is the service area identical but also, through proper construction phasing of the treatment plant and interceptors, sewer service can, in each alternative, be delivered to the same portions of the project area at approximately the same time. Therefore, differential land use impacts between the alternatives studied are limited to local effects due to the plant or the outfall. With this in mind, the geographic

TABLE 18. Costs of the Proposed Sewage Treatment Plant for the Powell Road-Olentangy Local Alternative

Phases of Planning	Phase 1		Phase 2		Phase 3	
Plant Capacity in mgd	1.5		3.0		6.0	
Cost Items / Costs	Capital Cost in $	O&M Cost in $/yr	Capital Cost in $	O&M Cost in $/yr	Capital Cost in $	O&M Cost in $/yr
Control House	110,000	-----	140,000	-----	110,000	-----
Chlorination of Raw Sewage and Secondary Effluent	60,000	15,330	64,000	53,000	49,000	75,000
Two-Stage Aeration and Post-Aeration of Secondary Effluent including Sludge, Return Pumps, Pipe Gallery, and Air Diffusers	1,100,000	17,050	1,300,000	48,200	1,090,000	64,300
Primary and Secondary Clarification	380,000	36,680	660,000	100,560	506,000	134,100
Rapid Sand Filtration including Back-Washing	130,000	47,630	400,000	113,880	330,000	151,800
Aerobic Sludge Digestion	135,000	2,410	210,000	4,960	177,000	6,600
Sewage Influent Pumps and Air Blowers	71,500	9,810	110,000	39,240	89,300	52,300
Land Requirement	200,000	---	---	---	---	---
Improvement of the Site	43,700	---	---	---	---	---
Customer Service & Accounting	---	23,850	---	51,060	---	68,100
General, Administration, Engineering and Contingency	557,660	44,850	721,000	90,000	587,800	120,000
T O T A L	2,787,800	197,610	3,605,000	500,900	2,939,100	627,200

Source: Enviro Control, Inc., 1975

TABLE 19. Costs of the Interceptor Sewer Network for the Powell Road-Olentangy Local Alternative

Phases of Planning	Phase 1		Phase 2		Phase 3	
Plant Capacity in mgd	1.5		3.0		6.0	
Cost Items / Costs	Capital Cost in $	O & M Cost in $/yr.	Capital Cost in $	O & M Cost in $/yr.	Capital Cost in $	O & M Cost in $/yr.
Gravity Flow Interceptor Sewers	4,515,430		3,817,950		7,063,090	
Force Mains	912,640	34,860	338,170	72,080	0	81,940
River, Highway, and Railroad Crossings	99,000		101,200		19,800	
Manholes	205,160		145,190		231,000	
Pumping Facilities	884,000	176,000	280,000	196,600	136,000	203,500
Easements	128,200		90,750		144,380	
Engineering Services, Legal and Administration and Contingency	1,282,300		907,460		1,443,780	
TOTAL	8,026,730	210,860	5,680,720	268,680	9,038,050	285,440

Source: Enviro Control, Inc., 1975

scope of the land use analysis of each alternative is limited to an area within one mile of the plant, one mile of the outfall and outfall line, and downstream from the outfall.

There are, however, three major land use problem areas associated with the analysis of alternatives. These are:

- Secondary effects associated with any downstream changes in water quality
- Compatibility with present land uses on and near the site
- Compatibility with potential or probable future land uses near the site

The secondary effects associated with changes in water quality downstream from treatment plant outfalls are primarily related to impacts on recreation uses. Presently, there are numerous activity-oriented recreation uses located near Alum Creek and the Olentangy River. Many of these uses depend, either directly or indirectly, on water quality. A major recreation plan, Watercourse Plan for Columbus and Franklin County (Labrenz Riemer, Inc., 1974), anticipates an even more concentrated future use of those portions of Alum Creek and the Olentangy River which flow through Columbus or Franklin County than that which prevails today.

Most of the alternatives are located in areas which have a good degree of compatibility with present nearby land uses.
The primary reason for this compatibility is that the surroundings of most of the sites are undeveloped. In those alternatives which present some degree of incompatibility, this incompatibility generally reflects the effects of construction or plant operation on nearby residences.

Upon consideration of future prospects, however, a number of alternatives are found to be, to some degree, incompatible with potential or probable land uses near the site. This incompatibility arises because the attractiveness of land for certain future uses will diminish. Most of the incompatibility is associated with potential residential development and its associated commercial uses.

5. Environmental Considerations

Four major areas of environmental problems for all the alternatives are considered. They are water quality impacts and problems of visual pollution, noise, and odor. Each of them is discussed successively.

To define and describe water quality impacts resulting from an alternative action, the existing water quality conditions are examined. Water quality data collected in the past are compared with the stream water quality standards established by the Ohio EPA on page 199 of this report. Violations of these standards are reported and responsible source by types are identified on pages 207-212 and conformity of all alternative action with the Scioto Waste Load Allocation Program is examined and discussed on page 198. The stream quality projected by a computer simulation, which utilized the spatial distribution of pollution sources as inventoried in the "Waste Load Allocation Report of the Scioto River Basin," is compared with the stream water quality standards to assess the likelihood of water quality degradation in the future (Ohio EPA, 1974). Following the above analyses, the compatibility of each alternative action with the environment in terms of water quality is assessed.

The factors which entered the above considerations and analyses are the dilution ratios derived from the historical mean river flow and the 7-day 10-year low flow, water diversion, stream classification including scenic river designation, pollution levels and pollutant loads. The water quality parameters considered are based on the available water quality data. They include dissolved oxygen (DO), biological oxygen demand (BOD), total phosphorus, ammonia nitrogen (NH_3-N), nitrate nitrogen (NO_3-N), total dissolved solids (TDS), total suspended solids (TSS), and coliform bacteria.

Visual impacts of the treatment plant are determined by the architectural design of the plant itself, by the effectiveness of screening, and by the distance to receptors. It can be seen from Table 20 that the plant would be within 1/2 mile and presumably clearly visible from residences at all local alternative sites. In certain areas existing trees provide screening. At most sites, however, the treatment plant would probably require both architectural modifications and tree screening to hide the plant and blend it into the surrounding area. In order to make the plant aesthetically pleasing, architectural modifications commensurate with those planned for the proposed facility (Burgess and Niple, Ltd., 1974) would be necessary. This modification would ensure that the visual impact of the plant would not be detrimental to nearby residential or recreational land uses. Slightly less expensive architectural design might be used at some sites given sufficient tree screening. An exact statement of required architectural modification at a given site is dependent upon an assessment of public opinion concerning construction at that site.

TABLE 20. Distance From Site Center to Nearest Existing Structure or Parkland as of 1973

Site Code	Distance to Nearest Structure (parkland) in mi	Distance to Nearest Downwind Structure (parkland) in mi
OR1	0.2	0.2
OR2	0.4	0.4
OR3	0.2	0.6 (0.3)
OR4	0.1	0.1
OR5	0.0 (0.3)	0.0 (0.3)
OR6	0.2	0.2
OR7	0.2	0.2
OR8	0.1	0.4
OR9	0.1	0.1
OR10	0.0 (0.1)	0.0 (0.2)
AC1	0.3	0.3
AC2*	0.2	0.4

*as of 1961

Source: Enviro Control, Inc., 1975

Compatibility of the project with its environment depends in part on ambient noise levels in the project area. For example, locating a sewage treatment plant close to a heavily travelled highway interchange would probably be very compatible, because the noises from the plant might be well masked by the traffic noises. This example demonstrates the importance of surveying existing noise conditions in a noise impact study. The second factor is the location of such sensitive receptors as people. Receptors farther from noise sources receive less impact than those closer to the source. Increasing the distance of interposing noise barriers between the noise source and receptor effectively minimize noise impact. These are the evaluative criteria used in the assessment of noise impact resulting from an alternative action.

Similar considerations apply to the study of odor problems. One major difference between the two is that odors derive from gaseous or particulate matters such as hydrogen sulfide, phenolic compounds, or sulfur dioxides.

The sources of odors in a sewage treatment plant are identified and discussed on pages 264-268. Odor emission rate is governed by two major factors: the concentrations of the odor-causing gases in the sewage, and the atmospheric conditions. Development of septic conditions in the sewage tends to increase the potential for odor generation. The effects of such atmospheric conditions as wind speed, humidity, and temperature on the odor emissions are briefly discussed as follows. Wind transports the odors released adjacent to the water surface. The passage of wind would reduce the vapor pressures of the odor-producing substance contained in sewage, thereby increasing the evaporation rate of sewage and hence, odor emission. Increased humidity increases the vapor pressure and thereby reduces the rate of evaporation and odor emission. Increased temperature increases odor emission both by promoting bacterial activity and by increasing the rate of evaporation.

Upon release from a sewage treatment plant, odors are carried by the wind and dispersed by the atmospheric turbulence which is determined by the atmospheric stability and mechanical mixing induced by wind action and the roughness of the terrain. As the odor "plumes" travel downwind, they expand both in vertical and cross-wind directions and decrease in concentration as a result of entrainment and dilution by cleaner ambient air. Temperature inversions and associated stagnant conditions tend to accumulate odors in the vicinity of a plant or elsewhere in "pockets" near the ground. In general, once the odors are generated, their transport and dissipation are affected primarily by prevailing winds, which in turn, are strongly influenced by local topography.

Therefore, sensitive receptors downwind from the source would certainly receive most odor impacts. Table 20 shows distances of the sewage treatment plant from the nearest structure and from the nearest structure in a downwind direction. Several assumptions have been made in this determination. U.S.G.S. 7 1/2 minute quadrangle maps were used as the basic source. Most of these are updated to 1973. Distances are measured from the center of the site to the closest structure or parkland to determine the second column. The downwind direction is defined to be the octant between east and northeast since the prevailing winds are from the west-southwest. The third column specifies the nearest structure or parkland within this octant. It is important to note here that nearest structure does not necessarily imply residence since these are not distinguishable from the map. From the foregoing discussions, it is concluded that the sources of odors, location of sensitive receptors, prevailing wind direction, atmospheric stability, and local topography are essential factors for odor problem assessment.

The water quality data in the study area are scant. Most of the water quality data do not reveal whether they were derived during the day or night. At night, respiration and the absence of photosynthesis can deplete dissolved oxygen more severely than during the day. The scarcity of field observations prevents statistical analyses. Therefore, comparison of the collected data with the stream water quality standards is difficult, because some of the standards are statistical in nature. The representativeness of these data for the area awaits further investigation. This is particularly true when one has a low river flow. However, they provide a qualitative guide for the assessment of the water quality impacts.

The same limitations and uncertainty apply to water quality computer modeling. Nevertheless, modeling can be a useful tool to depict the variation of water quality parameters with river reaches. Extending its uses beyond that would be erroneous.

Two assumptions must be made in order to delineate the water quality effects resulting from alternative future actions. Major streams in the State of Ohio were classified according to their water uses, for example, recreational uses or agricultural uses. Appropriate stream water quality standards were then designated to the classified stream to either maintain its existing quality or define its future goals of water quality. The water quality standards were then implicitly incorporated into the Basin Waste Load Allocation Program (Ohio EPA, 1974) which defined the assimilative capacities of a stream and allotted the permissible waste load among various pollution sources. In order to assess the future water quality impacts resulting from a proposed action, the future status of water quality must be established. Therefore, the Basin Waste Load Allocation Program (Ohio EPA, 1974) is assumed to be effectively implemented so that the stream water quality standards as required by the stream classification can be achieved. It is further assumed that the effluent quality of any pollution sources would be effectively regulated by the responsible authority to the extent allowed by the best technically available (BTA) treatment processes.

As discussed above, p. 57, one task is to identify the noise sources in the sewage treatment plant. This would be difficult unless it is assumed that the only noise sources are the air diffusers and the mixing action in the aeration tanks. The other noise sources, such as pumps, exhaust fans, and exhaust of generators, are assumed to be fully enclosed and properly muffled so that the residual noise levels at the property line of each alternative site are less than the existing ambient noise levels.

In the odor study, it is assumed that the influent wet walls, the pre-chlorination units, the post-chlorination units, and the rapid sand filters would be fully enclosed and ventilation exhausts would be equipped with activated carbon adsorption columns for odor removal. Therefore, the only possible sources of odors are the aerators and the clarifiers. Odors from the aerators usually are not strong and can be minimized by maintaining high DO levels in the aerator liquor. Odors from the clarifiers can be reduced by decreasing the height of weir drops which reduces flow turbulance and evaporative emission of odors. The detailed mitigative measures are presented on pages 273-294.

6. Biological Considerations

A major concern in Delaware County is the increasing problem associated with the county's sanitary facilities. There is only one sewage treatment plant that is over 1 mgd, and it is located in the City of Delaware. This plant serves only the residents of the City of Delaware; there are no other treatment facilities in the county other than individual septic tanks and package plants. The package plants do not always operate efficiently, and the individual septic fields are commonly located in soils that are not suitable for adequate wastewater treatment. Thus, the county is faced with an increasing sanitary and health problem. The Olentangy River presently exceeds the water quality standards for fecal coliform 100 percent of the time and causes health and water quality problems (Nottingham, 1975). Therefore, the county needs a sewage treatment plant to treat all of these wastes that are presently flowing into the river. The other two river systems in the county are used for drinking water supplies, and thereby preempted as a site for waste discharge. Thus, the Olentangy River was chosen for assimilating the waste discharges of the treatment plant.

This river, near the Franklin-Delaware County line, supports a diverse and abundant benthic fauna and fish population. There are various species of pollution-sensitive benthic (bottom-dwelling) organisms present in this area of the river along with many fish species that are also sensitive to the discharges of treated sewage. Approximately 1-1/2 to 2 miles downstream from the proposed outfall the Ohio Department of Transportation has built an artificial riffle-pool fish habitat area that supports an even larger fish population than that present at the county line. In order to support this larger fish population, the benthic community in this area is assumed to be even more abundant and diverse than that at the county line.

The fish in the area of the plant's outfall could be harmed by the concentrations of discharged chlorine and ammonia. The fish most sensitive to chlorine have been found to be the forage fish, such as minnows and shiners. These fish make up a large portion of the food of the game fish, such as the bluegill, crappie, and the various bass species in the river. The concentrations of chlorine and ammonia that would be present in the river during a low-flow condition are significantly deleterious to the fish population near the discharge and further downstream and possibly also to the artificial fish habitat area downstream. Upon expansion of the plant's capacity from 1.5 mgd to 3 mgd to 6 mgd, the ratio of the amount of the effluent to the amount of river water increases to the point where the effluent would comprise approximately 67 percent of the flow of the river during low-flow stages.

Further research is needed to determine which various rare and endangered benthic organisms and fish in the river are also present in this river area and might be affected by this project. If these designated rare and endangered organisms are found in the project area, then the effects of the proposed plant's discharges upon them also need to be assessed. This issue is discussed further on pages 240-242.

7. Institutional Considerations

Several federal, state, and local institutions have various responsibilities relevant to a proposed wastewater treatment plant located either in southern Delaware County or on alternative sites. Relevant federal institutions include the United States Environmental Protection Agency (U.S. EPA), the Farmers Home Administration of the Department of Agriculture, and the Federal Highway Adminstration. On the state level, the Ohio Environmental Protection Agency (OEPA), the Ohio Water Development Authority, and the Ohio Department of Transportation are concerned with the project. The most important institutions are local governments. They include those of Delaware County, Delaware City, Columbus, and Westerville. Franklin County will play a peripheral role in this project.

The construction of the project is dependent on the approval and funding of the U.S. EPA. If Delaware County's facilities plan is approved, the U.S. EPA, as authorized by the Water Pollution Control Act Amendments of 1972, will contribute 75 percent of the funds needed for construction. Delaware County is considering borrowing the remaining 25 percent from the Farmers Home Administration of the Department of Agriculture. This agency offers loans repayable over a 40-year period for the construction of wastewater treatment facilities only where projects cannot otherwise be financed at reasonable interest rates. The other federal agency which may become involved with the project is the Federal Highway Administration. If the proposed project has an outfall in Franklin County near I-270, then Delaware County would have to obtain the Federal Highway Administration's permission to use rights-of-way. This issue is discussed further on pages 93-94.

The most important state institution involved with the proposed project is the Ohio Environmental Protection Agency. The OEPA, created by Section 3745 of the Ohio Revised Code, is given comprehensive water resource management responsibilities. Following these responsibilities and acting under Section 6117.34 of the Ohio Revised Code, the OEPA, upon complaint by the State Board of Health, has ordered Delaware County to construct wastewater treatment facilities. Upon completion of a facilities plan, Delaware County must submit it to OEPA for certification before receiving any funding from U.S. EPA. If Delaware County's plans include any contractual agreement with another political entity for the joint usage or construction of any facilities, this contractual agreement must be approved by OEPA as stipulated by Section 6117.42 of the Ohio Revised Code.

The Ohio Water Development Authority was established in 1969 to help fund the wastewater and water management facilities of local communities. Delaware County is considering applying to OWDA for a loan to pay its 25 percent share of the proposed project (Burgess & Niple, Ltd., 1974). The remaining state institution which might be concerned with the proposed project is the Ohio Department of Transportation. If the Delaware County plant is located at the proposed site, a mitigative measure might include the emplacement of the outfall pipe along State Route 315 to its interchange with Interstate 270. This action would require the use of state rights-of-way and the obtaining of a permit from the Ohio Department of Transportation. This issue is discussed further on page 93-94.

The institutions most concerned with the proposed project are those that exist at the local level. On June 2, 1969, the Delaware County Commissioners established a County Sewer District under Section 6117 of the Ohio Revised Code. This Section enables the county to "lay out, establish, and maintain" sewer service throughout the county. As a County Sewer District, Delaware County is also authorized to enter into contracts with other political entities for the connection of sewers or the joint usage of sewage facilities. Furthermore, under 307.15 of the Ohio Revised Code, Delaware County can contract with any municipality in its borders to assume full responsibility for providing sewer service to that municipality.

Both Delaware City and Columbus have their own sewer systems as provided for by Article XVIII, Section 3 of the Ohio Constitution.

This Article enables municipalities to "exercise all powers of local self-government" including the providing of sewer service. In addition, Columbus's City Charter specifically creates a sewer system to be operated by the city's Department of Public Service (Malcolm Pirnie, Inc., December 1974). The other local institution which might be involved in the proposed project is the City of Westerville in Franklin County. If the proposed plant were to be located at an alternative site on Alum Creek, an outfall could be placed in Westerville, provided Westerville agreed and leased the needed land to Delaware County. The details of this approach are examined on page 121.

The institutional framework exists for the implementation of the proposed project on either the proposed site or on any of the alternative sites. The obstacle to implementation appears to be the attitudes of the parties involved. This is especially pertinent to the implementation of any regional solution. These attitudes are examined, as applicable, in the discussion of the various alternatives.

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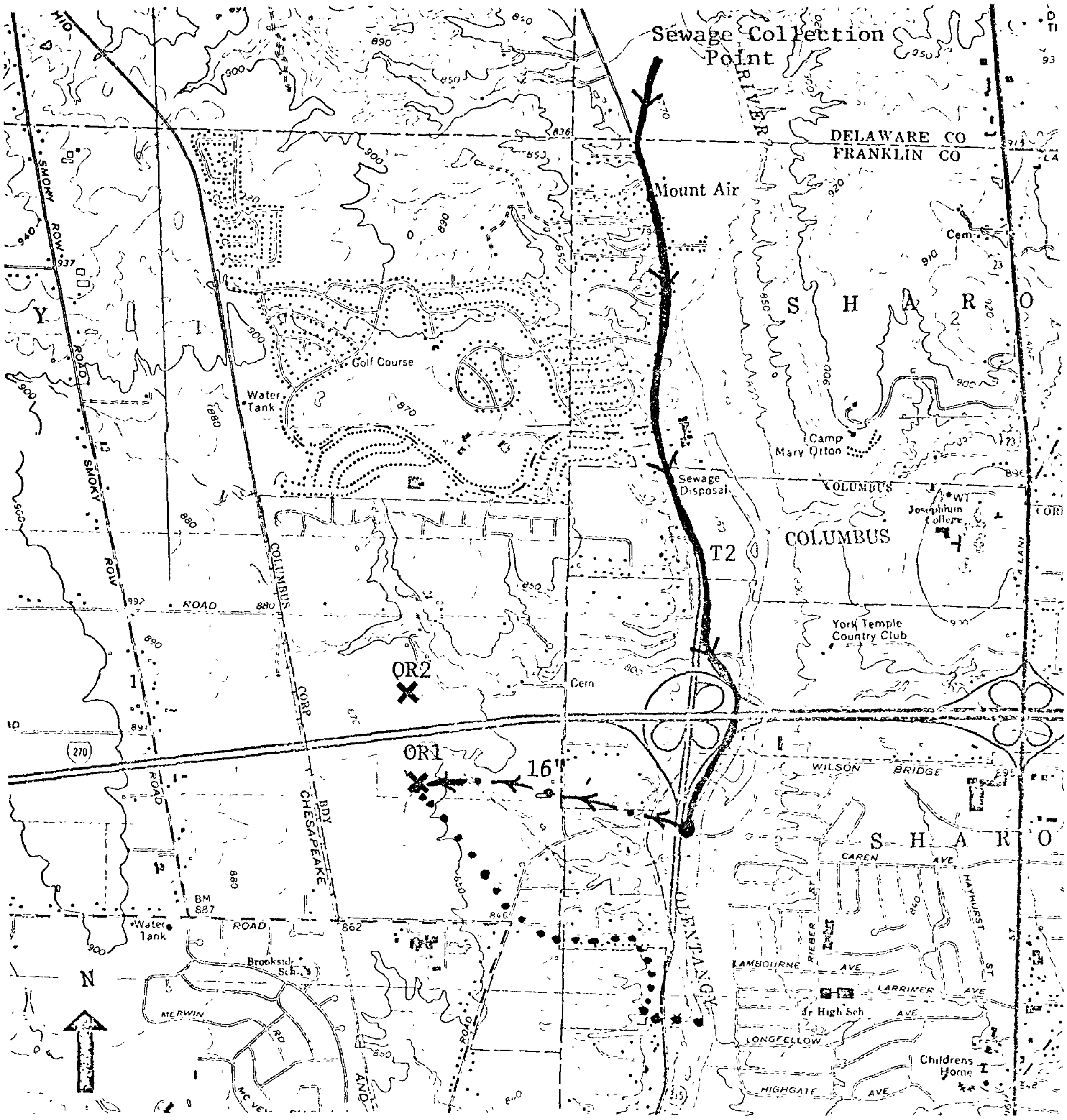
B. FRANKLIN COUNTY I-270

This section evaluates the relative merits of two sites located in Franklin County near the I-270 outerbelt. The more general engineering, environmental, biological, and institutional characteristics of the selected site are considered.

1. Overview

The proposed sites in Franklin County are located west of the Olentangy River near the I-270 outerbelt. They are designated OR1 and OR2 from south to north. These sites are considered in response to the recommendation of Dr. Carol Stein of the Ohio State Museum of Zoology. She suggested in public hearing that the plant be constructed so as to empty into the Olentangy in Franklin County south of the northern loop of Interstate 270 (Burgess and Niple, 1974). The main intent of this suggestion was to introduce the effluent into the portion of the river which has already been biologically degraded through channelization and highway construction. While a precise location was not selected by Dr. Stein, we have selected two sites in open areas north and south of the outerbelt, east of the Chesapeake and Ohio tracks. These sites are shown in Figure 11.

Site OR1 is located south of I-270, east of the Chesapeake and Ohio tracks, north of Snouffer Road and almost a mile west of the Olentangy River. The unused land is about 1/2 mile square. The elevation here is about 860 feet above sea level, or 100 feet above the river. The grade in the site area is not very steep. This site is located away from the river because there is both a dense residential development and a zone of steep slope near the river. The site is not located further south because here there is no available land outside of the flood plain.



KEY

Trunk Line

Force Main

Outfall Line

Local Plant Site ×

0 — 1 MILE

Scale in Miles

Figure 11. System Requirements for the Franklin County I-270 Alternative

Source: Enviro Control, Inc., 1975

Site OR2 is located immediately north of the previous site on the north side of the outerbelt. The area is bounded on the north by a forested area and a small stream. It is smaller than the previous site, measuring only 1/4 mile on a side. The elevation is similar and is between 860 to 870 feet above sea level. This is the only site in this general area which is not obviously in an existing subdivision.

In most characteristics, sites OR1 and OR2 are similar. Both are located at relatively high elevations, about a mile from the river. The effluent discharges from either location would be in the same river reach. The current land uses, however, are somewhat different. The necessary system changes from the Burgess and Niple, Ltd. facilities plan (1974) would include an additional interceptor line in Franklin County, a pumping station, and an extended outfall pipe.

2. Site Selection

Site OR1 is the preferred site in this group. Its selection is based on slight but important differences in engineering, land use, environmental, and biological impacts. Institutional, political, and legal considerations would be essentially the same since both sites are within the corporate boundaries of Columbus and the outfall would enter the Olentangy River opposite Worthington.

The basic engineering differences between the sites concern the placement of interceptor and outfall lines in relation to nearby roads. The north site (OR2) would require a line crossing of the Ohio 315 I-270 interchange or the outerbelt itself in at least two places. Both the intake and outfall lines would have to cross these roads. This would involve either tunneling or temporary disruption of a major interchange. With the use of the Wilson Bridge Road as a right-of-way across Ohio 315, only one crossing of the outerbelt would be necessary. This one crossing could utilize the existing tunnel, where the river flows under the outerbelt, to minimize additional construction.

The land uses at the two sites are different in that site OR2 is immediately adjacent to a planned subdevelopment. An on-site visit and photographs of the site reveal that grading is in progress in some portions and may be expanded to much of the rest of the site. There is currently enough land which is either dormant or under agricultural use to accommodate the treatment plant, but there would clearly be a significant impact on adjacent planned residences. The southern site is occupied by brush and scrub which have grown on previously abandoned land. While current land use would not interfere with location of the plant, there are indications that the northern site at least has been planned for residential development. This may be true for the southern site as well.

Effects on the immediate environment might include problems of odor, noise, and visual pollution. There are a number of residences that could be affected near both sites. The northern site has a high density populated area nearby in Worthington Hills and Mount Air. The planned development next to the site would be well within the objectionable range. The southern site is within a mile of some residences. Density is lower here.

Biological impacts from plants at both sites would include noise and construction effects on nearby forested areas; the northern site would affect a more extensive forest and a nearby stream. Most of the trees near the southern site are classified as brush rather than as grown forest. Aquatic impacts would be identical for the sites, provided that an appropriate outfall location was utilized. This outfall development might entail more difficult and expensive construction for the northern site, as mentioned above.

On the basis of the above considerations, site OR1 is identified as the best site in this group. It would result in lower cost, construction problems, and certain environmental impacts than the more northern site. Amplification of characteristics of site OR1 is contained on pages 72-82. The final comparison of the selected site with sites from other areas is presented on pages 185-194.

3. Engineering Analysis

Construction of the proposed facility at site OR1 would require three major modifications of the planned system: extension of the large interceptor which collects from the three basins, a pumping station, and a relatively lengthy outfall line.

Approximately 2 1/2 additonal miles of 42 inch interceptor line through Franklin County would be necessary to reach site OR1 (Figure 11). This could be most easily laid near Ohio 315 south to the I-220 interchange. Here it could utilize the river underpass before running inland to the site.

Sewage would be regulated by the wet walls of a pumping station located 3/4 mile south of the interchange and to the east of Highway #315 and relayed to the site by a 16 inch force main of 1 mile in length. The pumping station would have a system lift of approximately 130 feet and design peak flow of no less than 9 mgd. Two minor highway ramp crossings for the 42 inch sewer line and a highway crossing for the 16 inch force main would be required.

The outfall location here is of prime importance since the major reasons for suggesting this site were to minimize biological impacts. The outfall should be located downstream of the areas of good aquatic habitat. This consideration would place the outfall location about a half mile north of Ohio 161 and immediately downstream of the riffle area. At 1 1/2 mile outfall pipe would be required in order to meet this demand. To avoid major highway crossing and damage to forested areas, the outfall pipe would run southwestward for approximately one half mile, thence along Snouffer Road eastward, swing southward at Highway #315, and cross Route 315 where the divided highway section ends.

4. Land Use Analysis

Land in the immediate vicinity is a mixture of unused speculative holdings and residential or agricultural uses. Major transportation arteries already exist to the north and east of the site. Nearby land includes forested and recreational areas utilized by fishermen (Perry, 1974; Griswold, 1975). These and other unintensive uses are being diminished by the continued expansion of metropolitan Columbus. Construction and operation of both the plant and its sewer system could have impact on surrounding land use.

The plant would have small impact on land use at the site because it is presently composed of small trees, undergrowth and some agricultural fields. There are no commercial or industrial areas close by and only light residential development at present. Secondary effects might include limitation of the residential and commercial development that usually occurs near major highway interchanges. Some local depression in land values might be expected.

The sewer and outfall lines would cause only temporary disruption of surrounding land during construction. Reduction in recreational use of this section of the river for fishing is to be expected only during the construction period. This use should return to normal upon project completion since the pumping station and lines are to be underground and the outfall would be located below the major fishing area. Secondary effects of sewer construction might be to stimulate some growth north of the plant if the Worhtington Hills and Mount Air areas were to be serviced.

The outfall itself could possibly cause impacts on the densely populated Worthington area located east of the river. Although exact determination of these impacts is beyond the present scope, factors to be considered should be possible secondary odor effects from the growth of odor-causing algae and possible contamination of nearby groundwater supplies.

5. <u>Environmental Effects</u>

Environmental effects on people could be significant in this location if proper mitigative procedures are not used. These effects are classified as visual impacts, odor, and noise.

Visual impact is extremely variable due to possible differences in plant design. If the present parklike design were to be used, this impact would not be a significant factor. Conventional treatment plant architecture is not usually pleasing. A plant at either of these sites would be clearly visible from the outerbelt.

Odor and noise would be much more adverse in this residential area than in other more rural sites. Prevailing winds could carry odors northeast to Mount Air or eastward over Worthington and outlying suburbs of Columbus. The noise and odor reduction characteristics in the plant design would have to be very carefully controlled to satisfy nearby residents. If left uncontrolled, these might also influence nearby recreational, commercial, and light industrial use. The extra pumping station required might also contribute a certain amount of noise, but this would probably be covered by the normal highway noise at the interchange.

Water quality degradation is determined by both the effluent concentration and the instream flow. Since the effluent concentration is assumed to be the same at all sites and the instream flow varies to only a minor extent, water quality effects would be nearly equal for all sites on the Olentangy River.

The dilution ratio is defined as the ratio of the effluent flow to the mixed flow. During 7-day 10-year low flow periods, the dilution ratio would be 0.34, 0.51, and 0.67 for the 1st, the 10th, and the 20th years, respectively, after the project becomes operational. The above numbers are based on the assumption that the Delaware City STP would be operating 20 years from the commencement of the project operation.

During 7-day 10-year low flow periods, water quality would deteriorate in terms of DO, BOD_5, NH_3, NO_3, and TDS, simply because of the limited dilution water. The problems would increase significantly with the growth of the plant as long as the quantity of dilution water remains unchanged.

Under most probable conditions, the Olentangy River would have an average flow of 223 mgd and median flow of 47.8 mgd. Using the median flow as the evaluative criteria, the dilution ratio would be 0.030, 0.059, and 0.112 for the 1st, the 10th, and the 20th years, respectively, after the project becomes operational. These dilution capacities are 11.3, 8.6, and 6.0 times those in dry weather conditions. Under most probable conditions, the impacts of the project on the river water quality are expected to be insignificant for DO, BOD_5, NH_3, NO_3, and TDS.

6. Biological Impacts

The major point in favor of this location is that it is better suited to reducing impacts on the natural environment than sites in Delaware County. This particularly concerns the aquatic environment in the Olentangy River. No destruction of established forest areas would be necessary at this site.

The Olentangy River in Franklin County has not been designated as scenic below Wilson Bridge Road, and much of the river species habitat in this reach has been reduced or destroyed by channelization. As shown in Figure 12, the populations of both living and dead collected mollusk specimens are low immediately north of the artificial fish habitat area, 3 miles south of Powell Road.

Table 21 shows that populations of desirable fish reach a distinct peak north of the artificial habitat area and drop abruptly south of the area toward Henderson Road. Benthic organisms which are the fish's main food supply are numerous and have diversity and abundance north of the site at Powell Road (Olive and Smith, 1975). Because there are large populations of fish near the site, it is assumed that the benthic organisms in this area must also have high populations. The outfall from the site should be placed south of the I-270 interchange about 1/2 mile

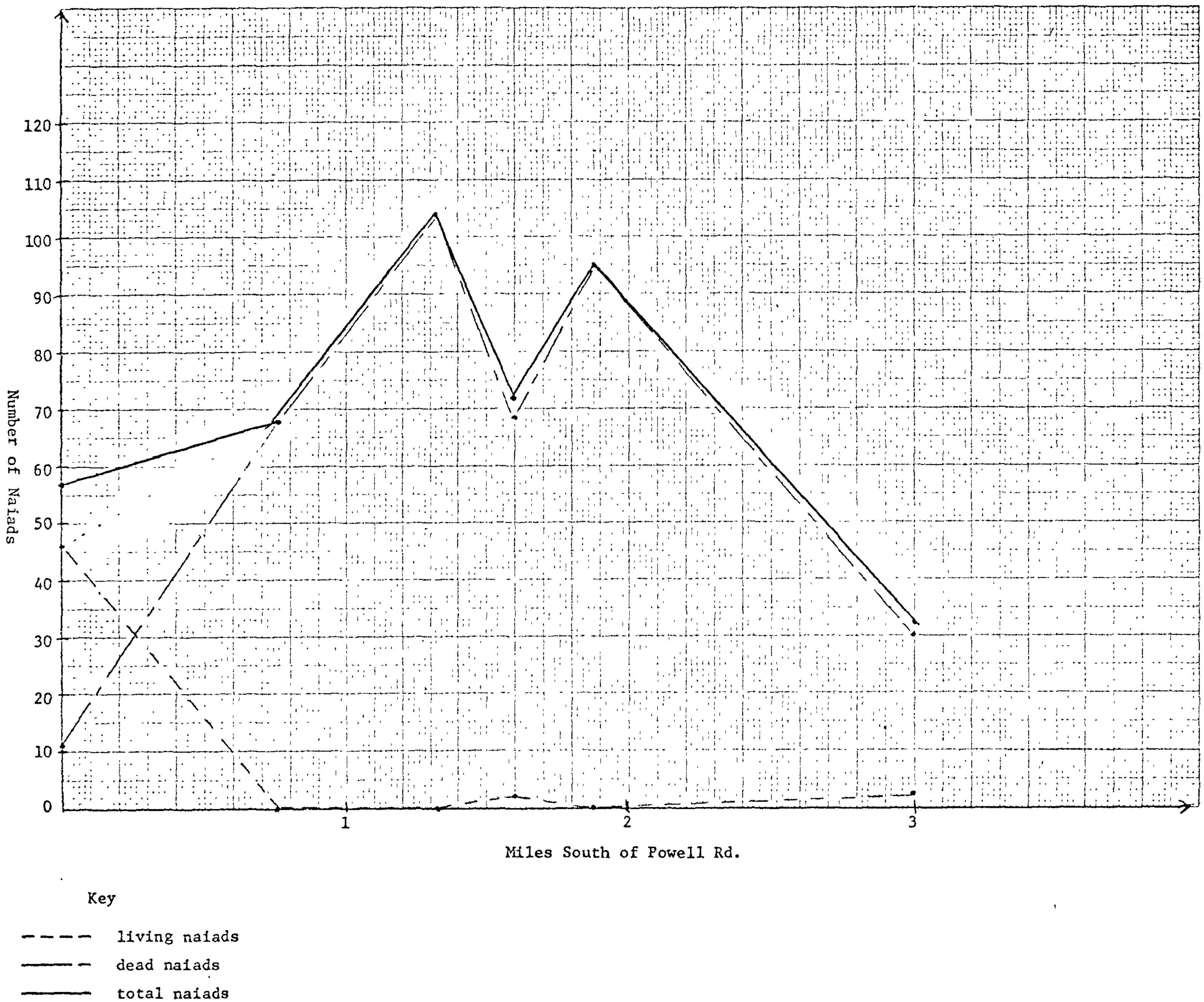


Figure 12. Naiad (Unionidae) Population on the Olentangy Below Powell Road

TABLE 21. Number of Fish Caught on the Olentangy River. South of Powell Road, May to November 1974.

River Reach / Fish	A - At Powell Road	B - Channelized Area 3 miles south of Powell Road	C - At Henderson Road 8 miles south of Powell Road
Catfish and Bullheads	38	67	37
Carp	266	289	321
Smallmouth Bass	274	793	47
Rock Bass	217	337	16
All Sunfish	667	1,763	291
Other	841	874	925

Source: Griswold, 1975

north of Ohio Route 61 in order to avoid the desirable fishing area near the interchange. Because of the scarcity of large organisms downstream from the outfall, the placement of the plant and outfall at site OR1 would have few noticeable biological effects on the river.

The large influx of nutrients from the effluent would result in an increase in algal and bacterial growth. This growth, however, is largely independent of location. It depends on the dilution of the effluent by the amount and flow of water in the river. The greatest flow and hence the largest dilution factor occurs at the most southerly site due to inflow of water from upstream tributaries. Water quality deterioration would be reduced slightly for these same reasons.

Two rare and endangered species of naiades (mollusks) and one fish species have been found in past years near the site. Subfossil shells of the naiad Epioblasma torulosa rangiana (the northern riffle shell) and more recent but empty shells of Quadrula cylindrica cylindrica (the cob shell) have been found near Wilson Bridge Road. However, no living specimens have been found here in the few studies that have been carried out since 1961. The Spotted Darter (Etheostoma maculatum) is on the list of Ohio rare and endangered fish, and has been collected three times in the Olentangy River. This fish was found at Snouffer Road on at least two occasions during the period 1958-1963 by Trautman (Ohio State University, Museum of Zoology, 1975). The presence of these rare and endangered species is an important consideration in treatment plant placement; however, due to their low numbers, their range and present existence in the river is poorly defined. Further investigation into the present existence of these species needs to be conducted since the river system in the area has been greatly altered by the artificial riffle-pool structure.

7. Institutional Considerations

Delaware County, as a County Sewer District under Section 6117 of the Ohio Revised Code, can not condemn land in another county for the construction of a wastewater treatment facility. However, Section 6117.41 of the Ohio Revised Code does enable a county to contract with another political entity for the joint construction and usage of sewers and wastewater treatment facilities. Therefore, the proposed facility can be constructed at site OR1 within Columbus if it services some area of Columbus, and perhaps Mt. Air and Worthington Hills within Franklin County, along with Delaware County and if Delaware County and Columbus agree to the necessary contract. It should be noted that the northern areas of Columbus along the Olentangy River are not yet being serviced by metropolitan sewers.

There are political obstacles, however, to the signing of such a contract between Delaware County and Columbus. Delaware County feels its autonomy threatened by the rapidly growing Columbus metropolitan area while Columbus, cognizant of Delaware County's attitude and concentrating on developing its own facilities plan, is not currently anxious to cooperate.

Delaware County has planned to finance the proposed facility by obtaining 75% of the needed funds from a United States Environmental Protection Agency grant and borrowing the remaining 25% from either the Ohio Water Development Authority or the Farmers Home Administration of the Department of Agriculture. However, if the proposed plant is built at site OR1 within Columbus, this funding arrangement would be altered. The question would arise concerning whether Columbus or Delaware County would be the lead applicant and therefore eligible for federal funds. A financial arrangement providing for the maintenance and operation of the proposed plan would also have to be decided upon by Delaware County and Columbus. These financial arrangements can be successfully negotiated, but given the distrust existing between Columbus and Delaware County, it will be difficult for the two entities to cooperate.

PRIVATE COMMUNICATIONS

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C. POWELL ROAD - OLENTANGY

In this section the relative merits of three sites on the Olentangy River near Powell Road are evaluated. Engineering, environmental, and institutional characteristics of the area are discussed.

1. Overview

The three sites on the Olentangy River near Powell Road are designated OR3, OR4, and OR5 from south to north. They were originally suggested by Burgess and Niple, Ltd. in their Feasibility Survey and Report for Sanitary Service and Sewage Treatment Facilities (1970). All three have been subsequently discussed as the major three feasible alternatives in locating the southern Delaware County facilities (Ohio EPA, 1973). The southernmost site, OR3, is the site of the currently proposed action and thus is discussed here only in highlight form. More detailed reference to this site is given on pages 195-294.

Site OR3 is located on the west bank of the Olentangy approximately 1.2 miles south of Powell Road (Ohio 750) in Delaware County. The site is only 900 feet north of the Delaware-Franklin County line and is on the lowest usable land within the county at an elevation of 770 feet above sea level. The site size is about 1/3 mile on a side. It is 0.2 mile from the nearest structure according to 1973 data.

Site OR4 is on the flood plain or river terrace on the east bank of the river about 0.25 mile south of Powell Road. Elevation here is between 770 and 780 feet above sea level. This site is smaller than OR3 and only has an area 0.2 mile square. It is about 0.1 mile from the nearest residence as of July 1975.

Site OR5 is also on the east bank but to the north of Powell Road. It extends from the road northward for only 0.15 mile before being intersected by a small stream. In an east-west direction the terrain becomes very steep about 0.2 mile back from the river. The entire site is on steeper terrain than either OR3 or OR4, ranging in elevation from 770 to 800 feet. There is a residence on the site itself.

Among the most important engineering considerations are the relative site, size, slope, and the presence of rocky soils. Important impacts on land use and the environment involve the effects of recreation use on the nearby Highbanks Metropolitan Park. Biological impacts could be quite severe particularly on aquatic organisms. Institutional considerations are not a factor, since all three sites are in Delaware County.

2. Site Selection

Site OR3 is the preferred site in this group. Its selection is based mainly on cost, engineering considerations, and biological and other environmental impacts. Differences in land use impacts are deemed to be minimal between the sites. Institutional considerations are not applicable within the Delaware County Sewer District.

The major engineering differences between the three sites involve differences in line length, site size, and subsurface conditions. These last two considerations influence the ease and expense of excavation and other construction. The sites are equal in terms of pumping facilities and number of required river crossings.

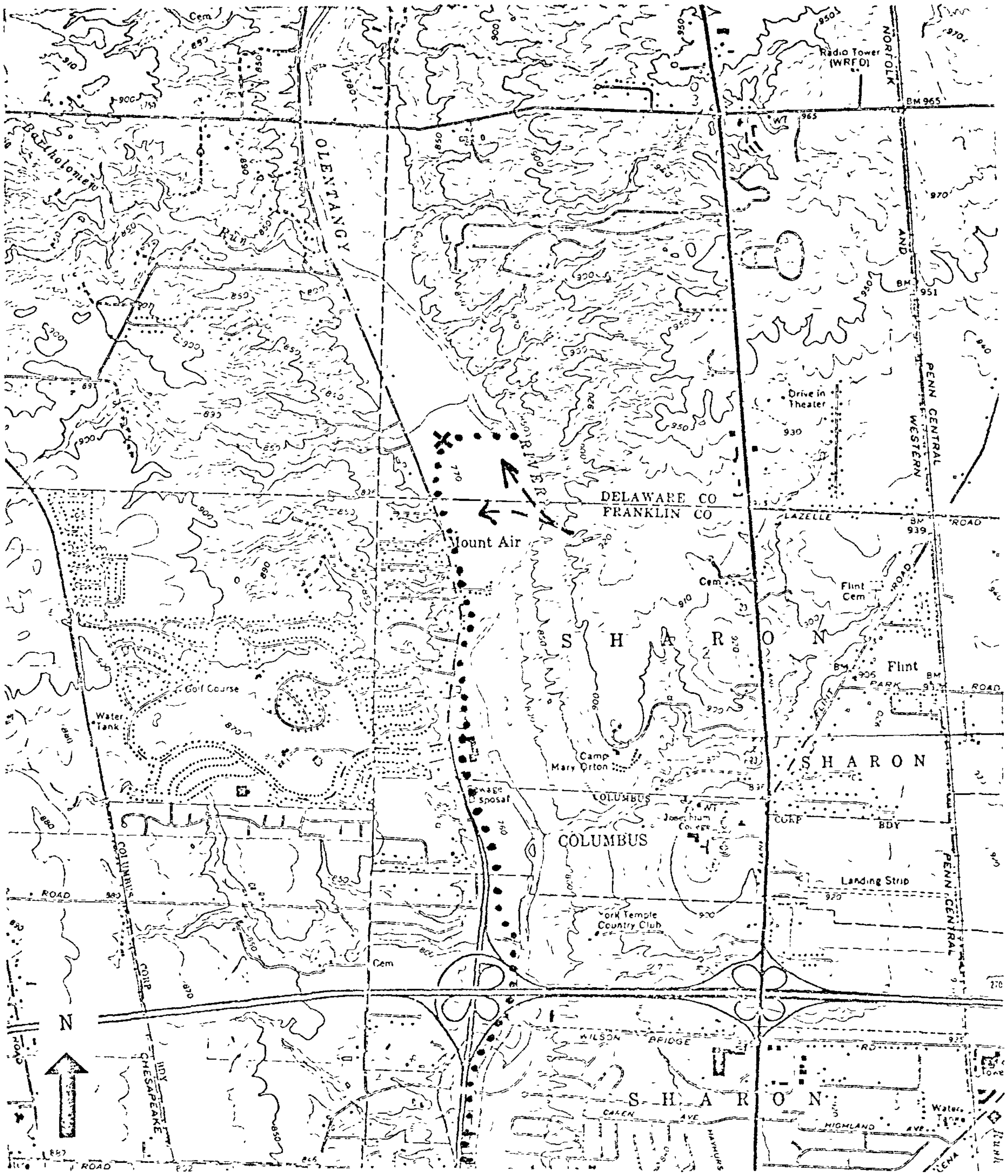
Site OR3 requires approximately one mile more of 42" interceptor than do OR4 or OR5. This is the interceptor which would extend from

Powell Road, south to the site. As Figure 13 indicates, sites OR4 and OR5 are adjacent to Powell Road and could utilize the east-west interceptor directly with only slight rerouting. Due to biological considerations, it may be advantageous to relocate the outfall downstream from the plant south of the county line. This course of action would partially or completely nullify the savings of interceptor line at sites OR4 and OR5 since an equivalent amount of extra discharge pipe would be necessary from these sites.

The most northern site, OR5, would probably involve some difficulty and added expense in construction and excavation. The site is the smallest of the three, and there are indications that this area may have shallow soils. The topography is also somewhat steeper than the other two sites. In addition, there is currently a farm on this site which would have to be acquired and demolished.

Land use at sites OR3 and OR5 is agricultural. However, OR5 contains a dwelling and farm buildings whereas OR3 does not. Site OR4 is on land owned by Highbanks Metropolitan Park. The actual plant location here is presently an undeveloped field, but development for picnicking and recreational use is underway nearby.

Odor, noise, and visual impact would be least significant from the proposed plant at site OR5 since it is relatively isolated from the park and residences. The other sites are both visible and upwind from some portions of the park. Visual detriment, however, is not expected in any site with the proposed design. Water quality would be equal at the three sites, but the Park Board has expressed concern over possible airborn pathogens at site OR4 near the picnic areas. Pathogen



Scale in Miles

0 1/2 1

KEY

Outfall Line. . . . . . .

Local Plant Site ✕

Figure 13. System Requirements for the Powell Road-Olentangy Alternative

Source: Enviro Control, Inc., 1975

contamination of the air seems unlikely, but the possibility cannot be excluded.

Biologically, the equivalence or difference between the sites depends on outfall location. If the proposed plant at each site were to utilize a discharge pipe to a downstream location, all three could be considered equivalent. If the plants at sites OR4 and OR5 were to discharge at Powell Road, however, significantly more biological damage would be done to aquatic organisms, particularly naiades downstream. The plant at site OR5 would also have some detrimental impact to terrestrial biota because it is adjacent to forested areas north and east of the site.

On the basis of the above considerations, we have selected site OR3 as the best site in this group. The optimal course of action of locating the sewage outfall south of the sites in Franklin County makes this site equivalent or better from both an engineering and biological standpoint. It has slight advantages with respect to current land use and only a minimal disadvantage with respect to aesthetic environmental impacts. Amplification of the characteristics of the selected site is contained in the following sections. Since this site is the one presently proposed by the Burgess and Niple facilities plan, more detail will be found on pages 195-294 concerning the proposed action. Comparison with other selected sites will be presented on pages 185-194.

3. Engineering Analysis

As this is the site designed in the facilities plan, the interceptor lines required are those outlined in the plan. The site eliminates the necessity for any pumping stations on the Olentangy Basin due to its low elevation. A recommended mitigative measure to reduce biological impacts is the extension of the outfall line south into Franklin County to the same point recommended for the discharge from site OR1. This extension is shown in Figure 13.

Construction needs for the site have been discussed in detail in the facilities plan. Mitigative measures relating to river crossings are discussed on pages 273-278. All indications are that subsurface conditions would not pose any particular construction problems at the site.

4. Land Use

Site OR3 is currently devoted to agriculture. It also serves as part of a scenic vista from portions of the Highbanks Metropolitan Park. Park authorities have expressed considerable concern about impacts to recreational use in adjacent parkland. It is possible that there would be slight impacts on park users from odor and noise, but the effect would not be severe enough to change the land use of the park.

Across Route 315 from the site, land is occupied by scattered residences. There is also a subdivision several thousand feet to the west-northwest. Significant residential development could potentially occur in this and other nearby areas.

The main land use impact of locating the plant at the site would be to take a small amount of farmland out of production. It seems unlikely that the scenic vista from the park would be affected considering the extensive visual design modifications in the facilities plan and the fact that the scenic vista can only be completely protected through the purchase of extensive amounts of land or scenic easements west of

Ohio 315. Indeed, the degradation of the scenic vista from the park by a visually camouflaged treatment plant would be insignificant as compared to the damage that would be caused by potential development on land west of Ohio 315.

A plant located here might limit future public access to the river in this area. This access along the Olentangy River is considered important by the Ohio Department of Natural Resources in its Statewide Plan for Outdoor Recreation in Ohio 1971-1977 (1970). Construction of the sewers would also cause changes in land use, such as differences in industrial, commercial, and residential use. These changes are discussed in more detail on pages 245-259. Location of the outfall could cause land use changes by affecting downstream recreation. Maintaining water quality for recreational purposes is viewed as extremely important by the Columbus Department of Recreation and Parks and is an integral component of the Watercourse Plan for Columbus and Franklin County (1974).

5. Environmental Effects

Visual impact of the plant at this site is expected to be minimal due to the extensively designed beautification program in the facilities plan. Construction of ponds, gazebos and walkways will all help the plant blend with its surroundings. The exterior of the plant itself is such as to foster a wooded and parklike atmosphere. In addition, extensive screening with trees and shrubs is planned. Effectiveness of this screening could be increased through more use of trees with thick evergreen foliage such as white pines (*Pinus strobus*), especially in directions where visual impact is more important.

Odor problems from the plant at this site might be significant to the Highbanks Park. The park is in the direction of the prevailing winds. It is very difficult to predict the magnitude of the odor problem since the treatment process involves the production of odor-causing substances, and its importance depends upon weather factors and the sensitivity of the human receptor. Mitigative steps to control odor are discussed on pages 264-268. It should be noted, however, that the highbanks are more than 1/4 mile from this site.

Noise problems should not be significant here. Noise levels at the park should be far below the decibel levels recommended by HUD for recreational areas. This topic is further discussed on pages 268-271.

Water quality in this section of the Olentangy has been poor both historically and presently due to significant sewage discharges from leaking septic tanks and nutrient runoff from surrounding farmland. Water quality standards are currently violated 100 percent of the time on the basis of fecal coliform counts, according to Ohio EPA (Nottingham, 1975). The water is also high in both phosphorus and nitrogen, as documented in Table 45 on page 209. The plant would eventually help reduce the amounts of coliform bacteria through treatment and chlorination. Levels of phosphates, nitrates, chlorine, and ammonia would be increased. The effects of these increases on aquatic life are discussed below. Possible airborne pathogens from either the treatment plant or the effluent would pose no problems at this site.

6. Biological Impacts

The major impacts upon aquatic life that might occur involve effects on populations of naiades, fish, and benthic organisms. The naiades are organisms that feed on small particles of organic matter and plankton. They are fed on, in turn, by muskrat, mink, otter, raccoon, and turtles. The benthic organisms which have been investigated are mainly insect larvae which form the main food source for the fish.

Changes in the populations of naiades, fish, and benthos could result from various chemical compositions of the effluent. The main effects are due to oxygen depletion and toxic substances. The highlights of these effects are discussed below. A more detailed description is presented on pages 225-244.

Untreated sewage effluent is commonly rich in nutrients and often results in increased populations of undesirable algae. As these algae decay, oxygen in the water is consumed in the decomposition process. This reduction of dissolved oxygen usually occurs for some distance downstream from the point of effluent discharge. It could eliminate many desirable species of fish and naiades from this part of the river. Insufficient information is available on expected levels of dissolved oxygen and the effects of reduced oxygen on native species to accurately predict the impact.

Several biologically-toxic substances would be discharged from the proposed plant. Chlorine and ammonia are of particular importance and the Ohio Fish and Wildlife Service (Faulkner, 1975) has expressed concern about their effect. An artificial habitat fishery is located two miles south of site OR3 and it is doubtful that much of the chlorine or ammonia discharged would be dispersed or assimilated before reaching this point in the river. According to biological data, significant fish kills could result. Supportive bioassay data is contained on pages 226-238.

Impacts upon terrestrial life would be minimal at site OR3. Placement of the plant would not involve any loss of trees since most of the site is a cultivated field. The trees presently on the site are on the riverbank. These include typical riverbank species such as cottonwood, sycamore, boxelder, oaks, and maples. It is proposed to plant various evergreen and deciduous trees around the treatment plant for beautification and screening purposes. These trees would also provide some habitat for birds and small mammals (see Appendix B).

Adverse impacts on or the elimination of rare and endangered species could occur with respect to the naiades, mollusks, *Quadrula cylindrica* (cob shell), and *Epioblasma torulosa* (northern riffle shell), and the fish, *Eteostoma maculaturn* (Spotted darter). These species have been discussed above on page 80. Their most probable locations are downstream from site OR3 and hence, more detailed investigation is warranted. Outfall relocation is a promising mitigative measure to reduce the impact on these species.

7. Institutional Considerations

A mitigative measure for site OR3 is the placement of an outfall along the sides and median strip of State Route 135 in Delaware and Franklin Counties, past the interchange of State Route 315 and Interstate 270 in Columbus. Although this would involve a routine procedure, it is doubtful whether it could be done in this instance.

The State of Ohio owns the median strip and usually 30 to 40 feet on each side of the center line on state routes. Delaware County must apply to the Ohio Department of Transportation to use this right-of-way along State Route 315. The Ohio Department of Transportation would review this application and elicit the comments of Franklin County, Columbus, and other interested state agencies before deciding whether to issue the permit. The application would also have to be approved by the Federal Highway Administration and the City of Columbus, since they contributed funds to construct the interchange of State Route 315 and Interstate 270.

Franklin County and Columbus would probably not object to this measure, but Worthington would. The proposed outfall, as indicated in Figure 13, lies directly across from a junior high school and a heavily populated residential neighborhood. The likely opposition of Worthington to the location of the outfall at this site constitutes a major obstacle to the implementation of this measure.

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D. POWELL ROAD - POWELL

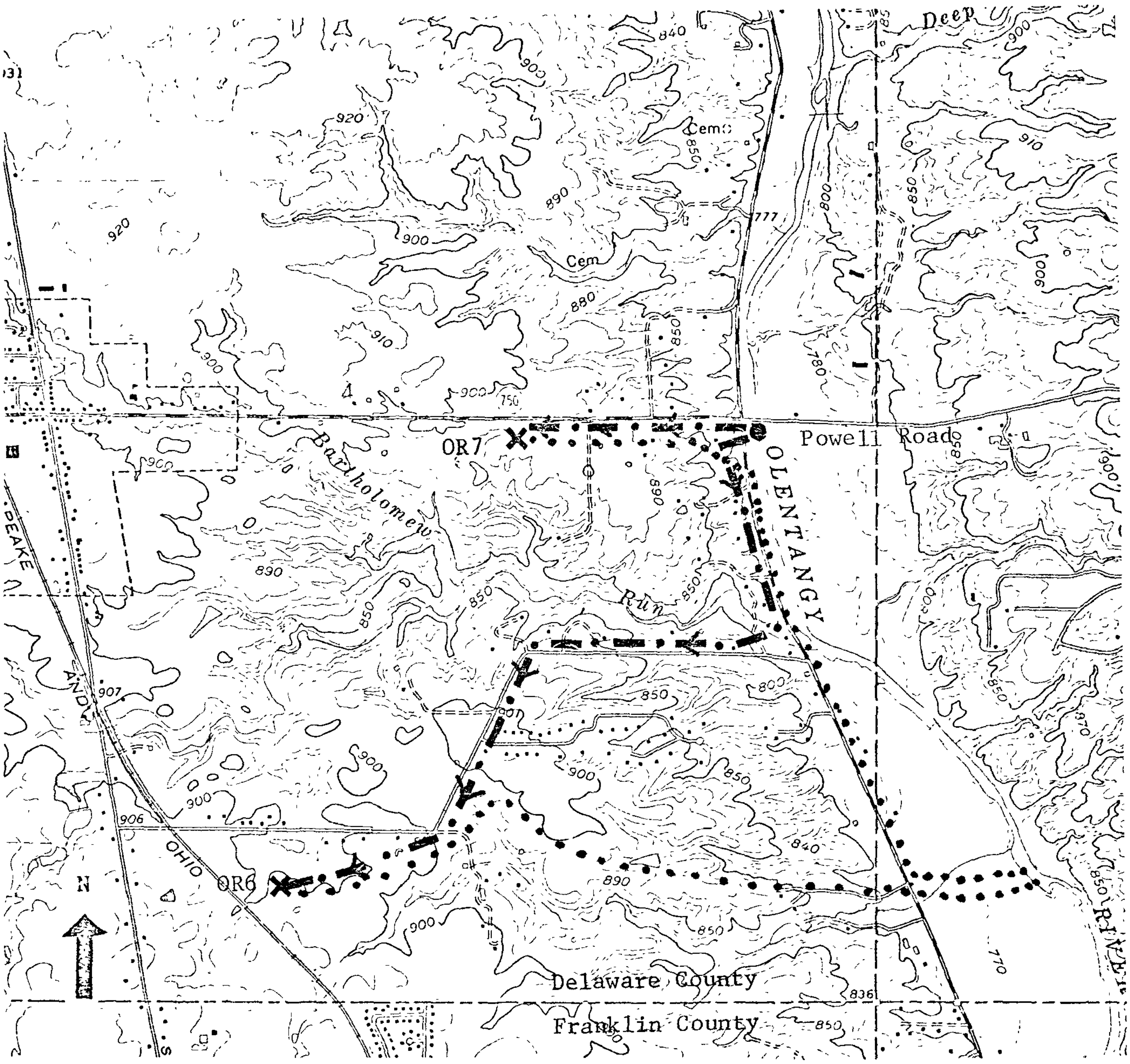
This section evaluates the relative merits of two sites west of the Olentangy River on high ground in the vicinity of the village of Powell. The characteristics of the selected site are discussed as well.

1. Overview

The two proposed sites near the village of Powell are designated OR6 and OR7 from south to north. These sites are considered in response to suggestions by Mr. Edward Hutchins, Director of Highbanks Metropolitan Park, and Dr. Robert Teater, Ohio Department of Natural Resources, to the effect that the plant should be located on high ground 3/4 to 1 mile west of the river to minimize encroachment on Highbanks Park (Burgess and Niple, Ltd., 1975). One site (OR7) adjacent to Powell Road has been selected as representative and fulfills the intent of removing the plant from the park vicinity. Burgess and Niple, Ltd. selected a different site near the county line (OR6) to fulfill the same purpose, as documented by their letter to Mr. Fred Stults on April 10, 1975 (Burgess and Niple, Ltd., 1975). Both sites are shown in Figure 14.

Site OR6 is on land immediately east of the Chesapeake and Ohio tracks and immediately north of the Delaware-Franklin County line. It would be advantageous to modify this location slightly by moving it 1/4 mile northward along the tracks to remove it from residences immediately south of the county line. There is about 1/2 mile square unused land with an elevation of about 900 feet on relatively level land.

Site OR7 is located on the south side of Powell Road about 0.6 mile west of the Olentangy. The site extends 0.3 mile east-west and 0.2 mile north-south. It is immediately adjacent to Powell Road to the north and



KEY

Force Main — • — • — •

Outfall Line• • • • • •

Local Plant Site ✕

Lift Station ●

Scale in Miles
0 1 MILE

Figure 14. System Requirements for the Powell Road-Powell Alternative

Source: Enviro Control, Inc., 1975

the forested area of Bartholomew Run to the south. The elevation is 890 feet above sea level. The center of the site is 0.2 mile from the nearest structures according to 1973 U.S.G.S. quadrangle maps.

The major differences between the two sites derive from engineering and cost considerations involving pump requirements and force main length. Environmental factors which interact with construction are biological impacts from sedimentation and noise, as well as effects on planned land use development in the area.

2. Site Selection

Site OR7 is the preferred site in this group. The differences between the sites, however, are relatively minor. Engineering and cost differences are the main factor in favor of site OR7. While some land use and biological considerations argue against this selection, they are of a minor nature in this particular instance and can be corrected by proper mitigative procedures. Environmental influences are nearly identical and institutional aspects are similar to those described on p. 93-94.

Primary engineering and cost differences between the two sites result from the requirement for 7,000 feet of additional force main for site OR6 due to its distance from the river. Increased frictional drag in this longer force main would also necessitate larger pumping facilities and use of more electrical power in the long run. Burgess and Niple, Ltd. in their April 10, 1975 communication with Mr. Fred Stults, have estimated the incremental cost of utilizing site OR6 over site OR3 to be $1,900,000 (Burgess and Niple, Ltd., 1975). It is anticipated that this incremental cost for site OR7 would be significantly less. Force main cost would be less than one-third and pumping requirements would be about two-thirds of this cost.

With respect to land use, however, site OR7 is at a slight disadvantage. The site is near the center of one of the four major development areas in the recently completed plan for the village of Powell (Lando and Bohm, 1975). Placement of the plant at this site would necessitate some changes in the Powell plan. Land use in the area is presently extensive and a slight modification to the plan should not cause any major long range problems. Furthermore, site OR6 is adjacent to a rail line and hence, this is an area more likley than OR7 to undergo industrial development. The plant would be more compatible with this type of use than with the residential uses planned for OR7.

Environmental considerations are nearly identical at the sites. Visual impact, odor, and noise are equal, since housing densities near both sites are the same. The proposed plant at either site would not impact on recreational or other sensitive areas. Water quality would be similar, but biological impact of water quality changes would be greater at site OR7 unless mitigative outfall relocation was used.

The plant at site OR7 would have some biological impact on the nearby forested scenic ravine at Bartholomew Run. This impact would include noise disturbance and sediment runoff, mostly during construction. Site OR6, on the other hand, is within 1/2 mile of a small creek and woods area near the county line. While little noise impact would be expected, sediments could still be important here. Sediment runoff could damage the habitat of terrestrial and aquatic organisms as well as destroy the scenic quality of the ravine area. Sediment problems could easily be avoided at both sites by use of proper construction procedures.

Site OR7 has been selected as the preferred site primarily due to engineering and cost considerations. In this case, differences in environmental and biological effects are all minor or can be mitigated easily. Land use disadvantages are considered to be outweighed by the increased difficulties, cost, and use of electrical energy that would be connected with site OR6.

3. Engineering Analysis

Construction of the proposed facility at site OR7 would require a lift station located immediately south of Powell Road and on the east bank of the Olentangy River. A 16-inch force main 3,000 feet in length would be required to deliver the sewage from the Olentangy and Alum Creek Basins to the site. The lift station would have a peak capacity of 6 mgd and a total system head of 200 feet. One river crossing and one highway crossing would be required for the force main, which would run along Powell Road east to the river. The force main and interceptor system carrying sewage from the Scioto Basin would need to be re-routed; however, no significant change in length of line would be required.

The extent of outfall work depends on the selected outfall location. Two possible locations are proposed. One is located immediately south of Powell Road, and the other approximately 1 1/8 river miles south of Powell Road at the county line. The two would require 3,000 and 10,000 feet of outfall pipe, respectively. Both would cross Ohio 315 once. The general route would be east along Powell Road, crossing Ohio 315 at the intersection and thence following Ohio 315 south-southeasterly for about a mile. This route is shown in Figure 14. The route would then turn eastward toward the river near the county line. In the entire biologically active scenic river segment, additional outfall piping would be necessary. The incremental piping requirements would be the same as those of site OR3.

The site is on flat terrain and there is no indication of near-surface bedrock, which would increase construction problems. Some grading work accompanied by rapid planting of ground cover might be required on the southern end of the site to reduce sedimentation into the Bartholomew Run area.

4. Land Use Analysis

Site OR7 is currently open field, possibly used for grazing animals, with some adjacent cropland. A forest area adjoins the site on the south and partially surrounds it on the west. None of this forested area is now suitable for development due to the steep gradient. A small pond exists on the western edge of the site and a dirt road defines the eastern border. There are several residences within 1/2 mile of the site. The plant would be far enough away from the Highbanks Park to ensure mimimal impact.

Primary land use impact from the plant would be aesthetic impact on drivers on Powell Road and possible changes in the casual recreational use of the Bartholomew Run area. Future impacts would include necessary changes in the planning concept of the village of Powell. Currently, plans for the first development stages are centered around site OR7.

All sewer and outfall lines would be run along road rights-of-way and so would have little or no impact on land use except during construction. Secondary impacts, however, involving recreational water use below the outfall would be similar to those for OR3.

5. Environmental Effects

Impact of the proposed plant on visual aesthetics is insignificant. Although the plant will be visible from Powell Road, trees planted on the northern perimeter would eliminate this impact. No additional expense or effort would be necessary to accomplish this, since the proposed plan already includes significant tree and shrub plantings.

No significant wind channelization would be expected due to the high elevation of the site. Prevailing wind flow would be similar to the regional pattern from the southwest. The development within a one-mile radius of the site is quite sparse so that odor and noise problems would not be significant on residential receptors. There could be odor impacts on Powell Road.

Water quality impacts would be identical with previously described sites. The amount of impact on biological organisms would be dependent on which of the three possible outfall locations were chosen. These impacts have been discussed on pages 75-77, and 91-93.

6. Biological Considerations

All impacts on aquatic life relate to the outfall location of the plant at this site. There are three possible locations:

- On the Olentangy directly east of the plant
- South of the plant site on the Olentangy at the Franklin-Delaware County line
- On the Olentangy in Franklin County south of the artificial riffle-pool area.

Placement of the discharge on the river east of the site would affect the naiade population in this area of the river. The largest number of living naiades was found in this area near Powell Road by

Stein (1975). Thus, the possibility of adverse impacts to this population would be increased by placing the outfall in this location. The previously discussed fish population, considered by the Ohio Fish and Wildlife Service (Griswold, 1975) to be abundant and diverse in this area, would also be affected by the chlorine and ammonia discharges from a plant at this location. The even more abundant fish populations at I-270 intersection would also be affected, since the chlorine and ammonia concentrations in the discharge would not be adequately reduced in the river. Use of the discharge at the Delaware-Franklin County line has been previously discussed for site OR3 in pages 91-93.

The placement of the discharge location south of the artificial riffle-pool area in Franklin County is the most ecologically desirable. The areas of the most abundant naiades and fish would be avoided, since both of these populations rapidly decrease below this area. Although this outfall location is ecologically desirable, it would require more pipeline as discussed above on pages 99-101.

The site is not forested, thus no clearing would be necessary to construct the plant at this site. This site is close to Bartholomew Run, which is an area that contains a mixture of upland vegetation in the higher areas and some lowland and riverbottom vegetation in sloping and lower areas. The characteristic upland vegetation is comprised of such species as beech, red and sugar maple, red oaks, white oaks, and ash. The lowland riverbottom vegetation is characterized by sycamore, cottonwood, boxelder, maples, yellow poplar, and oaks. Some of these areas would have to be crossed in order to place the plant's outfall at either the county line or in Franklin County below the fish habitat area.

Rare and endangered species that would be impacted are the aquatic naiad and fish species mentioned above on pages 92-93. Again, the choice of outfall location might have some effect on the threat to these species, but existing data on their whereabouts in the river are too sparse to draw a definite conclusion.

7. Institutional Considerations

The only course of action which would involve institutional considerations is the placement of an outfall in Franklin County below I-270. This is discussed on pages 93-94.

Private Communications

Griswold, Bernard, U.S. Fish and Wildlife Service, July 1975.

Stein, Carol, Ohio State University Museum of Zoology, July 1975.

References

Burgess and Niple, LTD., Letter to Fred L. Stults, Delaware County Engineer, 10 April 1975.

Lando, Thomas J., and Friedrich Bohm, "The Birth of a New Town," Cities and Villages, July 1975.

E. STRATFORD - OLENTANGY

This section evaluates three sites on the Olentangy River south of the town of Stratford. These sites were proposed to accommodate a regional facility combining the service areas of Delaware City and southern Delaware County. All of the sites are poorly suited geographically for use in treating the southern Delaware County area alone. An overview and site selection are presented here, but all other aspects are discussed on pages 125-139, as part of the regional plan.

1. Overview

These three sites, located on the Olentangy River 1-2 miles south of Stratford, are shown in Figure 15. They are designated OR8, OR9, and OR10 from south to north. The sites were originally proposed by Burgess and Niple, Ltd. in their Feasibility Survey and Report for Sanitary Service and Sewage Treatment Facilities (1970). The intent of the proposal was to utilize one of the sites as a combined Delaware City - Southern Delaware County treatment plant. Since that time, however, the Del-Co water supply intake has been constructed about 2.5 miles south of site OR7. Use of any of these three sites would involve either outfall relocation or relocation of the drinking water intake.

Site OR8 is located on the east bank of the Olentangy River at the junction of Chapman and Winter Roads. It is approximately 5 miles north of Powell Road. The available land measures about 0.3 mile in a north-south direction and 0.2 mile in an east-west direction. On the north and east, the site is bordered by forested areas adjoining Camp Lazarus, a nearby Boy Scout camp. The elevation is 830 feet above

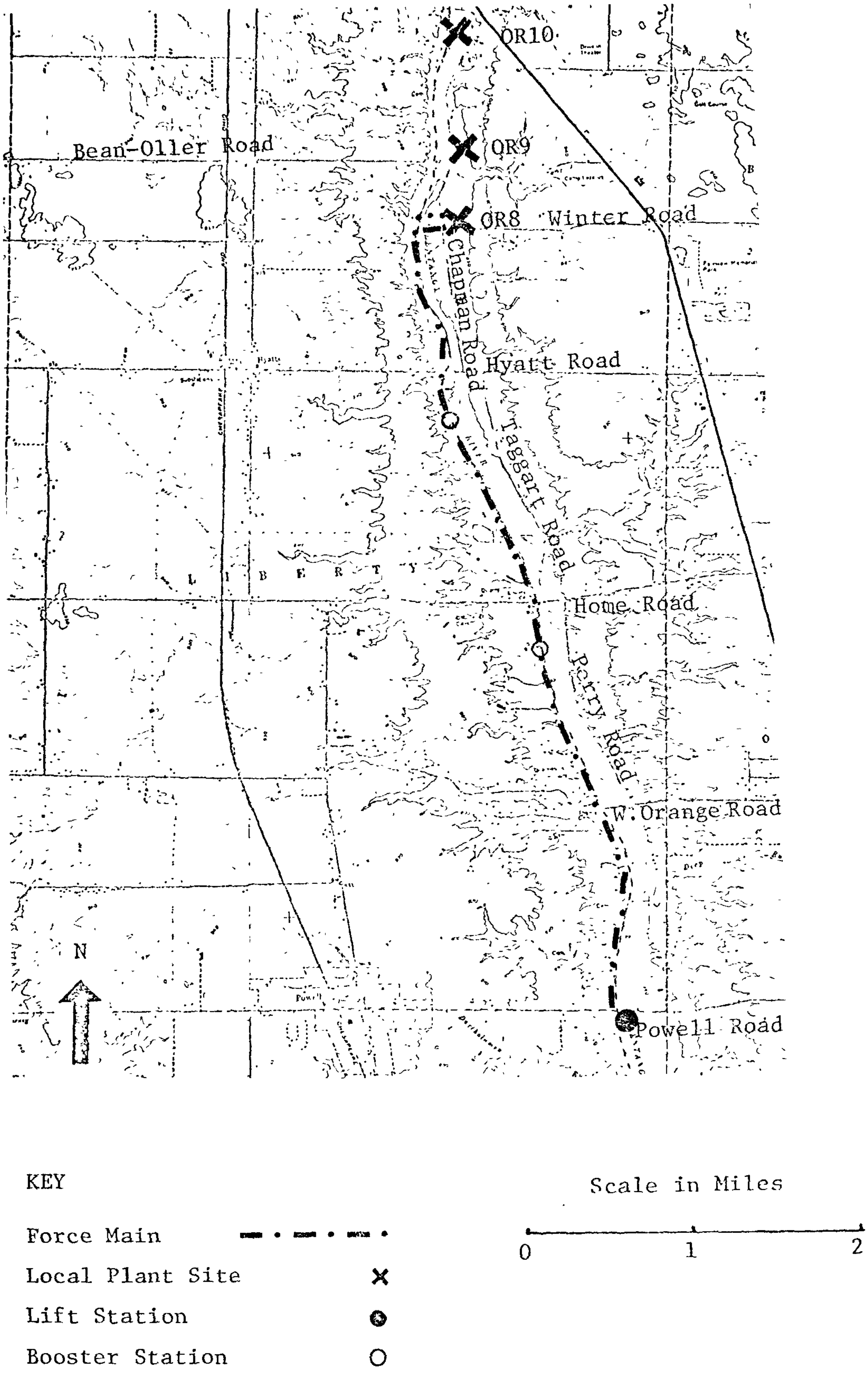


Figure 15. System Requirements for the Stratford-Olentangy Alternative

Source: Enviro Control, Inc., 1975

sea level and is fairly level in the plant site. However, the slope is much steeper immediately east of the site.

Site OR9 is located 1/2 mile further north on Chapman Road opposite the point where Bean-Oller Road intersects Ohio 315. The unused land here is substantially smaller than site OR7 and also somewhat steeper. Only an area measuring 0.3 mile (north-south) by 0.1 mile (east-west) is on moderately sloping ground. Use of the area further east would entail increased difficulty in grading and possibly blasting due to rock. Elevation here is from 830 to 850 feet above sea level. Site OR9 is bordered on the south by the forested area which surrounds Camp Lazarus.

Site OR10 is located on the river's west bank, east of Ohio 315, between the river and the road. It is located 0.8 mile north of site OR9 and 0.8 mile south of Stratford. The area here is extremely small, being less than 0.1 mile east-west at the widest point and only 0.3 mile long. A significant portion of this land is within the floodplain. Elevation is 820 to 830 feet above sea level. River bottom vegetation covers the eastern parts of the site; several residences are within the site near its western boundary.

The most important considerations in site-selection here are engineering and cost factors due to small land areas, steep slopes, and encroachment of the floodplain. There are minor differences in land use and terrestrial biological impacts. Environmental effects and institutional considerations are nearly identical among the three.

2. Site Selection

Site OR8, shown in Figure 15, is the preferred site in this group.

Its selection is based primarily on engineering considerations and environmental impacts; land use and biological impacts contribute to a lesser degree. Institutional considerations are equivalent for all three sites.

Engineering differences between the sites are primarily related to force main and outfall length, pumping requirements, site size, and subsurface conditions. Force main length and pumping requirements are governed by geographical location and elevation, whereas recommended outfall line length may be governed by the distance upstream of the Del-Co water intake. Site size and subsurface conditions influence construction cost and difficulty and, in extreme cases, may cause changes of plant design configuration.

The development of any of the three sites would require the emplacement of a force main from Powell Road north along the river to the site. Site OR9 would require 0.4 mile more than OR8 and site OR10 would require 1.2 miles more than OR8. Pumping requirements would be slightly increased at sites OR9 and OR10 because there would be increased friction from a longer line; the elevations are nearly equal.

Outfall line length is approximately equal if each site is discharged into the river at the closest point. It might be desirable, however, to locate the outfall below the Del-Co water intake. In this case, outfall line lengths would be 2.5 miles for OR8, 2.9 miles for OR9, and 3.7 miles for OR10.

Only general descriptions can be made with respect to usable site size and subsurface conditions. Sites OR9 and OR10 are small; site OR10 is partially in the floodplain (p. 106-108). The floodplain poses significant problems, because extensive flood protection features would be required. Subsurface conditions at these sites have not been explored in detail. Soil survey information, however, indicates that limestone presumably underlies sites OR9 and OR10 at a depth of about 20 feet and site OR8 is probably underlain by sand and gravel to a depth of at least 5 feet.

Site OR8 is now open field with some agricultural use. Site OR9 is covered by an open field with no agricultural use. Site OR10 is overgrown derelict farmland, gradually becoming forested. There are several buildings on the northern part of this site which would have to be removed.

Wastewater treatment plants at any of the three sites would have about equal impact on the low-density residential receptors. Plants at site OR8 and OR9, however, might cause some odor impact on Camp Lazarus. Plants at all three sites would be roughly equivalent in aquatic impact. Terrestrial biological impacts would be most extensive at site OR10 where considerable forest habitat would be destroyed during plant construction.

From the above discussion, it can be seen that sites OR9 and OR10 are disadvantageous for nearly all considerations. Site OR8 is the best of the three under all considerations except odor impact. Site OR8 is therefore the selected site for this group. Further details for this site are discussed on pages 125-139 as one of the possible regional alternatives.

References

Burgess and Niple, Ltd., Feasibility Survey and Report for Sanitary Service and Sewage Treatment Facilities, 1970.

F. ALUM CREEK

In this section, the relative merits of two sites on Alum Creek are evaluated. An analysis of the selected site's characteristics is presented to facilitate subsequent comparison with selected sites in other basins.

1. Overview

The two proposed sites on Alum Creek are widely separated geographically; one is in the southern part of the county and the other is in the north near Kilbourne. The sites are designated AC1 and AC2 from south to north. Site AC1 was suggested by Burgess and Niple, Ltd. (1974) as a possible site on a basin other than the Olentangy. Site AC2 was suggested by Finkbeiner, Pettis, and Strout (1969) as a site for a 1.25 mgd plant to service the northern Alum Creek area. Since the time of this proposal, the Alum Creek Reservoir, an intended recreational and drinking water source, has been constructed downstream from the site.

Site AC1 is located 0.3 mile east of Alum Creek, and 0.9 mile north of the Delaware-Franklin county line. It is 0.6 mile east-southeast of the intersection of Powell Road and Worthington-Galena Roads. The unoccupied land that is clearly above the floodplain measures 0.4 mile east-west by 0.5 mile north-south. The elevation is 820-840 feet or 15-35 feet above normal creek water level. The grade here is flat and there were no buildings or forests on the site in 1973. At this time, the nearest structures were 0.4 mile from the center of the site.

Site AC2 is located 0.5 mile south of the intersection of Ohio 84 and Ohio 10 near Kilbourne. It is on the west side, and immediately adjacent to the north end, of the newly-filled Alum Creek Reservoir. The potential site size is 0.3 mile (east-west) by 0.6 mile (north-south).

The land is gently sloping and lies at an elevation of 930-940 feet above sea level, or 40-50 feet above normal reservoir level. A forested tract adjoins the site to the northeast and to the south. The most recent information on this site is 1961 data from the U.S.G.S. Galena quadrangle map. It places the nearest structure at 0.2 mile from the site center.

2. Site Selection

Site AC1 is the recommended site in this group. Site selection between these two sites is a simple process because there are important disadvantages at the northern site.

Site AC1 is located below Alum Creek dam in the southern part of the county. Hence, a plant here could be fed by gravity interceptors, whereas a plant at site AC2 would require pumping stations and 13 miles of force main up Alum Creek. A plant at AC2 would have severe impacts on human health and aquatic biota due to its discharge into the recently constructed Alum Creek Reservoir. The Ohio Environmental Protection Agency strongly recommends against effluent discharged into reservoirs and drinking water supplies (Nottingham, 1975).

One reason for the severity of impacts is that site AC2 was never considered for the presently proposed facility. It was considered as a site for a 1.5 mgd plant to service northeastern Delaware County, while a plant similar to the proposed one serviced southern Delaware County. The site is particularly unsuitable for the currently proposed facility because of the more recent construction of the reservoir.

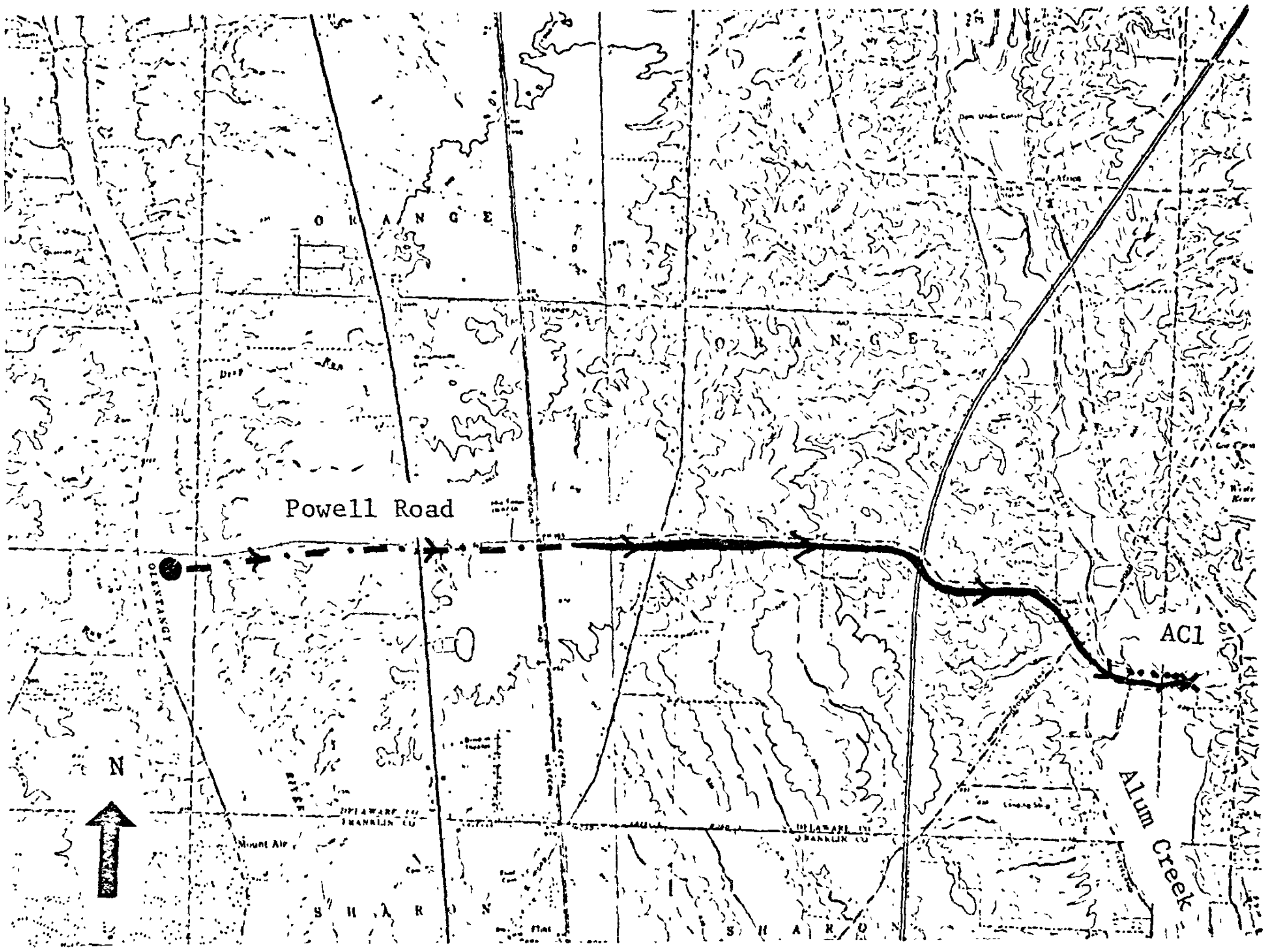
Therefore, site AC1 has been selected for this group. However, location of the proposed facility here is controversial from many engineering and environmental standpoints. Many of the controversial points cannot presently be resolved due to lack of information. The individual points are presented below.

3. Engineering Analysis

The construction of the proposed facility at site AC1 would require modification of the interceptor trunk, force main, and pumping facilities between Olentangy River Basin and Alum Creek Basin, as illustrated in the base layout of the interceptor network in Figure 16.

The modification would require a lift station located south of Powell Road at the Olentangy River to deliver the sewage from both the Scioto River Basin and the Olentangy River Basin through a 20-inch force main eastward along Powell Road beyond the ridge line approximately 500 feet east of the Norfolk and Western Railraod. From this ridge line, the sewage would be conveyed to the plant by a gravity flow interceptor 42 inches in diameter. The 42-inch interceptor would take a route along the north side of Powell Road eastward, past Worthington-Galena Road where Powell Road terminates, then extend southeastwardly down the valley, cross beneath the Alum Creek, and reach the plant from the east. The modified interceptor would require the addition of:

- 13,000 feet of 42-inch diameter gravity flow interceptor line
- 16,000 feet of 20-inch diameter force main
- One lift station with peak capacity of 7 mgd and system head of 330 feet.



Scale in Miles

0 1 2

KEY

Trunk Line

Force Main

Outfall Line

Local Plant Site ×

Lift Station ●

Figure 16. System Requirements for the Alum Creek Alternative

Source: Enviro Control, Inc., 1975

However, the following items could be eliminated:

- 11,000 feet of 27-inch diameter gravity flow interceptor line
- 13,000 feet of 18-inch diameter force main
- Lift station with peak capacity of 2.3 mgd and system head of 205 feet.

The incremental cost for this modification excluding pumping facilities is approximately $410,000. Adoption of this alternate site would considerably increase the construction and operation costs of the lift station, because it would require a larger capacity and higher lift than the base system.

Three outfall locations are possible. One would discharge into the river directly west of the site, requiring a pipe length of 1,000 feet. The route is indicated in Figure 16. Two other outfall locations have been considered to mitigate effects on the Westerville drinking water intake which is presently located 1/2 mile south of the Delaware-Franklin County line. The second outfall location would be at the Delaware-Franklin County line. The rationale for this is that it would be possible for the City of Westerville to relocate their drinking water intake north of this location in Delaware County. It is doubtful, however, whether this can be legally done. Line length for this choice would be about 0.9 mile. The third location would be in the City of Westerville, south of the intake. However, Westerville would have to agree to lease the needed land to Delaware County.

The plant site is in a flat area with no forested areas. The soils are silt loams with no limestone or bedrock in the top five feet (USDA, 1969). Grading, site preparation and construction would be simple and inexpensive at this site.

4. Land Use Analysis

Presently site AC1 is an undeveloped open field. The immediate vicinity includes residential, transportation and recreational uses. Residences near the site are of low density except 1/2 mile to the northeast where there is considerable development near the Westerville Reservoir. Recreational use is also primarily near the reservoir. The Alum Creek Reservoir is over two miles north of this site and would not be significantly affected.

Direct plant impacts would be minimal. Possible slight impacts would be odor impacts on nearby residences and recreation areas to the northeast. In the normal course of events, the land on the site would probably become residential in the near future; plant construction would limit this use.

Construction of sewer and outfall lines for a plant on site AC1 would be similar in land use impact to sites on the Olentangy River. Although the interceptor system requires additions and deletions for this site, most of these are changes in line sizing rather than routing. Pipeline construction areas might be somewhat larger along the major trunk from the Olentangy to Alum Creek, but impacts would cease with the completion of construction. As with the Olentangy sites, some impacts on stream recreation use would be expected downstream from the outfall. There are some potential recreation areas downstream, but the extent of their use is not presently known.

5. Environmental Analysis

Environmental effects at this site include the usual aesthetic impacts of visibility, odor, and noise. In addition, however, a plant on this site would discharge water originally taken from the Olentangy River by Del-Co Water Company into Alum Creek. This water would not rejoin its original water course until many miles downstream at the confluence with the Scioto River. Water quality impacts from the water diversion and from the discharge are compared below with those expected to occur on the Olentangy River.

A treatment plant on this site would be quite visible from all directions, although following the presently-proposed parklike architecture for the plant would help minimize visual impact. If this were not done, considerable landscaping, and structural re-arrangement would be necessary to minimize visual impact. The residential development in the north and northeast sectors, approximately 1500 feet and farther from the site, would receive some odors, because it is situated in the path of the local prevailing wind. Noise problems would be minimal because the plant could be located nearly 1/2 mile from the nearest residence.

Most of the water in the initial 1.5 mgd and projected 6.0 mgd sewage flows would originate from the Olentangy River because the Del-Co water supply which services all three basins draws its water from the Olentangy River. This would imply a deficit of about 6.0 mgd in the segment of the Olentangy River south to the confluence of the Scioto River and Big Walnut Creek, of which Alum Creek is a branch. This water would be added to the normal flow of Alum Creek.

The exact effects of this withdrawal and diversion are complicated by such factors as the schedule of withdrawal and use of holding and storage tanks by Del-Co Water Company and the recent construction of the Alum Creek Dam. Complete water quality determination in these segments is beyond the scope of the present study. Under the most probable circumstances, however, the water diverted across basins would be approximately 9 percent of the median flow (66.6 mgd or 103.0 cfs) in the Olentangy River. This small amount would have, at worst, minor adverse effects on the river's water quality.

The low flow in Alum Creek, previous to dam construction, was only 2.5 mgd (3.87 cfs). The U.S. Army Corps of Engineers (1972) has indicated that a 3.23 mgd (5 cfs) low flow will be maintained by the Alum Creek Reservoir.

Based on this low flow of 5 cfs, the dilution ratios would be, respectively, 0.32, 0.48, and 0.65 for the 1st, 10th, and 20th years after the plant becomes operational. These dilution ratios can be compared with those expected in the Olentangy, which are 0.34, 0.51, and 0.67, respectively; no significant differences exist. The existing water quality data in the Waste Load Allocation Report (Ohio EPA, 1975) indicate that the water quality standards of total fecal coliforms has been violated 100 percent of the time, ammonia 10 percent of the time, and total dissolved solids 10 percent of the time. These situations are very similar to those of the Olentangy River. Thus, water quality impact during the most severe conditions would be similar to those discussed for sites OR1, OR3, and OR7 on pages 75-77, 90-91, 102. A treatment plant at this site could pose a significant problem to the Westerville water supply if mitigative or ameliorative procedures discussed above are not taken. Expected impacts on the water supply would include problems from ammonia, nitrates, and total dissolved solids.

6. Biological Impacts

The effects of the new Alum Creek dam upon the aquatic biota in Alum Creek are presently unknown. The benthic assemblage in the creek was studied in 1967-1969 by Olive (1971). He reported that the benthic community of the stream contained various species of beetles, mayflies, dragonflies, stoneflies, and caddisflies in the approximate area of the proposed site. Stansberry (1972, as cited by the U.S. Army Corps of Engineers, 1972) states that there were five species of crayfish in Alum Creek and that it is a rare occurrence for such a small stream to have such a diverse grouping. Alum Creek also had a known naiade (freshwater mollusk) fauna of 27 species.

Alum Creek has been described by the U.S. Bureau of Sport Fisheries and Wildlife (1961, as cited by the U.S. Army Corps of Engineers, 1972) as a smallmouth bass and rock bass stream. The effects of the dam construction and operation upon the aquatic biota in the portions of the creek below the dam need to be investigated to accurately determine the presence or absence of the benthic and fish populations that were previously there. Only when this investigation is completed can a rational decision to use this site as an alternative be made.

No significant terrestrial habitat would be destroyed by the use of this site. Scrub plant species would be removed and small animals inhabiting the open field would relocate in nearby areas.

The naiad, Simpsoniconcha ambiqua, is known to occur in Alum Creek, This mollusk is declared by the State of Ohio as an endangered species. It is typically found under rocks in flowing streams. The only significant population of this naiade in the state is in Alum Creek. The life cycle of this species is precarious, since the species depends upon the aquatic salamander Necturus maculosus as its host during its larval metamorphosis. The naiade species Villosa fabilis is not rare or endangered, but its numbers are greatly reduced in the state. This species is characteristically found on firm sand-gravel bottoms beneath fast-flowing waters. It is presently uncommon to rare where it still lives in Alum Creek and other isolated areas (U.S. Army Corps of Engineers, 1972). Further investigation into these two mollusk species in Alum Creek is necessary to accurately assess the aquatic biota in this stream.

7. Institutional Considerations

The placement of the proposed plant on Alum Creek with an outfall in Westerville below the Westerville water intake would cause grave institutional and legal problems. Because Westerville is located within Franklin County, Delaware County cannot condemn easements within that municipality. Delaware County can place an outfall within another county if they receive a permit to use state-owned rights-of-way. However, there are not state highways close enough to Alum Creek to make this action practical. Delaware County could place the outfall in Westerville, if Westerville were to agree to lease the land to Delaware County.

Institutional problems may be minimized if the outfall is located in Delaware County. However, this would require the relocation of Westerville's water intake, north of the Delaware-Franklin County line. It is questionable whether this can be legally done (Lashutka, 1975).

Private Communication

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References

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G. OTHER BASINS

Two other Delaware County water basins, Scioto River and Big Walnut Creek, merit consideration. Only an overview is presented here, along with an explanation of the problems with locating the proposed facility in these basins, because there are strong reasons to discount the plant site that has been proposed.

A site on the Scioto Basin was proposed in 1969 by Finkbeiner, Pettis and Strout for a 0.50 mgd plant to service the northern Scioto Basin. This site is designated SR3 to differentiate it from the regional site at the existing Columbus Southerly Plant (SR1) and from the Frank Road Plant (SR2) in Franklin County. These regional sites are discussed on pages 140-164. Site SR3 is located 0.5 mile south of the Ohio 198 bridge over the Scioto River near Radnor.

Site SR3 is not suitable for the presently proposed facility, primarily because of engineering and water quality considerations. A considerable length of additional force main and a large number of pumping stations would be required. The cost in both construction and energy commitments would be prohibitive. Furthermore, the discharge would be into the Scioto River only a few miles above the O'Shaugnessy and Grigg's Reservoirs, which are primary drinking supplies for Columbus. Discharge into these impoundments would be very undesirable and mitigative measures such as a circumventive outfall location would be impractical from cost and engineering considerations. Because of these extreme problems, this site is given no further consideration.

No sites have been suggested on Big Walnut Creek primarily because the Hoover Reservoir extends south of the Delaware-Franklin County line, and because Big Walnut Creek is outside of the planned service area (Burgess and Niple, Ltd., 1974). The City of Columbus has expressed an intent to eventually service the southern Big Walnut Creek Basin in Delaware County (Burgess and Niple, Ltd., 1974).

References

Burgess and Niple, Ltd., The Sanitary Sewerage Facilities Plan for South-Central Delaware County, Ohio, July 1974 (revised August 1974).

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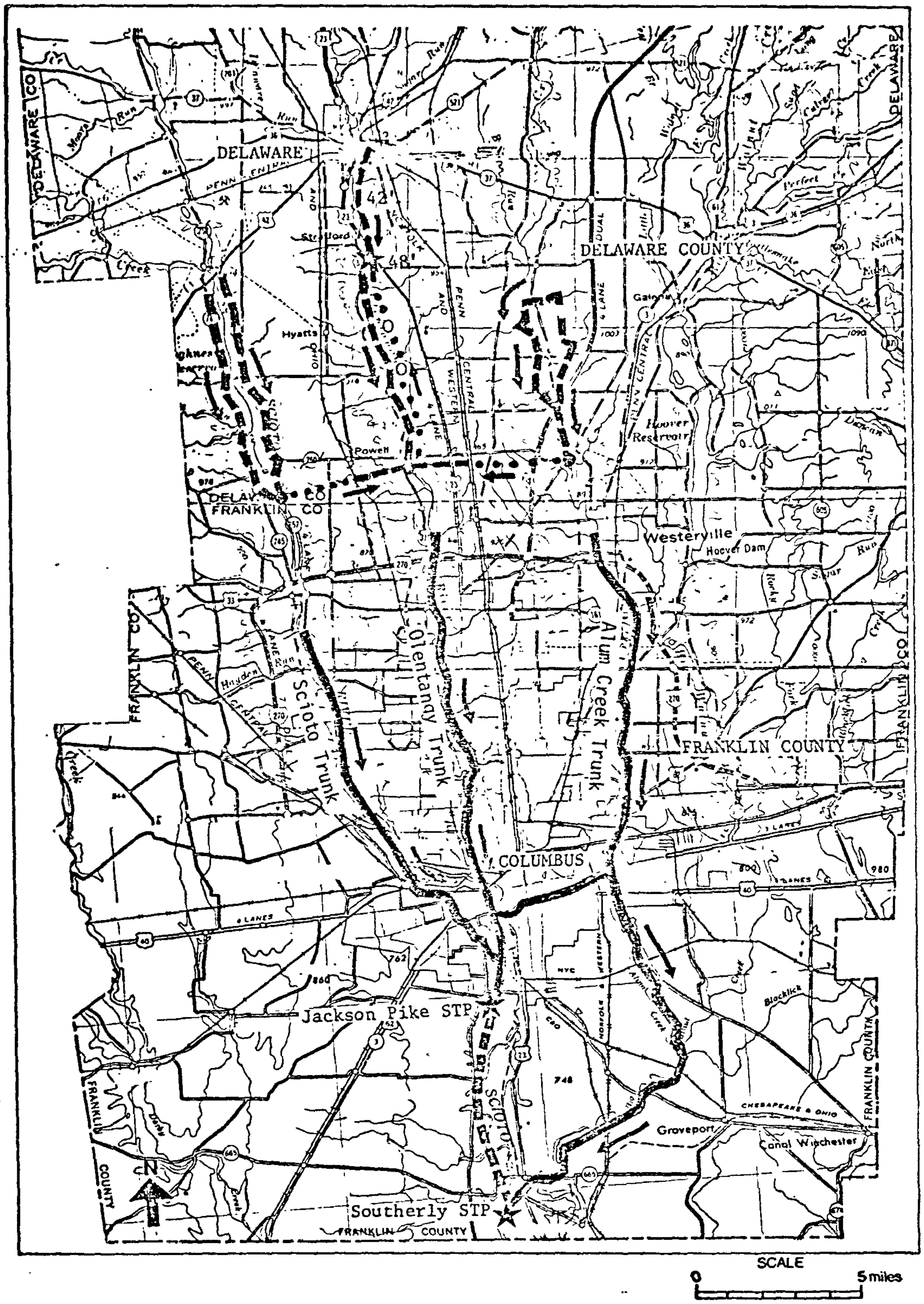
H. DELAWARE COUNTY - CITY OF DELAWARE

This section examines the alternative of a regional system to serve both Delaware County and the City of Delaware. This alternative would combine southern Delaware County and the City of Delaware into one sewered area serviced by a regional wastewater treatment plant. An overview is presented, followed by a discussion of cost-effectiveness, environmental effects, and institutional considerations.

1. Overview

The wastewater treatment plant for this alternative could be either a totally new plant located between the population centers of the two jurisdictions, designated site OR8 and described on pages 106-111, or the existing Delaware City wastewater treatment plant upgraded to the required capacity at site OR11. The former is here called subalternative 1 and the latter, subalternative 2.

The first subalternative would require both the Delaware City wastewater treatment plant to be phased out by year 10 in the plan, and the City's interceptor network to be retained. Since, in this subalternative, a new wastewater treatment plant would be constructed, no further discussion on the available treatment facilities is needed. The system requirements for this subalternative are a new plant, as presented on pages 40-50, and the required pumping facilities and sewer works. Compared to the basic plan for the interceptor sewer network as given on pages 40-50, an additional force main 20 inches in diameter and 30,000 feet (5.68 miles) long would be required between the collection point at Powell Road and the proposed site OR8 at Winter Road, as shown in Figure 17. One additional lift station with peak capacity of 9 mgd, a system head of 200 feet, and two additional booster



KEY

Existing Trunk Line	▬▬▬▬	Regional Plant Site	☆
Proposed Trunk Line	▬ ▬ ▬ ▬	Lift Station	●
Force Main	• • • • • • • •	Booster Station	O

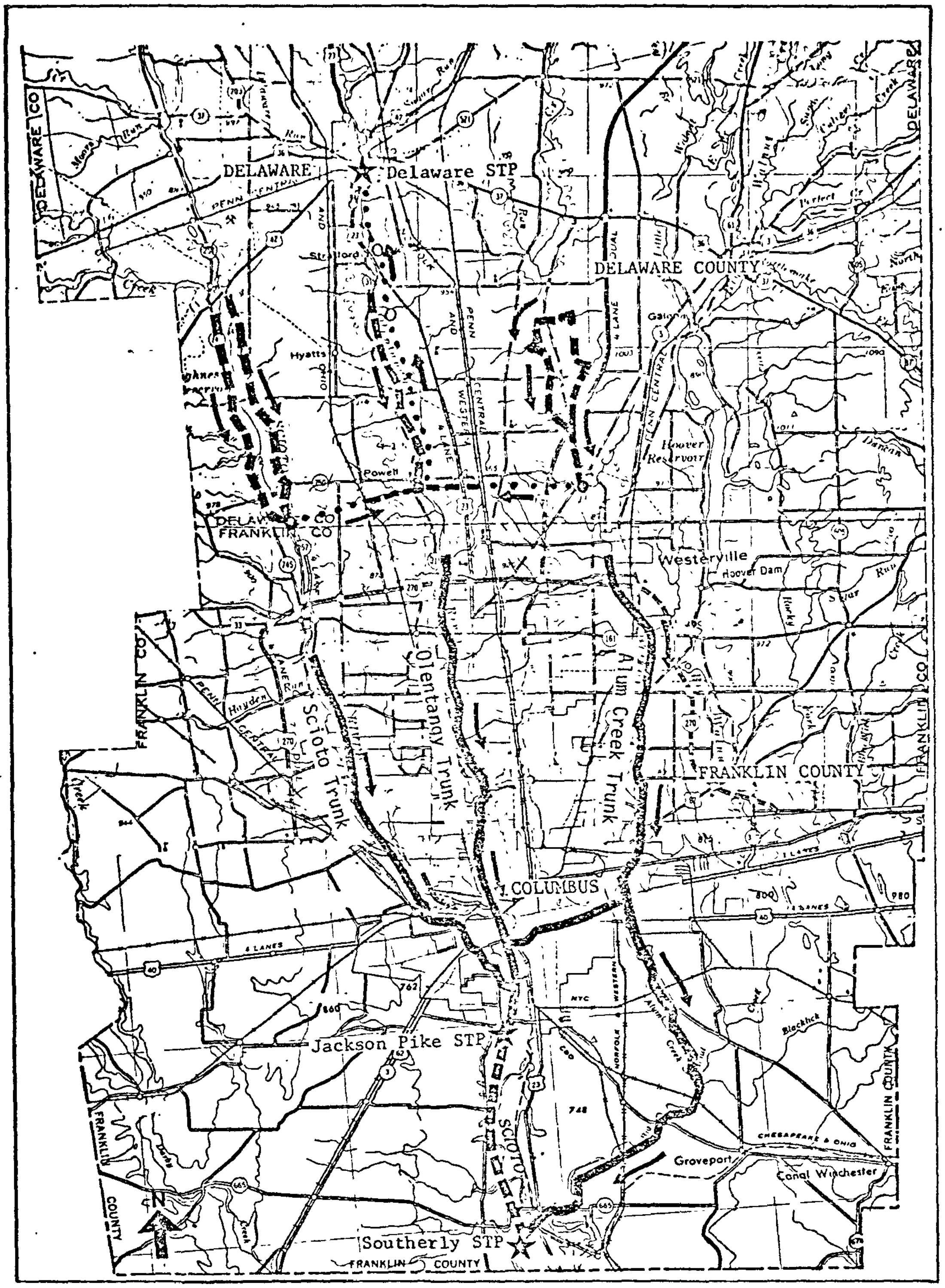
Figure 17. Delaware County-Delaware City Regional Alternative, Subalternative #1

Source: Enviro Control, Inc., 1975

stations, having the same capacity, with a system head of 130 feet each, would be necessary, as shown in Figure 17. An additional trunk sewer composed of 10,050 feet of 42-inch sewer pipe and 12,750 feet of 48-inch sewer pipe would be required to convey the sewage from the City of Delaware to the proposed site.

The second subalternative (Figure 18) requires the use of the existing Delaware wastewater treatment plant (OR11), as the proposed regional plant after required expansion. The Delaware wastewater treatment plant was upgraded in 1974 and has a hydraulic capacity of 2.5 mgd. The plant uses a contact stabilization process for sewage treatment, which is one version of the activated sludge treatment process. The incoming sewage of the plant is subject to grit removal by grit chambers, followed by contact stabilization units for removal of suspended solids and BOD, and then chlorinated before being discharged to the Olentangy River. The outfall location is adjacent to the plant site. In the contact stabilization units, clarifiers are provided to remove suspended solids and some BOD. The sludge from the clarifiers is dewatered by the sludge concentrators. The concentrated sludge is subsequently deposited in sanitary landfill.

Expansion of the contact stabilization process to accommodate more sewage can be easily doubled by simple redesign of the units, such as the addition of pumping facilities, and modification of sludge wasting and piping requirements. The existing plant can be easily expanded to take up to 7 mgd of raw sewage with some modification (Sprague, 1975; Metcalf and Eddy, Inc., 1972). The County also owns 50 acres of land which would be sufficient for the expansion of the plant to an ultimate capacity of 8.5 mgd.



KEY

Existing Trunk Line		Regional Plant Site	☆
Proposed Trunk Line		Lift Station	●
Force Main	••••••••	Booster Station	O

Figure 18. Delaware County-Delaware City Regional Alternative, Subalternative #2

Source: Enviro Control, Inc., 1975

This subalternative requires the upgrading of the plant components from 2.5 mgd to 4.0 mgd in the first year of the project, 5.5 mgd in the 10th year, and 8.5 mgd in the 20th year of the project. As far as the level of treatment is concerned, a second stage of activated sludge process with clarification, and dechlorination and post-aeration of the effluent would be added, in the expanded plant, to meet the effluent standards promulgated by the Ohio EPA. As Figure 18 shows, an additional force main 20 inches in diameter and 22,800 feet (4.3 miles) long would be needed to convey the Delaware County sewage from the Stratford area to the plant. Two booster stations would be expanded in terms of system head of lift. The system head for each booster station would be 290 feet in order to overcome the frictional loss and the elevation differences.

2. Cost-Effectiveness

The costs of the two subalternatives were calculated on the basis of the basic plan and its phasing scheme discussed on pages 40-50, and the additional system requirements delineated in the preceding discussion. The costs are separated into two major categories, the treatment facilities and the interceptor sewer network. In each category, costs are broken down into three phases. Phase 1 would extend from completion of initial construction to the 10th year of the total planning period, phase 2 from the 11th year to the 20th year of the planning period, and phase 3 from the 21st year after the plant becomes operational until the end of its service life (U.S. EPA, 1975).

Capital costs of the various treatment components, the operation and maintenance (O&M) costs of the various treatment processes, and the plant management were obtained from reports by Robert Smith (U.S. Department of the Interior, 1967 and 1969), and were adjusted to the April 1975 dollar utilizing several cost indices. These indices include the sewer construction cost index; the sewage treatment construction cost index, published by the Office of Water Program Operation of the U.S. EPA; the labor cost index for water, steam, and sanitary system non-supervisory works; the wholesale price index for industrial commodities; and the consumer price index for residential, water, and sewerage services, published by the U.S. Department of Labor.

All the costs for the first subalternative are shown in Tables 22 and 23, and those of the second subalternative are shown in Tables 24 and 25. According to the 6 1/8 percent discount rate recommended by the Water Resources Council (1975), both the present worth value and the annual cost of the first subalternative are calculated as $32,005,000 and $2,533,000, respectively. The present worth and the equivalent annual cost of the second subalternative are calculated as $27,577,000 and $2,183,000 respectively.

3. Environmental Effects

The system configuration of the first subalternative is presented in Figure 17; the configuration for the second alternative is given in Figure 18. Under both subalternatives, the dilution ratio during the 7-day 10-year low flow periods, assuming the outfall is located at the proximity of the proposed plant site OR8, would be 0.34, 0.65, and 0.75 for the first year, the 10th year, and the 20th year after the initiation of the project. However, under the most probable conditions, the corresponding dilution ratios would be 0.022, 0.076, and 0.008, respectively.

During dry weather periods, the effects of the plant effluent on the water quality would be adverse, especially in terms of DO, NH_3, NO_3^-,

TABLE 22. Costs of the Interceptor Sewer Network for the Delaware County-Delaware City Regional Alternative, Subalternative 1

Phases of Planning	Phase 1		Phase 2		Phase 3	
Plant Capacity in mgd	1.5		5.5		8.5	
Cost Items / Costs	Capital Cost in $	O & M Cost in $/yr.	Capital Cost in $	O & M Cost in $/yr.	Capital Cost in $	O & M Cost in $/yr.
Gravity Flow Interceptor Sewers	5,491,000		3,818,000		7,063,000	
Force Main	2,208,000	43,000	338,000	80,000	0	157,000
River, Highway, and Railroad Crossings	132,000		101,000		20,000	
Manholes	297,000	--	164,000	--	231,000	--
Pumping Facilities	1,456,000	325,000	852,000	494,000	136,000	501,000
Easements	186,000	--	102,000	--	144,000	--
Engineering Services, Legal and Administration and Contingency	1,858,000	--	1,022,000	--	1,444,000	--
TOTAL	11,628,000	368,000	6,397,000	574,000	9,038,000	658,000

Source: Enviro Control, Inc., 1975

TABLE 23. Costs of the Proposed Regional Sewage Treatment Plant for the Delaware County-Delaware City Regional Alternative, Subalternative 1

Phases of Planning	Phase 1		Phase 2		Phase 3	
Plant Capacity, in mgd	1.5		5.5		8.5	
Cost Items / Costs	Capital Cost in $	O & M Cost in $/yr.	Capital Cost in $	O & M Cost in $/yr.	Capital Cost in $	O & M Cost in $/yr.
Control House	110,000	--	140,000	--	110,000	--
Chlorination of Raw Sewage and Secondary Effluent	60,000	15,000	64,000	53,000	49,000	75,000
Two-Stage Aeration and Post-Aeration of Secondary Effluent including Sludge, Return Pumps, Pipe Gallery, and Air Diffusers	1,100,000	17,000	1,300,000	48,000	1,090,000	64,000
Primary and Secondary Clarification	380,000	37,000	660,000	101,000	506,000	134,000
Rapid Sand Filtration including Back-Washing	130,000	48,000	400,000	114,000	330,000	152,000
Aerobic Sludge Digestion	135,000	2,000	210,000	5,000	177,000	7,000
Sewage Influent Pumps and Air Blowers	72,000	10,000	110,000	39,000	89,000	52,000
Land Requirement	200,000	--	--	--	--	--
Improvement of the Site	44,000	--	--	--	--	--
Customer Service & Accounting	--	24,000	--	51,000	--	68,000
General, Administration, Engineering and Contingency	558,000	45,000	--	90,000	--	120,000
TOTAL	2,789,000	198,000	2,884,000	501,000	2,351,000	672,000

Source: Enviro Control, Inc., 1975

TABLE 24. Incremental Costs of Using the Delaware City STP as the Regional Plant, Subalternative 2

Phases of Planning / Cost Items \ Incremental Capacity in mgd	Phase 1	Phase 2	Phase 3
Incremental Capacity in mgd	1.5	1.5	3.0
Incremental Capital Cost in $	1,000,000	800,000	1,700,000
Annual O&M Cost in $/yr.	149,000	191,000	264,000

Source: Enviro Control, Inc., 1975

TABLE 25. Costs of the Interceptor Sewer Network for the Delaware County-Delaware City Regional Alternative, Subalternative 2

Phases of Planning	Phase 1		Phase 2		Phase 3	
Plant Capacity in mgd	1.5		5.5		8.5	
Cost Items / Costs	Capital Cost in $	O & M Cost in $/yr.	Capital Cost in $	O & M Cost in $/yr.	Capital Cost in $	O & M Cost in $/yr.
Gravity Flow Interceptor Sewers	3,942,000		3,818,000		7,063,000	
Force Main	3,026,000	39,000	338,000	76,000	0	152,000
River, Highway, and Railroad Crossings	132,000		101,000		20,000	
Manholes	279,000		169,000		231,000	
Pumping Facilities	1,632,000	416,000	1,028,000	677,000	136,000	684,000
Easements	175,000	--	106,000	--	144,000	--
Engineering Services, Legal and Administration and Contingency	1,746,000	--	1,057,000	--	1,444,000	--
TOTAL	10,932,000	455,000	6,617,000	753,000	9,038,000	836,000

Source: Enviro Control, Inc., 1975

BOD_5, and total dissolved solids (TDS). This is also true in terms of waste loads. A computer simulation at low flow would have to be undertaken; otherwise, quantification of these effects would be difficult. The water quality impacts on the drinking water intake area would be negligible, assuming the Del-Co Water Company would not withdraw water from the Olentangy River during low flow periods.

During the most probable conditions, compliance with stream water quality standards is without difficulty. However, the less stringent ammonia effluent standard and the absence of an effluent standard for residual chlorine might have some implication for possible deterioration of the river flora and fauna.

The outfall of the first subalternative would be located approximately 5 river miles upstream from the Highbanks Park, providing some opportunity for the natural cleanup of the plant's effluent before it reaches Highbanks Park. This advantage, however, is even stronger for the second subalternative, which utilizes the existing Delaware STP, because the northern location of the outfall would provide an additional 6 river miles for self-purification processes.

Siltation and erosion problems associated with project construction are the same for both subalternatives, since the additional system requirements for each subalternative would be small compared to the whole construction requirement.

Referring to Figures 17 and 18, the sewage conveyance from the collection point of the system to the proposed alternative sites is exclusively furnished by force main. The erosion and siltation problems are minimal, since construction of the force main involves less excavation work and thus less exposed land surface as compared to construction of gravity flow sewers.

Odor problems would originate primarily from the aeration and clarification processes and could be mitigated by providing higher DO levels in the aerated liquor and reducing the weir drop elevation. However, the odor problems would increase if the plant size continues to grow. The odor problems are less for subalternative 2, because the Delaware STP is an existing plant.

Noise would not be a problem for either alternative, because the only noise sources are the air diffusers in the aeration units. Noise is effectively mitigated by providing enough buffer distance between the plant and the surrounding sensitive receptors. The noises from the regional lift station and booster stations would not be a problem, because they would be underground, and properly isolated and insulated.

4. Institutional Considerations

Two legal arrangements can be devised to construct the proposed regional facility at Stratford along the Olentangy River, site OR8, to eventually service both Delaware City and southern Delaware County. Section 307.15 of the Ohio Revised Code enables Delaware City to contract with Delaware County for Delaware County to assume full responsibility for handling Delaware City's sewer system. Under this contract, Delaware County can construct the proposed plant at Stratford and gradually phase out the Delaware City plant as they provide service to the city. However, because the Delaware City plant would not be phased out for another ten years, a contractual agreement under Section 6117.41 of the Ohio Revised Code is more likely. Under this agreement, Delaware City and Delaware County would develop plans to provide for the eventual connection of their sewer systems and the joint usage of the proposed plant.

If the proposed facility is built at Stratford to provide regional service to both Delaware County and Delaware City, it would be financed, with only one slight difference, the same way as if it were built in southern Delaware County to service only the county. In both cases, Delaware County would build the plant with 75 percent of the funds being provided by a U.S. EPA grant. The other 25 percent would be raised by a loan from either the Ohio Water Development Authority or the Farmers Home Administration of the Department of Agriculture. This loan would be repaid from revenue raised from tapping fees on those residences that would be serviced (Burgess and Niple, Ltd., 1974). This revenue would also be used for the maintenance and operation of the plant.

If the proposed plant serviced Delaware City along with Delaware County, Delaware City would have to compensate Delaware County a predetermined amount for the usage of the plant. Through negotiations, this amount would be agreed upon by the parties involved and approved by the Ohio Environmental Protection Agency as provided for by Section 6117.42 of the Ohio Revised Code. Section 6117.43 of the Ohio Revised Code stipulates that this compensation be raised by the levy of taxes, special assessments, or sewer rentals.

The contractual and financial agreements needed to service both Delaware City and Delaware County could probably be easily negotiated. There exists a cordial, cooperative relationship between these two political entities. Also, in the recent past they have considered building one treatment plant for their mutual use.

However, despite their cordial relationship and the available legal and financial mechanisms, there would probably be opposition by Delaware City to a plan which would involve the phasing out of their plant. Delaware City, with the aid of U.S. EPA funds, recently completed in 1974 a two million dollar remodeling program of its wastewater treatment plant. The remodeled plant can be expanded considerably and is anticipated to have a lengthy life span. Delaware City officials are opposed to phasing out in the near future a facility in which they recently expended considerable planning, time, and money. However, both Delaware City and County officials would probably be receptive to a plan to expand Delaware City's plant to service the southern part of the county.

Private Communications

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Sprague, Rex, City Engineer, City of Delaware, August 1975.

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I. DELAWARE COUNTY - COLUMBUS

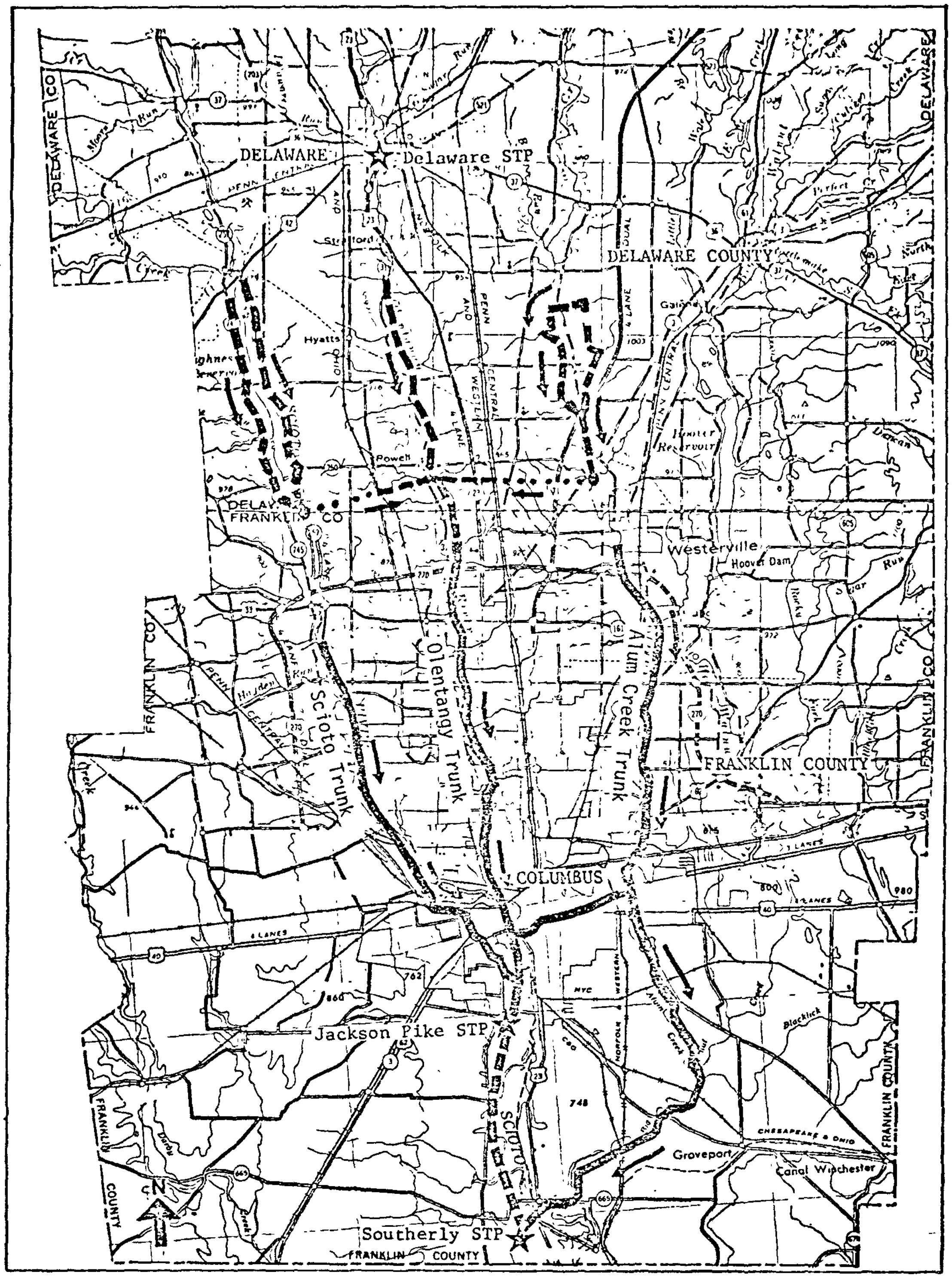
This section examines the Delaware County-Columbus regional alternative. Under this plan, the sewage of southern Delaware County would be diverted to the Columbus sewer system. An overview of this alternative is followed by a discussion of cost-effectiveness, environmental effects, and institutional considerations.

1. Overview

If this alternative is implemented, the sewage from southern Delaware County would receive the required treatment by the Columbus Southerly Plant located on the Scioto River close to the Franklin and Pickaway County line. The Columbus Southerly Plant would be expanded accordingly to accommodate the incremental sewage flow. Five possible subalternatives were developed from engineering judgment for this inter-county connection of sewer systems. These subalternatives are depicted in Figures 19, 20, 21, 22 and 23. Detailed routing of the connector trunk or the force main is not attempted at this stage of the study.

The first subalternative, shown in Figure 19, would use the existing Olentangy Interceptor Trunk of the Columbus sewer network whose northern terminus is located between the Delaware and Franklin County line and the outerbelt, I-270. A gravity flow connector sewer 42 inches in diameter would be run from the sewage collection point at Powell Road along the Olentangy River southward to the northern terminus of the existing Olentangy Trunk. It is estimated that approximately 6000 feet (1.14 miles) of the gravity flow sewer would be required.

The second subalternative would involve the construction of a trunk line paralleling the Olentangy Trunk and entering the Columbus system



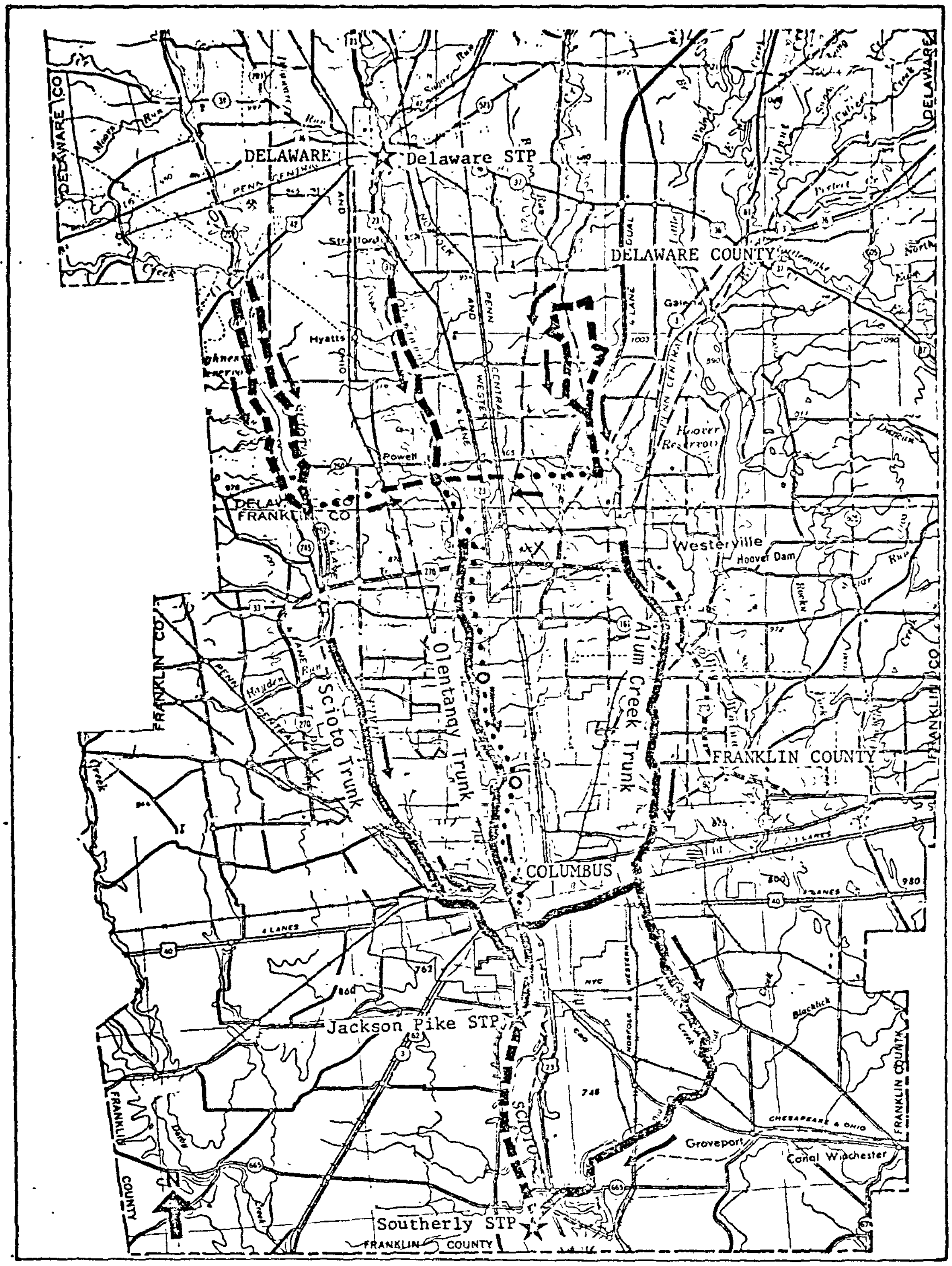
KEY

SCALE 0 — 5 miles

Existing Trunk Line	▬▬▬	Regional Plant Site	☆
Proposed Trunk Line	▬ ▬ ▬	Lift Station	●
Force Main	••••••••		

Figure 19. Delaware County-Columbus Regional Alternative Subalternative 1

Source: Enviro Control, Inc., 1975



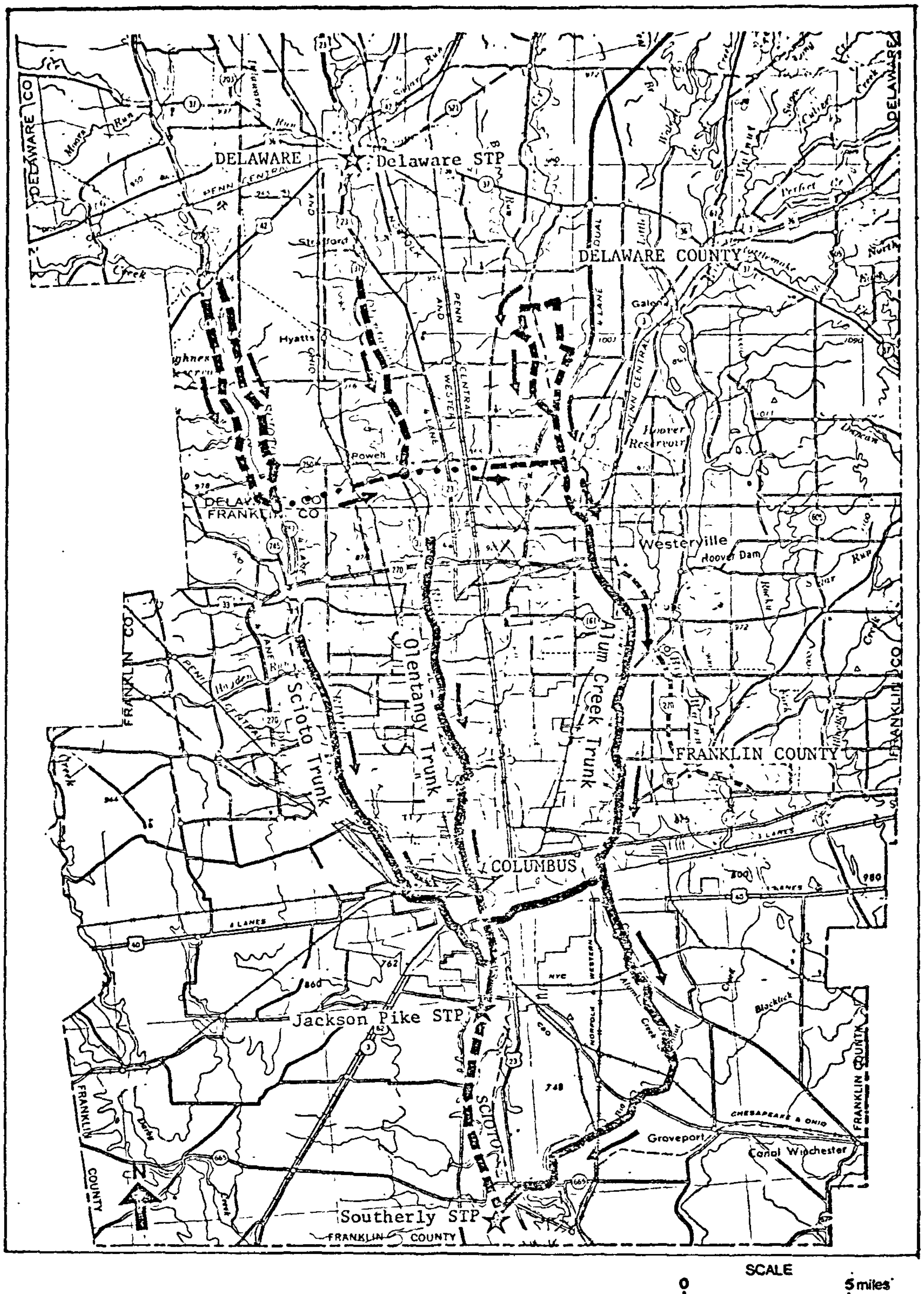
KEY

SCALE
0 5 miles

Existing Trunk Line	▬▬▬▬	Regional Plant Site	★
Proposed Trunk Line	▬ ▬ ▬ ▬	Lift Station	●
Force Main	• • • • • • • •	Booster Station	O

Figure 20. Delaware County-Columbus Regional Alternative, Subalternative 2

Source: Enviro Control, Inc., 1975

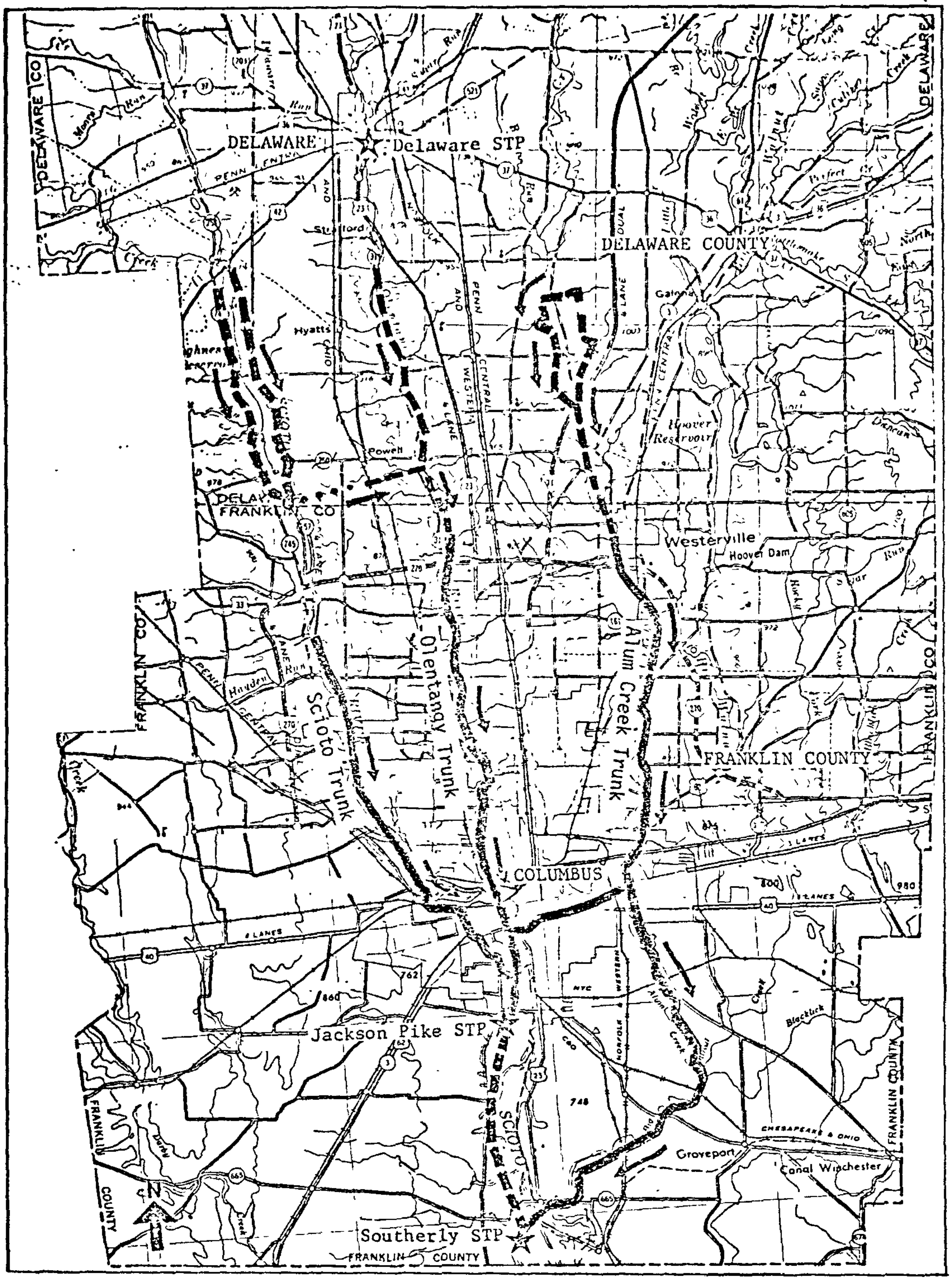


KEY

Existing Trunk Line		Regional Plant Site	
Proposed Trunk Line		Lift Station	
Force Main			

Figure 21. Delaware County-Columbus Regional Alternative, Subalternative 3

Source: Enviro Control, Inc., 1975



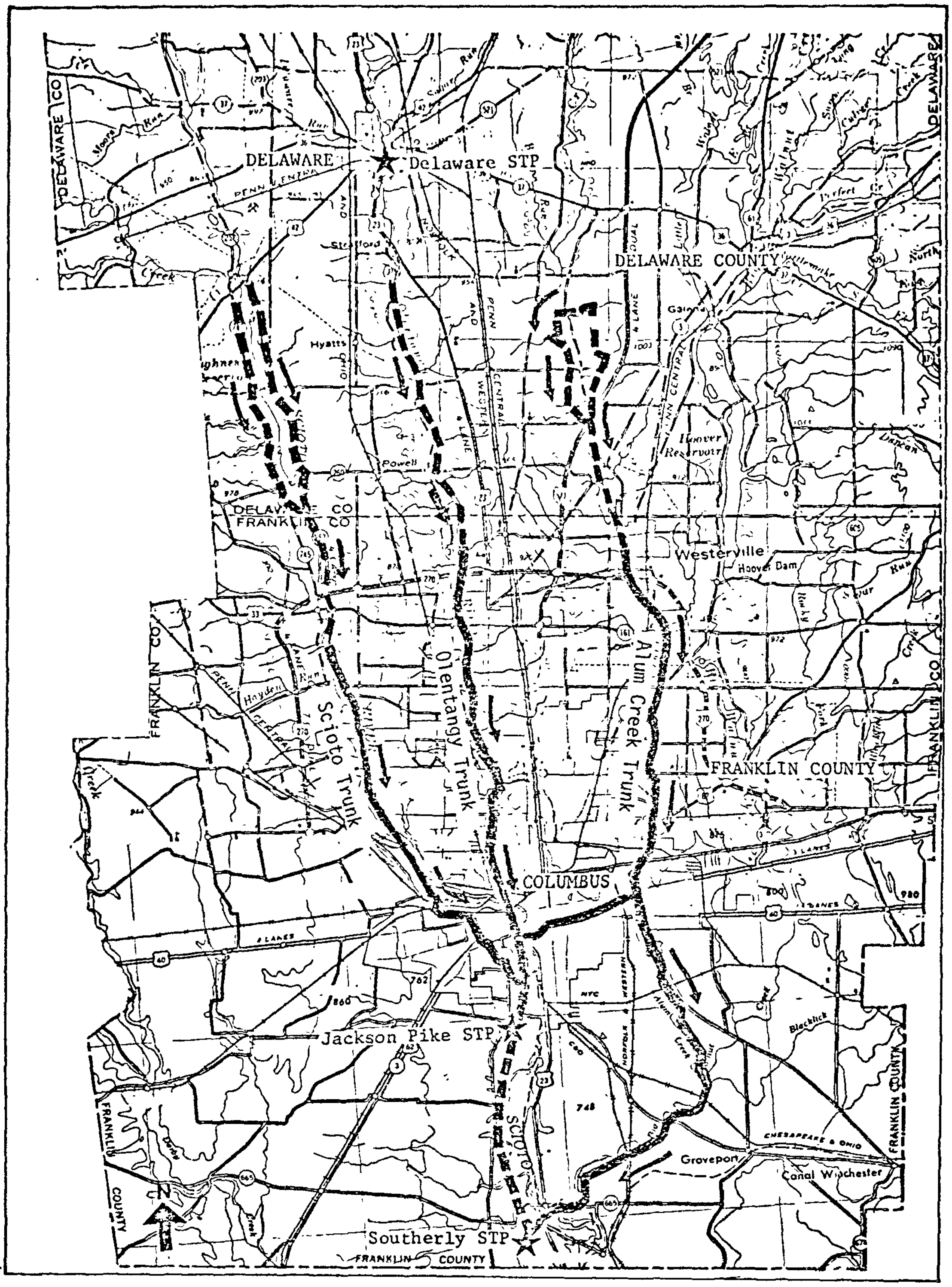
SCALE
0 5 miles

KEY

Existing Trunk Line		Regional Plant Site	★
Proposed Trunk Line		Lift Station	●
Force Main	••••••••		

Figure 22. Delaware County-Columbus Regional Alternative, Subalternative 4

Source: Enviro Control, Inc., 1975



KEY

SCALE
0 5 miles

Existing Trunk Line

Proposed Trunk Line

Regional Plant Site

Figure 23. Delaware County-Columbus Regional Alternative, Subalternative 5

Source: Enviro Control, Inc., 1975

near the junction of the Olentangy and Scioto Rivers. Figure 20 indicates that the second subalternative would require construction of a 16-inch force main approximately 84,480 feet (16 miles) long between the collection point of the proposed Delaware County sewer network and the junction of N. Broadway Street and the Olentangy River in Columbus. This subalternative is based on the assumption that no excess capacity of the Olentangy Sewer Trunk would be available. In this subalternative, one lift station with peak capacity of 9 mgd and system head of 400 feet would be situated at Powell Road. This subalternative would require two booster stations with the same capacity and a system head of 130 feet each, as indicated in Figure 20.

The third subalternative (Figure 21) presumes an interconnection of the southern Delaware County sewer network with the Alum Creek Interceptor Trunk in Franklin County. The combined use of a gravity flow sewer and a force main would be necessary for the transportation of the sewage from the Olentangy Basin to the Alum Creek Basin. The system requirements of this subalternative would be a lift station with peak capacity of 6 mgd and system lift of 150 feet to accomplish the inter-basin transportation of sewage, and an additional 13,200 feet of 42 inch sewer pipe to provide the inter-county sewer connection.

The fourth subalternative is illustrated in Figure 22. In this subalternative the Alum Creek sewer subsystem in southern Delaware County would be separated from the other two subsystems in the Scioto and Olentangy Basins. The sewage from the Scioto and Olentangy River Basins would be combined at the junction of Powell Road and the Olentangy River, and connected to the Olentangy Interceptor Trunk of the Columbus sewer network. The sewage from the Alum Creek sewer subsystem would be dumped into the Alum Creek Interceptor Trunk of the Columbus sewer network by a gravity flow sewer.

The system requirements of this subalternative would be an additional 19,200 feet of 36-inch sewer pipe for inter-county sewer connection, as shown in Figure 22. This subalternative probably would be one of the least costly, because the interbasin connection between the Olentangy River Basin and the Alum Creek Basin and the pumping facilities would be eliminated. The entire system would use gravity flow connector sewers and, therefore, no additional pumping facilities would be required as compared to the basic plant discussed on pages 41-42.

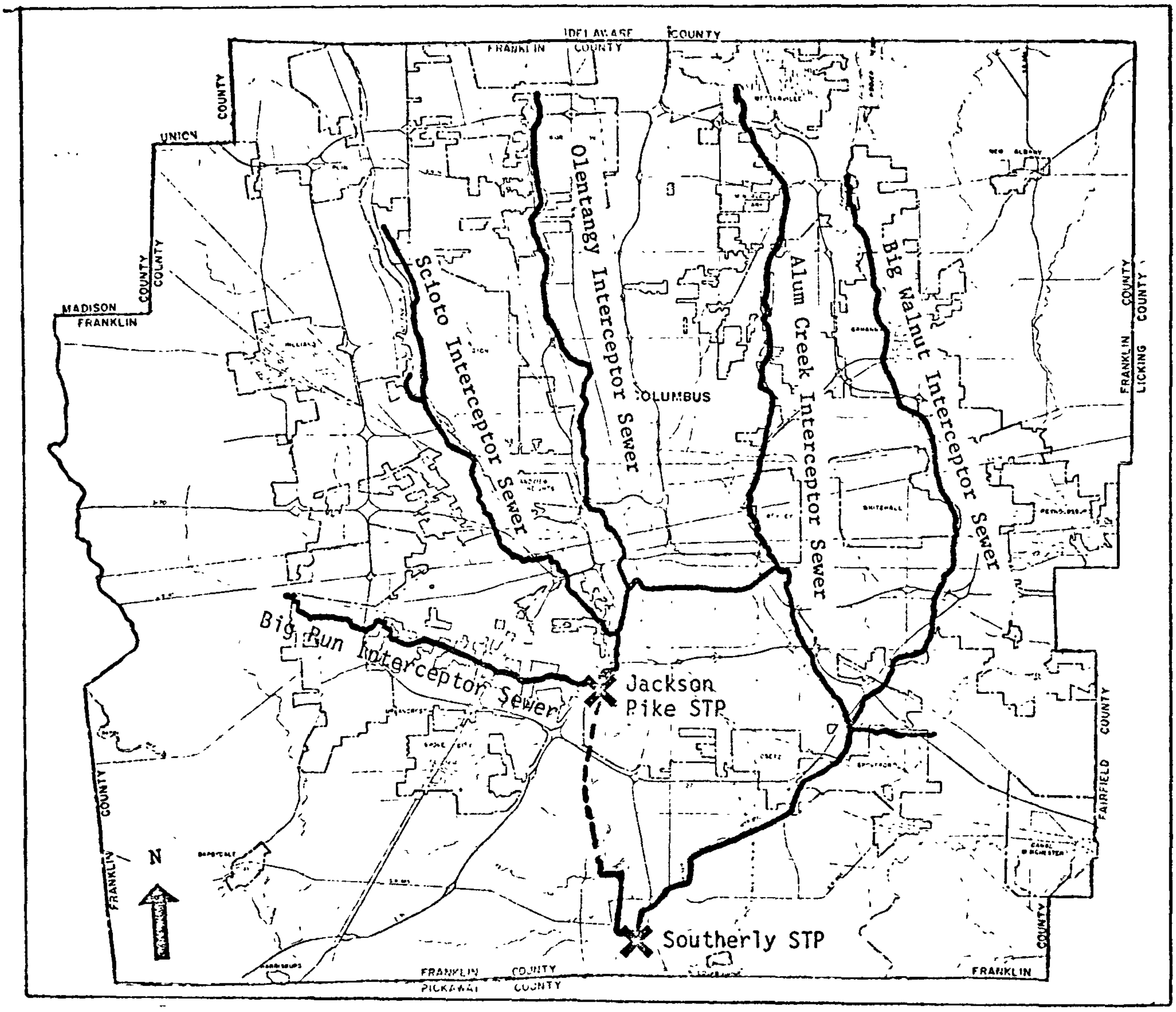
The fifth subalternative is shown in Figure 23. Under this concept the Scioto River sewer subsystem, Olentangy subsystem, and Alum Creek subsystem would be connected to the existing Columbus Scioto Interceptor Trunk, Olentangy Trunk, and Alum Creek Trunk, respectively. This subalternative would completely eliminate all interbasin pumping facilities and force mains. The system requirement would be an additional 45,600 feet of 36-inch sewer pipe for inter-county sewer connections, as shown in Figure 23.

All these subalternatives would use the existing Columbus Southerly Plant for sewage treatment. The treatment processes of the Southerly Plant include screening, grit removal by grit chambers, pre-aeration of incoming sewage, one-story primary sedimentation with mechanical sludge collection, activated sludge process with diffuser aeration, secondary clarification, and post-aeration. The wasted sludge is digested anaerobically, followed by sludge thickening, vacuum filtration, and incineration. The treated effluent is discharged into the Scioto River adjacent to the plant. The plant has an average capacity of approximately 108 mgd. No proposed expansion of the plant is anticipated.

At the last stage of the development of sewerage service in southern Delaware County, approximately 6 mgd of raw municipal sewage would be introduced to the Columbus treatment facilities which includes the Jackson Pike (or Frank Road) Sewage Treatment Plant. This amounts to approximately 5.6 percent of the capacity of the Columbus Southerly Plant and approximately 3.1 percent of the total capacity of the two plants combined. The Jackson Pike Plant has a capacity of 88 mgd. In the Columbus sewage treatment facilities plan (Franklin County Regional Planning Commission, 1964), an interconnector interceptor trunk would be placed between the Columbus Southerly Plant and the Jackson Pike Plant, as shown by the dashed line in Figure 24. Because the Jackson Pike Plant has almost identical treatment processes as those of the Southerly Plant, the eventual destination of the sewage from southern Delaware County would not affect the level of treatment it would receive.

From the analysis of the sewage flows, it is found that the incremental sewage load imposed on the Southerly Plant by this regional alternative would not require drastic upgrading of the plant, because the peaking factor used for the treatment plant design would be large enough to compensate for it. This would be more true if a gravity flow sewer trunk, such as the Olentangy Trunk, Alum Creek Trunk, or Scioto Trunk, could be used for sewage transmission instead of a force main. The time required for the sewage to reach the plant might be so long that it would not reach the plant during the peak hour period. It is estimated that the time lag will be from 2.5 to 4.0 hours between the arrival time in Delaware County and the arrival time at the Southerly Plant.

The usefulness of the Olentangy Sewer Trunk, the Alum Creek Sewer Trunk, or the Scioto Trunk in this regional alternative is dependent upon their available hydraulic capacities. There are six interceptor trunk



Scale

0 5 mi

KEY

Existing Trunk Line

Proposed Trunk Line

Regional Plant Site

Figure 24. The Columbus Sewer Interceptor Trunks

Source: Adapted from Franklin County Regional Planning Commission, 1969 lines in the Columbus Service Area: the East Scioto Trunk, the Olentangy Trunk, the Alum Creek Trunk, the Big Walnut Trunk, the Big Walnut Trunk Outfall, and Scioto Big Run Trunk. The Big Walnut Trunk Outfall Sewer was originally designed for two barrels, only one of which has been installed to date. Among these sewer trunks, only the Olentangy Trunk, the Alum Creek Trunk, and the East Scioto Trunk would be useful for interconnection, because of their proximity to the southern Delaware County service area.

An analysis of the Columbus trunk sewers was conducted by the Franklin County Regional Planning Commission (1969) and was applied in the Water-Related Facilities Plan in 1969. The study reveals that the infiltration and abuse allowances for sewer trunk design in the 1954 plan are greater than those recommended in most engineering manuals and higher than those used in other cities (Franklin County Regional Planning Commission, 1954). The results of the analysis are duplicated in Table 26.

The first column in Table 26 provides, at various points, the actual sewer capacity in cubic feet per second for each of the major trunk sewers. Column "A" is the sewage flow at those points on the basis of the 1954 design criteria and 1985 distributed population. Column "B" is the sewage flow on the basis of the 1954 design criteria modified to reflect only those total acres that would be developed by 1985. Column "C" is the sewage flow at each point based on 1985 population distribution, with the peak flow factor applied <u>only</u> to the average sanitary flow.

The criterion "C" modification reflects the approach in general engineering practice that design flow is equal to a factored sanitary flow plus an infiltration allowance. It is different from the general practice of applying a peak flow factor to an infiltration

TABLE 26. Capacity of Columbus Trunk Sewers

Sewer	Capacity in cfs	Flow in cfs		
		A	B	C
East Scioto Trunk				
Bethel Road	33	44	30	28
Fishinger Road	52	60	45	42
Griggs Dam	155	180	105	125
Olentangy Trunk				
Outerbelt	48	35	28	22
S.R. 161	53	56	48	40
Morse Road	77	84	74	59
North Broadway	115	117	106	86
Frambes	184	139	128	106
Alum Creek Trunk				
Westerville	87	62	53	47
Morse Road	130	141	132	109
U.S. 62	205	200	191	159
Broad Street	205	231	218	189
Livingston Avenue	252	279	264	236
Big Walnut Trunk				
Havens Corners Road	190	117	85	82
U.S. 40	190	163	124	116
Outfall	290	217	173	164
Big Walnut Trunk Outfall				
Junction	335	507	435	404
Groveport Road	335	562	457	443
Scioto Big Run Trunk (excluding Hellbranch Run Drainage Area)				
Georgesville Road	68	35	22	17
Early Ditch	122	84	60	59
I-71	150	132	108	98

Source: Franklin County Regional Planning Commission, 1969 allowance, as is done in the 1954 criteria. The most generous allowance in the 1954 criteria indicates that there is excess capacity available for additional service areas, such as southern Delaware County (Franklin County Regional Planning Commission, 1969).

As indicated in Table 26, the Olentangy and Alum Creek Trunks would be marginally loaded by 1985 populations under criteria "A" and "B", but would have excess capacity under criterion "C". The excess capacities of the Olentangy Trunk by 1985 would be 16 cfs (10.9 mgd) at Outerbelt I-270 and 23 cfs (14.9 mgd) at S.R. 161, more than that needed by southern Delaware County 20 years after the regionalization. The excess capacity of the Alum Creek Trunk by 1985 would be 30 cfs (19.4 mgd), which again would be more than what southern Delaware County would need.

The East Scioto Trunk at Bethel Road would be overloaded by 1985 population under criterion "A", marginally loaded under criterion "B", and would have excess capacity of 5 cfs (3.23 mgd) under criterion "C", which would be marginally enough for the sewage coming from the Scioto Basin in Delaware County.

According to the analysis, the Olentangy and Alum Creek Trunk Sewers, among the six of them, would be the first to be fully developed in terms of service area. The implication of the preceding analysis is that excess capacity might be available after 1985. Whether or not extension could be made to serve Delaware County townships, however, would have to be based on a field analysis at the time of sewer loadings. In terms of availability of sewer capacity, the fifth subalternative, which would utilize the Alum Creek, Olentangy, and East Scioto Interceptor Trunks simultaneously, would be the most feasible one.

2. Cost-Effectiveness

The approach taken for the cost-effectiveness analysis is the same as discussed on pages 129-134 for the Delaware City and Delaware County regional alternative. The major difference is that the cost for the new treatment facilities would have to be replaced by the incremental costs for the modification and system upgrading of the existing Columbus Southerly Plant, the incremental capital cost of the plant, and the O & M cost for the incremental sewage treatment.

The results of cost-effectiveness analysis for all subalternatives are presented in Tables 27, 28, 29, 30, 31, and 32. Table 27 shows the incremental costs of upgrading the existing Columbus Southerly Plant to be used as a regional plant and its annual O & M costs in various planning phases. Tables 28 through 32 give the costs of the sewer system requirements and their O & M costs for all subalternatives.

The present worth and the equivalent annual cost for each subalternative were calculated by combining Table 27 with the corresponding table, i.e., Tables 28 through 32, and are summarized in Table 33. From Table 33, subalternative 5 appears to be the most economical choice.

3. Environmental Effects

This regional alternative uses the Columbus Southerly Plant as the regional plant for sewage treatment. The water quality problems caused by the effluent of the plant, if any, would appear in the Scioto River, because it is the receiving river for the effluent of the Southerly Plant.

As indirect effects, the water diversion from southern Delaware County to Columbus would result in some water quality problems in the Olentangy River during dry weather periods. This would occur even assuming that

TABLE 27. Incremental Costs of Using the Columbus Southerly Plant as the Regional Plant for the Delaware County - Columbus Regional Alternative

Phases of Planning / Incremental Flow in mgd / Cost Items	Phase 1	Phase 2	Phase 3
Incremental Flow in mgd	1.5	3.0	6.0
Incremental Capital Cost in $	700,000	700,000	1,500,000
Annual O & M Cost in $/yr.	26,000	50,000	100,000

Source: Enviro Control, Inc., 1975

TABLE 28. Costs of the Interceptor Sewer Network for the Delaware County-Columbus Regional Alternative, Subalternative 1

Phases of Planning	Phase 1		Phase 2		Phase 3	
Plant Capacity in mgd	1.5		3.0		6.0	
Cost Items / Costs	Capital Cost in $	O & M Cost in $/yr.	Capital Cost in $	O & M Cost in $/yr.	Capital Cost in $	O & M Cost in $/yr.
Gravity Flow Interceptor Sewers	4,883,000		3,818,000		7,063,000	
Force Main	913,000	36,000	338,000	73,000	0	150,000
River, Highway, and Railroad Crossings	209,000		101,000		20,000	
Manholes	220,000	--	145,000	--	231,000	--
Pumping Facilities	884,000	176,000	280,000	197,000	136,000	204,000
Easements	138,000	--	91,000	--	144,000	--
Engineering Services, Legal and Administration and Contingency	1,378,000	--	908,000	--	1,447,000	--
TOTAL	8,625,000	212,000	5,681,000	270,000	9,038,000	354,000

Source: Enviro Control, Inc., 1975

TABLE 29. Costs of the Interceptor Sewer Network for the Delaware County-Columbus Regional Alternative, Subalternative 2

Phases of Planning	Phase 1		Phase 2		Phase 3	
Plant Capacity in mgd	1.5		3.0		6.0	
Cost Items / Costs	Capital Cost in $	O & M Cost in $/yr.	Capital Cost in $	O & M Cost in $/yr.	Capital Cost in $	O & M Cost in $/yr.
Gravity Flow Interceptor Sewers	4,515,000	52,000 (Gravity Flow, Force Main, Crossings combined)	3,181,000	89,000 (Gravity Flow, Force Main, Crossings combined)	7,063,000	165,000 (Gravity Flow, Force Main, Crossings combined)
Force Main	3,238,000		338,000		0	
River, Highway, and Railroad Crossings	194,000		101,000		20,000	
Manholes	300,000	--	163,000	--	231,000	--
Pumping Facilities	1,440,000	336,000	836,000	517,000	136,000	524,000
Easements	188,000	--	102,000	--	144,000	--
Engineering Services, Legal and Administration, and Contingency	1,878,000	--	1,019,000	--	1,444,000	--
TOTAL	11,753,000	388,000	6,377,000	606,000	9,038,000	689,000

Source: Enviro Control, Inc., 1975

TABLE 30. Costs of the Interceptor Sewer Network for the Delaware County-Columbus Regional Alternative, Subalternative 3

Phases of Planning / Planning Capacity in mgd / Cost Items \ Costs	Phase 1		Phase 2		Phase 3	
Planning Capacity in mgd	1.5		3.0		6.0	
Cost Items	Capital Cost in $	O & M Cost in $/yr.	Capital Cost in $	O & M Cost in $/yr.	Capital Cost in $	O & M Cost in $/yr.
Gravity Flow Interceptor Sewers	5,959,000		3,818,000		7,063,000	
Force Main	807,000	38,000	338,000	75,000	0	157,000
River, Highway, and Railroad Crossings	99,000		101,000		20,000	
Manholes	248,000		145,000		231,000	
Pumping Facilities	884,000	176,000	280,000	197,000	136,000	203,000
Easements	155,000		91,000		144,000	
Engineering Services, Legal and Administration and Contingency	1,550,000		907,000		1,444,000	
TOTAL	9,702,000	124,000	5,680,00	272,000	9,038,000	360,000

Source: Enviro Control, Inc., 1975

TABLE 31. Costs of the Interceptor Sewer Network for the Delaware County-Columbus Regional Alternative, Subalternative 4

Phases of Planning	Phase 1		Phase 2		Phase 3	
Planning Capacity in mgd	1.5		3.0		6.0	
Cost Items / Costs	Capital Cost in $	O & M Cost in $/yr.	Capital Cost in $	O & M Cost in $/yr.	Capital Cost in $	O & M Cost in $/yr.
Gravity Flow Interceptor Sewers	5,414,000		3,818,000		7,063,000	
Force Main	377,000	34,000	338,000	72,000	0	154,000
River, Highway, and Railroad Crossings	194,000		101,000		20,000	
Manholes	213,000		145,000		231,000	
Pumping Facilities	684,000	119,000	280,000	139,000	136,000	146,000
Easements	133,000	--	91,000	--	144,000	--
Engineering Services, Legal and Administration and Contingency	1,334,000	--	907,000	--	1,444,000	--
TOTAL	8,349,000	153,000	5,680,000	211,000	9,038,000	300,000

Source: Enviro Control, Inc., 1975

TABLE 32. Costs of the Interceptor Sewer Network for the Delaware County-Columbus Regional Alternative, Subalternative 5

Phases of Planning	Phase 1		Phase 2		Phase 3	
Planning Capacity in mgd	1.5		3.0		6.0	
Cost Items / Costs	Capital Cost in $	O & M Cost in $/yr.	Capital Cost in $	O & M Cost in $/yr.	Capital Cost in $	O & M Cost in $/yr.
Gravity Flow Interceptor Sewers	6,052,000		3,818,000		7,063,000	
Force Main	69,000	35,000	338,000	72,000	0	154,000
River, Highway, and Railroad Crossings	194,000		101,000		20,000	
Manholes	203,000		145,000		231,000	
Pumping Facilities	292,000	85,000	280,000	105,000	136,000	112,000
Easements	127,000	--	91,000	--	144,000	--
Engineering Serivces, Legal and Administration and Contingency	1,267,000	--	907,000	--	1,444,000	--
TOTAL	8,204,000	120,000	5,680,000	177,000	9,038,000	266,000

Source: Enviro Control, Inc., 1975

TABLE 33. Costs of Various Subalternatives of the Delaware County-Columbus Regional Alternative

Costs	Subalternative 1	Subalternative 2	Subalternative 3	Subalternative 4	Subalternative 5
Present Worth in $	18,543,000	24,965,000	19,570,000	17,553,000	16,983,000
Equivalent Annual Cost in $/yr	1,468,000	1,976,000	1,549,000	1,390,000	1,344,000

Source: Enviro Control, Inc., 1975

Del-Co Water Company does not withdraw water from the Olentangy River. The resultant flow by accounting for the water along the Olentangy River would be only 1.26 mgd (1.95 cfs) immediately south of the City of Delaware with the assumption that the City of Delaware only withdraws 2.1 mgd (3.25 cfs) to suffice its basic need of drinking water. It is questionable whether this low flow could sustain the river ecosystems. Further investigation of possible implications of this action, such as a computer simulation of water quality during dry weather periods, would be needed.

Under most probable conditions, the median flow in the Olentangy River would be 66.6 mgd. The diverted water would be 2.3%, 4.5%, and 9.0% of the median flow in the 1st year, the 10th year, and the 20th year after the project becomes operational. The amount of water diversion might have some water quality effects, but they would be minor. However, they could be irretrievable in the sense that a huge financial penalty would have to be taken to correct them.

The possible water quality effects on the Scioto River derive from the additional effluent from the Southerly Plant. The incremental sewage flow would contribute approximately 5.6% of the capacity of the Southerly Plant at the fullest growth of the proposed project. It is anticipated that the effects on the water quality of the Scioto River would be insignificant. This could be attributed to the time shift between the arrival of this incremental sewage from southern Delaware County and the peak hours of the Southerly Plant. Along with the above argument, the design factor of the plant would be large enough to provide for absorbing sewage increment without sacrificing its performance, because the chracteristics of the sewage from southern Delaware County would be of domestic type and would not upset the biological treatment processes of the plant.

It is anticipated that the noise and odor problems resulting from this regional alternative would be much less compared to the southern Delaware County-Delaware City regional alternative, because the current capacity of the Southerly Plant would outweigh the incremental sewage from southern Delaware County.

4. Institutional Considerations

Delaware County can contract with Columbus under Section 6117.41 of the Ohio Revised Code for its sewage to be treated by an expanded Columbus Southerly Plant. This law also enables Delaware County and Columbus to contract with each other for the joint usage and/or construction of any sewer lines needed to transport Delaware County's sewage to the Columbus Southerly Plant.

If Delaware County contracted with Columbus for its sewage to be treated by the Columbus Southerly Plant, Delaware County would have to include provision for payment to Columbus for this service. Delaware County would also have to contribute to any expansion of the Southerly Plant which would be needed to accommodate the additional sewage. This payment would be negotiated by the parties involved as provided for by Section 6117.42 of the Ohio Revised Code. Delaware County could raise this money through a variety of means, including the levying of special taxes, special assessments, or sewage rentals. They may also be able to obtain their funds by securing a loan from the Ohio Water Development Authority.

It is unlikely that Delaware County would enter into such an agreement because of financial reasons. If the plant is located at the site proposed in their facilities plan, Delaware County, as discussed previously (p. 63-65) might get a grant from U.S. EPA and a loan from either the Ohio Water

Development Authority or the Farmers Home Administration of the Department of Agriculture. This funding arrangement is probably more attractive to Delaware County than an arrangement in which they would have to explore different means to raise money to pay Columbus, especially since the price to be paid would be set by Columbus.

There is another obstacle to the implementation of the required contractual agreement between Delaware County and Columbus. Friendly, cooperative relations do not exist between the two parties. As a small semi-rural area, Dleaware County is conscious of its autonomy being threatened by the Columbus area, which is expanding rapidly. Columbus is cognizant of Delaware's feeling and is also not anxious for regionalization. The idea of "home rule" is very strong in both Delaware County and Columbus. This includes an implicit belief that a political entity has the right and responsibility to provide sewer service and should not give up this aspect of self-government.

Neither Columbus nor Delaware County's recent facilities plans fully confront the issue of regionalization between Delaware County and Columbus (Burgess and Niple, Ltd., 1974; Malcolm Prime, Inc., 1974). Delaware County would rather provide its residents service itself and Columbus feels that it first must provide service to those areas of Franklin County which need it before providing service to another county. These attitudes must be surmounted before Delaware County and Columbus would agree to have Delaware County's sewage treated by an expanded Columbus Southerly Plant.

Private Communication

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J. DELAWARE COUNTY - DELAWARE CITY - COLUMBUS

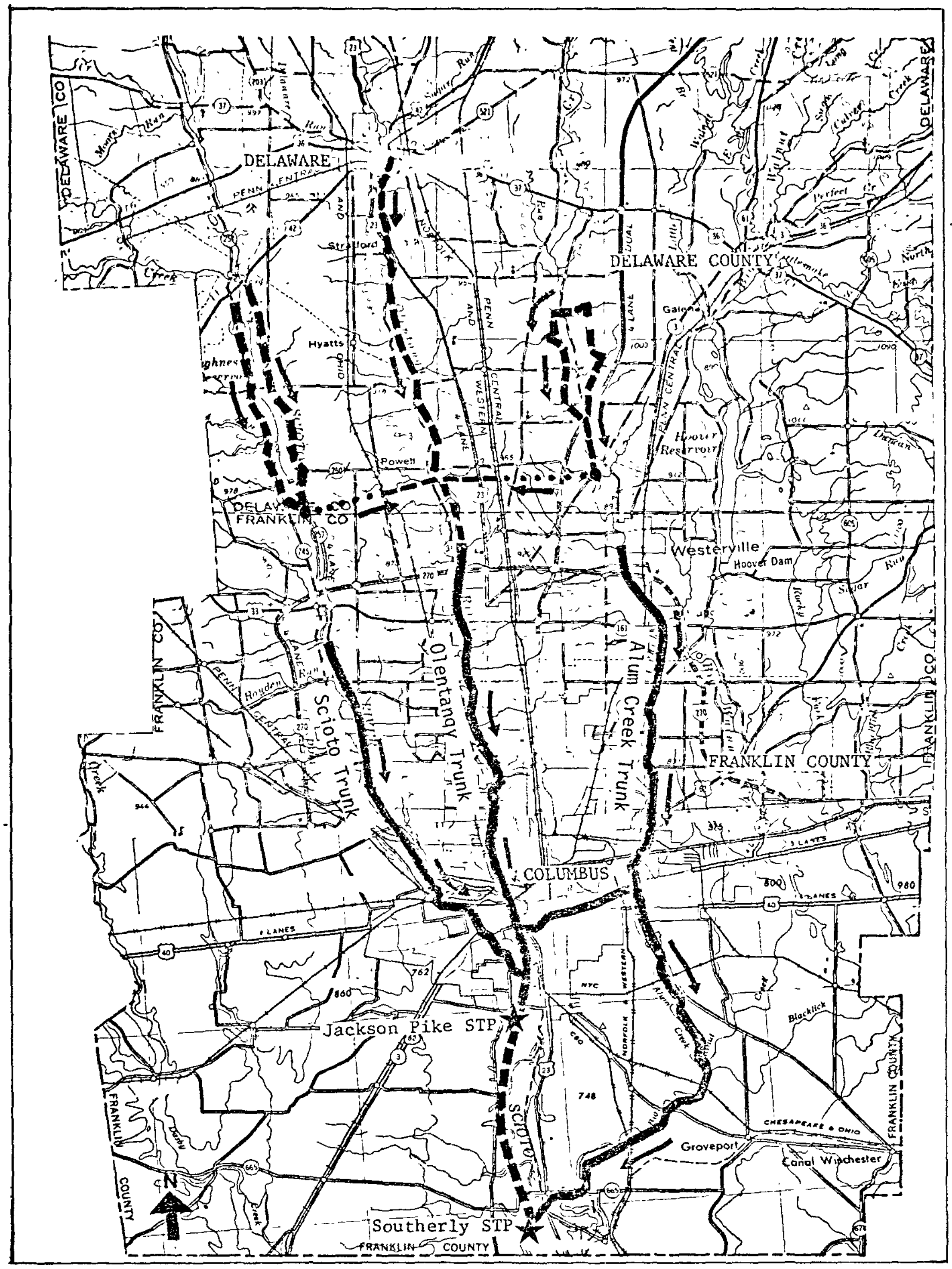
This section examines the Delaware County - Delaware City - Columbus regional alternative. This regional alternative of wastewater treatment would integrate the treatment systems of the City of Delaware, southern Delaware County, and Columbus sewage service areas into one regional system. An overview of this alternative is followed by a discussion of cost-effectiveness, environmental effects, and institutional considerations.

1. Overview

Under this alternative plan the existing Delaware Sewage Treatment Plant would be phased out by the 10th year of the planning period. The Columbus Southerly Plant would be utilized as the regional or central wastewater treatment facility. The total sewage flow from the City of Delaware and southern Delaware County combined would ultimately average approximately 8.5 mgd (13.1 cfs).

The system configuration would be essentially the same as that discussed on pages 140-152 and indicated in Figure 19. However, it would be necessary to replace the proposed Olentangy sewer trunk in Delaware County with a larger sewer pipe and to extend this pipe to the existing Delaware Sewage Treatment Plant, which would be used as the sewage collection point for the City of Delaware sewer network.

Four subalternatives of the inter-county sewer connections are identified. The first subalternative, shown in Figure 25, would use a gravity flow sewer trunk, which would parallel the Olentangy River from the Delaware S.T.P. site to the northern terminus of the Columbus



KEY

SCALE 0 5 miles

Existing Trunk Line

Proposed Trunk Line

Force Main

Regional Plant Site

Lift Station

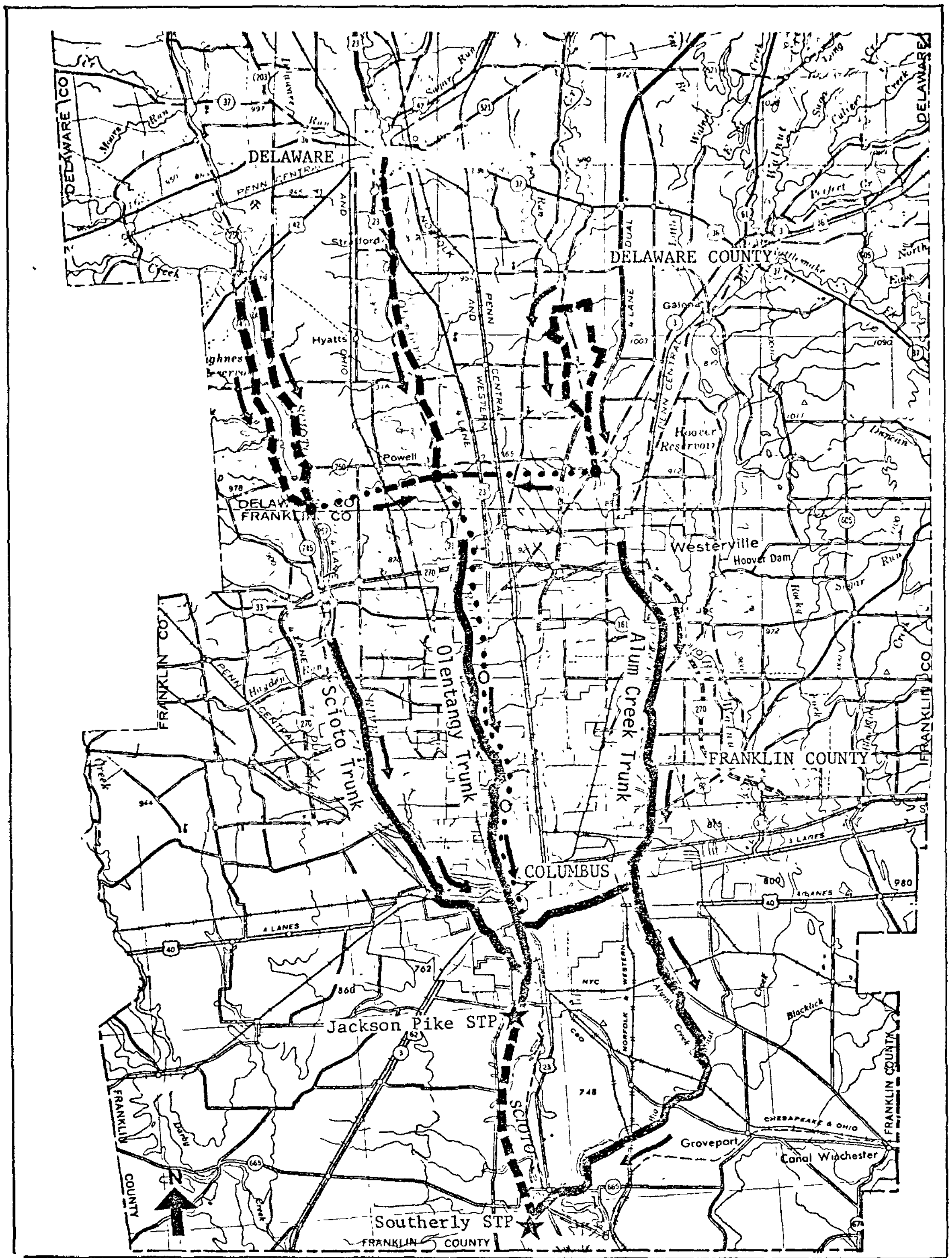
Figure 25. Delaware County - Delaware City - Columbus Regional Alternative, Subalternative 1.

Source: Enviro Control, Inc., 1975

Olentangy Sewer Trunk. This sewer trunk would consist of 10,050 feet of 42 inch pipe, 6,000 feet of 48 inch pipe, 32,000 feet of 54 inch pipe, and 10,800 feet of 60 inch pipe. This subalternative might not be feasible, because of limited capacity of the Columbus Olentangy Trunk Sewer.

The second subalternative shown in Figure 26 would use a gravity flow sewer trunk and a force main to transmit the sewage from the City of Delaware and southern Delaware County to the junction of the Olentangy River and North Broadway Street in Columbus. Here the sewage would be introduced to the Columbus Olentangy Sewer Trunk. The proposed transmission sewer trunk would consist of 10,050 feet of 42 inch pipe, 6,000 feet of 48 inch pipe, 32,000 feet of 54 inch pipe, and 89,760 feet (17 miles) of 16 inch force main as shown in Figure 26. One lift station, located at Powell Road, with a peak capacity of at least 10.5 mgd and system head of 400 feet would be needed. Two booster stations having the same capacity as the lift station and a system head of 200 feet also would be required.

The third alternative is presented in Figure 27. The Alum Creek sewer system in Delaware County would be separated from the Olentangy and the Scioto sewer subsystems. This plan differs from the first subalternative in that the connector sewer between the Olentangy and the Alum Creek sewer subsystems would be eliminated. The Alum Creek sewer subsystem would be connected to Columbus's Alum Creek Trunk with a gravity flow sewer. The combined Olentangy and Scioto sewer subsystems would be connected to Columbus's Olentangy Sewer Trunk by a gravity flow sewer. The system requirements of this subalternative would be essentially the same as in subalternative 1,

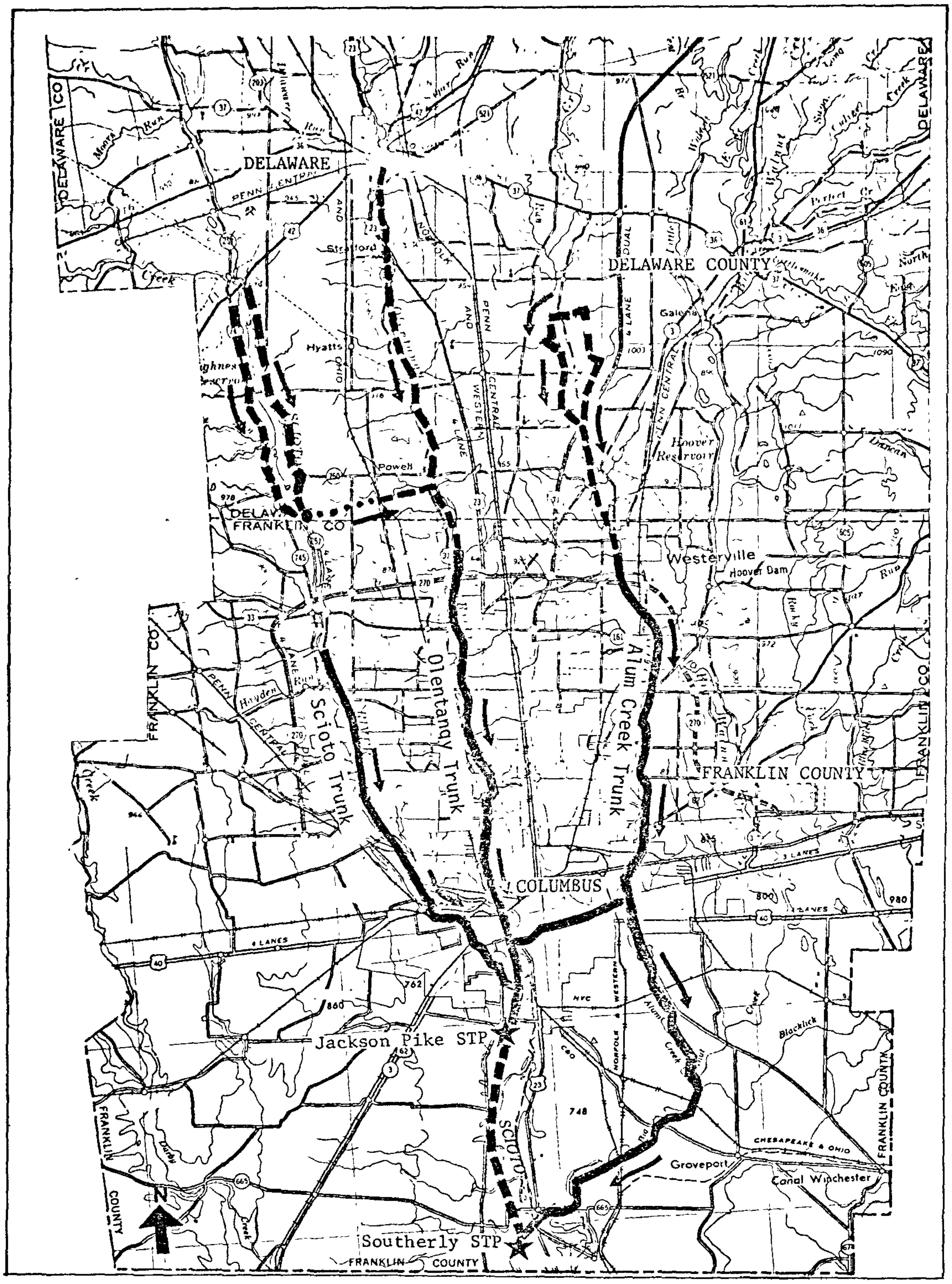


KEY

Existing Trunk Line	▬▬▬	Regional Plant Site	☆
Proposed Trunk Line	▬ ▬ ▬	Lift Station	●
Force Main	••••••••	Booster Station	O

Figure 26. Delaware County - Delaware City - Columbus Regional Alternative, Subalternative 2.

Source: Enviro Control, Inc., 1975



KEY

SCALE
0 5 miles

Existing Trunk Line

Proposed Trunk Line

Force Main

Regional Plant Site

Lift Station

Figure 27. Delaware County - Delaware City - Columbus Regional Alternative, Subalternative 3.

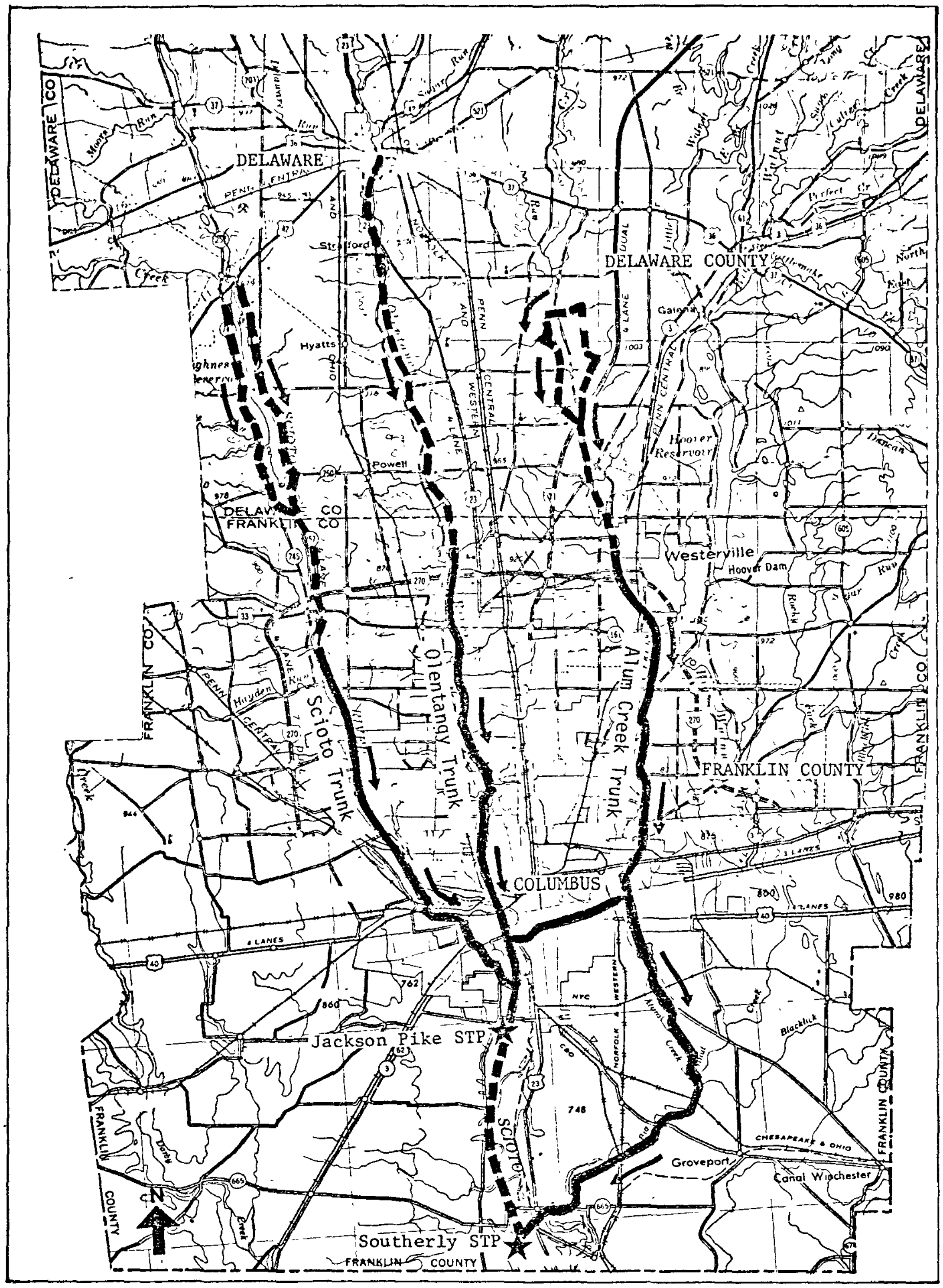
Source: Enviro Control, Inc., 1975

except that interbasin pumping facilities and sewage transportation between the Alum Creek Basin and the Olentangy Basin would be eliminated. The inter-county sewer connection between the Alum Creek subsystem and the Alum Creek Trunk would require an additional 13,200 feet of 36 inch sewer pipe.

In the fourth subalternative, shown in Figure 28, the Scioto Interceptor Trunk, the Olentangy Trunk, and the Alum Creek Trunk would be utilized simultaneously to convey the sewage to the Columbus Southerly Plant. No interbasin pumping facilities and sewer connection would be required. The system requirements of this subalternative would be essentially similar to those of subalternative 3, except that no interbasin connection between the Olentangy and the Scioto Basins would be required and an additional 26,400 feet of 36 inch sewer pipe would be needed to serve as sewer connector between the Scioto sewage collection subsystem and the Scioto Interceptor Trunk.

2. Cost-Effectiveness

The approach taken for the cost-effectiveness study is essentially the same as discussed on pages 153-160 of this chapter. All four subalternatives are considered for cost-effectiveness analysis. The results of the analysis are given in Tables 34, 35, 36, 37, and 38. Table 34 presents the incremental cost for upgrading the existing Columbus Southerly Plant to be used as a regional plant and the annual O & M costs in various phases of the planning. Tables 35 through 38 give the costs for the system requirements and the annual O & M costs for various subalternatives.



KEY

Existing Trunk Line

Proposed Trunk Line

Regional Plant Site

Figure 28. Delaware County - Delaware City - Columbus Regional Alternative, Subalternative 4.

Source: Enviro Control, Inc., 1975

TABLE 34. Incremental Costs of Using the Columbus Southerly Plant as the Regional Plant for the Delaware County-Delaware City-Columbus Regional Alternative

Cost Items \ Phases of Planning (Incremental Flow in mgd)	Phase 1	Phase 2	Phase 3
Incremental Flow in mgd	1.5	4.0	3.0
Incremental Capital Cost in $	700,000	1,800,000	1,100,000
Annual O & M Cost in $/yr.	26,000	92,000	141,000

Source: Enviro Control, Inc., 1975

TABLE 35. Costs of the Interceptor Sewer Network for the Delaware County-Delaware City-Columbus Regional Alternative, Subalternative 1

Phases of Planning	Phase 1		Phase 2		Phase 3	
Planning Capacity in mgd	1.5		5.5		8.5	
Cost Items / Costs	Capital Cost in $	O & M Cost in $/yr.	Capital Cost in $	O & M Cost in $/yr.	Capital Cost in $	O & M Cost in $/yr.
Gravity Flow Interceptor Sewers	7,888,000	51,000 (Gravity Flow Interceptor Sewers, Force Main, and River, Highway, and Railroad Crossings combined)	5,851,000	86,000 (Gravity Flow Interceptor Sewers, Force Main, and River, Highway, and Railroad Crossings combined)	6,807,000	163,000 (Gravity Flow Interceptor Sewers, Force Main, and River, Highway, and Railroad Crossings combined)
Force Main	913,000		338,000		0	
River, Highway, and Railroad Crossings	132,000		118,000		0	
Manholes	314,000		210,000		222,000	
Pumping Facilities	884,000	176,000	280,000	197,000	136,000	204,000
Easements	196,000		132,000		139,000	
Engineering Services, Legal and Administration and Contingency	1,963,000		1,317,000		1,389,000	
TOTAL	12,290,000	227,000	8,247,000	283,000	8,693,000	367,000

Source: Enviro Control, Inc., 1975

TABLE 36. Costs of the Interceptor Sewer Network for the Delaware County-Delaware City-Columbus Regional Alternative, Subalternative 2

Phases of Planning	Phase 1		Phase 2		Phase 3	
Planning Capacity in mgd	1.5		5.5		8.5	
Cost Items / Costs	Capital Cost in $	O & M Cost in $/yr.	Capital Cost in $	O & M Cost in $/yr.	Capital Cost in $	O & M Cost in $/yr.
Gravity Flow Interceptor Sewers	7,250,000	68,000 (Gravity Flow Interceptor Sewers, Force Main, and River, Highway, and Railroad Crossings combined)	4,851,000	103,000 (Gravity Flow Interceptor Sewers, Force Main, and River, Highway, and Railroad Crossings combined)	6,807,000	179,000 (Gravity Flow Interceptor Sewers, Force Main, and River, Highway, and Railroad Crossings combined)
Force Main	4,131,000		338,000		0	
River, Highway, and Railroad Crossings	132,000		118,000		0	
Manholes	416,000	--	230,000	--	222,000	--
Pumping Facilities	1,484,000	405,000	880,000	654,000	136,000	661,000
Easements	260,000	--	144,000	--	139,000	--
Engineering Services, Legal and Administration and Contingency	2,599,000	--	1,437,000	--	1,389,000	--
TOTAL	16,272,000	473,000	8,998,000	757,000	8,693,000	840,000

Source: Enviro Control, Inc., 1975

TABLE 37. Costs of the Interceptor Sewer Network for the Delaware County-Delaware City-Columbus Regional Alternative, Subalternative 3

Phases of Planning	Phase 1		Phase 2		Phase 3	
Planning Capacity in mgd	1.5		5.5		8.5	
Cost Items / Costs	Capital Cost in $	O & M Cost in $/yr.	Capital Cost in $	O & M Cost in $/yr.	Capital Cost in $	O & M Cost in $/yr.
Gravity Flow Interceptor Sewers	8,347,000		5,851,000		6,807,000	
Force Main	377,000	50,000	338,000	85,000	0	161,000
River, Highway, and Railroad Crossings	132,000		118,000		0	
Manholes	305,000		211,00		222,000	
Pumping Facilities	684,000	119,000	280,000	139,000	136,000	146,000
Easements	191,000		132,000		139,000	
Engineering Services, Legal and Administration and Contingency	1,908,000		1,317,000		1,389,000	
TOTAL	11,944,000	169,000	8,247,000	224,000	8,693,000	307,000

Source: Enviro Control, Inc., 1975

TABLE 38. Costs of the Interceptor Sewer Network for the Delaware County-Delaware City-Columbus Regional Alternative, Subalternative 4

Phases of Planning / Planning Capacity in mgd / Cost Items \ Costs	Phase 1		Phase 2		Phase 3	
Planning Capacity in mgd	1.5		5.5		8.5	
Cost Items	Capital Cost in $	O & M Cost in $/yr.	Capital Cost in $	O & M Cost in $/yr.	Capital Cost in $	O & M Cost in $/yr.
Gravity Flow Interceptor Sewers	9,050,000	} 151,000 (Gravity Flow Interceptor Sewers, Force Main, and River, Highway, and Railroad Crossings combined)	5,851,000	} 86,000 (Gravity Flow Interceptor Sewers, Force Main, and River, Highway, and Railroad Crossings combined)	6,807,000	} 162,000 (Gravity Flow Interceptor Sewers, Force Main, and River, Highway, and Railroad Crossings combined)
Force Main	69,000		238,000		0	
River, Highway, and Railroad Crossings	132,000		118,000		0	
Manholes	305,000		211,000		222,000	
Pumping Facilities	292,000	27,000	280,000	48,000	136,000	55,000
Easements	191,000		132,000		139,000	
Engineering Services, Legal and Administation and Contingency	1,908,000		1,317,000		1,389,000	
TOTAL	11,947,000	178,000	8,247,000	134,000	8,693,000	217,000

Source: Enviro Control, Inc., 1975

The present worth value and the equivalent annual cost for each sub-alternative are calculated by combining Table 34 with corresponding Tables 35 through 38. The results are summarized in Table 39 which shows sub-alternative 4 to be the most economical.

3. Environmental Effects

This regional alternative would use the Columbus Southerly Plant as the regional plant, and would have the same water quality effects as discussed on pages 153-162 for the southern Delaware County - Columbus regional alternative.

Under dry weather conditions, the Olentangy River would be subject to adverse stresses in terms of water quality, because of the relatively large water diversion from the Olentangy River to the Scioto River. At the last stage of the project development, this regional alternative plan would cause approximately 50 percent more water to be diverted than would the southern Delaware County - Columbus regional alternative.

Under most probable conditions, there would be some indirect impacts on water quality due to water diversion, but they would not be significant. The amount of water diversion would be 2.3 percent, 8.3 percent, and 12.8 percent of the median flow in the first year, 10th year, and 20th year after the proposed project becomes operational. Water quality effects on the Scioto River would not be significant for the same reasons presented on pages 153-162 for the southern Delaware County - Columbus regional alternative.

TABLE 39. Costs of Various Subalternatives of the Delaware County-Delaware City-Columbus Regional Alternative

Subalternative	Present Worth in $	Equivalent Annual Cost in $/yr
1	24,024,000	1,902,000
2	32,428,000	2,567,000
3	22,961,000	1,818,000
4	21,821,000	1,727,000

Source: Enviro Control, Inc., 1975

This regional alternative would require construction of a larger gravity flow sewer trunk from the Delaware S.T.P. site to the Delaware - Franklin County line than that required by the southern Delaware County - Columbus regional alternative. Therefore, more water quality problems would result from this regional alternative in terms of erosion and siltation, because more land surface would be exposed.

As indicated in the southern Delaware County - Columbus regional alternative, no significant noise and odor problems could be identified, because the existing capacity of the Columbus Southerly Plant would outweigh the sewage flow from southern Delaware County and the City of Delaware combined.

4. Institutional Considerations

Delaware County, Delaware City, and Columbus can contract among each other to treat Delaware County's and Delaware City's sewage in an expanded Columbus Southerly Plant. This contract can be effected by Delaware County contracting with Columbus in the manner previously described on pages 162-163 and by Delaware County contracting with Delaware City as provided by the same laws, Sections 6117.41 and 307.15 of the Ohio Revised Code, as previously discussed on pages 136-138. In addition, Delaware City would have to contract with Columbus in the same manner that Delaware County did unless Delaware County assumed responsibility for Delaware City's sewage system as provided for by Section 307.15 of the Ohio Revised Code.

The Delaware County - Delaware City - Columbus alternative can be legally implemented, but the same obstacles exist to its implementation that exist for the Delaware County - Delaware City and Delaware County - Columbus alternatives. Delaware City does not wish to phase out its newly remodeled plant and Delaware County and Columbus, because of financial and other reasons, probably cannot enter into the needed contractual agreement. Furthermore, the needed agreements are difficult enough to negotiate between two parties. It would certainly be even more difficult to successfully negotiate all the required financial and legal contracts among three parties.

PRIVATE COMMUNICATION

Smith, Robert, Advanced Waste Treatment Research Laboratory, 25 July 1975.

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Ohio Revised Code Annotated, 1975.

Smith, R., A Compilation of Cost Information for Conventional and Advanced Water Treatment Plants and Processes, U.S. Department of the Interior, December 1967.

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U.S. Environmental Protection Agency, Office of Water Programs Operation, Sewer and Sewage Treatment Plant Construction Cost Index, April 1975.

U.S. Water Resources Council, "Principles and Standards for Planning Water and Related Land Resources - Change in Discount Rate," The Federal Register, 30 July 1975.

K. CONSERVANCY DISTRICT

In the foregoing discussion of alternatives, only existing institutions were considered. However, there are other institutions which can be formed for the implementation of the proposed wastewater treatment plan, especially if a regional approach is adopted. Ohio law provides for Conservancy Districts, Sanitary Districts, and Regional Water and Sewer Districts. Sanitary Districts and Regional Water and Sewer Districts exist in various parts of Ohio, but in no case do they have multi-county jurisdiction. However, there is one present case in Ohio in which a regional, multi-county approach to wastewater treatment is being implemented by a Conservancy District.

Section 6101 of the Ohio Revised Code provides for the creation of Conservancy Districts. Section 6101.04 of the Ohio Revised Code states that "any area or areas situated in one or more counties may be organized as a conservancy district" for a variety of purposes, including "the collection and disposal of sewage and other liquid wastes produced within the district." Ohio law enables Conservancy Districts to borrow funds from the Ohio Department of Natural Resources for their incidental expenses and to levy assessments on all real property and on all public corporations upon which benefits have been appraised in order to fund their official plan.

A Conservancy District encompassing several counties has been in operation in the Miami Valley of southwestern Ohio for at least 50 years. Although originally established for flood control, the Miami Conservancy District recently submitted three facilities plans to the Ohio EPA. One of these plans includes a service area encompassing part of Warren and Montgomery Counties (Mapes, 1975).

If a Conservancy District were to be established to include Franklin and Delaware Counties and to handle the wastewater treatment problems for that area, many of the institutional problems associated with both the nonregional and regional alternatives discussed in Sections B through J would be eliminated. The need for agreements between unwilling parties would be eliminated as one entity would be given responsibility for the collection and treatment of wastewater regardless of municipal or county borders. There is, however, one major obstacle to implementing a Conservancy District in Delaware and Franklin Counties. Under Section 6101 of the Ohio Revised Code, a Conservancy District can only be created on the initiative of the communities involved and can only service municipalities which explicitly desire service. It is unlikely that the parties involved would take this initiative.

As was described above, Delaware County, Delaware City, and Columbus each have their own sewerage systems. They have invested much money and effort in their present systems and in the development of future plans. These parties would probably not surrender their autonomy regarding sewer service, especially to an entity which would have the power to tax them. Finally, the strained relations which exist between Delaware County and Columbus make the creation of a Conservancy District in the area in the near future improbable. A Conservancy District would be a means to implement the proposed plant in any of the alternative locations by avoiding the need for negotiation between antagonistic parties. Ironically, however, negotiations between these parties would be necessary for the creation of a Conservancy District.

Private Communication

Mapes, Greg, Environmental Planner, Ohio EPA, August, 1975.

Reference

Ohio Revised Code Annotated, 1975

L. SUMMARY

This section summarizes both the local and regional alternatives discussed on pages 69-181. Local alternatives are subjected to a second screening process. Regional alternatives are discussed without screening because the corresponding data are more limited.

1. Overview

On pages 69-124, five sites were selected on the basis of a preliminary screening within each geographical area. These sites were:

- OR1, south of the I-270 outerbelt
- OR3, on the Olentangy, 1 mile south of Powell Road
- OR7, on Powell Road near Powell
- OR8, at Chapman and Winter Road
- AC1, on Alum Creek near Powell Road.

Of these sites, the fourth, OR8, is actually a site for a regional alternative with Delaware City. Additional regional approaches were discussed on pages 125-181. The impacts of all these alternatives are summarized in Table 41. Each site is rated as producing negligible or various levels of detrimental impact for each impact category. The assessment in each case is based on the most environmentally compatible mitigative measures, such as outfall relocation, dechlorination, and landscaping. Recommended mitigative measures are discussed above under each alternative.

TABLE 40. Summary of Impacts of Selected Local Plant Sites and Regional Alternatives

	Engineering and Costs	Land Use	Aesthetic	Drinking Water Quality	Water Diversion	Aquatic Organisms	Terrestrial Organisms	Institutional Impediments
OR1 - Franklin County-I-270	4	1	3	3	1	2**	2	6
OR3 - Powell Road - Olentangy	2	1	3	1	0	2**	2	4*
OR7 - Powell Road - Powell	4	1	3	1	0	2**	3	4*
OR8 - Stratford-Olentangy	6	2	2	1***	0	6***	3	4
AC1 - Alum Creek	4	1	2	1***	5	Unknown	1	6*
Regional - with Delaware City	6	1	1	4	1	5	3	1
Regional - with Columbus	0	0	1	1	5	Unknown	2	5
Regional - with Columbus and Delaware City	0	0	1	1	6	Unknown	2	6

* impact of 0 if outfall is located at closest point on river
** impact of 5 if outfall is located at closest point on river
*** impact of 6 if outfall is located at closest point on river

KEY: 0 = no impact
6 = severe detriment

Source: Enviro Control, Inc., 1975

Decisions on the comparative merits of the regional approaches must be based on comparison of the best subalternatives, recommended in each section. It must be recognized, however, that the selection of these subalternatives and comparison of regional concepts is limited by the scope of this report mainly to engineering and cost considerations. Environmental and social impacts were assessed on the basis of the limited information available.

2. Local Alternatives

Four of the five selected sites on pages 69-124 correspond to alternative treatment plant locations of the proposed facility. These four are subjected to a secondary screening, described below, in order to determine which, if any, possibilities are comparable to the proposed action and merit further investigation. The comparisons are made on the assumption that the recommended mitigative measures for each location are followed. In some cases changes in these measures would greatly alter the comparability.

Sites OR1, OR3, and OR7 on the Olentangy River are similar in many respects if it is assumed that the outfall from each of the three is the same in location, and in quality and quantity of effluent. All local alternatives require the construction of a new wastewater treatment facility which must meet water quality standards promulgated by the Ohio EPA. Thus equal level of treatment can be assumed.

Engineering considerations and cost of plant construction are essentially the same for all three sites. Site OR7 might require more construction work due to the possible presence of shallow soils. The cost differences in these sites mainly result from additional system requirements of pumping, interceptor lines, and outfall lines. On this basis Sites OR1 and OR7 are both more costly than Site OR3.

There are only minor differences in land use among the sites. The sites near the outerbelt might interfere with future development near the I-270 and Ohio 315 interchange. It is not currently known, however, whether or not such development is in the planning stage. Site OR7 would affect planned residential land development and expansion of the village of Powell. Site OR3 has the least impact on land use, although concern has been expressed by officials of Highbanks Park that recreational use of the park might be affected.

Aesthetic effects differ slightly in terms of proximity to receptors. Visual impact from nearby roadways would be significant at Sites OR1 and OR7. A plant at Site OR3 could be more easily screened by trees and the current design includes such screening. Although Site OR3 is near the Highbanks park, odor and noise are not expected to cause a significant impact. The impact on water quality and that caused by water diversion from all three sites depends only on outfall location. These impacts would be identical from any of the sites if the outfall location south of I-270 were used.

Use of the southern outfall location in Franklin County is designed to minimize biological impacts on aquatic organisms. More northern outfall locations for any of the three sites would seriously jeopardize the survival of significant populations of aquatic organisms. Only Site OR7 would have detrimental effects on forested areas. This is due to the small segment of the Bartholomew Run which the outfall from this site must cross.

From the institutional standpoint, the most difficult site to implement is OR1. This is due to political problems and the question of joint usage. The other sites would have no institutional constraints except those of placement of the outfall line along the state highway right-of-way in Franklin County.

Site OR3, then, is in our judgment the preferred site on the Olentangy River due to lower cost and least engineering difficulty. Total impact on the environment is equal to or less than that of other sites, provided the mitigative measures recommended here are followed. This site also has the advantage of being the most thoroughly investigated. Thus, unplanned costs are less likely. The only remaining investigation of the site is an archaeological survey now underway.

Site AC1 on Alum Creek has certain disadvantages and advantages compared with Site OR3. Mitigative measures could be used to overcome many of the disadvantages which include diversion of river water, discharge of effluents in a stream of low median flow, discharge of effluent above a drinking water supply, some additional pumping requirements, and institutional problems. Advantages include elimination of impact on a recreational area, reduction of aesthetic impacts, and possible reduction of biological impacts. Little or no data is available on the latter, however, and more detailed study is required to adequately assess the feasibility of this site.

3. Regional Alternatives

The three regionalization concepts involve a merger of southern Delaware County with:

- Delaware City
- Columbus
- Columbus and Delaware City.

Each of these concepts contains two or more subalternatives. The merger with Delaware City could be accomplished either at site OR8 or at the site of the present Delaware City Plant. A merger with Columbus or with both entities involves subalternatives which differ mainly in routing and trunkline construction. A discussion as to which subalternatives are best from environmental considerations cannot be made without an in-depth study. Therefore, only the general merits of each regional scheme are discussed below. A cost comparison of the various subalternatives is given in Figure 29. Here costs are compared in terms of equivalent annual cost, which is explained on pages 129-130.

Delaware City and Southern Delaware County can merge their treatment efforts either by expanding the present City of Delaware Plant or by constructing a combined facility at site OR8. Both possibilities would require construction of a long upbasin force main. This would result in

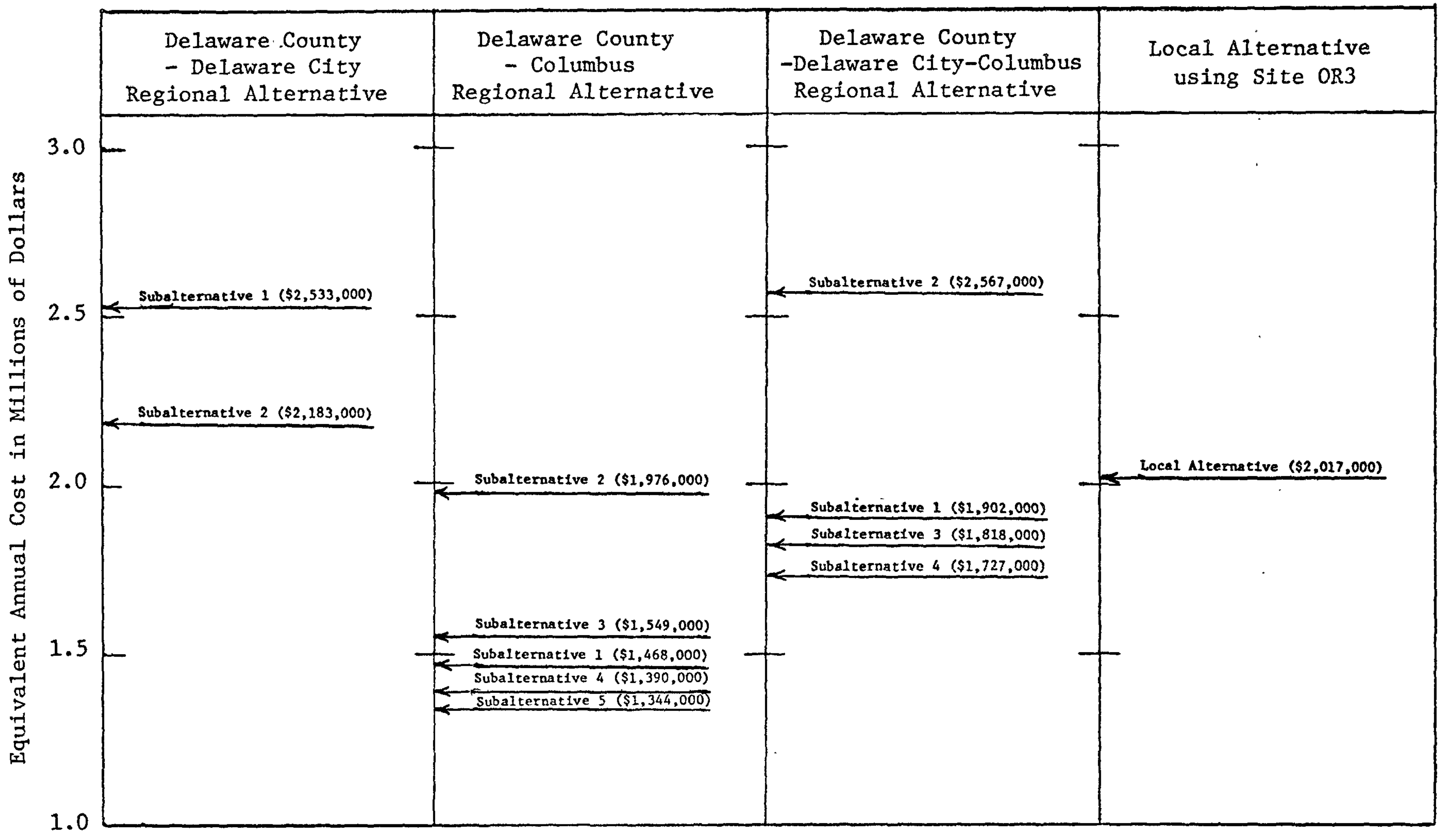


Figure 29. Costs of Various Alternatives

Source: Enviro Control, Inc., 1975

high operation and maintenance costs, as well as increased energy expenditure. Environmentally, no water diversion problems would be created. The outfall would be above the Del-Co water intake for the City of Delaware plant, but outfall relocation would be necessary for OR8 because of its proximity to the water intake. Both outfalls would be above the most biologically sensitive portions of the river. Site OR8 is in the scenic river segment, whereas Delaware City is not. Institutional considerations pose some problems, but this concept could be implemented.

The regionalization with Columbus would involve upgrading the existing Columbus Southerly Plant over a 20-year period. The incremental costs of upgrading the Columbus Southerly Plant would be less than the cost of a totally new plant or of upgrading the City of Delaware plant. Operation and maintenance costs would also be somewhat less than the merger with the City of Delaware. The subalternatives for this plan are:

- Connection with Olentangy Trunk
- Force main to Broad Street
- Connection with Alum Creek Trunk
- Connection with both Olentangy and Alum Creek Trunks
- Connection with the Olentangy, Alum Creek, and Scioto Trunks.

The information about the existing and future capacities of the various trunk lines can only be estimated at this time. Detailed environmental impacts of each of these subalternatives would require further study. However, water diversion by the Del-Co Water Company intake would impose a significant deficit in the Olentangy River between Home Road and the confluence with the Scioto River. The biological effects here could be significant. Institutional problems are severe in this alternative, but implementation is possible if cooperation between the parties can be achieved.

The merger of the three service areas, Delaware City, Southern Delaware County, and Columbus, is the most complex plan. In this case, the existing Delaware City Plant would be phased out in the first 10 years and the Columbus Southerly Plant would be upgraded. The four subalternatives are:

- Connection with the Olentangy Trunk
- Construction of a force main to East Broad Street
- Connection with the Olentangy and Alum Creek Trunks
- Connection with the Olentangy, Alum Creek, and Scioto Trunks.

As in the case of the previous alternative, present information and/or projections of trunkline capacity and load are of questionable validity. It is likely, however, that the marginal difference between the planned load and capacity in the Olentangy Trunk would eliminate the first subalternative. Thus, it might be necessary to use the more expensive force main subalternative or the subalternative involving connection with the Olentangy, Alum Creek, and Scioto Trunks. The system requirements for any of the subalternatives would be proportionally higher than those of the Columbus-Southern Delaware County concept.

Environmental effects would be slightly more severe in this case than in the case of the second alternative, because of the additional water diversion brought about by including the City of Delaware. Biological effects of the additional river loading south of the Southerly Plant might also be significant. Institutionally, this would be the most difficult alternative to implement. It would probably be nearly impossible for all three groups to come to an agreement on the implementation of the combined plant.

III. ENVIRONMENTAL EFFECTS OF PROPOSED ACTION

This chapter examines the environmental effects of the proposed plant, the Olentangy Environmental Control Center, described above as alternative OR3. The expected effects of this project on the area's water quality, biology, land use and population, and aesthetics are discussed.

A. WATER QUALITY

The effects on water quality resulting from the proposed action are determined by the flow conditions, the waste loads introduced into the receiving stream, and the existing and future ambient water quality conditions. Water quality problems of temporary duration are also associated with interceptor construction and its phasing.

1. Flows

The flow of the Olentangy River south of the Delaware Dam averages approximately 223 mgd (345 cfs) with a median flow of 47.8 mgd (74 cfs) and the 7-day 10-year low flow of 3.36 mgd (5.2 cfs). Close to the proposed plant site, at the Stratford Gage station, the 7-day 10-year low flow is measured at 2.93 mgd (3.77 cfs). At Worthington, the average flow is 227 mgd (429 cfs), the median is 66.6 mgd (10.2 cfs) and the measured low flow is 14.2 mgd (22 cfs). A schematic presentation of 7-day 10-year low flows along the Olentangy River is given in Figure 30.

If the proposed project, the Olentangy Environmental Control Center, were to be constructed, it would ultimately discharge 6 mgd (9.3 cfs) of effluent into the Olentangy River near the Delaware-Franklin County line. After the complete implementation of the

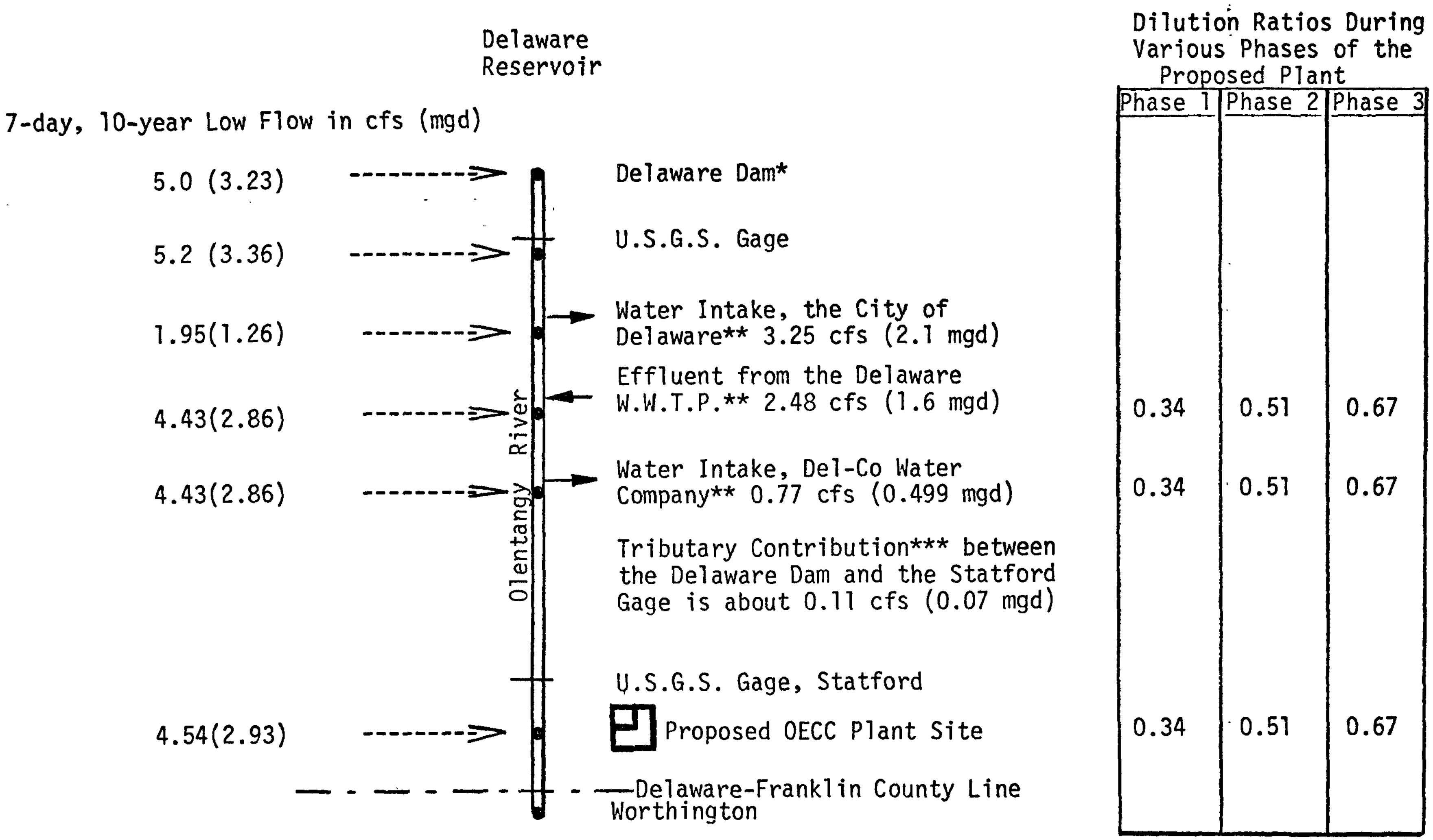


Figure 30. The 7-day 10-year Low Flow In the Olentangy River

Source: *U.S. Army Corps of Engineers, 1975; **Gilbert, 1975;
***Ohio Department of Natural Resources, Division of Water, 1963.

proposed project, the dilution ratios based on the median river flow and the 7-day 10-year low flow would be 0.083 and 0.67 respectively. The intermediate dilution ratios based on the 7-day 10-year low flow would be 0.34 and 0.51 for the first phase (effluent flow of 1.5 mgd) and the second phase (effluent flow of 3 mgd) respectively. The dry weather dilution ratios at various locations along the Olentangy River are shown in Figure 30.

To arrive at these dilution ratios, it is assumed that Del-Co Water Company would not withdraw water from the Olentangy River during 7-day 10-year low flow periods. This assumption is justified by the fact that, during low flow periods, the intake would be so close to the river bed so that, for drinking purposes, extensive purification work would be required to remove the silt content and turbidity from the raw water. The Del-Co Water Company has a storage reservoir with a capacity to meet 60-day water demand by its customers, and the Company plans to expand the reservoir to a 90-day capacity (Gilbert, 1975). One of the objectives of expanding the storage reservoir is to reserve water for dry weather periods during which withdrawal and purification of water from the Olentangy River would be difficult.

The proposed project would not incur any division of water into or out of the Olentangy River Basin, because the Del-Co Water Company and the City of Delaware are the sole providers of water supply systems serving the Delaware County area. The water withdrawn by the Del-Co Water Company and the City of Delaware would be returned to the Olentangy River in the form of sewage except for minor losses due to consumption and evapo-transpiration.

2. Waste Loads

The waste loads and their geographical distributions were investigated and compiled in the Scioto River Basin Waste Load Allocation Report (Ohio EPA, 1974). This report was the result of a basin plan study specifically required by Section 303(e) of the Federal Water Pollution Control Act of 1972. Table 42 tabulates the existing loads of BOD_5, total dissolved solids (TDS), ammonia (NH_3), and fecal coliforms in the Olentangy River reach between the Delaware Dam and the river mouth, at the confluence of the Olentangy River and the Scioto River in Franklin County. Their allowable loads (Ohio EPA, 1974) are also indicated in Table 42. The allowable loads were derived from the assumed low river flow of 9.7 mgd (15 cfs) and the water quality standards for the Olentangy River in the Scioto River Basin Waste Load Allocation Report (Ohio EPA, 1974). This low flow differs from the 7-day 10-year low flow calculated from the historical flow data. From the historical flow records, the 7-day 10-year low flow would be only 4.54 cfs at the site, which is less than one-third of the amount used for calculation in the Waste Load Allocation Program (Ohio EPA, 1974). The safety factor assigned in the Waste Load Allocation Program is approximately 2.0 or slightly larger, which will certainly not be able to provide the marginal safety if a 7-day 10-year low flow does occur.

The pollutant loads from the proposed plant based on its ultimate capacity of 6 mgd and its designated effluent quality standards are presented in Table 43. Comparison of the loads from the proposed plant with those allowable shows that the total dissolved solids (TDS) would exceed the allowable load by approximately 48%. This

TABLE 42. Waste Loads of the Olentangy River Reach Between the Delaware Dam and the River's Mouth

Variables	BOD_5 in lb/day	TDS in lb/day	NH_3 as N in lb/day	Fecal Coliform in 10^{10}/day
Load entering from upstream	178.2	22,194	14.8	19.48
Total Instream Load	59.4	4,293	113.5	tntc*
Allowable Load	768.1	20,250	117.1	7.35

*too numerous to count

Source: Ohio EPA, 1974

TABLE 43. Comparison Between the Waste Load of the Proposed OECC Plant and the Allowable Load of the Olentangy River

Para- meters	Effluent Concentration Monthly Average in mg/l(MPN/100 ml)	Waste Load from the Proposed Plant in lb/day (10^{10}/day)	Allowable Load of the Olentangy River with Built-In Safety Factor in lb/day (10^{10}/day)
BOD_5	8.0	400.8	768.1
TSS	8.0	400.8	---
TDS	596	29,860	20,250
NH_3as N	0.5	25.1	117.1
Fecal Coliforms	(200)	(4.54)	(7.35)
Phosphorus	3.0	150.3	---
Oil & Greases	10	501.0	---
Chloride	90	450.9	10,125

Source: Ohio EPA, 1974

would limit the value of the river water for irrigation of crops. No apparent waste load impacts are anticipated for BOD_5, NH_3, fecal coliforms, and chloride. The allowable loads for phorphorus, total suspended solids (TSS), and oil and greases have not been established. Therefore, their impacts could not be quantified at this stage of the study. It is speculated that the nitrate load might have some impact on the use of riverwater for irrigation of crops according to the water quality standards for nitrate (10 mg/l) set by the Public Health Service (Finkbeiner, Pettis, and Strout, 1969). This speculation could not be confirmed without defining the allowable load for the plant.

3. Water Quality

Based on the design capacity (1.5 mgd) of the proposed plant in the first 10 years of operation, a computer simulation was conducted using the Ohio EPA computer model of the water quality conditions (Burgess & Niple, Ltd, 1974) for the river segment between the proposed plant site and the U.S.G.S. gage station approximately 2.6 miles downstream from the site. The river dilution flow was assumed to be 8.6 mgd (13.3 cfs), the water temperature 25°C, and the flow velocity 0.33 feet per second. The DO_5 and NH_3 concentrations, and BOD_5, NH_3, and organic nitrogen loads were calculated by the computer program. The program is based on the Streeter-Phelps equations for mixing two pollutant streams, and several auxiliary equations for the determination of the coefficients in the Streeter-Phelps equations. The chief dependent variables in the Streeter-Phelps equations are oxygen deficit and flowing load. The major rate coefficients are the deoxygenation rate and the reaeration rate of the river. Equations of mass conservation were used for dilution calculation. The computer results are given in Figures 31, 32, 33, 34, and 35.

In Figure 31, two drops of DO value are to be noticed at the mixing points of the proposed plant and the Worthington Hills STP. However, all the DO values are well above the 6.0 mg/l standard promulgated by the Ohio EPA for this river system. In Figure 32, an increase of 0.02 mg/l of ammonia concentration from the upstream concentration of 0.5 mg/l is calculated at the mixing point of the proposed plant. This increase is attributable to the effluent of the proposed plant. The ammonia concentration remains approximately constant with flow downstream and undergoes a rise of 0.31 mg/l at the mixing point of the Worthington Hills STP. The stream water quality standard for NH_3 in this river segment is 1.5 mg/l, therefore, no violation of ammonia concentration is anticipated from the proposed action.

The flowing load of BOD_5 at the proposed site would be 270 pounds per day (Figure 33) which would be less than the allowable BOD_5 load (Table 43) established in the Waste Load Allocation Report (Ohio EPA, 1974). The waste load of ammonia at the proposed site would be 36 pounds per day of nitrogen compared to the allowable load of 117.1 pounds per day. Therefore, no violation would be observed.

The organic nitrogen load at the proposed site would be 89.0 pounds per day. No allowable load for organic nitrogen has yet been

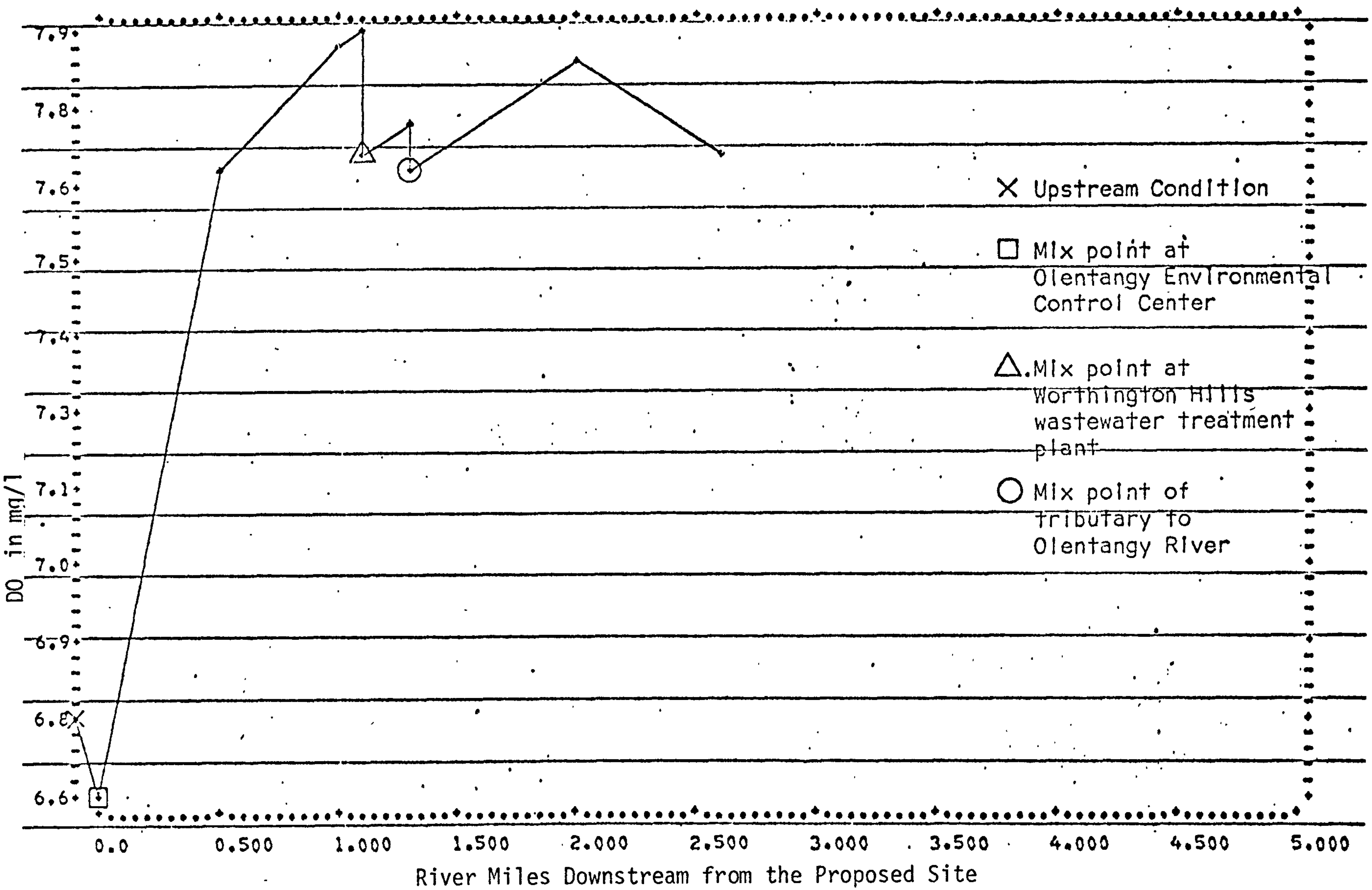


Figure 31. Profile of projected Dissolved Oxygen (DO) level.

Source: Burgess & Niple, Ltd., 1974

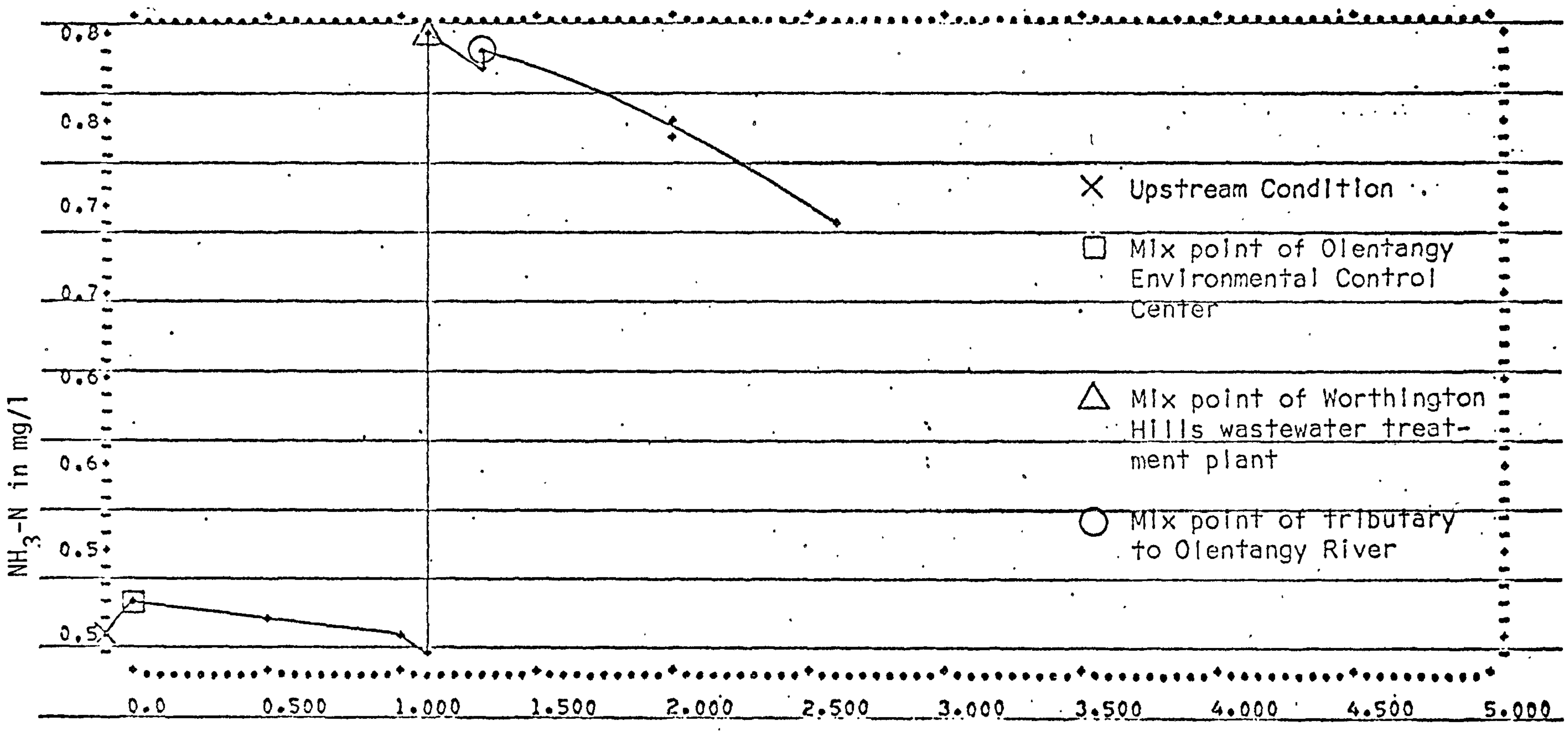


Figure 32. Profile of Projected Ammonia Level as Nitrogen (NH_3-N).

Source: Burgess & Niple, Ltd., 1974

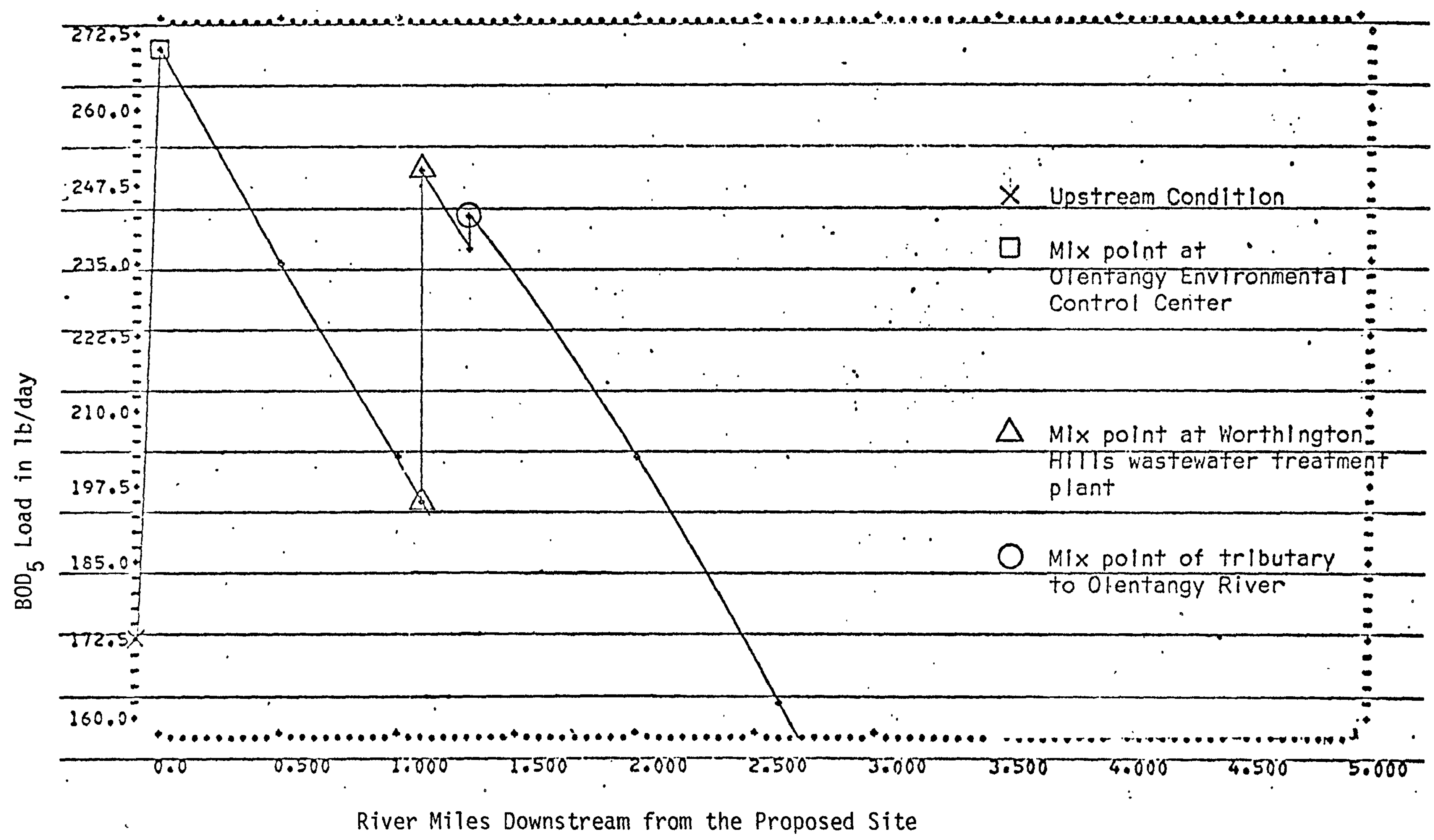


Figure 33. Profile of Projected Flowing Load of 5-day Biological Oxygen Demand (BOD_5)

Source: Burgess & Niple, Ltd., 1974

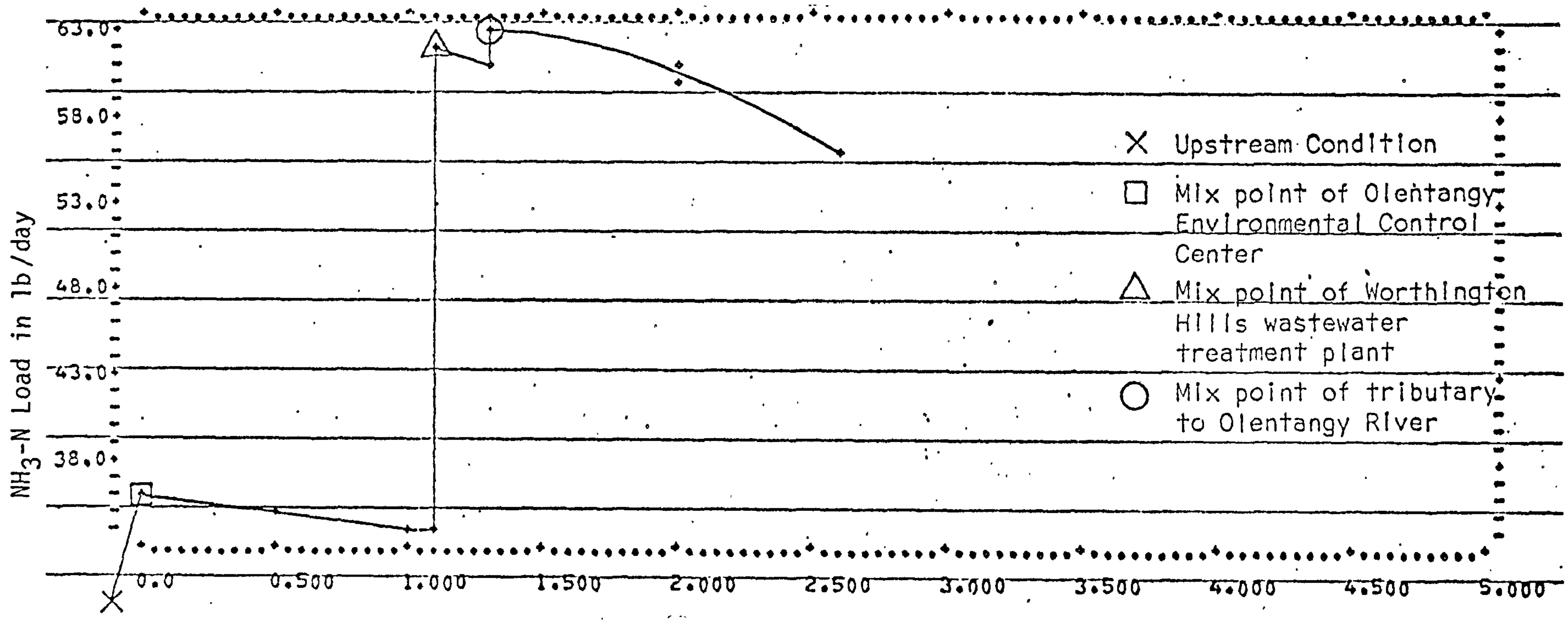


Figure 34. Profile of Projected Flowing Load of Ammonia as Nitrogen (NH_3-N)

Source: Burgess & Niple, Ltd., 1974

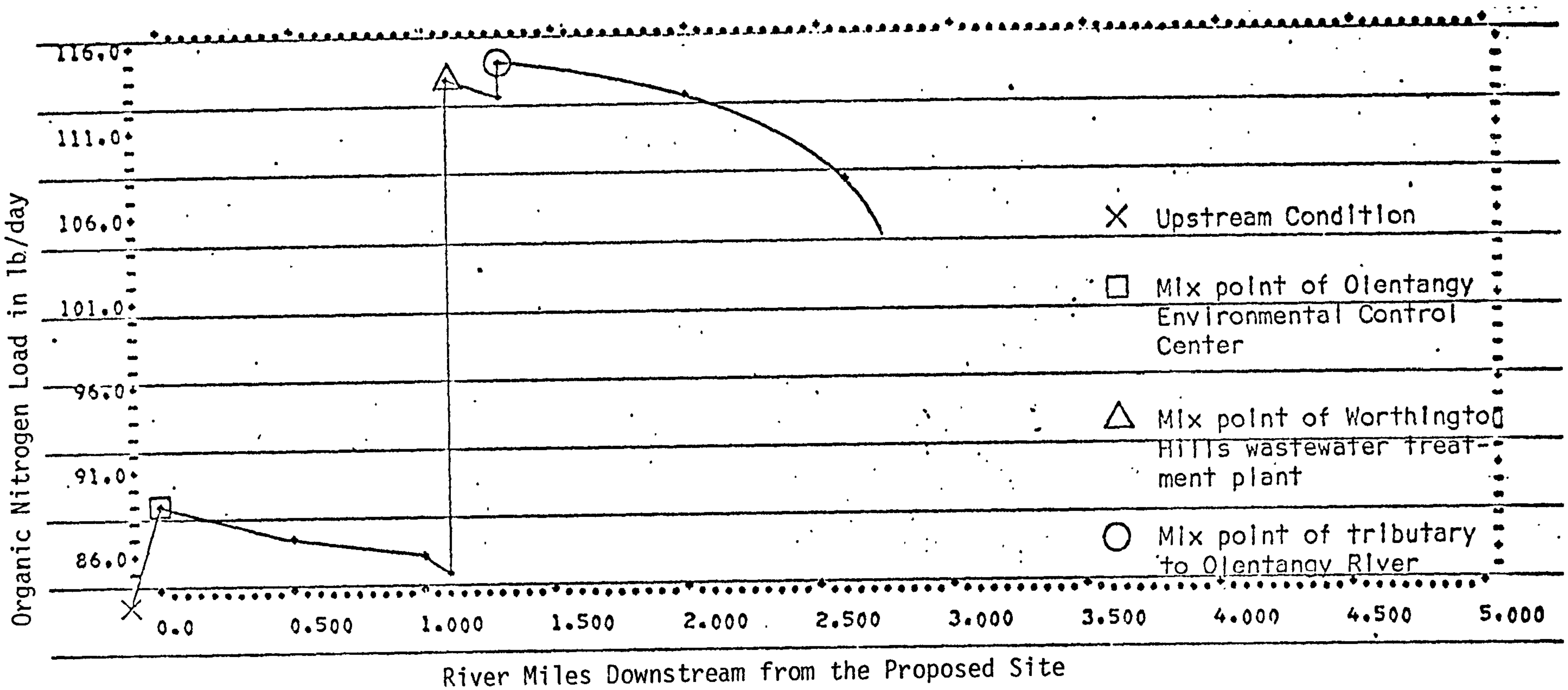


Figure 35. Profile of Projected Flowing Load of Organic Nitrogen.

Source: Burgess & Niple, Ltd., 1974

promulgated ; therefore, the impact resulting from the proposed plant cannot be quantified at the present time.

The aforementioned computer simulation is based on a low flow of 8.6 mgd (13.3 cfs) which is considerably higher than the calculated 7-day 10-year low flow of 29.3 mgd (3.77 cfs). To quantify the effects when the 7-day 10-year low flow does occur, additional computer simulation should be conducted. To derive a qualitative understanding of the effects, a simple extrapolation method is used to predict the effects. The results are presented in Table 44 for various phases of the proposed action. As this table illustrates, no apparent violations of water quality and allowable waste loads would be caused by the proposed action. The implication of the calculated ammonia concentration in terms of biological effects is discussed on pages 232-238.

Field observations of the water quality conducted by various agencies and individuals are summarized in Table 45. In this table, the stream water quality standards are also listed in comparison. The water quality standards for temperature are given separately in Table 46.

4. Impacts

In general, the water temperature, pH value, concentrations of dissolved oxygen, nitrate, total dissolved solids (TDS), chloride, dissolved iron, chromium, zinc and copper are well within the water quality standards. Considering that the effluent from the proposed plant would have at least 6 mg/l of DO, maximum BOD_5 of 8 mg/l,

TABLE 44. The Resulting Effects of the Proposed Action During Various Construction Phases (based on 7-day 10-year low flow of 3.77 cfs)

Variables	Phase 1	Phase 2	Phase 3	Stream Standard or Allowable Load
Design Capacity in mgd	1.5	3	6	---
DO in mg/l	6.53	6.4	6.26	6.0
NH_3 as N in mg/l	0.47	0.475	0.484	1.5
BOD_5 in lb/day	270	368	563	768
NH_3 as N in lb/day	36	42	54	117
Organic N in lb/day	89	95	107	---

Source: Enviro Control, Inc., 1975

TABLE 45. Water Quality of Olentangy River

Data Source	Burgess & Niple, Ltd.	Ohio Wesleyan Study Team	Scioto River Basin: Waste Load Allocation Report	John H. Oliver	Water Quality Standards for The River Segment
River Reaches Measured from the Proposed Site (miles	0-2.5	-22-1.	Delaware Dam to Mouth	6-47	Delaware Dam to Mouth
Conditions	Existing	Before the Expansion of the Delaware STP	Before the Expansion of the Delaware STP	Before the Expansion of the Delaware STP	Existing
No. of Observations	24	N.A.	13	13	---
Dates of Observations	10/31, 11/7, 11/25/74	6/13/72-7/28/72	before 3/1/74	Summer 1967-1969	---
DO in mg/l	7.4-12.4	4.3-6.7*	a. 4.3-7.4** b. 7.4-16	6.9-8.8	5.0
BOD_5 in mg/l	1.3-12.7	---	a. 2.5-13.2 b. 2.3-4.8	---	---
NH_3 as N in mg/l	0.0-1.7	---	a. 0.1-3.75 b. 0.0-0.1	---	1.5
NO_3 as N in mg/l	0.0-0.9	0.4-4.0	a. 2.1-2.8 b. 2.1-2.8	---	8.0
Organic N in mg/l	0.0-3.4	---	a. 0.25-6.1 b. 0.5	---	---
Total P in mg/l	0.11-1.16	---	a. 0.0-0.3 b. 0.0-0.3	0.32-2.13	---
Temp. in °C	4.5-20.0	17.5-28	a. 25.0 b. 19-28	21-24	See Table 46
pH	7.6-8.1	6.8-8.4	a. 7.9-8.7 b. 7.9-8.7	8.3-8.5	6.0-9.0
Total Coliforms in 100 ml	---	$800-2.4x10^4$*	---	---	---
Fecal Coliforms in 100 ml	$66-44x10^5$	5.6-1205*	a. 530-tntc*** b. 530-tntc***	---	200
Fecal Streptococci in 100 ml	$26-6.8x10^4$	---	---	---	---
T.S.S. in mg/l	6-65	---	---	---	---
T.D.S. in mg/l	---	---	a. 274-394 b. 274-394	---	500
C ⁻ in mg/l	40.4-73.2	---	a. 24-50 b. 24-50	32-43	250
e (dissolved) in mg/l	---	---	a. 200-300 b. 200-300	---	1,000
Cd in mg/l	<1	---	---	---	5
Cr in mg/l	<2-31	---	a. 0.0 b. 0.0	---	100
Zn in mg/l	<20-80	---	---	---	1,000
Mg in mg/l	---	---	a. 17 b. 17	56-86	---
Cu in mg/l	<25-58	---	---	---	500
Cyanide in mg/l	<3-8	---	---	---	200
Turbidity in JTU	7-43	---	---	---	---
Turbidity in ppm	---	---	---	29-156	---

*Only one observation per sampling location
**With one low value of 1.4 mg/l of D.O. at Station 5 between the Delaware STP's Sanitary Land Fill and Quarry
***Too numerous to count
a. During low flow periods
b. Other than low flow periods

Source: Enviro Control, 1975

TABLE 46. Maximum Allowable Water Temperature in the Olentangy River

Month	Temperature in °C
January	10
February	10
March	15.6
April	21.1
May	26.7
June	32.2
July	32.2
August	32.2
September	32.2
October	25.6
November	21.1
December	13.0

Source: Ohio EPA, 1974

and allowable waste loads for BOD and Cl, only the total dissolved solids content is likely to cause a problem. Although, the current total dissolved solids concentrations are within the water quality standards, the total dissolved solids load would exceed the allowable load by approximately 48%. This might have some impact on the stream biology and the agricultural uses of instream water.

Ammonia standards are reported to have been violated approximately 10 per cent of the time (Ohio EPA, 1974). Under the assumption that the Waste Load Allocation Program (Ohio EPA, 1974) would be successfully implemented, the instream ammonia concentrations would be so reduced that the ammonia concentration at the mixing point of the proposed plant site would be within the 1.5 mg/l limit at all times.

As the plant grows to its ultimate size, some problems associated with nitrate might occur as a result of conversion of ammonia into nitrate in the proposed treatment processes. Presumably, nitrate impacts would be confined to the agricultural uses of the instream water. The land south of the proposed site is limited in the acreage devoted to agricultural uses. By the time the nitrates reach the mouth of the Olentangy River, the large dilution capacity there would reduce their impact to an insignificant level. The ground water table in the area is generally so high that NO_3 contamination of the ground water system might be insignificant. It is calculated that, in the project area, yields of no more than 5 gallons per minute can be developed by well drillings (Ohio Department of Natural Resources, 1963). These yields are considered poor, indicating that the soils are relatively impermeable and that, therefore, the interaction between ground water and the water in rivers might be slight. It is therefore supposed that the ground water contamination by nitrates is predominantly controlled by molecular diffusion which is rather a slow process. However, lack of data on the fluctuation of ground water level and the characteristics of the soil make the impact quantification difficult.

The fecal coliform concentration of the river water has been reported many times as "too numerous to count" (Ohio EPA, 1974). The same situation has occurred throughout the entire river segment, indicating that it is highly polluted by municipal sewage. Municipal sources are specified because among the total source loads of BOD_5, TSS, phosphorus, NH_3, and TKN, the municipal sources account for more than 95 per cent and their discharges correlate well with the fecal coliform loads. These municipal sources include the Delaware Sewage Treatment Plant and small package treatment plants of various commercial facilities and educational institutions (Ohio EPA, 1974). Septic tank runoff also contributes to increased coliform levels in the Olentangy River. The effluent limitation of fecal coliforms is 200 per 100 ml, thereby assuring that the fecal coliform load from the proposed plant is kept within the allowable load standards of the stream. To achieve this goal, chlorination of the treated sewage after the second stage clarification and prior to rapid sand filtration is proposed in the plant design. There is concern about the possible adverse effects on stream fish by the residual chlorine in the plant's effluent. Although the post-aeration of the effluent before discharging into the Olentangy River could drive out some of the residual chlorine from the effluent, the residual chlorine concentration would still be high. The effluent concentration of total residual chlorines is estimated to be 0.5 mg/l without dechlorination of effluent. The impact of the residual chlorine on river flora and fauna is discussed on pages 226-232.

No effluent quality standards have been established for other constituents such as iron, cadmium, chromium, zinc, and copper so that the effects of discharging effluent containing these constituents cannot be determined. It is assumed that any industrial wastewaters which contain high concentrations of these constituents would be adequately pre-treated before discharge into the sewage collection system.

The construction of the plant is proposed to take place in three phases. The design capacities of each phase are 1.5 mgd, 3 mgd, and 6 mgd in the year zero, year 10, and year 20, after the plant becomes operational. The phasing scheme of the interceptor sewer network is shown in Figure 9.

Some impacts on water quality can result from the project construction. Erosion and siltation problems associated with sewer construction; dissolved oxygen depletion, BOD_5, and turbidity associated with the dredging activities for sewer river crossings and outfall work are the major concerns.

Erosion due to plant construction could have some effects on water quality such as increase of turbidity, total suspended solids, and total settleable solids. Upon discharging these materials into the river, siltation might result in the downstream segment where flow velocity decreases below that required to maintain the load in suspension. Siltation is a major factor in the modification of floodways and should this siltation be extensive, such modification might contribute to an increase in flood hazards and potential flood damages.

Dredging activities required by the construction of sewer river crossings and effluent outfall structures could cause some water quality problems. Dissolved oxygen depression would be a consequence of the high chemical oxygen demand by the re-entrainment of river bed sediments. It has been reported (Jeane & Pine, 1975) that near a harbor dredging site, the dissolved oxygen often dropped below 4.0 mg/l, which is the water quality criteria recommended by the Department of Ecology, State of Wahsington, and sometimes even down to the lethal range (Servizi et al., 1969). Levels of total sulfides, usually considered toxic substances, and chemical compounds of high oxygen demand would increase near a dredging site (Jeane & Pine, 1975). Although the river bed of the Olentangy River is essentially of calcareous nature, the low stream velocity at low flow cannot preclude the existence of some organic sediments. The dissolved oxygen depletion may occur during dredging periods, but will not be so significant as reported elsewhere (Jeane & Pine, 1975), because of lower organic content of the bottom sediments of the Olentangy River. The degree of depletion of dissolved oxygen due to river dredging cannot be quantified without knowing the oxygen demand of the river sediment.

Dredging can cause an increase of turbidity and total settleable solids. The amount of increase depends upon the characteristics of the river bed sediments, and cannot be quantified at the present time. Dredging of fine-grained silt and clay can increase river turbidity considerably and the resultant high turbidity may persist downstream along a long reach of river from the dredging site. However, in the dredging of gravels and coarse sands, the rate of sedimentation is generally much greater and the suspended sediment load does not tend to persist over such great distances. Increase of turbidity caused by construction might have some temporary impacts on the Olentangy scenic river segment in terms of visual aesthetics, and some damaging impact on sight-feeding fish species and benthic fauna.

The major impacts are summarized into two categories, reversible impacts and irreversible and irretrievable impacts. The impacts which fall into the category of reversible impacts are:

- Surface water contamination by the effluent total dissolved solids
- Surface water contamination by nitrate content of the effluent
- Surface water contamination by the possible high ammonia content of the effluent
- Surface water contamination by the residual chlorine in the effluent
- Turbidity increase of the surface water due to construction of river crossings, the outfall, and the plant
- Possible dissolved oxygen depletion due to dredging of river bed for construction of river crossings and the outfall

The impacts which fall into the category of irreversible and irretrievable impacts are erosion and siltation problems associated with project construction. These impacts include destruction of aquatic life, some of which would be unlikely to recover.

5. Interceptor Phasing

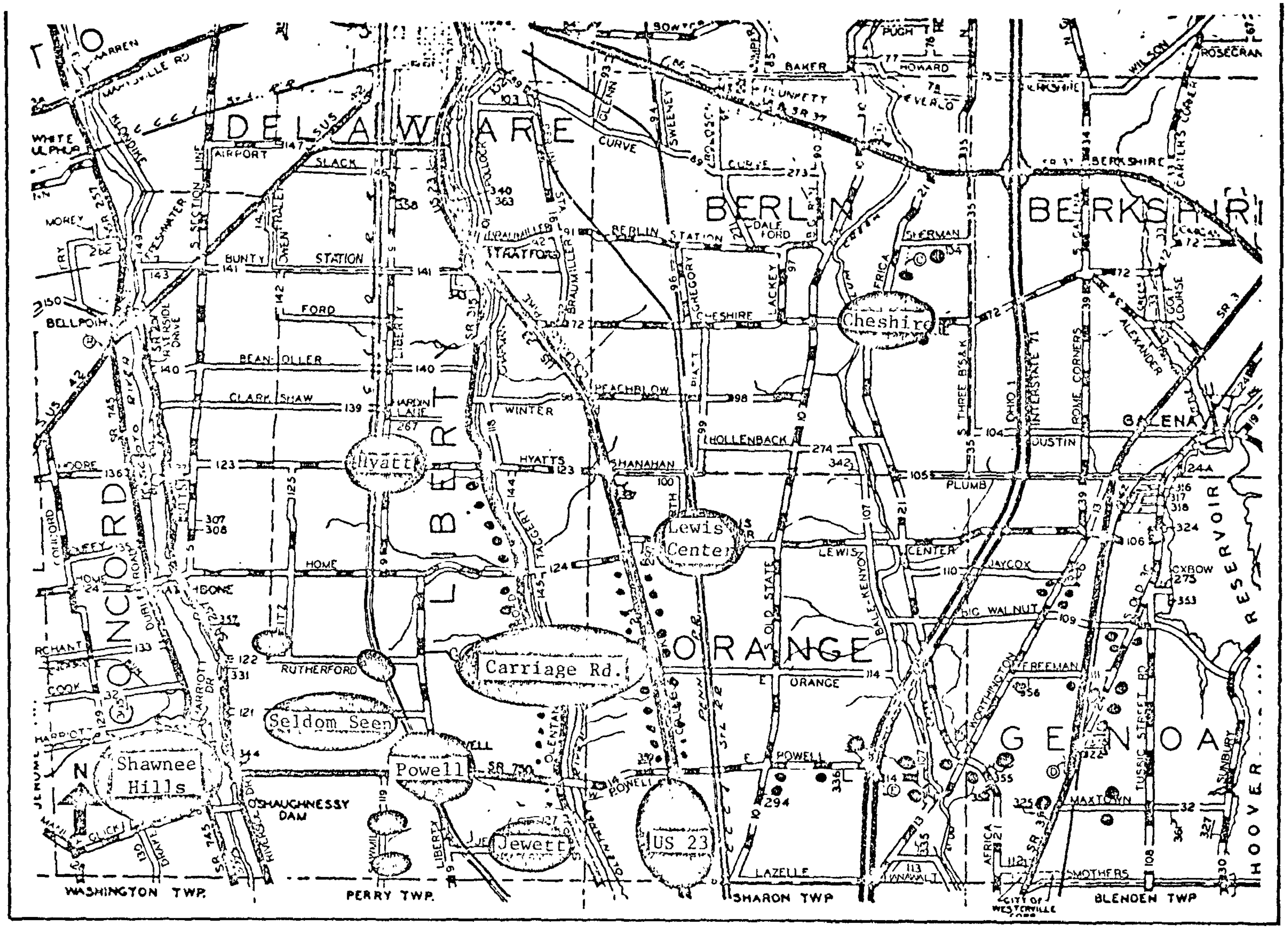
In the design of a new sewage system, it is important to schedule the completion of the various interceptor lines in response to current and anticipated needs. This phasing would be consistent with population densities, water quality problems and projected growth. Concern has been expressed, in Delaware County, that the proposed system does not adequately meet the needs of present residents, but rather is designed for a planned influx of population. The validity of this concern is assessed here and suggestions for improvements and modifications of the current phasing plan are made. The impact of alternative plant sites on phasing is evaluated as well.

The proposed interceptor lines are shown in Figure 9. Planning phases are expressed in terms of 10-year intervals, using 1975 as a baseline for Phase I, though, due to delays in the permit and impact statement processes, 1977 is a more accurate baseline date. The first phase consists of a short line along the Olentangy River to one proposed residential development and a major system in the Alum Creek Basin which would serve outlying areas north of Westerville in the vicinity of Westerville Reservoir, and the area around Alum Creek Lake. Service to the lake area would accommodate an expected increase in recreational activity, which is of concern to the Corps of Engineers.

During Phase II, it is proposed to construct extentions along the Olentangy River to include the village of Powell and more northerly areas, an expansion of the Alum Creek network, and the completion of a force main to the lower Scioto Basin, including Shawnee Hills. During Phase III, it is proposed to construct an extension of the sewer system northward in all basins and to install minor lines (Burgess and Niple, Ltd.,1974).

A map supplied by the Delaware County Health Commissioner (May, 1975) shows that significant problem areas exist in Shawnee Hills, Powell, Seldom Seen Road, Carriage Drive, Hyatts, Lewis Center, Cheshire, and the southern end of U. S. 23 (see Figure 36). Smaller problem areas occur in various limited areas in Liberty, Orange, Genoa, and Berlin Townships. These water quality problems result from untreated or poorly treated runoff from cesspools, septic tanks, and package plants and are caused by both the unsuitability of soils in the area for use as septic tank fields and the problems of sewage treatment.

The Delaware County Sanitary Engineer's Office has estimated that 1,575 people will be served by the initial phase of the project, mostly in the Alum Creek area. This figure is based on a house count within 1,000 feet of the planned interceptors, an assumed average of 3.22 persons per house, and a non-occupancy rate of 7 percent. This phase would service approximately 13.4 percent of the 1970 population in the total service area as estimated by Burgess and Niple (1974), or, by interpolation, 10.6 percent of the estimated present population. Phase II adds to this number significantly by including Shawnee Hills and Powell. It is not until Phase III that over half of the present or projected population would be served.



Legend

● Large water quality problem areas

• Smaller problem areas

Scale in Miles

0 1 2

Figure 36. Existing Water Quality Problem Areas in Southern Delaware County

Source: May, 1975

Development of sewerage to residents of the afflicted areas should be integrated with a comprehensive long-range plan. Failure to serve the existing population effectively would result in continuation of local water quality problems and probable low flow septic problems in the interceptors. These problems could be avoided or minimized by first serving the areas which have large population densities.

The root of the problem with the present system is that it is primarily designed to accommodate wastewater from the Alum Creek Lake recreation areas. A lesser problem is the exclusion of the village of Powell from the first phase in favor of a planned development area north of Powell Road. Both of these plans avoid high density problem areas in favor of lower density areas in Phase I. Solving these two problems and adding the town of Shawnee Hills on the lower Scioto Basin to Phase I would serve a much larger number of present residents. The plan does, however, serve well the densely populated southern Genoa Township area in Phase I.

The U. S. Army Corps of Engineers has proposed to construct package treatment plants for the wastes from the Alum Creek Lake recreational facilities. These wastes would fluctuate seasonally and would be expected to grow substantially due to increasing population influx into nearby areas. The Corps, in its Environmental Impact Statement, has postulated 911,000 visitor days per year in 1980. Assuming usage by each visitor for only a portion of the day and lack of showers or other larger water uses, an average daily sewage output of 0.04 mgd can be expected. The actual output would be much higher in the summer and smaller during winter months. On an average basis, this is comparable to use by 300-400 residents, or about 20 percent of the population served by Phase I. The lines for this area of the plan, however, comprise more than 25 percent of the total length of line proposed for Phase I and include one force main and one large reservoir crossing. If a line were to be laid to the lower Scioto Basin before the extension to the Alum Creek area to the north, it would require slightly less line mileage and would serve over 310 houses in the Shawnee area and 72 houses along the route. This is the equivalent of about 1,175 residents or 74 percent more than presently planned to be served by Phase I.

Because it is assumed that only a limited length of interceptor lines could be laid in a given time period and because laying of the force main and interceptors to the Scioto River would entail delay of the northern Alum Creek lines, some provision would have to be made for the Alum Creek sewage in the interim period. A lagoon or irrigation disposal method, as was discussed in October, 1973 by soil conservationists and consulting engineers, are possible interim provisions. The reports (cited in Burgess and Niple, Ltd., 1974) indicate no particular problems with the use of some land for this purpose.

Another alternative discussed was to pump the Alum Creek sewage through Westerville to Columbus, but this would still entail the the laying of a long pipe. Perhaps this could be done if some other entity, such as the Corps, agreed to pay for and construct the line to Westerville, which is on the Columbus sewage system, so as not to interfere with the Delaware County schedule. Then in Phase II, the line could be easily switched to the Delaware system. The Corps has already earmarked $600,000 for package plants on Alum Creek Lake. They have considered paying this money to Delaware County in return for sewerage service. Permission for this would almost certainly be given by Delaware County, since it would be extremely advantageous to them. It would speed their laying of lines but delay any additional expense at least until the line could be connected with the Delaware system in Phase II.

The village of Powell is presently not scheduled to be served until Phase II. A house count of Powell from the 1973 U.S.G.S. Powell Quandragle map shows 126 residences or approximately 380 residents. This represents 24 percent of the current planned Phase I service. The extension of a line from Powell from the presently planned treatment plant site would require little additional pipe and would actually result in a savings of pipe if the Phase I line to a proposed development north of Powell were delayed. This would not cause major problems because the development might otherwise be delayed in response to present economic conditions. Inclusion of Powell is also advantageous from a financial standpoint because existing houses are more certain to yield revenue than planned ones.

Thus, the main recommended modifications involved in the present or nearby plant sites are to include the Powell and Shawnee Hills areas in the first construction phase and either delay or use alternative plans in the northern recreational areas on Alum

Creek Lake. Construction phasing modifications arising from alternate plant locations are discussed below.

Both the Franklin County I-270 site and the highground site south of Powell would only require 2 to 3 additional miles of interceptor line. Both a lift station and a force main would also be required because these sites are significantly above river level. It is not expected that addition of a lift station or a short amount of line should significantly delay completion of other portions. The phasing priorities for these two locations would then remain as outlined on pages 219-221.

If site OR7, north on the Olentangy, was to be selected, approximately 6 or 7 miles of force main would be required to pump the Olentangy Valley wastes northward to the plant. The interceptors from the other two basins could cross the divides either at the south end of the county as is presently proposed, or at the latitude of site OR7. This latter plan, however, would entail pumping by force main up all three basins and would seriously delay the interceptor construction as well as adding a large expense in force main construction. Even crossing at the southern end of the county might delay completion of Phase I interceptor lines somewhat, due to the cost and effort of laying an extra force main.

The selection of the Alum Creek site would cause the most significant differences in system design. While the same line routes would be followed, a much larger pumping station and force main would be required in the Olentangy Basin near Powell Road to pump sewage from the Olentangy and Scioto Basins over the draining divide to Alum Creek. Difficulties and expenses involved in this double pumping might make it more cost-effective to concentrate on serving the nearby Alum Creek Basin more extensively in Phase I and postponing connection with the Scioto Basin until Phase II. Logical extensions in the Alum Creek Basin, based on population densities and water quality problems, should concentrate in the north and northeastern directions toward Cheshire and Berkshire Townships.

While the above discussion indicates the major considerations affecting the interceptor system, optimum arrangement of interceptor lines should be based on a study independent of the original concept, rather than changes in the concept. This should be developed only for sites for which a study of facilities plan depth is performed. These recommendations are applicable to site OR3 because a facilities plan has been prepared for it. (Burgess and Niple, 1974). Our recommendation of site OR3 as the optimum site on the Olentangy River includes the implementation of this phasing plan.

Private Communications

Beemer, Harold W.; Chief, Engineering Division, Huntington District, U.S. Army Corps of Engineers, 11 August 1975.

Gilbert, Gary, Delaware County Sanitary Engineer, August 1975.

May, Lloyd, Delaware County Health Commissioner, Delaware County Health Department, July 1975.

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B. BIOLOGY

Adverse impacts of the proposed facilities on aquatic biota are associated primarily with chlorine and ammonia discharges from the treatment plant. This section describes the aquatic biota in the Olentangy River and the rare and endangered naiade and fish species in the affected river segment. It discusses the effects of the increasing concentrations of chlorine and ammonia upon the fish of the river, and the expected impacts upon terrestrial biota both at the plant site and along the interceptor lines.

1. Aquatic Biota

The benthic assemblage in the Olentangy River downstream from the City of Delaware is not nearly as abundant and diverse as the number and grouping of clean water indicator species found at Powell Road (Olive, 1975). The numbers of mayflies, stoneflies, and caddisflies in this stretch of the river significantly increase upon reaching the Powell Road area of the river and further downstream, thus indicating the influence that the Delaware sewage treatment plant has upon the benthic macroinvertebrates of the river. It is apparent that the increase of the clean-water indicators, the mayflies, stoneflies, and caddisflies, which are also excellent fish food sources, in the area of Powell Road marks the area of the river where it significantly recovers from the effects of sewage effluent from Delaware City.

The fish populations in the stretch of the river between Powell Road and the river crossing of Route 23 are similar to those found in the Powell Road area (Griswold, 1975). This abundant and diverse benthic population extends downstream past the proposed plant site to the foot of the artificial riffle-pool area at I-270.

The largest populations of desirable fish species, such as the sunfish, smallmouth bass, rock bass, catfish, and bullheads, are found at the artificial riffle-pool structures about 2 miles downstream from the plant site. These structures, built to supply the fish with habitats, are effective as indicated by the increased numbers of fish being caught by fishermen and by electroshocking data for this area. These stream modification structures might also be responsible for the greatly decreased number of naiades found in this area. No specific data on this artificial fish habitat area have been collected, but the benthic community in this stretch of the river is even more abundant than that found and described at Powell Road by Olive (1975). Presumably, such bottom-dwelling animals as the larvae of mayflies, stoneflies and caddisflies must be present here in large numbers because they are essential as a food source for the fish reported to be here. Possible impacts to this large game fish population from the plant's discharges of chlorine and ammonia are discussed below.

2. Impacts from Chlorine Discharges

The calculated 7-day 10-year low flow at the proposed site (4.54 cfs) was used for the calculations in determining the chlorine and ammonia concentrations in the river at the point of plant discharge (pages 195-200). Because future drought conditions are possible in the area, the use of the worst river conditions is necessary for an accurate assessment of the possible adverse impacts to the aquatic biota of the river from this plant.

The concentration of chlorine in the effluent of the proposed plant is expected to be 0.5 ppm. At 1.5 mgd the concentration of residual chlorine during a low flow period in the immediate area downstream from the outfall would be approximately 0.17 ppm. When the 1.5 mgd plant is expanded to 3 mgd at a future date, the chlorine residual concentration in the immediate area downstream from the outfall during low flow period would be approximately 0.254 ppm. This is slightly above the concentration that causes the fish species diversity to go to zero (Tsai, 1971). Upon expansion of the plant to 6 mgd, the chlorine residual concentration in the immediate area downstream from the discharge point during a low flow period rises to 0.337 ppm. This concentration is very close to the level (0.37 ppm) at which all fish were found to be absent from the receiving waters (Tsai, 1971).

Combinations of chlorine with ammonia and organic matter may occur to the detriment of aquatic life. Thus, toxicity to aquatic life does not solely depend upon the amount of chlorine added, but also upon the concentration of residual chlorine remaining and on the relative amounts of free chlorine and chloramines present. Chloramines are formed whenever water containing ammonia, ammonium hydroxide, or ammonium ions is chlorinated. Chlorine and chloramines are further discussed on pages 286-294.

The Fish and Wildlife Service has recommended against the plant's discharges in a letter to Mr. Ned Williams, Director of the Ohio EPA (Faulkner, 1975). This letter refers to the recommendation by U.S. EPA that the concentration of residual chlorine in the receiving waters should not exceed 0.003 ppm in order to protect aquatic life. Brungs (1975), who made the 0.003 ppm of chlorine recommendation in 1973, more recently recommended to us, in 1975, a 0.01 ppm level to protect warm water fish.

Research by the U. S. EPA is presently underway at a sewage treatment plant in Grandville, Michigan. The Grandville treatment plant treats only domestic sewage and contains no industrial inputs. Most of the species of fish used for the experiments are the same species present in the Olentangy River; thus, comparisons can be drawn with the results of the experiments concerning the effects of the proposed plant's discharges. Table 46 presents the information obtained from the research group at the treatment plant in Michigan. This table shows that the species most sensitive to chlorine are such forage fish as the shiners and minnows. These fish are large portions of the diet of the larger and more desirable game fish, such as the bass and sunfish. Additional information on chlorine effects is supplied by Table 47.

Tsai (1971) studied the diversity of fish, in three states, in streams which maintained a residual chlorine concentration of 0.5 to 2.0 ppm below sewage outfalls. He typically found a clean bottom without living organisms in the immediate area below these discharge locations. He found that the stream bottoms near unchlorinated outfalls were usually covered by large growths of

TABLE 46. Acute 96-Hour TL-50* of Various Fish Species

Species		Chlorine Concentration in ppm
Golden Shiner		0.040
Pugnose Shiner		0.045
Northern Common Shiner		0.051
Fathead Minnows	test 1)	0.095
	test 2)	0.082
Crappie		0.127
Bluegills	test 1)	0.278
	test 2)	0.195
Largemouth Bass		0.241

* Median tolerance level (50 percent survival)

Source: DeGrave, 1975

TABLE 47. Toxic Effects of Residual Chlorine on Aquatic Life

Species	Effect Endpoint	Chlorine Concentration in ppm	Reference
Fathead Minnow	Safe concentration	0.0165	Arthur & Eaton, 1971
	Total kill - 96 hr.	0.16-0.21	Zillich, 1972
	Partial kill - 96 hr.	0.07-0.19	
	Sublethal stress	0.04-0.09	
	Threshold concen.	0.04-0.05	
	96-hour TL-50*	0.05-0.16	Zillich, 1969
	7-day TL-50	0.082-0.115	Arthur, 1971
	All killed in 3 days	0.154	Arthur & Eaton, 1971
Black Bullhead	96-hour TL-50	0.099	Arthur, 1971
Yellow Bullhead	96-hour TL-50	0.099	Arthur, 1971-72
Smallmouth Bass	Absent in streams	0.1	Tsai, 1971
White Sucker	7-day TL-50	0.132	Arthur, 1971-72
White Sucker	7-day TL-50	0.132	Arthur, 1971
Walleye	7-day TL-50	0.15	Arthur, 1971
Largemouth Bass	7-day TL-50	0.261	Arthur, 1971
Phytoplankton	50% reduction in photosynthesis and respiration	0.32	Brook & Baker, 1972
Largemouth Bass	12-hour TL-50	0.365	Arthur, 1971-72

* Median tolerance level (50 percent survival)

Source: Becker and Thatcher, 1973; Brungs, 1973 wastewater fungi. The fish species diversity showed a 50 percent reduction when the chlorine concentration increased to 0.1 ppm. The diversity then fell to zero at a concentration of 0.25 ppm, and no fish at all were found in the water when the concentration was 0.37 ppm. Tsai (1970) concluded that those species which are sensitive to low dissolved oxygen levels and organic enrichment decreased or disappeared in the area. They were then replaced by other species which were tolerant to the low dissolved oxygen levels and organic enrichment and are able to increase their abundance. Species found to be adversely affected included the important game fish, the smallmouth bass, largemouth bass, and black crappie.

Arthur (1971-72, as cited in Brungs, 1973) studied the effects of chlorinated secondary wastewater treatment plant effluent containing only domestic wastes on the amphipod, Gammarus pseudolimnaeus, and the water flea, Daphnia magna. He concluded that Daphnia magna is one of the more sensitive invertebrate species because it died when the residual chlorine concentration reached only 0.014 ppm. It did have acceptable reproduction at 0.003 ppm and below. The amphipod, Gammarus pseudolimnaeus, had its reproduction reduced by residual chlorine concentrations above .012 ppm. There were no toxic effects observed when the same wastewater was dechlorinated with sulfur dioxide.

Although there have not been any studies done on the zooplankton assemblages in the Olentangy River, the common species of the water flea, Daphnia, probably exist in the river system. It is a very important food source for both young and mature fish (Pennak, 1953). The amphipod, Gammarus, is also a very common fish food and presumably is present in the Olentangy River system (Faulkner, 1975). Olive (1971) reported the amphipod, Hyallella, to be present in the river near Powell Road.

Arthur (1971-72, as cited by Brungs, 1973), using a calculated chlorine concentration of 0.03 ppm, based on dilution of a measured concentration of 2.0 ppm, found that phytoplankton photosynthesis was reduced by more than 20 percent of the value obtained with a similar experiment using effluent having no residual chlorine. This effluent was dechlorinated by sulfur dioxide.

The Wyoming Bioassay Laboratory in Grandville, Michigan (DeGrave, 1975) has conducted experiments on the effects of 100 percent dechlorinated effluent upon the following fish species: fathead minnow, bluegill, largemouth bass, pugnose shiner, pugnose minnow, common shiner, and golden shiner. The effluent had been dechlorinated by sulfur dioxide. Except for the pugnose shiner, no mortality was found to occur when the fish were subjected to a 100 percent effluent solution that was 100 percent dechlorinated. The pugnose shiner experienced a 25 percent mortality under these conditions. Reasons for this mortality are not known, but the information obtained by these experiments shows that the forage species and the largemouth bass and bluegill, could swim through 100 percent dechlorinated effluent and survive.

Thus, in order to protect the benthic organisms and the abundant sport fish in the area of the plant site and downstream from the plant near I-270, it is recommended that dechlorination be used at this plant. Detailed discussion on dechlorination techniques is presented on pages 286-294, and a discussion on the best location of the outfall to protect the aquatic biota of the river is discussed on pages 278-280.

3. Impacts from Ammonia Discharges

In surface and ground waters, ammonia is usually formed by the decay of nitrogenous organic matter. Unpolluted rivers generally contain low ammonia concentrations, usually less than 0.2 ppm as nitrogen. Ammonia is soluble in water and reacts with it to form ammonium hydroxide, which readily dissociates into ammonium and hydroxyl ions. This tends to increase the pH level. At higher pH levels, the ammonium ion readily changes to NH_3 which is harmful to fish. All of the various ammonium salts are soluble in water and yield NH_4^+ and an anion (Becker and Thatcher, 1973).

The toxicity of ammonium salts and ammonia to aquatic life is related to the amount of ammonia which is a function of the pH of the water. A relatively high concentration of ammonia in water at a low pH may not have toxic effects on fish life, but the toxicity of the ammonia would increase as the pH is increased. The toxicity of ammonia to fish life is increased significantly with a decrease in dissolved oxygen levels.

The proposed sewage treatment plant would discharge 1.5 ppm of ammonia when it first goes into operation at 1.5 mgd. At this initial stage the concentration of total ammonia upon dilution with the river during a low flow period would be 0.51 ppm. Then, when the plant is expanded to 6 mgd at some future date, the concentration of total ammonia when diluted with the river during a low flow period would be 1.01 ppm. These discharges would experience pH increases upon mixing with the river water when moving downstream.

Cell membranes are relatively impermeable to the ionized form of ammonia (NH_4^+), but undissociated species (NH_3) can readily cross cellular barriers (Milne et al., 1958; Warren, 1962 as cited in Thurston et al., 1974). Tabata (1962 as cited in Thurston et al., 1974) attributes some degree of toxicity to invertebrates and fishes to the NH_4^+ species.

Flis (1968 as cited by Ohio Fish and Wildlife Service, Faulkner, 1975) has found that exposing carp to sublethal concentrations of undissociated ammonia in the ranges of 0.11 and 0.34 ppm caused rather extensive decay and tissue disintegration in various organs. Robinette (1974 as cited by McKim et al., 1975) conducted laboratory experiments with channel catfish fingerlings to evaluate the effects of sublethal concentrations of ammonia. He found that there was a significant growth reduction at 0.12 and 0.13 ppm of ammonia. Further studies indicated that there was no significant difference in the oxygen uptake between the control and experimental fish. Microscopic evaluation of the gills of the fish revealed that all fish exhibited hyperplasia (an abnormal increase in the number of cells of a tissue or organ). The fish that were exposed to the highest concentrations of sublethal un-ionized ammonia-nitrogen displayed the greatest degree of hyperplasia.

Table 48 presents the percentage of undissociated aqueous ammonia that could be present in the plant's discharge at the various pH ranges possible for the effluent. These percentages are based on the equilibrium constants for dissolved undissociated ammonia and the ammonium ion, NH_4^+. The relative percentage of these species is also governed by the water's temperature.

TABLE 48. The Percent Distribution of Aqueous Ammonia Species at Various pH Values and Temperatures

Species	pH value				Temperature in °C
	7	7.5	7.7	8	
$NH_3 \circ n\ H_2O$ aqueous	0.566	1.77	2.77	5.38	25
NH_4^+	99.434	98.23	97.23	94.62	25
$NH_3 \circ n\ H_2O$ aqueous	0.273	0.859	1.35	2.67	15
NH_4^+	99.727	99.141	98.65	97.33	15

Source: Thurston *et al.*, 1974

The pH value recorded by Olive (1971) for the Olentangy River near Powell Road was 8.5. The effluent's pH values from the plant, according to its permit, can range from 6 to 9. The pH value of the effluent will, of course, vary, but it will usually be near a pH of 7 or slightly higher.

At the initial 1.5 mgd capacity, the plant's effluent would contribute 33 percent of the flow in the river during a low flow period. The effluent plume, then, would experience a pH increase from 7 to 8 upon mixing with the river water. As shown in Table 49, the percentage of aqueous undissociated ammonia will increase almost by a factor of 10 when the pH value is raised from 7 to 8 at both the 15 °C and 25 °C temperatures. These two temperatures are within the range commonly experienced by the river. The increase of the aqueous undissociated ammonia, the toxic form of NH_3, by a factor of 10 when the pH changes from 7 to 8 does not necessarily mean that the plume's toxicity to the fish will be increased 10 times. This relationship is not definitely known, but this increase indicates that the fish within the mixing zone of the effluent plume would be more likely to be harmed than would fish outside the mixing zone.

When the plant's capacity is expanded to 3 mgd, the plant's effluent would contribute 51 percent of the river's flow during a low flow condition. The plant's effluent plume would undergo a pH increase from 7 to 7.74 when mixing with river water at a pH of 8.5. As shown in Table 48 this would increase the percentage of aqueous undissociated ammonia by a factor of 5 at both the 15 °C and 25 °C temperatures. Upon final expansion of the plant to 6 mgd the plant's effluent would comprise 67 percent of the river's flow during a low flow period. The effluent plume, when mixing with the river water, would increase in pH from 7 to 7.5. This increase, according to Table 48, would increase the aqueous undissociated ammonia level by almost a factor of 3.

The zone of the river downstream in which complete effluent plume and river water mixing has occurred would have the undissociated ammonia species present at the increased pH levels described above. This portion of the river would have complete cross channel mixing of the effluent and therefore the fish in the downstream stretch of the river would be exposed to increased concentrations of the toxic form of ammonia, the undissociated ammonia species. Because at the initial level of capacity of the plant, 1.5 mgd, this harmful species of ammonia would increase by a factor of 10 from the point of discharge, the potential for damage to the fish of the river would be significant. The most abundant and desirable fish population would be exposed to potentially damaging levels of ammonia within this zone of completely mixed effluent and water. This would occur in the river at the Interstate 270 intersection.

Because of the toxicity of ammonia to fish, the European Inland Fisheries Advisory Commission (EIFAC) (1970 and 1973 as cited by Thurston _et al._, 1974) has recommended a water quality standard of not greater than 0.025 ppm of undissociated ammonia. At a temperature of 25 °C and a pH of 8, the total ammonia concentration necessary for a level of 0.025 ppm of undissociated ammonia is 0.164 ppm. As indicated above, at the initial 1.5 mgd stage, the treatment plant would discharge, upon effluent plume dilution, 0.51 ppm of total ammonia. If this concentration of undissociated ammonia approximates a correct safety level, then during a low flow river period and under these temperature and pH conditions, the fish in the river could suffer adverse impacts from the effluent's ammonia concentrations and the plume's complete mixing farther downstream. Upon final expansion of the plant to the 6 mgd capacity, though the plant's effluent upon mixing would only experience a pH increase from 7 to 7.5, a possibility for damage to the fish of the river from undissociated ammonia would persist. The Olentangy River can experience a temperature increase of up to 30 °C (Faulkner, 1975). At this temperature and with the plume's pH at 7.5, a total ammonia concentration of 1.01 ppm would contain the 0.025 ppm of the undissociated ammonia which EIFAC identified as critical to fish. The 1.01 ppm of total ammonia is the exact concentration that the plant would discharge when it is expanded to 6 mgd.

The U. S. Fish and Wildlife Service (Faulkner, 1975) follows the concentration recommended by U.S. EPA of 0.02 ppm of undissociated ammonia to protect fish and other aquatic life. This concentration is even lower than that recommended by EIFAC, and indicates that the plant's discharges of total ammonia would have to be even lower than those previously discussed. In considering this recommended standard and the worst river conditions of 30 °C during river low flow, and a effluent plume pH increase up to 8.0 for the 1.5 mgd capacity, the plant could only discharge 0.79 ppm of total ammonia to achieve a 0.27 ppm concentration and, upon dilution, maintain a level of concentration of undissociated ammonia at or below 0.02 ppm. Under these same conditions and with a capacity of 6 mgd, the plant could only discharge 0.4 ppm of total ammonia to produce a concentration of 0.27 ppm total ammonia which, upon dilution, would achieve the 0.02 ppm recommended concentration of undissociated ammonia.

Further research upon the effects of ammonia on fish is needed. Thurston (1975) reports that the amount of data on the effects of ammonia upon both cold and warm-water fish species is so limited that an accurate assessment of the impacts from this proposed project cannot now be made. From the available information there is a significant possibility that the fish population of the river would be damaged by the proposed ammonia discharges of this treatment plant.

4. Terrestrial Biota

The proposed site is presently a cultivated field. The only trees on the site are those along the river bank on the east side of the site. These trees are the typical riverbottom species that are commonly found throughout the country. They include such species as the cottonwood, sycamore, boxelder, maples, and oaks. These trees would not be affected at all by this project and could serve as a portion of the buffer between the plant and the park across the river. The plans for the treatment plant include the planting of various evergreen and deciduous trees around the site to provide a scenic and aesthetic buffer. The planting of these trees is desirable because they would provide food and cover habitats for the various birds in the area. The wildlife that might live along or near the river banks adjacent to this site should not be affected by the operation of this plant.

The woodland vegetation to be crossed by the interceptor lines for this project include such upland associations as oak-hickory and beech-maple. There are riverbottom areas which contain sycamore, cottonwood and boxelder trees (Decker, 1975). The oak-hickory association is found on many sections of the hilltops where the soil is low in lime content, well-drained, and in most instances sandy. These trees grow in soils which have a fairly low pH; thickets of laurel, blueberries, and huckleberries are prominent as their understory. The more prevalent upland wildlife in these areas includes quail, rabbit, squirrel, larger mammals such as deer, smaller mammals such as mice, moles, and shrews, and a variety of passerine birds. In addition, some higher food chain species such as hawks, owls, foxes, and skunks presumably inhabit these areas and have stable populations.

The beech-maple association and the typical riverbottom sycamore-cottonwood-boxelder association are common along the streams and river areas in the county. These tree types are characteristically found in the lower elevations, along watercourses, that have moist soil conditions. Wildlife species common in the upland forest are also usually found in these lower areas in fairly abundant numbers. Such wildlife as the muskrat, mink, river otter, raccoon, opossum, and amphibians are presumably also abundant in these areas.

The use of various highway rights-of-way to install the interceptor lines would greatly reduce the amounts of vegetation to be removed in construction. This is especially true of Powell Road because the pipeline would follow it to reach both Powell and Alum Creek Reservoir. This alignment would eliminate the necessity of displacing and disrupting the wildlife and large-sized trees in hilltop and upland areas. The use of highway rights-of-way has been found to be ecologically the most acceptable method for emplacement of pipelines, because this location causes much less disruption to the environment than crossing tracts of forest areas. The wildlife in the areas that must be crossed by open trenches would be temporarily displaced to similar habitat areas nearby. Because such a small area of their habitat would be used for the pipeline, no significant crowding or lack of available food sources should occur. Construction of the interceptors should not take place during the spring but during the summer and fall so as not to cause unnecessary destruction of nesting areas and disruption of breeding and rearing habits.

5. Rare and Endangered Species

This subsection is a discussion of the rare and endangered species in the area of the proposed project. Stein (1975) found shells of two species of naiade mollusks (Quadrula cylindrica and Epioblasma torulosa rangiana) that have been declared by the State of Ohio to be rare and endangered. No living specimens of Quadrula cylindrica, the Cob shell, are known to have been found in the river system since 1961. Only four sub-fossil Northern riffle shell, Epioblasma torulosa rangiana have been found in the river previously. All of these sub-fossil specimens were found in Columbus.

Pleurobema clara and Simpsonaias ambiqua are included in the listing of naiades by Stein which she believes might currently be living in the project area downstream from the proposed plant. These two species are also considered, by the State of Ohio, as being rare and endangered. Stein found two dead shells of both these species during her work on the river in 1960 to 1963.

One rare and endangered fish species, the spotted darter (Etheostoma maculatum), has been collected from the Olentangy River. This species is recorded in the Ohio State University Museum records as having been collected in 1958, 1960, and 1963 in the area between Worthington Hills and the Interstate 270 intersection. 1963 is the last time that this species was reported to have been found in the river.

The bluebreasted darter (Etheostoma camurum) is considered to be a rare fish in Ohio and is known to be found only in a few localities in the state (Momot, 1975). This fish is found in the Olentangy and was collected during the electroshocking done by the Department of Zoology of Ohio State University in 1974 (Griswold, 1975).

The Indiana bat, Myotis sodalis, is listed as a threatened species by the Department of the Interior (1973, 1974). Its present distribution is in the midwest and eastern United States from the western edge of the Ozark region in Oklahoma to central Vermont, to southern Wisconsin, and as far south as northern Florida. Its distribution is associated with large cavernous limestone areas and areas just north of cave regions. It is presently decreasing in numbers with an estimated 500,000 still in its distribution range. These mammals breed in late June and their breeding rate is generally a single young per season. The Indiana bat is declining in numbers and distribution due to the commercialization of the caves and frequent laboratory raids for laboratory experimental animals (U.S. Department of Interior, 1973). This endangered species has not been reported to live in the project area, thus, it is not expected to be affected by this proposed project.

The endangered mollusks and fish species which may live in the stretch of the Olentangy River under consideration merit further investigation to determine their presence in the river system and to assess the effects of the project upon them. The impacts on the endangered mollusks will be difficult to determine because their ecology and life cycles are presently poorly understood or altogether unknown. To assess the impacts upon the endangered fish species will also be very difficult because their populations are so low and there are difficulties in sampling for these species.

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C. LAND USE

This section examines the existing pattern of land use in the proposed service area, and the secondary impacts of the proposed construction upon the growth of the area and therefore upon the future development of the land use pattern. This is followed by a discussion of the needs for planning in the area, in the presence of these forces, to channel development along desirable paths.

1. Current Land Uses

Most of the land in the proposed project area is either used for agricultural, residential, or recreational activities or is held for speculation and future development. Industrial and commercial uses occupy a very small part of the total land area. Information describing current land uses is given in Appendix A. This subsection contains an inventory of current land use, relevant land use plans, and an inventory of valuable natural areas.

The most current available representation of land use in the project area is shown in Figure 37. The predominant residential feature of the project area is the occurrence in roadside strips and small subdivisions of single-family detached homes interspersed with older, rural farm homes. Commercial uses generally consist of service stations, motels, restaurants and convenience stores widely scattered along transportation arterials or clustered near areas of residential concentration. Most manufacturing is concentrated in the area west and south of the City of Delaware. Elsewhere, industrial uses in the project area are restricted to a few scattered light industries along U.S. Route 23 and the railroads.

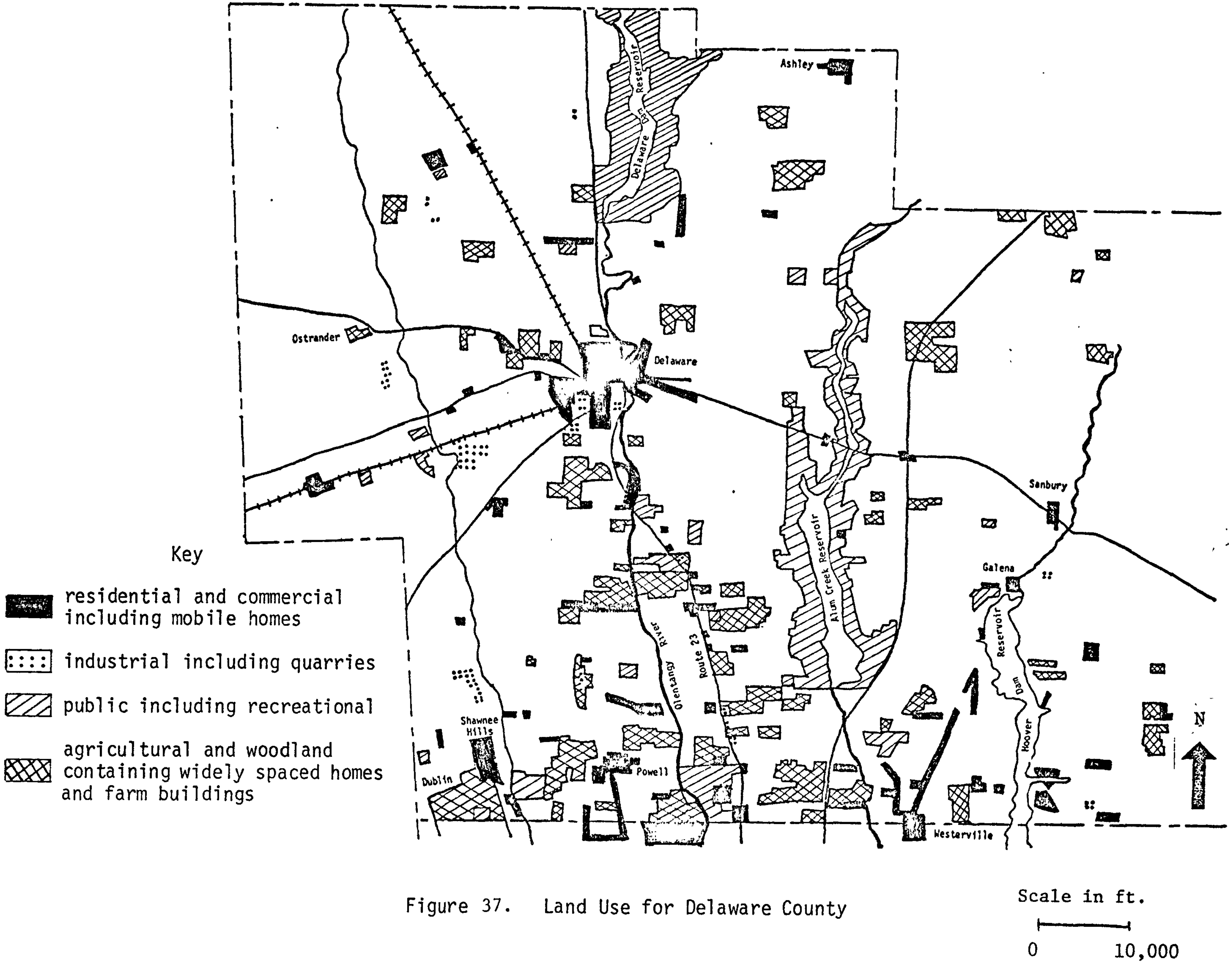

Figure 37. Land Use for Delaware County

Source: Delaware County Regional Planning Commission, 1973

Land used for transportation is so located as to provide excellent accessibility to most portions of the project area. However, the capacity of most existing roads is not adequate to handle high volume traffic flows and will need modification to handle the increased residential population projected for the future. Agriculture is a major land use; however, a large portion of agricultural land is held for speculative investment.

Land devoted to recreational uses is abundant and oversupplies local needs, but because of the regional orientation of most of the recreation facilities, they are used extensively by residents of other counties. The attractiveness of these recreation facilities is strongly influenced by the types of activities supplied, the number of users the facilities can support, the demand for the activities supplied, and the accessibility of the facilities from concentrations of population. The proximity and recreational demand of the nearby, rapidly expanding Columbus metropolitan area are significant factors which greatly influence Delaware County's recreation system.

A comparison of the general types and acreages of recreation facilities available in Delaware County to those in Franklin County and each of the five other counties adjacent to Franklin County is shown in Table 49. Delaware County has almost half of the total acreage of regional facilities in the entire seven-county region surrounding Columbus. Delaware County also has nearly half the total acreage of outstanding natural areas and over one-third of the total acreage of natural environment areas, as defined by the Ohio Department of Natural Resources. All of the Highbanks Metropolitan Park is classified as a natural environment area and all of those portions of state routes 745, 257, and 315 which lie in the proposed

TABLE 49. Recreation Facilities in Acres

Classification	Delaware	Fairfield	Licking	Madison	Pickaway	Union	Franklin
Facilities which have ability to attract or serve persons from throughout the state	256	235	143	282	6,147	10	365
Regional facilities serving people within a one- or two-hour driving radius	13,578	3,875	2,632	503	2,492	223	8,631
Municipal facilities which are too small or specialized to possess regional attraction (exclusive of school grounds)	102	216	187	44	21	125	3,742
Private and commercial areas - variable service areas	2,497	2,267	3,137	225	653	290	6,015
Historical or cultural areas having a regional or larger service area	4	48	166	0	7	6	165
I High density recreation areas	261	356	279	95	126	135	4,240
II General outdoor recreation areas	1,987	1,706	2,618	381	668	174	4,882
III Natural environment areas	13,935	4,171	2,343	578	8,519	339	9,539
IV Outstanding natural areas	250	230	135	0	0	0	90
V Primitive areas	0	0	0	0	0	0	0
VI Historic and cultural areas	4	178	890	0	7	6	167
Land	11,413	4,848	5,348	688	7,443	615	17,019
Water	5,024	1,793	917	366	1,377	39	1,899
Total	16,437	6,641	6,265	1,054	9,320	654	18,918

Source: Ohio Department of Natural Resources, 1970 service area are classified as outstanding natural areas.

The most current and detailed land use plan that describes the project area is the concept plan developed by Surveys Unlimited (1973). It describes and/or delineates the planned location of the following land use elements for a 20-year planning period:

- Regional role of Delaware City
- Major commercial areas
- Major industrial areas
- Major residential areas
- Major public and semipublic areas
- Major vacant and open space areas
- Major improvements to the transportation system.

The geographical location of these plan elements is shown in Figure 38.

This concept plan recommends that Delaware City be the center of major commercial, administrative, health, and civic needs in the county. The increasing countywide orientation to Columbus makes the achievement of this concept unrealistic. New major areas of residential development are expected in these portions of the project area:

- North and southeast of Powell
- North and south of Lewis Center
- East and west of Interstate 71
- North and south of Powell Road.

Major areas of residential expansion in the project area are expected north of Westerville and south and west of Shawnee Hills. Expansion of commercial areas is encouraged for Powell and Westerville.

The concept of planned commercial development is based upon the recommendation that growth of a countywide market be encouraged to locate in the City of Delaware and that convenience outlets be encouraged in scattered areas throughout the county. Major industrial development is

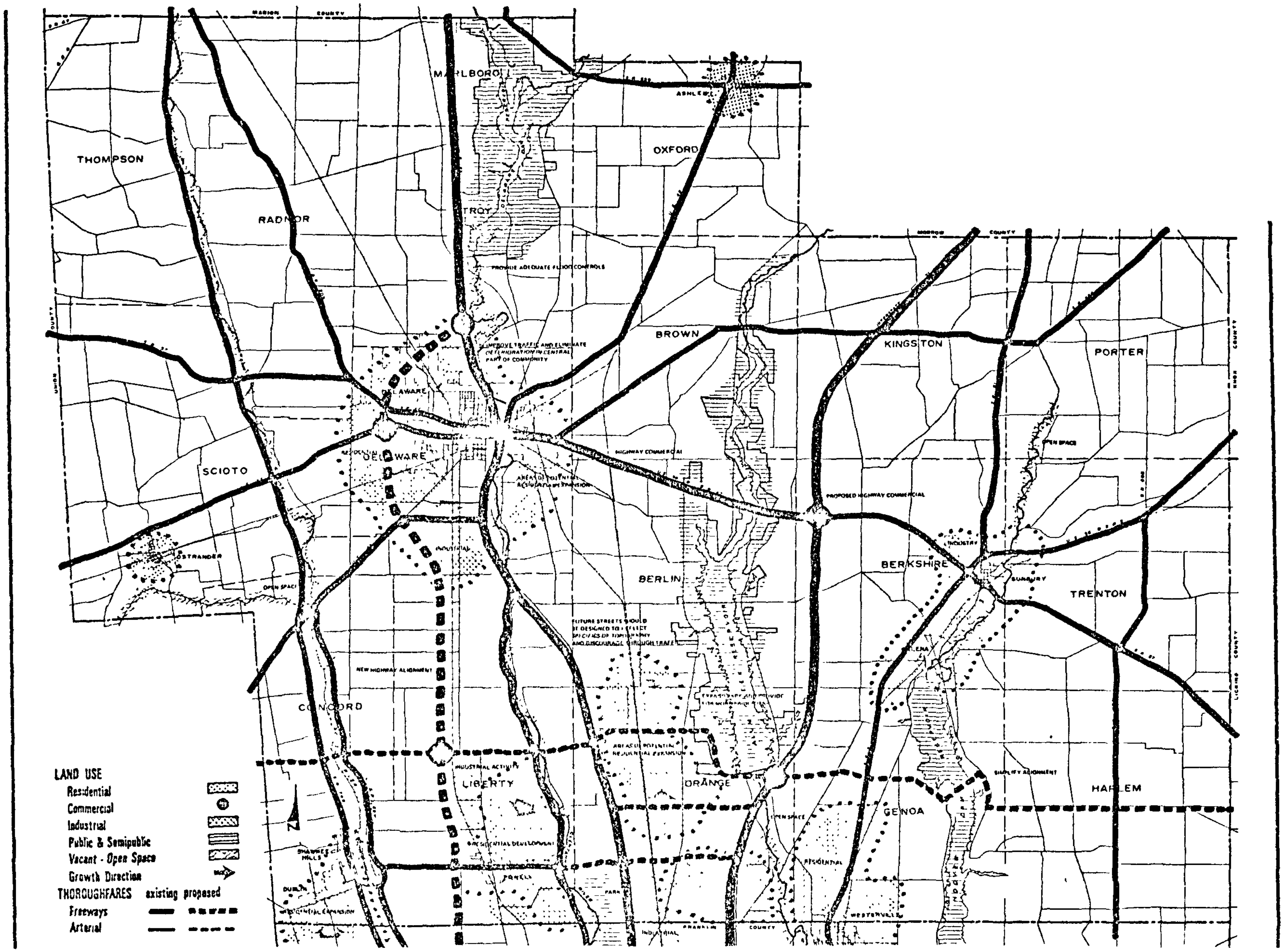

Figure 38. Land Use Plan for Delaware County

Source: Surveys Unlimited, 1973

recommended in the following portions of the project area:

- South of Home Road along the Chesapeake and Ohio Railroad
- Along the Penn Central Railroad south of Powell Road and east of U.S. Route 23
- Northeast of Westerville along Maxtown Road
- Near the intersection of U.S. Route 36 and Interstate 71
- Near the intersection of Big Walnut Road and Interstate 71
- Along U.S. Route 23.

The concept of recreational development centers around the development of additional facilities in the Highbanks Reservation and the Alum Creek Reservoir. Major areas of open space preservation are recommended in certain watersheds and along major drainageways. Recommendations for transportation include the improvement of the capacity of most existing arterial roads and collectors and the building of an interchange with Interstate 71 at County Road 109.

The Ohio Department of Natural Resources (1970) has designated three portions of the project area as outstanding natural areas. This designation is recognized by the U.S. Bureau of Outdoor Recreation. These three areas are, in general terms, the north-south traverse of State Routes 745, 257, and 315 through the project area. They are so classified on the basis of the high quality of the surrounding natural scenery.

2. Secondary Impacts on Growth

The land use of an area is both a reflection of the economy and society of the area and an expression of its historical evolution. It is an expression, supported by action, of the relative importance which that society places upon sites and functions. The introduction of a new element into the landscape, such as a sewage treatment plant, has an effect upon the use of land in the surrounding area which is dependent upon the way in which it is viewed and valued by the neighboring population. It may attract growth and development because it provides attractive services, contributes to the location of new homes and industries, or assures the preservation of public health. It may repel growth because it is presumed to cast a shadow of noise, malodor, and disease or blight upon the neighborhood.

Under these circumstances, secondary impacts may include those associated with industrial and residential development, changes in land values, shifts in the centers of retail trade concentration, shifts in the location of the most attractive recreational sites, and changes in the pattern of recreational activities.

Secondary impacts on growth which derive from the proposed action are determined by a comparison of the amount and types of development which would occur under a no-action alternative, which assumes that there would be no additional public sewering, with the amount and types of development which are projected to occur if the proposed action is implemented. A description of the growth which would occur under a no-action alternative is discussed on pages 1-33.

One secondary growth impact resulting from implementation of the proposed action would be an increased rate of growth in population and in economic activity in the project area. However, the size of the increased rate of growth would be small because, even if no public sewering were to be provided throughout the project area, there would still be significant rates of growth. High rates of growth will occur regardless of sewerage because the project area is highly attractive to residential and light industrial development.

Under these conditions, the absence of public sewering will not preclude development, but will, instead, only make development more costly. The extra cost involved in land development without sewers determines the degree to which the lack of public sewers will retard development. In this project area the significance of the extra cost of private package systems or septic fields is minimal. The project area is attractive to buyers of expensive housing units. The addition of a few thousand dollars to the initial cost of each house to provide for the added cost of a package system or septic field, over that of land serviced by public sewerage, would be expected to lower demand for such expensive housing only slightly. The extra costs of providing private treatment of the wastes of prospective industrial users are also expected to be a minor factor in their decisions to locate in the project area. Therefore, the demand for industrial development will be lowered, at most, only slightly.

Most of the relative increases in rates of population growth that could be caused by the proposed action relate to the construction of additional low and moderate cost housing. There would be increases in the construction of apartments, trailer courts, and lower cost single-family detached units. Public sewering, because it is financed in this case principally by federal monies, and because the remaining local debt would be amortized over a long period, has considerably less initial and long-term costs per dwelling unit than privately financed waste disposal. The size of this savings is significant to the decision to build less expensive types of residences. These lower cost residences would generate lower tax revenues than the amount that local governments might wish to spend on the public sewers for the occupants.

The increased availability of low and moderate cost residences would also increase the opportunity for blacks to reside in the project area. This increase would occur because lower cost housing is especially attractive to low and middle income families and the lower income of these families is strongly correlated to racial distinctions. For example, in the Columbus region black families have generally lower incomes than white families. In 1970 the median income for black families and unrelated individuals in Columbus and in Delaware County was several thousand dollars lower than the median income for white families and unrelated individuals (U.S. Bureau of the Census, 1970). The percentage of blacks in Columbus, though, is much greater than in Delaware County. Blacks comprise 18.5 percent of the population of Columbus, compared to 2.0 percent of the population of Delaware County (U.S. Bureau of the Census, 1970). The proposed project would increase the availability of low and moderate cost dwellings, and this in turn would increase the opportunity for blacks in Columbus to move to the project area.

The increased growth of population attracted by public sewering would cause a number of related impacts. These impacts would be minimal because each impact is directly related to the amount of increased development. The amount of increased development, as has been explained, would not assume large proportions. These impacts are:

- Increased erosion
- Increased stormwater runoff
- More polluted stormwater runoff
- Increased siltation in local streams
- Increased burdens on school systems and other public services.

Increased erosion would result from construction on the easily erodable soils that exist in most parts of the project area. Increased stormwater runoff would result from increases in impermeable areas resulting from increased development. More polluted stormwater would primarily result from rain flushing oils and other petro-chemicals from paved areas. Increased siltation in local streams would result from increased soil erosion on the slopes. This siltation could combine with increases in stormwater runoff to produce increased flood levels during rain storms.

The present schools in the project area, which are already old, crowded, and inadequate, would have to be improved to meet pressures caused by increased growth (Surveys Unlimited, 1973). In general, increased growth would increase local costs of providing services, but presumably would be accompanied by an expanded tax base. It is quite possible that revenues gained from this increased growth would not completely cover the extra expenditures necessary to provide the services to support the growth.

A number of other impacts which might result from the implementation of the proposed action are directly related to the types of growth and development that are facilitated by public sewering. These impacts are:

- Leapfrog development whereby suitable areas in northern Franklin County might be bypassed
- Increased speculation
- A lower concentration of new subdivision development along streams
- Lower total costs of liquid waste disposal over the long term.

Public sewering may possibly cause development to leapfrog past areas in Franklin County which have not yet developed to an extent commensurate with efficient utilization of their sewers and roads. The advent of public sewering, as argued above on page 254, would not greatly increase development in the project area. Hence, the relatively small amounts of excess development can be expected to cause little leapfrog effect beyond that which is now taking place and likely to continue. Speculation, which is generally high in areas expected to receive public sewering, would not be greatly increased.

Subdivisions of greater than 4 units require waste treatment through means other than septic fields; package plants must discharge into continuously flowing streams. Hence, without the proposed project, development of subdivisions with package plants would be largely restricted to the proximity of perennial streams. With the proposed project, development of subdivisions could occur in a greater variety of locations. Real estate development would not be as concentrated near perennial streams for this reason and the stream corridors, which best serve as buffers to increased urban stormwater runoff and stormwater pollution, would be freed from some pressure for development. Stream corridors are ideal areas for recreation and preservation of open space and high quality natural environments. They are likely, over the long range, to have greatest value as parklands.

The costs of first building a septic field or package system and then, at some time in the future, replacing it with a public sewer connection are duplications and therefore costly in terms of both public and private capital. This is especially true of sewering areas which have already undergone septic field development. The large lots required for septic field development necessitate the emplacement of long feeder lines. The duplication of costs is significant because public sewering will eventually become a necessity in the project area. The difficulties associated with the use of package plants or septic fields in the project area in the context of projected population growth are the determining factors which are expected to lead to the eventual installation of public sewering. Package plants have high operating costs per customer served, high rates of failure, and short life expectancies. Septic fields in the generally poorly suited soils in the project area also have short life expectancies and high rates of failure.

3. Planning Needs

Current growth pressure in the project area will necessitate changes in local and regional planning. These growth pressures both complicate and magnify the importance of the planning process. Population will grow significantly, composition of employment will change, and the already high accessibility will increase to all portions of the project area. Development, unless properly guided, will degrade valuable local recreational, scenic, and natural resources. Controlling development pressures will necessitate implementation of an overall planning program that is well coordinated between the local, county, and regional levels, not crisis-oriented, and dynamic in its ability to meet a changing social and technological environment and future contingencies.

Coordination is needed between the multiple levels of planning that are currently responsible for the project area. These multiple levels are municipal and township planning, county-wide planning, and regional planning. Numerous planning decisions are currently made at the municipal and township levels. County-wide planning decisions are made by the

Delaware County Regional Planning Commission. Regional planning decisions are made by the Mid-Ohio Regional Planning Commission. Frequent and detailed liaison between these three levels is needed to ensure the compatibility of planning policies and to facilitate the distribution of data and other inputs into the planning process. This liaison requires considerable manpower. However, the Delaware County Regional Planning Commission is currently considerably understaffed.

Sufficient manpower is also a pivotal factor in avoiding planning by crisis. A crisis-orientation to planning involves solving problems only after they have assumed large and not easily soluble proportions. The township and municipal planning authorities in the project area currently engage in a level of planning which most often operates under crisis conditions. Sufficient manpower enables a planning organization to anticipate and solve potential problems before they affect the planning area. Maintenance of a detailed and ongoing data base, establishment of a long-term planning framework, and formulation of detailed long-term goals and objectives each would aid in the anticipation and solution of potential problems.

A detailed and ongoing data base, a long-term planning framework, and detailed long-term goals and objectives are also essential elements of a dynamic planning process. A dynamic planning process increases a planning agency's ability to meet changing future contingencies. For a planning agency to achieve a dynamic planning process, it must use new information to continuously update its long-term planning process and refine its long-term goals and objectives. The Delaware County Regional Planning Commission needs to be able to achieve these time-consuming tasks.

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D. AESTHETICS

Aesthetic considerations which could be important in the selection of a site for a wastewater treatment plant are those related to the visual blight upon the landscape, the intensity and dispersion of malodorous emissions, and the noise disturbance which the plant might cause. These considerations are taken up below.

1. Visual Impacts

The visual impact is a function of the area within which a structure may be seen, the number of people in a position to see it and the aesthetic response to this sight. The area of visibility surrounding the proposed treatment plant is determined by a line-of-sight analysis based upon the assumption of a plant height of 18 feet, a general tree height of 40 feet and an observer height of 6 feet.

It is further assumed that an observer within a wooded area could see out of it, but that an observer outside of a wooded area could not see through it. Sixteen, equally spaced, radial line-of-sight transects, were constructed from the plant site to the maximum limits from which the proposed plant could be seen. These transects are shown in Appendix E. An example of the graphic line-of-sight analysis is presented in Figure 39.

The location of the radial transects and the interpolated area of visibility of the plant are presented in Figure 40. The area of visibility is an elipse in which the major axis, about 4500 feet long, extends along the Olentangy Valley and

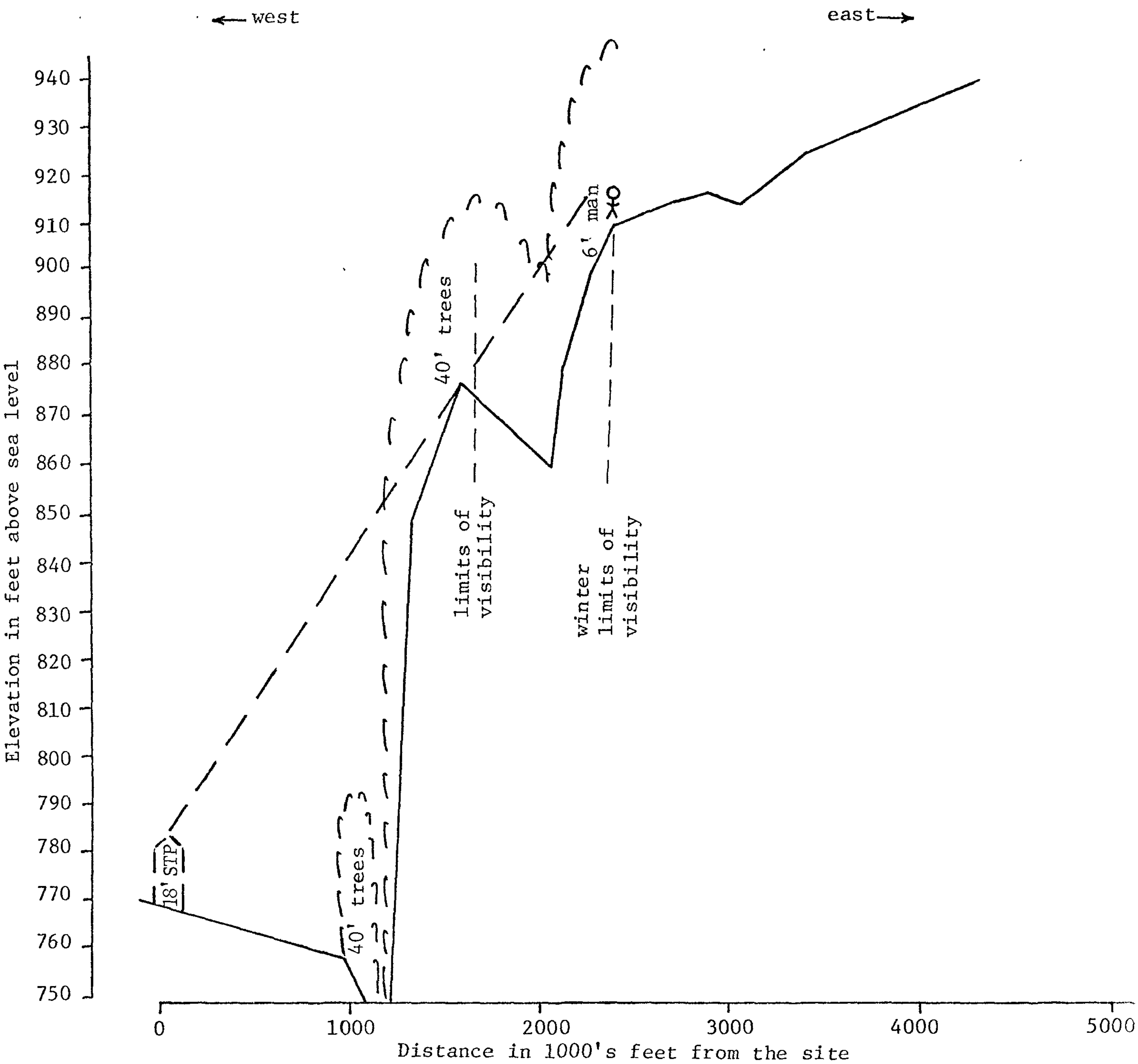

Figure 39. A Line of Sight Profile (Profile 5)

Source: Enviro Control, Inc., 1975

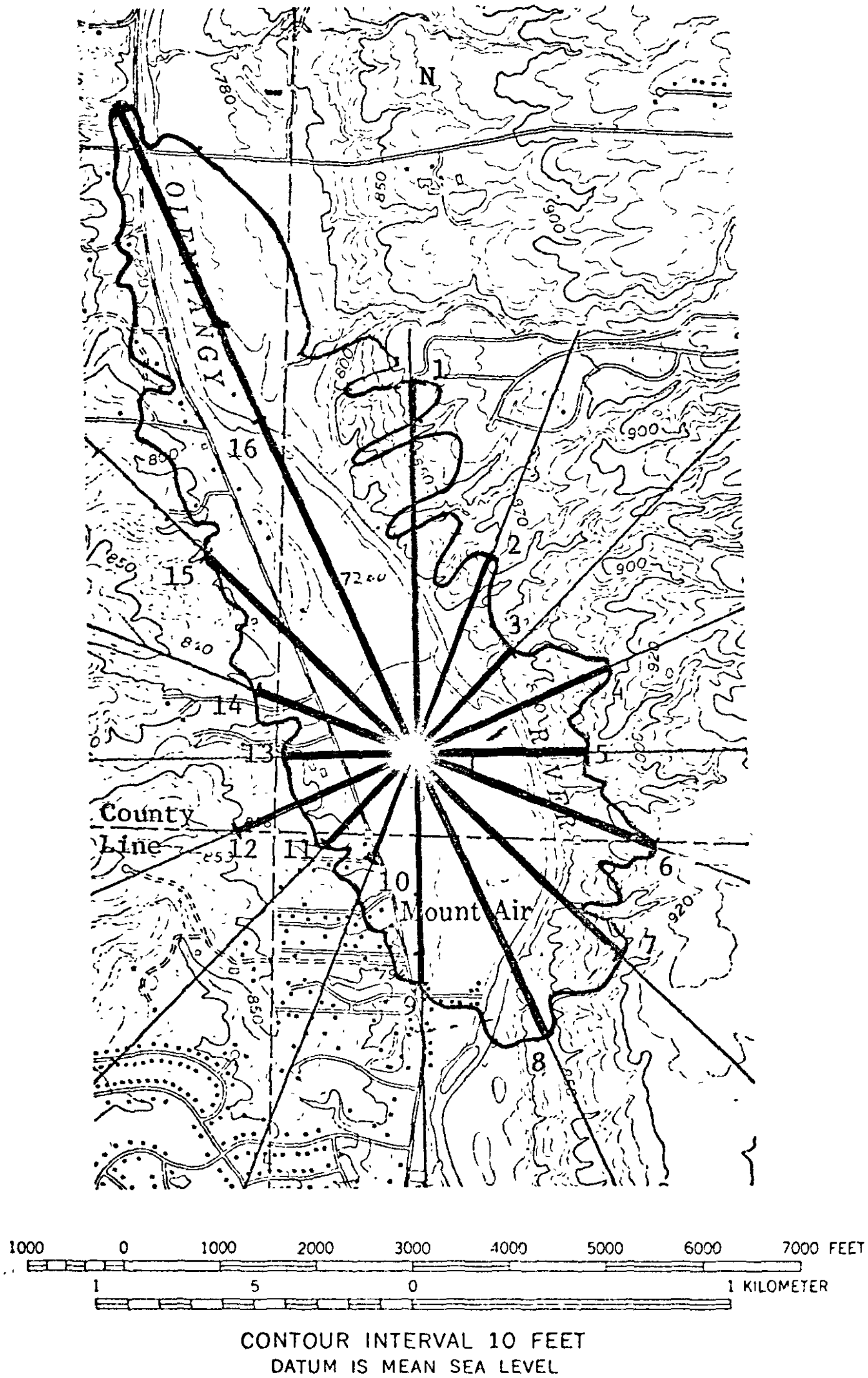

Figure 40. Area of Visibility of Proposed Plant

Source: Enviro Control, Inc., 1975

the minor axis, about 3000 to 4000 feet long, extends across the valley. It is noteworthy that, because of the roughly convex curvature of the Highbanks, the plant would not be visible from the top of the bluffs at an elevation of 890 feet above sea level. Ridges which extend normal to the Olentangy Valley and buildings, particularly in Mount Air, also obstruct visibility.

The people who might be affected by this visual impact include that fraction of the visitors to the Highbanks Park who climb part-way down the cliffs to points 100 to 130 feet above the river, about 18-20 home dwellers in the northern part of Mount Air, about a dozen home dwellers along the Olentangy River in Delaware County south of Powell Road and drivers along State Route 315 south of Powell Road.

In this context the Highbanks Park has proposed to establish three picnic areas

- On the bottomlands of the Olentangy River about 5000 feet north of the proposed plant site
- On the bluff above the Olentangy River about 4000 feet north of the proposed plant site
- On the bluff above the Olentangy River about 4000 feet north northeast of the proposed site

Except for the screening provided by trees along the Olentangy River and screening provided by tree planting about the site the plant would be visible from the first site. Because of both the convexity of the topography and the screening effects of trees in an intervening ravine the plant would be obscured from the second picnic area, proposed for group events. Similarly, the proposed plant would be obscured from the third proposed picnic area both by the convexity of the topography and the intervention of trees. However, the proposed plant would be visible through the trees from certain vantage points along the proposed nature trail in Highbanks Park.

The plan for the proposed plant and the site has a number of provisions designed to enhance the visual impact. The building is designed to be compatible with the rural-suburban character of the neighborhood and landscaping has been carefully planned to include trees that will screen the site.

2. Odor Impact

Odors in the proposed plant will occur from septic conditions in wet wells in the primary stage or as a result of upsets during the secondary stage of treatment. Substances which cause odorous emissions are hydrogen sulfide and ammonia. Other inorganic odors include sulfur dioxide or carbon disulfide. Organic odors identified are mercaptans, proteins degraded by bacteria, which often transform into various amines. The odor threshold, or minimum level detectable by people, of concentrations of mercaptans, certain amines, or hydrogen sulfide is about 10 times lower than that of sulfur dioxide, and it, in turn, is 10 times lower than the threshold for ammonia. When several odor-producing chemicals are emitted simultaneously, there are synergistic effects. However, accurate determination of these effects is difficult.

The sources of odors in municipal wastewater treatment plants are presented in Table 50. These odor problems can be prevented by proper plant design or eliminated by add-on treatment methods. Several odor prevention or removal methods are given in Table 51.

TABLE 50. Sources of Odors in Municipal Wastewater Treatment Plants

Location	Odor Source	Comment
Sewage entering treatment plant	Gas produced by anaerobic reactions in sewer line	Certain industrial wastes can intensify the odor (food processing)
Weirs	Volatile gases escape	Minimize weir drops elevation
Screening, grit removal	Evaporation from grit, screening or wash water	
Aeration tanks or basins	Evaporation of small droplets or the collapse of bubbles causes formation of aerosols	
Heat processing of sludge	Volatile products from digestors or pressure cooking off-gases	Proper design can eliminate these odors
	Supernatant hot liquors and warm sludge	Cooling reduces odor
Ponds or holding tanks	Usually caused by anaerobic reaction	Aeration will prevent odor
Sludge handling and solid/ liquid separation	Conveyors, filters, trucks, landfills, and drying beds	Proper sludge treatment can eliminate odor
Sludge incineration	Incomplete combustion	Proper design and operation will eliminate these odors

Source: Liptak, 1974

TABLE 51. Odor Prevention or Removal Methods

Method	Suggested Action	Typical Location
Prevent uncontrolled anaerobic conditions	Add air or water and agitate; add chlorine or ozone	Sewer, lagoon, pond and storage basin
Prevent formation of algae or microorganisms, which can form objectionable odors	Remove nutrients; chlorination, or cover to close out sunshine	Basins, lagoons, ponds, and storage tanks
Confine odors to prevent wind from carrying odors away	Covers, roof, housing	Clarifiers, trickling filters, screenings, vacuum filters and digestor supernatant tanks
Chemical treatment of wastewater	Oxidation through aeration, oxygen, ozone, chlorine, potassium permanganate, chlorine dioxide, and others	Primary clarifier, raw sewage and reactor-clarifier
Treat collected gases and destroy odor-producing material	Scrubbing of gas with water augmented by lime, hypochlorite, or other chemicals; add ozone to gas	Same as items 3 and 4

Source: Liptak, 1974

All of the unit operations in the proposed STP are aerobic, hence all of the gaseous by-products theoretically produced during sewage decomposition -- for example, carbon dioxide -- should be odorless. Septic odor-producing conditions may develop, however, in certain areas. These areas include the raw sewage lift station, the tertiary filter building, and the sludge concentrator building.

The raw sewage may be septic as it comes into the plant prior to its combination with activated sludge. Odor from fresh sewage is minimal and is confined to the lift station. In long sewer lines at low flow rates with no storm or ground water additions, sewage may become septic. Chlorine has been proposed as one method of odor control in the lift station. This is cost-effective because chlorine will be used also to disinfect the final effluent. Chlorine, however, reacts with some of the organic components in raw sewage, and certain chlorinated hydrocarbons, such as the chloramines, have been identified as possible health hazards.

In addition to the chemical control of odors in the raw sewage, the lift station air vent will be equipped with a scrubber system. This trap will effectively keep any lift station odors from reaching the outside atmosphere. This unit must be properly maintained in order to be effective.

The tertiary rapid sand filter and sludge concentrator building air vents will be equipped with activated carbon filters. Activated carbon will adsorb and absorb any odorous compounds and prevent their reaching the outside atmosphere. Although these filters are very effective, they do wear out and must be replaced or recharged. This maintenance is the responsibility of the plant operator and is necessary to ensure adequate odor control. The wastewater from the periodic backwashing of the tertiary filters will be returned to the aerators for treatment. Therefore, no periodic odor problems will result from filter backwashing.

Hydrogen peroxide, also, could be used for odor control. No chlorine is involved. However, a hydrogen peroxide system, in addition to the chlorinators for final disinfection, would add to the cost of the plant.

One other potential source of odor, though not necessarily an obnoxious odor, is the aeration-dechlorination system. One purpose of this operation is to reduce the chlorine residual by releasing it into the atmosphere. The chlorine may be detectable near the aeration tank, but its concentration there and certainly outside the plant area should not be objectionable. The use of another method of dechlorination, such as sulfur dioxide or granular activated carbon, would result in no release of chlorine into the atmosphere.

3. Noise Impact

Unwanted sound, referred to as noise, is generated by most mechanical equipment including that proposed for the Delaware County Sewage Treatment Plant. Noise can have an adverse impact on people that ranges from simple annoyance to psychological and physiological stress. Such reactions include increased irritability, loss of concentration, nervous tension, impaired aptitude, and loss of sleep. The extent of the impact depends primarily on the loudness, pitch, intermittency, and familiarity of the noise reaching sensitive human receivers.

Noise levels are typically measured in decibels in the "A" scale (dBA). The scale emphasizes a certain set of frequencies to which the human ear is most sensitive. Examples of common indoor and outdoor noise levels are listed in Figure 41.

Noise can be attentuated, i.e., reduced, before it reaches sensitive human receivers. Distance, vegetation, and topography, including hills and walls, can reduce noise levels significantly. For example, a five foot wall has been shown to reduce highway noise by five dBA (Sexton, 1969). Vegetation must be quite dense to attenuate noise. In a dense evergreen woods with a visibility of 70-100 feet, the attenuation of sound is approximately 18 dBA per 1000 feet. Trees with tall trunks to a height of 6 to 8 feet and spaced about 10 feet apart provide no attenuation (Embleton and Thiessen, 1962). Planting vegetation to improve the aesthetic appearance of the noise-generating area has been shown to reduce local sensitivity to noise without actually reducing the noise levels (Sexton, 1969).

The Delaware County Sewage Treatment Plant equipment that may cause a significant noise impact on receivers outside the plant area includes the blowers and the emergency power generator. The large pumps will also produce high noise levels, but this equipment will be located below ground level and the noise impact will be limited to plant personnel who must service this equipment.

The nearest non-plant receivers include a residence and a park approximately 400 feet and 1000 feet away, respectively, from the proposed site of the blower building. The blowers, with their piping and blow-offs are capable of routinely producing noise levels exceeding 100 dBA at a distance approximately three feet from the uncovered

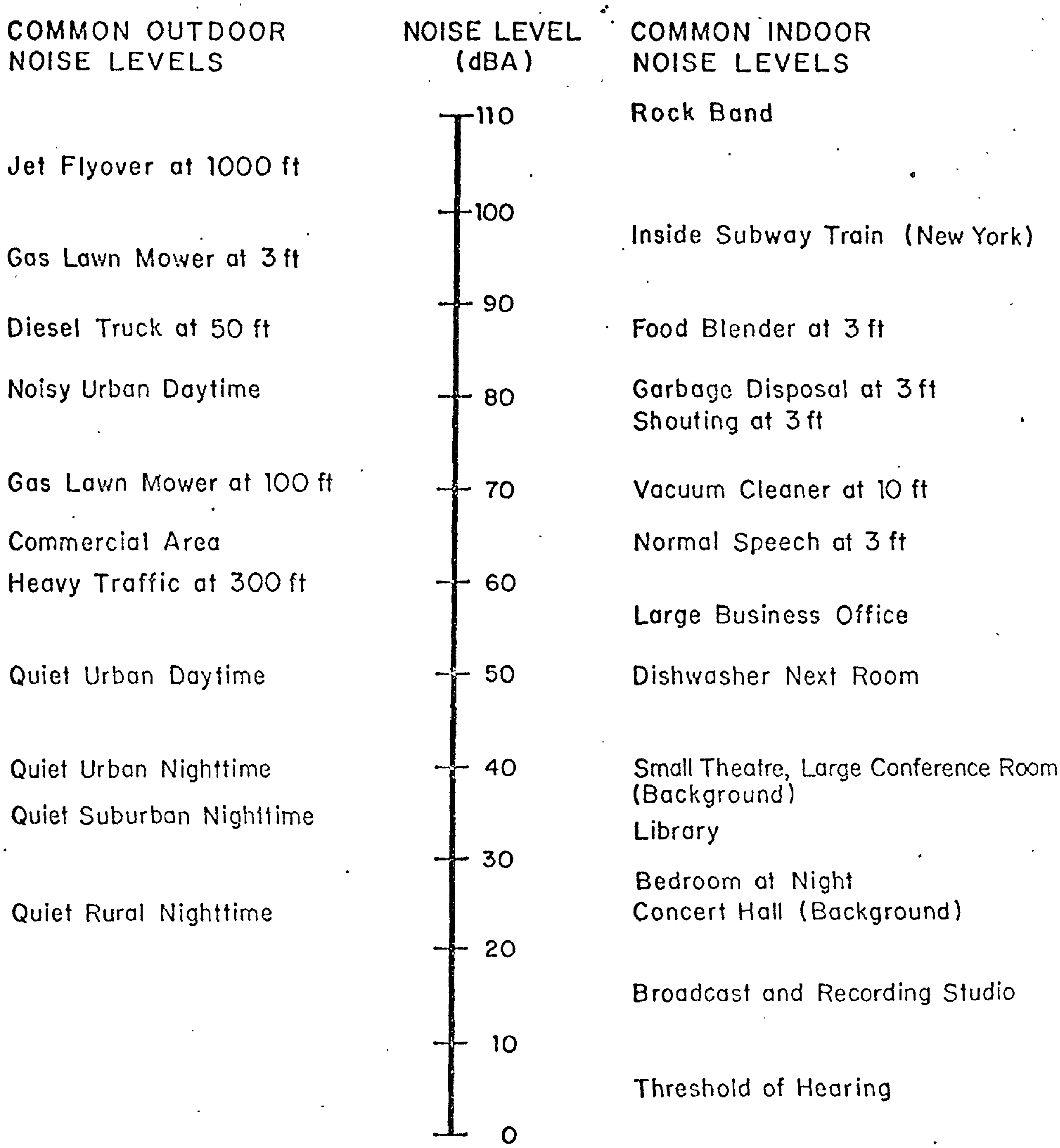

Figure 41. Common Indoor and Outdoor Noise Levels

Source: U.S. Department of Transportation, 1973 operating equipment (Allis Chalmers, Inc., 1975). However, this equipment would be housed in a structure with 8-inch thick cement block walls, 1 1/4 thick urethane insulation, and 5/8 inch thick redwood veneer. If the blow-off is vented inside the building, or if it is adequately muffled and vented outside, the total noise level immediately outside the building should be consistently below 90 dBA. Using a noise level of 90 dBA immediately outside of the building, the noise levels at various distances from the building are shown in Table 53.

TABLE 52. Noise Level in dBA at Various Distances from the Proposed Blower Building

Distance in ft.	50	100	200	500	1000	2000
Noise Level in DBA	78	75	72	68	64	57

Source: Enviro Control, Inc., 1975

These levels are derived by the dissipation law of sound pressure, assuming the absence of sound barriers. Lagging the piping, i.e., covering it with sound-deadening insulation, may further reduce outside noise levels (Allis Chalmers, Inc., 1975). These precautions, together with the distances to the sensitive receivers, should result in a minimum acoustical impact from this noise source. Moreover, strategic placement of the blower building and emergency power generator housing with regard to existing and proposed topography, and the planting of aesthetically pleasing vegetation, should ensure local acceptance of the minimum acoustical impact.

Private Communication

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Caterpillar Manufacturing Company, 1975.

References

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E. MITIGATIVE MEASURES

Several areas of special concern have been discussed relating to the impacts of the proposed facilities on water quality. Consequently, this section explores measures designed to mitigate the impacts of stream crossings, outfall location, and excessive nitrogen and chlorine content in the effluent.

1. Interceptor Stream Crossings

Placement of sewer interceptor lines across or beneath stream beds can cause temporary or permanent disruption of stream flow and a corresponding increase in sedimentation. This may in turn lead to impacts on water quality and sensitive biological organisms. These impacts can be minimized by careful consideration of:

- Number of crossings
- Placement of crossings
- Construction phasing
- Construction techniques

Minimizing the number of crossings and correct placement of those that are necessary are both important early in the planning process because these crossings affect emplacement of lines that lead away from the stream. Construction phasing provides assurance that such adverse impacts as erosion or sedimentation, which might occur during temporarily delayed construction, would be minimized. Construction techniques are related to sewer emplacement in that bedrock depth and soil type are determining factors in the identity of the environmental problems posed and both the cost and technical feasibility of the construction methods used.

The common method for minimizing stream crossings in a basin, in which the stream runs through the service area, is to align interceptors along both sides of the river. This permits connections to any segment from outlying areas with the use of gravity flow interceptors. This scheme is used on both the Scioto and Alum Creek Watersheds in the Delaware County interceptor plans because of the difficulty of constructing a crossing of the reservoirs. The present design for the Olentangy River, however, includes ten stream crossings between Winter Road (Figure 15) on the north and the Delaware-Franklin County line. Some of these crossings are designed to avoid areas in which rock excavation or deep entrenchment would be required; others are so located to avoid forested areas. The large number of crossings also facilitates connection with future housing developments and prevents developers from constructing their own lines across the Olentangy in order to connect with sewer service. In certain reaches of the river, these objectives can also be accomplished at some additional expense with a double line system.

The currently planned interceptor lines include five river crossings above Home Road (Figure 15) and five more at Home Road and below. These two areas are substantially different in both topography and the availability of highway rights-of-way. The topography below Home Road on the east bank of the river is much steeper than upstream and is interrupted by a substantial number of gulleys and small waterways. Shale lies near the surface in this area. It would be difficult and expensive to lay a sewer line entirely on the east bank in this area. Because there is no highway right-of-way on the east bank, it would be necessary to locate the sewer line through forested areas. Some damage to the wooded area would result. The five river crossings in this southern area are therefore justifiable insofar as both costs and adverse environmental impacts would be less than those incurred by the alternative.

North of Home Road, however, the emplacement of an interceptor line along both east and west banks would serve to eliminate five river crossings without significant impact on the terrestrial environment. The topography here is less steep than farther downstream, and Perry, Taggart, and Chapman Roads could provide convenient rights-of-way for the line. With the use of two lines the required size of each interceptor would be less.

Location of stream crossings should be determined from engineering, topographic, and environmental considerations. Engineering and topographic limitations have been well considered in the presently designed southern stream crossings. No information is available concerning aquatic life distribution on a fine geographic scale. No particular short stretches of river are known to possess important habitat requirements. Therefore, recommendations for small changes in interceptor crossing locations can not be made. The safest way to compensate for this gap in information is to reduce impact of the crossings through well-chosen construction phasing and techniques.

Well-planned construction phasing takes into consideration the adverse effects of construction sites on which work is delayed awaiting construction elsewhere. These delays usually result from attempts to reduce costs of mobilizing earth moving equipment by clearing all sites at once. Under such circumstances the savings are often obliterated by increased costs generated by erosion and sedimentation. In this case, such a policy would result in an increased load of sediments and pollutants washed into the Olentangy as well as onto adjoining farm, residential, or forested areas. A preferred phasing policy would call for completion of all construction phases on each river crossing site or on small segments of line construction before proceeding to the next section. This will prove more expensive in short-term costs but advantageous in the long run because it would minimize pollution runoff and lengthy habitat disturbance.

Stream crossing construction techniques may involve diversion or partial diversion of the river. Total diversion of the Olentangy would be unwise and unnecessary due to the lack of a suitable diversion course and the low water volume in the river. Other possible techniques involve either partial diversion with temporary impoundments, dredging, or boring under the river bed.

Diversion of half of the river at a time is the method proposed by the Delaware County Sanitary Engineer's Office (Gilbert, 1975). This entails building an embankment completely around the construction channel for half of the river width at a time. Both the building of the embankment and the channelization of the stream could cause increases in erosion and turbidity in the stream. This would, in turn, cause some detrimental impacts on downstream aquatic life. If this construction technique was chosen, its impacts could be reduced through

- Use of sandbags or other non-eroding material for the embankment
- Agreement with Delaware Reservoir to keep the river near low flow
- Rapid completion of the crossing
- Resurfacing over the upper cement pipe casing with the original bottom sediments and restoring the original topographic contour of the river bottom.

These measures should all be used in conjunction in order to achieve optimization of cost and reduction of damages. It is particularly important to leave the riverbed in its natural state after completion of construction. In this regard, some amount of bottom sediments should be replaced above the pipe casing as a buffer against riverbed changes caused by storm-generated surges in flow or by channel scour and fill.

Dredging and laying the pipe in an open trench without diversion is another possible construction technique. The pipe can be laid in segments and the water pumped out after completion of the crossing. This technique, however, causes a large amount of sediment to be washed into the river and thereby results in some disruption of river habitat. If dredging cannot be avoided, a settling basin and long effluent skimming weirs with significant retention time should be provided. The settling basin would provide for settling of the fine silt which must be dredged first as well as providing enough detention time for the oxidation of sulfides (HS or H_2S) into less toxic sulfates.

Boring under the riverbed is a more expensive but more environmentally compatible solution (Levins, 1975). In this technique, a hole 12-20 inches larger than the pipe diameter is bored and a steel casing inserted as the hole is drilled. After completion of the hole and pumping, pipe is inserted and the area between pipe and casing is filled with cement. This technique, if properly handled, has no adverse effects on the river, but it might have a greater effect than other methods on the surrounding terrestrial environment because a larger construction area is required. The cost-benefit tradeoff may, thus, vary with site, but this method merits consideration.

2. Outfall Location and Design

The location of the proposed plant's discharge is very important from a biological viewpoint. For example, placement of the outfall at the Delaware-Franklin County line would subject the fish of the river downstream of that point to potentially harmful chlorine and ammonia discharges. The concentrations of these compounds and their possible damaging effects are discussed on pages 226-232.

The best location for the outfall in order to protect the fish populations in the river is below the artificial fish habitat area which is located at Highway I-270. Emplacement of the outfall below this area would ensure preservation of those areas of the river that contain the most abundant numbers of the fish found there by electroshocking and creel surveys (Griswold, 1975). The electroshocking survey shows that from the fish habitat area of I-270 downstream to Henderson Road, the fish population decreases greatly because in this reach there is slow-moving water and a silty-mud bottom. Because the more desirable game species are not found in great numbers in this area, it is the best location for the sewage outfall.

The design of the outfall contributes substantially to the biological impact as well. Tsai (1971) studied the four types of outfall designs in Maryland, Virginia, and Pennsylvania , shown in Figure 42. Because Type I was located on one side of the river, its effluent mixed gradually downstream toward the opposite bank. Type II, located in the center of the river on the bottom, permitted mixing of the effluent downstream toward both banks. Type III consisted of two concrete barriers, each built out from one side of the stream, allowing the sewage to discharge into the middle of the stream and providing for thorough mixing of the effluent. Type IV had multiple outlet ports across the river bottom. Tsai found Types III and IV to have higher dilution efficiencies than Type I.

Type I was the most common outfall design in the three states studied. Type II was a commonly used design in Pennsylvania, while Types III and IV were represented by only one plant each. Types III and IV provide a quick mixing of the effluent and river water, but produce a zone of concentrated sewage across the river which caused heavy fish depletion and a barrier that adversely affected fish movement and migration. In contrast, the effluent leaving a Type I outfall traveled a greater length of river and required a longer time before it became completely mixed with the water across the river. Thus, the effluent underwent a better dilution and natural purification. The mixing zone in this type of design contained less concentrated sewage when compared to the other three types of outfalls. From the standpoint of fish protection, the primitive Type I outfall is a better design than the other more complicated types (Tsai, 1971).

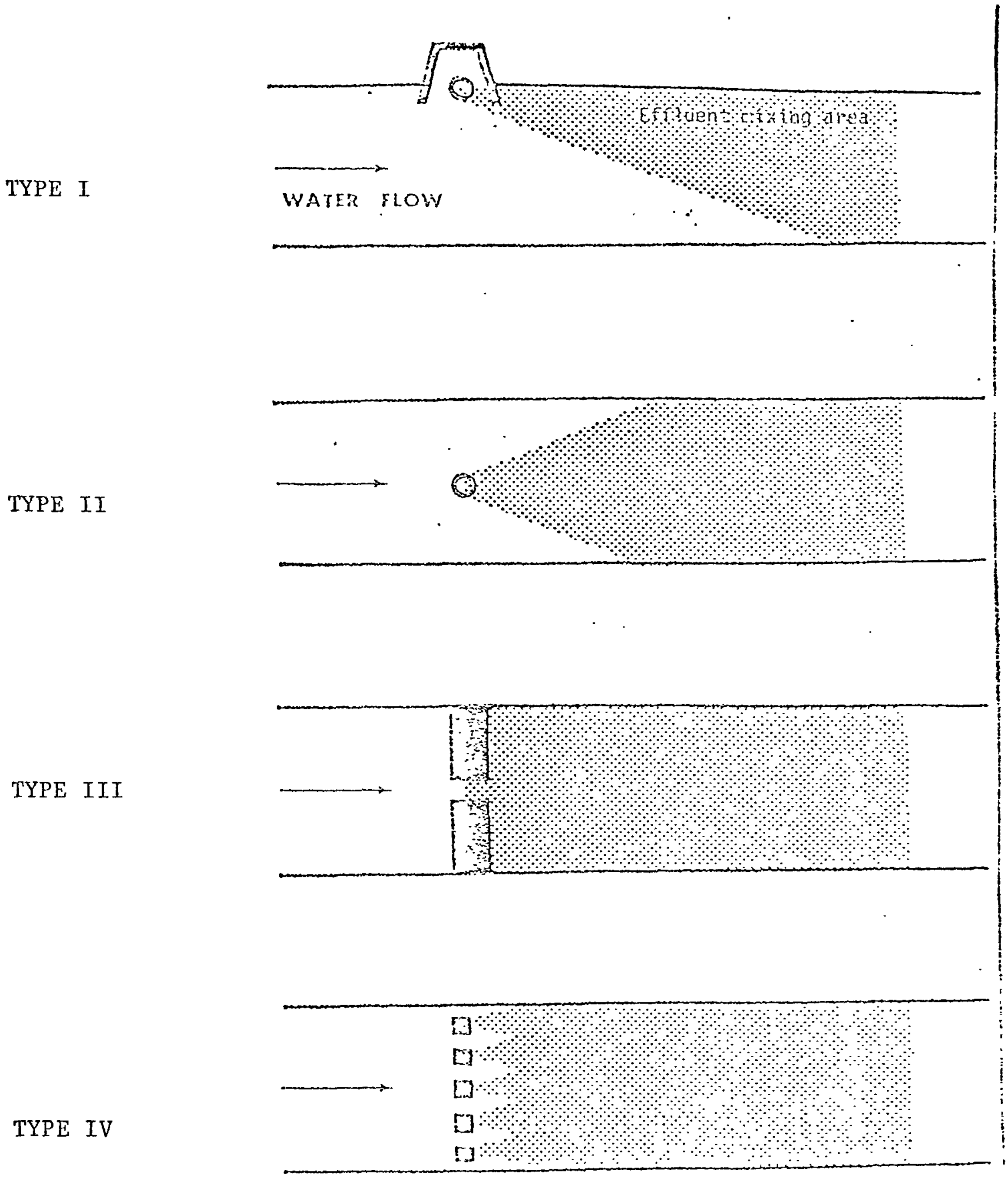


Figure 42. Sewage Outfalls Typed According To Locations and Methods of Sewage Dilution in Stream

Source: Tsai, 1971

3. Nitrogen Removal

The chief nitrogeneous pollutants in municipal wastewters have been categorized (Taras et al., 1971) into three groups: ammonia nitrogen, organic nitrogen, and nitrite and nitrate nitrogens. Ammonia N in wastewater is formed by the enzymatic breakdown of urea, proteins, and other nitrogen-containing substances. Most of the organic nitrogen in wastewaters is in the form of amino acids, polypeptides, and proteins. Nitrite and nitrate are the end products of the oxidation of ammonia in the wastewaters.

A high ammonia concentration on the order of 1.5 mg/l may have adverse effects on some aquatic flora and fauna (pages 232-238). A maximum ammonia concentration of 0.27 mg/l in the receiving water would be desirable to protect all aquatic species. This means that according to the dilution ratio of 0.67, the effluent concentration of ammonia from the plant must not exceed 0.4 mg/l as nitrogen.

The conventional biological treatment processes employed by the proposed plant have a short detention time in all biological treatment units, as shown in Table 53, and can have only 30 to 50 percent efficiency in nitrogen removal. This level of efficiency is not adequate to reduce the effluent containing a 1.5 mg/l ammonia as nitrogen to the desired level of 0.4 mg/l. Therefore, more advanced wastewater treatment processes would have to be employed. These nitrogen removal operations may be categorized into biological, chemical, and physical treatment processes.

The biological processes include nitrification, anaerobic denitrification, and algae harvesting. The nitrification process utilizes autotrophic bacteria of the genera Nitrosomonas and Nitrobactors to

TABLE 53. Comparison of Nitrogen Removal Processes

Process	Class	Removal Efficiency in percent	Estimated Cost in ¢/1000 gal.	Wastes To Be Disposed Of	Remarks
Conventional Biological Treatment	Biological	30-50	3-10	sludge	
Anaerobic Denitrification	Biological	60-95	2.5-3.0	none	
Algae Harvesting	Biological	50-90	2.0-3.5	liquid and sludge	Large land area needed
Ammonia Stripping	Chemical	80-98	0.9-2.5	--	Efficiency based on ammonia nitrogen only
Ion Exchange	Chemical	80-92	17-30	liquid	Efficiency and cost depend on degree of pretreatment
Electrodialysis	Chemical	30-50	10-25	liquid	Cost based on 1-10 mgd capacity, 1000 ppm solids
Reverse Osmosis	Physical	65-95	25-40	liquid	
Distillation	Physical	90-98	40-100	liquid	

Source: Eliassen and Tchobanoglous, 1969 oxidize ammonia to nitrate. The nitrates are then reduced to nitrogen gas by a number of facilitative bacteria including the genera Pseudomonas and Bacillus. Methanol is required as a supplementary source of carbon for the denitrification process in which nitrates are reduced to elemental nitrogen. A retention time of approximately 10 days in the anaerobic denitrification unit is normally required (Eliassen and Tchobanoglous, 1969).

Nitrogen in wastewaters may be removed by algae which are grown at the maximum sustainable rates in specially designed shallow ponds. Presumably, algae absorb nitrogen nutrients from the wastewater and use them for growth of cell tissue. It is necessary to supplement the waste with carbon dioxide and a carbon source such as methanol to achieve complete nitrogen removal. The process involves a large land area, and costs are incurred associated with harvesting and disposal of the algae.

On the basis of the same concept of algae harvesting, hyacinth harvesting and use of marshes as tertiary sewage treatment methods have been investigated. Experiments at Bay St. Louis, Mississippi, by researchers from the National Space Technology Laboratory (Engineering News Record, 1975) have revealed that the hyacinth readily thrives on phosphates and nitrates in wastewater. The hyacinth could easily be grown in a lagoon at the treatment site. The lagoon would serve as the tertiary bio-filtration system for water leaving the sewage treatment plant. As a side effect, the rapidly growing hyacinth could be periodically harvested and used as a source of fuel or cattle feed.

The use of marshes, bogs, and swamps for tertiary sewage treatment is currently being examined by researchers from the University of Michigan (Engineering News Record, 1975). Preliminary studies indicate that the natural processes at work in a marsh may provide final treatment of secondary effluent without ecological disruption.

Chemical methods include ammonia stripping, ion exchange, electrodialysis, and breakpoint chlorination. In the ammonia stripping method, the pH value of the wastewater is adjusted to 10 or above and the water is agitated in the presence of air. By this method more than 85 percent of the ammonia nitrogen is released as a gas. This generally is done in a packed tray tower equipped with an air blower. The process causes air pollution problems by the release of ammonia gas and ammonium sulfate aerosols. Calcium carbonate is deposited within the treatment tower as a product of the use of lime (CaO) to control pH (Eliassen and Tchobanoglous, 1969).

Ion exchange is a unit process in which ions of a given species are displaced from an insoluble exchange material (resin) by ions of different species from wastewater. With the use of resin as an anion exchanger, anionic nitrogen compounds can be removed efficiently. In this process, however, material tends to foul the resin by selective adsorption on the resin particles. To make ion exchange economical for tertiary treatment, it is desirable to use regenerants and restorants that remove both the inorganic anions and the organic material from the spent resin (Eliassen and Tchobanoglous, 1969).

Electrodialysis uses an induced electric current to separate the cationic and anionic components in the wastewater by means of selective membranes. Membrane fouling is the major problem with the electrodialysis. Acidification of the wastewater is required to reduce membrane fouling (Eliassen and Tchobanoglous, 1969).

Breakpoint chlorination provides a selective means for ammonia removal. The process is discussed in detail on pages 286-294. The end products of the process are chiefly gaseous elemental nitrogen and small amounts of nitrate and a nuisance residual of nitrogen trichloride. Neutralization of the excess acids produced with proper mixing during the process is required to reduce the formation of nitrogen trichloride (Presley et al., 1972). The advantage of breakpoint chlorination is that removal of ammonia and disinfection of effluent can be achieved in one process.

The physical methods of nitrogen removal include reverse osmosis and distillation (Eliassen and Tchobanoglous, 1969). Reverse osmosis involves the enforced passage of water through cellulose acetate membranes against the natural osmotic pressure. This method has been used for the production of fresh water from salt water. A major problem associated with reverse osmosis for desalinization is membrane fouling. In the application of this method to wastewater treatment, pretreatment of the water with sand filtration will reduce membrane fouling.

Distillation involves vaporization of wastewater by heating and subsequent condensation of water vapor. In practice, a variety of different processes exists, such as flash distillation, differential distillation, and steam distillation. They are all quite expensive.

The efficiency of nitrogen removal and costs are shown in Table 54. In order to reduce the ammonia concentration from 1.5 mg/l to 0.4 mg/l, removal or conversion of ammonia to nitrate at an efficiency of 74 percent would be required for the proposed plant. Among these processes, distillation would be the most effective, but the most expensive method. However, other methods such as ammonia stripping, anaerobic denitrification, algae harvesting, ion exchange, and reverse osmosis would be effective, if properly designed and operated. Electrodialysis would be the least cost-effective. Breakpoint chlorination followed by dechlorination would be an effective method of removing ammonia while disinfecting the effluent, and would be compatible with the ammonia stripping method in terms of costs.

4. Chlorination-Dechlorination and Ozonation

Chlorination is a common and cost-effective way of disinfecting the effluent from a sewage treatment plant. However, residual chlorine in the effluent can cause severe biological effects on aquatic flora and fauna in receiving streams. One way of reducing the biological effects is to dechlorinate the chlorinated effluent before discharging it to natural water systems. Ozonation of effluent proves to be an effective method with wide acceptance in effluent disinfection, and at the same time, increases the dissolved oxygen level in the effluent. This section starts out with discussion of various alternative methods of effluent disinfection followed by the discussion of dechlorination methods, and concludes with a discussion of ozonation methods.

The most common disinfectants are the oxidizing chemicals such as bromine, iodine, chlorine, ozone, and other non-oxidizing chemicals such as acids and alkalies. Bromination, chlorination, and iodination of the sewage effluent leave bromine, chlorine, and iodine, respectively, in the effluent. Disinfection by addition of acids or alkalies is not effective unless the pH value of the water is less than 3 or greater than 11. Except for ozonation, all the disinfection treatment processes which involve the addition of chemicals, discussed above, leave significant amounts of dissolved solids in the effluent.

Bromination and iodination are not commonly used for sewage treatment, because bromine and iodine are more costly than chlorine. Effluent disinfection by the addition of acids or alkalies requires large amounts of acids or alkalies and further requires neutralization of the effluent to pH 7. Only the chlorination-dechlorination and ozonation methods and their cost-effectiveness are considered here.

Chlorination is used in wastewater treatment operations for disinfection and reduction of BOD, ammonia-nitrogen, color, odor, cyanide, and hydrogen sulfide concentrations. In a plant the size of the proposed Delaware facility, chlorine as free chlorine gas is dissolved in a sidestream of water. Once the gaseous chlorine (Cl_2) goes into solution, it reacts almost immediately with the water (H_2O) to form hypochlorous acid (HOCl) and hydrogen and chloride ions (H^+ and Cl^-). The hypochlorous acid (HOCl) ionizes to form hypochlorite ions (OCl^-) and hydrogen ions (H^+). The ratio between elemental chlorine (Cl_2), hypochlorous acid (HOCl), and hypochlorite ions (OCl^-) depends on the pH of the solution. At the anticipated pH level of the effluent (6-7), hypochlorous acid (HOCl) should comprise 60-80 percent of the chlorine added, and elemental chlorine (Cl_2) should be almost absent. These three forms of chlorine are referred to as "free available chlorine residuals".

Ammonia (NH_3), present in the wastewater, reacts with the free available chlorine to form monochloramines (NH_2Cl), dichloramines ($NHCl_2$), and nitrogen trichloride (NCl_3). At the pH levels of wastewater, mono- and dichloramines will predominate. These compounds are referred to as "combined available chlorine residuals" and have some disinfecting ability; however, this disinfecting property is considerably less than that of free available chlorine residuals (Fair and Geyer, 1963).

By the addition of extra chlorine and the provision of adequate detention time, the ammonia may be completely oxidized, resulting in the formation and release of elemental nitrogen gas. This process is referred to as "breakpoint chlorination" and is one method of nitrogen reduction in wastewater. In general, the chlorine dosage required to achieve breakpoint on a molar basis is twice that of the ammonia. The necessary contact time must be determined by on-site tests (Fair and Geyer, 1963).

In addition to reacting with water and ammonia, chlorine will also react with organic matter in the sewage, thereby reducing the BOD but also forming complex organic chloramines. Certain of these compounds are possible health hazards.

Free and combined available chlorine compounds at varying concentrations are toxic to aquatic organisms. Examples of the effects of various concentrations of chlorine residuals on various fish types are listed in Table 48 on page 229 (Brungs, 1973; Becker and Thatcher, 1973). The recommended safe level for chlorine residuals in warm-water aquatic systems is 0.01 mg/l (Brungs, 1975). Assuming a river flow rate of 2.93 million gallons per day (mgd) (7-day 10-year low flow), and an effluent discharge of 1.5 mgd, the required residual chlorine concentration in the effluent, to keep the stream chlorine concentration below 0.01 mg/l, would be approximately 0.03 mg/l. Effluent residual chlorine levels of less than 0.01 mg/l are possible and desirable.

Reduction of chlorine residuals in sewage effluents may be accomplished by various methods, including aeration, sulfur dioxide addition, or granular activated carbon filtration. Aerating the chlorinated effluent for 15 minutes to 8 hours will reduce the concentrations of various related compounds, including elemental chlorine (Cl_2), hypochlorous acid (HOCl), dichloramine ($NHCl_2$), and trichloramine (NCl_3) (Fair and Geyer, 1963;

Hinde Engineering, 1975). Monochloramine, which is an important chlorine residual, is not removed. Consequently, the resulting residual chlorine concentration in the effluent is difficult to estimate without actual operating data. Aeration does not remove complex organic chloramines, but it increases the dissolved oxygen concentration in the effluent.

Sulfur dioxide addition is also a suitable technique for dechlorination. Sulfur dioxide reacts with chlorine to form sulfuric and hydrochloric acids; consequently, a provision for pH adjustment should be provided. Sulfur dioxide in the gaseous state is dissolved in the chlorinated effluent until the concentration of SO_2 exceeds that of the residual chlorine. At residual chlorine concentrations of 2 and 4 mg/l, approximately 37.5 and 62.6 pounds per day of SO_2 are required. A relatively short contact time of ten minutes is required. The resulting residual chlorine concentration should be less than 0.01 mg/l. Complex organic chloramines are not removed by the addition of sulfur dioxide. Furthermore, chlorides and sulfates, as end products of the method, are left in the effluent. The increase of total dissolved solids load from this method ranges from 300 to 600 pounds per day as compared to the TDS load of 29,860 pounds per day of the plant at flow rate of 6 mgd.

Granular activated carbon may also be used for dechlorination. It is more commonly used to adsorb organic matter and other compounds responsible for BOD and odor. Certain types of activated carbon systems, such as downflow units, also act as filters and remove suspended solids. Filtration may clog the downflow units and the BOD in the effluent may encourage the growth of microorganisms on the carbon. Backwashing of the downflow units reduces clogging and biological accumulations. Counter-current upflow units do not clog, hence do not require backwashing. Adsorption is a non-consumptive surface phenomenon, and the carbon can be regenerated and reused. In dechlorination, the chlorine is absorbed by the pores in the carbon granules and reacts with the carbon to produce carbon dioxide gas and hydrochloric acid. Therefore, in this process, carbon is consumed.

Activated carbon systems are more complicated and expensive to construct and operate than either aeration or sulfur dioxide units. A capital cost comparison of aeration, sulfur dioxide, and granular activated carbon dechlorination systems is presented in Table 54. A sulfur dioxide system has the lowest capital cost; the aeration units, depending on electrical rates, should have the lowest operating costs. Aerating systems, however, do accomplish the necessary goal of increasing the dissolved oxygen concentration in the effluent. A combined system using aeration and sulfur dioxide might be very cost-effective. The aeration time required to raise the dissolved oxygen concentration is less than the aeration time necessary to dechlorinate.

Assuming that the effluent prior to discharge has a dissolved oxygen concentration of 1 mg/l and that the final effluent must have 5 mg/l, then 4 mg/l or approximately 50 pounds of oxygen per day must be added. A typical design figure for aeration units is four pounds of oxygen transferred per horse power hour. At this rate, approximately 96 pounds of oxygen per day could be provided by a one horse power unit.

Allowing for BOD, residual dissolved oxygen requirements, and continuous supply regulation, two 2 horse power units would be needed. With a one hour detention time (instead of 8 hours), this system should be able to meet dissolved oxygen requirements. For dechlorination, sulfur dioxide could be fed into the tank using the air bubbles for mixing. This hybrid system is more expensive than the single dechlorination system, such as aeration or sulfur dioxide addition, but it appears to be the least expensive dual purpose system.

The dechlorination capacity depends on the residual chlorine concentration in the chlorinated wastewater. A pH of 7, a temperature of 21°C, a final residual chlorine concentration of 0.01 mg/l, and a loading of 1 gpm flows/foot^3 of carbon are assumed for the purpose of subsequent calculations. Using these assumptions, the dechlorinating life of 1042 cubic feet of granular activated carbon for incoming residual chlorine concentrations of 2 and 4 mg/l is 5.3 and 1.7 years, respectively.

TABLE 54. Costs of Various Dechlorination Processes

Process	Capital Cost in $ (1.5 mgd plant)	Operating Cost in $/1000 gal
Aeration	150,000	---
Sulfur Dioxide	50,000	.016
Granular Activated Carbon	300,000	.011
Combined Aeration, Sulfur Dioxide	80,000	.016+

Source: Calgon Corporation, 1975;
Hinde Engineering Corporation, 1975

Many complex organic compounds including chlorinated forms will be absorbed into the carbon surface. The resulting effect on the dechlorinating ability of the carbon should not be significant and the overall quality of the final effluent should be improved.

Use of ozone as a disinfectant as compared to conventional chlorination and dechlorination is increasing for a number of reasons. Ozone is a highly effective disinfectant and leaves no residuals and no dissolved solids. In addition to the bacterial kills, ozone treatment can purge virus particles and pollutants, such as surfactants, that survive treatment with chlorine. Coin (1969) has reported that a little more than 3 minutes of ozone treatment, with 0.4 milligram of ozone per liter of water, kills all three types of polio virus. Ozone is also capable of higher reductions of residual BOD and total organic carbon (TOC) than carbon adsorption polishing, and is fully cost competititve. Furthermore, ozone is more effective than chlorine against the major taste- and odor-causing compounds, such as phenols and amines. Chlorination merely converts these into compounds that are less resistant to oxidation (Environmental Science and Technology, 1970). The shorter half-life (20 minutes) of ozone in water, as compared to chlorine, limits its application because it provides no residual protection against contamination. This problem, quite pertinent to the treatment of drinking water, apparently does not exist in the treatment of secondary effluent.

In the process of ozonating effluent considerable amounts of air or oxygen are introduced into the waste, thus increasing the dissolved oxygen level of the receiving stream. Therefore, if the ozonation process were to be adopted for the project, the post-aeration process could be eliminated.

The two major inputs for a typical ozonation system are air or oxygen, and electricity. The air usually is first cleaned by filtration, its moisture removed by a refrigerative unit, and the air is further conditioned by air adsorptive dryer prior to ozonation. Electrodes with high voltage up to 20,000 volts are used to produce a corona in the air supply to generate ozone. The concentration of ozone generated is

APPENDICES

Technical data in support of the information contained in the report are presented in Appendices A through F. A record of private communications appears in Appendix G.

Appendix A	-	Factors Affecting Development
Appendix B	-	The River-Bank Trees Along the Olentangy River
Appendix C	-	Letter from C. E. Faulkner
Appendix D	-	Letter of US Army Corps of Engineers NPDES Permit Processing Guidelines No. 26
Appendix E	-	Visibility Analysis
Appnedix F	-	Extracts of Applicable Laws of the State of Ohio
Appendix G	-	Private Communications

APPENDIX A

FACTORS AFFECTING DEVELOPMENT

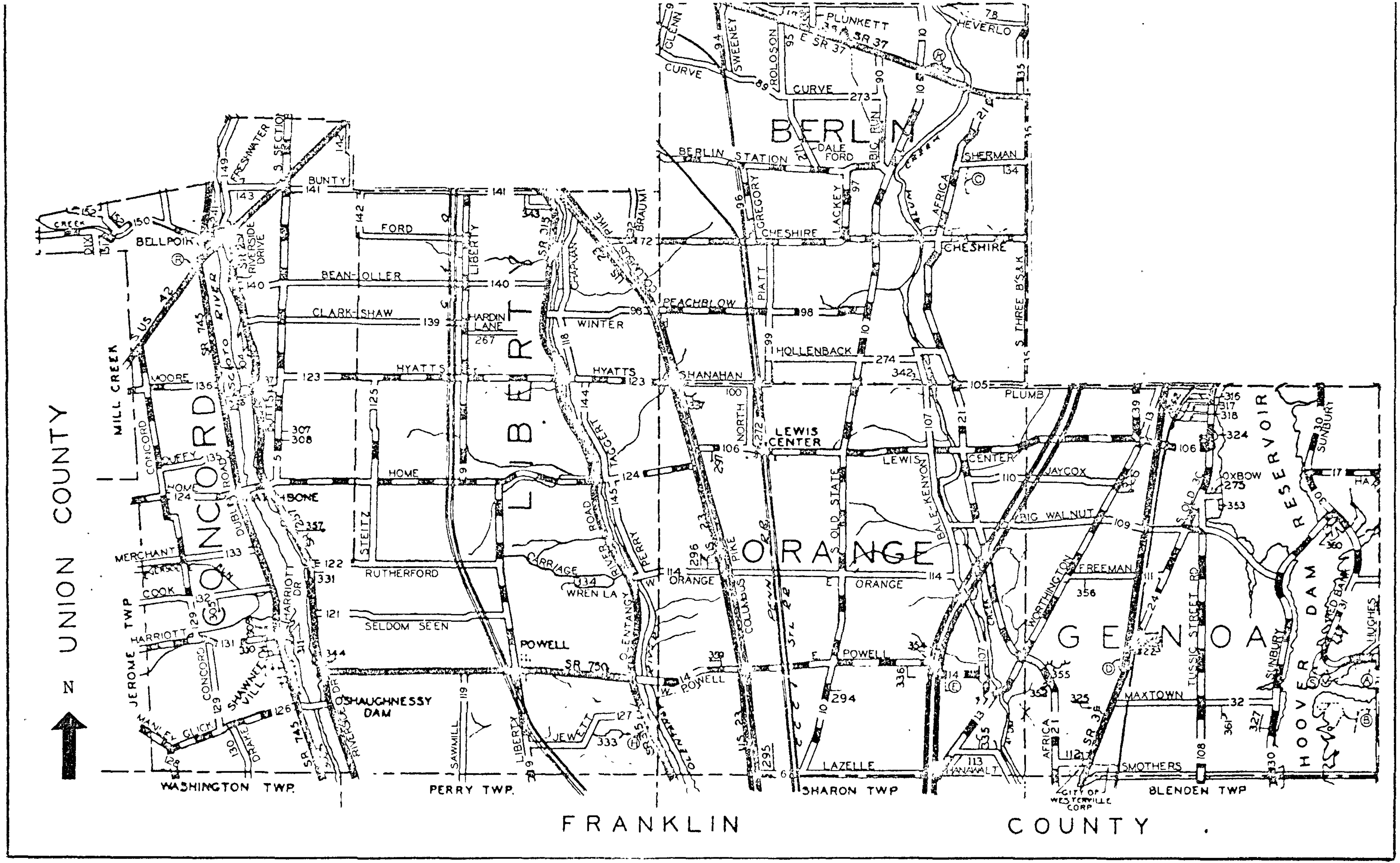
Five townships, Berlin, Concord, Genoa, Liberty, and Orange, form a close approximation of the proposed project service area in Delaware County. A geographic description of each of the geographic boundaries of these townships are displayed in Figure A-1. Factors affecting the location of development within each township are discussed in turn.

1. Berlin Township

Major factors affecting the development potential of Berlin Township are accessibility to major highways, attractiveness of and accessibility to the Alum Creek Reservoir, depth to bedrock, soil drainage characteristics, and the suitability of soils for septic systems. Accessibility of most of the township to the City of Delaware is excellent and both the interchange of US Route 36 on Interstate 71 and US Route 23 allow good access to population centers in Franklin County. The Alum Creek Reservoir should attract considerable numbers of recreation seekers, but is not expected to attract extensive residential development.

Shallow depth to bedrock in the area of Peachblow and Platt Roads might cause difficulty in the construction of homes with basements. Generally, most of the area west of the reservoir has a high water table and is poorly drained. Almost the entire township is poorly suited for septic tanks. Each of these soil characteristics contributes substantially to the costs of development.

Existing residential development is a mixture of old farm structures and newer large lot, single family homes. These residential areas are located in strips along existing roads; especially near Cheshire on



Scale in miles

0 1 2

Figure A-1. Map of Berlin, Concord, Genoa, Liberty, and Orange Townships

Source: Delaware County Engineer's Office, 1969.

Cheshire Road, along Peachblow Road, and along Shanahan Road. Cheshire Village has experienced a moderate growth rate. Small areas of commercial development are located near the northeast and southwest corners of the township. Industrial uses are virtually non-existent in the township.

There is a potential for moderate development in Berlin Township. Most of this development should be residential, although there may be the addition of small areas of neighborhood commercial development oriented to serving users of the Alum Creek Reservoir. Large lot, single family residential development may occur in strips along existing roads near US Route 23, near the intersection of US Route 36 with Interstate 71, and in the area near the Village of Cheshire.

Most of the small expected amounts of neighborhood commercial development will probably occur near US Route 23, near the Village of Cheshire and near the interchange of US Route 36 on Interstate 71. Some light industrial development can also be expected near the interchange of US Route 36 with Interstate 71. Residential development which can normally be expected near a newly constructed reservoir will probably not materialize here. The large acreage of government-owned land around the reservoir will preclude home sites next to the water and severely restrict the number of potential home sites within sight of the water.

2. Concord Township

Major factors affecting development in Concord Township are accessibility and soil conditions. Interstate 270, with interchanges at both Sawmill Road and State Route 161, provides easy access between Columbus and most parts of Concord Township. Most of the soils outside of the Scioto River Drainage Basin area are of a Blount-Pewamo-Morley association. These soils present moderate to severe limitations on development that does not have central sewering.

The Scioto River Drainage Basin area contains Milton-Morley soils which, primarily because of their better drainage characteristics, offer greater advantages to development that is not centrally sewered. As a consequence, most current development in Concord Township is located near the Scioto River. Erosion is a potential problem in almost all areas of the township.

Current development in Concord Township is predominately residential. The two incorporated areas are Shawnee Hills and part of Dublin. Shawnee Hills has less expensive and older housing than the areas immediately around it. Thus, much recent housing development has taken place in the area around, but not in, Shawnee Hills. A high income residential area is being actively promoted in the Dublin incorporation. Other residential development in the township is located in scattered sites on existing thoroughfares and in a few small subdivisions. Generally, this development lies relatively close to the Scioto River.

Commercial development is entirely of a neighborhood shopping and service type and is scattered on a few small sites throughout the township. Industrial development consists of a small site northwest of Shawnee Hills and a quarry adjacent to O'Shaughnessy Reservoir.

Potential development for that part of the township which does not have central sewers is greatest in the area near the Scioto River.

This development is primarily expected in the Shawnee Hills-Dublin area. Most development will be residential, although some small commercial and industrial uses may be attracted to the township.

3. Genoa Township

Major factors affecting the development potential of Genoa Township are restrictive zoning, accessibility, growth pressures caused by the presence of Westerville, and soil conditions. Genoa Township has two separate zoning ordinances. One ordinance, which affects only small portions of the proposed service area, allows for the reduction in minimum lot size required for planned unit developments. The other ordinance, which affects much more of the proposed service area, does not currently allow such reductions in the existing large minimum lot size. Accessibility to areas within the township, to Westerville and to Columbus is excellent. Growth pressures from Westerville, already expressed by a small annexation, are mitigated by restrictive zoning ordinances. Poor drainage, a high seasonal water table and poor suitability for septic fields contribute to the cost of any development in that portion of the township which lies in the project area.

Existing development is predominately residential of both strip and subdivided varieties. Within the project area there are some strip residential areas along Worthington-Galena Road and several small subdivisions near Africa Road and Worthington-Galena Road. Although commercial development is virtually non-existent, there is a commercially zoned area near the township line on the east side of Africa Road. Industrial development in the project area is insignificant in area.

Potential development within that portion of the project area lying in Genoa Township will be almost exclusively residential with some supportive neighborhood commercial uses. Construction of a proposed interchange at Big Walnut Road and Interstate 71 would enhance residential development and possibly light industrial development along Big Walnut Road. A possible interchange at Powell Road in Orange Township would enhance the same type of development, but the distance from the boundary of Genoa Township to the interchange would limit the amount of development in Genoa Township. Strict zoning regulations, if continued, will most certainly retard rapid future development of all types.

4. Liberty Township

Developmental factors in Liberty Township are planned major growth for Powell, accessibility to Columbus and the City of Delaware, and soil conditions. The Village of Powell anticipates large amounts of growth in the future and is presently in the first steps of implementing a land use plan and instituting a planning process. The plan envisions the rapid expansion of Powell from a village of approximately 400 people to a city of 30,000 people. Interchanges on Interstate 270 with Sawmill Road and State Route 315 provide excellent access to Columbus. State Route 315 provides easy access to the City of Delaware.

Soil conditions present severe limitations for septic tanks, except for small amounts of Fox soils in the Fox-Eel associations. All soils have poor bearing values and most soils have poor drainage. The poor bearing values and poor drainage contribute to development costs. Milton-Morley soils (steeper slopes) and Fox soils (mostly near the

Olentangy River) are well drained but need erosion controls to facilitate environmentally sound development.

Existing development consists of residential, commercial, and light industrial uses. Major residential areas consist of strip development along Seldom Seen Road, Sawmill Road, and the Jewett Road-Olentangy River Road area, small clusters in Hyattville and Powell, and several new subdivisions near Olentangy River Road. Most commercial usage is in scattered parcels adjacent to US Route 23, or clustered at the center of the Village of Powell. The major industrial users are Searle Reference Laboratories, Inc. (just north of Powell) and North Electric Research Center (on US Route 23).

The greatest potential for development in Liberty Township is for residential uses. However, there is substantial potential for small scale commercial and light industrial development. The major concentrations of residential development are expected in the area covered by Powell's land use plan. The plan visualizes the first major residential growth occuring to the southeast of the present boundaries of the Village of Powell.

A proposed subdivision, Liberty Woods, located just west of the Village of Powell may provide another node of residential development. Neighborhood commercial uses are expected to develop near subdivisions. Larger commercial uses are expected to eventually develop near the Village of Powell and along US Route 23 as the population density increases. Some additional industrial development is expected both along US Route 23 and along the Chesapeake and Ohio Railroad.

5. Orange Township

Major determinants of development potential in Orange Township are accessibility to major highways, slope of the land, drainage, suitability for on-site sewage disposal, and bearing strengths of the soils. Accessibility to Orange Township from other townships is good. US Route 23 provides excellent north-south access to the western portion of the township and Interstate 71 extends across the eastern portion. Although there are no interchanges located within the township one has been proposed for construction, either at Lewis Center and Big Walnut Roads or at Powell Road.

Accessibility to most points within the township is excellent; County Roads 10, 21, 13 and 106 serve as feeders to State Routes 315 and 750 and US Route 23. Slopes that might hinder development are located along the Olentangy River, Alum Creek and tributary streams. Most of the area west of Alum Creek Reservoir and west of Interstate 71 have soils with combinations of poor drainage, high water table, low bearing strengths, and poor suitability for sewage disposal. These factors add to the cost of, but do not preclude, development.

Existing development is primarily strip residential along existing highways. A large amount of this residential development consists of new homes. Commercial development is concentrated in strips along US Route 23. Swan Rubber Company on US Route 23, employing less than 100 people, is the only major industrial activity in the township.

Development potential is strong in several portions of Orange Township. A 244-acre residential complex is planned west of US Route 23 and north of Powell Road. Impetus provided by the building of this complex will set the pattern for a major future node of development.

The increased accessibility to Columbus created by the completion of any interchanges on Interstate 71 will foster large amounts of development. An interchange at Lewis Center and Big Walnut Roads would enhance residential and commercial development both at the interchange and in the vicinity of Alum Creek Reservoir. Large incentives for residential development near the reservoir do not exist, because the government controls most of the land adjacent to or within sight of the lake. An interchange at Powell Road would enhance residential, commercial, and light industrial development along Powell Road and, in general, in the southern portion of the township. Planned improvements in the Penn Railroad may foster industrial development along its north-south traverse of the county.

APPENDIX B

THE RIVER-BANK TREES ALONG THE OLENTANGY RIVER

The following discussion describes the tree types present along the riverbank area of the proposed plant site on the Olentangy River. Their expected periods of existence and replenishment are presented in relation to their use as a buffer zone for a treatment plant west of the Highbanks Park. A sycamore-cottonwood-boxelder tree association predominates along the riverbanks; some oaks, beech, elm, willow, and maples are interspersed. All of these trees are found on a variety of soil types, but the alluvial river bottom areas of Ohio are excellent areas for their best and most rapid growth.

1. American Sycamore

The American sycamore, Platanus occidentalis, is one of the larger eastern hardwoods. Commonly, it can attain a height of over 100 feet and have a diameter of 3 to 8 feet. Growth is fast, and the sycamore can live 500 to 600 years. The minimum seed-bearing age for a sycamore tree is about 25 years, and its optimum seed production occurs between 50 to 200 years. Sycamore, generally, is not dependable for seed production after the age of 250 years. The tree usually bears a good seed crop every 1 or 2 years with some seeds produced every year. The sycamore seeds are dispersed from September through May of the spring following ripening. The seeds are widely scattered by the wind and are also carried by water. Water-borne seeds are deposited on mudflats along river courses. These mudflats usually provide favorable conditions for germination.

The best seedbeds for sycamore germination are on moist to wet soils. Reproduction in some instances can be greatly reduced or totally absent if the leaf mold and other forest litter is too deep. Sycamore seedlings require direct sunlight to survive. Under favorable conditions they develop and grow rapidly, at a rate of up to 3 or 4 feet in height the first year. The sycamore is fast-growing throughout its life. Open-grown sycamores have a large, usually irregular crown that may spread out to a diameter of 100 feet. Sycamore is generally classed as being intermediate in tolerance to shade and competitive ability, and can compete successfully with cottonwoods and willows.

2. Eastern Cottonwood

The eastern cottonwood, *Populus deltoides*, is a medium- to large-sized tree that can attain a height of 100 to 175 feet, and a diameter of 4 to 6 feet. The cottonwood is a relatively short-lived species; trees over 70 years old begin to deteriorate, and the maximum life span is no more than two centuries.

Seed production begins when the trees are about 10 years old. Flowering takes place between February and April before the leaves appear, and the fruit matures from April through August of the first year. Seedfall occurs during this period. The optimum seed-bearing age is from 30 to 40 years; good seed crops are the rule. Much of the seed is carried from the parent tree by wind and by water. Some water-borne seeds are left on mud silt deposits. Unless floating on or immersed in water, the cottonwood seed needs to reach a favorable seedbed and germinate very soon after falling from the tree. The seeds remain viable for several weeks or longer in water, but cannot endure more than a week of exposure under dry conditions. Germinative capacity averages about 88 percent. Seedlings grow very slowly at first but accelerate steadily and rapidly after about three weeks. Full light for a substantial portion of each day is needed by the seedlings once they are well established. Within the better part of its range, unmanaged cottonwood stands pass the peak of their growth in about 45 years. On the better sites, the trees often grow two-thirds to one inch in diameter and 4 to 5 feet in height per year up to 25 to 30 years of age.

The cottonwood is less tolerant to shade than any of its associates except willow. The willow generally is found on the wetter areas in which the cottonwood occupies the slightly higher areas. Because of its intolerance and the absence of suitable seedbeds under existing stands, the cottonwood does not generally succeed itself, except along those river areas where there is a significant deposition of fresh soil material that serves as suitable seedbed material.

3. Boxelder

The boxelder, Acer negundo, is a common and well-known maple. It is a small to medium-sized tree that reaches a height of 50 to 75 feet and a diameter of 2 to 4 feet. The boxelder is characterized by an irregular bole (trunk), a relatively shallow root system, and a bushy, spreading crown. It is most common on deep, moist soils and is perhaps the most aggressive of the maples in maintaining itself in unfavorable locations. The boxelder grows rapidly, but it is a short-lived tree usually of poor form.

It has sexes on separate trees with greenish-yellow staminate and pistillate flowers. The stamens are in drooping clusters while the pistils are in drooping groups. The seeds are winged, in a V-shape, and are from one and one-half to two inches long. The seed clusters hang on the trees throughout winter and fall in the following spring. Most boxelder seeds are dispersed by wind. Growth of the boxelder saplings after germination is usually rapid.

4. Bur Oak

The bur oak, *Quercus macrocarpa*, is a medium- to large-sized tree that can grow 80 to 100 feet tall with a diameter of 3 to 4 feet, and can live 200 to 300 years. It characteristically has a massive trunk with a broad, open crown of stout branches. The bur oak flowers shortly after the leaves appear; this period of flowering varies from about the first of April to about mid-June. The minimum seed-bearing age is around 35 years, and the optimum age is between 75 and 150 years. Good seed crops occur every 2 to 3 years. Light crops occur in the intervening years.

The acorns become ripe within the year and drop from the tree between August and November. Germination usually takes place soon after seedfall, and reproduction of bur oak in open bottom-land areas is often prolific. The root growth is rapid, and the taproot penetrates deeply into the soil before the leaves unfold. Bur oaks are relatively slow-growing trees. In the sapling stage the taproot development continues to be rapid, accompanied by abundant lateral growth. The bur oak is intermediate in shade tolerance.

5. Swamp White Oak

The swamp white oak, Quercus bicolor, is a medium-sized tree ranging from 60 to 90 feet in height and 2 to 3 feet in diameter. Some trees have been reported to be 7 feet in diameter and 100 feet tall. The root system is relatively shallow, but the tree is relatively long-lived, up to 300 years or more in some instances.

Good seed crops of swamp white oak generally occur every 3 to 5 years; light crops are produced during the intervening years. The minimum seed-bearing age is 35 years; the optimum age is between 75 and 200 years. The swamp white oak flowers in May or June, depending upon its location. The acorns are about one inch long and one-half to three-quarter inch in diameter, mature in 1 year and fall during the months of September and October. The principal dispersing agents for the acorns are rodents, gravity, and water. In the autumn the acorns germinate shortly after they fall from the parent tree and the root system grows and develops. This growth is inhibited until the following spring by low temperatures. The swamp white oak is intermediate in shade tolerance, and seedlings can become established in moderate shade conditions. In forest stands, the swamp white oak has a straight trunk with ascending branches and a fairly narrow crown.

6. Pin Oak

The pin oak, Quercus palustris, is a moderately large tree that normally grows to a height of 70 to 90 feet and a diameter of 2 to 3 feet. Some specimens 120 feet tall and 4 to 5 feet in diameter have been found. The pin oak is not a long-lived tree; it usually attains its physiological maturity in about 80 to 100 years. It has rapid height growth and the trunk is well defined and distinct throughout the crown. In open areas the crown is generally pyrimidal and symmetrical in shape. In the forest the pin oak is tall, straight, and has a relatively narrow crown.

The pin oak flowers in early April to mid-May when or just after new leaves appear. It takes from 16 to 18 months for the acorns to develop and they then ripen and fall from September to November. Germination occurs the following spring. Pin oaks bear seed between the ages of 25 and 80 years. During good seed crop years approximately 70 percent of the acorns are fully developed and sound as compared to only about 10 percent during the poorest seed years. When favorable temperature and moisture conditions exist, shoot growth of the seedlings starts about the time of leafing-out and continues throughout the summer. On typical pin oak sites, moisture is not a limiting factor for seedling survival.

Pin oak is more intolerant of shade than are elm and boxelder. It is more tolerant than the cottonwood and willow. The pin oak is a sub-climax tree, but it persists in wet soil areas because it produces an abundance of fertile seeds and grows more rapidly than most other trees in the association.

7. Beech

The American beech, Fagus grandifolia, under optimum growing conditions, may become 120 feet tall. Generally they average between 60 to 80 feet in height. They live from 200 to 300 years, and occasionally more than 300 years.

The beech flowers in late April and early May when the leaves are about one-third grown. They generally begin to produce seed when they are about 40 years old, and by the time they are 60 years old large quantities of seeds are produced. Good seed crops occur at 2 or 3 year intervals. The beech nuts require one growing season to mature, and they ripen between September and November. Seed fall begins after the first heavy frosts have caused the burs to open, and usually is completed within a period of a few weeks.

The beech seeds germinate from early spring to early summer. Sometimes germination is slow due to a dormant embryo. On either mineral soil or leaf litter, germination is good, but on excessively wet sites it is poor. The beech seedlings develop better under the shade of a moderate canopy than they do in open areas where the surface soil may dry out below the depth of the shallow roots. Beech is a very tolerant tree to shade conditions, and in some parts of its range, it is the most tolerant species in its association.

8. American Elm

The American elm, Ulmus americana, may grow in the Lake States to a height of 100 to 125 feet and live 200 years with 300 years not being rare. The diameters of forest-grown trees may be up to 4 to 5 feet. This species matures at about 150 years of age.

The smooth flower buds of the elm swell in mid-April to early May and appear 2 to 3 weeks before the leaves unfold. The elm is mostly wind-pollinated, and the flowers are largely self-sterile. Pollination may be hampered during a wet spring since the flowers' anthers will not open in a saturated atmosphere. The fruit ripens in June, and seedfall is usually completed by late June.

Seed production by the American elm may begin in saplings as early as 15 years of age, but this fruiting is seldom abundant before the trees are 40 years old. After this age, seed production continues to be abundant until the trees are about 150 years old. In closed stands of trees the seed production is greatest in the exposed tops of the trees. The winged seeds are light and readily spread by the wind. The elm seeds usually germinate soon after falling, but some may remain dormant until the following spring.

The elm seedlings can become established on moist litter and decaying material such as logs or stumps but not as readily as on mineral soil. During the first year, their best growth is with about one-third full sunlight; after the first year or two, best growth is made in full sunlight. The depth of rooting varies with soil texture and soil moisture. In wet soils, as along river courses, the root system is wide spread and most of the roots are within 3 or 4 feet of the surface.

The elm is intermediate in shade tolerance among the eastern hardwoods. Once it has become dominant in a mixed hardwood stand, it is seldom overtaken by other species. However, it also persists as an understory species under such species as cottonwood and willow. The Dutch elm disease caused by the wilt fungus, <u>Ceratocystis ulmi</u>, is presently responsible for serious losses of both elm shade and forest trees throughout the East and Midwest. This fungus is carried on the bodies of bark beetles brought to this country presumably in a shipment of elm veneer logs from Europe. Due to its continued spreading across the country, there is a possibility that the elm trees present in the buffer zone along the river may be affected by this disease. If this does happen, then the tall and long-lived elms will be lost and will not be able to serve as part of the buffer zone for the treatment plant.

9. Black Willow

The black willow, Salix nigra, can grow to a height of 140 feet with a diameter of 3 to 4 feet. The black willow is a short-lived tree. The greatest age recorded for a sound tree is 70 years. The average black willow matures in 55 years.

Seed production can begin when the tree is 10 years old, but the optimum seed-bearing ages are from 25 to 70 years. The trees usually have good seed crops almost every year with only a few interspersed poor crops. Rare failures result from late freezes after the flower buds have begun to open. Flowering takes place in May or early June, and usually occurs after the leaves appear. The seeds mature and fall between April and July of the following year. When the seeds fall, the long silky hairs act as wings for the seed. The seeds are widely distributed by wind action and water systems. Unless the willow seed is floating on water, it must reach a suitable seedbed within 12 to 24 hours, because its viability is greatly reduced by only a few days of dry conditions. The germinative capacity is usually high and no dormancy is known. Very moist exposed mineral soil is best for satisfactory germination and early development. Full sunlight promotes rapid growth once the seedling is well established. Seedlings, in a favorable environment, may often grow as much as 4 feet in height the first year. Moisture is a controlling factor, and the seedlings grow best when there is abundant moisture available throughout the growing season.

Open-grown willows along stream and river bottoms are generally limby and have a fairly large canopy. The willow is also a very weak tree and is especially subject to wind breakage. Willow is less tolerant to shade than any of its associated trees.

10. Red Maple

The red maple, Acer rubrum, may grow under ideal conditions to a height of 120 feet and a diameter of 5 feet. However, average mature red maples are usually from 60 to 90 feet in height and from 1-1/2 to 2-1/2 feet in diameter. It is a short to medium-lived tree that seldom lives longer than 150 years. In northern hardwood associations, red maple begins to give way to sugar maple and other more tolerant hardwoods after about 80 years of age.

The red maple is one of the first trees to begin flowering in the spring. The flowers are perfect structurally but never functionally perfect. The red maple has a tendency to have the sexes on different trees. Thus, some of the trees are entirely female, some entirely male, and some have both male and female flowers, often found on different branches. The red maple usually has a good seed crop every year. The fruit, a samara, ripens during the period from March to late June. The seed of the red maple is the lightest of all maple seeds and their dispersant is wind.

The major portion of the seeds germinate in the early summer soon after falling, but some lie over until the following spring. The seeds do not need much sunlight to germinate. A thin layer of hardwood leaf litter poses no impediment to germination if the underlying soil is moist.

Seedlings on wet sites tend to form short taproots and a long, well-developed lateral root system. When favorable moisture and light conditions are available, the seedlings grow rapidly at a rate of 1 foot for the first year, and 2 feet or more annually during the next few years. Growth is rapid during early life, particularly during the pole stage, but later growth is not often as well sustained. The red maple is a subclimax species.

11. Silver Maple

The silver maple, Acer saccharinum, can reach 2 to 4 foot diameters and heights ranging from 70 to 120 feet. Some trees have occasionally grown to diameters of 5 feet or more. Under good moisture and light conditions it may grow as much as one-half inch in diameter a year. Its most rapid period of growth is during the first 50 years. The silver maple is a short-lived tree that seldom lives over 125 years.

The silver maple flowers from February to April, and its fruit ripens from April to mid-June. The flowers are vulnerable to frost damage due to this early flowering habit. The silver maple is a very prolific seeder, and it usually has a good seed crop every year. It has the largest sized seed of all the native maples. Forest-grown trees begin their seed production when 35 to 40 years of age. The seeds, after they have ripened, fall over a period of 10 to 20 days during the spring. They are largely distributed by wind, but some are also disseminated by water. Due to the seeds' sensitivity to drying, their viability is so transient that they must rapidly germinate after falling. When the seeds are dispersed their moisture content is approximately 60 percent. They will experience a complete loss of viability when their moisture content drops to 30 to 40 percent.

The best seedbed for the seeds is moist mineral soil with a considerable amount of organic matter. The seedlings' growth is rapid during the first year, and they may grow as much as 1 to 3 feet high. The silver maple is usually found in mixed hardwood stands, and it is moderately tolerant to shade on good soil sites.

12. Summary

Of the trees along the river bank area, the sycamore, cottonwood, bur oak, pin oak, American elm, black willow, and silver maple, will tend to be the tallest in the buffer zone. The other trees, the box-elder, swamp white oak, American beech, and red maple, are moderate in height and will also make up a substantial portion of the buffer zone. All of these trees, when considered together, will act as a barrier to reduce the visibility of the plant to the park areas and to help reduce the transmission of odors or noise from the plant. The additional planting of other evergreen and deciduous trees around the plant site would also reduce any visual impacts of the plant to the park areas.

The trees within this area should be able to reproduce and maintain themselves adequately throughout the life span of this proposed project. The soil and moisture conditions present in the buffer zone are adequate for growth and should be able to furnish good seedbeds for the trees to be replenished. This association of trees is a typical riverine grouping that is common along river systems in this part of the State of Ohio.

APPENDIX C

LETTER FROM C. E. FAULKNER

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Federal Building, Fort Snelling
Twin Cities, Minnesota 55111

IN REPLY REFER TO:
ES-PER

JUL 21 1975

Mr. Ned E. Williams
Ohio EPA
450 East Town Street
P.O. Box 1049
Columbus, Ohio 43216

RE: Powell Sewage Treatment Plant
Powell, Ohio
Board of County Commissioners
Delaware County
*OEPA Permit No: K 901 *AD*

Dear Mr. Williams:

The U.S. Fish and Wildlife Service has reviewed the referenced proposed facility and associated material describing the discharges and conditions under which the applicant proposes to operate the facility. This supercedes our letter of March 24, 1975. Our comments are submitted under the authority of and in accordance with the provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.).

On March 24, 1975, the Service sent a "no action" letter to the Ohio Environmental Protection Agency (EPA) to indicate that we did not have available resources, at the time, to make an investigation of the applicant's proposed facility and present our comments and recommendations. The subject permit became effective May 6, 1975. Since that time, possible problems of having the sewage treatment plant (STP) located at the proposed site and discharging into the Olentangy River have been brought to our attention by several sources. For this reason a biologist from our Lebanon, Ohio, field office made an onsite investigation of the proposed plant site on May 28, 1975. Our concerns, which are explained below, are followed by recommendations that we have determined to be necessary to protect fish and wildlife resources of the affected areas.

The applicant proposes to construct a sewage treatment plant with an average effluent flow of 1.5 million gallons per day (MGD) approximately one-fourth mile north of the Delaware-Franklin County line. We understand that the location of the STP will be within the flood plain but above the 100-year flood level. A March 28, 1975 memorandum from the U.S. EPA further indicated that the initial capacity of the STP would be 1.5 MGD with a 3.4 MGD peak flow capacity. Further expansion is planned to 6.0 MGD with 9.6 MGD peak flow. The effluent will enter the Olentangy River opposite the Highbanks Metropolitan Park located north of the Franklin-Delaware County line. The affected reach of the Olentangy River represents one of several streams in central Ohio with a water quality adequate to support a substantial warmwater sport fishery as indicated by the following surveys.

In a partial creel survey conducted on the Olentangy River from June 3, 1974 to September 24, 1974 (Weber, 1974) fishermen were interviewed on each of the 49 survey days at three 1,000-meter reaches of the river--at Powell Road, I-270, and Henderson Road. The Powell Road site is characteristic of the natural river and is located about 1 mile upstream from the proposed outfall. At the intersection of Interstate 270, the Ohio Department of Transportation has constructed a series of 5 artificial riffle-pool complexes which provide fish habitat along with a well maintained public access. This area is located about 2 miles downstream from the proposed outfall. The sampling area at Henderson Road, 4 miles below the outfall, is characteristic of an old channelized river in an advanced stage of recovery. The creel census data was extrapolated to include the entire June-September period for these three sites. The summarized data follow:

Total fishermen	1,560
Number fishermen-hours	2,753
Number of fish caught	1,079

Groups and species of fish caught expressed as a percentage include:

Rock Bass	34%
Sunfish	29%
Smallmouth bass	26%
Channel catfish	6%
Other	5%

More detailed creel census information is given in Table 1 of the Appendix. In addition, extensive electrofishing has been done in these three 1,000-meter sections of the river. This data is compiled by month in Table 2 of the Appendix. The fish population, which includes smallmouth bass and pan fish in abundance, is indicative of a healthy warmwater stream environment.

The Ohio State University, Department of Zoology, conducted other fishery surveys of the affected reaches of the Olentangy River and have found the spotted darter (Etheostoma maculatum), an endangered fish for the State of Ohio (Ohio's Endangered Wild Animals, Publication 316, Ohio Department of Natural Resources, Division of Wildlife). Further, dead shells of two State of Ohio endangered mollusks, cob shell (Quadrula cylindrica) and northern riffle shell (Epioblasma torulosa rangiana), were found in a November 1974 study of the area (Stein, 1975).

Two parameters limited in the proposed permit could be detrimental to aquatic life, especially during low-flow conditions: ammonia which is limited to 1.5 mg/l for both a 30-day mean and a 7-day mean during the 12-month period, and residual chlorine which is limited to 0.5 mg/l.

Un-ionized Ammonia

Various fish species have yielded mean 96-hour LC_{50} values of 0.29 to 0.89 mg/l of un-ionized ammonia (Ball 1967). Exposure of carp to sub-lethal un-ionized ammonia concentrations in the range of 0.11 to 0.34 mg/l resulted in extensive necrotic changes and tissue disintegration in various organs (Flis, 1968). The maximum acceptable concentration of un-ionized ammonia in water is 0.05 of the 96-hour LC_{50}. We understand that the un-ionized ammonia form is very persistent in the aqueous medium. If pH and temperature remain constant, un-ionized ammonia remains toxic until dilution reduces the concentration.

The concentration of toxic un-ionized ammonia is calculated from the concentration of total ammonia limited in the proposed permit. Since the percentage of resulting un-ionized ammonia is dependent on pH and temperature, these parameters must be considered in the calculations.

Using a pH of 9 allowable in the proposed permit, and a maximum temperature of 30° C, the final limitation of un-ionized ammonia could be 0.81 mg/l (Thurston, et al., 1974). U. S. EPA (1973) recommends that the concentration of un-ionized ammonia be limited to 0.02 mg/l, or less, for the protection of aquatic life. A dilution factor of 40.5 would be required to reduce un-ionized ammonia concentration to non-toxic levels under these conditions. We understand from the U. S. Army, Corps of Engineers that the minimum flow release from the Delaware Reservoir is set at 5 cubic feet per second (cfs) or 3.232 MGD. The 7-day 2-year low flow for the Olentangy River at Stratford is 3.736 MGD (Cross, 1965). Under such conditions effluent from the proposed facility would only be diluted 2.5 times, thus allowing toxic concentrations of un-ionized ammonia beyond the mixing zone.

Although the above values are possible, the following table utilized ranges of data from the U. S. Geological Survey, Water Resources Data for Ohio collected at the gauging station on the Olentangy River near Worthington, Ohio.

Table 1 indicates that under certain physical and chemical conditions likely to occur in the Olentangy River, un-ionized ammonia will be toxic to aquatic life. During peak load operations of the STP and with the increased volume of discharge due to projected expansion of the applicant's facilities, the concentration of un-ionized ammonia remains toxic at a lower pH and temperature. Such concentrations of toxic ammonia could exist in the Olentangy River over extended periods of the year.

In addition to the insurance of a minimum release of 5 cfs from the Delaware Reservoir, we understand from Corps of Engineers personnel that additional water (20 to 40 cfs total) has been released from the

TABLE 1. Using 1.5 mg/l for the concentration of total ammonia nitrogen in the proposed permit, calculations of un-ionized ammonia are indicated for a pH range of 7.5 to 8.5 and a temperature range of 15°C to 25°C. Dilution factors (DF) required to obtain a safe concentration of un-ionized ammonia for aquatic life are shown in the second row. Dilution factors for volume of flow are based on 20 cfs (12.926 MGD) flow of the receiving water obtained from data presented in Table 2.

	pH 7.5/15°C	pH 7.5/20°C	pH 7.5/25°C	pH 8.0/15°C	pH 8.0/25°C	pH 8.0/25°C	pH 8.5/15°C	pH 8.5/20°C	pH 8.5/25
Concentration un-ionized ammonia (mg/l)	0.02	0.02	0.03	0.05	0.07	0.10	0.15	0.20	0.23
Dilution Factor (DF) required safe for aquatic life	1.0	1.0	1.5	2.5	3.5	5.0	7.5	10.0	14.0
1.5 MGD effluent provides 8.6 DF	+ *	+	+	+	+	+	+	- **	-
4.4 MGD effluent provides 3.8 DF	+	+	+	+	+	-	-	-	-
6.0 MGD effluent provides 2.2 DF	+	+	+	-	-	-	-	-	-
9.0 MGD effluent provides 1.4 DF	+	+	-	-	-	-	-	-	-

* + = safe concentration of un-ionized NH_3 for aquatic life after dilution with the receiving water

** - = toxic concentration of un-ionized NH_3 for aquatic life after dilution with the receiving water reservoir to aid in controlling pollution of the Scioto River below Columbus, Ohio. There is, however, no binding agreement for this pollution abatement measure. An independent water treatment firm uses water from the Olentangy River downstream from the Delaware Reservoir. If the STP is built, this firm plans to increase its operations, which would decrease flows of the river affected by the proposed STP. Table 2 indicates periods of the water years 1961 to 1970 when the flow in the Olentangy River was 20 cfs or less, at which times (11.4%) such flows, under conditions indicated, would be inadequate to dilute toxic levels of un-ionized ammonia. It should also be noted that low-flow conditions are usually associated with the summer and early autumn when water temperatures of the streams are near maximum upper limits. The minimum flow for the consecutive 10-year period was 7.6 cfs.

TABLE 2. Periods of 4 consecutive days (96 hours), or more, in which the flow in Olentangy River near Worthington was 20 cfs, or less for water years 1961 to 1970.

Water year (Oct.-Sept.)	Total number of days with flow at 20 cfs or less	Periods (of 4 or more consecutive days)
1961	35	Dec. 9-13; Dec. 17-Jan. 13
1962	50	May 23-27; Jun. 2-5; Jun. 8-11; Jun. 13-23; Jun. 25-Jul. 2
1963	26	Jun. 26-Jul. 1; Jul. 7-12; Sept. 4-11; Sept. 14-30
1964	110	Oct. 1-Nov. 6; Nov. 24-Jan. 17; Sept. 13-19; Sept. 21-30
1965	59	Oct. 1-Nov. 16; Jun. 21-30
1966	15	Sept. 13-19; Sept. 23-30
1967	36	Oct. 1-10; Oct. 12-15; Oct. 18-24; Sept. 13-27
1968	25	Oct. 1-5; Oct. 11-18; Sept. 14-21
1969	41	Oct. 12-16; Oct. 19-28;Oct. Nov. 6
1970	18	Sept. 13-30

Residual Chlorine

The toxicity of chlorine in water to aquatic life depends on the concentration of residual chlorine and choramines which are formed when chlorine is in contact with nitrogenous materials. Choramines, however, are not monitored in the proposed permit. It has been shown that total numbers of fish and diversity of fishes in receiving waters are drastically reduced by chlorinated sewage effluents (Tsai, 1968, 1970). Zillich (1972) determined that the threshold toxicity for fathead minnow (*Pimephales promelas*) was 0.04-0.05 mg/l residual chlorine. The survival of *Gammarus*, an important food source for game fish, was reduced at 0.04 mg/l and reproduction was reduced at 0.0034 mg/l.

U.S. EPA (1973) recommends that the concentration of residual chlorine in the receiving waters should not exceed 0.003 mg/l at any time or place for the protection of aquatic life. If 0.5 mg/l were discharged, a dilution factor of about 166 would be required to reduce residual chlorine concentrations to non-toxic levels. Again, under low-flow conditions of 3.736 MGD, the effluent would be only diluted 2.5 times.

It can be concluded that if concentrations of ammonia and residual chlorine described in the issued permit are allowed, important populations of game fish along with forage fish and aquatic invertebrates will be seriously reduced or eliminated in the Olentangy River.

RECOMMENDATIONS

It is recommended that the permit for the proposed discharge be modified to include the following conditions:

1. That the effluent limitation on ammonia nitrogen should be such that un-ionized ammonia concentration in the receiving waters will not exceed 0.02 mg/l. Further, we recommend that ammonia nitrogen be ultimately limited in the receiving waters as determined by bioassays, performed by the applicant within two years after permit issuance, using the receiving water and the most sensitive aquatic fish and/or invertebrate species in the locality to determine possible acute and chronic effects of the discharge on these organisms. Provided further, that the U.S. Fish and Wildlife Service and other interested Federal and State agencies will be afforded the opportunity to review the results of these bioassays and submit subsequent recommendations.

2. That the effluent limitation on residual chlorine should be such that it will not exceed 0.003 mg/l in the receiving waters.

We would appreciate a response to this letter as to what action you plan to take with respect to our recommendations.

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Sincerely yours,
(Sgd.) C. E. FAULKNER

Acting Regional Director

cc: U.S. EPA, Permits Branch, Chicago
Chief, Ohio Div. of Wildlife, Columbus
Mr. Boussu, NMFS, Gloucester
Mr. Edward F. Hutchins, Metropolitan Park District of Columbus and Franklin Counties, Westerville
Mr. John T. Cuneo, Enviro Control, Rockville
Mr. Harlen Hirt, Region 5 Planning Branch, U.S. EPA, Chicago

APPENDIX D

LETTER OF US ARMY CORPS OF ENGINEERS
NPDES PERMIT PROCESSING GUIDELINE NO. 26

DEPARTMENT OF THE ARMY
HUNTINGTON DISTRICT, CORPS OF ENGINEERS
P. O. BOX 2127
HUNTINGTON, WEST VIRGINIA 25721

REPLY TO
ATTENTION OF:

ORHED-HO

11 August 1975

Mr. John Cuneo
Enviro Consultants
1530 East Jefferson Street
Rockville, Maryland 20852

Dear Mr. Cuneo:

The estimated 7-day, 10-year low-flow for the Olentangy River below Delaware Dam, which you requested by phone 24 July 1975, is 5.2 c.f.s. The present low-flow release schedule for Delaware Lake is tabulated below:

Period	Scheduled Discharge
1 - 10 July	25
11 - 20 July	25
20 - 31 July	35
1 - 20 August	40
21 - 31 August	35
1 September-31 October	20
Minimum Release	5

Low-flow discharges as listed above are released from storage when inflows are insufficient to maintain the required flows.

Storage for low-flow releases were authorized during the planning phase of Delaware Dam and the schedule of releases has been periodically adjusted to better serve the needs of the Olentangy and Scioto River Basins.

Any future changes in release schedules or minimum discharges must be throughly investigated to ascertain that the best all-around use is made of the limited storage available for that purpose.

ORHED-HO   11 August 1975

Mr. John Cuneo

Median flow for the Olentangy River at Worthington, Ohio, is computed to be 66.6 mgd. Median flow is defined as that flow which is exceeded 50 percent of the time and is not necessarily the same as the mean or average flow.

Sincerely yours,

Harold W. Beemer

HAROLD W. BEEMER
Chief, Engineering Division

TABLE D-1. Number of Fish Caught in Olentangy River, May - November 1974

Month	Fish	Powell Road	I-270	Henderson Road
May	Channel Catfish and Bullheads	4	10	2
	Carp	36	64	86
	Smallmouth Bass	29	101	8
	Rock Bass	18	33	3
	Sunfish	92	153	11
	Other	54	87	125
June	Catfish and Bullheads	6	4	5
	Carp	46	64	109
	Smallmouth Bass	66	143	5
	Rock Bass	77	101	1
	Sunfish	134	501	61
	Other	133	138	123
July	Catfish and Bullheads	3	18	11
	Carp	86	71	60
	Smallmouth Bass	19	134	9
	Rock Bass	114	75	6
	Sunfish	153	424	113
	Other	103	239	110
August and September	Catfish and Bullheads	8	10	3
	Carp	55	44	18
	Smallmouth Bass	23	108	4
	Rock Bass	68	26	2
	Sunfish	119	191	34
	Other	125	153	117
November	Catfish and Bullheads	17	25	16
	Carp	43	46	48
	Smallmouth Bass	137	307	21
	Rock Bass	168	102	4
	Sunfish	169	494	72
	Other	426	257	450
May through November	Catfish and Bullheads	38	67	37
	Carp	266	289	321
	Smallmouth Bass	274	793	47
	Rock Bass	217	337	16
	Sunfish	667	1763	291
	Other	841	874	925

Source: Adopted from Griswold, Bernard, private communication, 1975

March 27, 1974
PPA: March 12, 1975

NPDES Permit Processing Guideline No. 26

QUESTION: What is the most stringent requirement OEPA will specify for existing public and semi-public facilities?

POLICY: Effluent requirements for existing public and semi-public facilities shall not be more stringent than the following:

1. Existing Semi-Public Facilities

Constituent	Monthly Average	Weekly Average
BOD_5	8 mg/l	12 mg/l
SS	8 mg/l	12 mg/l
NH_3, N, July thru Oct.	1.0 mg/l	1.5 mg/l
Nov. thru June	2.5 mg/l	5.0 mg/l
Fecal Coliform	200 counts/100 ml	400 counts/100 ml
P* (1)	1.0 mg/l	1.5 mg/l
DO *(2)	-	-

2. Existing Public Facilities under 0.5 mgd capacity

Constituent	Monthly Average	Weekly Average
BOD_5	10	15
SS	12	18
NH_3, N, July thru Oct.	1.0	1.5
Nov. thru June	2.5	5.0
Fecal Coliform	200	400
P*(1)	1.0	1.5
DO*(2)	-	-

3. Existing Public Facilities over 0.5 mgd capacity

Constituent	Monthly Average	Weekly Average
BOD_5	8	12
SS	8	12
NH_3, N, July thru Oct.	1.0	1.5
Nov. thru June	2.5	5.0
Fecal Coliform	200	400
P*(1)	1.0	1.5
DO*(2)	-	-

New sources are to be in conformance with the permit to install regulations.

*(1) See NPDES Permit Processing Guideline No. 24
*(2) DO: 6.0 mg/l minimum for warm water fishery; 6.5 mg/l minimum for cold water fishery.

POSITION PAPER

A. BOD_5 - Justification included in the position paper for NPDES Permit Processing Guideline No. 25.

B. Suspended Solids - The U.S. EPA's Technology Transfer Manual entitled Process Design Manual for Suspended Solids Removal - January, 1975, clearly indicates that monthly and weekly average effluent levels of 8 mg/l and 12 mg/l, respectively, can normally be met with the following processes, which are listed in order of reliability:

1.) Filtration of chemically treated secondary effluent.

2.) Filtration of effluent from secondary biological treatment.

3.) Secondary Treatment followed by microscreens.

Jeffrey Van Atten's thesis, which was prepared for the University of Cincinnati during 1969, entitled, A Field Study on the Effect of a Surface Sand Filter for Polishing the Effluent from an Extended Aeration Plant, disclosed that the suspended solids levels in question can be obtained.

In summary, the above treatment schemes are capable of obtaining the specified suspended solids effluent levels when properly applied.

C. Ammonia (NH_3) -

1.) Summer

a.) Suspended Growth Systems - Nitrification can be accomplished in either single-stage or two-stage systems. Single-stage systems include activated sludge, contact stabilization, extended aeration, and oxidation ditches.

The Flint Wastewater Treatment Plant, which was described in October, 1972 JWPCF, is an activated sludge plant which was designed to obtain an effluent ammonia nitrogen limitation of 0.5 mg/l. The design detention times in the aeration tanks, including the return sludge, was 7.0 hrs. at average flow and 5.0 hrs. at maximum flow.

The Ohio EPA monitoring program, conducted during the summer of 1973, disclosed that well operated extended aeration plants consistently produced average NH_3 - N effluent values of less than 1.0 mg/l. Six extended aeration plants are included in this survey. This efficiency was improved by surface sand filters, not appreciably affected by rapid sand filters and microstrainers, and reduced by tertiary lagoons. The study also indicated that oxidation ditches accomplish high degrees of nitrification (0.2 mg/l average NH_3 - N obtained from the one underloaded plant tested.)

b.) Fixed Growth Systems - A high degree of ammonia re-removal can be obtained with plastic media trickling filters which follow secondary treatment plants. Duddles and Richardson in their paper on studies at Midland, Mich. entitled, Application of Plastic Media Trickling Filters for Biological Nitrification Systems, reported that, "High level nitrification can be achieved in summer at application rates in the range of 1.0 - 1.5 gpm/sq. ft., and winter application rates in the range of 0.5 gpm/sq. ft. plus recycle." However, "There appears to be a final effluent limitation for ammonia nitrogen in the range of 1 - 2 mg/l. F. F. Sampayo in his paper entitled, The Use of Nitrification Towers at Lima, Ohio reported that, "Ammonia nitrogen levels of less than 0.5 mg/l can be achieved by using plastic media trickling filters."

2.) Winter

a.) Suspended Growth Systems - The U.S. EPA technology transfer bulletin entitled, Nitrification and Dentrification Facilities, August, 1973, states that "It has been well established that no treatment plants, including those of the extended aeration type, are capable of accomplishing complete nitrification, year round, in our Northern States." It is obvious that winter temperatures reach levels in Ohio which greatly affect nitrification.

The Ohio EPA monitoring program conducted during the winter of 1974 disclosed that variable degrees of nitrification are obtained with extended aeration plants. One of the plants yielded an average NH_3 - N effluent of 2.7 mg/l for 8 tests; however, 4 of the 8 tests provided effluent NH_3 - N levels of 0.3 mg/l or less. The other extended aeration plant tested provided an average effluent of 4.6 mg/l. Tests on an oxidation ditch produced an average effluent level of 0.6 mg/l (all of the values were less than 1.5 mg/l).

b.) Fixed Growth Systems - Our winter monitoring program disclosed that a single-stage plastic media trickling filter plant produced an average NH_3 - N effluent level of 1.3 mg/l (all of the 7 tests results were below 1.7 mg/l). The study conducted by Duddles and Richardson (noted under C-1-b) disclosed that the system had shown consistent and stable performance in the winter; however, the winter application rates must be in the range of 0.5 gpm/sq. ft. plus recycle. They further noted that, "If a system is to be designed for high level performance throughout the year, i.e. producing an effluent of 1.5 mg/l of ammonia nitrogen at a treatment facility located in a northern climate, the system design would have to be based on a relatively low influent feed rate." Sampay's study (noted under C-1-b) provided the following information:

1) Ammonia oxidation through the tower is greatly reduced during the winter.

2) At the loadings investigated ammonia nitrogen levels of less than 1.0 mg/l NH_3 cannot be achieved in cold weather.

3) Although winter time operation produces a higher NH_3 - N content in the plant effluent, the increase in NH_3 discharge should not be deleterious to the stream since nitrification in the stream will be inhibited due to cold weather. The inhibition of nitrification in the stream will prevent lowering of the stream water D.O. due to the nitrogenous oxygen demand.

In summary, it is clear that some plants in Ohio are obtaining ammonia effluent levels of 2.5 mg/l monthly average and 5.0 mg/l weekly average, during winter time operation. However, the information indicates that high levels of winter ammonia removal are not assured with conventional type treatment plants and, therefore, cannot be adequately justified.

D. Fecal Coliform - The effluents limits specified are those used in the regulations contained in 40 CFR 133, which was intended to provide information on the level of effluent quality attainable through the application of secondary treatment. Section 301(b)(1)(B) of PL 92-500 requires that effluent limitations, based on secondary treatment, be achieved for all publicly owned treatment works in existance on July 1, 1977.

E. Phosphorous - The position paper for NPDES Permit Processing Guideline No. 24 is applicable.

F. Dissolved Oxygen - It is obvious that dissolved oxygen levels up to the effluent's saturation point can be obtained with conservatively designed reaeration facilities. Guideline 17 outlines what dissolved oxygen limitations are applicable.

April 30, 1975
PPA: April 30, 1975

NPDES Permit Processing Guideline No. 26.1

QUESTION: What is the most stringent requirement OEPA will specify for existing public and semi-public facilities?

POLICY: Effluent requirements for existing public and semi-public facilities shall not be more stringent than the following:

Constituent	Monthly Average	Weekly Average
BOD_5	10 mg/l	15 mg/l
SS	12 mg/l	18 mg/l
NH_3-N - July thru Oct.	1.5 mg/l	2.5 mg/l
Fecal Coliform	200 counts/100 ml	400 counts/100 ml
Phosphorus P	1.0 mg/l	1.5 mg/l
DO*		

POSITION PAPER: The Position Paper for NPDES Permit Processing Guideline No. 26 demonstrates tha the BOD_5, SS, and summer NH_3-N limitations can be obtained with available technology. The limitations are slightly less stringent than those in Guideline No. 26, in order to provide some flexibility in the degree of reliability which must be designed into the treatment works. Since waste load allocations are based on the annual minimum 7 day average flow which has a recurrence period of once in ten years, this flexibility in the reliability of the treatment works is considered appropriate.

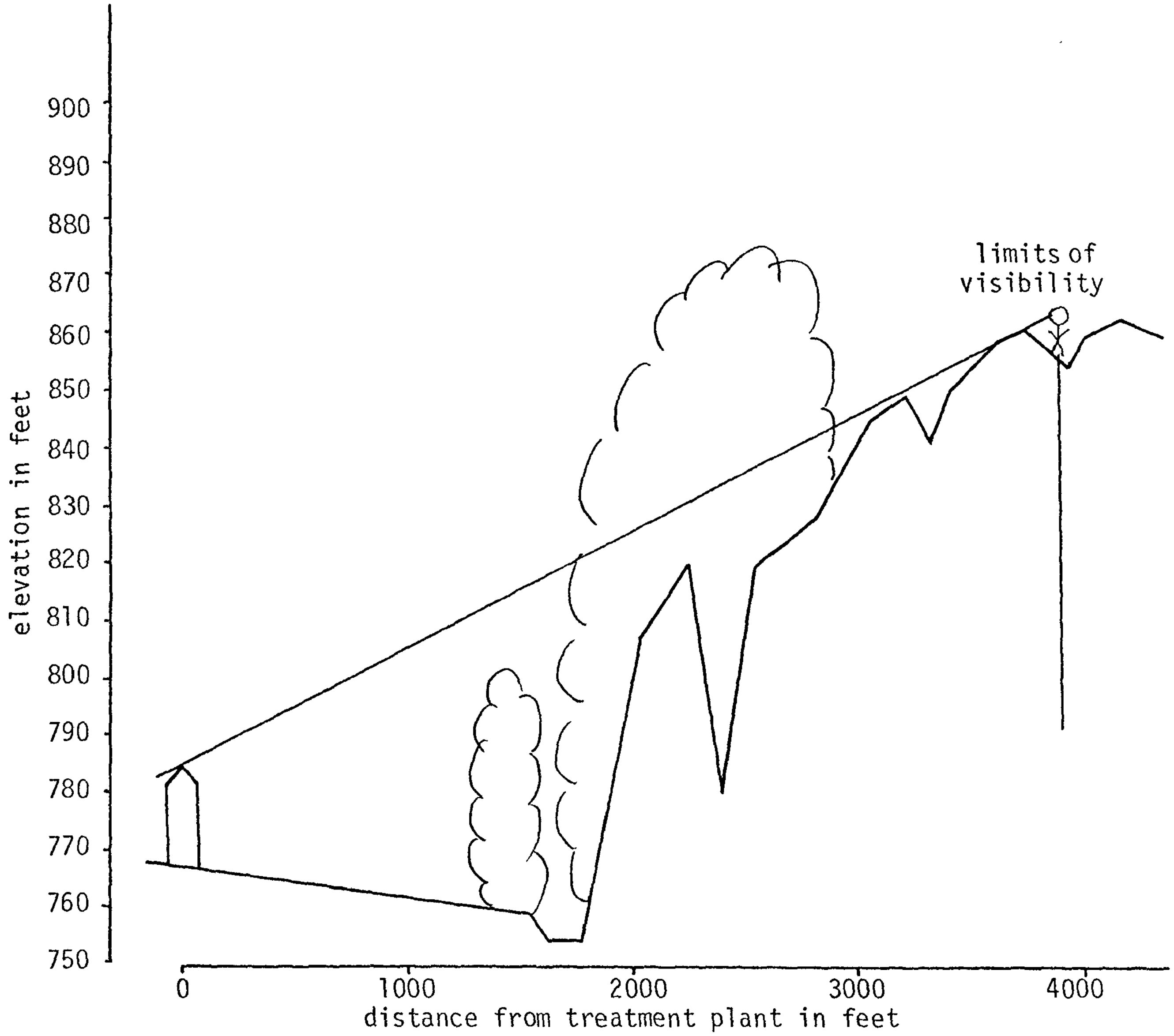
The winter NH_3-N limitation has been removed from the list of constituents because biological nitrification is severely inhibited by low winter temperaturc It is anticipated that treatment works designed to obtain high percentage summer NH_3-N removal will obtain lower but parallel levels of NH_3-N removal during the winter. Also, the information relative to winter nitrification included in the Position Paper for NPDES Permit Processing Guideline No. 26 is applicable.

*See Guideline 17

APPENDIX E

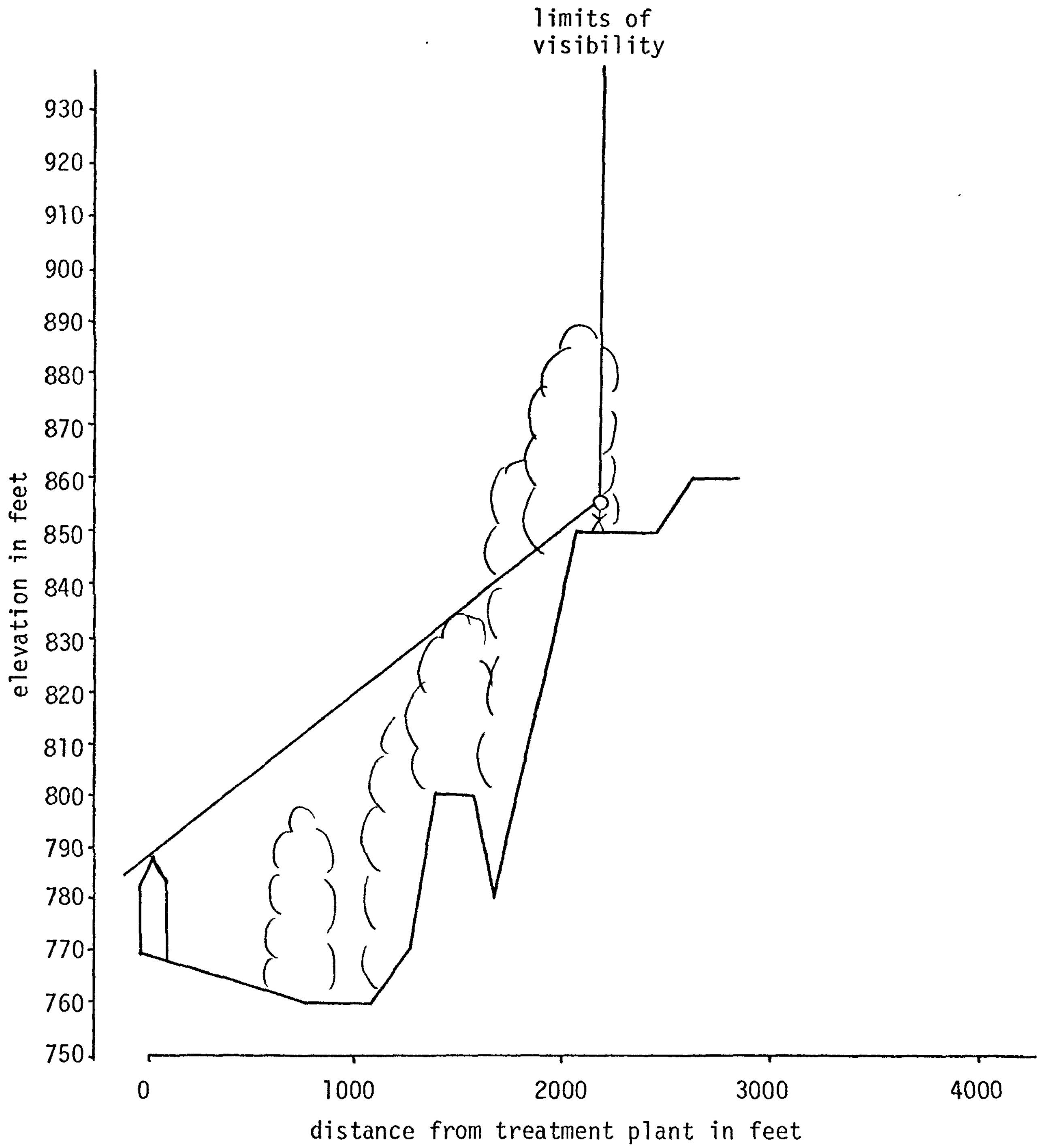
VISIBILITY ANALYSIS

The following 16 figures describe vertical profiles of the landscape in 16 different directions from the proposed site. Figure 41 on page 262 describes the direction and extent of each profile. Each of the profiles in this appendix shows the proposed STP on the left. The placement of the STP in no way affects the accuracy of the determined limits of visability.



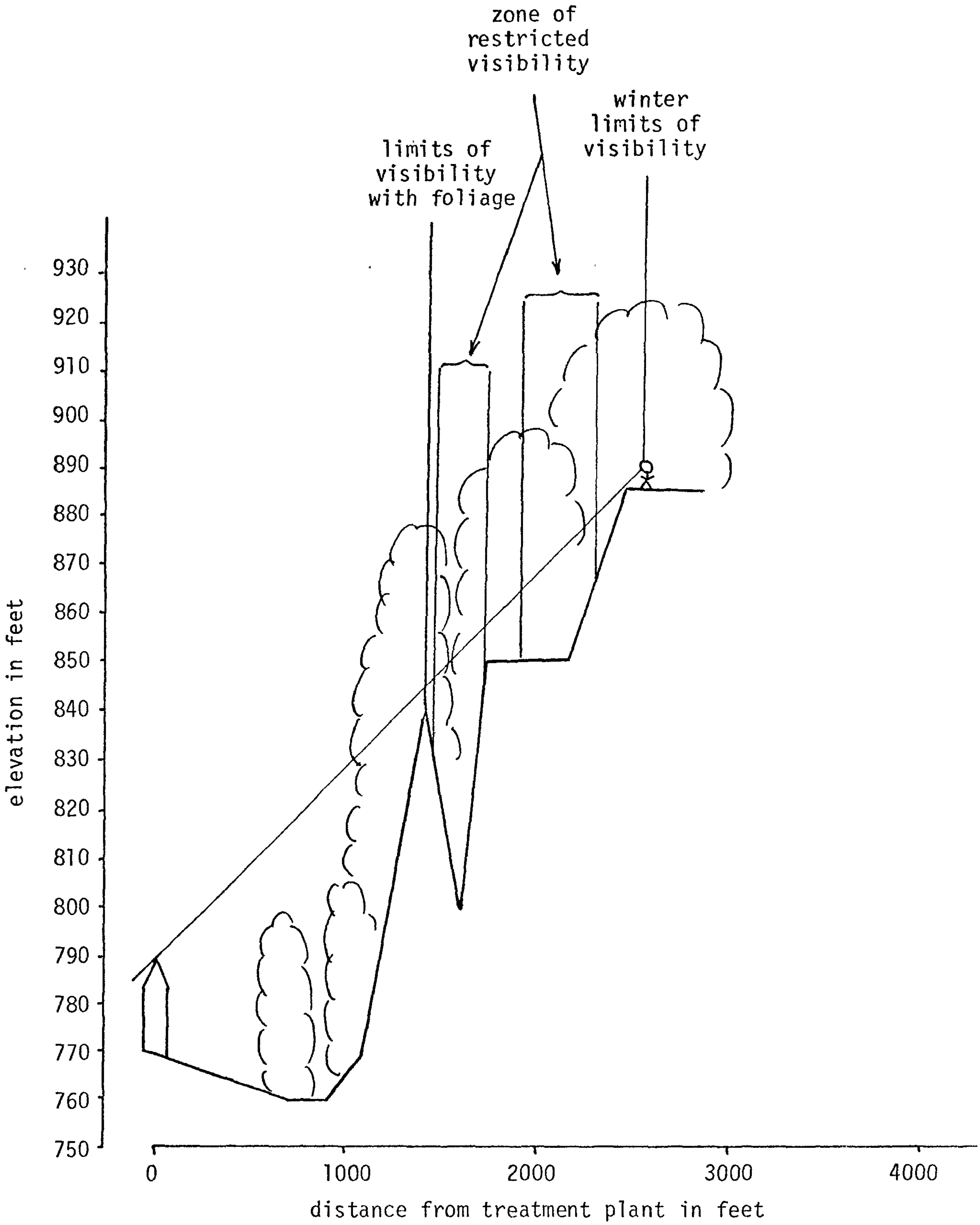
PROFILE 1

Source: Enviro Control, Inc., 1975



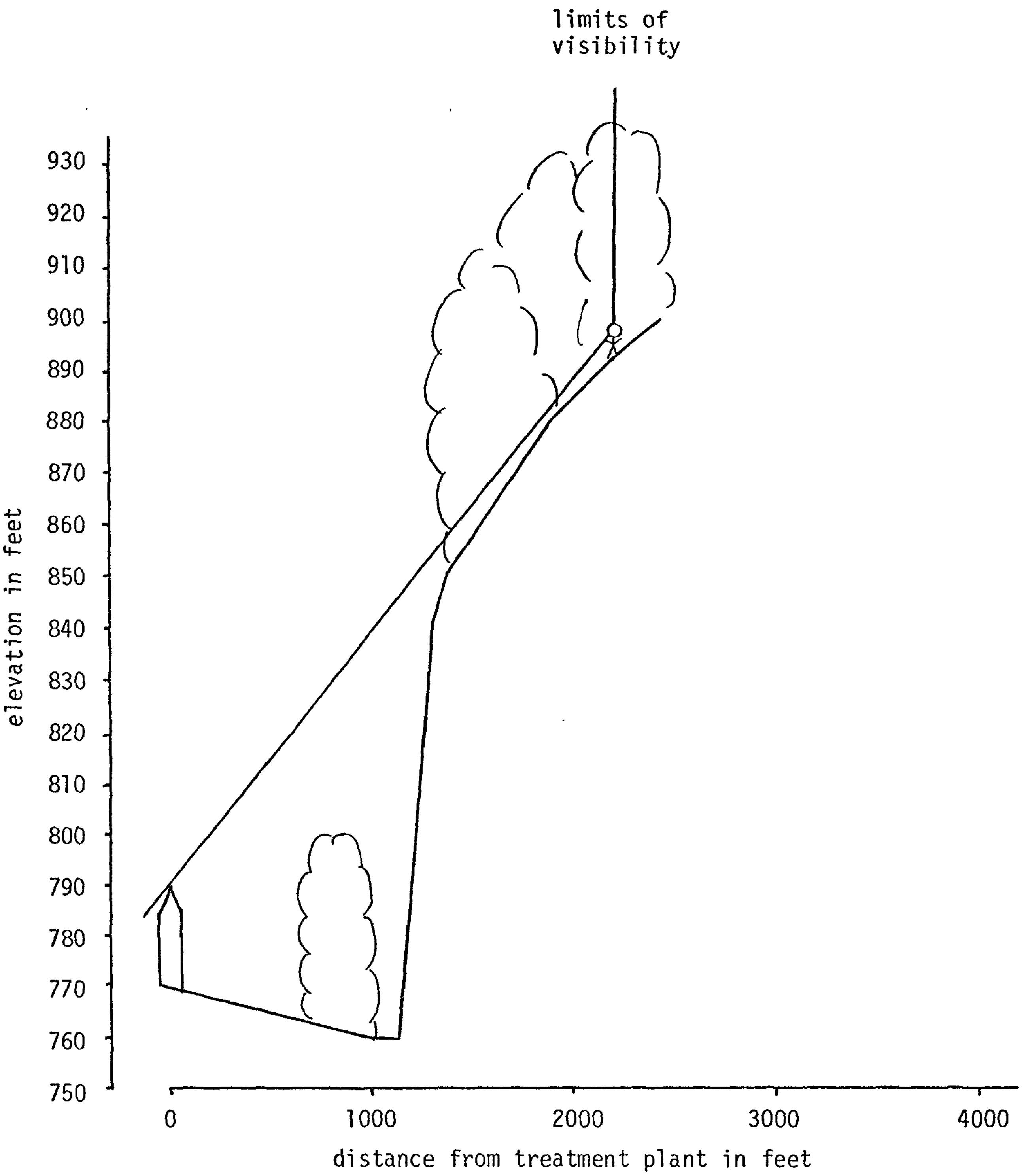
PROFILE 2

Source: Enviro Control, Inc., 1975



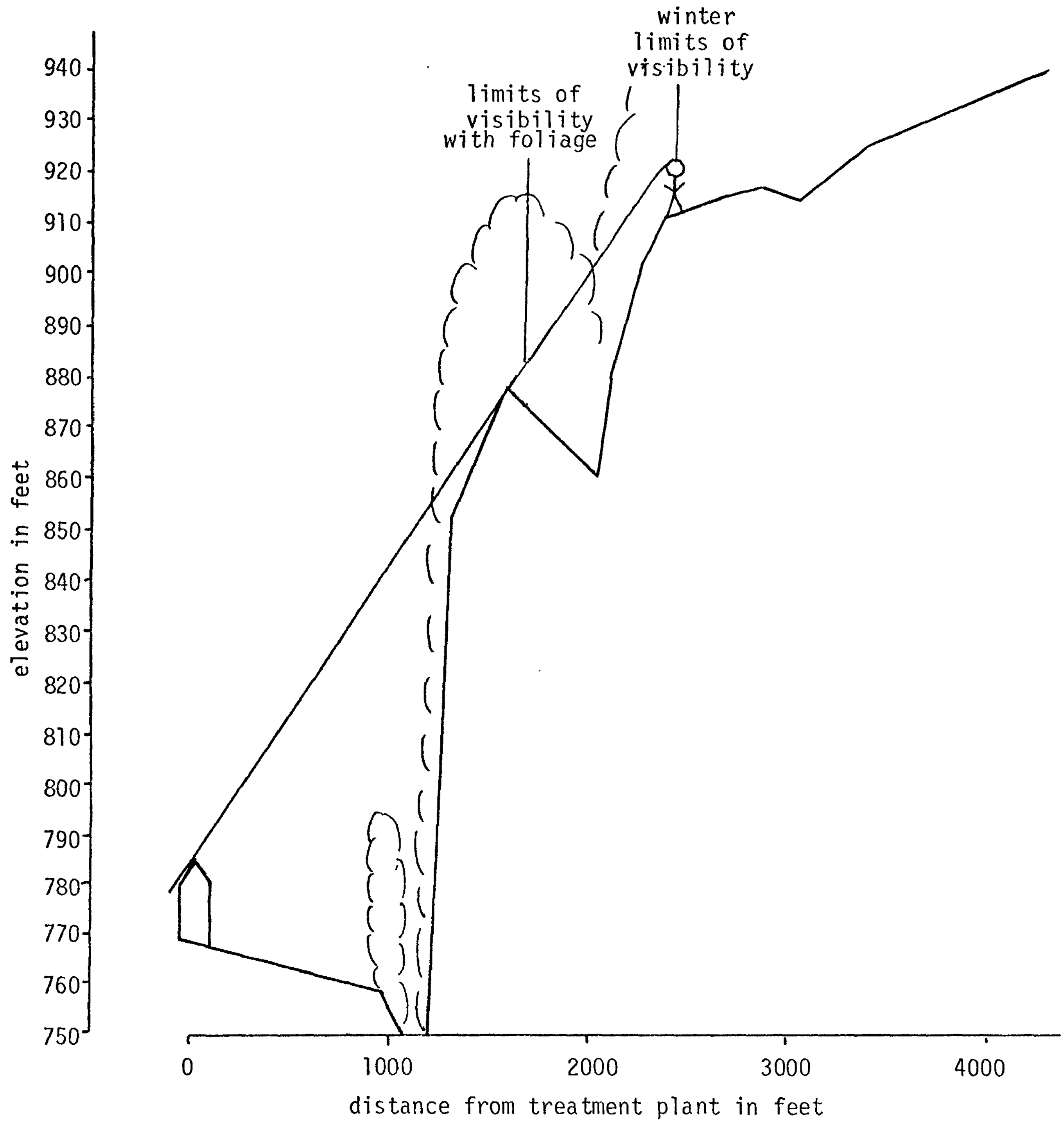
PROFILE 3

Source: Enviro Control, Inc., 1975



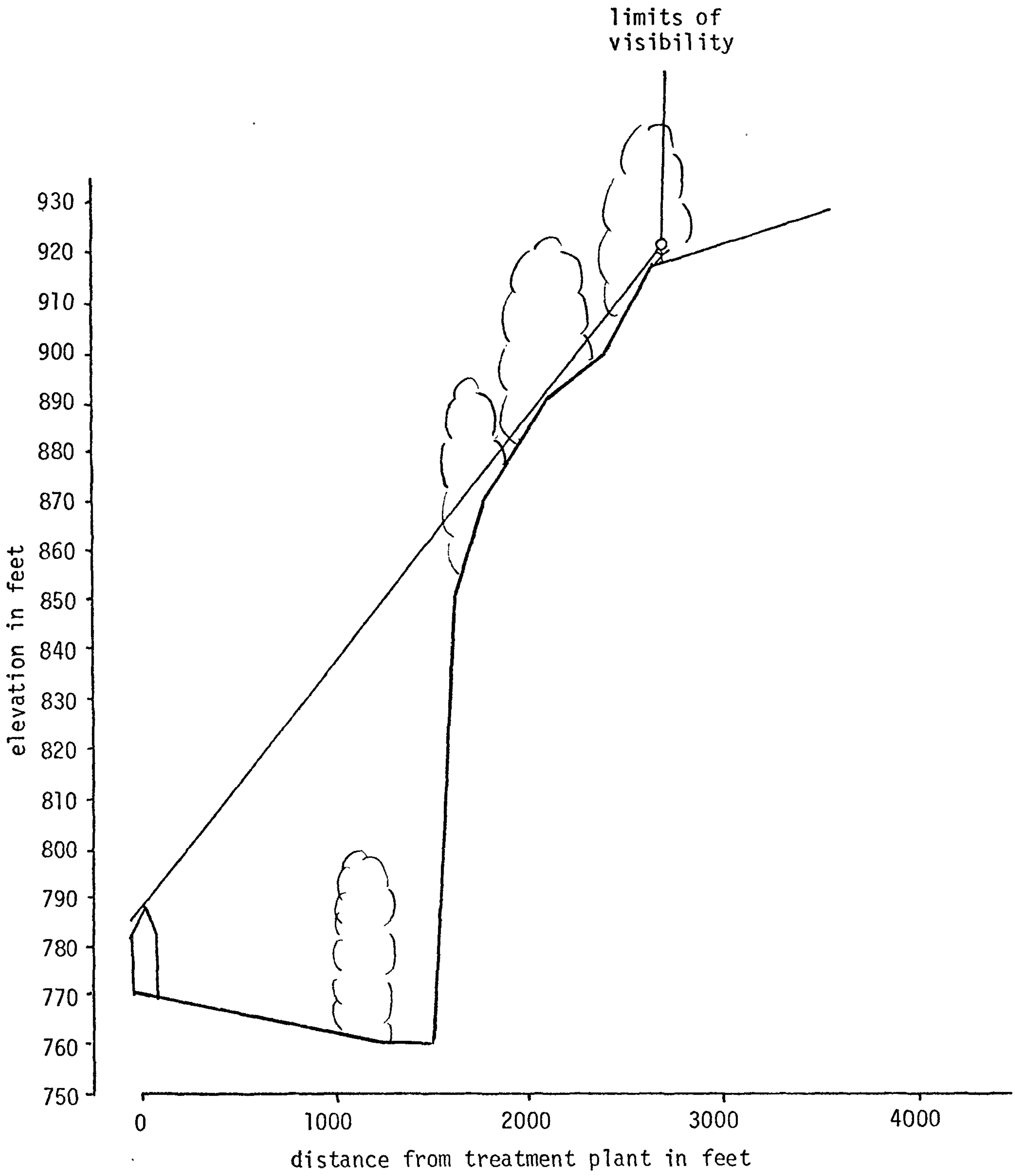
PROFILE 4

Source: Enviro Control, Inc., 1975



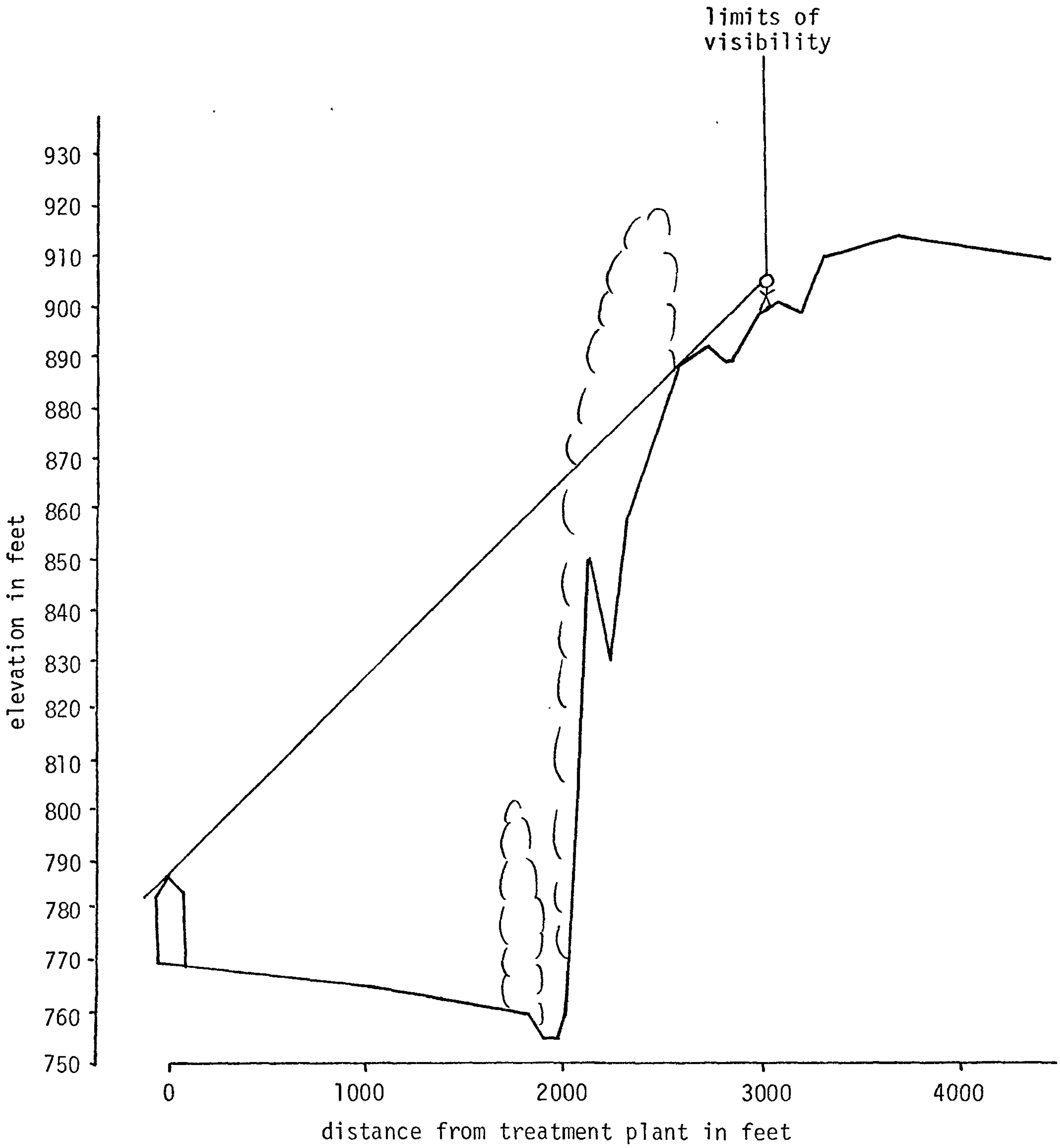
PROFILE 5

Source: Enviro Control, Inc., 1975



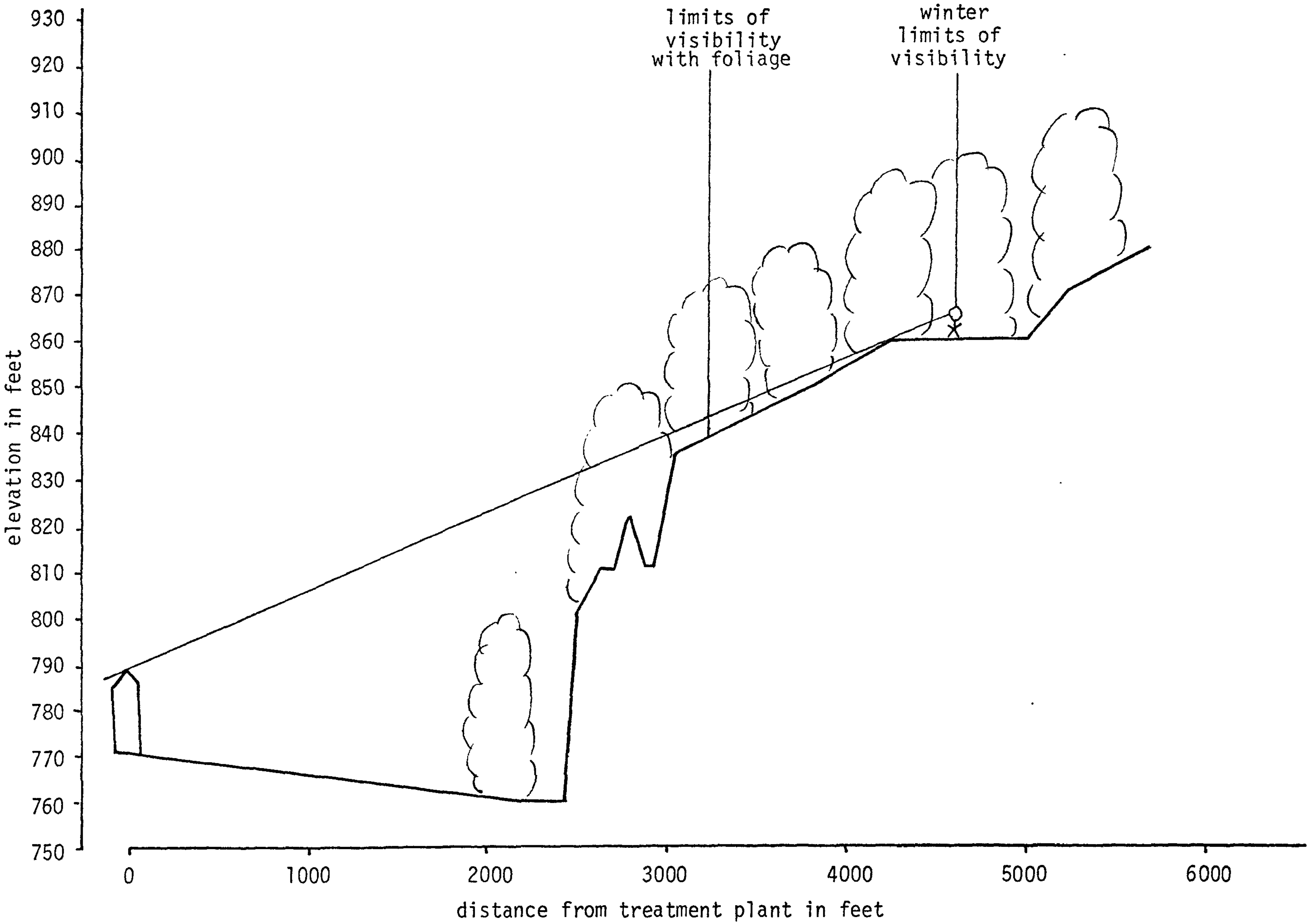
PROFILE 6

Source: Enviro Control, Inc., 1975



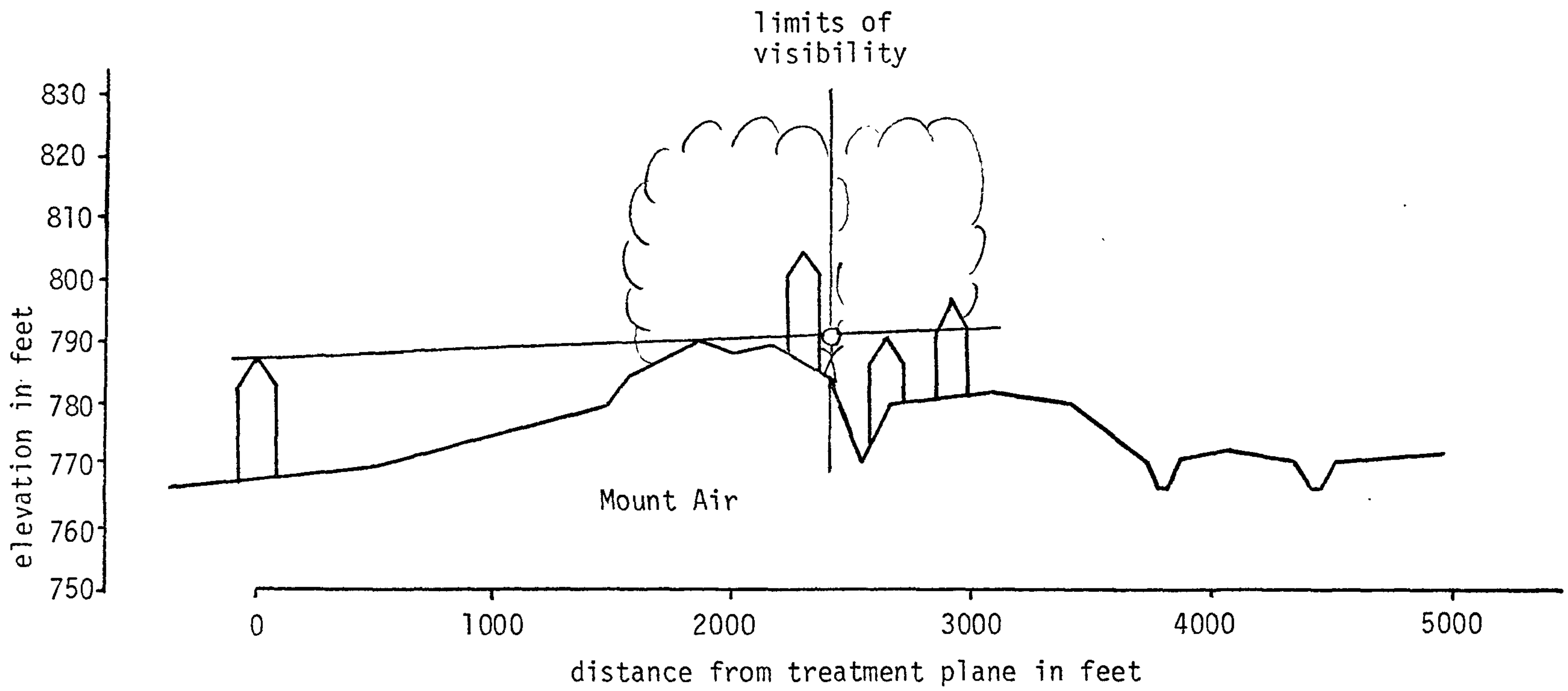
PROFILE 7

Source: Enviro Control, Inc., 1975



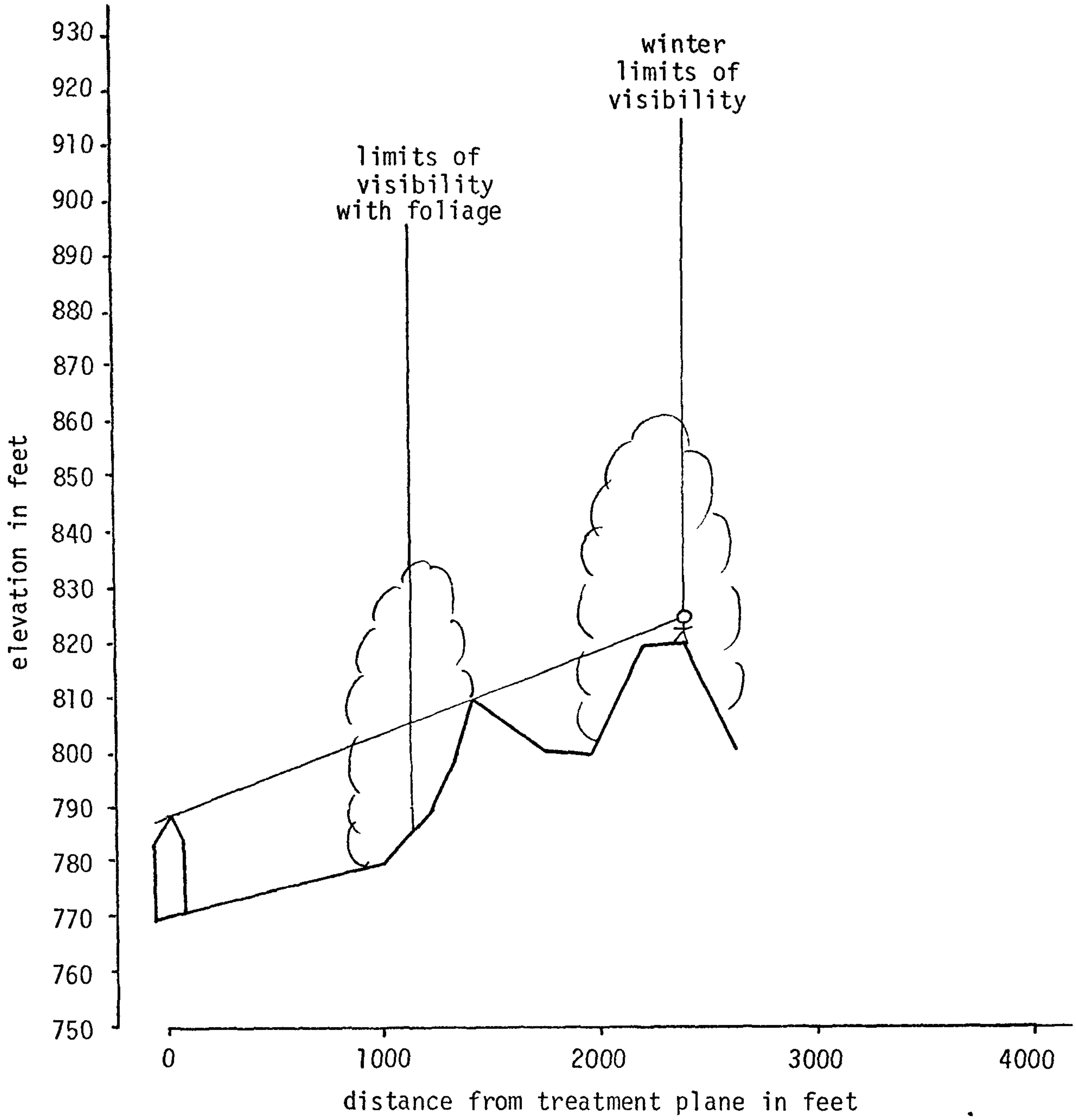
PROFILE 8

Source: Enviro Control, Inc., 1975



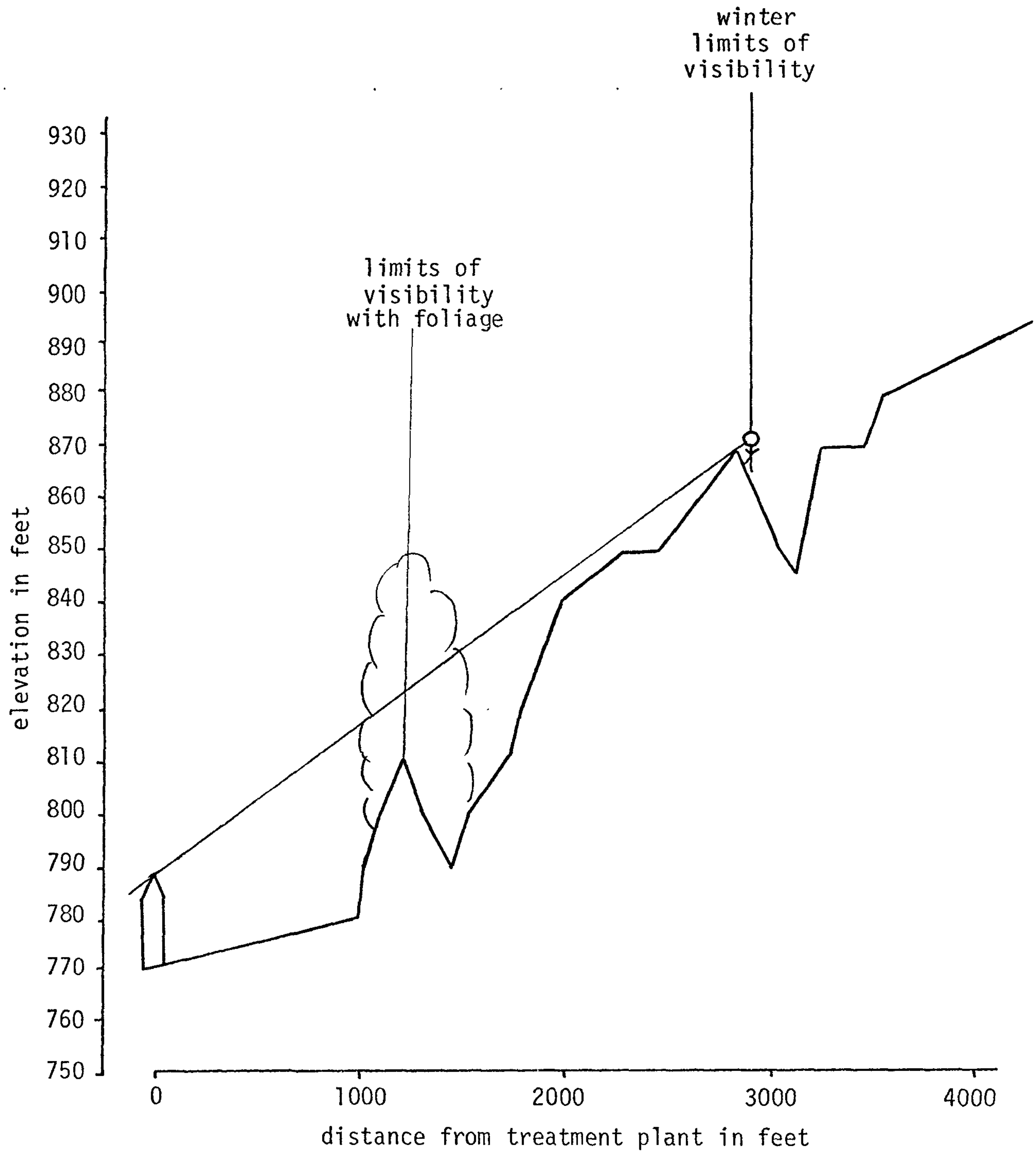
PROFILE 9

Source: Enviro Control, Inc., 1975



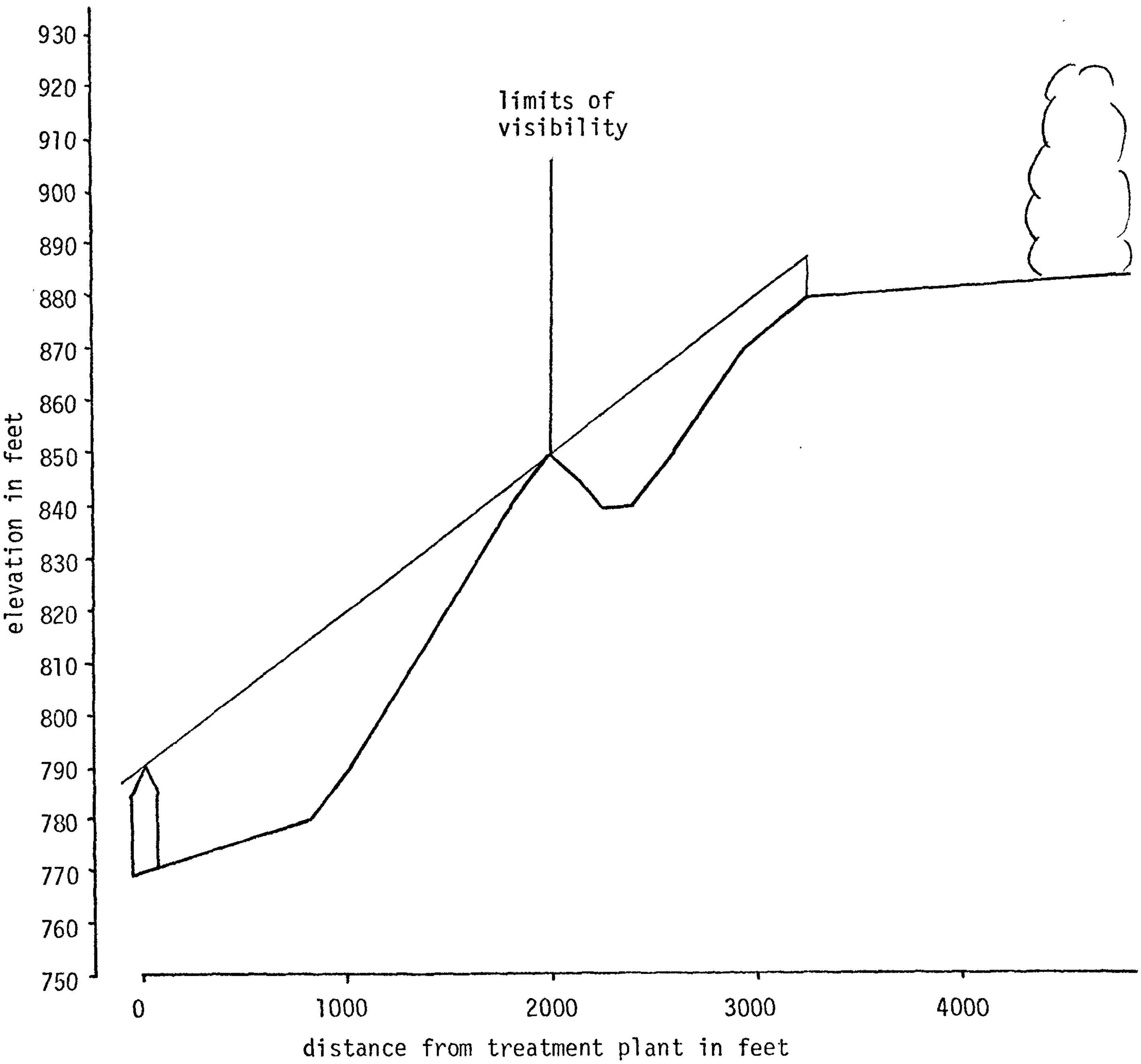
PROFILE 10

Source: Enviro Control, Inc., 1975



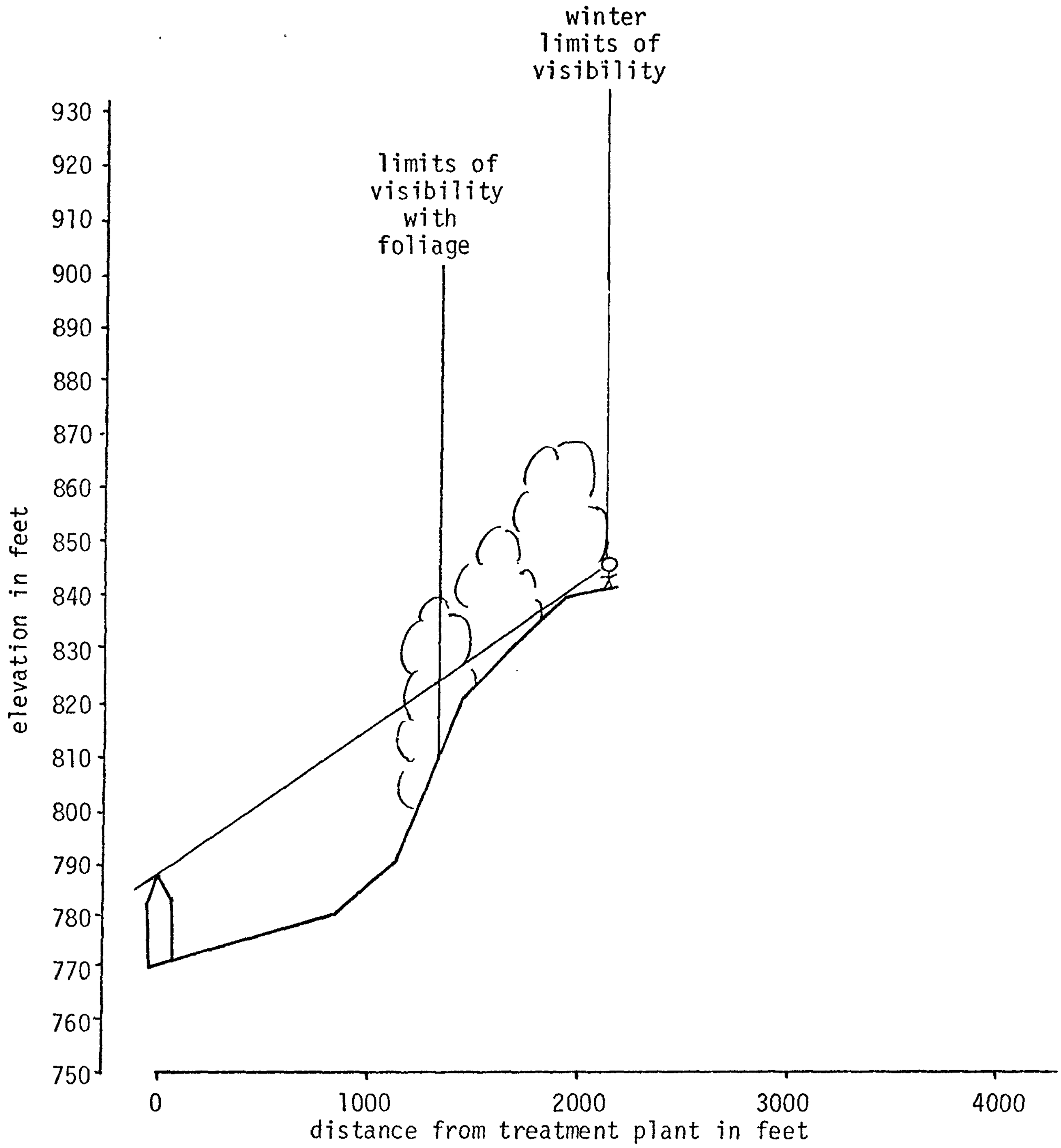
PROFILE 11

Source: Enviro Control, Inc., 1975



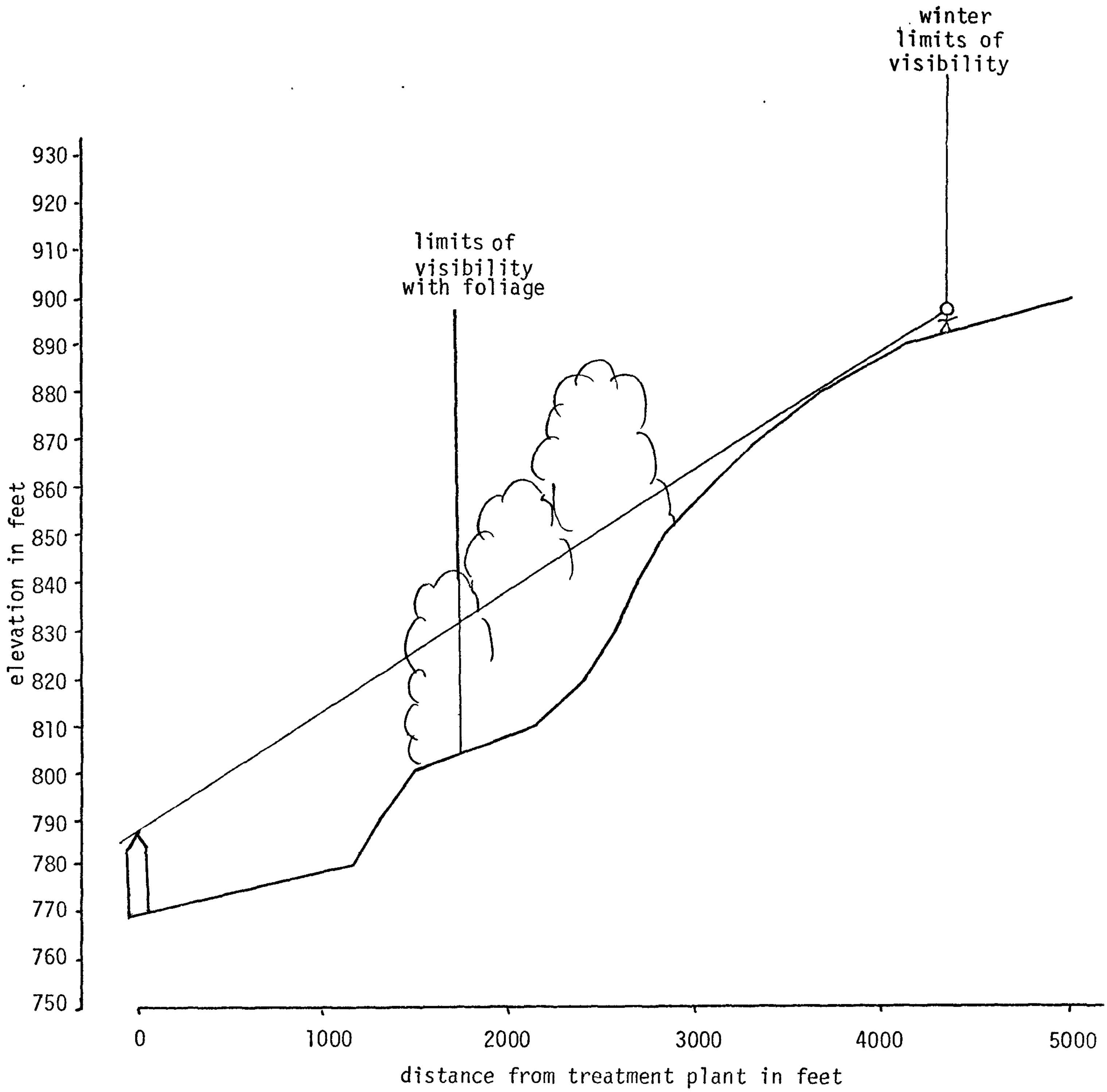
PROFILE 12

Source: Enviro Control, Inc., 1975



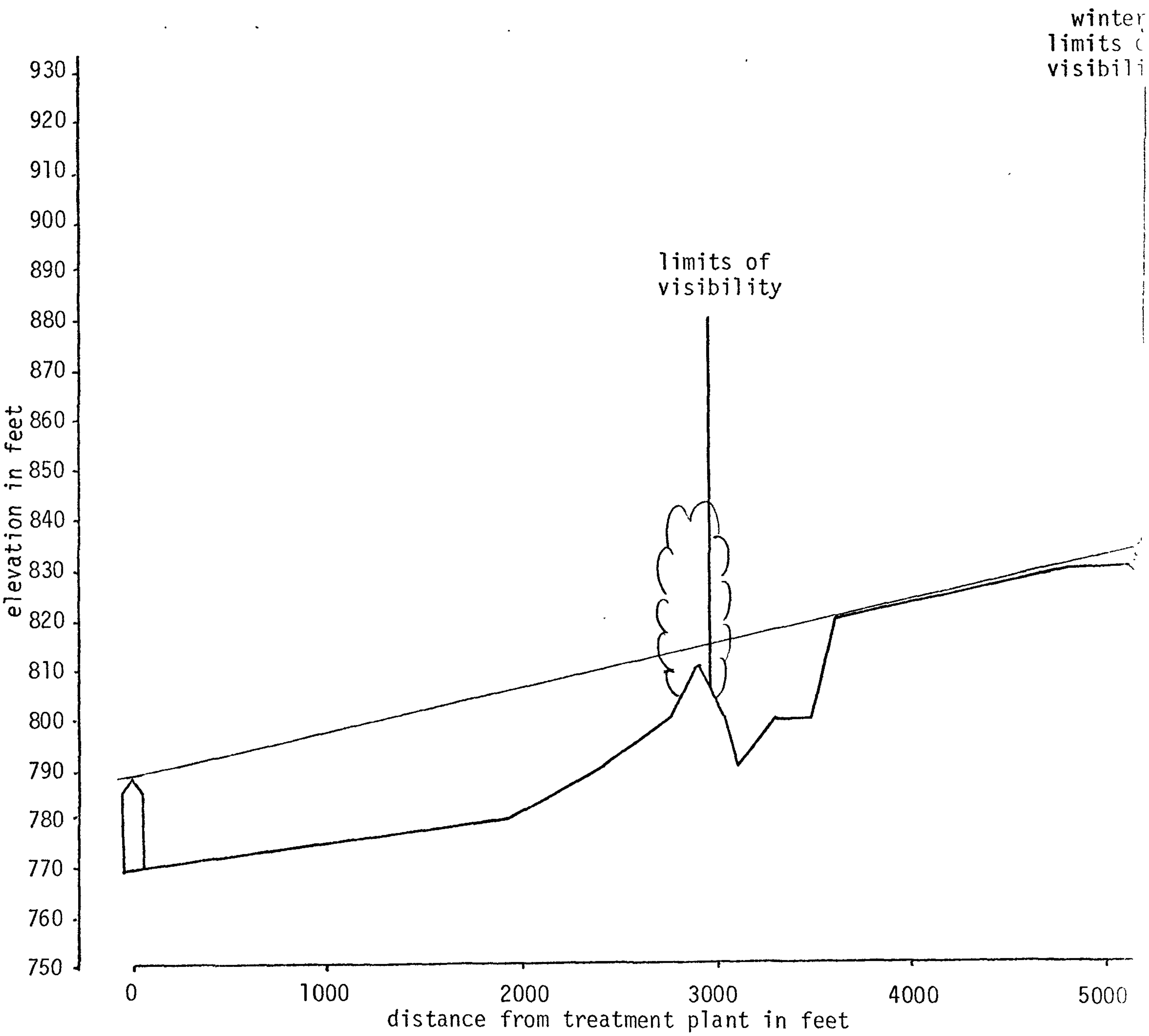
PROFILE 13

Source: Enviro Control, Inc., 1975



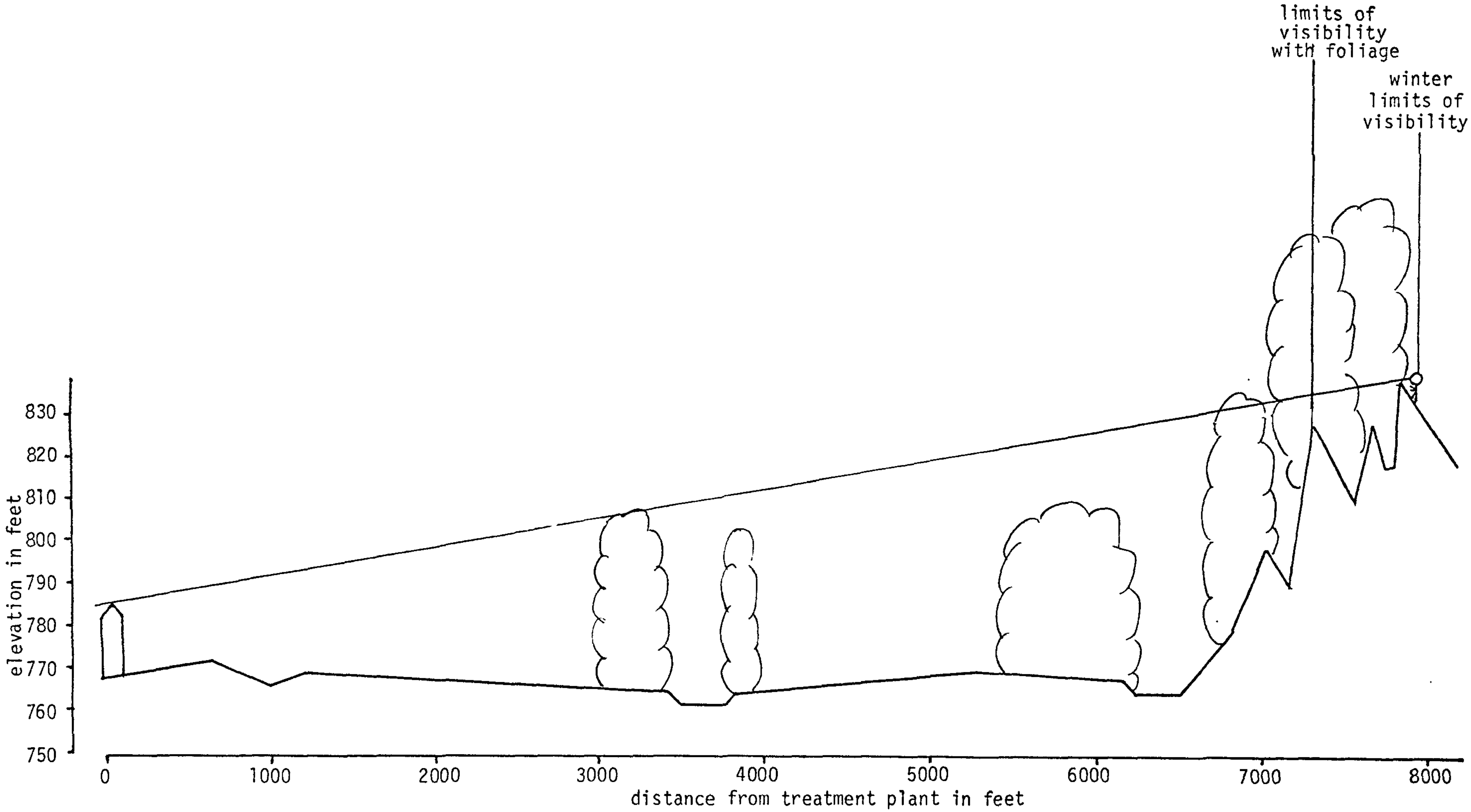
PROFILE 14

Source: Enviro Control, Inc., 1975



PROFILE 15

Source: Enviro Control, Inc.



PROFILE 16

Source: Enviro Control, Inc., 1975

3. A county is without authority in law to join with a city in the joint acquisition and ownership of a building for the housing of county and city offices, but may pursuant to GC § 2450-1 (RC § 307.14) et seq, contract with a city for the erection by the county of a building to house all such offices; and pursuant to such contract, such city may turn over to the county property real or personal, useful for such purpose, including the proceeds of bonds issued by the municipality: 1952 OAG No.1573.

4. Such contract may be for such term as the county and city may agree upon or for an indefinite term, and may provide for an agreed rental basis and costs of maintenance: 1952 OAG No.1573.

§ 307.15 **Agreements authorized between board of county commissioners and other legislative authorities; relative powers and duties.** (GC § 2450-2)

The board of county commissioners may enter into an agreement with the legislative authority of any municipal corporation, school district, library district, health district, park district, soil conservation district, water conservancy district, or other taxing district, or with the board of any other county, and such legislative authorities may enter into agreements with the board, whereby such board undertakes, and is authorized by the contracting subdivision, to exercise any power, perform any function, or render any service, in behalf of the contracting subdivision or its legislative authority, which such subdivision or legislative authority may exercise, perform, or render.

Upon the execution of such agreement and within the limitations prescribed by it, the board may exercise the same powers as the contracting subdivision possesses with respect to the performance of any function or the rendering of any service, which, by such agreement, it undertakes to perform or render, and all powers necessary or incidental thereto, as amply as such powers are possessed and exercised by the contracting subdivision directly. In the absence in such agreement of provisions determining by what officer, office, department, agency, or authority the powers and duties of the board shall be exercised or performed, the board shall determine and assign such powers and duties. Sections 307.14 to 307.19, inclusive, of the Revised Code, or any agreement authorized by such sections, shall not suspend the possession by a contracting subdivision of any power or function exercised or performed by the board in pursuance of such agreement. Nor shall the board, by virtue of any agreement entered into under this section, acquire any power to levy taxes within and in behalf of a contracting subdivision unless otherwise provided for by law.

HISTORY: GC § 2450-2; 116 v 102, § 2; 124 v 264, § 11. Eff 10-1-53.

Cross-References to Related Sections

Power to levy taxes, RC § 5113.02.

Research Aids

Power to contract:
O-Jur: Counties § 236
Am-Jur: Counties § 46

CASE NOTES

See also case notes 1, 2 under RC § 307.16.

1. County commissioners, city officials and township trustees may not enter into an agreement whereby the county commissioners or an agent appointed by them would investigate and handle temporary and partial relief cases for the contracting subdivisions; municipalities have the right to appoint an investigator and would have the right under this section to enter into an agreement with other cities or municipalities for the appointment of an investigator and may contribute to his compensation because of express statutory authorization; township trustees have no power to compensate from public funds an investigator which they may appoint: 1937 OAG No.750.

2. County commissioners and villages are authorized under this section et seq., to adopt resolutions providing that the board of county commissioners sponsor the construction of sidewalls, street and storm sewer improvement projects within municipal corporations within their county as works progress administration projects, providing none of the cost of the same is paid by said villages; if the villages pay any part of such cost, the action of council providing for the expenditure of the money of the village on such project must be by ordinance and must follow the usual legislative steps required in each case: 1938 OAG No. 2660.

3. A county and a municipality may not legally enter into a contract for point ownership of a police broadcasting system unless such joint ownership is specifically provided for by statute: 1939 OAG No.600.

4. A county may, by contract, furnish to a municipality information over the county broadcasting system for a sum to be agreed upon between the proper county and municipal authorities. The sum agreed upon may be paid by the municipality in advance of receiving such information or service: 1939 OAG No.827.

§ 307.16 **Agreement to provide manner of payment.** (GC § 2450-3)

Every agreement entered into under sections 307.14 to 307.19, inclusive, of the Revised Code, shall provide, either in specific terms or by prescribing a method for determining the amounts, for any payments to be made by the contracting subdivision into the county treasury, in consideration of the performance of the agreement. In cases where it is deemed practicable, the agreement may provide that payment shall be made by the retention in the treasury of the amounts due from taxes collected for the contracting subdivision and the county auditor and county treasurer shall be governed by any such provision in settling the accounts for such taxes.

HISTORY: GC § 2450-3; 116 v 102 (103), § 3. Eff 10-1-53.

CASE NOTES

1. This section does not prescribe a mandatory form requiring payments to be made by contracting subdivision into county treasury. It does prescribe a mandatory form to be followed in case the agree-

GC §§ 6602-32a and 6602-32b (RC §§ 6103.21, 6103.-22) to contract with a city adjacent to such sewer district for such facilities as are deemed necessary to obtain a water supply for such district and its inhabitants, and may pay the cost of the same out of the general fund of such county: 1951 OAG No. 892.

53. Under GC § 6602-21 (RC § 6103.13) et seq the cost to the county of obtaining such water supply may be assessed upon the property in such district in accordance with the benefits conferred, and upon collection of such assessments, the general fund may be reimbursed for the amount advanced: 1951 OAG No 892

§ 6117.02 Rates. (GC § 6602-1)

The board of county commissioners may fix reasonable rates or charges of rents to be paid to the county for the use of the sewers or sewage treatment or disposal works referred to in section 6117.01 of the Revised Code by every person, firm, or corporation whose premises are served by a connection to such sewers or sewage treatment or disposal works, and may change such rates or charges as it deems advisable. When any such charges are not paid, the board shall certify the same to the county auditor, who shall place them upon the real property duplicate against the property served by such connection. Such charges shall be a lien on such property from the date the same are placed upon the real property duplicate by the auditor and shall be collected in the same manner as other taxes. All moneys collected as rents for use of such sewers or sewage treatment or disposal works in any sewer district shall be paid to the county treasurer and kept in a separate and distinct fund to the credit of such district. Such fund shall be used for the payment of the cost of the management, maintenance, and operation of the sewers of the district and sewage treatment or disposal works used by the district. Any surplus in such fund may be used for the enlargement or replacement of such sewers and sewage treatment or disposal works, for the payment of the interest and principal on any debt incurred for the construction of such sewers or sewage treatment or disposal works, or for the creation of a sinking fund for the payment of such debt. Money so collected shall not be expended otherwise than for the use and benefit of such district.

HISTORY: GC § 6602-1; 107 v 440, § 1; 108 v PtI 369; 110 v 392; 112 v 275 (276); 123 v 111, § 1 Eff 10-1-53. Former GC § 6602-1 was repealed in 107 v 440 (448), § 19.

See RC § 6103.17 which refers to this section.

See case note 6 under RC § 6117.01

§ 6117.03 Board of county commissioners may lay out, establish, and maintain sewer districts. (GC § 6602-1a)

Whenever authorized by the legislative authority of any municipal corporation, the board of county commissioners may by resolution lay out, establish, and maintain one or more sewer districts within its county to include a part or all of the territory within such municipal corporation as the whole or a part of such district. Such authority shall be evidenced by an ordinance or resolution of the legislative authority of such municipal corporation, entered upon its records.

HISTORY: GC § 6602-1a; 110 v 338 (339). Eff 10-1-53.

Cross-References to Related Sections

See RC § 6117.40 which refers to this section.

Research Aids

Sewers within municipality:
O-Jur: Sanitary Dist. §§ 13, 16
Am-Jur: Sanitary Dist. §§ 20, 21, 25, 26

CASE NOTES

1. Authority granted under GC § 6602-1b (RC § 6117.04) and this section cannot be limited or defined by ordinance or resolution of council in such a manner as to give supervisory powers to the council over the establishment, construction, repair and operation of a county sewer district. The board of county commissioners should not regard any limitation or qualification as giving the consent of the municipality to the establishment of the sewer district: 1925 OAG p.66.

§ 6117.04 Authority of the board in regard to sewer districts. (GC § 6602-1b)

The authority of the board of county commissioners to provide sewer improvements and to maintain and operate the same within sewer districts which include a part or all of the territory within one or more municipal corporations is the same as provided by law within districts wholly outside of municipal corporations, including the levying of assessments. Such authority shall be limited to main works only, and does not include construction and maintenance of lateral sewers for local service within such municipal corporation. The plans, specifications, and estimated cost for any improvement within such municipal corporation shall be approved by its legislative authority prior to the letting of any contract for the construction thereof. All road surfaces, curbs, sidewalks, sewers, water pipes, or other public property disturbed or damaged by such construction shall be restored to their original condition within a reasonable time by the board, and the cost thereof shall be a part of the cost of such improvement. After such main works are constructed, such municipal corporation may use the same as an outlet for branch and local sewers constructed by it for the service and use only of that part of the municipal corporation which lies within the area assessed or to be assessed for the cost of such main works, subject to such rules and regulations as are established by the board and subject to all requirements of the department of health.

At any time after a district is established comprising or including a part or all of the territory engineer. For the purpose of paying for said sewers and the maintenance thereof, the board may issue bonds or certificates of indebtedness and assess the cost against the benefited property in the same manner as provided by sections 6117.01 to 6117.40, inclusive, of the Revised Code, for the construction of an original sewer.

HISTORY: GC § 6602-8h; 107 v 410 (418), § 16; 108 v PtI 368 (371); 112 v 275 (291). Eff 10-1-53. The legislature numbered this section 6602-8h, but it was printed 6602-h, by mistake, in 108 v PtI 368 (371).

Research Aids

Acquisition of property by county:
Page: Counties §§ 95, 96
O-Jur: Counties § 218
Am-Jur: Counties § 35

CASE NOTES

1. Under GC § 6602-8h (RC § 6117.38) the owners of premises in an area adjacent to a sewer district may, by contract, be permitted to connect the sewage system within such adjacent area to the system already existing within such district, and the payment for such service may be made by special assessment on the lots or parcels of land involved, but such assessments may not be less than the original assessment for similar property within the district. Such contract payments, even though made by way of special assessments, do not constitute such a re-apportionment of the cost of the main sewer line in such original district, but any funds raised under such arrangements may properly be appropriated for the use of the original sewer district and specifically may be used to pay the cost of maintenance and operation of the original improvement. 1953 OAG No.2364.

§ 6117.39 Right of eminent domain. (GC § 6602-8i)

Whenever in the opinion of the board of county commissioners it is necessary to procure real estate, a right of way, or an easement for the construction, maintenance, or operation of any sewer or other improvement authorized by sections 6117.01 to 6117.45, inclusive, of the Revised Code, or the right to construct, maintain, and operate such sewer or other improvement in and upon any property within or without a sewer district, it may purchase the same, or if such board and the owners thereof are unable to agree upon its purchase and sale, or the amount of damages to be awarded therefor, the board may appropriate such real estate, right of way, easement, or right. For such purposes the board shall make an accurate survey and description of the parcel of land needed for such purposes and shall file it with the probate judge of the county. Thereupon the same proceedings shall be had as are provided for the appropriation of private property by municipal corporations by the laws governing such procedure at the time such appropriation is made. The board shall perform all duties required to be performed by the mayor or legislative authority of a municipal corporation by such laws and the passage of equivalent resolutions by such board shall fulfill the requirements of such laws as to resolutions and ordinances to be passed by the legislative authority of a municipal corporation.

HISTORY: GC § 6602-8i; 107 v 410 (448), § 17; 112 v 275 (292). Eff 10-1-53. Analogous to Supp. to P&A § 6602-9.

Research Aids

Eminent domain:
Page: Eminent Domain § 33
O-Jur: Counties § 218, Eminent Domain §§ 34, 356
Am-Jur: Counties § 35, Eminent Domain §§ 27, 49 to 59, 63, 65 to 81

§ 6117.40 Board may construct sewer within municipal corporation. (GC § 6602-9)

Whenever in the opinion of the board of county commissioners it becomes necessary to construct a sewer within the boundaries of a municipal corporation for the service of sewer districts wholly outside of such municipal corporation, the board may construct such sewer in the streets and alleys of such municipal corporation but shall restore all such streets and alleys to their original condition, and the cost thereof shall be a part of the cost of such sewer.

Prior to the preparation of plans for such improvement, such municipal corporation shall be given an opportunity to co-operate in the construction and use of such sewer as provided in section 6117.03, 6117.04, or 6117.41 of the Revised Code.

HISTORY: GC § 6602-9; 112 v 275 (292). Eff 10-1-53. Former GC § 6602-9, 103 v 734 (740), § 9 was repealed in 112 v 275 (306), § 4.

Research Aids

Sewers within municipalities.
O-Jur: Sanitary Dist. § 16
Am-Jur: Sanitary Dist. §§ 20, 21, 25, 26

[JOINT SEWER DISTRICTS]

§ 6117.41 Joint construction and use of sewers and sewage disposal works. (GC § 6602-10)

The board of county commissioners of any county or the legislative authority of any municipal corporation may enter into a contract, upon such terms and for such period of time as are mutually agreed upon, with any other county or municipal corporation to prepare all necessary plans and estimates of cost, to connect any sewers of such county or municipal corporation with any sewers constructed, or to be constructed, by any other county or municipal corporation, and to provide for the joint use by such contracting parties of such sewers and of any sewage treatment or disposal works of such county or municipal corporation.

HISTORY: GC § 6602-10; 107 v 59, § 1. Eff 10-1-53. Analogous to Supp. to P&A §§ 6602-10 and 6602-11. Former GC § 6602-10 was repealed in 107 v 59 (60), § 5.

§ 6117.34 Director of environmental protion may order improvement.

Whenever the legislative authority or board health, or the officers performing the duties the legislative authority or board of health of nunicipal corporation, the board of health of general health district, or a board of township istees makes complaint in writing to the envimental protection agency that unsanitary conions exist in any county, the director of envimental protection shall forthwith inquire into d investigate the conditions complained of. If on investigation of such complaint the director ds that it is necessary for the public health and lfare that sewer improvements or sewage treatnt or disposal works be constructed, mainned, and operated for the service of any terriry outside of municipal corporations in any unty, the director shall notify the board of unty commissioners of such county of its findg ◆. The board shall obey such order and proed as provided in sections 6117.01 to 6117.45 of the Revised Code, to establish sewer disicts, provide necessary funds, and construct ch sewers or treatment works, or maintain, reir, or operate the same, as are required by such der and in such manner as is satisfactory to the rector. Any or all of the cost of such improveent or maintenance may be assessed upon the operty benefited as provided in sections 6117.01 6117.45 ◆ of the Revised Code.

* **HISTORY:** 134 v S 397. Eff 10-23-72.

CASE NOTES

1. This section provides that when the director health finds unsanitary conditions existing in any unty and that it is necessary for the public health d welfare that sewer improvements or sewage eatment works be constructed, for any territory itside municipal corporations, he shall order the unty commissioners to make such improvement, d such commissioners are required to construct or pair such sewers or treatment works, and may assess e cost thereof upon the property benefited: 1958 AG No. 2504.

§ 6117.35 Repealed, 134 v S 397, § 2 GC § 6602-8e; 107 v 440; 112 v 275]. Eff 0-23-72.

§ 6117.36 Order may be enforced by a writ of mandamus.

If the board of county commissioners fails after thirty days after the notice and order given to it y the director of environmental protection to erform any act required of it by sections 6117.01 o 6117.40 ◆ of the Revised Code, and by any uch order and notice of the director, such order nay be enforced by a writ of mandamus issued by any court authorized to issue such writs.

* **HISTORY:** 134 v S 397. Eff 10-23-72.

[The reference in the History to this section in the bound volume, to 108 v PtI 368 should be to 112 v 275 (290).]

§ 6117.38

Research Aids

Acquisition of property by county:
O-Jur2d: Counties §§ 195 to 197

CASE NOTES

1. Where pursuant to RC § 6117.38, a county has obtained title to privately owned sewer lines constructed within a sewer district established by the commissioners of such county, and such lines are connected to the county system, the county commissioners may lawfully fix a reasonable rate for receiving and disposing of the sewage from the lines so acquired, and is obligated to maintain them: 1955 OAG No.5419.

§ 6117.39 Appropriation or purchase of property.

Whenever in the opinion of the board of county commissioners it is necessary to procure real estate, a right of way, or an easement for the construction, maintenance, or operation of any sewer or other improvement authorized by sections 6117.01 to 6117.45, inclusive, of the Revised Code, or the right to construct, maintain, and operate such sewer or other improvement in and upon any property within or without a sewer district, it may purchase the same, or if such board and the owners thereof are unable to agree upon its purchase and sale, or the amount of damages to be awarded therefor, the board may appropriate such real estate, right of way, easement, or right. ◆ Such proceedings shall be had as are provided for ◆ in sections 163.01 to 163.22, inclusive, of the Revised Code.

* **HISTORY:** 131 v 1429. Eff 1-1-66.

Research Aids

Eminent domain:
O-Jur2d: Counties §§ 195 to 197

§ 6117.41

1. Under RC §§ 6117.41, 6117.42 and 6117.43, a board of county commissioners having established a sewer district in an unincorporated area adjoining a city, may enter into a contract with the city whereby the county shall pay to the city a part of the cost of a sewage treatment plant and interceptor sewers to be constructed by such city entirely within the city limits, which contract gives the county the right to discharge its sewage into the city sewer and disposal works: 1956 OAG No.6981.

§ 6117.42 Provisions in regard to payment on contracts; exceptions.

All contracts under section 6117.41 of the Revised Code shall provide for payment to the county or municipal corporation owning, constructing, or about to construct a sewer or sewage treatment or disposal works, to be jointly used, of the amount agreed upon by the county or municipal corporation so contracting for the joint use thereof. Any such county or municipal corporation owning, constructing, or agreeing to construct any such sewer improvement or sewage treatment works, as provided in sections 6117.41 to 6117.44 ◆ of the Revised Code, and permitting the use thereof by such other county or municipal corporation, shall retain full control and management of the construction, maintenance, repair, and operation of such sewer improvement and sewage treatment or disposal works, except when conveyed to a municipal corporation as provided in this section. Any such contract before going into effect shall be approved by the director of environmental protection Any completed sewer improvement or sewage treatment works constructed under sections 6117.01 to 6117.45 ◆ of the Revised Code, for the use of any sewer district and located within any municipal corporation or within any area which may be annexed to or incorporated as a municipal corporation, may by mutual agreement between the board of county commissioners and such municipal corporation be conveyed to such municipal corporation, which shall thereafter maintain and operate such sewer improvement or sewage treatment works. The board may retain the right to joint use of such sewers or treatment works for the benefit of the district. The validity of any assessments levied to provide means for the payment of the cost of construction or maintenance of such sewer improvement or sewage treatment works or any part thereof shall not be affected by such conveyance.

* HISTORY: 134 v S 397. Eff 10-23-72.

CASE NOTES

See case note 1 under RC § 6117.41.

1. The county is authorized by this section and § 6117.43 to finance its cost in payment of its obligation to such city under such contract, by levy of taxes or by the issuance of general obligation bonds of the county, such bonds to be retired from the proceeds of special assessments levied on the property in the sewer district which will be served by the sanitary sewers constructed or proposed to be constructed by said county in said sewer district: 1956 OAG No 6981.

§ 6117.43

See case note 1 under RC § 6117.41; 1 under RC § 6117.42.

§ 6117.46 Construction of trunk or main sewers in counties.

When the director of environmental protection finds that a trunk or main sewer is necessary in a county for sanitary purposes, the board of county commissioners of such county may make surveys thereof and prepare plans and specifications thereof. Upon approval by the director of such plans and specifications, the board may construct and maintain said trunk or main sewer or part thereof within or without the limits of a municipal corporation, regulate the tapping thereof by lateral sewers, and prescribe the conditions of such tapping.

* HISTORY: 134 v S 397. Eff 10-23-72.

§ 6117.47

Research Aids

Eminent domain:
O-Jur2d: Counties §§ 195 to 197

§ 6117.48 Appropriation of property.

When it is necessary to procure real estate or a right of way or an easement therein for a trunk or main sewer provided for in section 6117.46 of the Revised Code, and the owners thereof are unable to agree upon the compensation therefor, the board of county commissioners may appropriate it in accordance with sections 163.01 to 163.22, inclusive, of the Revised Code. ◆

* HISTORY: 131 v 1429. Eff 1-1-66.

§ 6119.01 Organization of district; purpose.

Any area situated in any unincorporated part of one or more contiguous counties or in one or more municipal corporations, or both, may be organized as a regional water and sewer district in the manner and subject to the conditions provided in Chapter 6119. of the Revised Code, for either or both of the following purposes:

(A) To ◆ supply water ◆ to users within and without the district;

(B) To provide for the collection, treatment, and disposal of ◆ waste water ◆ within and without the district.

* HISTORY: 134 v S 166. Eff 11-19-71.

Cross-References to Related Sections

Bonds for purchasing, constructing, improving, or extending water or sewerage systems not considered in certain tax limitations, RC § 133.03 (D).

[§ 6119.01.1] § 6119.011 Definitions.

As used in Chapter 6119. of the Revised Code:

(A) "Court of common pleas" or "court" means, unless the context indicates a different meaning or intent, the court of common pleas in which the petition for the organization of a regional water and sewer district is filed.

31. General Code §§ 6828-1 to 6828-79 (RC § 6101.01 et seq) *contain abundant provisions* which grant not only to the parties to the cause but to anyone who may desire to become a complainant or objector, his "day in court" and by reason thereof said act does not violate the "due process" clause of the federal constitution. This includes the three-tenths mill levy of the act: Miami County v. Dayton, 92 OS 215, 110 NE 726 [see to the same effect, Ambrose v. Miami Conservancy Dist., 104 OS 615].

32. Since GC § 6828-1 (RC § 6101.01) et seq provide for notice in GC § 6828-5 (RC § 6101.07), and make ample provision for a hearing in GC § 6828-6 (RC § 6101.08), such statute does not provide for taking property without due process of law: Miami County v. Dayton, 92 OS 215, 110 NE 726 [see to the same effect, Ambrose v. Miami Conservancy Dist., 104 OS 615], Silvey v. Commissioners, 273 Fed 202.

33. An adjudication in a proceeding for appraising real property to defray the cost of an improvement in carrying out an official plan for flood control under the conservancy act of Ohio (GC §§ 6828-1 to 6828-79 [RC § 6101.01 et seq]) is final and incontestable as to all property appraised, and is res judicata as to all owners of property which was appraised in such proceeding: State ex rel Gross v. Miami Conservancy Dist., 141 OS 52, 25 OO 149, 46 NE(2d) 407.

Delegation of legislative power

38. Where a power is quasi-legislative, quasi-administrative or quasi-judicial, or so mixed in its nature that it may be regarded as a combination of all of them, the legislature may in the first instance characterize such power and confer it either upon an existing agency of the government or an agency especially created for that purpose. There is no delegation of legislative power in the conservancy act violative of any constitutional provision: Miami County v. Dayton, 92 OS 215, 110 NE 726 [see to the same effect, Ambrose v. Miami Conservancy Dist., 104 OS 615].

39. This and following sections providing for establishing conservancy districts on petition to the court of common pleas, do not delegate legislative power to the courts; nor do they delegate the power of taxation to the directors of the district in violation of Art. II, § 1 of the Ohio constitution: Miami County v. Dayton, 92 OS 215, 110 NE 726 [see to the same effect, Ambrose v. Miami Conservancy Dist., 104 OS 615].

40. This and following sections providing for establishing conservancy districts on petition to the court of common pleas, do not delegate legislative power to the courts, in violation of Art. IV, § 1 of the Ohio constitution. Miami County v. Dayton, 92 OS 215, 110 NE 726 [see to the same effect, Ambrose v. Miami Conservancy Dist., 104 OS 615], Silvey v. Commissioners, 273 Fed 202.

§ 6101.02 Style of conservancy bonds, books, and records.

(A) The bonds issued under sections 6101.01 to 6101.84, inclusive, of the Revised Code, may be called "conservancy bonds," and shall be so engraved or printed on their face.

(B) The tax books and records provided for in such sections shall be termed "conservancy books" or "conservancy records," and such titles shall be printed, stamped, or written thereon.

HISTORY: Bureau of Code Revision. Eff 10-1-53.

Comment

This section is derived from GC § 6828-1. See also RC § 6101.01.

§ 6101.03 Short forms and abbreviations. (GC § 6828-77)

(A) In any orders of the court the words "The court now here finds that it hath jurisdiction of the parties to and of the subject matter of this proceeding" are equivalent to a finding that each jurisdictional fact necessary to confer plenary jurisdiction upon the court, beginning with the proper signing and filing of the initial petition to the date of the order containing such recital, has been scrutinized by the court and has been found to meet every legal requirement imposed by sections 6101.01 to 6101.84, inclusive, of the Revised Code.

(B) No other evidence of the legal hypothecation of the special tax to the payment of the bonds is required than the passage of a bonding resolution by the board of directors of a conservancy district and the issuance of bonds in accordance therewith.

(C) In the preparation of any assessment or appraisal record the usual abbreviations employed by engineers, surveyors, and abstractors may be used.

(D) Where properly to describe any parcel of land, it would be necessary to use a long description, the board of appraisers of a conservancy district, after locating the land generally, may refer to the book and page of the public record of any instrument in which the land is described, which reference shall suffice to identify for all the purposes of such sections the land described in the public record so referred to.

(E) It is not necessary in any notice required by such sections to be published to specify the names of the owners of the lands or of the persons interested therein; but any such notice may be addressed "To All Persons or Public Corporations Interested" with like effect as though such notice named by name every owner of any lands within the territory specified in the notice and every person interested therein, and every lienor, actual or inchoate.

(F) Every district declared upon hearing to be a conservancy district shall thereupon become a political subdivision and a public corporation of the state, invested with all the powers and privileges conferred upon such districts by such sections.

HISTORY: GC § 6828-77; 104 v 13 (56), § 77; 117 v 163 (216), § 1. Eff 10-1-53.

[ORGANIZATION OF DISTRICT]

§ 6101.04 Organization and purposes of conservancy districts. (GC § 6828-2)

Any area or areas situated in one or more counties may be organized as a conservancy district, in the manner and subject to the conditions provided by sections 6101.01 to 6101.84, inclusive, of the Revised Code, for any of the following purposes:

(A) Preventing floods;

(B) Regulating stream channels by changing, widening, and deepening the same;

(C) Reclaiming or filling wet and overflowed lands;

(D) Providing for irrigation where it may be needed;

(E) Regulating the flow of streams and conserving the waters thereof;

(F) Diverting or in whole or in part eliminating water-courses;

(G) Providing a water supply for domestic, industrial, and public use;

(H) Providing for the collection and disposal of sewage and other liquid wastes produced within the district;

(I) Arresting erosion along the Ohio shore line of Lake Erie.

This section does not terminate the existence of any district organized prior to July 19, 1937, entirely within a single county.

The purposes of a district may be altered by the same procedure as provided for the establishment of such a district.

HISTORY: GC § 6828-2; 104 v 13 (14), § 2; 117 v 163 (164), § 1; 122 v 157, § 1. Eff 10-1-53.

Research Aids

Organization:
Page: Drainage § 49
O-Jur: Conserv. Dist. § 9

CASE NOTES

See also case note 2 under RC § 6101.18.

1. The appointment of directors and appraisers for conservancy districts under GC § 6828-1 (RC § 6101-01) et seq, is not legislative in character, and a grant to the court of common pleas of the power to appoint such directors and appraisers is not a grant of legislative power. Miami County v. Dayton, 92 OS 215, 110 NE 726, Hawthorne v. Troy, 102 OS 689, 130 NE 943, *State ex rel Silvey v. Miami Conservancy Dist.*, 102 OS 690, 130 NE 943.

2. The fact that an order establishing a conservancy district under GC § 6828-1 (RC § 6101.01) et seq is rendered by a court which is composed of more than one common pleas judge, does not prevent such court from being a court of common pleas; nor does it prevent such judgment from being a judgment of the court of common pleas. Miami County v. Dayton, 92 OS 215, 110 NE 726 [see to the same effect, Ambrose v. Miami Conservancy Dist., 104 OS 615].

§ 6101.05 Petition to establish conservancy district. (GC § 6828-3)

Proceedings for the establishment of a conservancy district shall be initiated only by the filing of a petition in the office of the clerk of the court of common pleas of one of the counties containing territory within the proposed district, which petition shall be signed either by five hundred freeholders, or by a majority of the freeholders, or by the owners of more than half of the property, in either acreage or value, within the limits of the territory proposed to be organized into a district. Such a petition may be signed by the governing body of any public corporation lying wholly or partly within the proposed district, in such manner as it prescribes, and when so signed by such governing body such a petition on the part of the said governing body shall fill all the requirements of representation upon such petition of the freeholders of such public corporation, as they appear upon the tax duplicate; and thereafter it is not necessary for individuals within said public corporation to sign such a petition. Such a petition may also be signed by railroads and other corporations owning lands.

Such petition may be filed by any city interested in some degree in the improvement, upon proper action by its governing body.

The petition shall set forth the proposed name of said district, the necessity for the proposed work and that it will be conducive to the public health, safety, convenience, or welfare, and a general description of the purpose of the contemplated improvement, and of the territory to be included in the proposed district. Said description need not be given by metes and bounds or by legal subdivisions, but it is sufficient if a generally accurate description is given of the territory to be organized as a district. Said territory need not be contiguous, provided it is so situated that the public health, safety, convenience, or welfare will be promoted by the organization as a single district of the territory described. Except in the case of a subdistrict organized in pursuance of section 6101.71 of the Revised Code, said territory shall not be included wholly within the limits of a single municipal corporation.

Said petition shall pray for the organization of the district by the name proposed.

Upon the filing of such petition a judge of the court of common pleas of the county wherein the petition was filed shall determine whether it bears the necessary signatures and complies with the requirements of this section as to form and content. No petition with the requisite signatures shall be declared void because of alleged defects, but the judge, or the court in subsequent proceedings, may at any time permit the petition to be amended in form and substance to conform to the facts by correcting any errors in the description of the territory, or in any other particular. Several similar petitions or duplicate copies of the same petition for the organization of the same district may be filed and shall together be regarded as one petition. All such

6101.32 of the Revised Code, any such notice may be addressed "To All Persons or Public Corporations Interested" with like effect as though such notice named by name every owner of any lands within the territory specified in the notice and every person interested therein, and every lienor, actual or inchoate.

• • •

* HISTORY: 130 v Pt. 2, 296. Eff 12-18-64.

See provisions, § 3 of H 19 (130 v Pt. 2, 296) following RC § 6101.43.

§ 6101.04

Research Aids

Organization:
O-Jur2d: Conserv. Dist. § 5

§ 6101.05 Petition to establish conservancy district.

Proceedings for the establishment of a conservancy district shall be initiated only by the filing of a petition in the office of the clerk of the court of common pleas of one of the counties containing territory within the proposed district, which petition shall be signed either by five hundred freeholders, or by a majority of the freeholders, or by the owners of more than half of the property, in either acreage or value, within the limits of the territory proposed to be organized into a district. Such petition may be signed by the governing body of any public corporation or watershed district created under section 6105.02 of the Revised Code lying wholly or partly within the proposed district, in such manner as it prescribes, and when so signed by such governing body such a petition on the part of the said governing body shall fill all the requirements of representation upon such petition of the freeholders of such public corporation or watershed district, as they appear upon the tax duplicate; and thereafter it is not necessary for individuals within said public corporation or watershed district to sign such a petition. Such a petition may also be signed by railroads and other corporations owning lands.

Such petition may be filed by any city interested in some degree in the improvement, upon proper action by its governing body.

The petition shall set forth the proposed name of said district, the necessity for the proposed work and that it will be conducive to the public health, safety, convenience, or welfare, and a general description of the purpose of the contemplated improvement, and of the territory to be included in the proposed district. Said description need not be given by metes and bounds or by legal subdivisions, but it is sufficient if a generally accurate description is given of the territory to be organized as a district. Said territory need not be contiguous, provided it is so situated that the public health, safety, convenience, or welfare will be promoted by the organization as a single district of the territory described. Except in the case of a subdistrict organized in pursuance of section 6101.71 of the Revised Code, said territory shall not be included wholly within the limits of a single municipal corporation.

Said petition shall pray for the organization of the district by the name proposed.

Upon the filing of such petition a judge of the court of common pleas of the county wherein the petition was filed shall determine whether it bears the necessary signatures and complies with the requirements of this section as to form and content. No petition with the requisite signatures shall be declared void because of alleged defects, but the judge, or the court in subsequent proceedings, may at any time permit the petition to be amended in form and substance to conform to the facts by correcting any errors in the description of the territory, or in any other particular. Several similar petitions or duplicate copies of the same petition for the organization of the same district may be filed and shall together be regarded as one petition. All such petitions filed prior to the determination of the sufficiency of said petition shall be considered as though they had been filed with the first petition placed on file.

In determining when a majority of landowners has signed the petition, the names as they appear upon the tax duplicate govern and are prima-facie evidence of such ownership.

* HISTORY: 130 v 1378, § 1. Eff 9-24-63.

See RC § 6105.12 which refers to this section.

Forms

Petition to establish conservancy district, Bates § 165.11.

Research Aids

Organization:
O-Jur2d: Conserv. Dist. § 5

[§ 6101.06.1] § 6101.061 Notice to board, director of natural resources, and director of environmental protection; hearings.

Upon determining that a sufficient petition has been filed, the judge making such determination shall cause written notice thereof to be given to the director of the department of natural resources, the director of environmental protection, and to the board of directors of any conservancy district having jurisdiction over all or part of the territory affected by the proceeding or within the same major watershed area as defined by the department of natural resources and the director of environmental protection. The director of natural resources, the director of environmental protection, and the directors of such conservancy districts may appear at any hearing considering the establishment, dissolution or merger of any conservancy district or subdistrict thereof, and be heard concerning the need for a conservancy district, the area that should be included, desirable improvements, and any other matters which in their opinion should be brought to the attention of the court.

HISTORY: 128 v 967 (Eff 10-12-59); 134 v S 397. Eff 10-23-72.

§ 6101.07 Organization of court; powers and jurisdiction.

Upon the determination of a judge of the court of common pleas that a sufficient petition has been filed in such court in accordance with section 6101.05 of the Revised Code, he shall give notice thereof to the court of common pleas of each county included in whole or in part within the proposed conservancy district. The judge of the court of common pleas of each such county, or in the case of any county having more than one such judge, one judge assigned by order of the judges of the court of common pleas thereof, shall sit as the court of common pleas of the county wherein the petition was filed to exercise the jurisdiction conferred by sections 6101.01 to 6101.84, inclusive, of the Revised Code. In case of the inability to serve of the judge of any county having only one judge, the chief justice of the supreme court, upon application of any interested person and proper showing of need, may assign a judge from another county to serve as a judge for such county during the disability of its local judge. The court of any county, presided over by the judges provided for in this section, may establish conservancy districts when the conditions stated in section 6101.05 of the Revised Code are found to exist. Except as otherwise provided by sections 6101.08 to 6101.84, inclusive, of the Revised Code, such court has, for all purposes of sections 6101.01 to 6101.84, inclusive, of the Revised Code, original and exclusive jurisdiction coextensive with the boundaries and limits of the district or proposed district and of the lands and other property included in, or proposed to be included in, such district or affected by such district, without regard to the usual limits of its jurisdiction. The judges of the court shall meet in the first instance upon the call of the judge determining the sufficiency of the petition and shall elect one of their number as presiding judge. Each judge when sitting as a member of the court shall receive such compensation and allowance for expenses as provided by law for a judge of the court of common pleas serving by assignment outside the county wherein he resides, which shall be paid as other expenses of the organization or operation of the district are paid.

The court shall adopt rules of practice and procedure not inconsistent with sections 6101.01 to 6101.84, inclusive, of the Revised Code, and the general laws of this state. If the court consists of more than three judges, it may designate three of its members from three different counties to preside over the court, hear matters coming before the court, and make determinations and decisions or findings and recommendations, as the rules of the court provide, with respect to any matters authorized by such rules, the disposition of which is vested in the court, except that it shall not make final decisions and orders as to:

(A) The establishment, dissolution, or merger of the district or of subdistricts thereof;

(B) The adoption, rejection, or amendment of the official plan;

(C) The appointment and removal of directors and appraisers;

(D) The confirmation of the appraisers' report of benefits, damages, and appraisals of property;

(E) The authorization of maintenance assessments in excess of one per cent of benefits;

(F) The authorization of a readjustment of the appraisal of benefits in accordance with section 6101.54 of the Revised Code;

(G) The approval of the method of financing improvements and activities under section 6101.25 of the Revised Code;

(H) The determination of rates of compensation for water under sections 6101.24 and 6101.63 of the Revised Code;

(I) The examination of the annual report of the board of directors of the conservancy district as provided under section 6101.66 of the Revised Code.

The concurrence of two of the three judges so designated shall be necessary for any action or determination thereby and it has, if so provided by the rules of the court, the same effect as though taken or made by the full court. All actions and determinations by the full court require the affirmative vote of a majority of the judges constituting the court. In all cases in which the judges are evenly divided that side with which the presiding judge votes shall prevail. In the event the court consists of two judges and they find themselves unable to agree on any question left to their decision, a judge of the court of common pleas of some other county shall be designated by the chief justice of the supreme court to sit and vote as a third member of the court until such question is decided.

When the court by its order entered of record decrees that a subdistrict be organized, the judge

APPENDIX G

PRIVATE COMMUNICATIONS

Beemer, Harold, Chief of Engineering Division, United States Department of the Army - Huntington District, Corps of Engineers, Huntington, West Virginia, 11 August 1975.

Brungs, William, EPA National Water Quality Laboratory, Duluth, Minnesota, 14 August 1975.

Calgon Corporation, July 1975.

DeGrave, Mick, Wyoming Bioassay Laboratory, Grandville, Michigan, 14 August 1975.

Desmond, Richard, Attorney, Squires, Sanders & Dempsey, Cleveland, Ohio, July 1975.

Dodge, Melvin, Director, Department of Recreation and Parks, Columbus, 31 July 1975.

Elliot, Thomas, Director, Delaware County Regional Planning Commission, 30 July 1975.

Gilbert, Gary, Delaware County Assistant Sanitary Engineer, 4 September 1975.

Grissom, Catherine, Environmental Impact Statement Unit, United States Environmental Protection Agency, Region V, 4 September 1975.

Griswold, Bernard, U.S. Fish and Wildlife Service, 1975.

Habig, William, Director, Mid-Ohio Regional Planning Commission, 31 July 1975.

Hinde Engineering Corporation, July 1975.

Kacmar, Steve, Malcolm Pirnie, Inc., 4 September 1975.

Lashutka, Greg, Staff Assistant for Ohio Affairs, Office of Representative Samuel Devine, August 1975.

Levins, Ed, Washington Suburban Sanitary Commission, July 1975.

MacMullen, Michael, Environmental Impact Statement Unit, United States Environmental Protection Agency, Region V, 4 September 1975.

Mantor, Ray, Superintendent, Delaware City Sewage Treatment Plant, August 1975.

Mapes, Greg, Ohio Environmental Protection Agency, 3 September 1975.

May, Lloyd, Delaware County Health Commissioner, Delaware County Health Department, July 1975.

Miller, Dean, Delaware County Commissioner, 4 September 1975.

Nottingham, Jim, Ohio Environmental Protection Agency, 4 September 1975.

Parkinson, Robert, Director, Department of Public Service, Columbus, 4 September 1975.

PCI Ozone Company, August 1975.

Reid, Kenneth, Delaware County Commissioner, 4 September 1975.

Richards, Earl, Assistant Director, Ohio Environmental Protection Agency, 3 September 1975.

Robbins, Payton, City of Columbus, 4 September 1975.

Savely, David, Franklin County Commissioner, July 1975.

Seiler, Albert, Burgess & Niple, Ltd., 4 September 1975.

Shepard, Paul, Burgess & Niple, Ltd., 4 September 1975.

Smith, Greg, Ohio Environmental Protection Agency, 3 September 1975.

Smith, Robert, Advanced Waste Treatment Research Laboratory, 25 July 1975.

Sprague, Rex, City Engineer, City of Delaware, August 1975.

Stein, Carol, Ohio State University Museum of Zoology, July 1975.

Stults, Fred, Delaware County Engineer, 4 September 1975.

Thomas, James, Director of Research, Columbus Area Chamber of Commerce, 29 July 1975.

Virden, Bill, Contracts Division, Ohio Environmental Protection Agency, 3 September 1975.

Walkenshaw, George, Engineer, Columbus Southerly Plant, 30 July 1975.

Whitney, James, Delaware County Commissioner, 4 September 1975.

Wilhelm, Carl A., Planning Coordinator, Ohio Environmental Protection Agency, 3 September 1975.

Williams, Ned, Director, Ohio Environmental Protection Agency, 3 September 1975.

Willis, Roger, Design Engineer, Department of Public Service, Division of Sewerage and Drainage, Columbus, 30 July 1975.

Wojcik, Eugene, Environmental Impact Statement Unit, United States Environmental Protection Agency, Region V, 4 September 1975.

Wolfe, Robert, Burgess & Niple, Ltd., 4 September 1975.

Wright, Gene, Ohio Environmental Protection Agency, 3 September 1975.

APPENDIX H

LIMITATIONS OF ECONOMIC BASE METHODOLOGY

Hans Blumenfeld attacks the economic base methodology in his article "The Economic Base of the Metropolis" (page 13). This methodology divides all employment in a community into basic or primary employment and nonbasic or secondary employment. The former describes export-related employment; the latter, employment related to local consumption. Basic activities are identified through the method of proportional apportionment.

In analyzing the economic base methodology, Blumenfeld points out that the use of proportional apportionment to identify basic activities is misleading. This methodology includes only export-related employment as a basic activity. It neglects import-related employment, which is equally important. Blumenfeld also maintains that employment is not a usable unit of measurement for a balance of payment approach. Rather, a value of product measure is more applicable.

Blumenfeld concludes that the basic-nonbasic ratio is only meaningful in small and simply structured communities. The ratio is less applicable and the methodology less useful in analyzing the economy of a larger, more complex community.

To Blumenfeld's objections, it should be observed that the economic base method is based on activities now present on the scene, with no provision for the introduction of new activities. This is a serious objection, because the economic development of this country is full of examples of the change or revival of local economies through the introduction of new industries.

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(Please read Instructions on the reverse before completing)

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9. PERFORMING ORGANIZATION NAME AND ADDRESS Enviro Control, Inc. Environmental Studies Group 1530 East Jefferson Street Rockville, Md. 20852		10. PROGRAM ELEMENT NO. 11. CONTRACT/GRANT NO. 68-01-2853
12. SPONSORING AGENCY NAME AND ADDRESS U.S. Environmental Protection Agency Region V 230 South Dearborn Chicago, IL. 60604		13. TYPE OF REPORT AND PERIOD COVERED final report 14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

16. ABSTRACT

The report was prepared to provide information to the U.S. Environmental Protection Agency for their preparation of an Environmental Impact Statement on the Olentangy Environmental Control Center and Interceptor System, Delaware County, Ohio. Population and economic projections for the area and larger region are reviewed. An extensive study of local and regional sewage treatment service is presented. Site evaluations consider engineering, land use, biological, environmental, and institutional factors. The environmental impacts of a sewage treatment facility at the chosen site are evaluated in terms of water quality, biology, land use, and aesthetics. Mitigative measures for reducing adverse effects are discussed.

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a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
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